GOVERNMENT OF KERALA

PERSPECTIVE PLAN 2030 - KERALA

Volume III

Entrepreneurialism and Environmental Sustainability

Kerala State Planning Board
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Foreword

Sri. Oommen Chandy
Chief Minister of Kerala

Kerala Perspective Plan 2030 is a perception of the future, which reveals and points to something new, beyond what is already available and accessible. The goal of the Perspective Plan is to improve the quality of life of the people of Kerala to the level of Nordic countries (Sweden, Denmark, Norway and Finland), by 2030. These countries have achieved high material, human, social and ecological development and a highly regarded balance of all aspects of development. In order to get there, we need a framework that defines clearly where we are today, what challenges we face, where we want to be by 2030 and how to get there. Perspective Plan for a State/region means creating a set of alternative long term development strategies and integrated implementation approaches, for reaching the goal of future development.

Our future is about the people. This plan has been prepared after considerable consultations with various expert groups and citizens. The expected change would be to transform Kerala into a healthy and knowledge based economy, in which people enjoy high standards of living, a good quality of life and have access to quality education, health and other vital services.

The Vision of Perspective Plan 2030 is the creation of a diversified, knowledge economy with a resource-based industrial sector, competitiveness and productivity in agriculture, placing great emphasis on skills development. In addition, the Plan will promote competitiveness in all sectors, in terms of product quality and differentiation.

As required by this perspective, the State will operate a totally integrated, amalgamated, flexible and high quality education and training system, which prepares Kerala's learners to take advantage of a rapidly changing global environment, including developments in science and technology. This, in turn, would contribute to the economic and social development of the people of Kerala. Arising from the overall capacity building investments, Kerala will be transformed into a knowledge-based society, and changes in production and information technology will revolutionalize all aspects of the manufacturing process.

Perspective Plan 2030 is expected to reduce disparities and move the State significantly up the scale of human development, to be ranked on par with the developed countries in the world. There will thus be a pervasive atmosphere of tolerance in matters relating to culture, religious practices, political preference and differences in social background. The plan will facilitate equity in access to social services and facilities, as well as access to productive resources such as land, labour and capital. Kerala will be a just, moral, tolerant and safe society

with legislative, economic and social structures in place to eliminate marginalisation and ensure equity between women and men, the diverse and ethnic groups, and people of different ages, interests and abilities and harmony and peace in society.

The major challenge of this Perspective Plan is for all of us (Government, private sector, civil society, as well as individuals) to make a determined effort to concentrate on resolving, not just addressing, very important State level problems. This document: Perspective Plan 2030, presents a clear view of the major problems faced by the State and how these problems can be effectively resolved by deploying-to the fullest extent-our human and natural resources.

Kerala's future will also depend largely on the people themselves; much will depend on our ability and willingness to respond with innovation and commitment to new challenges. The immediate challenge we face as a State, now that we have a Perspective Plan document that defines our state's future development possibilities, is to ensure that the Perspective Plan is translated into reality. As a step in that direction, implementation strategies will be developed and human and financial resources will be mobilized. The programmes of Perspective Plan 2030 have specific targets and periodically, through the State Development Plans, we will evaluate the programme's performance. The success of the Perspective Plan depends on commitment not only of successive governments at the State level and local body level but also on the support we receive from the Union Government in achieving the goals. By the year 2030, with all of us working together, we should be the most developed state in India enjoying prosperity, interpersonal harmony and peace.

(Oommen Chandy)

Preface

Sri. K.M. Chandrasekhar
Vice Chairman, State Planning Board

Perspective Plan is a plan for a fairly long period, say 15 or 20 years, less detailed and less concrete than plans actually implemented scheme wise. The purpose of a perspective plan is to set a 'perspective' for the short term plans. The short term plans, so worked out, would be such as to lead to certain long term results. Thus it is neither a fully worked out plan nor just a theoretical exercise, but a framework within which concrete short term plans can be fitted.

Kerala Perspective Plan 2030 presents a clear view of where we are, where we want to go from here, and over what time frame. It is a vision that will take Kerala from the present into the future; a vision that will guide us to make deliberate efforts to improve the quality of life of our people. Creation of a knowledge-based economy is central to this Perspective Plan. It is designed as a broad, unifying vision which would serve to guide the State's five-year development plans and, at the same time, provide direction to government departments, the private sector, NGOs, civil societal and local Government authorities. Therefore, Kerala Perspective Plan 2030 will create policy synergies, which will effectively link long-term perspectives to short-term planning. The plan will be implemented through the next four Five Year Plans.

Unless and until there is commensurate increase in productive capacity, maintaining growth rates above 8 per cent may prove to be difficult to sustain in the long run. There is relatively high personal and regional inequality in Kerala. The State faces several problems: an aging population, rapidly increasing urbanisation and increasing pressures on natural resources, especially land and water. In a highly competitive business scenario, there is need to improve the quality of growth in terms of productive capacity, structural transformation and the quality of human development. Strategic planning is an essential first step to place a region on an upward trajectory.

One of the major principles upon which our Perspective Plan 2030 is based is 'partnership'. Partnership is recognised as a major prerequisite for the achievement of dynamic, efficient and sustainable development in the State. This involves partnership between government, communities and civil society; partnership between different branches of government, with the private sector (the business community), banks and financial institutions, nongovernmental organisations, community-based organisations and the international community; partnership between urban and rural societies and, ultimately, between all members of Kerala society. While the principle of sustainable development is the cornerstone on which the strategies for realizing the objectives of perspective Plan 2030, the driving force among the complex agents of our development comprises the sectors Tourism, Information Technology,

Education, Science and Technology, Health, Sustainable Agriculture, Energy, Social Justice, Gender Equality.

In support of the objectives of Perspective Plan 2030, capacity building will be pursued with the utmost vigour by both the private and public sectors to facilitate the implementation of the Plan. The capacity building process (including institution restructuring and building, and human resource development) will continue to be promoted by the existence of a suitable, economic resources and opportunities, and social norms which are conducive to sustained development. In order to realise the objectives of capacity building in Perspective Plan 2030, human resource information management systems will be strengthened; the ultimate objective is to balance supply and demand in the labour market and in this way achieve full employment in the economy. With determined effort to address macro economic imbalances, and to achieve effective implementation of the strategies and action plans suggested in this four volume document, there are strong possibilities of bringing our State on par with the status of developed countries by the year 2030.

Acknowledgements are necessary in full measure of those who helped us in the task of preparation of Perspective Plan 2030 in the State to suggest suitable framework for both long term and short term plans. We are thankful to the National Council of Applied Economic Research (NCAER), New Delhi and its officials, particularly, Dr. Shekhar Shah, (Director General), Dr. Aradhna Aggarwal (Coordinator of the team) and Dr. Bornali Bhandari (Fellow) for carrying out this task in consultation with various stakeholders and submitting the report in time. We are most grateful to the Chief Minister, Ministers and MLAs for their valuable guidance. We are obliged to the Government Secretaries, Heads of Departments, officials of line departments and experts involved in preparation of this document. Our sincere thanks to the general public and students who have offered valuable suggestions and comments on the draft report.

I would like to place on record the valuable inputs and contributions provided in shaping the document by the Members and Member Secretary of State Planning Board, Dr. D. Narayana, (Consultant, State Planning Board), Division Chiefs of State Planning Board and officials of Perspective Planning Division who have coordinated this initiative.

I am sure that Kerala Perspective Plan 2030 would serve as a blue print for the development of Kerala through shorter term Annual and Five Year Plans. We look forward to support and assistance from the Government of India to convert this Perspective Plan into reality.

(K.M. Chandrasekhar)

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Acronyms

ALS	Airborne Laser Scanning
ANERT	Agency for Non-conventional Energy and Rural Technology
APDRP	Accelerated Power Development and Reforms Programme
APFAMGS	Andhra Pradesh Farmers Ground Water Management System
AT&C	Aggregate Technical &Commercial
BAU	Business-as-Usual
BBMP	Bruhat Bangalore Mahanagara Palike
Bcm	Billion Cubic Meters
BEE	Bureau of Energy Efficiency
BG	Biomass Gasifier
B-I	Bhopal-India
BLY	Bachat Lamp Yojana
BMP	Bangalore Mahanagara Palike
BMW	Biomedical Waste
BOT	Build-Operate-Transfer
BP	Biomass Power
BRO	Border Roads Organisation
C&I	Criteria and Indicators
CADA	Command Area Development Authority
CAGR	Compounded Annual Growth Rate
CDM	Clean development mechanism
CEA	Central Electricity Authority
CEPI	Comprehensive Environmental Pollution Index
CER	Certified Emission Reductions
CESS	Centre for Earth Science Studies
CETP	Common Effluent Treatment Plants
CFL	Compact Fluorescent Lamp
CHRP	Coastal Housing and Resettlement Programme
CMC	City Municipal Councils
CP	Cleaner Product
CPCB	Central Pollution Control Board
CPSU	Central public sector undertakings
CT	Census Towns
CT	Clean Technology

CWRDM	Centre for Water Resources Development and Management
DOS	Department of Space
DSC	Decision Support Centre
ECBC	Energy Conservation Building Code
EFL	Ecologically Fragile Land
EGSS	Environmental Goods and Services Sector
EHT	Extra High Tension
EMC	Energy Management Centre
EST	Environmentally Sound Technologies
ETG	Expert Transport Group
ETP	Effluent Treatment Plants
EWP	Engineered Wood Product
EWS	Economically Weaker Sections
FB	Forest Biorefinery
FDA	Forest Development Agencies
FSI	Forest Survey of India
GCA	Gross Cropped Area
GHG	Greenhouse Gas
GIA	Gross Irrigated Area
GIS	Geographical Information Systems
GSDP	Gross State Domestic Product
GWD	Groundwater development
HLWG	High Level Working Group
HT	High Tension
HW	Hazardous Waste
ICT	Information and Communication Technology
ICTT	International Container Transhipment Terminal
IEC	Information, Education and Communication
IGEA	Investment Grade Energy Audit
IIM	Indian Institute of Management
IPD	Intensive Paddy Development
IPP	Independent Power Producers
IWRM	Integrated Water Resource & Management
IWT	Inland Water Transport
JFM	Joint Forest Management
JRY	Jawahar Rozgar Yojana
KFDC	Kerala Forest Development Corporation
KFRI	Kerala Forest Research Institute
KSCSTE	Kerala State Council for Science, Technology and Environment
KSEB	Kerala State Electricity Board

KSERC	Kerala State Electricity Regulatory Commission
KSHB	Kerala State Housing Board
KSIDC	Kerala State Industrial Development Corporation
KSPIFC	Kerala State Power and Infrastructure Finance Corporation
KSRTC	Kerala State Road Transport Corporation
KURDFC	Kerala Urban and Rural Development Finance
KWh	Kilowatt Hour
LEED	Leadership in Energy and Environment Design
LIG	Low Income Groups
Lps	Litres Per Second
LSGI	Local Self-Government Institutions
LT	Low Tension
Mbgl	Metre below Ground Level
MDF	Medium Density Fibre Board
MDR	Major District Roads
MNRE	Ministry of New and Renewable Energy
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoU	Memorandum of Understanding
MSW	Municipal Solid Waste
MTA	Metric Tons per Annum
MU	Million Units
MVD	Motor Vehicles Department
MW	Megawatts
NATPAC	National Transportation Planning and Research Centre
NCA	Net Cropped Area
NCDMA	National Clean Development Mechanism Authority
NFP	National Forest Policy
NH	National Highways
NHAI	National Highways Authority of India
NIA	Net Irrigated Area
NOC	No Objection Certificate
NRSC	National Remote Sensing Centre
NRY	Nehru Rozgar Yojana
NTFP	Non-timber Forest Produce
NW3	National Waterways No. 3
NWFP	Non-wood Forest Products
O&M	Operations and Maintenance
OVS	Ooru Vikasana Samithi
PA	Protected Area
PFDF	Pooled Finance Development Fund

PMGSY	Pradhan Mantri Gram Sadak Yojana
POL	Petroleum, Oil and Lubricants
PPPs	Public-Private Partnerships
PT	Property Tax
PUB	Public Utilities Board
PWD	Public Works Department
PZ	Piezometer
RAY	Rajiv Awas Yojana
RBDCK	Roads and Bridges Development Corporation
RES	Renewable Energy Sources
RET	Rare, Endangered and Threatened
RF	Radio Frequency
RO	Reverse Osmosis
RWA	Residents Welfare Organisation
SEWA	Self-Employed Women's Association
SFM	Sustainable Forest Management
SHP	Small Hydro Project
SH	State Highways
SLD	Safe Land Disposal
SPP	Solar Photovoltaic Programme
SPV	Solar Photovoltaic Pumps
STP	Solar Thermal Programme
SURK	State Urbanisation Report Kerala
SWD	Surface water development,
SWM	Solid Waste Management
T&D	Transmission and Distribution
TARWR	Total Actual Renewable Water Resources
JNTBGRI	Jawaharlal Nehru Tropical Botanic Garden and Research Institute
TLS	Terrestrial Laser Scanning
TMC	Town Municipal Council
TOD	Transit-Oriented Development
ToT	Training Of Trainers
TRA	Transport Regulatory Authority
TSDF	Treatment, Storage and Disposal Facilities
U&I	Urban & Industrial Waste Power
UA	Urban Agglomeration
ULB	Urban Local Bodies
UnB	University of Brasília
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organisation
URGD	Urban-Rural Growth Differential
VFCs	Village Forest Councils
VLS	Vehicle-Based Laser Scanning
VSS	Vana Samrakshana Samithis
WAR	Watershed Appraisal Reports
WBM	Water-Bound Macadam
WDMS	Water Distribution Management System
WEEE	Waste Electrical and Electronic Equipment
WTE	Waste-to-Energy

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General Introduction*

TOWARDS A GLOBALLY COMPETITIVE KERALA

An Innovator Lagging Behind?

Historically, Kerala was an innovator. It chartered a path somewhat different from that followed by other Indian states and many countries. Kerala's approach put human development at its centre — it emphasised education and health; upheld gender parity; and channelled public funds to schools, hospitals and infrastructure. Individual resources too were directed into areas such as private expenditure on health and education as well as to build health and educational institutions. The results of these policies and investments are there for everyone to see. Global recognition came, with Kerala celebrated as one of the few cases of 'good health at low cost' and, more generally, 'high human development at low per capita income'. The State stood alongside Cuba, Costa Rica and Sri Lanka on these parameters.

The high human development, however, had two dark spots: the 'outliers' who missed the larger gains in human development and the regional inequalities, which were not entirely independent of the 'outliers'. It also could not take growth to a new level. Hence, a new development model more responsive to local needs, which also responded to the voices of the poor and marginalised on the one hand and faced the challenges of growth on the other, had to be invented. An opportunity came Kerala's way in 1992 with the 73rd and 74th amendments to the Constitution of India and the consequent instituting of the third tier of government. Kerala took the lead in devolving the three Fs — funds, functions and functionaries — to the local governments. No other Indian state has thought it necessary to devolve over one-third of plan funds to local bodies and give them the freedom to experiment with local planning.

The enactment of the 73rd and 74th constitutional amendments ushered in a new era of decentralised democratic governance in Kerala. By giving a legal status to the rural (panchayats) and urban (municipalities) local bodies it intended to enable them to function as effective democratic self-government institutions. This ensured people's participation in local level planning and enabled them to be part of the development process. The effective functioning of local governments was, however, subject to the devolution of larger funds to them. Kerala has done this since 1996, the results of which are being taken note of.

Kerala has also made creditable progress in the reduction of poverty and the provision of public services through decentralisation. The Multi–Dimensional Poverty Index (MPI) constructed in terms of lack of access to education, health and other basic services has shown a remarkable reduction in the recent past in the State. For instance, the Adjusted Headcount Ratio for Kerala, which shows the percentage deprivation in terms of the MPI indicators, was 0.136 in 1999, the third lowest in India, and fell to the lowest at 0.038 by 2006 (Alkire and Seth, 2013[1]). The Multi–Dimensional Headcount Ratio too has performed very well. This is especially noteworthy for a state like Kerala, where deprivation levels were comparatively low by the 1990s, as it is generally difficult to bring it down further. The Population Census 2011 confirms the findings of Alkire and Seth as Kerala is reported to have the largest proportion of households with latrines and *pucca* houses. Access to basic services, the levels of which took over 40 years to reach, could be reached in less than half the time. These achievements are largely attributable to the experience of the past two decades of decentralisation ensuring local planning and people's participation.

* ***General Introduction is common to all volumes***

Kerala has continued with its human development achievements. Its local governments have strived to provide access to basic services to all and the State has reached income levels above the national average. While the quality of infrastructure and the quality of nutrition supplements in anganwadis and schools have shown an improvement, it is doubtful whether the quality of education has got much better. The infrastructure in primary healthcare centres and hospitals has improved, but a worrying public health situation persists. Kerala's growth rate has continued to move above the national average, but it is nowhere near the top; there are many states doing just as well if not better. Agriculture, where local governments have made many interventions, has slipped into negative growth in recent years. Even sectors where Kerala had the lead seem to have lost out: One of the first techno-parks was established in Kerala, but neither the State's exports nor its companies are visible at the very top. Companies based in some other states in India have gained a global reputation through high value addition, with marketing and effective branding. Unfortunately Kerala-based companies have yet to be recognised as major players in any field.

Kerala is part of a globalised world in which rapid change is a constant. In such a setting, the State's growth hinges on ensuring that it is competitive, accessible, liveable and safe. In order to achieve this, Kerala needs to foster an economic environment that helps businesses succeed, simultaneously holding on to the gains in human development and decentralised democratic governance. As the experiences of some of the world's leading nations show, a free, open and innovation-embracing economy can lay the foundation for thriving businesses, markets and investors, which, in turn, will create an impetus for development.

The US is still on top because it embraces innovation, helping promising businesses flourish irrespective of their size. Similarly, Germany is an industrial powerhouse because of its higher education and training sectors and infrastructure; its training and career track programmes are the envy of the world. Likewise, Finland's competitiveness stems from its top ranking position on parameters such as innovation, higher education and training institutions, health and primary education. Singapore is among the best in the world as it ranks high on infrastructure, financial market development, health, primary education and institutions. All these countries are great places for doing business, and that spurs growth.

The imperative for Kerala, therefore, is to create an international business climate, clearly prioritise investments and link spatial development and infrastructure. The State needs to work towards this goal alongside the central government and local governments, spelling out clearly defined responsibilities, simple rules and selective government involvement and by creating freedom of choice for individuals and companies. This new approach will require an overhaul of the State's policies and programmes. Kerala Perspective Plan 2030 (KPP 2030) seeks to set out the contours of such an approach.

Need for a Policy Change

A thriving private sector with new firms entering the market contributes to a growing economy. Governments play an important role by setting clear rules that create and support a dynamic ecosystem for firms. Without good rules, entrepreneurs have a hard time starting and building small and medium-size firms that are the engines of growth.

The World Bank's 'Ease of Doing Business' reports provide a snapshot of business environments across the world, including the bureaucratic and legal hurdles that entrepreneurs need to overcome to start a business. So where does India (and Kerala within the country) stand on creating an enabling environment for firms to start business?

The 11th edition of the report, released in 2014, ranks India at 134 of 189 countries in ease of doing business. In areas such as starting a business, dealing with construction permits, getting electricity, paying taxes, trading across borders, enforcing contracts and receiving insolvency, India is ranked

between 111 and 179. On the ease of registering property, India is somewhere near the halfway mark. It is only on parameters such as getting bank credit and protecting investors (both more of a central government domain) that India is ranked high, at 28 and 34 respectively.

While all the states and cities in India have similar legal and institutional frameworks, local regulations and the implementation of national laws vary. And these variations are not small. The report found that, "… it is easiest to start and operate businesses in Ludhiana, Hyderabad and Bhubaneswar. Starting a business is fastest in Mumbai and Noida, at 30 days, while it takes 41 days in Kochi." The report found that among the 17 Indian cities considered, Kochi ranks 16th overall. Kochi's does poorly on starting a business (16), dealing with construction permits (15), paying taxes (14) and receiving insolvency (10). Therefore, it seems the economic environment for doing business is not very conducive in Kerala.[2]

Over the past few years, The Institute for Competitiveness, India has regularly published 'State Competitiveness reports', a 'Manufacturing Competitiveness Index' and a 'City Liveability Index'. The Manufacturing Competitiveness Index is constructed based on four inter-related factors — company operations and strategy, state business environment, social infrastructure and political institutions and macroeconomic indicators. In the index for 2014 Kerala is ranked 'medium' along with Chhattisgarh, Madhya Pradesh, Uttar Pradesh and others, way below the 'medium and strong' category (Uttarakhand, Karnataka and Andhra Pradesh) and 'strong' category (Punjab, Haryana, Tamil Nadu, Gujarat and Maharashtra). Kerala's score at 58.30 is only about six or seven points above the lowest scoring Meghalaya (51.47) and Bihar (52.35), while Maharashtra scores highest at 67.07.[3]

Similarly, the Liveability Index 2013 computed for 50 Indian cities puts Thiruvananthapuram at 19, Kozhikode at 21 and Kochi at 24. The cities are ranked on the basis of demographics, education, health and medical standards, safety, housing conditions, socio-cultural and political environment and economic environment, and 20 constituent sub-pillars. Surprisingly, all three cities of Kerala are not only ranked low, but have also slipped in their rankings from 2010: Thiruvananthapuram from 16, Kochi from 12 and Kozhikode from 15. This suggests that over the past three years, other cities have been improving their liveability standards relative to these three cities in Kerala.[4]

The 'India Public Policy Report 2014' goes beyond the ease of doing business and competitiveness and liveability indices and assesses public policy effectiveness in the broad area of well being. The policy effectiveness index presented in the report is a composite of four component indices — livelihood opportunity index, social opportunity index, rule of law index and physical infrastructure development index. The component indices reflect livelihood opportunities, socially meaningful life, security of life and rule of law and amenities for a sustained improvement in living standards. The indices have been estimated for four points of time, 1981, 1991, 2001 and 2011. The analysis at the state level shows that Kerala's rank, which was 18 in 1981, after showing a slight improvement by 1991 (rank 16) has dropped to 20 in 2001 and 21 in 2011. Kerala seems to be doing well on gender equality, reducing infant mortality rate and raising school education. But in terms of crime, inequality in consumption, proportion of underweight children and access to electricity, water and sanitation, the State's performance is poor.

Similarly, Kerala does rather poorly on factors such as the time taken to obtain construction permits, get electricity connections, pay taxes and other similar services required to run a competitive businesses; the delays involved are among the longest in India. The State's manufacturing competitiveness is poor because of a weak business environment, unhelpful social infrastructure and political institutions; it does not appear to provide sufficient livelihood and social opportunities. Overall, it seems that Kerala does not provide a conducive environment for starting a business. This possibly explains why few businesses are started, and grow, in Kerala.

What Trajectory to Take?

Encouraging, sustaining and enhancing growth will require decisive action by the State's leaders in order to boost its competitiveness and improve its future economic outlook. Reforms and the right set of investments to enhance competitiveness are crucial for the economic transformations that can lead to sustained higher growth and development over the long term. It is, therefore, imperative that competitiveness — the set of institutions, policies and factors that determine a country's level of productivity — features high on the economic reform agenda.

A competitive economic environment is built on eight pillars, of which the first is the institutional environment determined by the legal and administrative framework within which individuals, firms and governments interact to generate wealth. The quality of institutions has a strong bearing on competitiveness and growth. The role of institutions goes beyond the legal framework. Government attitudes toward markets and freedoms and the efficiency of its operations are also very important. Excessive bureaucracy and red tape, overregulation, corruption, lack of transparency and trustworthiness and the inability to provide appropriate services can considerably slow the process of economic development.

An equally important factor in the institutional environment that determines investor interest is the credibility of the government. A government that promises, but fails to deliver will not attract as much interest as a government that offers an answer after careful examination of a proposal and sticks to its decision with firmness, regardless of opposition from pressure groups. A recurring and persisting gap between promises and delivery will quickly lead to the loss of all credibility of the government among entrepreneurs, adversely affecting the business environment.

The second pillar is infrastructure. It is critical for ensuring the effective functioning of the economy as it is an important factor in determining the location of economic activity and the kinds of activities or sectors that can develop within a region. Well-developed infrastructure reduces the effect of distances, lowers costs and reduces inequalities in a variety of ways. Effective modes of transport — quality roads, railway, ports and air transport — enable entrepreneurs to get their goods and services to market in a secure and timely manner and facilitates the movement of workers to the most suitable jobs. The quality of electricity and telecommunications too play an important role.

The third pillar of a competitive economic environment is health and primary education. A healthy workforce is vital to a region's competitiveness and productivity, not to mention the State's well being. Workers who are ill cannot function to their potential and will be less productive. Poor health leads to significant costs for businesses, as sick workers are often absent or operate at lower levels of efficiency. Catastrophic health expenditure could also greatly reduce savings and investment. This pillar takes into account the quantity and quality of the basic education received by the population, as basic education increases the efficiency of each individual worker. Often, workers who have received little formal education can carry out only simple manual tasks and find it much more difficult to adapt to more advanced production processes and techniques, thereby constraining productivity growth.

The fourth pillar is quality higher education and training, which is crucial for economies that want to move up the value chain, beyond simple production processes and products. Today's globalising economy requires countries to nurture pools of well educated workers, who are able to perform complex tasks and adapt rapidly to their changing environment and the evolving needs of the production system. Higher education is also crucial for sustaining a knowledge economy by providing a continuous supply of personnel for centres of higher learning.

The fifth pillar is labour market efficiency. The efficiency and flexibility of the labour market is critical to ensure that workers are allocated to their most effective use in the economy and provided with

incentives to give their best effort in their jobs. Labour markets must, therefore, have the flexibility to shift workers from one economic activity to another rapidly and at low cost, and to allow for wage fluctuations without much social disruption. Efficient labour markets must also ensure clear, strong incentives for employees along with efforts to promote meritocracy in the workplace, and must create gender equity in the business environment.

Development of the financial sector is the sixth pillar of a competitive economic environment as it allocates the resources saved by citizens, as well as those entering the economy from abroad, to their most productive uses. It channels resources to entrepreneurial or investment projects with the highest expected rates of return rather than to the politically connected. A thorough and proper assessment of risk is, therefore, a key ingredient of a sound financial market. Therefore, economies require sophisticated financial markets that can make capital available for private sector investment from such sources.

The seventh pillar is technological readiness, which is the agility with which an economy adopts existing technology to enhance the productivity of its industries. It also includes a specific emphasis on its capacity to fully leverage information and communication technology (ICT) in daily activities and production processes to increase efficiency and enable innovation for competitiveness. ICT has evolved into the 'general purpose technology' of the era, given its critical spillovers to other economic sectors and its role as industry-wide enabling infrastructure. Therefore, ICT access and usage are key enablers of a region's overall technological readiness.

The eighth pillar, innovation, can emerge from new technological and non-technological knowledge. Non-technological innovation is closely related to the know-how, skills and working conditions that are embedded in organisations. In the long run, sustained gains in productivity depend on innovation, which is a strong source of market power that entrepreneurs compete with existing firms to build. The introduction of innovation is responsible for both the progress and instabilities of the capitalist economic system. Entrepreneurs positioned at the top of the knowledge economy excel at ideating and taking these ideas to the market. Ideation requires powerful higher education initiatives provided by dynamic centres of learning and university-industry linkages. The creative arts and broader humanities too can drive, produce, apply and diffuse innovation in different, but equally useful ways compared to the science and technology sector. Therefore, a broad platform that embraces both science and technology and the arts and humanities needs to be built: That is the fount of knowledge creation. Innovation is also not just about coming up with new products — it is also about doing things differently. For this to happen, the entire innovation ecosystem, which consists of a set of closely intertwined and reinforcing factors, is critical.

Local governance (increasingly urban governance, as the State is urbanising rapidly) too has an important role to play in sustainable competitiveness. Globalisation and state devolution establish the contemporary context of urban governance. Economic globalisation has made cities more vulnerable to the ebbs and flows of the international economy, compelling them to compete for business investment. Cities have to become competitive to be successful. Cities such as New York, London and Paris, which have adjusted to the 'new economy' that emphasises corporate and financial services, high technology, higher education and tourism and entertainment services, are advantageously placed to attract mobile capital and skilled workers. If cities have to work towards such a goal, then more administrative authority and functional responsibility should be transferred from the higher to the lower levels of government.

Economic globalisation involving mobile capital investments, the emergence of world wide economic sectors and large movements of domestic labour has changed the context of urban governance. In an increasingly competitive world, urban governance has been forced to transform from welfarist models into economic development models where city governments, both elected members and officials,

have to become more entrepreneurial. Globalisation demands that pro-growth and environmental sustainability concerns be balanced. The mode and manner of governing has to change from hierarchism and bureaucracy to self-organising networks. The general consensus is that positive benefits are to be had from cities taking an entrepreneurial stance towards economic development. Urban entrepreneurialism could take advantage of the resource base, location or physical and social infrastructure created through public and private investments. Direct interventions to stimulate the application of new technology, the creation of new products or the provision of venture capital to new enterprises may also be significant. International competitiveness also depends on the qualities, quantities and costs of local labour supply. Labour of the right quality, even though expensive, can be a powerful magnet for new economic development.

Sustainable competitiveness is the keystone of rapid economic growth in a globalising era. Throughout the second half of the 20th century, increasing productivity and economic growth went hand in hand with better and improving living conditions. But it does not seem to hold true any longer. The relationship between economic competitiveness and social and environmental sustainability has become tenuous. The need to consider sustainability along with competitiveness has become all the more relevant. The World Economic Forum puts it as competitiveness adjusted by two additional pillars: The **social sustainability pillar,** *"the set of institutions, policies and factors that enable all members of society to experience the best possible health, participation and security; and to maximise their potential to contribute to and benefit from the economic prosperity of the country in which they live"* and the **environmental sustainability pillar** which measures *"the institutions, policies and factors that ensure an efficient management of resources to enable prosperity for present and future generations."* [5]

In 1987 the Brundtland Commission defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This initial concept, which mainly focused on the environmental aspects of development, has evolved significantly over time and today it is widely accepted that sustainability also includes economic and social dimensions. But the complex relationship between competitiveness and sustainability is poorly understood. Although environmental limitations to growth are important, recent studies have shown that the state of the environment tends to worsen during the initial stages of industrialisation, but then improves as income increases — a concept known as the Environmental Kuznets Curve. But it cannot be assumed that environmental sustainability will be automatically achieved at a certain income level. In order to preserve future generations' ability to benefit from nature's resources and services and increase standards of living, policies and measures that ensure an efficient use of natural resources as well as the adoption of clean industrial processes need to be in place. The efficient use of natural resources includes both managing exhaustible raw materials and using renewable resources within their regenerative capacity in order to minimise production costs, ensure the legacy of future generations and reduce pollution.

Environmental degradation can impact the way ecosystems work and reduce biodiversity. Biodiversity losses caused by deforestation or significant land use changes increase the vulnerability of terrestrial and aquatic ecosystems. Biodiversity is also the key driver of economic growth because it provides the basis for many innovations in pharmaceuticals and cosmetic products. Also, investing in the greening of tourism can reduce the cost of energy, water and waste and enhance the value of biodiversity. And overall, opinions are moving towards the belief that 'green' growth leads to higher energy and resource efficiency.

The concept of social sustainability is not widely accepted, but human rights, equity and social justice are its recurring themes. While the relationship between social sustainability and development is hazy, the sense is that an unbalanced social model can undermine the stability of the growth process for both current and future generations. If economic benefits are perceived to be unequally distributed

within a society, discontent could erupt, undermining the growth process. Thus, the growth process needs to be inclusive, which is a prerequisite for social cohesion. Social exclusion, apart from being non-democratic, could have a negative impact on competitiveness. Lack of access to basic necessities, gender discrimination, polarisation and lack of social security could be serious problems.

Social sustainability and environmental sustainability are interrelated. Institutions that set clear rules on managing the environment increase the quality of life and provide better opportunities to the whole community. Well managed environmental systems may also translate into equitable income flows. Environmental degradation, on the other hand, could seriously affect the health of the population, especially the underprivileged segments, while pressures on water and land could aggravate social instability. That demography, poverty and environmental sustainability are intricately related is well known.

Combining the ideas of competitiveness and sustainability, sustainable competitiveness may be defined as "the set of institutions, policies and factors that make a nation remain productive over the longer term while ensuring social and environmental sustainability," (Schwab, 2013: 61[6]). **It is a combination of competitiveness or high quality growth, an equitable society and sustainable environment that creates the ideal conditions for life.**

Kerala wishes to be one such society by 2030, and that requires developing policies that balance economic prosperity with social inclusion and environmental stewardship. KPP 2030 explores the current status of Kerala on these dimensions and offers strategies to take the State towards sustainable competitiveness.

Vision in terms of Measurable Indicators

In order to assess progress and facilitate meaningful discussions on a vision for Kerala 2030, a series of indicators have been identified. These include economic prosperity, quality of life, equitable society and environmental sustainability.

Economic prosperity

- To achieve a compound annual growth rate of 7.5 per cent in GSDP per capita for the next 20 years.
- Increase per capita income from the current US$4,763 (in terms of purchasing power parity of 2005[7]) to US$19,000 by 2030, and then to US$36,000 by 2040.
- Achieve sectoral growth rates of:
    - √ 2 per cent minimum growth in agriculture
    - √ 9 per cent in manufacturing
    - √ 9 per cent in construction
    - √ 7.5 per cent in communication
    - √ 10 per cent in the education and health sectors

Quality of life

- Increase the share of the education and health sectors in GSDP to 15 per cent from the current 11 per cent by 2030.
- Increase the enrolment ratio in higher education to 48 per cent by 2030.
- Create health security for all.

- Move Kerala to the highest category of the UNDP human development index.
- Achieve high standards of living with a focus on:
  - √ The growth of smart urban and rural areas.
  - √ Transforming Kochi into a global city to take it onto A.T. Kearney's Global Cities Index.

Equitable society

- Reduction in:
  - √ Unemployment rate from 9.9 per cent in 2011−12 to 2 per cent in 2031 (reduce the female unemployment rate from 26.2 per cent to 5 per cent).
  - √ Gini coefficient of economic inequality from around 45 per cent in 2009−10 to 23 per cent in 2031.
  - √ Poverty rate from 7.1 per cent in 2011−12 to 1 per cent in 2031.
- Maintaining a culturally diverse, safe and just society

Environmental sustainability

- Upgrade ecosystems, biodiversity and resources through sustainable production systems and consumption.
- Protect wetlands.
- Conserve the World Heritage biodiversity of the Western Ghats.
- Increase energy efficiency to save 10 per cent of Kerala's energy and water consumption by 2030.
- Recycle between 60 and 75 per cent of waste generated depending on the type of waste.
- Identify and maximise the use of sustainable resources.

Organisation of the Perspective Plan

The framework for the development of the Kerala Perspective Plan 2030 has been conceived in terms of innovation-embracing entrepreneurs at the centre of the economy, with eight pillars of institutional elements, infrastructure, health and primary education built on the foundational elements of environmental sustainability and social sustainability (See Figure 1). The driving force of the economy is envisioned as the stream of entrepreneurs in all sectors of the economy, embracing innovation, pushing for new technology and raising productivity to be at the forefront of the global economy. An economy can only be as dynamic as the entrepreneurs and enterprises of the state, as emphatically put by Lazonick (2011) comparing the development experience of industrial Great Britain and post-war Japan with the technology boom in Silicon Valley. As argued by him, the creation and growth of indigenous enterprises was the necessary ingredient for lasting development. While investment in education and foreign direct investment may make important contributions to growth, these are insufficient without entrepreneurial activity within the domestic economy (See Chapter 12 in Volume II for an elaboration of the theme).

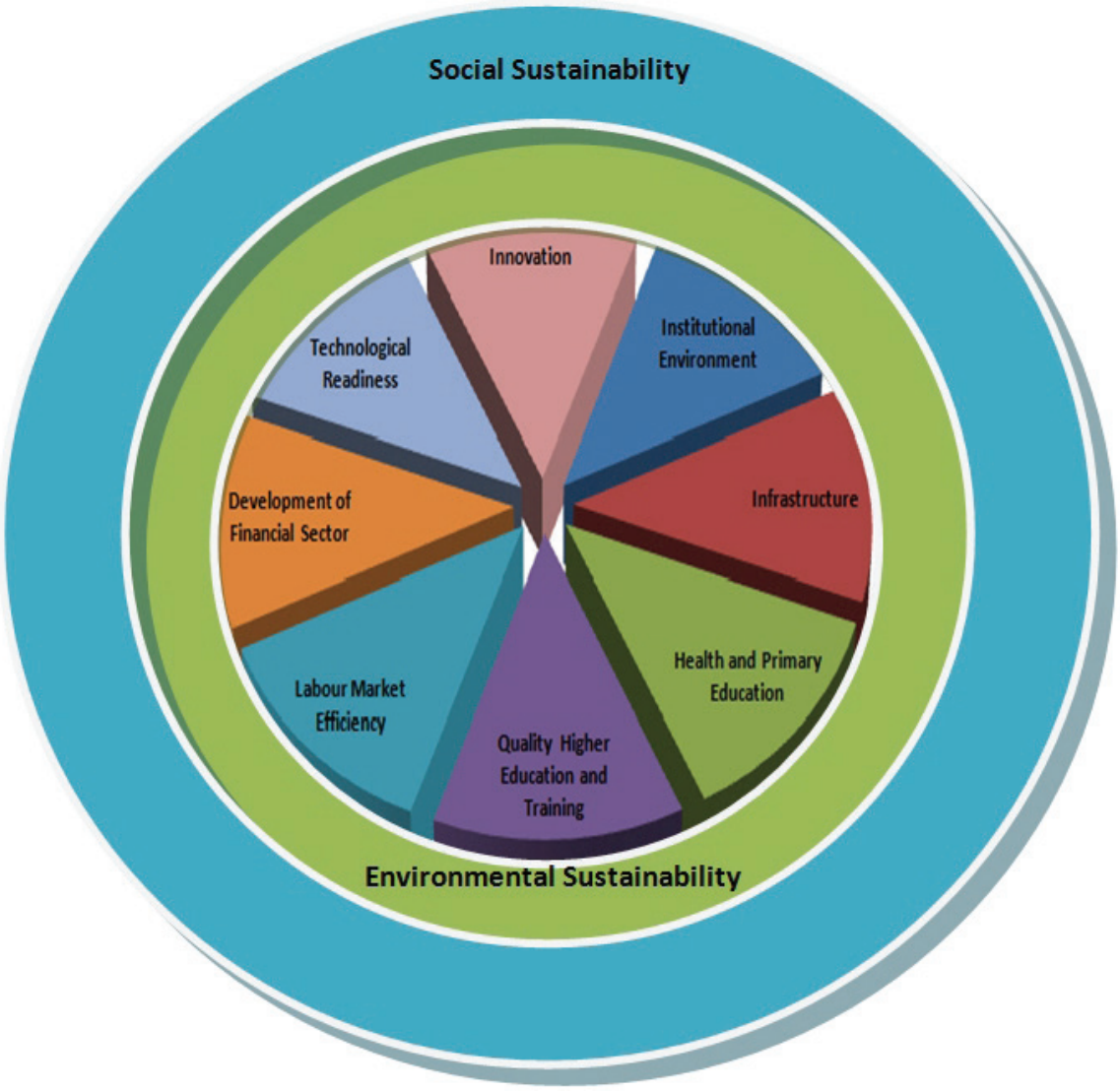

Figure 1. Framework of Kerala Perspective Plan 2030

The approach of KPP 2030 is to build on Kerala's achievements, discuss the challenges faced by the State in a globalising economy and think up strategies to achieve the goals. That is why KPP is organised in four volumes, which elaborate on four interconnected themes that together constitute its central tenet of balancing economic prosperity, social inclusion and environmental stewardship (See Figure 2 for the diagrammatic representation). Volume I begins with an analysis of the growth of the economy, identifies growth drivers and dynamism of enterprises in different sectors and then goes on to discuss strategies needed to spur entrepreneurial initiative. Seven material production sectors are taken up for detailed analysis to ascertain the nature of entrepreneurial activity, the evolution of the policy environment and the challenges faced by them in each of the sectors. Volume II takes up the eight pillars of entrepreneurial activity, except some, such as health, that are more foundational and are taken up in the social sustainability volume (Volume IV) and some such as infrastructure that go into the environmental sustainability volume (Volume III). Thus, each volume has its own merit and adds to overall value.

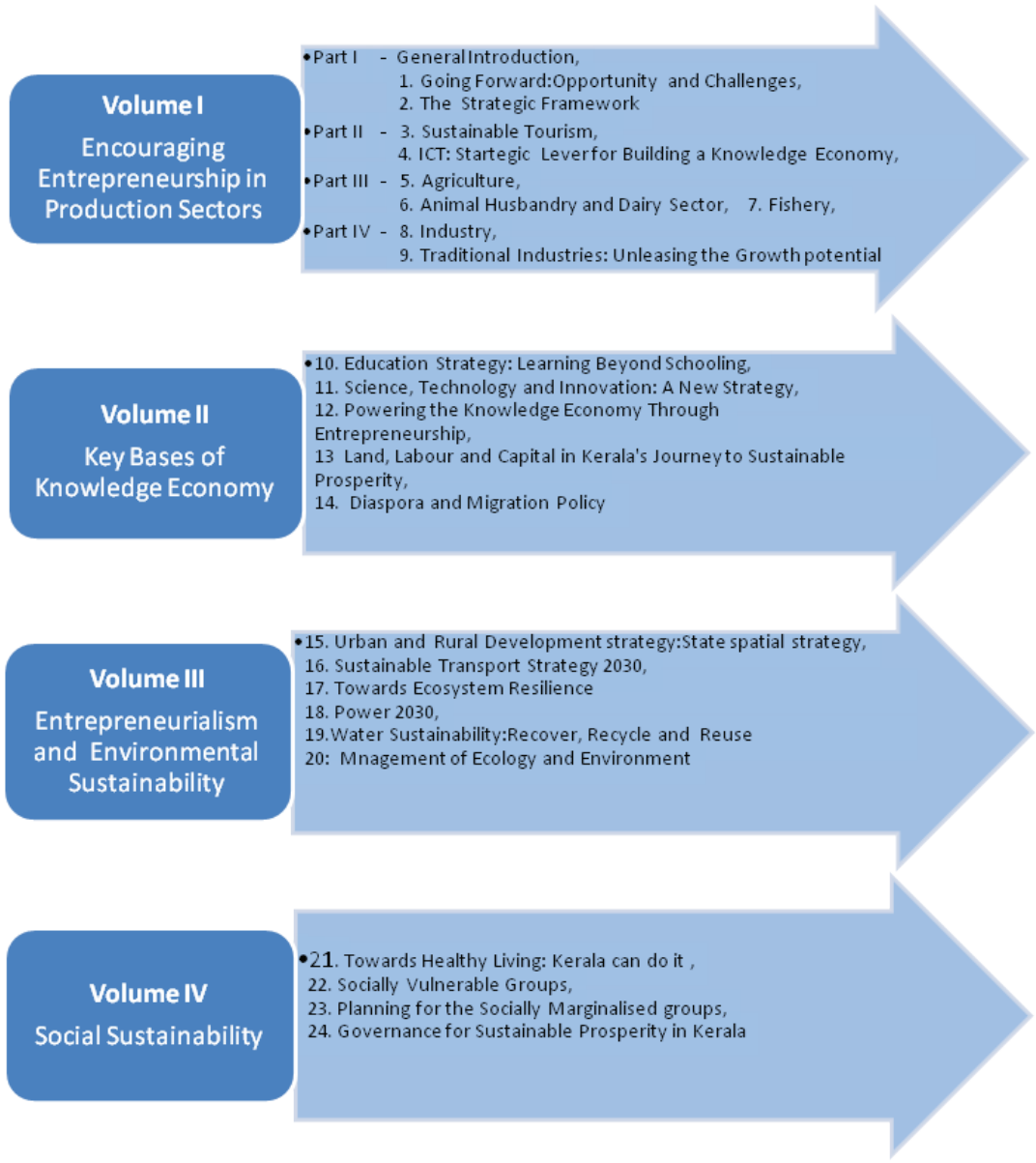

Figure 2. Organisation of Kerala Perspective Plan 2030

Volume I begins with a short introduction and continues in four parts. Part 1 contains Chapters 1 and 2, that discuss the opportunities and challenges, and the strategic framework required for the economy to move forward. Part 2 contains two chapters, one on tourism and the other on ICT, the two sectors that offer great opportunities in a globalising economy. Unconstrained by the market and receiving lots of government support, the two sectors, however, show contrasting performances in Kerala. Tourism zoomed ahead, establishing the Kerala brand across the world and setting benchmarks for other Indian states. ICT on the other hand, despite early advantages, lagged behind and is finding it challenging to make its presence felt in a very competitive market. Part 3 on agriculture, livestock and fisheries analyses these ailing sectors with some sparks of success. Part 4 on industry, including traditional industry, draws attention to the constraints and the major steps needed to take the sector out of decline. Comparing and contrasting the growth experience of the different sectors lays bare the fact that innovation and entrepreneurship go side by side in dynamic sectors such as

tourism and subsectors such as cardamom or natural rubber cultivation. Other sectors lack the two and languish. The centrality of innovative entrepreneurs for growth dynamism of the economy is well brought out.

Volume II is on the Key Bases of the Knowledge Economy. Education, innovation and entrepreneurship are among the factors that foster competitiveness. By responding to the needs of labour markets, educational systems help economies avoid skills gaps and ensure that adequately trained human capital is available. Kerala's education sector, a key base of the knowledge economy, has to be transformed to raise the skill levels of those who pass through it and enter the labour force, as well as of those who enter institutions of higher learning. In short, it needs to become a knowledge-creator of excellence.

Education in the form of dynamic centres of higher learning also supports the growth of entrepreneurship and a culture of ideas and innovation. Entrepreneurs are at the pinnacle of the knowledge economy, creating new products, services, technology or production methods.

Similarly, the creative arts, and the broader humanities stream, can drive, produce, apply and diffuse innovation in different, but equally useful ways compared to the science and technology sector. Consequently, a much broader platform that embraces both science and technology and the arts and humanities needs to be conceived. The ever expanding cycle of innovation is transformed into economic progress when capital and labour shift from failing technologies to those at the cutting edge. These movements of factors of production are greatly affected by factor rigidities, so the move from the sphere of ideas to the market can be greatly eased by loosening the factor rigidities. Institutions, therefore, have to be designed to ease the rigidities of the land, labour and capital markets.

The diaspora too can play an active role in the growth of the knowledge economy by making use of its global exposure to ideas, markets and institutions. This exposure can be then brought home to Kerala in various ways. Transitioning to a knowledge economy, thus, calls for an inclusive strategy that brings together education, science and technology, higher learning, entrepreneurship, land and labour rigidities and the diaspora.

Volume III is on Environmental Sustainability. The fact that economic growth requires extra inputs of natural resources can be attributed to increased urbanisation and changing consumption patterns. Urbanisation leads to substantial use of raw materials for building urban infrastructure such as water supply and sewage systems, roads, buildings and so on. Similarly, rising incomes change consumption patterns, raising the demand for a number of goods, the production of which requires many natural resources. For Kerala, these are issues to consider, as the depletion of natural resources will affect the Western Ghats, wetlands and coastal regions.

The State also faces new challenges in the context of the Kasturirangan Report and related notifications. Many parts of Kerala come under its purview, thus introducing limitations on economic activity in several regions of the State. At the same time, the notifications are also an opportunity for the State to channelise reverse migration from the hills to its urban centres more systematically, while using areas falling within the Western Ghats for forest regeneration and preservation.

Likewise, the environmental sustainability of Kerala's urban areas has to be in sync with the distinctive patterns of urbanisation in the State. For instance, overall population growth in the State is low and is concentrated in a few urban agglomerations. These urban centres need to have sustainable power, water, sanitation and transportation systems of international standards. Likewise, they need proper green spaces, while the Ramsar sites located around them have to be preserved and the coastal zones have to be conserved.

Volume IV is on Social Sustainability. Social sustainability is achieved when the economy has a fair and equitable health and social security system. It has two parts: one, preserve and protect the health of the population, and two, protect and support the vulnerable — the aged, disabled, disadvantaged and marginalised. The first requires investments in health, which has forward links to economic growth and productivity. Financing, architecture and governance of health of the population to reduce the IMR, CMR, MMR and infectious and lifestyle disease burden is its goal. The burden of lifestyle diseases is aggravated by smoking, consumption of high calorie processed food and consumption of alcohol. Injuries from traffic accidents form an additional burden. Financial protection against catastrophic health expenditure is also part of the healthcare system. The social sustainability pillar of KPP 2030 intends to reduce the difference between Kerala and the developed countries on parameters such as infectious, maternal and child mortality outcomes and lifestyle diseases.

The principle underlying the social security system is solidarity. This is solidarity between various social groups, especially between the employed and unemployed, the young and the old, the healthy and the ill and so on. Social solidarity evolved from simple insurance against social risks to a guarantee of subsistence security. The charter of the socially insured is basically to protect the population through a set of rules to be respected by all social security institutions; the automatic adaptation of social benefits to the evolution of the consumer price index; and electronic governance of social security institutions by reducing the number of forms, reducing the number of times information is asked for and reduction in the time needed for filling forms through the increased use of ICT. By 2030, Kerala's social security system will be comparable to that in any of the Nordic countries.

Governance systems too form the base of social sustainability. It is often said, "A common problem for many governments is that they use yesterday's institutions to meet tomorrow's problems." These are blunt instruments, which have to be replaced. Kerala has already made some progress with decentralisation initiatives following the 73rd and 74th amendments to the Constitution. Local governments are participatory, with their gram/ward sabhas. The aim is to go further with participatory budgeting and transparent project formulation and implementation so that the efficiency of public spending can be enhanced. But other government institutions are archaic and call out for a complete overhaul.

The local government system in Kerala may be characterised as welfarist. The bulk of the funds that flow from the central and state governments go towards meeting social security and welfare activities. This will have to change because urbanisation is taking place at a rapid pace and in an increasingly competitive world, urban governments have to become more entrepreneurial.

Kerala will have to balance the welfarist and pro-growth or urban entrepreneurialism models of governance. Sustainable competitiveness calls for a system of urban governance that creates conditions for higher local economic growth. As the source of such growth is knowledge-intensive business, urban governance should be building a favourable image of the city to attract investment. Urban entrepreneurialism needs to take advantage of the local resource base, location or physical and social infrastructure to push for sustainable competitiveness. Urban governments will, therefore, need to explore all the options before them, with some leveraging their status as tourism or entertainment centres and others growing as centres of higher education or finance. This requires the institutional structure of local government-state government interaction to move in the direction of promoting urban entrepreneurialism, with the state government creating appropriate incentives to facilitate the process.

Some Limitations

Perspective plans such as KPP 2030 detail a vision of where a community wishes to be in 20 or so years. Any vision is a projection, a visualisation of something that does not exist today; it combines

what exists with what is possible. The possibilities generated by the imagination are born out of what exists, which in turn is the result of the past that is our history and the evolution of the economy and society to the present. While imagination remains in the realm of the mind, creativity is its result and tangible creation.

This requires a depth of understanding that is multi-layered, with the past and present serving as a continuum as well as a spur to further evolution. Such deep understanding is the result of observation, analysis and introspection. In other words it stems from a critical analysis of the reality around, an analysis that draws from research studies and experience. This is essential if visualisation is to be kept within realistic limits.

This is broadly the perspective with which this document needs to be viewed. Therefore, KPP 2030 can only be as rich as the critical analysis of different sectors that were available during its preparation. Kerala is fortunate to have detailed studies on a number of sectors such as health, education, social vulnerability, governance and marginalisation and so on. Equally, there are few comprehensive studies on a number of sectors such as urbanisation, transportation, the environment and so on. The integral link between the idea of future and the present may be perceived as strong for some sectors and weak for others in the document, depending on availability of data and baseline scenarios. While an effort has been made through various rounds of stakeholder consultations and insightful study of relevant documents and best practices around the world, gaps do remain.

It is possible that some of these issues have been pointed out by experts during the workshops held to review the draft document. But the absence of adequate studies could be a serious challenge to bridging the gap between the reality that is Kerala's society and economy today and a vision of the future. This, therefore, needs to be viewed as a stimulus for further studies rather than a rigid document.

1 *Alkire, S. and S. Seth (2013), Multidimensional Poverty Reduction in India between 1999 and 2006: Where and How?, OPHI WP 60, 2013.*

2 *www.doingbusiness.org/India and www.doingbusiness.org*

3 *businesswireindia.com/news/news-details/states-india-assessed-ranked-according-different-stages-development-ma/38139*

4 *Liveability Index 2010: The Best Cities in India, A CII–Institute for Competitiveness Report*

5 *http://www.weforum.org/content/pages/sustainable-competitiveness/ accessed 27 March 2014*

6 *Klaus Schwab;The Global Competitiveness Report 2012–2013,World economic forum.*

7 *Purchasing power parities (PPPs) are indicators of price level differences across countries. They indicate how many currency units a particular quantity of goods and services costs in different countries (http://epp.eurostat.ec.europa.eu/portal/page/portal/purchasing_power_parities/introduction).*

8 *Lazonick,M. Entrepreneurship and the Developmental State. 2011. In W. Naudé (ed), Entrepreneurship and Economic Development (254−270). Palgrave Macmillan*

Introduction

Entrepreneurialism and Environmental Sustainability

While reflecting on the much acclaimed Brundtland Report (1987) titled 'Our Common Future'[1], Amartya Sen (2013)[2] has made the case for a "freedom and choice" based approach to sustainable development as an alternative to the need-based approach of the Brundtland Report. Sen argues that "it is not so much that humanity is trying to sustain the natural world, but rather that humanity is trying to sustain itself." Sen modifies the Brundtland report's sustainable development as "development that prompts the capabilities of present people without compromising capabilities of future generations," (Sen, 2013, p.11). It needs to be achieved not by compulsion, but by freedom and choice:

> "Human beings are reflective creatures and are able to reason about and decide what they would like to happen, rather than being compellingly led by their own needs — biological or social. A fuller concept of sustainability has to aim at sustaining human freedoms, rather than only at our ability to fulfil our felt needs, something that human beings share with animals." (Sen 2013; p 6)

A freedom-based approach to addressing environmental sustainability is likely to result in admirable outcomes.

In the context of the need to balance management of ecology, environment and climate change with economic development, the management of forests becomes an important priority. As per the National Forest Policy of 1988, forests should not be looked upon as a source of revenue, but as a renewable national resource. They are national assets to be protected and enhanced for the well being of the people and the nation. The tropical forests of Kerala are valuable not only for its carbon sequestration ability, but also for its water holding capacity. It is this capacity of the forest ecosystem that makes the flow Kerala's 44 rivers perennial. Water in these rivers is used not only by Kerala, but also by neighbouring states, Tamil Nadu and Karnataka.

A new dimension to conservation is added with the recommendations of the Western Ghats Ecology Expert Panel (WGEEP). The Western Ghats is a magnificent mountain range, next only to the Himalayas, and is a biological treasure trove with a high degree of endemism (11 per cent to 78 per cent) and scenic beauty. This unique ecosystem has been threatened by increasing habitat pressures and has been declared one of the world's hottest hotspots of biodiversity. Realising the need to protect and rejuvenate the ecology of the Western Ghats and the need for sustainable development in the region, the Ministry of Environment and Forests (MoEF) constituted the Western Ghats Ecology Expert Panel (WGEEP). The mandate of WGEEP was to demarcate ecologically sensitive zones and suggest measures to conserve, protect and rejuvenate the ecology of the Western Ghats region.

The panel, after careful examination of the different approaches available for characterising the Western Ghats system and after extensive discussions with experts, has defined the extent of the Western Ghats as an area of 164,280 sq km, extending from North to South over a distance of 1,500 km traversing six states. It was revealed that already close to 60 per cent of the Western Ghats region in Kerala is under cultural landscape — human dominated land use of settlements, agriculture

and plantations (other than forest plantations) — and only 41 per cent of the land area can currently be classified as natural landscape. Of the natural landscape, the biologically rich area with some measure of contiguity is roughly 37 per cent of the Western Ghats, which is about 60,000 sq km. The working group has identified this 37 per cent of natural landscape — having very high biological richness and low fragmentation and low population density and containing Protected Areas (PAs), World Heritage Sites (WHSs) and tiger and elephant corridors — as Ecologically Sensitive Area (ESA) and recommended it for notification.

The intensive use of the Western Ghats in Kerala is recent history. It is the history of migration to the Ghats in search of livelihoods. Migration began in the early decades of the 20th century in Idukki. The population of the district more than doubled in the first decade of the century when the population of the State was growing by about 12 per cent (Table 1). The trend during 1921-31 was more or less similar. This trend continued till the 1960s. A clear reversal became evident in the 1980s and the 2000s, marking a decline in the population of Idukki. While no in-migration could be witnessed into Pathanamthitta in any decade, the movement out of the district was becoming evident in the 1990s and 2000s. The movement into Wayanad began much later than that into Idukki. The period of 1940 to 1980 witnessed a population increase of over 50 per cent in every decade in Wayanad. Migratory trends were not visible for the next two decades as the population growth was closer to the State average. But in the 2000s, signs of a mild trend of movement out of the district may be seen. Interestingly, Idukki and Pathanamthitta are the only two districts reporting a negative decadal growth in population during 2001-11.

Table - 1
Decadal Variation in Population in Kerala: 1901-2011

State/ District	Decadal Variation (Percentage)							Popu-lation Density*
	1901-11	1921-31	1941-51	1951-61	1961-71	1991-01	2001-11	
Idukki	108.75	72.53	35.69	74.94	31.89	7.03	-1.93	254
Pathanamthitta	14.78	27.24	24.78	23.48	15.75	3.84	-3.12	453
Wayanad	9.85	8.26	59.17	62.60	50.35	16.14	4.60	383
Kerala	11.75	21.85	22.82	24.76	26.29	9.43	4.86	859

Source: Census of India Web site: Office of the Registrar Gene

The trends in population growth discussed above can largely be explained by issues of livelihood. The largely agricultural society, with the pressure of a growing population, was moving in search of cultivable land since the early decades of the 20th century. This began earlier in south Kerala and later in north Kerala. That probably explains the difference between migration into Idukki and Wayanad. It was a movement of people in search of livelihood. By the 1990s two definite trends were observable in Kerala. First, fertility was declining rapidly and Kerala was moving into a replacement growth rate regime. Second, the economy was moving away from agriculture into becoming one dominated by the services sector. Along with these two trends there was also a substantial population movement taking place, with urbanisation gaining ground.

Share of agriculture in the Gross State Domestic Product was close to 10 per cent by 2011 and the services sector's share was over 60 per cent. The transformation of the economy saw the level of urbanisation reaching close to 50 per cent by 2011. The urban centres were not taking shape in Idukki, Wayanad or Pathanamthitta, but predominantly in the coastal and midland stretches of the State. The number of census towns increased from 99 in 2001 to 461 in 2011, with none in Idukki and Wayanad and only one in Pathanamthitta. These were also the districts with low and declining population density. People who went to the hills in search of a livelihood were sending their children

back as technicians and professionals into the urban centres. Thus, the pressure on land observed till about the 1980s was not to be seen beyond that period.

Kerala is also rich in wetlands and coastal zones calling for conservation. The Ramsar Convention is an inter-governmental treaty providing a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It defines wetland as, "Wetlands are area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres." The treaty covers a variety of wetlands and calls for their 'wise use' — the maintenance of their ecological character, achieved through the implementation of ecological system approaches, within the context of sustainable development. The National Environment Policy has emphasised the need for a holistic view of wetlands: "India's freshwater resources comprise the single most important class of natural endowments enabling its economy and its human settlement patterns. The freshwater resources comprise the river systems, groundwater and wetlands. Each of these has a unique role, and characteristic linkages to other environmental entities… A holistic view of wetlands are necessary which looks at each identified wetlands in terms of its causal linkages with other natural entities, human needs, and its own attributes." It is important to note that three of the 26 Indian Ramsar Sites are in Kerala, covering 213,023 hectares (30.9 per cent) out of the 689,131 hectares of area in India.

Thus, the pressure on the natural environment and, particularly, the Western Ghats is not so much the result of population growth, but of the reverse migration of the population into urban centres and the higher needs of urban areas. The level of urbanisation is expected to increase to over 70 per cent by 2030, with enhanced demands for infrastructure and the related pressure on natural resources. The pressure has been high during the last two decades with the emergence of construction as a driver of the economy (see Chapter 1, Volume I). The same urbanisation has caused the problems of coastal areas as well as some of the wetlands, as the urban corridors are located in some of these stretches. The other driver of the economy — tourism — draws on location and nature (especially wetlands and coastal areas) and can also be a pressure on natural resources (see Chapter 3, Volume I).

Management of natural resources, thus, becomes a top priority. A safe, healthy environment requires good environmental quality, flood protection and a reliable drinking water supply, as well as protection of cultural heritage and unique natural values. Good environmental quality means that the quality of soil, water and air must, at a minimum, comply with national and international standards. The quality of the living environment must be improved by tackling pollution at source. People's health must be protected from negative influences such as noise pollution. In principle, the same level of protection should apply to all parts of the State and the most marginalised groups.[3]

Kerala's unique environment is under threat from climate change, industrialisation, urbanisation and intensive use by some of the growing sectors of the economy. Kerala's ability to sustain its environment, to use its natural resources wisely and to manage waste is central to the society and economy. How Kerala builds its cities and towns, how it plans transport systems, uses water and forest resources will determine its ability to sustain development. This Volume visualises Kerala in 2030 in terms of these issues.

The Volume is organised in six chapters. The chapter on **Urban and Rural Department** proposes a new spatial strategy of development and a new model of urban governance. Kerala has seen a massive increase in urbanisation during the last ten years, reaching a level of almost 50 per cent by 2011. Forecasts suggest that about 70 per cent of the population will be living in urban centres by 2030. Rapid urbanisation poses daunting challenges in infrastructure, with the resulting environmental and social problems. The strategy for the future will be based on a holistic approach of developing a 'Kerala State Spatial Strategy' within the framework of the Perspective Plan 2030.

The State Spatial Strategy will safeguard areas of State interest and provide guidelines aimed at maximising the efficiency of human settlements and other productive efforts and enhance rural-urban complementarities. Mixed land use, developing smart, compact, clean and green cities will be the focus of this strategy. Kochi is envisioned to become a global city by 2030. The '4R' maxim — reduce, reuse, recycle and recover — will be adopted in all areas. Water and sanitation facilities, transit-oriented development with emphasis on development of pedestrian and bicycle-friendly roads and provision of public transport are elements of urban development. Providing housing for the poor through various models is suggested to achieve the goal of inclusive growth in urban areas. Improved urban governance and improving the revenue base of urban local bodies are suggested to deliver an improved quality of life to the residents of Kerala.

Economic globalisation involving mobile capital investments, the emergence of world wide economic sectors and large movement of domestic labour has changed the context of urban governance. Urban governance has been forced to transform from the welfarist models towards the economic development model or urban entrepreneurialism model. Globalisation demands that growth and environmental sustainability be balanced. Urban entrepreneurialism could take advantage of the resource base or location or physical and social infrastructure created through public and private investments. Direct interventions to stimulate the application of new technology, the creation of new products or the provision of venture capital to new enterprises may also be significant. International competitiveness also depends on the qualities, quantities and costs of local labour supply. Labour of the right quality, even though expensive, can be a powerful magnet for new economic development.

The chapter on **Transport** addresses the challenges faced by Kerala in providing its citizens with safe and efficient transportation systems. Single digit rate of growth of the road network accompanied by double digit vehicle growth rates has created a challenging situation in Kerala. The goal is to build a sustainable inter-modal transport network, which will include all options such as road, rail and water. Inter-modal transit terminals will be built. Roads will be pedestrian and bicycle-friendly to accompany the transit-oriented development in urban corridors. A decentralised transit network is suggested. Infrastructure should be built so as to mainstream the concerns of gender (well-lit public transport, sub-ways and so on), senior citizens (use of escalators and elevators wherever possible) and the physically challenged (low-floor buses with automatic doors so that wheelchairs can be wheeled in). An integrated transport network is the only solution for Kerala to preserve its unique environment and attract business from all over while creating a sustainable and inclusive transport network for its residents.

Power 2030 is the chapter on energy. Kerala has done extremely well in providing electricity to a majority of the households, lowering transmission and distribution losses and using the cleanest source of traditional energy, hydel power. However, there is a demand-supply gap. The challenge in this sector is to provide quality power to all at affordable rates. Kerala is especially constrained. In terms of comparative advantage, Kerala is well endowed with hydroelectric (hydel) energy. However, because of environmental concerns, there are constrains on expanding it. Its dominant strategy, then, is to increase its allocation from the central government and tie up with other states. Every source of energy carries uncertainties in terms of either politics or price or technology. What is the way forward for Kerala? Unfortunately, there are no easy or right answers: no silver bullet for Kerala's energy concerns. The energy issue requires a flexible and innovative approach, with ties to the knowledge economy that help to provide answers to evolving challenges. The demand-supply framework is used for this analysis. It should work on strategies of conserving demand and augmenting supply. Augmenting supply means looking at all options (renewable and non-renewable) in a cost-benefit analysis framework where every choice carries a cost, and assessing whether the benefits outweigh the costs. Also, can the costs be mitigated and, therefore, minimised? For conserving demand, a combination of price, effective regulations and improvements in technology can be used. KPP 2030 suggests various options on the demand and supply framework for the energy sector. While some

may not seem feasible in the short term, in the long term, over a period of fifteen-odd years, it may become feasible. Kerala is not the only state to be in this situation, and economically and technologically feasible models from around the world should be studied and adapted. This is not a one-time process, but an evolving one. Integrated, dynamic approaches, along with cooperation from other states may help push Kerala into a more energy secure environment.

Water Sustainability: Recover, Recycle and Reuse analyses the demand for water and the challenges Kerala will face in the years to come and the strategies to be adopted for sustainability. Water is a precious resource and it has to be treated as such. Water is mainly used for irrigation, industrial uses and drinking. Increasing demands on land, which affects water bodies and leads to water pollution and its consequent effects on the economic, social and environmental fabric of the State is one of Kerala's significant challenges. The analysis shows a lack of management of water resources in Kerala and a tendency to view water and sanitation or water and waste management as separate subjects. The strategy should be one of sustainable integrated management of water in all areas. Water needs to be conserved and valued. Recovering, recycling and reusing water is the sustainable way out. New technology will be adopted both on the supply and demand side for using water in a conservative fashion. Pricing and water metering may be used to monitor water usage. Micro irrigation schemes are recommended for Kerala. Plus, water availability 24x7 is a key hallmark of smart, compact and global cities. Existing rural water schemes may be extended to supply water in the rural areas. Scaling up of infrastructure will be expensive and could be financed through backing from the diaspora.

The chapter titled **Towards Eco Systems Resilience** discusses the problem of environmental pollution. Water pollution is a serious problem in Kerala, as biological, toxic, organic and inorganic pollutants contaminate almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves. Waste is generated at various stages, such as production, transportation, storage, distribution and final consumption, and solid waste management has emerged as a major problem. Kerala faces a serious deterioration in the environment quality due, mainly, to land and water pollution. This, in turn, poses a threat to its biodiversity. Kerala has been undertaking several green management initiatives, both at the state and the local government level. The proposed knowledge-driven sustainable development strategy seeks to identify and develop actions to enable Kerala to achieve continuous improvement in the quality of life of its people. The underlying principle of the new strategy is 'mainstreaming environment', which proposes environmental management whether it is developing infrastructure or agriculture (integrated farming) or adopting clean production systems in industry.

Chapter 20 titled **Management of Ecology and Environment** discusses the challenges of balancing the use of forests, wetlands and coastal areas for economic development with sustainability. Forests and wetlands are vital for sustaining the life support systems on earth. Kerala has a complex ecosystem, with about 40 per cent of its area under forest cover and 4 per cent under wetlands rich in biodiversity. The key challenges before Kerala are that the share of forestry in total GSDP has been declining continuously and the wetlands are being used beyond their carrying capacity in many locations. Moreover, in forestry, there is a high share of plantations and a declining trend in the 'growing stocks'. Thus, the strategy will draw on the principle of sustainable development. Reserved forests have to be preserved for ecological balance and, therefore, should be protected with no conversion allowed. The goal is to improve both the quantity and quality of forests by adopting and adapting newer and better technology, better forest management techniques and creating new products out of both forest and non-forest produce. The integrated forest strategy will especially focus on the communities that live inside forests and on economically and socially empowering them without taking away their sense of identity. Forests will have a multi-functional role in Kerala, with a beneficial impact on the lives of people. Wetlands being among the world's most productive environments will be regenerated and preserved.

[1] *Available at http://www.un-documents.net/our-common-future.pdf*

[2] *Amartya Sen (2013): The Ends and Means of Sustainability, Journal of Human Development and Capabilities: A Multi-Disciplinary Journal for People-Centered Development, 14:1,6-20. Available at http://www.tandfonline.com/doi/abs/10.1080/19452829.2012.747492?journalCode=cjhd20#.UqreWeJJj6M*

[3] *(Adapted from http://www.government.nl/issues/spatial-planning-and-infrastructure/safeguarding-the-quality-of-the-living-environment accessed 26 March 2014)*

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Chapter 15

URBAN AND RURAL DEVELOPMENT STRATEGY: STATE SPATIAL STRATEGY

Chapter 15

Urban And Rural Development Strategy: State Spatial Strategy

15.1 The Setting

15.1.1 Kerala stands out from the rest of the country in the nature and pace of its urbanisation and the resulting challenges to urban development. Urbanisation, as measured by the share of the urban population of the State, has experienced a tremendous increase from 26.39 per cent in 1991 to 25.96 per cent in 2001 to 47.72 per cent in 2011.[1] The past 10 years witnessed a sharp rise in urbanisation in Kerala, along with the rapidly growing states of Southern and Western India, which is missing from the all India numbers. The corresponding numbers for India were 25.52 per cent in 1991, 27.78 per cent in 2001 and 31.16 per cent in 2011.

15.1.2 Considering that the economy has been growing at over 7 per cent for the past 25 years, the higher pace of urbanisation is not unexpected. However, the nature of urbanisation in Kerala is quite different. In general, urbanisation is accompanied by economic and social transformation. Towns and cities are engines of growth, not only in creating skills and wealth for the nation, but also in generating employment for migrants from rural areas. Cities play a crucial role as hubs of economic and innovative activity. Large concentrations of people and goods provide increased opportunities for creativity, larger labour markets, higher levels of productivity and cultural and political opportunities. The productivity benefits they provide to business are important for the prosperity of an economy.

15.1.3 The growth of urbanisation in Kerala is not fuelled by growth in the major cities, but by the growth of census towns. Urbanisation in Kerala has picked up due to the re-classification of rural areas as urban ones. This, in turn, has resulted in a rural-urban continuum, especially in the coastal areas. The cities of Kerala still hold an attraction in terms of jobs, but people travel to work from the outskirts, partly because of the better rural road network in the State. Census 2011 shows that the major cities display a decline in population, whereas it is increasing in the census towns. Urban sprawls are a direct consequence of this growth process, which, in turn, have both economic and ecological consequences.

15.1.4 Rapid urbanisation has posed daunting challenges due to insufficient investment in basic services such as water supply, sanitation, transport and power and civic administration, with the resulting environmental and social problems. The situation is exacerbated by unemployment, overcrowding and the growth of slums. This urgently calls for strategic urban planning and urban development, not just in terms of infrastructure, but also capacity building of people to meet the challenges.

15.1.5 The Department of Town and Country Planning of Kerala has recently prepared a report, 'State Urbanisation Report Kerala 2031' (SURK).[2] As part of the preparation of this report, it undertook an extensive study of the scattered development pattern of the State, its development issues and the influence on urbanisation in Kerala. The highlights of its recommendations are:

- Kerala should develop a settlement policy that will prevent urbanisation of adjacent suburban areas, thereby saving eco-fragile and fertile farm fields from urban construction.
- Kerala will have five urban corridors in the next two decades: Thiruvananthapuram–Kollam, Pathanamthitta–Kottayam, Alappuzha–Ernakulam–Thrissur–Palakkad, Malappuram–Kozhikode and Kannur–Kasaragod. These corridors will avoid areas that are environmentally fragile and are used for agricultural purposes. This will enable Kerala to spread its development services to all corners of the State.
- In two decades, Kerala will be a state with 20 mid-level towns and 86 small towns apart from the urban corridors.
- The aim of town planning in Kerala should be a compact urban form.

15.1.6 The Kerala Perspective Plan 2030 carries forward these proposals as part of the overall development of the Sate. It proposes that given the settlement peculiarities of the State, Kerala must have a 'Spatial Strategy' with an integrated framework for urban and rural development.

15.2 Patterns of Urbanisation in Kerala and Emerging Challenges

15.2.1 Trends

Urban explosion during the past decade

15.2.1.1 Kerala's urbanisation experience has been unique compared to the rest of the country. Until 2001, the level of urbanisation in Kerala was similar to that of India. In fact, the level of urbanisation was slightly lower in Kerala (25.96 per cent) in 2001 versus India (27.78 per cent). Between 2001 and 2011, urbanisation skyrocketed in Kerala. The decadal growth of the urban population between 2001 and 2011 was 92.7 per cent and the rural population declined by 25.6 per cent. The Average Exponential Growth Rate (AEGR) of Kerala between 2001 and 2011 was 6.56 per cent as opposed to India's 2.76 per cent (Table 15.1).

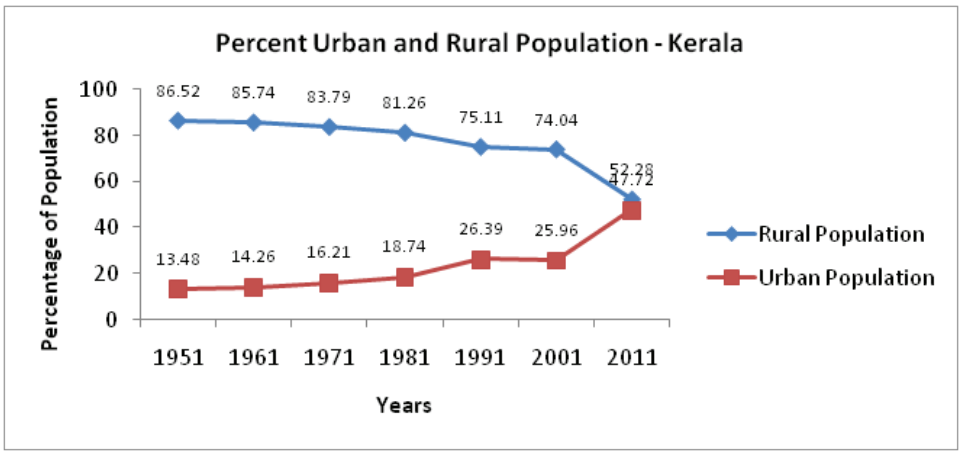
Table - 15.1
Annual Exponential Growth Rate of Kerala and India (%): 1951–61 to 2001–2011

Year	AEGR	
	Kerala	India
1951–61	3.25	2.34
1961–71	3.16	3.23
1971–81	3.15	3.68
1981–91	4.80	3.22
1991–2001	0.74	2.73
2001–2011	6.56	2.76

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

15.2.1.2 Consequently, urbanisation increased from 25.96 per cent in 2001 to 47.72 per cent in 2011. This sharp increase in the level of urbanisation is depicted in Figure 15.1.

Figure 15.1
Composition of Rural and Urban Population in Kerala: 1951–2011(%)

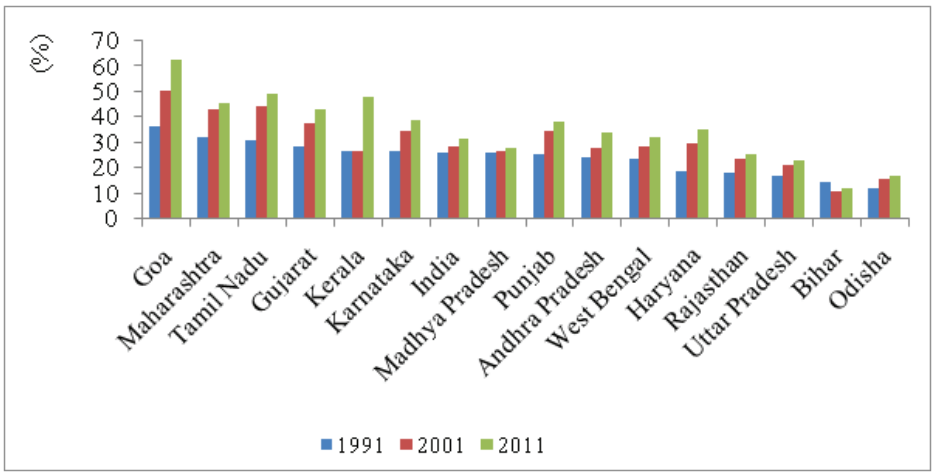


Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

Highest growth in urbanisation among Indian states

15.2.1.3 Among the major Indian states, Kerala recorded the highest growth in urbanisation over the past decade (Figure 15.2). In 1991, it was the fifth most-urbanised state in the country. By 2001, it was relegated to the eleventh position among 15 states. Over the past decade, however, it raced to catch up with other states and leapfrogged most of them to be ranked second, just behind Goa.

Figure 15.2
Level of Urbanisation in India by State: 1991, 2001, 2011



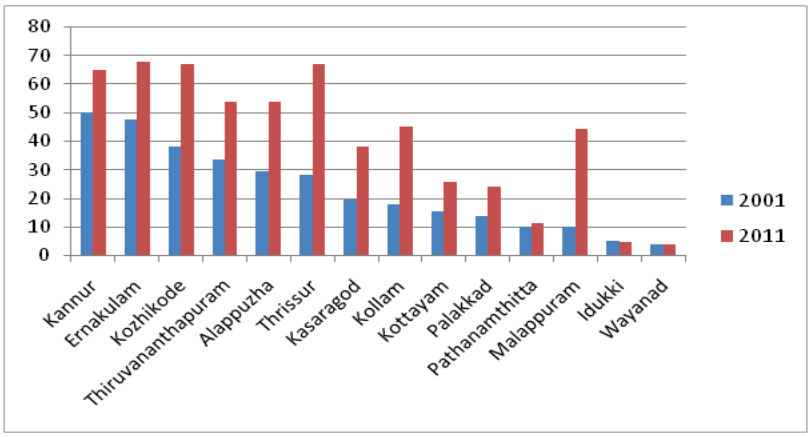
Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

Urban explosion is widespread across the State

15.2.1.4 In 2001, in only six districts was the percentage of the urban population above the national average. These were Kannur, Ernakulam, Kozhikode, Thiruvananthapuram, Alappuzha and Thrissur. In all other districts, it ranged between 10 and 20 per cent. In 2011, the picture changed. All the districts recorded expansion in the urban population. This increase varied from 15 per cent to 40 per

cent across districts. Malappuram witnessed the fastest increase in urban population, from 10 to 40 per cent, on account of the formation of 39 new census towns. Further, Kollam, Thrissur, Kottayam, Kasaragod, Palakkad and Kozhikode had above 5 per cent growth in the level of urbanisation. Overall, Ernakulam emerged as the most urbanised district of Kerala, with 68.1 per cent of its population living in urban areas, followed by Thrissur, Kozhikode and Kannur with levels of urbanisation above 65 per cent. Idukki and Wayanad remained the least urbanised districts (Figure 15.3).

Figure 15.3
District-wise Level of Urbanisation: 2001 and 2011 (%)



Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

Urban explosion is likely to continue

15.2.1.5 Urban areas are likely to grow further. The State Urbanisation Report Kerala (SURK), which has projected the urban population for the State, provides two estimates. In the first case, the existing trend of urban population growth is assumed to continue. In the second case, the average growth rate of the urban population is assumed to remain the same in the next two decades. In both cases, by 2031 the level of urbanisation will exceed 90 per cent, the report says. The NCAER, using the UN methodology of population projection to calculate the urban population of Kerala for the period 2012−31, shows that for the year 2025, the share of the urban population works out to 63.4 per cent and by 2031 it is likely to increase to 68.87 per cent (Appendix A.15.1). The various estimates, thus, indicate that the urban population is projected to grow over the next 20 years and, at the minimum, 70 per cent of Kerala's population will live in urban areas.

15.2.1.6 This sudden explosion of urbanisation has posed challenges in the provision of urban infrastructure. These challenges are likely to be compounded by the unique pattern of urbanisation in Kerala.

15.2.2 Patterns of urbanisation

Patterns of urbanisation

15.2.2.1 Kerala shows marked peculiarities in its patterns of urbanisation. In general, an increase in urban population growth rate is the result of over-concentration in existing cities due to a natural increase in population or migration from rural areas. Growth in urban population is due to the areal reclassification according to SURK.

- There are 5 municipal corporations and 60 municipalities — 12 first grade, 22 second and 26 third grade.[3]

- Increase in the number of urban areas (urban area is defined in Box 15.1): The rapid increase in urban population in Kerala can be explained by the rise in the number of villages designated as towns. These are termed Census Towns (CTs). In 2001, there were 60 statutory and 99 CTs, which added up to 159 towns. Over 60 per cent of the towns (76 per cent CTs) were concentrated in Kannur, Thrissur and Ernakulam. In six districts — Wayanad, Idukki, Pathanamthitta, Thiruvananthapuram, Kollam and Malappuram — no village was designated as a CT. In 2011, the scenario changed. The number of statutory towns was reduced from 60 to 59, whereas the number of CTs rose to 461 (an increase of 362). In 2001, six districts had no CTs, but in 2011 CTs proliferated in all the districts with the exception of Idukki and Wayanad. Ernakulam, Kannur and Thrissur continued to dominate, but their share declined to 50 per cent.

15.2.2.2 These new census towns are unprepared for the changes that inevitably accompany rapid urbanisation. Urban infrastructure build-up is going to be a key factor in meeting the urban challenge and calls for planning in a manner that it is 'green'. A major challenge is to ensure the development of the census towns in a planned manner.

Box No 15.1

Definitions

Urban area: An urban area can be defined in a number of ways — legal, demographic or economic — but all towns have the basic characteristics of being spatial concentrations of people and economic activities. In India, the definition of 'urban' given by the Census of India, which is generally accepted, is as follows:

(i) A minimum population of 5,000.
(ii) At least 75 per cent of the male working population engaged in non-agricultural pursuits.
(iii) A density of population of at least 400 persons per sq km.

Urban Agglomeration: An Urban Agglomeration (UA) is a continuous urban spread constituting a town and its adjoining urban outgrowth or two or more physically contiguous towns together and any adjoining urban outgrowth of such towns. In some cases, railway colonies, university campuses, port areas, military camps and so on would have come up around a city or statutory town outside the statutory limits, but within the revenue limits of a village or villages contiguous to the town. Each such individual area by itself may not satisfy the minimum population limit to be treated as an independent urban unit, but deserves to be clubbed with the town as a continuous urban spread.

In the 2001 Census two more conditions were added to the concept of Urban Agglomeration:

(i) The core town or at least one of the constituent towns should necessarily be a statutory town.
(ii) The total population of all the constituent units — towns and outgrowths of an urban agglomeration — should not be less than 20,000 (as per 1991 census).

The following are the different possible situations in which an urban agglomeration would be constituted:

(i) A city or town with one or more contiguous outgrowth.
(ii) Two or more adjoining towns with their outgrowths.
(iii) A city and one or more adjoining towns with their outgrowths, all of which form a continuous spread.

Census town: A census town lacks a notified municipal entity, but satisfies the criteria of urban areas.

Statutory town: Urban areas with a notified municipal entity for governance.

Class I UAs/Towns: UAs/towns are grouped on the basis of their population in the Census. A UA/town that has a population of at least 100,000 people is categorised a Class I UA/town.

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

- Urbanisation of the peripheral areas of existing major urban centres: As discussed above, the number of towns increased manifold between 2001 and 2011, resulting in an urban explosion. However, most of these towns were under the jurisdiction of urban agglomerations or UAs (Box 15.1). In 1971, even after the concept of urban agglomeration (UA) was introduced, no UA was formed in the State. It was only in the 1981 Census that nine UAs were formed, and their number in the 1991 Census increased to 16. The number of UAs increased to 17 with the addition of Kasaragod in the 200l Census and then to 19 in 2011. UAs account for about 93.74 per cent of the urban population.

15.2.2.3 The percentage share of the urban population that resides in the urban agglomeration population is 100 per cent for the districts of Ernakulam and Kannur. For the other districts, the share of UAs to the total urban population in the district is over 84 per cent (Table 15.2). Most of the 362 new census towns that have emerged in and around existing statutory towns are becoming part of UAs. This also explains the fact that over 94 per cent of the population in urban Kerala is accounted for by UAs.

Table - 15.2
Urban Population Residing in Urban Agglomerations in Kerala (%):2011

S. No.	District	Share of Urban Agglomeration Population to Total Urban Population (%)	Urban Agglomerations
	Kerala	94.2	
1	Ernakulam	100	Kochi, Kothamangalam
2	Thrissur	94.3	Thrissur, Chalakudy
3	Kozhikode	97.9	Kozhikode
4	Kannur	100	Kannur
5	Alappuzha	98	Cherthala, Alappuzha, Kayamkulam
6	Thiruvananthapuram	94.8	Thiruvananthapuram
7	Kollam	93.6	Kollam
8	Malappuram	93.5	Malappuram
9	Kasaragod	83.6	Kasaragod, Kanhangad
10	Kottayam	85.8	Kottayam, Changanassery
11	Palakkad	88.6	Palakkad, Chittur–Thathamangalam, Ottapalam

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011.

Ribbon development of UAs

15.2.2.5 Kerala is more urbanised along the north–south corridor along the coastal belt and the midland region, while the agricultural and forest area is concentrated in the midland and highland regions. The coastal area of Kerala is highly urbanised, with 12 out of 19 UAs on the coast. The other UAs are mainly in the midlands, and the highlands are mostly rural/forest land. Urban spread appears to correspond with UAs.

Patterns of urbanisation by size class of towns

15.2.2.6 Although the urban population exploded in UAs, Class I cities' population reported a decline in their growth rates during the past decade. While 10 individual towns in the 18 UAs reported populations of above one lakh in 2001, the number declined to nine in 2011, with two towns entering the Class II category and one Class II town jumping to Class I. Further, all the Class I towns reported negative growth in population during 2001–11. Since there are no independent Class I cities/towns in the State and all cities/towns are part of UAs, this implies that there was substantial out-migration from the main cities to peripheral areas, and that agglomeration is the characteristic of urbanisation in Kerala (Table 15.3).

Table - 15.3
Distribution of Urban Population by Town Size

Class	Population range	No. of towns in 2001	Total urban population in Lakh 2001	No. of towns in 2011	Total urban population in Lakh 2011
I	1,00,000 and above	10	36.9	9	32.6
II	50,000–99,999	24	15.9	29	18.9
III	20,000–49,999	72	23.0	254	79.3
IV	10,000–19,999	37	5.7	159	23.5
V	5,000–9,999	15	1.2	61	4.7
VI	Less than 5,000	1	0.05	8	0.4
Total		159	82.7	520	159.3

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011

15.3 Urban Development Initiatives in Kerala

15.3.1 Elaborate administrative structure

15.3.1.1 The Department of Urban Affairs (formerly Department of Municipal Administration) was formed in 1962 by the bifurcation of the Department of Local Bodies into the Department of Municipal Administration and the Department of Panchayats. In 2002, the Department of Municipal Administration was renamed the Department of Urban Affairs. This department is concerned with the administration of municipalities and municipal corporations, together called Urban Local Bodies (ULBs) in Kerala.[4]

15.3.1.2 The Department of Town Planning started functioning in 1957, mainly to ensure planned development of urban settlements in the State. Later, given the unique scattered development pattern of settlements as well as the rural–urban continuum prevalent in the State, it was decided to widen the department's sphere of activity to cover rural settlements as well. Accordingly, in 1999, this department was renamed the Department of Town and Country Planning.

15.3.1.3 The Kerala Urban and Rural Development Finance Corporation (KURDFC)[5] has been set up as an entity for financing rural and urban development. It provides loan assistance to various local self-government institutions (LSGIs) in Kerala for their development activities. The KURDFC acts as a nodal agency for implementing central government schemes such as housing and shelter upgrades under Nehru Rozgar Yojana (NRY) and low-cost sanitation. The Government of Kerala has also appointed the KURDFC as the entity for implementing the Pooled Finance Development Fund (PFDF) Scheme of the Ministry of Urban Affairs, Government of India. The PFDF scheme has been formulated to enable cities to access market funds for their infrastructure projects.

15.3.1.4 Kerala has been active in the housing sector with several innovative schemes and programmes to help the weak and the needy as part of its social security and support programmes. The government accorded the highest priority to housing for the economically weaker sections. The Kerala State Housing Board (KSHB) is the nodal agency of the Government of Kerala for implementing housing schemes, particularly for the economically weaker sections. The KSHB also undertakes ventures such as housing loan schemes, house construction, plotted development schemes, construction of commercial complexes and revenue towers and implementation of the Coastal Housing and Resettlement Programme (CHRP) by mobilising institutional finance. There are government-sponsored programmes for Kochi and Thiruvananthapuram. There are numerous programmes directed towards the development of urban infrastructure and the urban poor.

15.3.2 Policy reforms

15.3.2.1 In January 2013, to give a boost to the construction sector in Kerala, the State Cabinet approved a Cabinet sub-committee recommendation to amend the Kerala Building Construction Rules and grant major concessions in the floor area ratio. The floor area ratio was increased from 2.75 to 3; if a fine of Rs 3,000 per square metre is paid, the ratio can be raised to 4. The amendment allows builders to construct large buildings on small plots. Up to 65 per cent of the total land area can be used for construction.[6] The definition of high-rise buildings has been changed from buildings with a height of 15 metres with four floors to buildings with a height of more than 16 metres.

15.3.2.2 Another major change is the stipulation that five metres of vacant space should be left on all sides of the building.[7] This stipulation is now limited to the front and any one side of the building. There are also concessions on the height of the building based on the width of the approach road. A high-level authority will be set up to grant permission to large projects. The government also intends to introduce amendments to building rules in panchayat areas.

15.4 Situation Analysis of Urban Kerala

15.4.1 Quality of infrastructure

Housing

15.4.1.1 Kerala has been a leader in terms of providing housing for the poor. Even before the major initiatives of the central government in providing housing for the poor, the Government of Kerala accorded the highest priority to housing for the economically weaker sections and initiated several innovative schemes to provide affordable housing to the marginalised and the poor. Yet, households on the lowest rung of the socio-economic ladder have been unable to construct houses. An analysis of the public housing schemes reveals that the marginalised sections of society, the destitute, women-headed households and the poorest of the poor have been inadequately covered. A target-driven mode by the implementing agency to achieve the physical and financial targets shows little concern for the participation of end-users, and there is lack of social infrastructure and poor supply of basic services. Overall, lack of a holistic habitat development approach and inadequate livelihood support programmes mark the housing schemes.[8]

15.4.1.2 As part of the Rajiv Awas Yojana (RAY) reforms, the Ministry of Housing and Urban Poverty Alleviation (MoHUPA) circulated a draft of the 'Model Provision for Amendment to the Respective Municipal Act(s)/Town Planning Act/Urban Development Act/Preparation of new legislation and so on as applicable, for reservation of Land for Housing to Economically Weaker Sections and Low Income Groups' that aimed to reserve 20 per cent of developed land (10 per cent of gross land) for plotted housing development schemes for the urban poor.[9] This has not yet been implemented in Kerala, although the Housing Policy of 2011 mentions that attempts will be made to do so.[10]

15.4.1.3 A technical group set up by the Ministry of Housing and Urban Poverty Alleviation and National Buildings Organisation noted that the shortage of housing is mostly in the lower economic strata of the population across urban India.[11] Further, the group calculated that the average number of BPL households and *kutcha* households in Kerala is 2.7 lakh, which forms 2.9 per cent of total households in India.[12] The total housing shortage predicted by it in Kerala was 0.54 million units.[13]

15.4.1.4 According to NCAER estimates, a total investment of Rs 10,800 crore at current prices during the 12th Plan period will be required to meet the estimated housing shortage if the Kerala government's norms are adopted. Using the norms of the MoHUPA, the investment required in urban Kerala is Rs 21,600 crore at current prices for the corresponding period (Appendix A.15.1 shows the detailed calculations).

15.4.1.5 Water supply: The supply of drinking water is far from satisfactory in Kerala. Only 40 per cent of the population has access to tap water from a treated source within the premises compared to 69 per cent in urban India. The dependence on wells is quite high in the State. Covered wells provide water to 15 per cent of the households compared to 1.6 per cent for urban India, and uncovered wells provide water to 44 per cent of urban households in Kerala compared to 4.5 per cent in urban India. The dependence on hand pumps, tube wells and tanks is much lower in the State.

15.4.1.6 Further, access to safe drinking water is relatively low in Kerala compared to the other southern states and the Indian average. In Kerala, only 39 per cent of urban households have access to safe drinking water against 90 per cent of households in neighbouring states and Gujarat who have access to safe drinking water.

15.4.1.7 Sanitation: The figure for latrines within the premises is 97 per cent in urban Kerala compared to 81.4 per cent in urban India. However, the share of the piped sewer system is a mere 15 per cent compared to 40 per cent for urban India. Further, 88.8 per cent of households in urban Kerala have access to bathrooms in comparison to 77.5 per cent for urban India, but only 33.5 per cent of households have access to closed drainage compared with 44.5 per cent in urban India.

15.4.1.8 Drainage: The management and conservation of urban water has become a serious development issue in Kerala, as in several developing countries. Even a city such as Kochi, which lies in a heavy rainfall region, now faces a shortage of reliable water supply, because water in the city is polluted far above the safety limits. Also, coastal cities such as Kochi face challenges from changing climatic conditions; a one-metre rise in sea level may submerge almost 80 per cent of the city.

15.4.1.9 Waste management: Solid and liquid waste management is a challenging task in Kerala. Plastic and other solid waste from the domestic sector often block the drainage system and during the summer rains flash floods occur in the cities. In addition, indiscriminate conversion of low-lying paddy fields, water bodies, ponds and so on has resulted in drainage problems. Successive governments have taken various initiatives to improve latrine coverage and waste management through intensive information, education and communication (IEC) campaigns, but these initiatives are yet to catch up with the growing population. Official studies based on 2006 data indicate that the total solid waste generated in the State is about 8,300 tonnes per day, of which 70–80 per cent is biodegradable.

Further, 13 per cent of the waste is generated by the five city corporations, 23 per cent by the 53 municipalities and the rest by the 999 gram panchayats. Of the municipalities, 27 have already constructed solid waste processing plants, which are in the possession of the municipal corporations. But gaps and issues remain. The waste processing plants have been facing issues about water/air pollution. There have been public protests by some urban local bodies and growing public concern over this.

15.4.1.10 Industrial and biomedical waste also pose severe challenges. The River Periyar is highly polluted by toxic effluents from several factories on its banks. Pollutants such as untreated domestic waste, fertilisers, pesticides and motor oil are also carried into the river through numerous canals. Though rainfall is high, proximity to the sea and pollution from industrial and domestic sources makes the surface and groundwater unusable.

15.4.1.11 Infrastructure: Traffic congestion, lack of good urban public transport, a large number of accidents and power shutdowns are other key issues that plague Kerala. Issues and strategies for urban transport are discussed in detail in Chapter 16 and for energy in Chapter 17.

15.4.2 Functional situation

Municipal finances in Kerala across various size classes of towns/cities

15.4.2.1 The Thirteenth Finance Commission observes that at the all-India level, own revenue, which formed about 63 per cent of the total revenue in 2002−03, systematically declined to about 53 per cent in 2007−08. In Kerala, the drop was marginal. The percentage share of own revenue came down slightly, from 41 to 40 per cent during this period (Table 15.4).

15.4.2.2 The share of capital expenditure registered an increase for all ULBs during 2002−08 at the all-India level. This trend is true for all classes of ULBs in the states of Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Tamil Nadu and West Bengal. Other states such as Odisha and Rajasthan also registered an increase. Uttar Pradesh and Punjab are the two states where the share of capital expenditure remained stable. Kerala is the only state where the share of capital expenditure went down, from 43.4 per cent to 41.3 per cent during 2002−08. Property tax and professional tax are the most important sources of income for Kochi in Kerala.[14]

Table - 15.4
Percentage Distribution of Expenditure of ULBs in India: 2002−08

Year	Share of Revenue in Total Expenditure (%)			Share of Capital in Total Expenditure (%)		
	Municipalities	Municipal Corporations	Consoli-dated	Municipalities	Municipal Corporations	Consoli-dated
Kerala						
2002−03	35.36	46.83	40.86	51.68	34.3	43.42
2003−04	38.19	44.29	40.86	54.67	41.53	48.47
2004−05	33.47	42.27	37.41	47.75	40.33	44.43
2005−06	34.67	44.39	39.06	46.5	47.59	47.06
2006−07	38.24	41.56	39.69	42.69	34.81	38.79
2007−08	37.57	42.09	39.52	43.86	38.76	41.27
All-India						
2002−03	41.51	75.62	62.95	31.28	24.22	27.47
2003−04	38.96	75.43	62.02	31.8	25.2	28.7
2004−05	38.13	72.44	60.4	35.57	27.62	30.87
2005−06	34.3	70.44	57.2	40.26	31.67	34.97
2006−07	31.45	68.43	55.24	41.59	32.6	36.1
2007−08	29.33	64.54	52.67	44.88	37.36	39.55

Source: 13th Finance Commission, Finance Commission Web site (http://fincomindia.nic.in/ShowContentOne.

Urban poverty

15.4.2.3 All-India urban poverty decreased from 25.7 per cent in 2004–05 to 20.9 per cent in 2009−10, declining by 4.8 percentage points.[15] In Kerala, poverty came down to 12 per cent for both rural and urban areas. In urban areas, it declined from 18.4 per cent in 2004–05 to 12 per cent in 2009–10, whereas the decline was sharper in rural Kerala, from 20 per cent to 12 per cent. Despite the fact that the poverty rates are relatively lower in Kerala, they are still high when compared with the developed nations.

15.4.2.4 The upshot is that Kerala is a rural–urban continuum and there is little difference between rural and urban Kerala. This also holds true for access to services, infrastructure and markets for the economically better-off sections. Therefore, the proposed development strategy should be one that integrates both rural and urban areas.

15.5 A New Approach: Kerala State Spatial Strategy

15.5.1 Elements of the strategy

15.5.1.1 Since Kerala has the unique feature of a rural–urban continuum, it needs a unique strategy for urban development that will not focus on urban development alone. Rather, it will be based on a holistic approach of developing a 'Kerala State Spatial Strategy' within the framework of the Perspective Plan 2030. "Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy."[16] The State Spatial Strategy will safeguard areas of state interest and provide guidelines aimed at maximising the efficiency of human settlements and other productive efforts and enhancing rural urban complementarities.[17]

15.5.1.2 There are four elements in this strategy:

Element 1: Identify across the State:

- Education and health hubs
- State industrial and manufacturing zones, eco-industrial parks
- Tourism zones
- Agricultural and allied activity zones (agri-zones, dairy zones, forests)
- Food processing centres and cold chains
- Traditional industry zones and villages
- Special economic zones

Element 2: Develop these zones into compact integrated townships and compact rural human settlements.

Element 3: Link them with trade and transport corridors.

New planned, integrated cities along these transport corridors complemented by links to rural service and production centres will enhance the competitiveness of economic activities, efficiencies of upgraded infrastructure and, above all, the viability of both rural and urban areas.

Element 4: Initiate a programme for upgrading infrastructure and services within the existing urban centres and existing intercity networks to improve the quality of both rural and urban areas.

15.5.1.3 The new spatial strategy will be implemented by bringing together state and local government bodies and business and community leadership to formulate comprehensive plans and

carry out coordinated targeted investments. The Department of Town and Country Planning along with the departments of urban affairs and rural development, panchayats, water, forest and transport infrastructure authorities will coordinate to draw up a detailed spatial plan for the State. Investments in urban and rural areas will be enhanced through public-private partnerships and other innovative modes.

15.5.1.4 In short, the authorities will select a concentration of urban and rural settlements and develop compact urban and rural areas through deliberate planning so as to contain the urban spread. The State Urban Report of Kerala, 2012, has identified five urban corridors that will exist in 2031 based on the concentration of population:

i. Thiruvananthapuram–Kollam
ii. Pathanamthitta–Kottayam
iii. Alappuzha–Ernakulam–Thrissur–Palakkad, with a special emphasis on Ernakulam and Thrissur
iv. Malappuram–Kozhikode
v. Kannur–Kasaragod

15.5.1.5 Based on spatial and demographic analysis, it has also identified 10 urban clusters: Thiruvananthapuram, Kollam, Alappuzha, Kochi, Thrissur, Palakkad, Kozhikode–Malappuram, Kottayam–Pathanamthitta, Kannur and Guruvayoor.

15.5.1.6 Most of these urban clusters are also the economic nodes proposed in KPP 2030. While it is proposed to develop Thiruvananthapuram, Thrissur, Palakkad, Kozhikode, Malappuram, and Pathanamthitta as education and health hubs, Kollam, Kannur and Alappuzha will be developed into hubs of traditional industries. The Ernakulam–Palakkad corridor is proposed to be a state manufacturing and investment zone. Kochi is to be developed into a global city. Indeed, population concentration in these nodes is likely to increase further and this calls for the development of new cities and the updating of old ones. These will then be connected through trade and transport routes. It will also require the preservation and development of rural areas by limiting urban sprawl. In what follows, urban and rural development strategies will be discussed comprehensively.

15.5.2 Development of smart, green and compact cities

15.5.2.1 Urban development will have four pillars:

- Physical planning and regulations
- Attempts to influence residents' behaviour
- Urban governance
- Transformation of Kochi into a global city

Pillar 1: Physical planning

15.5.2.2 Physical planning will be based on the principles of high density, better options for walking or public transport, reduced need for transportation by car, increased accessibility, preservation of green areas outside the cities, promotion of existing infrastructure, better quality of life, better relations with neighbours and greater safety. There are nine elements in physical planning.

Element 1: Land management

15.5.2.3 Land supply plays a critical role in supporting the quality of life. Land use will be improved through — appropriate and affordable land use, building standards and regulations; improving procedures for land transfers (including cadastral mapping, titling and registration); implementing measures to stop land being held vacant for speculative purposes; and providing information to the public on land market indicators. Digitisation of land records and GIS maps are critical elements here.

15.5.2.4 Ecologically sensitive land (whether in rural or urban areas) needs to be zoned — no conversion should be allowed in non-occupied wetlands. Human settlements' zoning needs to be based on the principle of 'mixed land use' to facilitate the development of integrated townships. Current and future high-density zones within the urban agglomerations may be identified under the regional spatial strategy. In other words, there should be integrated development of urban and rural areas. High-quality housing, commercial establishments, public utilities, urban public/community spaces, social infrastructure and so on will be the future requirements in Kerala.

15.5.2.5 For the economically weaker sections, the community land trust model proposed in Chapter 13 on Land, Labour and Capital may be explored for building houses. It is important that housing schemes for the poor mobilise beneficiary participation in the programme.

Element 2: Compact cities

15.5.2.6 The compact city does not have an exact definition, but three characteristics define it[18]:

- Dense and contiguous development patterns[19]
- Urban areas linked by public transport systems
- Accessibility to local services and jobs

15.5.2.7 The concept of a compact city has been at the core of urban planning in most developed countries. Since Kerala is a land-scarce state, a compact city is the ideal policy for urban revitalisation and the formation of new cities.

15.5.2.8 OECD (2011) points to the need for flexibility of building forms. High-rise buildings are not a guarantee of high density.[20] The study compares and contrasts a Parisian district with buildings of 6 or 7 storeys, which is denser than a 20 or 30-storey building neighbourhood in Hong Kong on the same area of land. Mixed land use zoning is necessary to achieve accessibility to local services and jobs.

15.5.2.9 Urban design guidelines will evolve based on citizens' preferences and mainstreaming ideas of sustainability, gender[21] and even arts. While newer areas need to develop, older neighbourhoods need guidelines to re-develop while preserving their cultural heritage. All the elements, together, should improve the quality of life for residents. A common element that is suggested is the encouragement and preservation of public spaces, especially community areas.[22] Developing parks within cities is an important element of healthy living.

Element 3: Smart cities

15.5.2.10 While general urban development in Kerala will be based on the principle of compact cities, the global hubs of education and health will be more advanced. These will be knowledge-based 'smart cities'. One definition of a smart city is "a city well performing in a forward-looking way in economy, people, governance, mobility, environment and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens."[23] Cities, companies and universities are exploring smart city opportunities.

15.5.2.11 The government will explore solutions to plan the new cities based on these principles.

Element 4: Mobility and transport (strong infrastructure and sustainable transport systems[24])

15.5.2.12 A key principle of a compact city is a good public transport system. The city has to be designed to encourage usage of the public transport system. The model that is suggested for development of new cities and regeneration of old cities in Kerala is transit-oriented development (TOD).

15.5.2.13 Suzuki et al. (2013)[25] lay down two particular characteristics of transit-oriented development:

- Proximity to and a functional relationship with transit stations and terminals and service provi¬sion by high-quality public transit (bus rapid transport or BRT systems, underground trains and so on). Given the lack of road space in Kerala, BRT development may be impractical. Right of way to buses may be provided as an alternative.
- Compact, mixed-use buildings and neighbourhoods that, because of their design, encourage walking, cycling and use of public transit by residents, employees, shoppers and visitors.

15.5.2.14 Successful TOD includes strategic (macro) and design (micro) elements such as a strong development climate and master plans for multi-use, high-intensity development supported by implementation plans. They also include investments that promote the following:

- Easy and direct pedestrian, bicycle and public transit access.
- Good signage and a pleasant environment to attract substantial pedestrian flows.
- Significant regional accessibility to major job and activity centres.
- Short, direct connections between transportation modes and transit facilities.
- Bicycle lanes and parking facilities that feed stations.
- Attractive facilities that are well integrated with the surroundings (public spaces, street furniture and so on).
- Safe and secure designs, including adequate lighting.
- Effective parking management around stations.

15.5.2.15 As Box 15.2 shows, TOD can fit into the regional spatial strategy that is being suggested for Kerala. Further, literature shows that transit-oriented development leads to increased public transit usage, improved access to regional jobs and reduced commuter times per household worker. Box 15.2 illustrates the cases of Singapore and Copenhagen, which planned their urban development strategy much in advance and then developed the transport network. The two countries adapted the model to suit their economic needs and geography.

Box No 15.2

Transit-Oriented Development

USingapore has embraced Scandinavian planning principles that call for radial corridors that interconnect the central core with master-planned new towns. Its spatial plan has the appearance of a constellation of satellite 'planets' (new towns) that surround the central core, interspersed with protective greenbelts and interlaced with high-capacity, high-performance rail transit.

Copenhagen's Finger Plan is a textbook example of a long-range planning vision shaping rail investments, which, in turn, shaped urban growth. They identified corridors to channel overspill growth from urban centres early in the planning process. Rail infrastructure was built, often in advance of demand, to steer growth along desired growth axes.

Source: Suzuki, H., Cervero, R. and Iuchi, K. (2013). Transforming Cities with Transit. World Bank.

Element 5: Quality of roads and transport development[26]

- The cities should be completely integrated within and between each other through transport networks.
- Good, efficient, on-time inter-modal public transport system is crucial, especially for senior citizens and women. Both the timings and tickets need to be integrated.
- Bus and rail terminals should be next to each other as in Thiruvananthapuram. A footbridge is required to connect the rail and bus terminals. Cities should be pedestrian-friendly. While a BRTS may be difficult to construct within the cities of Kerala, buses can be given right of way.
- All lanes in the cities are to be paved. Roads should have at least two lanes with a sidewalk on at least one side and strict speed limits should be implemented for motor vehicles. All houses should leave some public space from their private land for roads and lanes. Further, all roads and lanes in Kerala, especially in urban areas, need to have name boards so that locals, tourists and visitors can easily find their way through the road network. Every road should have road signage for easy navigation. Motion sensor streetlights need to be used. These policies need to be implemented starting from the panchayat level due to the rural–urban continuum in Kerala.
- ICT is the lynchpin of any smart city, especially of an on-time public transport network.

Element 6: Cultural facilities[27]

15.5.2.16 Cultural facilities often influence where individuals choose to live and work. Promotion of festival marketplaces, entertainment districts, fine arts galleries, performing arts centres, sports arenas, convention centres and office complexes are important components in urban revitalisation strategies.

15.5.2.17 In Chapter 3 on Tourism, cultural tourism, especially museum tourism, is advocated. It is a way to conserve and promote the rich cultural heritage of the State. A majority of domestic tourists come from within the State. The Kerala Tourism Policy 2012 discusses hop-on-hop-off buses for tourists. The tourism department should coordinate with the public transport system to offer such services. This strategy has been very successful in Delhi.

Element 7: Community facilities to enhance the working, living and business environment of cities[28]

15.5.2.18 Social infrastructure is important for a smart city. The provision of community facilities contributes to developing social capital by bringing citizens together. Facilities such as urban centres, networked public libraries, clubs, local play areas and parks are crucial components of healthy urban living.[29] ICT can be used to announce activities and events being organised in various parts of the city. Libraries are an important place for all generations of people to meet and network. ICT-embedded libraries are a marked feature of the developed Western world that needs to be brought to the very literate and aware Kerala.

Element 8: Encourage academic courses on architecture and urban planning

15.5.2.19 There are college degrees offered in architecture and urban planning, and these need to be strengthened. Further, a process of interaction between colleges and communities needs to be initiated. Organising design competitions among students for the various types of communities can get creativity and innovation flowing, which will help address the changing challenges.

Element 9: Provision of utilities

15.5.2.20 Upgrading the energy, water, sanitation and waste management infrastructure is crucial for the development of smart cities. This calls for excellent coordination between all departments. In India, it is often the case that one utility company digs up a road, lays cables and repairs the road, only to have another utility company dig up the road again. This impacts the quality of life of the people. Instead, the various agencies need to coordinate, plan the necessary infrastructure or the changes required and then carry out the appropriate action, such as digging up a road.

15.5.2.21 **Energy:** Cities and towns need to explore green energy options. Since KPP 2030 focuses on health and education as the growth engines, the future growth of the State may be building-intensive. Therefore, green building norms should be standardised and implemented, while old buildings need to be upgraded.

15.5.2.22 **Water:** The government needs to develop a water management programme. This will have the following components:

- Augmentation of water resources.
- Conservation of water resources through reduced use.
- Water treatment and its re-use for non-drinking activities.
- Designing housing societies so as to minimise water supply and drainage problems.
- Safe disposal of liquid waste.
- Laws on rainwater harvesting.

15.5.2.23 Chapter 18, on Water, discusses various strategies in detail.

15.5.2.24 Sanitation: The government will promote the setting up of an underground sewerage system and liquid waste treatment plants by drafting a Sanitation Policy. To make urban structure an effective tool that caters to people's needs, administrative reform is necessary and outdated laws need to be redrafted. The chapter on Water discusses the integrated policy for water and sanitation in detail.

15.5.2.25 Solid waste: It is proposed that Kerala develop a Waste Management Programme. The components of this plan will be:

- Appointment of a waste planner within the urban and rural departments.
- Introduction of an 'environment fee' for all residents for waste management.
- Profiling of waste and its projections by district.
- Designing the waste management strategy: Components of the strategy will include collection, recycling, reuse and reduction.

  - Collection: The policy will provide for haulers to collect refuse and recycling material from commercial and multi-family properties.
  - Reduction: This will be encouraged as the most desirable behaviour. Reduction of solid waste is the most efficient way to keep materials out of landfills, reduce costs of collection and reduce air pollution from collection trucks.
  - Reuse: Reusing material is an excellent way to reduce solid waste.
  - Recycle: When the first two steps of collection and reduction cannot be avoided, recycling of all possible materials reduces the amount of material going to the landfill and produces new products from waste. There has been an explosion in waste management technology. Civic bodies have the option of adopting a suitable technology or a combination of technologies to process waste and reduce untreatable waste. Waste, for instance, can be converted into energy. Waste-to-energy plants, where waste is converted into electricity, can supply power to the city. This reduces the volume of waste by 90 per cent, thus decreasing the amount sent to the landfill. The largest landfill station of Los Angeles in the US has been closed down after a new waste-to-energy plant was set up.
  - Landfill: The solution of last resort is when waste is buried in the ground. Importance has to be given to the selection of landfill sites. These should be identified based on an examination of environment issues. They should be away from habitation clusters, forest areas, water bodies, monuments, national parks, wetlands and places of important cultural, historical or religious interest. Also, they should be away from airports and airbases by at least 20 km. They should be large enough to last 25 years.

- Promoting private waste management and recycling companies. These will be new types of enterprises that will ensure sanitation, resource recovery, employment and economic prosperity. The ULBs could also earn an income from the sale of locally produced compost.
- Changing public attitudes and behaviour through rigorous campaigns will be an important component of this strategy.

15.5.2.26 **Liquid waste management:** Kerala needs to develop a policy for liquid waste management at the city level that involves the 4Rs (Reuse, Reduce, Recycle, Recover). The chapter on Environment expands on this. Kamyotra and Bharadwaj (2011) discuss various wastewater technologies that municipalities can use.[30] For example, treated sewage water can be used for irrigation.

Investment requirement in the provision of utilities

15.5.2.27 The NCAER has calculated the investment required over a period of 20 years to provide basic urban infrastructure. These estimates are based on the population projections made by it and a host of assumptions. It shows that the total investment requirement will be Rs 5,843 crore during the 12th Plan, which will almost triple to Rs 17,750 crore by the 15th Plan (Table 15.5). In terms of the share of GDP, it will increase from 2.1 per cent in the 12th Plan to 4.1 per cent by the 15th Plan. A major challenge is to meet this funding requirement and implement programmes to achieve the targets.

Table - 15.5
Investment Requirements for the Provision of Utilities over 2012–2030

	12th Plan (2012–17)		13th Plan (2017–22)		14th Plan (2022–27)		15th Plan (2027–31)*	
	Estimated Cost 2017 in million Rs	Estimated O&M 2017 in million Rs	Estimated Cost 2022 in million Rs	Estimated annual O&M 2022 in million Rs	Estimated Cost 2027 in million Rs	Estimated annual O&M 2022 in million Rs	Estimated Cost 2031 in million Rs	Estimated annual O&M 2031 in million Rs
Water Supply	8,138.24	399.3	9,044.9	443.8	9,932.8	487.3	10,515.8	5,159.5
Sewerage	6,661.02	595.6	7,403.1	661.9	8,129.8	10,903.2	8,607.02	7,695.5
Solid Waste Management	2,931.40	1,330.2	733.02	332.6	804.97	5,479.1	852.2	3,867.1
Storm Water Drainage	32,271.72	484.1	8,069.8	121.04	8,861.9	1,993.8	9,382.1	1,407.2
Total	55,619.38	2,809.1	25,250.8	1,559.4	27,729.4	18,863.5	65,456.3	1,12,049.1
Avg. projected GSDP for the Plan period	1,54,22177		23,04,0303	31.28	24.22	27.47	24.22	27.47
% to GSDP	2.01	0.1	0.91	0.06	1.00	0.68	2.36	4.05

Source: Computer by NCAER

Pillar 2: Change in values and perceptions

15.5.2.28 People's values and attitudes drive their behaviour. Hence, initiatives to promote quality of life need to focus on changing people's values and attitudes. For instance, successive governments in Kerala initiated several programmes for solid waste management, but they did not succeed, perhaps, because of the lack of public involvement. Unless people are directly involved, urban development programmes are not successful.

15.5.2.29 Human practices are structured by[31]:

- Know-how and embodied habits
- Institutionalised knowledge and explicit rules
- Engagements
- Technologies

15.5.2.30 All these elements need to be addressed to change public practices and governments can play an important role in changing behaviour and practices. Two examples are provided in Box 15.3.

Box No 15.3

Changing values and perceptions through government intervention: Two case studies

Bicycle policy in Odense, Denmark: Odense is Denmark's third largest city. For several years, the municipality has had a comprehensive bicycle policy with several initiatives to promote bicycling as a means of transport within the city. From 1999 to 2002 the municipality conducted a project called 'Odense – the national bike city of Denmark'. The project included several improvements in conditions for bicyclists, such as better parking facilities at public places, services such as free pump stations for inflating bicycle tyres and adjustments to traffic lights in order to create 'green waves' for bicyclists instead of for cars. It also tried to improve the 'image' of bicycling. Through advertising and distribution of magazines, it promoted the idea that bicycling is stylish and closely related to health. Thus, efforts were made to restructure people's habits by affecting all the factors that determine habits.

Use of seat belts in cars: In Delhi, the traffic police initiated a campaign to increase the use of seat belts in cars to 100 per cent. This was supported by advertising and heavy fines on defaulters. The programme has had a high success rate.

Source: Jensen, J.O., Christensen, T.H. and Gram-Hanssen, K. 2011. Sustainable urban development – compact cities or consumer practices? Sustainable Urban Development Boligforsker Seminar 2011. http://vbn.aau.dk/files/56542117/Jensen_et_al._Sustainable_urban_development_Boligforskerseminar2011.pdf.

Pillar 3: Improved urban governance

15.5.2.31 Kerala is exemplary in its adoption of the 73rd and 74th Constitutional amendments and devolution of funds, functions and functionaries to local bodies. Chapter 24, on Governance, discusses this in more detail. However, there is space for improvement as the structural transition in Kerala intensifies over the next 20 years.

15.5.2.32 "Good urban governance is the sum of the many ways individuals and institutions, public and private, plan and manage the common affairs of the city. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action can be taken. It includes formal institutions as well as informal arrangements and the social capital of citizens. Urban governance is inextricably linked to the welfare of the citizenry. Good urban governance must enable women and men to access the benefits of urban citizenship. Good urban governance, based on the principle of urban citizenship, affirms that no man, woman or child can be denied access to the necessities of urban life, including adequate shelter, security of tenure, safe water, sanitation, a clean environment, health, education and nutrition, employment and public safety and mobility. Through good urban governance, citizens are provided with the platform which will allow them to use their talents to the full to improve their social and economic conditions."[32]

15.5.2.33 The overarching goal is to build inclusive cities that encompass the following:

- Sustainability: Balanced social, economic and environmental priorities
- Subsidiarity: Local autonomy and accountability
- Equity
- Efficiency in service delivery
- Transparency and accountability

- Civic engagement and citizenship
- Security in terms of environment management, disaster preparedness and personal safety

15.5.2.34 The transition phase may require detailed training of the urban local bodies in technical and governance issues. Systems may, therefore, be set in place to guide the ULBs. Usage of ICT too is essential to support good urban governance.

15.5.2.36 A special recommendation for Kerala is the following:

Expand the existing boundaries of Urban Local Bodies (ULBs) to include census towns: Governance in the existing and newly formed census towns could be strengthened by expanding the existing boundaries of municipal corporations to include census towns and other small towns depending on their proximity to urban areas. The regional spatial strategy can be used to determine which towns will be better off being merged under the urban agglomeration and urban government, and which ones will be better off under rural governance. This will ease the pressure on local governance in urban Kerala. An administrative change in the jurisdiction of Bangalore and adjoining ULBs took place in January 2007. Seven City Municipal Councils (CMCs), one Town Municipal Council (TMC) and 110 villages were merged with Bangalore Mahanagara Palike (BMP) to form the new Bruhat Bangalore Mahanagara Palike (BBMP). Kerala is following this approach in Thiruvananthapuram and Kochi using two different models. Similar initiatives should be taken for the large UAs in Kerala to bring newly demarcated urban areas under the governance framework. However, diseconomies of scale may set in if the governance area becomes too large. Further, the trend of urban sprawl needs to be controlled and city sizes should be firmed up, because the costs of an urban sprawl are much too high.

Pillar 4: Envisioning Kochi as a global city by 2030

15.5.2.38 One proposal is to transform Kochi into a global city. This means Kochi's entry onto A.T. Kearney's 'index of global cities' (Box 15.4). Kochi is one of Kerala's fastest growing business centres and is the right candidate to be India's first smart city to appear on the global city index. Its main asset is its port. Although strictly not comparable, cities such as Hamburg in Germany and Rotterdam in the Netherlands are port cities. After the fall of the Berlin Wall in 1989, Hamburg strategically reinvented itself as a crucial hub for Central Europe. Similarly, in Kochi the focus should be to integrate the city and the port. Port cities around the world, such as Singapore, Hong Kong and Hamburg, should be studied to see how they continuously reinvent themselves.

Box No 15.4

Metrics to Measure a Global City, 2012

A.T. Kearney's Global Cities Index ranks metropolitan areas on 25 metrics across five dimensions:

1. **Business activity:** It is measured by the presence of the headquarters of major corporations, locations of top business service firms, the value of a city's capital markets, the number of international conferences and the flow of goods through ports and airports (weight 30 per cent).
2. **Human capital:** It evaluates a city's ability to attract talent based on the following measures: size of foreign-born population, quality of universities, number of international schools, international student population and number of residents with university degrees (weight 30 per cent).
3. **Information exchange:** This examines how well news and information circulate within and outside the city. The five metrics are level of censorship, broadband subscriber rate, accessibility to major TV news channels, Internet presence (capturing the robustness of results when searching using the city's name in major languages) and number of international news bureaus and 10 major TV networks (weight 15 per cent).
4. **Cultural experience:** This measures diverse attractions, including number of major sports events a city hosts, number of museums, performing arts venues, diverse culinary establishments, number of international travellers and number of sister-city relationships (weight 15 per cent).
5. **Political engagement:** This reviews how a city influences global policy dialogue as measured by the number of embassies and consulates, major think tanks, international organisations, local institutions with international reach that are based in the city and the number of political conferences that a city hosts (weight 10 per cent).

Source: AT Kearney. 2012. 2012 Global Cities Index and Emerging Cities Outlook. http://www.atkearney.com/documents/10192/dfedfc4c-8a62-4162-90e5-2a3f14f0da3a.

15.6 Finance

15.6.1 Interventions to ensure sustainable urbanisation in the State within the next two decades calls for funding strategies. Some of these mechanisms are given below.

Mechanism 1: Improve the tax base of ULBs

15.6.2 Increasing the tax base of ULBs would allow local bodies to invest in capital projects related to providing basic services in urban areas. This could be achieved by adopting the following measures:

1. Increase property tax rates to 3–4 per cent of state GDP and ensure 100 per cent cost recovery for municipal services: Property tax is the major source of own revenue. Currently, it forms a small share of municipal income in India. In order to access world-class urban facilities, municipal bodies in Kerala should raise property tax to such an extent that it accounts for 3−4 per cent of the state GDP. The ULBs should also ensure 100 per cent cost recovery of user charges for municipal services. Although this is one of the mandatory reforms under the JNNURM, stricter compliance is required.
2. Eliminate all exemptions on property tax including those on state and central government properties.
3. Provide cross-subsidies for slum areas.
4. Impose registration taxes on motor vehicles based on vehicle characteristics and carbon

dioxide emissions plus annual road taxes (Box 15.5).
5. Impose heavy congestion fees on private vehicles.
6. Parking fees can be a substantial source of revenue for municipalities.

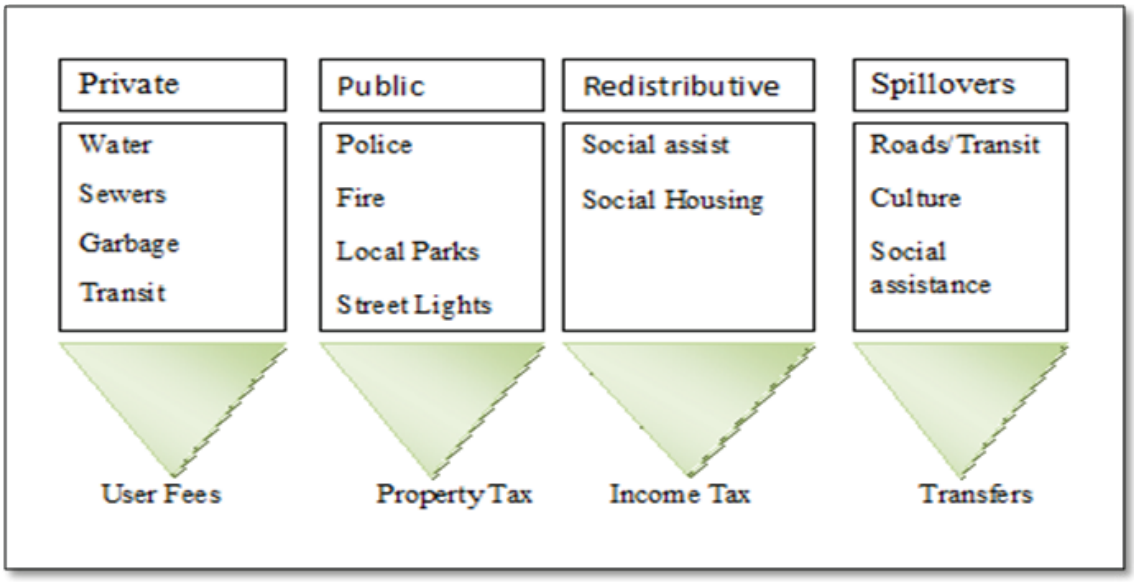
Box No 15.5
The Singapore Model

Car buyers in Singapore must pay excise and registration duties of about 150 per cent of the vehicle's market value, as well as bid for a limited number of government permits, called certificates of entitlement, that allow a car on the road for 10 years. A similar model can be implemented in Kerala with annual road taxes increasing over time.

Source: Singapore Ministry of Transport Web site. http://app.mot.gov.sg/Land_Transport/Managing_Road_Use/Vehicle_Ownership.aspx

15.6.3 Figure 15.4 provides guidance on municipal finance and recommends the use of different financial tools for different services.

Figure 15.4
Different Tools for Different Services



Source: Slack, E. 2009. Guide to Municipal Finance. UN Habitat. Nairobi.

Mechanism 2: Introduce pooled financing mechanism in small towns to ease their access to capital markets

15.6.4 In Tamil Nadu, a pooled financing mechanism was used to finance water supply in small towns to ease their access to capital markets. Such practices could be adopted in Kerala where small ULBs do not have the financial strength to access the bond market. The KURDFC could be used for this purpose under the PFDF, which the central government set up for this explicit purpose. This could also be used to develop infrastructure in all towns including census towns.

Mechanism 3: Set up an Urban Regulatory Authority

15.6.5 An Urban Regulatory Authority is necessary to ensure efficient private sector participation in water and power in municipal services, to maintain the quality of services and to make sure that the cost of services to the public is reasonable. This authority may be given statutory powers to enforce these objectives.

15.7 Rural Development

15.7.1 The background

15.7.1.1 Rural development primarily means improvement in economic and societal conditions and the quality of life in rural areas in harmony with natural endowments and the landscape of the countryside, preserving its irreplaceable resources and culture. In this sense, it is a comprehensive and multidimensional concept that encompasses the development of agriculture and allied activities, traditional industries and crafts, socio-economic infrastructure, community services and facilities and, above all, human resources in rural areas in a socially and environmentally sustainable manner. It will, thus, draw on the perspective plans of the respective sectors. Rural development will be an integral part of the spatial strategy because Kerala is a case of an urban–rural continuum.

15.7.1.2 More than 50 per cent of the population in Kerala currently lives in rural areas, but over the next 20 years it will decline to 30 per cent. Therefore, it becomes even more important to develop rural areas to facilitate their transition. This requires a comprehensive perspective plan to develop rural areas.

15.7.2 Strategic planning

15.7.2.1 Rural development programmes can make a vital contribution to the attractiveness of rural areas. They can also ensure that in a competitive, knowledge-based economy, a sustainable balance between urban and rural areas is maintained. The six pillars of rural development are:

- Competitiveness of agriculture and rural-based industries
- Diversification of non-farm income
- Improvement in quality of life
- Environment
- Towards smart villages
- Infrastructure

Pillar 1: Competitiveness of agriculture and rural-based industries

15.7.2.2 So far, the focus of planning has been on providing livelihoods. Under the new strategy, the focus will shift towards enhancing the locational advantages of rural areas and increasing their global competitiveness. As suggested in the respective chapters in KPP 2030, a range of measures will target human and physical capital in the agriculture, livestock, fisheries, food and forestry sectors to promote knowledge transfer and innovation and high quality production. Local strengths and challenges should be identified. Most rural communities can be grouped into one of five categories, although several may fall into more than one category:

- **Villages adjacent to high-amenity recreational areas such** as national parks, national forests and coastlines. They provide food, lodging and associated services. Increasingly popular places to live, work and play, these communities often struggle with strains on infrastructure and the natural environment. Many of these communities also experience seasonal population cycles that can strain resources.

- **Resource-dependent villages** are often home to single industries, such as farming or mining, so their fortunes rise and fall with the market value of that resource. A key challenge facing resource-dependent communities is diversifying the economy while maintaining their rural quality of life and character
- **Transition villages** are located on the fringes of metropolitan areas and are typically connected to them by state and interstate highways. Residents have access to economic opportunities, jobs and services. More affordable housing and access to metropolitan amenities have made many of these peripheral areas grow at a faster pace than their adjacent metropolitan areas as a whole. But precisely because they are such attractive places to settle in, these villages often face pressures to continue to provide more housing and services to new residents. They eventually transform into urban areas.
- **Traditional industry-based villages**. The economy of these villages or cluster of villages is based on traditional industries.
- **Second home and retirement villages** might overlap with some of the above groups. These villages struggle to keep pace with new growth while maintaining the quality of life that drew residents in the first place.

15.7.2.3 The nature of the enterprises encouraged to locate in rural areas must be appropriate to those areas in economic, social and environment terms. Incentives can help direct commercial and industrial development to appropriate locations. For instance, emerging strategies that can help a traditional resource economy adapt to the changing global market and sustain it over the long term include more sustainable agriculture practices; production and distribution of renewable energy such as wind, solar, biomass, methane from livestock, and geothermal energy; and green jobs in former rural manufacturing plants converted to produce, distribute, install and maintain green energy facilities and distribution networks. Similarly, the needs of the development strategies of other types of villages can be identified and suitable approaches can be developed for their competitiveness.

Pillar 2: Diversification of non-farm income

15.7.2.4 Diversification is necessary for growth, employment and sustainable development in rural areas, because it contributes to a better territorial balance in both economic and social terms. The resources devoted to diversifying the rural economy should contribute to the overarching priority of creating employment opportunities and conditions for growth. The range of measures available will, in particular, be used to promote capacity building, skills acquisition and organisation for local strategy development and also to help ensure that rural areas remain attractive for future generations. Policies should be especially geared towards women and the elderly, as it is seen that unemployment rates among women is quite high in Kerala. Key recommendations to improve the economy are[33]:

- Raise the economic activity and employment of the region by diversifying the economic base.
- Provide better infrastructure: Rural Kerala is extremely well developed and networked, both in terms of roads and ICT. However, there is always space for upgrading infrastructure and using green technology. Water transport infrastructure can play a major role in the development of Kerala's economy. It can connect rural areas and attract more tourists by giving them a chance to experience local culture.
- Invest in local cultural heritage: Even small towns and villages in the developed countries have at least one museum to showcase their local culture, art and heritage. The diversity of Kerala's culture can be showcased. This may attract tourists and thereby generate employment and income for the local economy.
- Organic farms can be homestays and provide organic food while also being tourist attractions.
- Develop new comparative advantages, train local people in various vocations, develop capacity and promote entrepreneurship and innovation. This will tie in with various aspects of the rural economy.

- Develop the provision and innovative use of renewable energy sources. This can help create new outlets for agricultural and forestry products, enhance the provision of local services and diversify the rural economy.

Pillar 3: Improvement in quality of life

15.7.2.5 Smart planning is required for rural areas. Careful planning of rural areas and close cooperation between rural and urban planning authorities can help ensure that commercial development in rural areas strengthens the local economy while protecting the environment and the quality of rural life.
15.7.2.6 Development standards should be established in areas such as land use requirements, regulations for zoning, subdivision standards, landscaping and so on.

15.7.2.7 Areas for village centres should be designated, where needed. As mentioned in Chapter 13 on land, zoning is critical to save ecologically fragile land. Like smart cities, smart villages will be pedestrian-friendly and connected to public transport networks.[34]

15.7.2.8 Make it a requirement that infrastructure, such as roads, water and sewer systems and schools, have to be in place when a new neighbourhood is constructed.

Develop plans, codes and policies, especially regarding the laying of utilities

15.7.2.9 Community facilities such as networked libraries (using inter-library digital loans) and parks are critical for a good quality of life. At the same time, commercial corridors, traditional industrial areas, agricultural service areas (often near railroads) and markets may be developed. A financial feasibility analysis, identifying appropriate potential uses, can help the development community understand the opportunities. Localities and business groups can map underused sites along major commercial corridors and evaluate their potential.

15.7.2.10 As mentioned in the chapter on Land, strategies for land use should also be developed at the panchayat level.

Pillar 4: Improving the environment and the countryside

15.7.2.11 The priority areas are biodiversity and the preservation and development of high-value nature farming and forestry systems and traditional agricultural landscapes, water; and climate change. These environmental objectives should be integrated so that they can contribute to the preservation of biodiversity.

Pillar 5: Towards smart villages

15.7.2.12 The adoption and diffusion of ICT in rural areas is essential for diversification, as well as for local development and the provision of local services and the promotion of e-inclusion. Economies of scale can be achieved through village ICT initiatives that combine IT equipment, networking and e-skills training through community structures. Such initiatives can greatly facilitate IT adoption by local farms and rural businesses and the adoption of e-business and e-commerce. Full advantage needs to be taken of the possibilities afforded by the Internet and broadband communication, supported, for example, by regional programmes to overcome the disadvantages of location. Significant investment will be undertaken in major telecommunications, transport, energy and water infrastructure over the coming years. Considerable support needs to be given to developing connections with business or science parks.

15.7.2.13 **Rural call centres:** Indian services companies are opening business process outsourcing (BPO) operations in rural areas as a way to keep costs down while bridging the digital divide in the country. Andhra Pradesh and Karnataka have taken the lead. In Kerala, too, some initiatives have been reported; one such rural BPO centre has been set up in Kasaragod. Concerted efforts need to be made to promote these centres in rural areas in Kerala. This will help bridge the rural–urban divide in income.

15.7.2.14 **Promote social entrepreneurs:** Social enterprises need to be developed to provide skills and training to the rural population in ICT and absorb them into this sector. HarVa India is an example, which runs a project in Haryana to promote rural entrepreneurship and ICT training in rural areas in the State. Kerala must draw on these experiences.

Pillar 6: Infrastructure

15.7.2.15 Energy, water and waste management needs should be strategised from the panchayat level.

15.7.3 Implementation

Building local capacity for a community-led local development strategy

15.7.3.1 Rural development in India is marked by a top-down approach and most programmes are centrally sponsored. Due to the flow of funding to rural development, there has been little incentive in India to notify census towns as urban areas. Further, there has been little progress in rural development due to the lack of people's involvement. One such programme is the centrally sponsored 'Provision of Urban Amenities to Rural Areas' (PURA) project (Box 15.6), which has been implemented in Thirurangadi panchayat, in Kerala's Malappuram district.

Box No 15.6

Provision of Urban Amenities to Rural Areas (PURA)

The Ministry of Rural Development, Government of India launched the PURA scheme as a Central Sector scheme during the remaining period of the 11th Plan. The scope of the scheme is to select private partners to develop livelihood opportunities, urban amenities and infrastructure to prescribed service levels and to be responsible for maintaining them for a period of ten years in select panchayats/ cluster of panchayats. Under the programme, private sector entities with experience in development and management of community-oriented infrastructure projects are selected through an open, competitive bidding process based on rigorous qualifications and evaluation criteria. The selected private partners are required to provide amenities such as water supply and sewerage, roads, drainage, solid waste management, street lighting and power distribution and undertake some economic and skill development activity as part of the PURA project. The private partners may also provide add-on revenue-earning facilities such as village-linked tourism, integrated rural hub, rural market, agri-common services centre and warehousing and so on, in addition to the above mentioned amenities. When the PURA project spans several panchayats in a cluster, the private partner will propose sub-projects with PURA elements for each of the panchayats.

Leveraging of public funds with private capital and management expertise for creation and maintenance of rural infrastructure is the essence of the PURA scheme. It is envisioned to act as the catalyst not only for convergence between different infrastructure development schemes, but also for the new model of managing urbanisation in rural areas. There has been little evaluation of the programme, but it has not yet made a mark in terms of performance.

Source: Ministry of Rural Development, http://rural.nic.in/sites/downloads/pura/Modified_Preface.pdf

15.7.3.2 Rural development requires a shift from top-down planning approaches to bottom-up approaches, where the community is involved in identifying its own problems, conceptualising solutions to those problems and planning and implementing development programmes. It is necessary to encourage communities to work together as a coalition to gain an advantage in seeking central and state economic and community development funding.

15.7.3.3 Integrated approaches involving farmers, foresters and other rural actors can safeguard and enhance the local natural and cultural heritage, raise environmental awareness and invest in and promote specialty products, tourism and renewable resources and energy. Box 15.7 discusses local participation in South Korea.

Box No 15.7

Local participation: The Case Study of South Korea

After it was devastated by the war, the government of South Korea started a movement called 'SaemoulUndong'. Under the rural development plan, they had a village headman, the parallel of India's gram panchayat, an executive committee and a village fund. Experts were deputed to local bodies to hold council meetings in order to prepare a village development plan according to priority. The priority could be roads, healthcare facilities, electricity, drinking water, irrigation, schools or anything else. Then, the money allocation issue was discussed and settled. After completion, project reports were scrutinised. Under 'SaemoulUndong', each village took up some projects in the first year, others in the second, many more in the third and so on. In a systematic manner, the basic development needs of a rural area could be resolved within a short span of time. This experiment incentivised healthy competition among village communities — those with honest leaders had better achievements to their credit. This created a bottom-up approach for planning, reform and personal integrity. The whole idea is so simple and India, possibly, has plenty to learn from this experience..

Source: Sinha, Y. 2013. Governance Reforms Must Aim Big. Inclusion. 4(1). January−March.

15.8 The Reporting System

15.8.1 For strategic monitoring of urban and rural development plans, a common set of indicators will be adopted across districts (Box 15.8). Baseline indicators defined at the start of the programme period will allow for assessment of the initial situation and form the basis for the development of the programme strategy.

Box No 15.8

Indicators for Spatial Development

- Right to adequate housing: Durable structures, overcrowding, housing prices and rent-to-income, right to adequate housing, proportion of urban population living in slums.
- Security of tenure: Secure tenure, authorised housing and eviction.
- Equal access to credit, housing finance to basic services, access to safe water, population with access to sanitation (percentage), connection to services, price of water, water consumption per person (litres per person per day), water system leakages (percentage), water quality policy and water sustainability policy.
- Equal opportunities for a safe and healthy life: Under-five mortality, significant improvement in the lives of slum dwellers, homicides, HIV prevalence, urban violence, gender violence and traffic accidents.
- Gender equality in human settlements development: Literacy rate, school enrolment, women councillors and gender inclusion.

- Environment management: Population density (people/km), green spaces per person (m/person), land use policy, planned settlements, green building policy, share of wastewater treated (percentage), share of waste collected and adequately disposed (percentage), waste generated per person (kg/person/year), sanitation policy, waste collection and disposal policy, waste re-cycling and re-use policy, energy and CO2, CO2 emissions per person, energy consumption per US$ GDP, clean energy policy, climate change action plan, daily nitrogen dioxide levels (ug/m3), daily sulphur dioxide levels (ug/m3), daily suspended particulate matter levels (ug/m3), clean air policy and local environment plans.
- Disasters and rebuilding settlements: Houses in hazardous locations, disaster prevention and mitigation instruments.
- Effective and environmentally sound transportation systems: Travel time; public transport network covering trams, light rail, subway and BRT; urban mass transport policy; and congestion reduction policy.
- Decentralise and strengthen local authorities: Local government revenue, voter participation, civic associations and citizen participation.

15.8.2 Evaluation will take place on an on-going basis at the programme level — ex ante, mid-term and ex post — along with other appraisal activities considered useful for improving programme management and impact. The exchange of good practices and the sharing of evaluation results can contribute significantly to the effectiveness of the spatial strategy.

15.9 Conclusion

15.9.1 Rapid urbanisation poses daunting challenges due to insufficient investment in basic services such as water supply, sanitation, transport and power and civic administration, with the resulting environmental and social problems. The strategy for the future will be based on a holistic approach by developing a 'Kerala State Spatial Strategy' within the framework of the Kerala Perspective Plan 2030. The State Spatial Strategy will safeguard areas of state interest and provide guidelines aimed at maximising the efficiency of human settlements and other productive efforts and enhancing rural-urban complementarities. The strategy will complement comparative advantages in economics and geography. This will mainstream environmental concerns. Mixed land zoning needs to be adopted in rural and urban areas to protect forests, wetlands and other ecologically fragile land. The 4R maxim — reduce, reuse, recycle and recover will be adopted in all areas.

15.9.2 Development of smart, compact, clean and green cities will be the focus of this strategy. Increasing the density within the cities in Kerala is important. Transit-oriented development will be adopted with the emphasis on developing pedestrian-friendly and bicycle-friendly roads. Provision of public mass transport is a necessary condition for green growth. Water and sanitation facilities and energy will be provided. Kochi is envisioned to become a global city by 2030. Kerala's cities are envisaged as the hubs of economic, social and cultural activity. Community spaces in the form of parks and public libraries will enhance the quality of life for all. Better urban living will be financed through measures to improve the revenue base of urban local bodies. Providing housing for the poor through various models is suggested to achieve the goal of inclusive growth in urban areas.

15.9.3 It is recommended that rural areas develop competitiveness in agriculture and diversify non-farm income based on the spatial strategy. Smart, clean, green and compact villages will be developed. Better transport and ICT infrastructure is proposed to improve connectivity between rural areas and the main urban hubs.

Appendix.A.15.1: Forecasts for Urban Requirements

A.15.1.1 Population Projections

State Urbanisation Report Kerala (SURK 2012) has attempted to make projections of the urban population for the State. In the first case, the existing trend of urban population growth is assumed to continue. In the second case, the average growth rate of urban population is assumed to remain the same in the next two decades. In both cases, the level of urbanisation exceeds 90 per cent by 2031. It is true that Kerala has experienced wide fluctuations in the growth rate of the urban population over the past few decades. The average growth rates of the urban and rural population for the decades 1981−1991, 1991−2001 and 2001−2011 have been calculated. The average growth rate of urban population during 1981−2011 works out to 0.04 and the corresponding rural growth rate is (–) 0.006. The URGD (Urban-Rural Growth Differential) has been calculated by subtracting the rural growth rate from the urban growth rate. Based on this formula, the URGD for Kerala works out to 0.0458.
The UN methodology of population projection has been used to calculate the rural and urban population of Kerala for the years 2012−31.
The term URGD is used in this case.

$$\text{URGD} = \text{Urban growth rate} - \text{Rural growth rate}$$
$$= r_U - r_R,$$

The exponential model used by the Population Division of the UN (brought out in World Urbanisation Prospects) at regular intervals is as follows:

$$U_2/R_2 = (U_1/R_1)e^{t.URGD}$$

where U_1 and U_2 are urban and R_1 and R_2 are rural population, at time points t_1 and t_2, respectively. Using the above formula,

For the year 2025, the share of urban population works out to 63.41.

For the year 2031, the share of urban population works out to 68.87.

The share of urban population as projected above is then applied to the projected total population calculated by the Registrar General, Census of India for the year 2025. The growth rate of total population of Kerala is expected to stabilise in the year 2025. Therefore, the growth rate of the year 2025–26 has been used to project the total population for the year 2031. Based on the respective R-U percentages, the population figures have been calculated for the years 2012–31 (Tables A.15.1 to A.15.3).

Table A.15.1
Estimation of Urban Population of Kerala (trend-based)

Census Year	Total population	Growth rate (decadal) of total pop. (trend-based) (%)	Urban pop. Growth rate (trend- based) (%)	Urban population	% Urban
1951	1,35,49,118			18,25,897	13.48
1961	1,68,86,394	24.63	3.84	25,26,473	14.96
1971	2,13,47,375	26.42	3.72	34,66,968	16.24
1981	2,54,53,680	19.24	3.7	47,51,249	18.67
1991	2,90,98,518	14.32	6.16	76,80,194	26.39
2001	3,18,41,374	9.43	0.76	82,66,925	25.96
2011	3,33,87,677	4.86	9.27	1,59,32,171	47.72
2021	3,46,87,677	3.89	6.05	2,64,47,403	76.24
2031	3,54,54,677	2.21	6.65	2,80,47,471	79.1

Table A.15.2.
Estimation of Urban Population of Kerala assuming Constant Annual Growth Rate

Census Year	Total population	Growth rate (decadal) of total pop. (trend-based) (%)	Urban pop. Growth rate (annual, 4.5%)	Urban population (%)	% Urban
1951	1,35,49,118			18,25,897	13.48
1961	1,68,86,394	24.63	3.84	25,26,473	14.96
1971	2,13,47,375	26.42	3.72	34,66,968	16.24
1981	2,54,53,680	19.24	3.7	47,51,249	18.67
1991	2,90,98,518	14.32	6.16	76,80,194	26.39
2001	3,18,41,374	9.43	0.76	82,66,925	25.96
2011	3,33,87,677	4.86	9.27	1,59,32,171	47.72
2021	3,46,87,677	3.89	4.5	2,31,01,647	66.59
2031	3,54,54,677	2.0	4.5	2,41,41,221	68.09

Table A.15.3.
Estimation of Urban Population of Kerala assuming Average Growth Rate of Three Decades using UN Methodology

Years	CDS projection ('000)	Rural Population	Urban pop. Growth rate (annual, 4.5%)	Urban population (%)
2011	33,388	17,456	15,932	47.78
2021	33,995	14,210	19,785	58.20
2031	32,459	10,106	22,353	68.87

Sources: Planning Commission, Government of India. 2008; Kerala Development Report, Academic Foundation; NCAER calculations

Appendix.15.1.2 Investment Requirements for the Housing Sector in Kerala

Investment in housing has multiplier effects on the economic growth of the country. The building sector generates demand for building materials, expansion of the transport network and employment opportunities for skilled and unskilled workers. It is estimated that overall employment generation in an economy on account of additional investment in the construction/housing industry is eight times that of direct employment. In the Kerala scenario, the cost of the labour and material components in the construction cost of a building can be reasonably apportioned in the ratio 2:3.

"According to the general survey conducted in 2007, it was estimated that the projected demand was 10.84 lakhs housing units in the State. Based on this survey, the housing stock of the State was 6,985,419 units and the current stock is estimated at 75 lakh residential units. The projected demand for the new population up to the end of the 12th Plan period is 6.5 lakhs. Apart from this, there is a need for reconstruction of 5.5 lakhs units of dilapidated houses. The State has to undertake the task of constructing 12 lakh housing units, of which around sixty per cent is meant for the economically weaker sections of the society."[35] By using an amount of Rs 2 lakh as the cost of construction of a residential unit, it is estimated that a total amount of Rs 15,000 crore is needed as investment in the housing sector for economically weaker sections and disadvantaged groups.

Despite continued efforts by the state government to provide adequate shelter to the economically weaker sections of society, the housing shortage still exists in the State. The TG–12, noted that the shortage of housing is mostly in the lower economic strata of the population across urban India.[36] Further, households in *kutcha*[37] houses that represent the housing deprivation are not distributed in the same proportion as total households. Economically backward states have a larger share of *kutcha* structures compared to their share of total households. Even though households residing in *kutcha* houses represent housing deprivation, it was thought prudent to incorporate BPL households as well in determining the criteria for distributing the total housing shortage among states. The TG-12 accordingly decided that the total estimated shortage should be distributed among states/UTs in proportion to their share of households living in *kutcha* houses and that of BPL households in the national total. It would have been desirable and more appropriate to exclude households that belong to both categories in order to avoid double counting. However, disaggregated data for this is not available. Further, the overlap factor is unlikely to differ across states and consequently the share of the total households would not be significantly altered. The TG-12 used the number of *kutcha* houses from the Census 2011 and state-wise BPL households from the Planning Commission, 2009–10 figures with equal weightages to distribute the total shortage across states. The average number of BPL households and *kutcha* households in Kerala is 2.7 lakh, which forms 2.9 per cent of total households in India. The total housing shortage predicted by TG–12 in Kerala was 0.54 million units. Two estimates of investment in the housing sector have been arrived at. The investment required to meet the housing shortage of 0.54 million units in urban Kerala is Rs 108,000 million at current prices for the 12th Plan period. This is based on the Kerala government's norms of Rs 200,000 per unit cost excluding the cost of providing infrastructure and services (sewer lines, water supply, electricity and so on). As per the norms of the Ministry of Housing and Urban Poverty Alleviation, the unit cost at current prices is estimated at Rs 2.75 lakh and the cost of infrastructure provision for servicing the land is Rs 1.25 per unit. Based on these figures, the investment required to meet the housing shortage of 0.54 million units in urban Kerala is Rs 216,000 million at current prices for the 12th Plan period.

Appendix.15.1.3 Investment requirements for Urban Services

Water supply

The investment requirements for water supply are calculated for both domestic customers and industrial customers. For domestic customers, investment requirements are calculated as the sum of the investment sub-sectors: water production (includes source augmentation, treatment and transmission); distribution extension for 24x7 standards (distribution network, storage and metering); and distribution upgrading/replacements for 24x7 standards. For industrial customers, only production investments are calculated. O&M costs are estimated separately on an annual basis for domestic customers. However, for industrial customers, only the production and O&M has been calculated.

India has one of the lowest standards of continuity of water supply. The recent results of the Government of India's sanitation rating — where water quality samples from only 39 of 441 cities qualified on three basic water quality parameters — highlight the urgency of moving to a continuous water supply system. Data from a few pilot projects across the country suggests that for the current population 24x7 water supply can be designed with the current levels of per capita supplies of source water.
It is difficult to estimate how per capita consumption will respond to income growth and efficient pricing, given that most utilities do not charge their customers the full economic cost of service provision. While income growth may increase the demand for water, the introduction of efficient pricing may deter further increases in consumption. The committee has assumed that non-revenue water constitutes 20 per cent of the total consumption. Accordingly, the per capita production norm works out to 168 lpcd (litres per capita per day) for all size classes of cities.

The estimation of per capita investment cost (PCIC) is based on project costs. It was not possible to rely solely on project data for the estimation of PCICs for 24x7 upgrading and distribution extension (24x7 standards), given the limited number of 24x7 pilot projects in urban India. Hence, a cost simulation was conducted to complement the project cost data analysis. The cost simulation is based on city-level data provided in the City Development Plans (CDPs) as well as inputs from water experts.

The spatial pattern of urbanisation is a key determinant of the unit cost of service provision. For example, it is more expensive on a per capita basis to provide piped water supply services to low-density and small urban settlements than to metropolitan cities. The PCIC shows a steady increase from Rs 3,517 for large metropolitan cities (Class IA cities or cities with population more than 5 million) to Rs 5,901 for towns (Class IV+ or towns with a population less than 20,000). Production PCIC varies from 30 per cent to 50 per cent of the total PCIC across city classes and tends to be greater in larger cities since the water sources are located further away from these cities. However, there are significant economies of scale in distribution costs as density of population is the main cost driver, with distribution PCIC for large metropolitan cities being Rs 2,030 and for towns Rs 4,619.3. Small cities and towns have lower densities and, therefore, higher per capita distribution costs than large cities.

For upgrading to a 24x7 water supply network, it is assumed that 80 per cent of the distribution network needs to be replaced. This would generally depend on the condition of the existing assets, including network architecture, knowledge of the location of pipes and the types of pipes used. For example, in Hubli, 90 per cent of the distribution network was replaced, while in Nagpur it was only 30 per cent. So, replacement will depend on the state of maintenance of the system.

Of the total water requirement, 20 per cent has been assumed for industrial purposes for cities with a population of more than 500,000. For other cities, industrial water has not been taken into account. While metering is generally kept out of investment calculations, as it is generally paid for by users,

it has been included in this estimation exercise because a continuous water supply system requires meters to be in proper working condition, so that ULBs can monitor and charge for usage.

The high O&M cost for water supply (relative to the capital investment requirement) is due to the large base of existing assets. The main cost driver that explains variation in O&M cost across city size classes is the size/height of the required water head: a higher head implies higher power charges, which are estimated to account for about 40 per cent of the total O&M cost. Maintenance costs are estimated to account for only 10 per cent of the total O&M cost, while operations account for 90 per cent. Large cities tend to have higher unit O&M costs mainly because they tend to rely on more distant sources of water supply.

Sewerage

The assumptions used in preparing the estimates for investment in sewerage for the 20-year period, 2012–2031, as well as the associated O&M expenditure for existing and new assets are presented in tables A.15.4 to A.15.6. The total capital expenditure requirement for sewerage is Rs 2.4 lakh crore and the O&M requirement is also Rs 2.4 lakh crore.

Table A.15.4.
Service backlogs for Sewerage (per cent)

City Size Class	Network	Treatment
Class IA	53	53
Class IB	44	53
Class 1C	64	77
Class II	84	88
Class III	90	96
Class IV+	100	100

Source: High Powered Expert Committee Report and Recommendations, 2011
Jawaharlal Nehru National Urban Renewal Mission

Table A.15.5.
Underground sewerage PCIC Norms

City Size Class	Network	Treatment	Total
Class IA	2092	1268	3360
Class IB	2573	1268	3841
Class 1C	2338	1073	3841
Class II	3246	2070	5316
Class III	3637	2012	5649
Class IV+	4636	2012	6648

Source: High Powered Expert Committee Report and Recommendations, 2011
Jawaharlal Nehru National Urban Renewal Mission

Table A.15.6.
Per Capita Operations and Maintenance Cost for Sewerage

City Size Class	PCOM per year
Class IA	414
Class IB	373
Class 1C	290
Class II	290
Class III	207
Class IV+	145

Source: High Powered Expert Committee Report and Recommendations, 2011
Jawaharlal Nehru National Urban Renewal Mission

The investment requirements are calculated as the sum of the investment costs for: network and treatment (sewage pumping stations and sewage treatment plants). The investment requirements are calculated only for domestic customers. An underground sewerage system has been considered for all city size classes.

While the data gathered is not large enough to estimate investment requirements with sufficient accuracy for each city size class, significant trends and correlations emerge from such an analysis. Larger and more densely populated cities tend to have lower costs on a per capita basis for sewerage networks, with the PCIC increasing from Rs 3,360 in large metropolitan cities (Class IA cities or cities with population more than 5 million) to Rs 6,648 in towns (Class IV+, or towns with population less than 20,000).

The average O&M cost for the network is estimated at Rs 3.3 per cu.m. and the O&M cost for treatment is estimated at Rs 5.4 per cu.m. on average. The total O&M cost for sewerage covering existing and new assets is lower than that of water supply because of the existing low service coverage and lower unit cost of O&M. Industrial wastewater collection and treatment have not been considered for the purpose of estimating investment requirements.

Solid waste management

The assumptions used in preparing the estimates for investment in solid waste management for the 20–year period, 2012–2031 as well as the associated O&M expenditure for existing and new assets are presented in the following section.

The investment requirements are calculated as the sum of: (i) Collection and Transport: trucks, containers, pushcarts, mechanical sweeping, and transfer stations, (ii) Processing: treatment plants, and (iii) Disposal: development of landfill sites. The assumptions underlying the estimation exercise for solid waste management are based on the Municipal Solid Waste (Management and Handling) Rules, 2000.

Over 60 per cent of the waste generated in India is biodegradable and, hence, suitable for composting. This is unlike the situation in western countries, which have a higher proportion of non-biodegradable waste. Given this scenario, the share of waste processed is assumed to be 80 per cent of the total waste generated and the share of waste disposal 20 per cent in the project's design year. Of the waste disposed, 50 per cent is direct landfill and 50 per cent is processed.

The higher PCIC in large cities is due to the higher per capita waste generated compared with other city classes. There are no significant economies of scale in processing. A uniform unit cost for O&M has been assumed for all city classes based on the assumption that large cities would adopt highly mechanised systems, while smaller cities would adopt comparatively more labour-intensive processes.

Storm water drains

The assumptions used in preparing the estimates for investment in storm water drains for the 20–year period, 2012–2031, as well as the associated O&M expenditure for existing and new assets are presented in the following sections.

The investment requirements are calculated as the sum of network and outfall. Components for network and outfall include widening of drains and structures to prevent waste dumping, laying of pipelines with pipe support bridges/culverts, catch pits, manholes, outfall structures with gates and covers for the drain.

The PCIC trend for storm water drains follows that for urban roads because the same road densities and backlog have been considered to estimate storm water drain requirements. As with the estimates for urban roads, the estimates for storm water drains are subject to the specific work to be undertaken, based on factors such as city topography, rainfall patterns and integration with road works.

Investment requirements for water supply

India has one of the lowest standards of continuity of water supply. The recent results of the Government of India's sanitation rating — where water quality samples from only 39 of 441 cities qualified on three basic water quality parameters — highlight the urgency of moving to a continuous water supply system. Data from various pilot projects across the country suggest that for the current population, 24x7 water supply can be designed with the current levels of per capita supplies of source water (Karnataka, Punjab, Maharashtra).

It is difficult to estimate how per capita consumption will respond to income growth and efficient pricing, given that most utilities do not charge their customers the full economic cost of service provision. While income growth may increase the demand for water, the introduction of efficient pricing may deter further increase in consumption.

The High-Powered Expert Committee has assumed that non-revenue water constitutes 20 per cent of the total consumption. Accordingly, the per capita production norm works out to 168 lpcd for all size classes of cities.

While calculating the investment requirement figures for Kerala for the period 2011–31, capital costs have been calculated for households that were not covered by piped drinking water in 2011. For the rest of the population, O&M has been worked out on an annual basis for the entire population. For the subsequent years, Plan period-wise incremental population has been worked out to calculate the capital costs. O&M has been worked out on an annual basis for the entire population. Finally, the estimated investment expenditure, both capital and O&M, as a share of GDP has been calculated for every Plan period. These estimations have been worked out for all the services. If the population with no access to piped water is covered, then the share of expenditure in the GDP rises to 3.26 per cent for the 12th Plan. Inclusion of housing investment further increases the total investment requirements to 17.25 per cent of the GDP. The state government should devise strategies to clear the backlog either in the 12th Plan or in a phased manner in the subsequent Plans.

Reference

1 *The source for all population and urbanisation numbers are from the following source unless mentioned otherwise: Census of India Website: Office of the Registrar General and Census Commissioner of India. 2011.*

2 *Department of Town and Country Planning, Government of Kerala. 2012. State Urbanisation Report Kerala: A Study on the Scattered Human Settlement Pattern of Kerala and its Development Issues. March.*

3 *Department of Town and Country Planning, Government of Kerala. 2012. State Urbanisation Report Kerala: A Study on the Scattered Human Settlement Pattern of Kerala and its Development Issues. March.*

4 *"The Kerala Municipalities Act do not prescribe any criteria for constitution of Municipalities. However Government as per G.O MS 108/67/HLD dated 2nd March 1967 had laid down the following standards for the constitution of new Municipalities: (i) the locality should predominantly be urban i.e. at least 3/4th of the adult population of the area should be engaged in pursuits other than agriculture, (ii) the population of the locality should not be less than 20,000 and the density of population should not be less than 4000 per 2.59 sq.km. except in hilly areas and (iii) Per capita revenue resources of the locality should not be less than Rs 5".*
Department of Town and Country Planning, Government of Kerala. 2012. State Urbanisation Report Kerala: A Study on the Scattered Human Settlement Pattern of Kerala and its Development Issues. March.

5 *Kerala Urban and Rural Development Finance Corporation Website. http://www.kurdfc.org/index.php/6-666.*

6 *Government of Kerala. 2013. Local Self Government (RD) Department Notification. http://www.go.lsgkerala.gov.in/files/gz20130201_8162.pdf. 2(325). 5th February.*

7 *Government of Kerala. 2013. Local Self Government (RD) Department Notification. http://www.townplanning.kerala.gov.in/KMBR/kmbr_247-2013.htm. 2(1982). 8th July.*

8 *Department of Housing.2011. Kerala State Housing Policy 2011.Government of Kerala, Thiruvananthapuram, Kerala.*

9 *Ministry of Housing and Urban Poverty Alleviation. 2012. Task Force on Promoting Affordable Housing. Government of India.November.*

10 *Department of Housing.2011. Kerala State Housing Policy 2011.Government of Kerala, Thiruvananthapuram, Kerala.*

11 *The reference for this paragraph is: Ministry of Housing and Urban Poverty Alleviation and National Buildings Organisation. 2012. Report of the Technical Group on Urban Housing Shortage (TG–12) 2012–17. Government of India. 22nd September.*

12 *Appendix A.13.1 shows the detailed calculations.*

13 *Lack of detailed data prevent us from de-composing the housing shortage as per income categories for Kerala.*

14 *Mohanty, P.K., Misra, B.M., Goyal, R. and Jeromi, P.D. 2007.Municipal Finance in India: An Assessment. Department of Economic Analysis and Policy Working Paper No. 26.Reserve Bank of India, Mumbai. December 27.*

15 *Planning Commission, Government of India. 2012. Press Note on Poverty Estimates, 2009–10. http://planningcommission.nic.in/news/press_pov1903.pdf. March.*

16 *The Council of Europe Website. http://www.coe.int/t/dg4/cultureheritage/heritage/cemat/leaflet_en.pdf.*

17 *An example of a National Spatial Strategy for Ireland 2002 to 2020 is available here for reference. http://nss.ie/pdfs/Completea.pdf.*

18 *Organisation for Economic Cooperation and Development (OECD). 2011.Compact City Policies: A Comparative Assessment – Final Report. http://esci-ksp.org/wp/wp-content/uploads/2012/03/Compact-Cities-Report-DRAFT.pdf.*

19 *Kerala is already one of the most densely populated states (859 people per square kilometer, km in 2011). However, the SURK (2012) shows that the cities are not. As per 2001 data, Kollam was the most densely populated with 6,095 people per square km. The population density of Kochi was 2,995.7 people*

per square km whereas the population density in million plus cities vary between 12,000 to 24,000 in India.

[20] *Organisation for Economic Cooperation and Development (OECD). 2011.Compact City Policies: A Comparative Assessment – Final Report. http://esci-ksp.org/wp/wp-content/uploads/2012/03/Compact-Cities-Report-DRAFT.pdf.*

[21] *Vienna in Austria is a model for gender mainstreaming of cities, which was adopted as a philosophy by the city in 2005. The city asked women what made them feel safe. This has the added benefit of increasing security of women in Kerala, which is mentioned in the Social Justice chapter as a significant problem. City of Vienna website. http://www.wien.gv.at/english/administration/gendermainstreaming/*

[22] *A discussion on public and private spaces is required to not only prevent the familiar encroachment story but to preserve it for the use of the generic community. Road outside one's house is a public space that is cleaned by the homeowner for the benefit of the community. This is a philosophy that is adopted by the West. India needs to re-adopt the concept of preserving commons. The road outside one's house is not for one's personal use like parking but for the use of the community at large. This change in behaviour needs to be inculcated within the citizens.*

[23] *Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., and Meijers, E. 2007.SmartCities: Ranking of European Medium-Sized Cities. Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology. Available from http://www.smartcities.eu/download/smart_cities_final_report.pdf.*

[24] *This is a reproduction of Box 1.5 (Page 37) from the following reference. This is used as a reference for this section unless mentioned otherwise.*

[25] *Suzuki, H., Cervero, R. and K. Iuchi (2013).Transforming Cities with Transit. World Bank*

[26] *Kuala Lumpur Structure Plan 2020.http://www.dbkl.gov.my/pskl2020/english/index.htm*

[27] *Kuala Lumpur Structure Plan 2020.http://www.dbkl.gov.my/pskl2020/english/index.htm.*

[28] *Ibid.*

[29] *A good public library system is a hallmark of civilisation. The concept of a library has changed from being a just repository for books or even digital content to even more. Its space is now used as a place to meet for the community, a place for lifelong learning, a place where children can learn and play. The Western library system is a model not only for its network but for the intrinsic value of the building themselves and are a part of the itinerary of any tourist. Kerala should build such a public library system with the library doubling up as a community space. Further the buildings in the main three cities and the networks within them should serve as symbol of modern tourism and guided tours are organised within the library.*

[30] *Kamyotra, J.S. and R.M. Bharadwaj. 2011. Municipal Wastewater Management in India. India Infrastructure Report 2011.*

[31] *Jensen, J.O., Christensen, T.H. and Gram-Hanssen, K.. 2011. Sustainable urban development – compact cities or consumer practices? Sustainable Urban Development Boligforsker Seminar 2011.http://vbn.aau.dk/files/56542117/Jensen_et_al._Sustainable_urban_development_Boligforskerseminar2011.pdf.*

[32] *The source for this paragraph is: UN-Habitat. 2002. Global Campaign on Urban Governance. Concept Paper. The quotation has been cited in the above paper from the following: Good Urban Governance: A Normative Framework (HS/C/PC.1/CRP.6), 26 February2000, available at http://www.un-habitat.org.*

[33] *Department of Environment and Rural Affairs Web site. Community Strategic Guidelines for Rural Development: Link With Proposed Key Actions. http://archive.defra.gov.uk/rural/documents/rdpe/axis3measfishes.pdf.*

[34] *Nelson. K. 2012. Essential Smart Growth Fixes for Rural Planning, Zoning, and Development Codes. United States Environment Protection Agency.http://www.epa.gov/smartgrowth/pdf/rural_essential_fixes_508_030612.pdf. February.*

[35] *Department of Housing.2011. Kerala State Housing Policy 2011.Government of Kerala, Thiruvananthapuram, Kerala.*

[36] *The reference for this paragraph is: Ministry of Housing and Urban Poverty Alleviation and National Buildings Organisation. 2012. Report of the Technical Group on Urban Housing Shortage (TG–12) 2012–17. Government of India. 22nd September.*

[37] *Kutcha refers to houses made of local products, such as bamboo and mud*

Chapter 16

SUSTAINABLE TRANSPORT STRATEGY 2030

Chapter 16

Sustainable Transport Strategy 2030

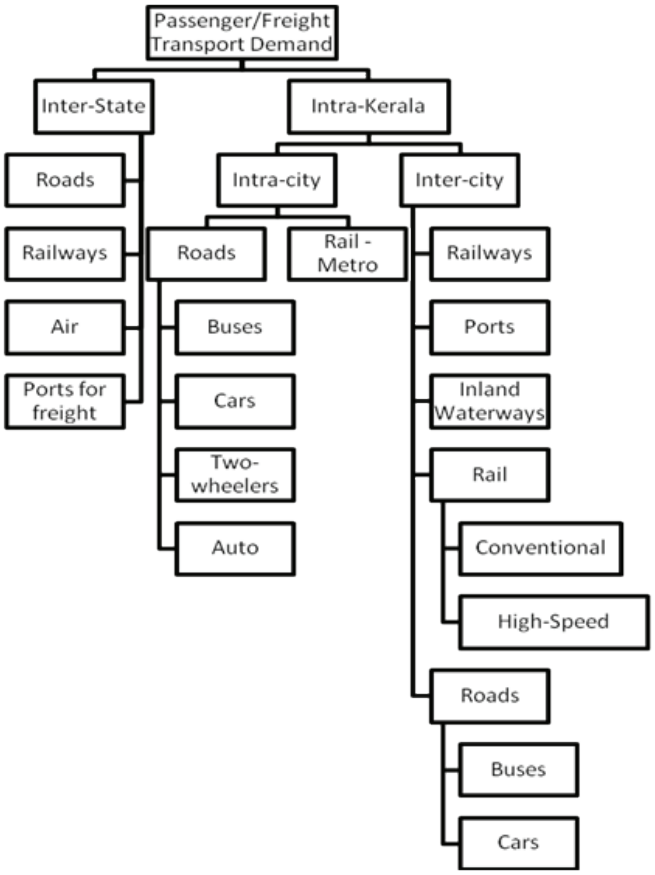
16.1 Introduction

116.1.1 Transport infrastructure is closely related to economic growth and the reduction of poverty. Simultaneously, the demand for transport is derived demand — as income increases, demand for transport increases. Kerala is in an economic transition and is visioning a knowledge economy. Therefore, it needs to plan and develop transport infrastructure that will help the State achieve its goals. In strategising for infrastructure in Kerala over the next twenty years, there are several things that have to be kept in perspective: geography; demographic changes over the next 20 years including population density and ageing; urbanisation; economy; and future environmental challenges.

16.1.2 The uniqueness of Kerala's geography means that it has five options for transport — roads, railways, airports, seaports and inland waterways. Of these, roads are the most popular for both passenger and freight traffic. Roads have the advantage of last mile connectivity. As India grew self-sufficient in food grains and Kerala became dependent on wheat and rice from the rest of the country, these domestic imports came in by road, making it the most used transport option. Kerala has built a formidable road network connecting its villages and towns. Despite such achievements, the State's road infrastructure has not kept pace with the demand for road transport, creating bottlenecks in the movement of freight and passengers, besides leading to loss of lives due to road accidents. All these, together, cause social and economic impacts, including losses in GDP.

16.1.3 The way forward is to recognise that land is limited and given ecological concerns it is necessary to evaluate the most green and economically efficient way to move passengers and freight within Kerala. The State has to use its five options efficiently and create an inter-modal transport system. Figure 16.1 illustrates the transport modes for passenger and freight movement to and from Kerala and within the State as well.

Figure 16.1
Possible Modes of Transport



Source: Conceptualised by NCAER

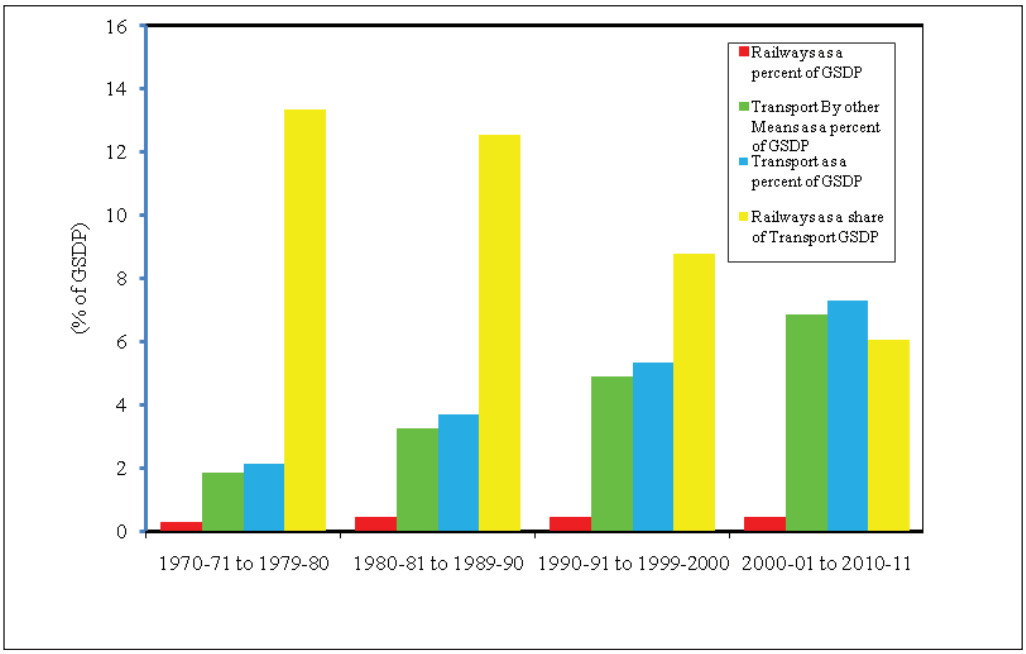
16.2 Situation Analysis

16.2.1 Direct contribution of transport to Gross State Domestic Product (GSDP)

16.2.1.1 Figure 16.2 shows that transport GSDP has increased its share in Kerala's total GSDP from 2.13 per cent in the 1970s to 7.29 per cent in the 2000s. Both railways and other means of transport also show a larger share of GSDP over time. However, the patterns are completely different. While railways' share of GSDP after increasing from 0.29 per cent in the 1970s to 0.46 per cent in the 1980s has remained stagnant thereafter, other transport modes' share increased from 1.85 per cent in the 1970s to 6.85 per cent in the 2000s. The share of railways in total transport GSDP has shown a steady decline from 13.37 per cent in the 1970s to 6.04 per cent in the 2000s, with a dramatic decline between the 1980s (12.53 per cent) and 1990s (8.8 per cent).

16.2.1.2 Unfortunately, further breakdown of other transport data is not available at the state level. However, data at the national level indicates that road transport has the highest share of transport Gross Domestic Product (GDP). Road transport formed 4.7 per cent of GDP in 2009−10. Railways formed 1 per cent of GDP and both air transport and water transport formed 0.2 per cent of GDP in 2009−10.[1] Further, since 1999–2000, growth has only taken place in road transport. Other modes have retained their shares of GDP while road transport has increased. Given national trends, one can infer that road transport dominates in Kerala too.

Figure 16.2
Share of Transport in GSDP, Kerala: 1970−71 to 2010−11
(at Factor Cost in 2004–05 prices)



Note: 2010−11 data are quick estimates.

Source: Economics and Statistics Department, Government of Kerala

16.2.2 Institutions

16.2.2.1 The Department of Transport is the nodal department in the Government of Kerala for transport related activities. The following line departments and organisations fall under this department. A point to note is that there is seemingly little coordination between the departments.

The departments/organisations are:

- Motor Vehicles Department: Managing motor vehicles such as issuing licenses, registrations and so on.
- State Water Transport Department: Providing water transport services.
- Kerala State Road Transport Corporation: Providing bus transport services.
- Kerala Transport Development Finance Corporation
- Railways (Land Acquisition): Land acquisition for setting up a Railway Coach Factory in Palakkad
- Airports Authority of India (Land Acquisition): Land acquisition for Kannur, Thiruvananthapuram and Kozhikode airports.
- Kochi Metro Rail Project (Land Acquisition): Acquiring land.

16.2.2.2 Each mode of transport has separate sets of institutions for construction of infrastructure. Roads in Kerala consist of three broad categories — National Highways (NHs), State Highways (SHs) and Major District Roads (MDRs) and Village Roads. Appendix A.16.1 contains all the definitions related to roads. “The Central Government is responsible for the development and maintenance of the NHs. The development and maintenance works of the NHs are being implemented on an agency

basis. The State Governments (State PWDs), Border Roads Organisation (BRO) and National Highways Authority of India (NHAI) implement the development and maintenance works on NHs."[23] The SHs and MDRs are managed by the Public Works Department (PWD) of Kerala. There are several wings under the PWD. They are:

- The Kerala Road Fund Board is a professional body that looks after the fund management affairs of the Kerala State Public Works Department. It primarily oversees and manages non-budgetary funds and deploys such funds to implement innovative road projects and other related infrastructure. The Kerala Road Fund Board aims to bring in greater private sector participation in development activities.
- The Kerala Highway Research Institute is a research institute of the PWD connected with improving the quality of roads.
- The Roads and Bridges Development Corporation (RBDCK) is a company established and fully owned by the Government of Kerala and has been incorporated as a limited company under the Companies Act 1956. RBDCK mainly deals with movable and immovable properties and assets including land, road projects, railway over-bridge projects, toll collection rights and works under construction.
- The Kerala State Transport Project is a programme to modernise the State Highways with external aid from the World Bank.

16.2.2.3 Village roads are under the local bodies, with generous funding coming in from the Centre through schemes such as the Pradhan Mantri Gram Sadak Yojana (PMGSY) and Jawahar Rozgar Yojana (JRY). There are two other types of roads — urban roads, which are managed by the urban local bodies and project roads, which are managed by the respective authorities, such as railway roads.

16.2.2.4 Railways come under the Ministry of Railways, which is managed by the Centre. The Cochin Port, Kerala's major port, is also managed by the Centre. The construction of minor ports and airports is a state subject. The Department of Ports manages the minor ports, while the harbour engineering department is a separate specialised department structured as a service department for fisheries and ports. Last, but not the least, is the Kerala Coastal Shipping and Inland Navigation Corporation, which oversees shipping of both passengers and freight, does R&D in the sector and is involved in the construction of boats, among other things.

16.2.2.5 The National Transportation Planning and Research Centre (NATPAC) is an R&D institution under the Kerala State Council for Science, Technology and Environment. It undertakes research and consultancy work in the fields of traffic engineering and transportation planning, highway engineering, public transport system, alternate options for transport systems, transport energy, inland water transport, tourism planning and rural roads. The activities of NATPAC range from surveying to preparation of techno-economic studies, feasibility analysis and detailed project reports for infrastructure development projects involving multi-modal systems of transport covering road, rail, water, ports/harbours and airports.

16.2.3 Roads and road transport

16.2.3.1 Roads are the dominant mode of transport in Kerala as they are in India.[4] By March 2011, the total road length in Kerala was 201,220 km (this forms 5.3 per cent of India's road network), 517.8 km road length per 100 square km (the highest in the country, with West Bengal a distant second at 337.1 km per 100 square km) and road length of 602.68 km per one lakh population. The corresponding all India numbers as of March 2011 were 142.68 km road length per 100 square km and road length per one lakh population at 387.57 km.

16.2.3.2 The National Highways (NHs) and expressways together are considered the primary road network in the country, and carry 40 per cent of all national traffic and connect each state to the rest of the country. The secondary road network in India consists of State Highways and Major District Roads. It is assumed that Kerala's primary and secondary road network carry the same proportion of traffic — 40 per cent each.

National Highways

16.2.3.3 The total length of the NHs in Kerala is 1,457 km — it forms 0.72 per cent of the total road network of Kerala.[5] There are eight NHs that run through the state: NH numbers 47, 17, 49, 47A, 208, 212, 213 and 220. Although the length of the NHs has remained the same since 2007−08, there has been improvement in quality in terms of widening of the roads. The share of roads that are four lanes and above has gone up from 6.9 per cent in March 2010 to 8.2 per cent in March 2011.[6] The share of NHs that are intermediate or single lane is 18.3 per cent, and has remained the same and the share of NHs which are two lane has declined to 74.9 per cent in March 2011 from 76.2 per cent in March 2010. All the NHs are surfaced.

State Highways and Major District Roads

16.2.3.4 The total length of SHs was 4,341 km as of March 2011, and their length has remained the same since March 2009. The SHs are 100 per cent surfaced, and 99.9 per cent are surfaced with bitumen/concrete. Of this, 2,119 km of roads are standard single lane and 2,222 km standard double lane. The total length of the PWD roads (MDRs) is 18,890 km. Hundred per cent of the PWD roads are surfaced, with 2.4 per cent surfaced with water-bound macadam (WBM). Out of this, 11,340 km of roads are standard single lane and 7,550 km standard double lane. The secondary road network comprising SHs and PWD roads form 11.5 per cent of the total road network.

16.2.3.5 The paradox of Kerala is that 12.3 per cent of the road network carries 80 per cent of the traffic (assuming national level traffic loads on the primary and secondary road network). And out of this, 55.4 per cent of the network is single lane.

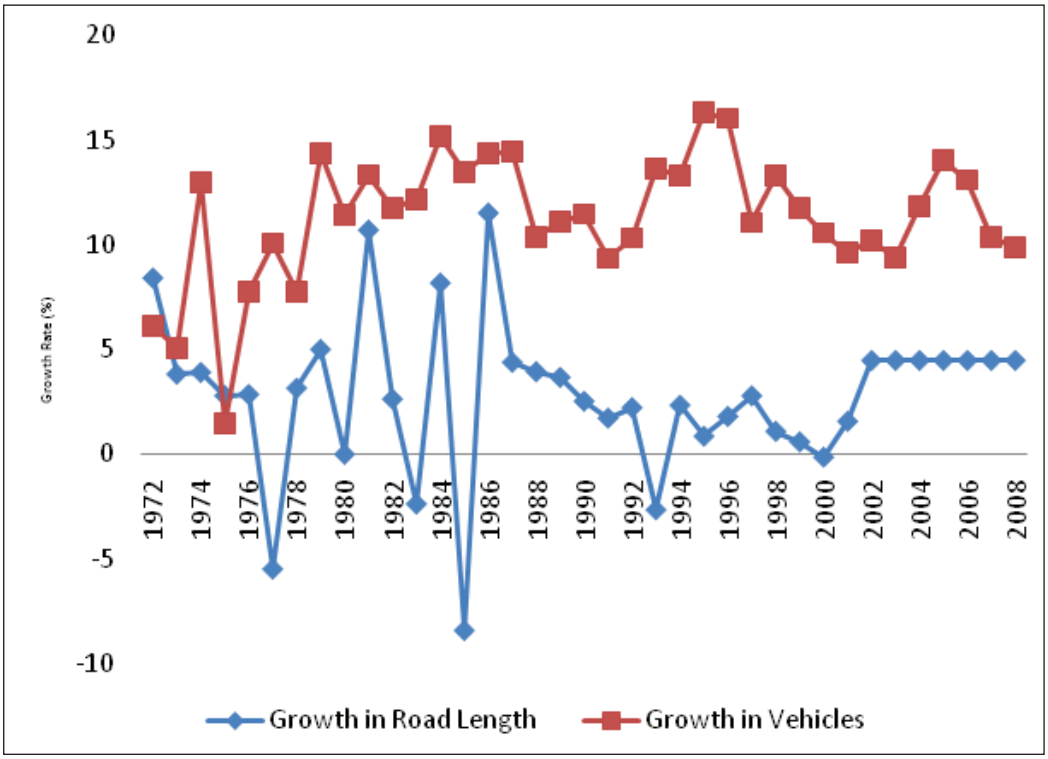
Rural roads

16.2.3.6 Kerala has been a pioneer in building a village road network. The State had 1.6 lakh km of rural roads as of March 2011, which forms 77.1 per cent of the road network in Kerala. Out of the total rural road network, only 46 per cent of the roads are surfaced. It may be argued that a good rural road network has resulted in an urban sprawl, as people live in villages with standard amenities and are still able to travel to work in the major cities. Urban sprawls typically feed into the 'car culture' and Kerala is no different.

Road transport

16.2.3.7 Kerala had 6,072,000 registered motor vehicles in March 2011.[7] Between 2001 and 2011 it experienced a compounded annual growth rate of 11.1 per cent in the number of registered motor vehicles.[8] The number of vehicles per 1,000 population for Kerala in March 2011 was 182.[9] The number of vehicles per 1,000 population was the highest in Ernakulam (291.9) and lowest in Wayanad in 2010−11 (83.1).[10] The number of vehicles per 1,000 population in 2009 for India was 18, China 47 and the US 507.[11] In sum, Kerala's road network has not been able to keep up with the growth in the number of vehicles (Figure 16.3) as the growth rate in motor vehicles (double digits) outpaced the growth in roads (single digits).

Figure 16.3
Growth Rate of Roads and Motor Vehicles: 1972−2008 (%)

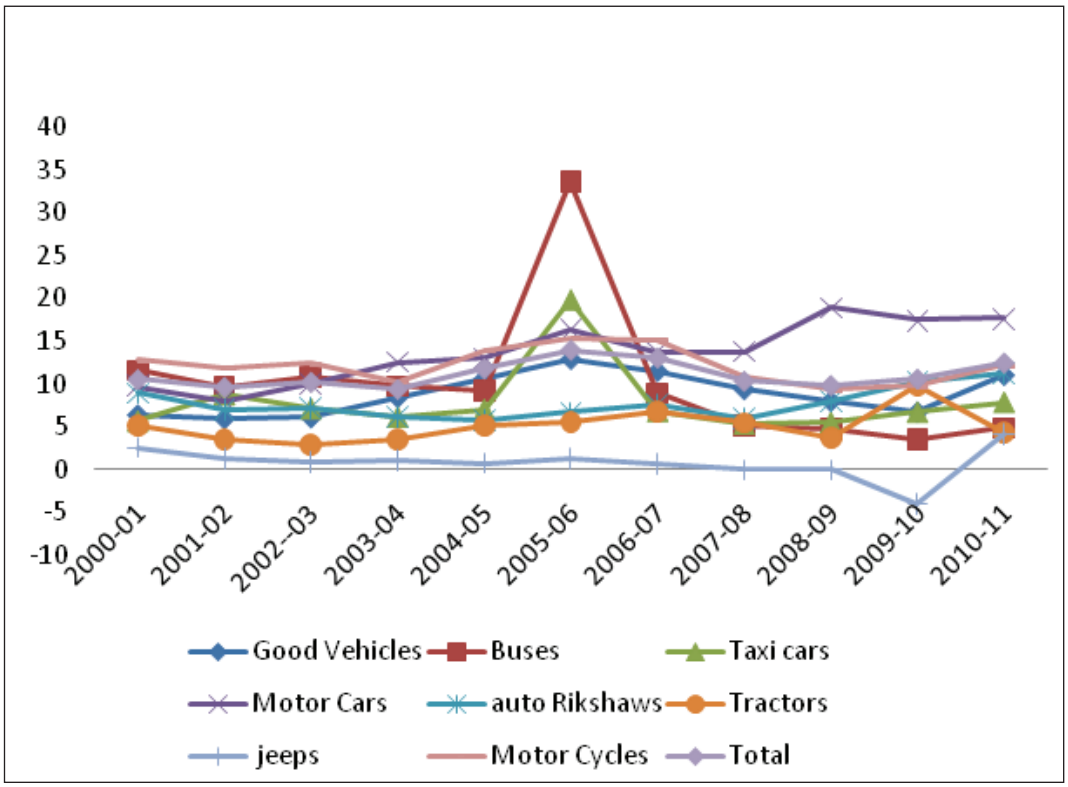


Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

16.2.3.8 The data on registered motor vehicles shows that cars have led the growth in the total number of motor vehicles over the past five years (Figure 16.4). Further, when the total motor vehicles for 2010−11 is decomposed, it shows that motorcycles (two-wheelers) accounted for 59.5 per cent of total vehicles, followed by cars (17.5 per cent) and auto rickshaws (8.5 per cent). In sum, 85.5 per cent of the total vehicles on the roads are private vehicles. Buses form only 2.7 per cent of the total vehicles. The Kerala Economic Review 2012 shows that out of 46,620 stage carriers, Kerala State Road Transport Corporation (KSRTC) only owns 5,803 buses. The share of the KSRTC (public sector) was barely 11 per cent of the total in 2010−11. Further, of the 5,803 public buses, 1,672 (28.8 per cent) are aged 10 years and above.[12]

16.2.3.9 The Census 2011 shows that 20.5 per cent of households own a bicycle, 24.1 per cent of all households own a two-wheeler and 10 per cent of households own a four-wheeler. In case of four-wheelers, Kerala is ranked behind Chandigarh, Goa, Delhi, Punjab and Haryana.

Figure 16.4
Rates of Growth of Registered Motor Vehicles: 2000−01 to 2010−11



Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

Road accidents

16.2.3.10 Kerala reports an increasing number of road accidents. In 2012, the State was (104) ranked second behind Goa (237.3) in terms of road accidents per one lakh population.[13] Kerala had the highest number of persons injured per lakh population (120) in 2012, followed by Tamil Nadu (116) and Goa (115). As regards the number of accidents per 10,000 vehicles, Kerala was ranked fourth (58) behind Sikkim (105), Jammu and Kashmir (72) and Madhya Pradesh (67) in 2012. Kerala is ranked low in terms of the number of people killed per 10,000 vehicles (6.8) in 2012. The severity of road accidents — number of people killed per 100 accidents — has gone up from 10.8 in 2009 to 11.3 in 2010 and 11.8 in 2011 and 2012.

Current policies

16.2.3.11 Given the above scenario, the state government is trying to expand the road network using public-private partnership (PPP) schemes. The Kerala State Transport Project is being implemented with the aid of the World Bank to upgrade the secondary road network in four phases. The other objectives of the programme are to improve road maintenance planning and management practices; reduce road accidents and fatalities along project roads; strengthen planning, technical and management capacities of key road sector institutions; implement reforms in the road sector to bring greater private sector participation; and pilot an inland water transport (IWT) project for testing approaches to correct the current imbalance in the nodal share between roadways and IWT in the State.

16.2.3.12 The National Highways Development Project has also been involved in Kerala to expand the NH network. Like the rest of the country, Kerala has also run into road blocks related to land acquisition, which adds to the woes of the road network.

16.2.3.13 The Kerala PWD is e-ready and offers several services to citizens — informing them of the shortest routes on roads, e-tendering and so on. However, the Web site needs to be regularly updated and more data on roads needs to be collected. The Kerala Police (this needs to be connected with the PWD and transport department) is also planning to build a GIS-based road safety management system.

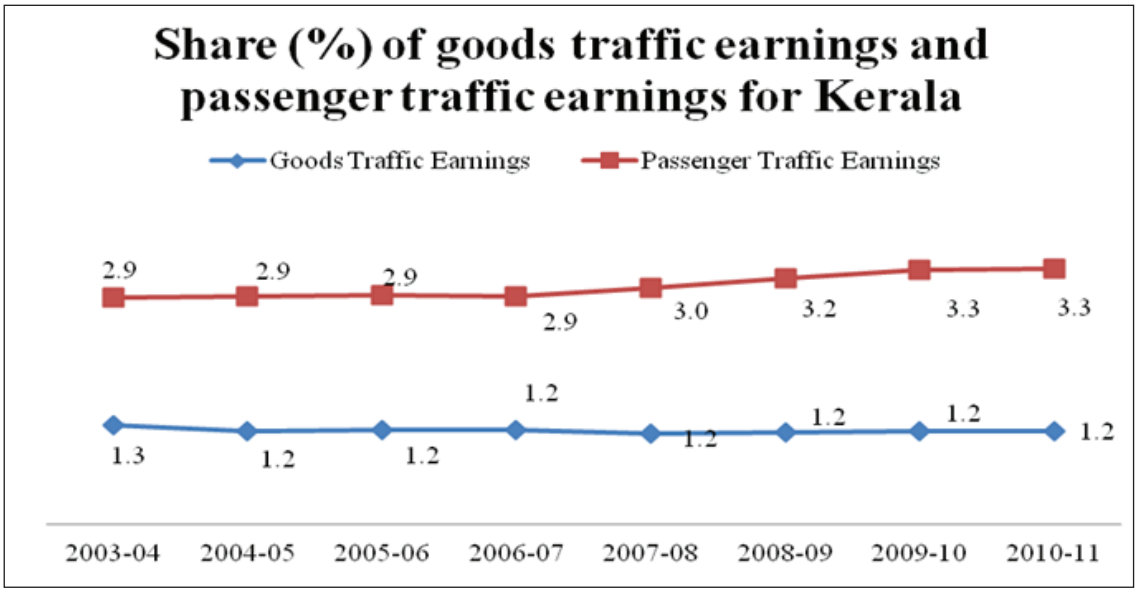
16.2.4 Railways

16.2.4.1 The Southern Railway zone, headquartered in Chennai, controls rail transportation in Kerala. The railway divisions in Thiruvananthapuram, Palakkad and Madurai jointly carry out railway operations in the State. The current length of railway lines in Kerala is 1,257 km and covers thirteen railway routes. The density of route length is only 27.02 km per 1,000 square km of land area. The total number of trains originating from Kerala is 83.There are 200 railway stations in Kerala and 47 passenger train services. There is no rail connectivity to districts such as Idukki and Wayanad; Kozhikode is the nearest railway station for Wayanad district and Ernakulam for Idukki.

Stagnant freight traffic and positive, albeit low growth in passenger traffic

16.2.4.2 Compared to the rest of India, Kerala's share of goods traffic earnings between 2003–04 and 2010–11 was stagnant (Figure 16.5). However, Kerala's share of passenger traffic earnings to the rest of India showed an increase, albeit a slow one, between 2003–04 and 2010–11 (Figure 16.5).

Figure 16.5
Stagnant Kerala Railways (% Share of all-India)



Sources: Indian Railways Annual Statistics, various issues and estimation by NCAER

Backward linkages of the railways sector

16.2.4.3 Railway transportation is vital to the movement of both freight and passengers, which is also an important economic activity. The contribution of railway transportation is estimated using a Kerala-specific Input-Output (IO) table. There are two estimates: The first by R.H. Dholakia in 1988, and the second by Ramesh Kolli in 2010. The present exercise has used both estimates to observe historical transition and the importance of backward linkage of railway transportation in different product categories.

16.2.4.4 The total backward linkage derived from Dholakia's IO estimation for 1988 and NCAER's Kerala IO is shown in Table 16.1. The estimation clearly shows a structural shift of coefficient and the importance of railway transportation services in Kerala's economy. First, the overall backward linkage of railway transportation has gone up from 1.85 to 1.91, which is a significant contribution. In 2010, Rs 100 invested in the railways would impact output by Rs 191. Second, sectoral linkages too are shown to have undergone transition in which other manufacturing, electricity, construction and mining along with trade and financial services have shown the strongest backward linkages.

Table .16.1.
Backward Linkages of the Railway Sector

1988			2010		
Sectors	Backward Linkage	Rank in terms of importance	Sectors	Backward Linkage	Rank in terms of importance
Railway transport services	1.025	1	Railway transport services	1.002	1
Construction	0.157	2	Other manufacturing	0.321	2
Other services	0.096	3	Electricity	0.106	3
Petroleum products	0.083	4	Construction	0.088	4
Rail equipment	0.078	5	Mining	0.088	5
Crude petroleum & natural gas	0.062	6	POL, rubber, plastic	0.061	6
Mining	0.053	7	Trade	0.040	7
Electricity	0.051	8	Financial services	0.038	8
Other transport service	0.051	9	Chemicals	0.035	9
Iron & steel	0.041	10	Other transport service	0.025	10
Electrical machinery	0.032	11	Real estate and business services	0.020	11
Non-metallic mineral products	0.017	12	Non-metallic mineral products	0.013	12
Other chemicals	0.014	13	Medical and health	0.013	13
Other manufacturing	0.013	14	Wood and paper	0.010	14
Wood and paper	0.012	15	Electronics and communication equipment	0.009	15
Total	1.852		Total	1.912	

Source: Appendix Table 4, Dholakia, Ravindra H and Bakul H Dholakia (1988), Working Paper, 747, IIM Ahmedabad, Calculation is done by NCAER Team.

Overburdened railway network of Kerala

16.2.4.5 Kerala's railway infrastructure seems to be overworked when compared to other developed and developing countries. For example, the total length of railway lines in the Netherlands is double that of Kerala, but carries less freight and passenger traffic (Table 16.2). The above results are not surprising, especially if one reflects on the fact that the density route length of Kerala has remained the same for over a decade at 27.02 per 1,000 square km. In contrast, many states have seen increases in their density route length. Bihar, for example, has gone up from 36.55 in 2000−01 to 37.33 per 1,000 square km in 2008−09, Tripura from 4.29 to 14.39 during the same period, West Bengal from 41.92 to 43.83 and Chandigarh from 72.73 to a whopping 145.45.

Table.16.2.
International Comparison of Railways: 2010

Country	Railways, goods transported (million ton-km)	Railways, passengers carried (million passenger-km)	Rail lines (total route-km)
Brazil	267,700	N.A.	29,817
China	2,451,185	791,158	66,239
Finland	9,760	3,959	5,919
Germany	105,794	78,582	33,708
India	600,548	903,465	63,974
Israel	1,062	1,986	1,034
Japan	20,432	244,235	20,035
Kerala	5,258.33†	19,365.2†	1,050#
Netherlands	4,331***	15,400	3,016
Norway	2,092**	2,674	4,114
Russia	2,011,308	139,028	85,292
South Korea	9,452	33,027	3,379
Sweden	11,500*	6,774	9,957
UK	12,512*	55,019	31,471
USA	2,468,738	9,518	228,513

*Notes: * 2009, ** 2005, *** 2004, # 2008–09, † 2010–11.*

Sources: World Development Indicators http://www.ircep.gov.in/AboutUs.html Ministry of Railways, Government of India.2010–11 and previous reports. Indian Railways Annual Statistical Statements 2010–11.

Current policies

16.2.4.6 The current policies for railway development in Kerala include the following:

- Conversion of the remaining metre-gauge to broad gauge, which is expected to be completed and operational by 2014.
- The current policies in railway development are geared toward development of railway transport within cities in order to create more public transport.
  - o The first project is the development of the metro in Kochi/Ernakulam.
  - o The second and third projects consist of setting up monorail systems in Thiruvananthapuram and Kozhikode.

- In addition, there have also been discussions about north-south high-speed rail connectivity in Kerala.
- Recently, the rail network in Kerala has seen some activity with the beginning of the Mainline Electrical Multiple Units (MEMU) train between Kollam and Ernakulam (started on 18 March 2012) and on the Kollam-Thiruvananthapuram-Nagercoil (Tamil Nadu) line (on 2 December 2012).

16.2.5 Airports

16.2.5.1 Kerala has thee international airports, which are located in the cities of Kochi, Thiruvananthapuram and Kozhikode. The Kochi airport is a joint venture and the other two are operated by the Airports Authority of India. There is also a military airport in Kochi, and two more international airports are planned, in Kannur and Aranmula respectively.

16.2.5.2 Kerala was a pioneer in airport development. It developed the Kochi airport on a PPP basis during 1994−1999, the first to do so in the history of civil aviation in India.[14] Kochi is the fourth largest airport in Southern India after Bengaluru, Chennai and Hyderabad in passenger and cargo traffic.

16.2.5.3 Internationally, the three airports cater to the West Asian and South East Asian regions. Domestically, Kochi is the best connected to other cities in India and has direct flights to Delhi and Mumbai. The other two are connected to various Indian cities via major hubs such as Mumbai, Bangalore, Chennai and Hyderabad.

16.2.5.4 Table 16.3 shows the passenger and freight growth rate between 2004−05 and 2009−10 for the three airports. Except for 2008−09, the year of the financial crisis, all three show robust growth. Surprisingly, Kochi and Thiruvananthapuram show double digit growth in freight even during 2008−09. Even during the current period, both Thiruvananthapuram and Kochi had more than a million passenger movements, each, in the period between April 2012−October 2013. During the corresponding period of April 2011−October 2012, most airports experienced negative growth in passenger traffic except Srinagar, Port Blair, Thiruvananthapuram and Kochi. The good news is that all three airports in Kerala experienced positive growth in freight traffic as well between April 2012 and October 2013.

Table.16.3.
Growth Rates of Passenger and Freight Traffic: 2004−05 to 2009−10 (%)

	Passenger Traffic Growth Rate (%)			Freight Growth Rate		
	Kochi	Thiruvanantha-puram	Kozhikode	Kochi	Thiruvanantha-puram	Kozhikode
2004−05	19.8	8.2	43.1	38.9	−9.9	35.4
2005−06	18.2	14.0	2.4	−4.2	3.9	1.4
2006−07	35.9	−12.3	18.0	7.5	−3.7	7.8
2007−08	30.5	80.9	16.2	10.2	35.7	−18.4
2008−09	0.4	−7.0	27.5	23.8	−1.6	38.2
2009−10	15.0	17.0	11.0	30.4	3.9	35.5

Source: Directorate General of Civil Aviation.

16.2.5.5 What explains the resilience of the growth in air passenger traffic in Kerala? Two possible factors are tourism and the migrant population. Table 16.4 shows the correlation between tourists and passengers — domestic, international and total — for each airport and the corresponding district. The surprising result is the weak correlation between tourists and air passengers in Kozhikode.

16.2.5.6 The Centre for Development Studies has carried out Migration Surveys in 1998, 2003, 2008 and 2011. Using the last three years of data and international passengers data for the same years (Table 16.4), the correlation between migrants and international passengers is strong (0.95) for Kozhikode and negative for Ernakulam (−0.92). Zachariah and Rajan (2012) mention the northward shift of emigrants and this correlation is a reflection of that.

16.2.5.7 The correlations show that tourists and emigrants are linearly associated with passengers, but each airport is being driven by different dynamics.

Table.16.4.
Correlations: 2002−03 and 2009−10

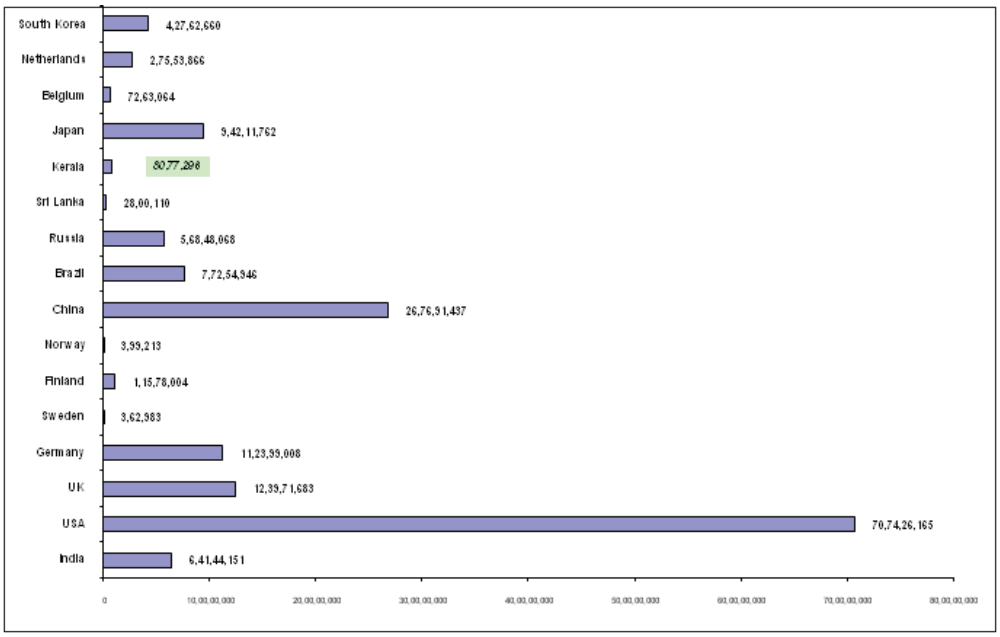
City	Thiruvananthapuram			Kozhikode			Ernakulam		
Type	I	D	T	I	D	T	I	D	T
Correlation Coefficient between passengers and tourists	0.89	0.71	0.91	0.60	0.51	0.89	0.85	0.84	0.88
Correlation Coefficient between passengers and foreign emigrants	0.79			0.95			−0.92		

Notes: I stands for International, D for domestic and T for total

Sources: Directorate General of Civil Aviation, Airports Authority of India, Kerala Tourism Statistics and Zachariah, K.C. and S.I. Rajan. 2012. "Inflexion in Kerala's Gulf Connection: Report on Kerala Migration Survey 2011". Centre for Development Studies Working Paper No. 250. September

16.2.5.8 Figure 16.6 shows that the number of air passengers carried in Kerala is higher than in Belgium, a high income country.

Figure 16.6
Air Transport: Passengers Carried (2010)



Sources: World Development Indicators, World Bank and Directorate General of Civil Aviation

Current policies

16.2.5.9 The current policies include plans to develop two new international airports in Kannur and Aranmula. Kannur is a key tourist destination in the Western Ghats and Aranmula is close to the Sabarimala shrine, which attracts millions of devotees every year. The proposed airport in Aranmula is to be the first private greenfield airport in the country.

16.2.6 Ports

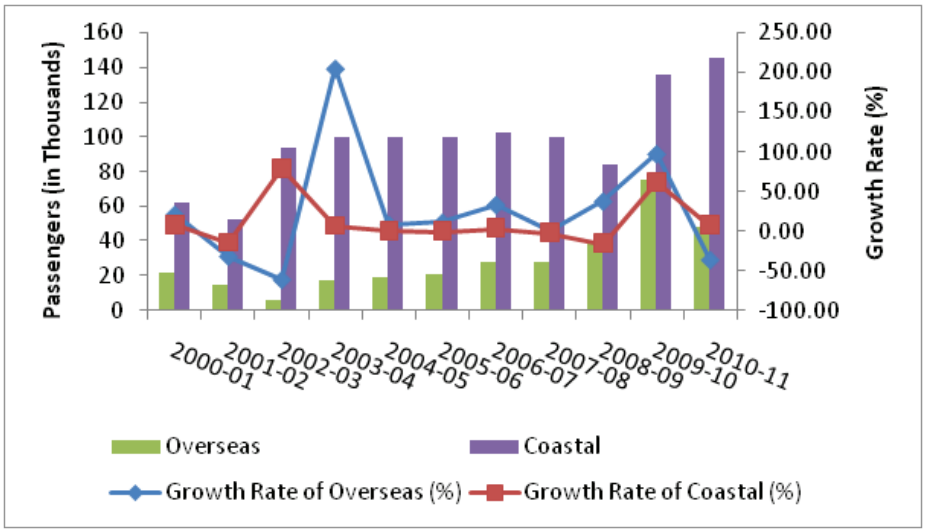
16.2.6.1 Kerala's spices have attracted people to its coast for centuries. Thomas the Apostle is supposed to have come to Kerala in 52 AD. Jews escaping the wrath of the Romans also came to the Malabar Coast of Kerala. Vasco da Gama came in search of spices and landed in Kozhikode in 1498. Kerala has 590 km of coastline, with one major port in Kochi and 17 minor ports.

16.2.6.2 Only four minor ports are operational,[15] and are considered intermediate ports based on berthing, cargo handling and storage facilities available in them. At present cargo operations take place only in Vizhinjam, Beypore, Azhikkal and Kollam ports. "Beypore is the second biggest port in Kerala after Kochi handling about 100,000 tonnes of cargo and 7,500 passengers per annum."[16] In 2011−12, Beypore handled 95,323 tonnes, Vizhinjam 6,162 tonnes, Azhikkal 4,678.1 tonnes and Kollam 1,264 tonnes of cargo. The total cargo handled by the minor ports in 2011−12 was 107,400 tonnes.

16.2.6.3 The Kochi port is the only major port in Kerala. It is spread over 827 hectares and has a water frontage of 7.5 km. The port has connectivity to the hinterland through NH 47, NH 17 and NH 49. Rail links to the Konkan and Southern Railway also give key rail access to its hinterland. An inland waterway connecting Kollam and Kottappuram, to the south and north respectively, is being developed by the Inland Waterways Authority of India.

16.2.6.4 Figure 16.7 shows the coastal and overseas passengers handled by the port over the last decade. Coastal shipping drives the passenger traffic in the Kochi port. The CAGR over the last ten years for coastal and overseas passengers has been a healthy 8.1 and 7.3 per cent, respectively.

Figure 16.7
Passengers Handled by Kochi Port: 2000−01 to 2010−11



Sources: Ministry of Shipping

16.2.6.5 Table 16.5 shows the cargo traffic handled by the Kochi port. The CAGR between 2000−01 and 2010−11 is 3.1 per cent.[17] The Kochi port accounted for 98 per cent of cargo traffic in Kerala in 2010−11. Cargo traffic is also decomposed in two parts — overseas and coastal. The Kochi port handles most of the overseas cargo traffic. Coastal cargo accounts for 37 per cent of the cargo traffic at the Kochi port. The commodity that drives the cargo traffic at the Kochi port is petroleum, oil and lubricants (POL) — the share among commodities imported is 80 per cent and share among commodities exported 66 per cent (2009−10). Of course, spices continue to form a significant import (2 per cent) and export (5 per cent) of Kochi's port operations.

16.2.6.6 The cargo traffic handled by the minor ports also showed a CAGR of 2.8 per cent between 2000−01 and 2010−11. The minor ports handle 80 per cent of the coastal traffic. The two major imports at the other ports in 2008−09 were wheat (39 per cent) and soda ash (40 per cent). Coastal exports from the minor ports consisted of cement (15 per cent), metal (30 per cent) and miscellaneous items (55 per cent). Most of the cargo from the Beypore port goes to Lakshadweep.

16.2.6.7 There is a very high correlation of 0.95 between GDP industry and total cargo traffic of Kerala (2000−01 and 2010−11).

Table.16.5.
Cargo Traffic Handled at Kerala ports in '000 tonnes: 2000−01 and 2009−10

Year	Kochi	Other Ports	Kerala
2000−01	13,144	94	13,238
2001−02	12,059	127	12,186
2002−03	13,024	89	13,113
2003−04	13,572	58	13,630
2004−05	14,103	81	14,184
2005−06	13,888	135	14,023
2006−07	15,257	172	15,429
2007−08	15,810	104	15,914
2008−09	15,494	131	15,625
2009−10	17,429	119	17,548
2010−11	17,873	124	17,997

Source: Ministry of Shipping

Table.16.6.
Cargo Traffic Handled at Kerala Ports (in '000 tonnes)

Year	Overseas	Coastal	Total
2000−01	7,354	5,884	13,238
2001−02	7,032	5,154	12,186
2002−03	8,347	4,766	13,113
2003−04	9,830	3,800	13,630
2004−05	10,365	3,819	14,184
2005−06	9,842	4,181	14,023
2006−07	10,862	4,567	15,429

2007−08	10,670	5,244	15,914
2008−09	11,111	4,514	15,625
2009−10	11,898	5,650	17,548
2010−11	13,159	4,838	17,997

Source: Ministry of Shipping

16.2.7 Inland waterways

16.2.7.1 Kerala has 1,548 km of navigable waters with 840 km of navigable rivers and 708 km of canals.[18] The West Coast Canal from Kottappuram to Kollam with Udyogamandal and Champakara canals has been declared National Waterway No 3 (NW3) in 1993. It is 205 km long.

16.2.7.2 Kerala had the highest number of inland water vessels in the country (9,060 in 2006−07). It grew from 4,202 in 2002−03.[19] Table 16.7 shows the cargo traffic handled by the three canals in NW3. The CAGR between 2001−02 and 2011−12 is 2 per cent. The Udyogamandal canal has shown the highest growth in cargo movement over the last ten years (CAGR 9.2 per cent). There is negative correlation between GDP industry and cargo movement on NW3.

Table.16.7.
Cargo Movement in NW 3: 2001−02 and 2011−12 (lakh tonnes)

Year	Champakkara Canal	Udyogamandal Canal	West Coast Canal	Total
2001−02	3.06	3.44	5.15	11.65
2002−03	3.63	3.3	4.95	11.88
2003−04	4.04	4.24	5.34	13.62
2004−05	3.66	2.69	5.24	11.59
2005−06	4.58	2.44	4.53	11.55
2006−07	4.14	2.15	3.94	10.23
2007−08	2.15	1.2	3.43	6.78
2008−09	2.48	1.87	3.32	7.67
2009−10	1.87	2.4	2.56	6.83
2010−11	3.41	3.24	2.23	8.88
2011−12	2.92	8.67	1.85	13.44

Source: Inland Waterways Authority of India, Regional Office Kochi

16.2.7.3 The Kerala Shipping and Inland Navigation Corporation offers only cargo services. The State Water Transport Department offers passenger services. The state waterways network includes Kovalam to Kollam (74 km) and Kottappuram to Neeleswaram (349 km), a total of 423 km.[20] This system has feeder canals with an aggregate length of 1,097 km. The state government has set a minimum width of 14 m and depth of 1.5 m for state waterways. In addition, 5 m overboard clearance is required. There are missing links along the state waterways, which require land acquisition. The Beypore and Azhikkal ports have inland water connectivity. Similarly, the Kollam port and the inland waterways are separated by 350 m; an artificial link would require land acquisition.

16.3 Projections

16.3.1 The projections are made separately for passengers and freight transport (given that physical infrastructure continues to grow at the same rate). The usual units of measurement for passengers and freight — passenger-million-km and freight-tonne-km — are not available at the state level. Using assumptions from the national level, passenger-million-km for roads, railways and airports has been estimated. Then, Compounded Annual Growth Rate (CAGR) has been used to predict 20 years into the future. The projections match the analysis and the evidence above confirms the numbers. Plus, a sensitivity analysis was done using several models. The results, unfortunately, do not change much. The projections are meant to highlight the challenges that Kerala will face if it does not take corrective action

16.3.2 For passenger traffic, only roads, railways and airports were used, as the share of water transport is negligible. Predictions for passenger traffic at the Kochi port are presented in Table 16.8b. Table 16.8a shows that the roads sector dominates passenger traffic and will continue to increase its share over the next twenty years in a 'business as usual' (BAU) scenario.[21] The share of railways will fall while the share of airports continues to remain at the same level.

Table 16.8 a.
Projection of Passenger Traffic, Roads, Railways and Airports

Year	Passenger km in millions (PKM)			(%) Share of Passenger km		
	Roads PKM	Railways PKM	Airports PKM	Roads	Railways	Airports
2011	9,32,604	23,369	1,319	97.42	2.44	0.14
2015	13,56,263	28,790	2,040	97.78	2.08	0.15
2020	21,65,968	37,367	3,517	98.15	1.69	0.16
2025	34,59,077	48,500	6,062	98.45	1.38	0.17
2030	55,24,187	62,949	10,451	98.69	1.12	0.19

Source: Computed by NCAER

Table 16.8 b.
Projection of Passenger Traffic at Kochi Port (in thousands)

Year	Overseas	Coastal	Total
2011−12	53.0	154.2	158.3
2015−16	77.6	191.2	191.5
2020−21	124.8	250.1	242.8
2025−26	200.7	327.3	308.0
2030−31	322.99	428.3	390.6

Source: Computed by NCAER

16.3.3 Tables 16.9a shows projections for freight traffic in Kerala. Roads dominate the transport of freight.

Table 16.9 a.
Predictions of Freight Traffic for Railways and Roads (million-tonne-km)

Year	Railway	Roads (4 wheelers & above)
2011–12	5,226	1,60,686
2015–16	5,097	2,14,996
2020–21	4,940	3,09,382
2025–26	4,788	4,45,204
2030–31	4,641	6,40,654

Source: Computed by NCAER

Table 16.9 b.
Projections for Cargo Traffic in Kerala Ports (thousand tonnes)

Year	Cochin	Other Ports	Kerala
2011–12	18,430.81	127.48	18,558.29
2015–16	20,841.66	142.42	20,984.03
2020–21	24,303.42	163.57	24,466.84
2025–26	28,340.16	187.87	28,527.70
2030–31	33,047.4	215.78	33,262.55

Source: Computed by NCAER

Table 16.9 c.
Cargo Movement in NW-3 (in lakh tonnes)

Year	Champakara Canal	Udyogamandal Canal	West Coast Canal	Total
2011–12	2.92	8.67	1.85	13.44
2015–16	2.94	11.67	3.46	16.65
2020–21	2.97	16.93	7.55	21.76
2025–26	3.0	24.55	16.48	28.44
2030–31	3.02	35.6	35.98	37.16

Source: Computed by NCAER

16.4 Challenges

16.4.1 Kerala's challenges in the transport sector are summed up below:

- The roads sector dominates passenger and freight movement in Kerala even though there are other modes of transport in the State. Road transport and air traffic movements in Kerala match the traffic movements of developed countries.
- Unfortunately, in the case of roads, the physical capacity does not match the need, leading to traffic jams and high accident rates (which are among the highest in the country). Road width of major road networks is woefully inadequate.
- Loss of time, property and lives ultimately costs Kerala GDP growth.
- Land acquisition for road development is an issue and is a huge challenge for Kerala, especially given the limited land and high population density.
- Further, private transport dominates public transport.

16.4.2 The challenge for Kerala is to manage land for expanding the transport network and to achieve a more balanced, efficient and sustainable usage of its five transport options.

16.5 Strategic Way Forward

16.5.1 The way forward has to be sustainable and should match the realities of geography, structural changes, urbanisation and urban development (of smart compact cities), ageing and economics. The desire is to achieve sustainable green infrastructure with low impact on the environment.

16.5.1 Vision

16.5.1.1 Green, sustainable and safe transport.

16.5.2 Mission

16.5.2.1 The goal is to build a sustainable transport system — one that has "The capacity to support the mobility needs of people, freight and information in a manner that is the least damageable to the environment."[22] It should achieve the 3Es — economic efficiency, social equity and environmental sustainability.[23]

16.5.3 Strategic goals

16.5.3.1 The goal is to develop regional, inter-state and international connectivity that caters to the economic and social aspirations of the people and also fosters Kerala's presence in the global economic, education, health and tourism arenas. Developing effective intra-city (city/town/UA level) integrated transport facilities that give due importance to pedestrian facilities and non-motorised transport (including bicycles) is one aspect. Developing concerted strategies to increase the share of public transport and to reduce the number of private vehicles/single passenger occupied vehicles on the roads also needs to be part of the overall plan.

16.5.3.2 Numerical indicators are suggested below, to track progress towards the achievement of these goals:

- Transport Shares
  - Share of road transport in Kerala in passengers-billion-km – 70 per cent
  - Share of rail transport in Kerala in passenger-billion-km – 25 per cent
  - Share of water transport in Kerala in passenger-billion-km – 4 per cent
  - Share of air transport in Kerala in passenger-billion-km – 1 per cent
  - Share of road transport in Kerala in freight-ton-km – 60 per cent
  - Share of rail transport in Kerala in freight-ton-km - 20 per cent
  - Share of water transport in Kerala in freight-ton-km - 20 per cent

- Sustainability
  - Measure of mass public transport within cities
  - Revamp public transportation system to increase its share from existing 33 per cent of total passenger traffic to 80 per cent by 2025.
  - Average vehicle occupancy: Average number of people in each vehicle/car: 5
- Safety
  - Number of accidents per 10,000 vehicles: 5

16.6 Strategic Framework

16.6.1 The key strategy for Kerala is to plan for an inter-modal, integrated transport system across the State and within its emerging urban agglomerations. Rodriguez (2013) defines this as "the movements of passengers or freight from one mode of transport to another, commonly taking place at a terminal specifically designed for such a purpose."[24]

16.6.2 The overall paradigm has to move towards the outcome of improving users' satisfaction with the quality of the transport system. The transport strategy has to be synced with the regional spatial strategy, which is dependent on building an efficient transport network. Trade and transport corridors are identified as important elements in this strategy. Sustainable competitiveness needs to be supported by good quality infrastructure. Smart, green, compact cities require strong infrastructure and sustainable transport systems. Further, a transit-oriented development strategy as proposed in the urbanisation chapter (Chapter 15) requires that the corridors be seamlessly linked.

16.6.3 There are five pillars to this strategy. They are:

Pillar 1: Institutions
Pillar 2: Physical infrastructure
Pillar 3: Economic efficiency
Pillar 4: Social equity
Pillar 5: Environmental sustainability

16.6.3.1 Pillar 1: Institutions

Element 1: Establishment of new institutions and establish cooperation between existing ones

Expert Transport Group

6.6.3.1.1 Establish an Expert Transport Group (ETG) that functions within Kerala's transport department. The ETG will include transport and urban planners, representatives of various modes of transport, engineers, representatives of NATPAC, behavioural scientists and economists. Its responsibilities will be the following:

(1) Create a transport plan for the next twenty years, synchronising it with the regional spatial strategy and transit-oriented development strategy outlined in Chapter 15 on Urbanisation.[25]
(2) Assess transport needs.
(3) Enable the Department of Transport to publish a 'Transport Monitor', every year, presenting the status of transport-related matters and issues. This document will help plan further action.

Transport Regulatory Authority (TRA)

16.6.3.1.2 The government may set up Transport Regulatory Authority for all modes of transport. All transport operations will be as per regulations and will be monitored. Modernisation of all public transport operations, use of GPS, ICT for public information systems and so on will become part of the regulations.

Public Transit Authority

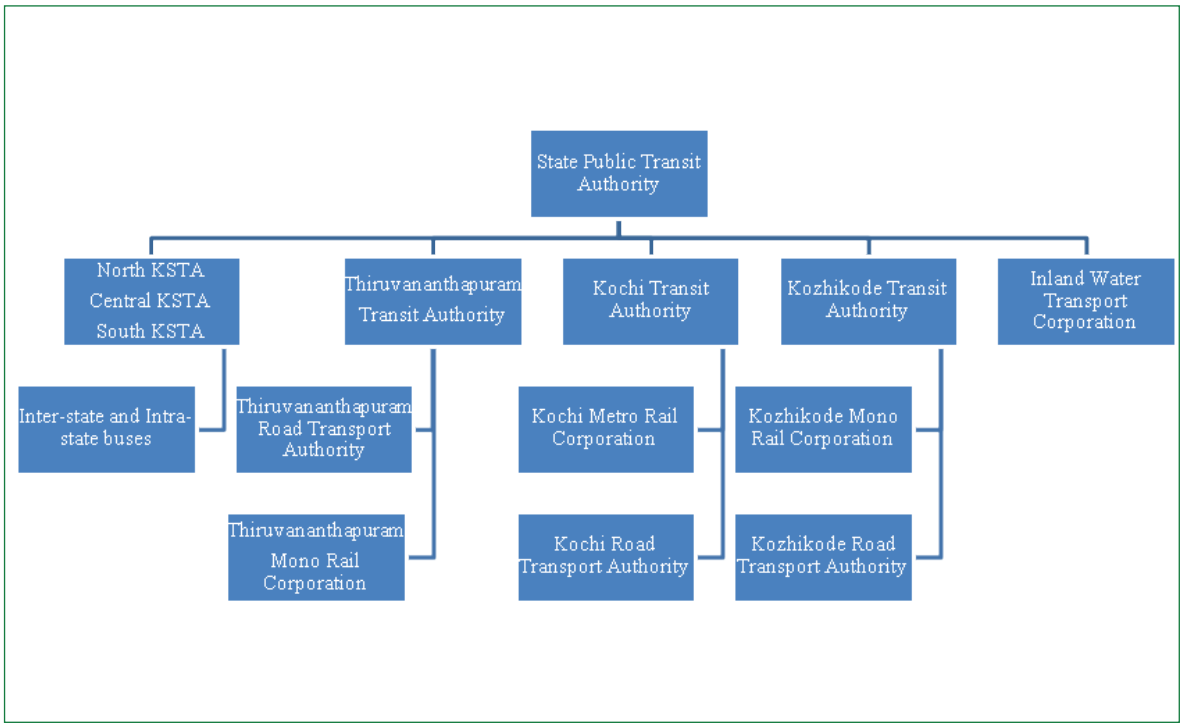
16.6.3.1.3 This authority will work under the aegis of the Department of Transport and will operate the transport network. It will also be subject to regulations set by the TRA.

16.6.3.1.4 A decentralised transport system is proposed and is illustrated in Figure 16.8. As the number of urban agglomerations is bound to increase, the picture will change.

16.6.3.1.5 Thiruvananthapuram, Kochi and Kozhikode will establish their own transit authorities to operate and manage all modes of public transport in these three Urban Agglomerations (cities and their immediate peripheral areas).[26] City bus networks for the public may be placed directly under the respective bus authorities. Water transport and rail transport can have their own independent organisations, but working under the aegis of the transit authorities in order to match schedules, tickets and so on.

16.6.3.1.6 It is proposed that the Kerala State Road Transport Corporation (KSRTC) be divided (three departments within the same organisation) into three zones — North, Central and Southern Zones. Interconnectivity between them (in terms of routes and schedules) will be implemented by the public transit authority along with the three sub-transit authorities. Further, they will work with other modes of transport to sync schedules.

Figure 16.8
Rates of Growth of Registered Motor Vehicles: 2000−01 to 2010−11



Source: Conceptualised by NCAER

Motor Vehicles Department (MVD)

16.6.3.1.7 This organisation is already in the process of modernising and restructuring its operations. System improvement and transparency contribute to efficiency and speedy delivery of services. Capacity building is another exercise, which has to be made a continuous process. An officer trained once has to undergo training again, if not in the same subject, at least in newer areas.

A few recommended actions are:

(a) Modernisation and restructuring.
(b) Capacity building exclusively for officers of the department, and also jointly with police officers.
(c) Issue of Citizen's Charter.
(d) Transparency should be the key principle of departmental functions.
(e) Licensing intermediate transport vehicles should be based on carrying capacity of roads within an urban area or a rural region and the availability of parking stands.
(f) A close monitoring system should be developed for taxis, autos, mini-vans and jeeps on hire.

Coordination between physical infrastructure providers

16.6.3.1.8 The Public Works Department (PWD), railways, Inland Transport Authority, airports and coastal shipping agencies will coordinate to build transport infrastructure and for the operations and maintenance (O&M) of existing ones.

Element 2: Private transport

16.6.3.1.9 Private buses may continue to ply intra and inter-state routes. Within the urban agglomerations, they may be eased out over time due to better availability of public transport. Both economic theory and evidence from around the world suggests that public transport is better than private transport, at least for transportation within cities. Of course, if at all, the choice of public over private transport is made, easing private operators out overnight is going to be an issue. Therefore, for practical purposes, till a policy choice is made, private buses will continue to ply on roads. Even if the choice is to continue the status quo, private buses need to be regulated and monitored in the same way as public buses. They will be subject to the same monitoring and regulation as public buses. Quality of transport needs to be maintained. Only trained and certified bus drivers from the bus corporations may be used. Even private buses will have GPS installed and their timings will be relayed for real time updates of passenger information. Buses more than 10 years old will be retired. Private operators' behaviour will be subject to the same scrutiny as that of their public counterparts. The TRA will regulate and the MVD will monitor the operations of the private bus systems on an annual basis. Intermediate transport has been mentioned before. It will also be subject to the regulations of the TRA, with licensing and monitoring being carried out by the MVD.

Element 3: Stringent road driving laws

16.6.3.1.10 Road driving laws need to be modified to standards adopted in European countries.[27] A carrot and stick policy may be used to reward good driving and punish bad driving. Of course, KPP 2030 recognises that it may not be possible for the State to change all laws at the state level, but the central government can be pushed to adopt more stringent policies. Given the pervasive alcohol problem in Kerala, it is recommended that a zero tolerance policy be adopted.

Element 4: Adoption of ICT

16.6.3.1.11 Adoption of ICT is key to enabling the inter-modal transport network. For example, intelligent transport management systems, intelligent signalling systems (possibly using CCTV), usage of GPS on public transport, smart licenses and informing the public about traffic schedules will all be supported by usage of ICT. Usage of social media to converse with the public, especially about traffic jams, is extremely popular around the world and has met with success in Delhi. Mobile apps can be developed to inform the traveller about the approximate time of arrival of a bus, train or metro.
16.6.3.1.12 UID-linked driving records may be maintained and be made available to the public for a small fee to check on the driving backgrounds of individuals.

16.6.3.1.13 Laws and infrastructure have to go hand-in-hand for a safe travel experience.

16.6.3.2 Pillar 2: Physical infrastructure

Element 1: Provision of physical infrastructure

16.6.3.2.1 Physical infrastructure has to be designed to support an inter-modal transport network. The chapter on Land discusses many solutions for land acquisition.

Design

16.6.3.2.2 The design of the physical inter-modal transport network will be in sync with the spatial strategy. Box 15.2, in Chapter 15, discusses Singapore's and Copenhagen's strategies of building transport networks ahead of urbanisation to fuel growth in a particular manner. As has been mentioned before, location of the central bus station next to the main railway station, as in Thiruvananthapuram, is a good design element for inter-modal transport. The Anand Vihar metro station in New Delhi is another example. The metro station, bus terminus and railway station are all located in the same transit area, making it very easy for passengers to travel. City buses and the metro link the new international airport to the city in New Delhi. Plus, the design of the transport system within cities has to be in sync with smart, compact, vertical cities. The centres of excellence in education are designed to attract students from all over Kerala, India and the world. They will be encouraged to use public transport to go around. Plus, these students may be encouraged to use public transport to travel to nearby tourist sites too (hub and spoke model). Similarly, with respect to medical centres of excellence, other than the time spent in hospitals, patients and their companions or visitors may want to travel. Design of physical infrastructure, therefore, has to be done keeping in mind the economic model that Kerala aspires to create by 2030.

16.6.3.2.3 The exact designs will be part of the Transport Plan of the State. It may be a unified plan with further details left to the urban agglomerations and urban local bodies.

Roads

16.6.3.2.4 Widening and improvement of roads is necessary for the State, since the importance of road transport will continue. When any road is widened, land for widening has to be taken equally from both sides. Road widening and improvement is an opportunity for geometric corrections. This possibility should be used, for roads and road intersections/junctions with bad geometrics cause accidents and result in traffic bottlenecks.
16.6.3.2.5 Design standards of roads are crucial and have to be maintained and improved to international specifications.

- Primary road network should be well linked to the secondary road network, which, in turn, should be linked to rural roads. Road construction, redevelopment, resurfacing and so on should be based on planned strategies and not on an ad-hoc basis.
- Road designs should be done based on 15-year traffic forecasts even with an inter-modal transport network. Planning for the future is a must.
- Pedestrian-friendly roads are critical, even for highways.
- There is an increasing tendency to compromise on the width of right-of-way, carriageway, lane width and median width. Such scaling down of recommended standards may be damaging to the State. For instance, reducing the central median to 30 cm from 60 cm would make it difficult for vehicles to make 'U' turns, and when that happens vehicles block the straight moving lane, disrupting traffic or they reverse into the straight moving lane, colliding with the vehicle behind. Compromises on road standards are at the cost of life and property.

- 'Four laning' or 'six laning' may not yield the desired results if one lane on either side is used for parking vehicles or stopping buses or if slow moving vehicles use the speed track. The alternatives are: provide bus bays off the carriageway wherever bus halts are proposed and these should be strictly monitored, and provide off the carriageway (off-street) parking bays (build them in pay and park mode so that long-duration parking of vehicles can be avoided).
- Road design is a critical element of building roads, especially in a state like Kerala that has two monsoons.

16.6.3.2.6 National Highways and expressways/primary road network

- The National Highways link Kerala to the rest of the country and are economic corridors of the highest order.
- Expansion of the road network, not in terms of just quantity, but quality is crucial. Roads need to be widened and riding surface quality improved as per prescribed standards to serve as fast movement corridors and to cater to freight movement.
- Bypasses for cities will be built for local traffic.
- Subways or pedestrian flyovers at regular intervals will be critical for highways.
- Most of the container traffic, multi-axle trucks, oil tankers, national permit trucks, high-speed inter-state buses and so on travel on the highways (NH and State Highways). These need lay-byes for driver relaxation, rest and for servicing. Lay-byes should be provided on the highways.

16.6.3.2.7 State Highways and major district roads/secondary road network

The role of the Public Works Department is crucial:

(1) The PWD should prepare a strategy for road development in consultation with the overall plan of the ETG. Quality improvements in road construction should be an important aspect, since this will save the State huge expenditure on road repairs and maintenance.
(2) The PWD road construction specifications should be improved to international specifications (ADB, World Bank and so on) and insisted on for longer life of roads. It is the life cycle cost of the road that should be considered and not the initial cost of construction.
(3) Road maintenance protocols should be issued.
(2) An inventory of all road bridges needs to be prepared.
(3) Road signage is mandatory and should invariably be installed as necessary, as should lane marking.
(4) Good detailed road maps need to be prepared by the State PWD. Road and bridge inventories should be carried out and recorded. Such printed records, of maps and inventories, should be the base for additional construction, repairs, maintenance and so on. This should be available to academic institutions, researchers and the public.

All the elements recommended above for NHs also hold true for the secondary road network.

16.6.3.2.8 Local roads

- Road inventory records and maintenance data should be made mandatory for ULBs and gram panchayats.
- Roads in hilly areas should be constructed according to the specifications laid down at the central level.
- Rural roads should be widened and hundred per cent surfaced. Two-way traffic with pedestrian and bicycle-friendly roads should be the minimum norm for designing roads.

Urban roads

- Transit-oriented development design of roads should be adopted by the urban agglomerations and bigger municipalities. All ULBs should be made to prepare a perspective road network plan and road improvement plan for five years in consultation with the ETG. Based on the perspective plan for the road network, building lines should be declared and enforced. The permissive provision in the Municipality Act should be utilised. (In the absence of this building line declaration, buildings are constructed close to the existing road boundaries totally preventing any future widening of the roads)
- City road planning should be related to land use zoning. Land use zoning within a city/town should be such that inter-zone travel needs are minimal.
- Pedestrian and bicycle travel within the zone should be planned and encouraged (Box 16.3). This is crucial to persuade people to choose to live in smart and compact cities. Even small roads, by-lanes will follow specifications set by the PWD and urban planners under the aegis of the ETG. This will have a tremendous impact on the quality of life of citizens.
- Marking lanes and road signage are crucial in designing urban roads.
- Designated, paid-parking places have to be in the design. On-street parking during peak hours should be paid parking.
- Roads should be designed so that buses can be given right of way.
- Good inter-modal interchange facilities (terminals/hubs) should be built so that a person travelling a long distance by one mode of public transport can easily shift to another mode of travel /local transport at the same point.

Railways

16.6.3.2.9 The elongated shape of the State has made it easy to provide road transport. It is also a good fit for rail transport. The railway network offers a green transport option. A public mass rapid transport system connecting north and south Kerala is crucial. This particular mode needs to be encouraged for both passengers and freight traffic and holds the greatest potential to move both off the roads. A Perspective Plan for railway development in Kerala needs to be built in consultation with the ETG.

16.6.3.2.10 Railway infrastructure design has to be built for passengers and freight.

16.6.3.2.11 Passengers

- The passenger rail network should include a range of trains to facilitate travel both within cities and within the State.
- Within cities: The metro and the monorail have already been discussed. Further, there can be more MEMU trains especially for the three main cities.
- Very fast rail: A high-speed rail line from Thiruvananthapuram to Kasaragod is being considered.
- Fast: Two Shatabdi trains also run along Kerala's North-South axis.
- Slow: Slower trains, which run along the length of the State and stop at all stations, need to be considered.[28] There is always the concern that railways is a central subject. However Gujarat has got around this problem and Box 16.1 discusses one such example. The State can finance such a rail project and Non-resident Keralites can be asked to pitch in.

Box No 16.1

Kutch Railway Company Ltd

The Ministry of Railways under the National Rail Vikas Yojana has embarked on strengthening rail connectivity to various ports. Developments in ports in the Gandhidham area established the need for an additional freight corridor to the northern hinterland. Accordingly, the Ministry of Railways decided to convert the existing meter gauge line between Gandhidham and Palanpur (301 km). After RVNL (a PSU under the Ministry of Railways) came into being, this project was transferred to it for execution. RVNL set up a special purpose vehicle for gauge conversion of the Gandhidham-Palanpur line and the Kutch Railway Company (KRC) was formed with equity contributions from RVNL, Kandla Port Trust, Mundra Port and SEZ Ltd and the Government of Gujarat to undertake the gauge conversion.
KRC was incorporated on 22 January 2004 under the Companies Act, 1956. The Ministry of Railways leased all assets, including land, buildings, bridges and so on, on the above line to KRC for a period of 32 years and authorised it to finance, construct, operate, maintain and manage the Palanpur-Gandhidham section. Commercial operations on the KRC line started from 1 July 2006.

Source: Suzuki, H., Cervero, R. and Iuchi, K. (2013). Transforming Cities with Transit. World Bank.

16.6.3.2.12 Freight

16.6.3.2.13 Building the rail network for freight and connecting it to shipping and inland water transport will help build the logistics industry in Kerala as proposed in Chapter 8 on Industry. Specific measures include:

- Rail hubs with sufficient warehousing facilities.
- Efforts are being made by the railways to attract freight traffic. A new freight train 'Kairali Black' carrying bitumen was run recently to Falakata and New Guwahati goods shed from Kochi Refinery Ltd.[29]
- Aggregate piecemeal traffic from various companies.
- Parcel movement is also being encouraged.

16.6.3.2.14 Railway stations need to be modernised and upgraded for both passengers and freight.

Air transport

16.6.3.2.15 The existing three international airports, with two more planned, are more than enough given Kerala's geography. More airports, if built, should all be domestic ones. Airports should be linked to the rail/bus network, so a person who arrives in a city by air can take a train (metro/mono/light rail) to the city centre. This is very useful for both leisure and non-leisure travellers.
Inland shipping

16.6.3.2.16 India is far behind Germany and China in its usage of inland waterways. A detailed transport plan under the aegis of the ETG needs to be done to make Kerala's waterways relevant. The waterways system should be similar to the highway system, with national and state waterways.

16.6.3.2.17 Certain specific suggestions are:

- Build the required water transport infrastructure for NW3 and commission the project as early as possible.

- NW3 access should be developed for Kayamkulam and Kottayam towns with boat terminals in these towns.
- Develop the state waterways network and connect it to NW3.
- Initiate steps to extend NW3 to Veli in Thiruvananthapuram by rejuvenating, widening and improving the old canals. Build a good water transport terminal at the Veli backwaters, linking it to the proposed Kochuveli transport hub to facilitate easy inter-modal transfers and city connections.
- The Veli boat terminal could be linked to the Veli–Kovalam water transport facility, which can be planned along the existing Parvathy Puthanar (part of the TS canal).
- The old AVM canal can be rejuvenated, at least up to the State border (this could greatly relieve the present road traffic problems along the Karamana–Parassala stretch of NH47).
- Identify rivers flowing East–West, which can be developed for water transport, perhaps linking them to the backwaters and ensuring water flow throughout the year.
- Along with development of water transport infrastructure, facilities should also be developed for inter-modal transfers, for instance from water transport to road transport and vice-versa.
- Kochi city and Alappuzha town should be prioritised for development of intra-city water transport, with time targets assigning specific departmental responsibilities.
- The canals and rivers should be cleaned up and maintained.

16.6.3.2.18 A note of caution is that inland water transport can run into conflict with fisher folk as faster boats disturb the fishing patterns, nets and so on. Options to address this include a coordination mechanism or defined slow zones to preserve fish, fixing particular paths for boats or fixing times for the boats so that the goals of faster transport and preservation of livelihoods and the ecosystem are achieved. Any inland water transport plan should be done in consultation with the Department of Fisheries.

Coastal shipping

16.6.3.2.19 The coastal shipping department has made a detailed outline of its plans. They need to be synced with the other modes of transport under the ETG for maximum benefit to the State.

- The State's major port is the Cochin Port, but the financial status of the Cochin Port Trust and the status of operations at the Vallarpadam Container Terminal show that significant revamping is required to rejuvenate port operations in Kochi. The major constraint at Kochi is the shallow draft and the huge amounts spent annually on continuous dredging operations to keep the draft at 12 to 14 metres. The continuous heavy silt formation retards further development. Therefore, senior level, policy-related interventions are required for the continued health of the port.
- The international shipping route connecting Dubai, Colombo and Singapore is nowhere near any of India's western ports, not to speak of the eastern ports. The big post-Panamax ships that ply along the international shipping routes need a draft of more than 20 metres. It is in this context that the proposed Vizhinjam (Thiruvananthapuram) International Container Transhipment Terminal (ICTT) becomes relevant and important for the country as a whole. At present, cargo destined for India is transhipped at Dubai, Colombo or Singapore. The smaller ships into which international cargo is transhipped then sail to Indian ports, which means that India pays more for every kilogram of cargo that enters through its existing ports. The proposed ICTT at Vizhinjam may save the country this additional cost. However India and the State are still to realise the potential of the Vizhinjam ICTT and its likely economic impact on the country.
- When the Vizhinjam ICTT is commissioned, the State may need to develop the other smaller ports along the Kerala coast to permit small ships to reach those destinations. There is good scope for development of Kollam, Kozhikode and Kannur ports. Coastal shipping becomes relevant in that context.

- Kerala is considered a major international tourism destination attracting tourists from all over the world to Kovalam, Varkala, Alappuzha, Kochi, Kannur and Kasaragod along the coast and to the Western Ghats and its forest attractions. Occasionally the State receives tourist ships at Kochi and, very rarely, at Vizhinjam too, though the port and associated facilities for tourist traffic are not available there. There is a need to develop facilities for tourist ships in these destinations.
- Coastal shipping for passengers can be developed from Kovalam to Bekal, with stops at the minor ports. This should have a positive impact on reviving the ports sector too. The ports sector can be inter-linked to the inland waterways. The ports and the inland water sector should be well integrated into the design of the cities. The cities can then have the added advantage of using those areas as tourist attractions like it is done in Hamburg and Rotterdam.

16.6.3.2.20 The dredging costs for water transport have to be borne by the state.

Element 2: Financing

- The PPP model adopted by the State in developing various modes of infrastructure may continue.
- The diaspora can be involved through the creation of an Infrastructure Development Fund to finance the new transport network.
- Tolls on National Highways are a concern. Building bypasses for local traffic may address this issue.
- PPP models can be implemented for rural roads too. Many rural roads, together, can be given to a concessionaire for attaining scale. Of course, these roads will be built on annuity schemes because traffic volumes will be low.
- Multi-modal logistic parks built in the PPP mode may generate revenue.
- All inter-modal hubs should be so developed that markets and commercial areas can grow around them. In South Korea, the metro stations are where people shop.
- Advertising revenue may be earned through billboards on the sides of buses or within the metro, monorail, bus, in transit terminals and so on.
- Taxes may be used to finance infrastructure creation at the local level. It is recommended that municipalities impose congestion tax, vehicle tax and so on. Congestion tax is a good concept except that good public transport should be offered as an alternative — right now private transport is the only alternative. Singapore has an elaborate and expensive tax system to discourage people from buying cars. However, it does offer an excellent public transport system. Therefore, the Singapore model can only be implemented after a good public transport system has been developed. A limited introduction of congestion taxes may help mobilise some finance.
- Pricing of mass public transport has to be reasonable. However, different pricing mechanisms may be tried out on a pilot basis. Dynamic pricing may be experimented with, which is essentially charging different prices for different times of the day.

16.6.3.3 Pillar 3: Transport

16.6.3.3.1 Human beings respond to incentives and not just financial ones. If they want to go from point A to point B, they will choose the option which is fastest, reliable, secure, on-time and gives last mile connectivity. In Kerala's case, it is roads, and especially private transport. In order to change behaviour and make people use mass transport, the system has to be made accessible to common citizens.

Element 1: Passengers

- Inter-modal transit stations have to be designed with options for superfast, fast, medium and slow buses, trains and ferries.
- Bus stands can be adjacent to ferry/train stations so that people can move seamlessly from one mode to another.
- Synched schedules and common tickets may convince people to switch from road transport to other modes.
- Bus stops/transit stops need to be designed keeping in mind user preferences and behaviour. Public amenities should be provided at major transit stops. Real time passenger information systems should be implemented, with encouragement for on-time arrival of transport. Information kiosks for tourists should be available at major transit and tourist stops. Electronic fare collection (off-board or on-board) will help.
- Speed limits on roads.[30]
- Buses will have the right of way in cities.

Intermediate transport

16.6.3.3.2 The state recognises that 'intermediate transport' consisting of taxis, three-wheelers, mini-vans, jeeps and so on play an important sub-role in providing, mainly, local transport facilities for people. However, their number and operations need to be strictly regulated and monitored. Permitting a higher number of three-wheelers (autos) than the carrying capacity of a town/city not only results in an increase in the accident rate, but also in chaotic and slow-moving traffic.

16.6.3.3.3 The state must recognise that intermediate transport needs to be regulated with pre-determined routes. Three-wheelers should be limited to plying only for short distances. There are now e-rickshaws available. However their haphazard introduction in Delhi, without any regulation and or monitoring created a traffic nightmare. Intermediate transport, especially e-rickshaws, can help provide last mile connectivity in cities such as Thiruvananthapuram by linking the bus stand or railway station with places of residence. Similarly, government-regulated private mini-bus/van and jeep services will be a welcome arrangement in mountainous regions and interior areas having only narrow access roads. They could be run on 'seat hiring' basis as in KSRTC buses. In order to reduce traffic volumes by reducing the number of 'single passenger occupied vehicles' it may, perhaps, be required to limit the number of three-wheelers or even eliminate them. Of course, this will be possible only if an efficient mass transport system exists alongside.

16.6.3.3.4 Water taxis may also be encouraged in coastal shipping and inland waters to provide public transport. This will help with cruise tourism too.

Vehicle parking facilities

16.6.3.3.5 The following issues need to be recognised to appreciate why facilities to park vehicles are required:

(1) A parked vehicle on the carriageway obstructs the movement of other vehicles, narrows the road space and becomes a cause of accidents.
(2) Every square meter of space on the road cost the government money. In a city or town, such land is very costly. Often, it is only after taking great effort and overcoming several hurdles that the government is able to acquire land for widening or building a road. Such road space should not be misused or held for a single person's use. Further, shops and residences will need to have built-in parking of some sort. Any mall should be permitted only if it creates parking within the facility. Similarly, multi-storied parking facilities can be created, but in a mixed use format.

16.6.3.3.6 With regard to cities and towns, the Local Self Government Department (LSGD), Government of India adopted and issued an Urban Vehicle Parking Policy in 2010. This policy speaks of the need to provide off-street parking spaces and the options that can be explored by local governments to create vehicle parking facilities. It also suggests that such off-street parking spaces at the ground level or at multiple-levels can be provided with LSG funding or in PPP mode or by private investment and can be run on pay and park basis. The policy also recommends that even where on-street parking can be provided without intruding into the carriageway, it should be on a pay and park basis so as to restrict the parking duration.

16.6.3.3.7 It is recommended that all municipal corporations and major municipalities prepare vehicle parking strategies on the lines of the state policy and draft action plans for implementation in a time bound manner. These plans should include designation of taxi and auto parking/waiting stands, in order to avoid the present tendency of arbitrarily locating them at road intersections, which not only obstructs drivers' vision, but also makes the area accident prone.

16.6.3.3.8 It is recommended that parking of vehicles on the carriage way be prohibited even on roads that are not highways or major district roads. Wherever possible, and when vacant land is available off the carriageway, parking spaces may be provided.
16.6.3.3.9 As highways are used for long distance travel, lay-byes may be provided at regular intervals so that people can rest and vehicles attended to, if necessary.
Traffic enforcement

16.6.3.3.10 The traditional concept of traffic management talks about the '3 Es' —engineering, education and enforcement — which are still valid. The education and enforcement parts are emphasised here. These need have to be preceded by engineering (good roads, lane marking, road furniture and other transport infrastructure).

(a) Driving is a privilege. Defensive driving should be the mantra.
(b) Driver training, education and licensing: These are important, but are presently carried out in the traditional methods. Driver training has to be professional. The Department of Transport should issue 'training modules' and private trainers must adhere to those modules. Many drivers (both private and professional) do not even know the simple hand signals. Road behaviour and parking ethics is another missing element. Yet another recent observation is that a majority of the drivers do not know 'lane-driving'. Most drivers cannot read road signs. Licensing of driver training schools and training of trainers should be carried out by the Motor Vehicles Department at regular intervals in different centres. The trainers should participate in these training programmes in order to retain their licenses. Further, Kerala's licensing norms for drivers should match international standards.
(c) Traffic education should be a continuous process. Even senior drivers, perhaps, do not know the basic rules/regulations. Roadside hoardings, newspaper notices, free brochures, education through the electronic media and so on are some methods of continuing driver education. Drivers of educational institution vehicles and professional drivers must necessarily go through short duration training programmes (by paying a fee) once in five years to recap what they have learnt and to get to know about newer developments. Areas in which mistakes are often seen include:
    - Lane driving: Slow moving vehicles and heavy vehicles have to necessarily take the outer lane and the inner lane should be considered as an 'overtaking lane' or fast moving lane.
    - Roundabout: It is to be insisted on that 'the vehicle which first entered the roundabout' or simply, the vehicle on the right has the right of way (preference). It is observed that in 'un-signalled' roundabouts vehicles squeeze through, cutting off the other vehicles
    - No vehicle should be allowed to stop, even for a while, inside a lane/carriageway. In case a driver wants to make enquiries or talk on the phone or has some other reason, he/she should stop the vehicle only off the carriageway and that too with appropriate signals.

- Overtaking and lane changing should be done only while using indicator lights.
- Pedestrian traffic: Pedestrians should walk on the right edge (right side of the person) of the road, if the road has no footpath on either side. On roads that have lane markings and raised footpaths this principle need not be insisted on. However, crossing the road should only be at marked crossings. Pedestrian crossings should be invariably marked on all roads.
- At road intersections with signals, it is often observed that stopping vehicles violate the lane concept. A vehicle waiting on the left side suddenly turns to the right causing near accidents and also stopping vehicle movement when the signal is on. This should be curbed.

(d) In spite of all engineering measures and driver education, enforcement has a positive effect in the observance of road rules and traffic regulations. Enforcement should be carried out through vehicle inspectors/police who are trained in the task and show no partiality or bias. Except emergency vehicles, everyone irrespective of their status or position should be made to observe traffic rules. Every driving licence should be issued based on a mandatory two-hour driver education session (which could involve a nominal fee to meet training expenses).

(e) With changing infrastructure, all users of the new transport infrastructure need to be trained in using it, for example on using subways and pedestrian flyovers. Behaviour needs to be inculcated.

(f) Community policing can be introduced to regulate traffic. The government will encourage creating a reserve of traffic wardens after giving necessary training to students, youth and other volunteers to regulate traffic at congested intersections during peak periods on a voluntary/ part time basis (NATPAC, 2011).

(g) All public transport vehicles should have GPS tracking systems. Private transport vehicles can gradually be allowed to use GPS trackers too.

Element 2: Freight

16.6.3.3.11 A model can be created to transport freight. Transport hubs can be set up in Thiruvananthapuram, Kollam, Ernakulam and Trissur. Warehouses can be built as part of the system so that commodities can be aggregated for movement by trains or waterways.

16.6.3.3.12 Containers that are inter-modal and can also slide off from the boat to the train or the truck or vice-versa should be encouraged. The NTDPC also suggests standardisation of waterways to ensure depth and width, which, in turn, enable fixing barge specifications and configuration. A study by Deloitte on coastal shipping talks about river-sea vessels being brought into use.[31] This is already being implemented in Kerala. The report also suggests building ship repair units in Kerala.

16.6.3.3.13 The movement of bulk cargo including petroleum, oil and lubricants and mining goods should be completely transferred to the waterways. Here, taxes and surcharges can be used to incentivise using water transport. All cargo that is not time sensitive can also be moved to the waterways.

16.6.3.4 Pillar 4: Environment

16.6.3.4.1 Mainstreaming environment in transport design is the key. As more people switch from private to mass transport, this will have a significant impact on the quality of air and on the quality of life. Other action items include:

- Euro emission norms may be adopted.
- Incentives for clean fuel.
- Regular pollution checks either at a central location or at designated centres is a useful way to control pollution.
- Withdrawing old cars from the roads.

16.6.3.5 Pillar 5: Social Equity

16.6.3.5.1 Ensuring that Kerala's transport network is sensitive to the needs of gender, the aged and the differently-abled is necessary for social equity.

16.6.3.5.2 Railway and bus stations need to be designed for the aged, the differently-abled and for gender security. Well-lit transit areas equipped with lifts and escalators are a must in railway stations to address the needs of society. Subways or pedestrian flyovers should have elevators or escalators to ease movement. Footpaths with ramps for the disabled are necessary. All building should also have ramps for the disabled. CCTV monitored transit and bus stations and buses (though an expensive idea) may help reduce the menace of sexual harassment of women in public spaces. Plus, capacity building and application of ICT along with a carrot and stick policy is needed so that drivers/ conductors operating various modes of transport assume the role of 'community policeman' in the absence of a formal structure. Buses with GPS and connectivity to a central control centre can help in quickly transmitting information on instances of harassment to the appropriate authorities. Public transport workers who act above and beyond the call of duty should be rewarded. Whereas those who do nothing or abet or are active perpetrators should be punished, both with the relevant legal punishment as well as the possibility of losing their jobs for dereliction of duty. Enabling transport workers, especially bus drivers and conductors, to report instances of inappropriate behaviour during the journey to a central control centre will help boost the security and safety of women in Kerala.

16.6.3.5.3 Low floor buses are good for the aged and differently-abled and provide a superior quality road experience for all. Low floor and low capacity mini buses can be introduced on low-density rural routes.[32]

16.6.3.5.4 The state transit agencies can offer:

- Special services for the aged such as taking them to the hospital if they have asked for this service beforehand.
- Special services for women, including those related to security if they are travelling very late in the night or early in the morning.

16.6.3.5.5 Links with the knowledge economy: Research on transport needs to be encouraged. Transport economics should be encouraged in undergraduate courses in economics. Also, courses that cater to transport, whether in engineering, economics or inter-disciplinary programmes should be encouraged in universities. Entrepreneurs developing mobile apps for various transport requirements including schedules, the safety of women and so on (overlapped with maps) will help.

16.7 Monitoring

16.7.1 Detailed transport surveys carried out at regular intervals will give information to the ETG on how people travel in Kerala.

16.7.2 Table 16.10 shows the indicators that may be used to monitor the progress of Kerala's transport network on its journey towards becoming a sustainable one.

Table.16.10
Indicators of Transport[33]

Type of Transport	Indicator	Metric
Road	Stock	Passenger Cars
		Goods Vehicles
	1st Registrations	Passenger Cars
		Goods Vehicles
	Performance	Passenger-million-kilometre
		Million-ton-kilometre
	Air Emissions	Carbon dioxide emissions
Rail	Performance	Passenger-million-kilometre
		Ton-million-kilometre
	Air Emissions	Carbon dioxide emissions
Inland Waterways	Performance	Ton-million-kilometre
	Air Emissions	Carbon dioxide emissions
Road Accidents		Injury Road Accidents
		Fatalities
		Injuries
		Fatalities per million inhabitants
		Injuries per million inhabitants
		Number of gender harassment cases reported

Source: Computed by NCAER

16.8 Conclusion

16.8.1 Land in Kerala is limited and it is not feasible to keep expanding the road network. Therefore, Kerala needs to look beyond roads, at leveraging other modes of transport. Further, good transport systems within cities, towns and other areas should be publicly provided and be under the control of urban governments. Of course, costs will have to be regularly updated. The task is not easy and the challenges are myriad. However, Kerala has an opportunity to be a real game changer and set an example for other states in creating a sustainable transport network.

Appendix A.16.1
Terms and Definitions of Roads

Sl. No.	Terms	Definitions
A. ROADS		
1.	Track	A path on land, much trodden by people and animals.
2.	Cart Track	A land way for use by carts.
3.	Road	A way on land with a right of way for the public.
4.	Urban Road	A road within the limits of the area of a Municipality, Military Cantonment, Port or Railway Authority.
5.	Project Road	A road within the limits of the area of a development project of a public authority for the exploitation of resources such as forest, irrigation, electricity, coal, sugarcane, steel and so on.
B. HIGHWAY CLASSES BY FUNCTION		
1.	Expressways	Expressways offer a superior highway facility with higher specifications. It provides for more lanes, better surface, divided carriageway, controlled access grade separations at crossroads, fencing and so on. Expressways permits only fast moving vehicles and are meant to carry through traffic. The expressway may be owned by the central government or state government depending upon whether the route is a National Highway or a State Road.
2.	National Highways	The arterial roads of the country for inter-state movements of goods and passengers. They traverse the length and width of the country connecting the national and state capitals, major ports and rail junctions and link up with border roads and foreign highways.
3.	State Highways	The arterial roads in a state for inter-district movements. They traverse the length and width of a state, connecting the state capital, district headquarters and important towns and cities and link up with the National Highways and adjacent State Highways.
4.	District Roads	The branch roads of the State and National Highways that serve as the main roads for intra-district movement. They traverse the length and breadth of a district to connect the areas of production and marketing in the district to one another and to the National Highways.
5.	Village Roads	These roads serve as the feeder roads as well as the roads for inter village movement. They pass through rural areas, connecting villages to one another and to the nearest road of a higher category such as District Roads, State Highways and National Highways.
C. HIGHWAY CLASSES BY WIDTH		
1.	Below Standard Single Lane(BSSL)	Surfaced roads having clear carriageway width of below 3.75 M.
2.	Standard Single Lane (SSL)	Surfaced roads having clear carriageway width between 3.75 M and below 7.0 M.
3.	Standard Double Lane (SDL)	Surfaced roads having clear carriageway width between 7.0 M and below 10.5 M.
4.	Standard Multi Lane (SML)	Surfaced roads having clear carriageway width of 10.5 M and above.

D. ROAD SURFACE		
1.	Bitumen or Tar Macadam	A type of construction in which the fragments of coarse aggregate are bound together by bitumen applied using either premix or grouting method.
2.	Bitumen Concrete Surfacing	A type of construction in which coarse and fine mineral aggregates are mixed with bitumen and laid not to the desired thickness.
3.	Black Top Surface	The surface of roads made with bitumen as a binder.
4.	Brick Paving	A paving composed of bricks laid in regular courses.
5.	Cement Bound Macadam	A surface in which a matrix of a cement sand mixture is interposed between two layers of road metal spread on the road and the whole mass watered and consolidated so that the matter works into the interstices of the road metal to produce a compact mass.
6.	Cement Concrete	A surface obtained by placing and consolidating cement concrete to required thickness.
7.	Earth Road	A road with the carriageway composed of natural soil.
8.	Gravel Road	A road with the carriageway composed of a consolidated layer of gravel.
9.	Water Bound Macadam	A type of surfacing in which stone fragments are first inter locked by rolling and then bound with smaller stone gravel and so on, which are enforced into the intersection by brimming, watering and rolling.
10.	Motorable	(i) For Plain Areas: Surfaced or un-surfaced road of minimum 3.0 M carriageway width is motorable.

Source: Computed by NCAER

Reference

1 *Ministry of Road, Transport and Highways, Government of India. 2011. "Report of the Sub-Group on Policy Issues". http://morth.nic.in/writereaddata/linkimages/Policy%20Issues-9224727324.pdf. September. Accessed January 7, 2013.*

2 *Ministry of Road Transport and Highways, Government of India. 2012. Basic Roads Statistics 2008−09, 2009−10 and 2010−11. New Delhi. August 6.*

3 *The National Highways Authority of India was constituted by an act of Parliament, the National Highways Authority of India Act, 1988. It is responsible for the development, maintenance and management of National Highways entrusted to it and for matters connected or incidental thereto. The Authority was operationalised in Feb, 1995. http://www.nhai.org/.*

4 *The statistics on roads have been taken from various reports of the Basic Road Statistics that is published by the Ministry of Road Transport and Highways unless mentioned otherwise. The Central Government data are used to enable comparisons with the rest of the country and the statistics contain relatively more in-depth data on quality of infrastructure. Wherever possible and relevant, we have supplemented with state level data.*

5 *The PWD website of Kerala shows longer length of National Highways at 1,542km, State Highways is 4,655 km and Major District Roads is 17,117 km. These numbers do not affect the main argument laid out in the paragraph that the quality of the road network in terms of width is dismal.*

6 *Appendix A.14.1 contains the definitions of single lane, two-lane and four lanes.*

7 *Ministry of Road Transport and Highways, Government of India. 2012. Road Transport Year Book 2009−10 and 2010−11. July.*

[8] *Ibid.*

[9] *Ibid.*

[10] *State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram.*

[11] *World Development Indicators, World Bank.*

[12] *State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram*

[13] *All the statistics in the paragraph are from the following:*
Ministry of Road Transport and Highways, Government of India. 2013. Road Accidents in India 2012. New Delhi.

[14] *Kochi airport Website. http://cial.aero/.*

[15] *The statistics in this paragraph are from the following reference.*
Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram. Appendix 5.20 is used for the cargo carried in 2011−12.

[16] *Deloitte Touche Tohmatsu India Private Limited. 2011. "Preparation of Strategy Road Map Cum Action Plan for Development of Coastal Shipping in Kerala". June.*

[17] *The statistics in this section have been taken from this report unless and until otherwise mentioned. Deloitte Touche Tohmatsu India Private Limited. 2011. "Preparation of Strategy Road Map Cum Action Plan for Development of Coastal Shipping in Kerala". June.*

[18] *This section has been referred from the following report unless and until otherwise mentioned. Report of the Sub Group VIII (Inland Water Transport) of the Working Group on Ports and Shipping under National Transport Development Policy Committee (NTDPC)."Development of Inland Water Transport Sector by 2020 and 2030".*

[19] *Inland Water Transport, Ministry of Shipping.*

[20] *Deloitte Touche Tohmatsu India Private Limited. 2011. "Preparation of Strategy Road Map Cum Action Plan for Development of Coastal Shipping in Kerala". June.*

[21] *Business as usual means an on going and unchanging state of affairs despite difficulties or disturbances.*

[22] *Rodriguez, J. 2013. The Geography of Transport Systems. New York: Routledge, 416 pages. ISBN 978-0-415-82254-1. http://people.hofstra.edu/geotrans/index.html.*

[23] *Ibid.*

[24] *Rodriguez, J. 2013. The Geography of Transport Systems. New York: Routledge, 416 pages. ISBN 978-0-415-82254-1. http://people.hofstra.edu/geotrans/index.html.*

[25] *Rodriguez (2013) clearly enunciates the difference between a transport plan and a policy. "Transport policy deals with the development of a set of constructs and propositions that are established to achieve particular objectives relating to social, economic and environmental development, and the functioning and performance of the transport system.Transport planning deals with the preparation and implementation of actions designed to address specific problems." The Kerala Perspective Plan 2030 is giving the transport policy. The plan will be implemented by the Expert Transport Group at the Department of Transport in Kerala.*
Rodriguez, J. 2013. The Geography of Transport Systems. New York: Routledge, 416 pages. ISBN 978-0-415-82254-1. http://people.hofstra.edu/geotrans/index.html..

[26] *Please look at the Metropolitan Transit Authority of New York for one example of the proposed system. http://new.mta.info/.*

[27] *Please look at these websites for further reference and guidance.*
a.European Commission on Road Safety: http://ec.europa.eu/transport/road_safety/index_en.htm.
b.Oregon Department of Motor Vehicles: http://www.odot.state.or.us/forms/dmv/37.pdf.

[28] *The importance of the slow trains can be highlighted by the following comment from meetings with stakeholders in Kerala. "The rolling stock availability in Kerala leaves much to be desired. Many trains do not have enough bogies. The stations often witness fights between reserved passengers and railway staff since reserved sleeper class and A.C. Coach Passengers are asked to go in unreserved second class coaches. Moreover, the coaches are seen to be badly maintained or serviced and to be unsafe due to age. Accidents have happened because of these".*

[29] *Sundar, A. 2012. "Increased Customer Satisfaction and Earnings". Indian Railways. October.*

[30] *Some accident studies in the Cherthala – Angamali stretch of the National Highway have shown that after widening the road to 4 lanes, accident rates have increased. Because of this the police restrict the speed limit in the NH to 70 kmph. Highway widening to 4 lanes or 6 lanes should allow fast moving vehicles (60 mph or about 100 kmph is the speed on US Highways). Accidents happen when slow moving local traffic interferes with the long distance highway traffic. Often one can see local traffic crossing the highway unmindful of the fast movement of vehicles. It is necessary to construct local flyovers / underpasses across the highways for the crossing local traffic. It is also seen that local slow moving vehicles – autos, scooters and cycles - are driven across the traffic flow in 4-laned divided carriageway. It may be possible to construct alternative parallel roads or improve the existing roads for local traffic so that they do not have to come on to the highways. (This is done in the US where the old highways are retained and new freeways are made as access controlled roads.*
Source: Comments from the State Planning Board.

[31] *Deloitte Touche Tohmatsu India Private Limited. 2011. "Preparation of Strategy Road Map Cum Action Plan for Development of Coastal Shipping in Kerala". June.*

[32] *National Transportation Planning and Research Centre. 2011. "Draft Transport Policy for Kerala: Discussion Paper". 31st March.*

[33] *United Nations Economic Commission for Europe website. http://www.unece.org/fileadmin/DAM/trans/main/wp6/publications/TryptiqueMainTransportIndicators_English.pdf.*

Chapter 17

TOWARDS ECOSYSTEM RESILIENCE

Chapter 17

Towards Ecosystem Resilience

17.1 Introduction

17.1.1 Kerala's distinctive environment is one of its most valuable assets. It is important in its own right and for the range of vital services it provides to the people of the State. To build a sustainable future, Kerala will need to manage environmental pressures more effectively and address new challenges that are likely to be posed by a sustained growth rate. The Environment Strategy recognises the importance of the environment for Kerala and explains how the challenges it faces can be tackled over the next 20 years. It sets out the vision that Kerala will have a thriving environment by 2030 that will contribute to the economic and social well being and health of all the people of the State.

17.1.2 Kerala has relatively fewer sources of pollution as industrial production, one of the main contributors to pollution, has a lower share in its GSDP compared to many other states. Typically, mining is another major source of pollution, which too is almost absent in Kerala. The available statistics indicate that hazardous industrial waste, also, is not a challenging issue in Kerala. Generally speaking, hazardous waste (HW) refers mainly to solids, semi-solids and other industrial wastes, which do not come under the purview of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981. Because of the nature of this type of waste, its storage, transportation, treatment and disposal is required to be controlled in an environmentally sound manner. As per the Central Pollution Control Board's (CPCB's) data of 2009, there were 36,165 numbers of hazardous waste generating industries in India, generating 62,32,507 metric tonnes of hazardous waste every year (MTA).[1] Kerala's share was only 1.33 per cent of the total hazardous waste produced in India, with a rank of 13 on the list of 30 states/union territories. According to the 'state inventory of hazardous waste generating industries' prepared by the Kerala State Pollution Control Board, the State generated about 71,050 metric tonnes of hazardous waste in 2009-2010, which was 15 per cent less than the 83,000 metric tonnes of waste generated in 2007. Of the total HW in 2009-10, 30 per cent was either recyclable or incinerable.

17.1.3 Kerala seems to be in a comfortable position relative to its neighbouring states, even in terms of the common treatment, storage and disposal facilities (TSDF) (Table 17.1).

Table - 17.1
Number of TSDF/ Individual facilities for Management of HW (Existing TSDF/Incineration)

Selected States	Number of Facilities		
	Safe Land disposal (SLD) Only	Incineration Only	Both (SLD & Incineration)
Andhra Pradesh	-	Individual - 23	TSDF - 2
Karnataka	1	Common - 3	Nil
		Individual - 7	
Kerala	TSDF - 1 (under Construction)*	Common - 1	Nil
	Individual - 17	Individual - 1	
Tamil Nadu	TSDF – 1	Nil	Nil

**Installed by Cochin Economic Zone Processor, Cochin to incinerate the Hazardous Wastes of Industries of that particular association only.*

Source: CPCB (2009) "National Inventory of Hazardous Wastes Generating Industries & Hazardous Waste Management in India," February.

17.1.4 Further, it is evident (Table 17.2) that Kerala has a surplus capacity with respect to incinerable waste as of 2009. The latest available data of 2009-10 indicates generation of incinerable waste to the tune of 183 metric tonnes per annum (MTA). So, the capacity for waste disposal is not a problem.

Table.17.2.
Status of Incineration Capacities vis-à-vis Incinerable Waste Generation in Selected South Indian States (Qty in MTA)

States	Common hazardous waste incinerations		Captive hazardous incinerations		Total capacity	Incinerable waste	
	Number	Capacity	Number	Capacity		Genera-tion	Surplus Capacity
Andhra Pradesh	2	18000	26	29823	47823	31660	16163
Karnataka	3	5100	7	2743	7843	3713	4130
Kerala	1*	250	1	1500	1750	233	1527
Pondicherry	-----	-----	1	2700	2700	25	2675

**Access is limited to members only*
Source: CPCB (2009) "National Inventory of Hazardous Wastes Generating Industries & Hazardous Waste Management in India," February

17.2 Challenges

17.2.1 An overview

17.2.2 Of late, the Central Pollution Control Board (CPCB) has been measuring the status of 88 major industrial clusters in India. Among them, only Kochi in Kerala figures on the list. The scores are given separately for different sub-indices of air, water and land environment, as well as an overall score of the 'Comprehensive Environmental Pollution Index' (CEPI). Table 17.3 presents the summary statistics of these scores in Kochi in comparison to the average of the 12 centres in South India. The table reveals that the position of the Kochi cluster is in the critical to serious range in terms of all dimensions of pollution: air, water and land. The CEPI score for water pollution is above 60 (critical). The cluster also scores high on all the three sub-indices of water pollution — pollutant score, pathway score and receptor score. Its performance in terms of land and air pollution is no better either. Overall, Kochi is highly polluted.

Table.17.3.
Comprehensive environmental pollution scores of air, water, and land and soil quality

Source of pollution	Cluster	A	B	C	D	CEPI
Air	Kochi	15	7	20	15	57
	Average	24.2	7.4	15.4	11.2	58.2
Water	Kochi	25	9	20	10	64
	Average	16.4	10.5	17.2	11.5	55.7
Land and Soil	Kochi	15	9	20	10	54
	Average	13.8	8.2	15.9	11.7	49.5

A : Pollutant Score based on the presence of toxin and scale of industrial activities
B : Pathway Score based on pollutant concentration , impact on people, and impact on eco-geological feature
C: Receptor Score, constructed using potentially affected population; level of exposure, and risk to sensitive receptors
D= Additional High Risk Element
CEPI=A+B+C+D
Source: Based on CPCB (2010) Comprehensive Environmental Assessment of Industrial Clusters, Ecological Impact Assessment, Series: EIAS/5/2009–2010

17.2.3 The upshot is that Kerala faces a serious deterioration in environment quality due, mainly, to land and water pollution. This, in turn, can pose a threat to its biodiversity, which is a unique advantage of Kerala. What follows examines the three dimensions of pollution — land, water and air, and other environmental challenges in detail.

17.2.2 Land and soil pollution

Urban waste

17.2.2.1 Sewerage and solid waste volume: Economic prosperity and the associated changes in consumption patterns, production technology and scale, together with population growth and increasing urbanisation have resulted in the generation of an ever-increasing volume of waste of various kinds. Solid waste management has, thus, emerged as a major issue in Kerala. This problem is likely to aggravate in Kerala's journey to prosperity. During the Perspective Plan period of 20 years, the urban population is projected to increase from 15.9 million in 2011 to 23.1 million in 2021 and further to 24.1 million in 2031. This massive increase in urban population is likely to put tremendous pressure on urban infrastructure. Massive investment in domestic water supply, sewerage networks and solid waste management is needed to meet the requirements of the growing population. Further, with rising incomes, demand for infrastructure services such as sewerage, solid waste treatment and even water supply will increase.

17.2.2.2 By multiplying population projections with the average of the per capita solid waste generated in different types of towns cities, the volume of sewerage and solid waste generation is projected. An annual growth of 1.3 per cent per year is added to the projections, to take into account income growth and changing consumption patterns. The final estimates are presented in Table 17.4. It shows that by 2030, the sewerage generated and water requirement will increase 1.4 times from current levels; the increase in solid waste generation will be almost 1.8 times.

Table.17.4.
Domestic Water requirement and sewerage and solid waste generated per year

Years	Sewerage		Solid waste		Biomedical Waste (BMW)	
	Water requirement*	Total Sewerage generated**	Total municipal solid waste***	Of which organic waste*****	Projected no. of bedi	Projected BMW per day kgii
	(in 10000 kilo-litre)	(in 10000 kilolitre)	(in 1000 kg)	(in 1000 kg)		
2011	215	180	5,582	4242	171005	51302
2020	262	219	7,635	5803	178165	53450
2031	300	251	9,961	7571	179825	53948

**Water requirement is assumed to be 135 lpcd;*
Sewerage generated is 113 litres per person per day (80per cent of the domestically used water, 6 litre infiltration from underground to pipe)Municipal solid waste generated per person per day (average for different class of cities/ towns) is 0.35 kg;****Average organic solid waste is 76per cent of the municipal solid waste.*
(The sources of these norms are drawn from Report on Indian infrastructure & services (RIUFS), Government of India, 2011)
i. Based on the international norm of 5 beds per 1000 population (based on Gujarat Study. See footnote 3)
ii. Waste is generated at the rate of 300 gms per bed per day

Source: NCAER's projections

Biomedical waste (BMW)

17.2.2.3 Hospitals, in general, generate waste at an average rate of 1 kg/bed/day.[2] Based on a study conducted by the Government of Gujarat, it turns out to be 300 gm/bed/day.[3] A part of this waste is toxic and harmful not only to the staff and patients, but also to the public at large. The improper management of biomedical waste causes serious environmental problems in terms of air, water and land pollution. It finds its way to the common plains along with common household waste, as a diluent. Rapid growth of the healthcare sector, particularly hospitals, testing laboratories, blood banks and so on is accompanied by even faster growth of biomedical waste, a significant part of which is highly hazardous to human health. Biomedical waste needs a special system of collection (using particular types of packages) and treatment before dumping. A few specialty hospitals have the treatment facility, but their quality remains unknown. Table17.4 presents an estimate of the BMW likely to be generated in 2020. This provides the bare minimum so as to give a perspective as to how much waste will be generated. Even at the minimum, Kerala will generate 53,948 kg of BMW per day.

Rural solid waste

17.2.2.4 The key driver of degradation of ecosystems in rural areas is increasing nutrient loading — particularly of nitrogen (in the form of reactive nitrogen) and phosphorus. There have been unprecedented changes in the global nitrogen cycle due to the introduction of excess reactive nitrogen into environmental systems in the process of fertiliser production/consumption and fuel combustion. Further, rural areas generate solid waste, particularly at the harvesting stage when the useful part of the plant is gathered leaving the remaining as waste; at the post-harvest processing stage; and at the stage of consumption of fruits, vegetables and grains. Finally, with the development of communication, people in rural areas are increasingly consuming urban packaged goods, which generate toxic waste, causing severe harm to the environment.

Hazardous waste

17.2.2.5 Kerala does not contribute significantly to hazardous waste in India, as discussed above. However, Table 17.5 reveals that Ernakulam district is the hazardous waste capital of Kerala. The district is the top contributor to the amount of hazardous waste generated in the State, producing about 45,560 metric tonnes of hazardous waste annually. Ernakulam is followed by Kollam (18,302 metric tonnes) and Thiruvananthapuram (2,679 metric tonnes). The extent of waste generation has declined over time in most districts, possibly due to improved use of technology; but in Ernakulam it has increased. Kochi is projected to be a global city in Kerala by 2030, but as already mentioned (see 17.2.1), the quality of the environment in the city may pose a major challenge in the years to come.

Table.17.5.
Hazardous Waste Generated in Kerala by District: March 2007 and 2009−10

District	Total Quantity (MTA)		Disposal in land-fills (MTA)		Recyclable (MTA)		Incinerable (MTA)	
	Mar–07	2009–10	Mar–07	2009–10	Mar–07	2009–10	Mar–07	2009–10
Alappuzha	3,107	883.6	2,697	294.7	380	559.3	30	29.7
Ernakulam	41,506	45,560.8	14,531*	28,518.9	18,718	13,059.8	190	147.2
Idukki	23	19.9	0	0	23	19.9	0	0
Kannur	479	383.4	155	148.1	324	235.3	0	0
Kasaragod	556	19.7	15	0.32	541	19.4	0	0

Kollam	30,831	18,302.7	30790	18,265	41	37.7	0	0
Kottayam	859	917	27	2.4	832	914.6	0	0
Kozhikode	544	541.8	101	100.34	441	441	2	0.5
Malappuram	97	151.8	8	30	89	121.83	0	0
Palakkad	780	1,212.7	164	944.5	616	265.9	0	2.36
Pathanamthitta	57	56.16	34	0	23	15.75	0	0
Thiruvananthapuram	2,626	2,679.5	1,887	1,857.3	738	823.1	1	0
Thrissur	1,398	281.67	1,114	86.97	284	191.1	0	3.7
Wayanad	36	47.2	1	1	35	46.2	0	0
Total	82,899	71,058	59,591	50,249.41	23,085	16,749.7	233	183.3

*Note: MTA – Metric tons per annum *Includes other categories of waste*

Sources: Krishnakumar, G. 2012. Ernakulam is Hazardous Waste Capital of Kerala. The Hindu. February. 10.Central Pollution Control Board, Hazardous Waste Management Division. 2009. National Inventory of Hazardous Waste Generating Industries and Hazardous Waste Management in India. February.

17.2.3 Water pollution

17.2.3.1 Water pollution is a serious problem in Kerala, as biological, toxic, organic and inorganic pollutants contaminate almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity, as it limits its availability for both human use and for the ecosystem. Since backwaters-based tourism and marine resources provide livelihoods to a significant proportion of Kerala's population, water pollution can have wide ramifications for its economy.

17.2.3.2 The irrational and unsustainable water withdrawal from groundwater sources, tanks and reservoirs is on the increase. As a result, a large number of habitations are affected by water quality problems. Table 17.6 provides a snapshot of the water quality-affected habitations in Kerala and selected neighbouring states. As the table shows, fluoride, nitrate, iron and salinity affected sizeable population and habitats in Kerala. Incidentally, many of these habitats are located in tribal dominated areas.[4] Efforts are being made to cover all the affected habitats in Kerala with safe drinking water with central government funding.[5 6] Construction of check dams can help overcome many of these problems.

Table.17.6.
Contamination-wise number of Habitations and affected Population in selected states: As on 01/04/2012

		Andhra Pradesh	Karnataka	Kerala	Maharashtra	Tamil Nadu	India
Fluoride	Habs (% of total)	83.8	47.8	11.3	28.9	0.9	17.3
	Pop.(lakh)	2.1	30	2.1	11.8	0	111.7
Arsenic	Habs (% of total)	0	0.3	0	0	0	4.1
	Pop.(lakh)	0	0.3	0	0	0	46.4
Iron	Habs (% of total)	0	16	62.6	20.2	76.7	53.9
	Pop.(lakh)	0	7.7	12.8	4.9	1.8	238
Salinity	Habs (% of total)	16.2	12.5	19.9	20.5	21	23
	Pop.(lakh)	0.7	7.7	3.4	6	0.5	86.2
Nitrate	Habs (% of total)	0	23.5	6.1	30.5	1.3	2.6
	Pop.(lakh)	0	13.5	1.3	12.7	0	33

Note: 1. Habitations With Any Contamination Including Arsenic Are Counted Under 'Arsenic' Row
2. Habitations With Any Contamination Including Fluoride And Without Arsenic Are Counted Under 'Fluoride' Row

Source: CPCB Web site

17.2.3.3 Expectedly, infrastructure for drinking water testing is needed if habitats are to be provided with safe drinking water. Kerala has laboratories in all districts, with considerable manpower (Table 17.7).

Table.17.7.
Number of water quality testing laboratories and manpower in district laboratories in selected states: 2010-2011

States/UTs	No. of District Water Testing Laboratories	Manpower in District Laboratory	No. of Sub-Divisional Laboratories set up
Andhra Pradesh	51	259	27
Karnataka	41	261	71
Kerala	**14**	**93**	**16**
Maharashtra	30	232	381
Tamil Nadu	63	126	46
India	**691**	**2176**	**814**

Source: www.indiastat.com

17.2.3.4 Lately, the central government has been providing funds to research institutions, universities and State Pollution Control Boards under the National Water Quality Monitoring Programme. Kerala seems to have made considerable progress in obtaining funds under this scheme (Table 17.8).

Table.17.8.
Allocation of Central Pollution Control Board (CPCB) funds to selected states: 2006-07 to 2009-10 (% in All India allocation)

States/UTs	2006-07	2007-08	2008-09	2009-10
Andhra Pradesh	5.5	6.4	7.5	12
Karnataka	5.2	7.6	4.9	4.1

Kerala	5	6.9	10.3	8.5
Maharashtra	6.9	11	9.2	12
Tamil Nadu	5.4	5.6	4.8	3.6
India	100	100	100	100

Source: Central Pollution Control Board

17.2.3.5 A water cess is one source of supplementing finance for pollution control activities. As Table 17.9 indicates, Kerala has collected only Rs 113 lakh from water cess from April 2007 to December 2008. This is only 0.06 per cent of the state's NSDP (Table 17.9).

Table.17.9.
Water cess collected in selected States (In Rs Lakhs)

States	Collection of Water Cess from April, 2007 to December, 2008	As percentage of states NSDP	Amount of Water Cess Re-imbursed till date against these Collections
Andhra Pradesh	5025.49	1.31%	866.13
Karnataka	600.61	0.23%	88
Kerala	**113.84**	**0.06%**	**34.1**
Maharashtra	5692.54	0.84%	1066.1
Tamil Nadu	1465.43	0.41%	299.88
India	**37416.6**		**8179.9**

Source: www.indiastat.com

17.2.3.6 With regard to polluted river stretches in India, out of the 150 such stretches in the country (Table 17.10), three are in Kerala. One of the main causes of such pollution is that only 50 per cent of all waste in Kerala is being treated. The rest is dumped in ponds, land and so on, part of which mixes in rivers and backwaters.

Table.17.10.
Number of polluted river stretches in selected states (As on June, 2010)

States	River	No. of Polluted Stretches
Andhra Pradesh	Godavari, Krishna, Manjira, Musi, Maner, Nakkavagu, Pennar and Tungabhadra	9
Maharashtra	Bhima, Godavari, Mula and Mutha, Pawana, Panchganga, Patalganga, Indrayani, Koyna, Kundalika, Kalu, Kanhan, Kolar, Mithi, Tapi, Girna, Nira, Weinganga, Wardha, Krishna, Purna, Nira, Chandrabhaga, Venna river, Ulhas, Rangavali and Bhatsa	28
Tamil Nadu	Adyar, Coovum, Cauvery, Noyyal, Vaigai, Tambiraparani, Bhavani and Palar	9
Karnataka	Bhadra, Tunga, Tungabhadra, Laxmantirtha, Kali, Krishna, Hundri, Kundu, Arkavati and Malprabha	11
Kerala	Karamana, Puzhackal and Kadambayar	3
India		**150**

Source: www.indiastat.com

17.2.3.7 Water pollution in Kerala has a significant cost for its inhabitants, ecosystems and biodiversity. The principal source of water pollution is industry. It has been observed that even though many industries have effluent treatment facilities, they did not comply with prescribed pollution standards (Murthy, 2011).[7] Further, in Kerala, there are a significant number of small-scale industrial units contributing to almost 30-40 per cent of industrial water pollution. Due to the presence of scale economies in water pollution reduction, it is uneconomical for these units to have effluent treatment plants (ETPs) of their own (Murthy et al. 1999).[8] Of course, small-scale units located in many industrial estates have gone for common effluent treatment plants (CETPs), but these are inadequate. SMEs need financial assistance and technical guidance for their installation.

17.2.3.8 Agricultural run-offs affect groundwater and surface water sources as they contain pesticide and fertiliser residues (Murthy, 2011). Fertilisers have an indirect adverse impact on water resources. By increasing the nutritional content of watercourses, fertilisers allow organisms to proliferate. These organisms may be disease vectors or algae. The proliferation of algae may slow the flow in watercourses, thus increasing the proliferation of organisms and sedimentation. In Kerala, the level of fertiliser/pesticides is lower compared to other Indian states. However, the pattern of rainfall in Kerala is intense. So, the possibility of pollution from agricultural run-offs exists.

17.2.3.9 Finally, Kerala's construction boom may have its economic spin-offs, but has had a disastrous impact on its water resources due to illegal mining from rivers, river banks and paddy lands. Attempts to regulate it through the district administrations and police have not been able to curb this menace. It must be recognised that sand mining is directly related to the construction industry.

17.2.3.10 Pollution of rivers and ponds has a direct implication for the wetlands of Kerala, which are an important part of the State's ecosystem. As mentioned in Chapter 1, they serve as buffer for food, water and drainage; function as groundwater recharge sites; offer habitat for a variety of plants and animals; act as breeding sites of several aquatic species; help in maintaining the local microclimate; and help in carbon sequestration. However, this ecosystem is subjected to severe quality degradation in the State due, in part, to land and water pollution. The problem has assumed alarming dimensions due to the filling up of wetlands and paddy growing areas and their conversion into built-up areas. Protecting this important ecosystem from further degradation will be a challenge for the government.

17.2.3.11 The effects of water pollution are, thus, serious for the inhabitants of Kerala. It causes a high incidence of water borne diseases, with rising health expenditure, physical disabilities and death in extreme cases and loss of work due to ill health.

17.2.4 Air pollution

17.2.4.1 Air pollution is a relatively less serious problem in Kerala, except in Kochi. Typically, the major sources of air pollution are energy production, transport and industry. Absence of coal–based thermal power stations in Kerala means that greenhouse gas (GHG) emissions from the energy sector are relatively low (see Chapter 18). However, the same cannot be said about transport. The rising number of private vehicles is surely going to have a serious impact on Kerala like it has in the bigger cities of Delhi, Bengaluru and Mumbai. Further, limited availability of CNG in Kerala means that public buses have not converted to CNG, unlike in cities such as Delhi. Even the ubiquitous three-wheelers have not been able to completely convert to using CNG in Kerala, unlike in Delhi. Industrial air pollution is a specific problem in Kochi.

Table 17.11 provides estimates of GHG emission in Kerala over the period under observation, 2010-11 to 2030-31. It may be seen that per capita emission of Kerala will rise from 1.5 tonnes in 2010-11 to 5.33 tonnes in 2030-31. One of the assumptions is that the share of hydro-power energy will drop

to 20 per cent from the current 81 per cent with the current growth trajectory (see, Appendix 17A for the methodology and Table 17A.1 for sectoral GHG emission).

Table.17.11.
Forecast of GHG emission in Kerala

Sectors	Emission in Preferred Scenario (Tonnes of CO2 Equivalent)				
	2010-11	2015-16	2020-21	2025-26	2030-31
Total	50084439	61625092	86183590	121126830	174579604
Per Capita Emission	1.5	1.83	2.54	3.57	5.33

Note: Emission of CO2, CH4, and N2O are accounted for.

Source: NCAER's Estimate

17.3 Financing Pollution Abatement

17.3.1 The biggest problem in cleaning up or abatement of water pollution is finance. Neither the municipal bodies, nor the state pollution control board have the funds to carry out clean up activities. Given the poor finances of the State, the government will not be able to fund such activities. The total funding requirement will further increase over the next 20 years. Projections of the funding requirements for pollution abatement have been developed and are presented below:

Cost of solid waste and sewerage management

17.3.2 The State generates a large volume of municipal and biomedical waste. This waste, with the rise in population, income, urbanisation and changes in consumption patterns, will increase substantially in the future. The State has to make substantial investments for their proper disposal as shown below (see Table 17.12):

- Capital investment is required for sewerage network, treatment plants and solid waste management to meet the incremental demand in 2020 and 2031, and the additional capital investment required to meet the current backlog. The capital cost of solid waste management involves collection, transport, treatment and disposal equipment/vehicles; storage and annual operations; and maintenance (O&M) costs.
- The cost of treatment of biomedical waste (BMW) is estimated to be around Rs 26 per kg, which can be substantially reduced to Rs 10 per kg through an innovative method used in Surat.[9]

Table.17.12.
Investment requirement of waste management*(Rs Crore) (2011-12 prices)

Year	Total Solid Waste Management		Sewerage Network and Treatment Plant		Biomedical waste (BMW)	
	Total Capital cost	Total Operational and Maintenance Cost (O&M) costs	Total Capital cost	Total O&M costs	Annual cost of treatment of BMW @ Rs 26 per kg	Annual cost of treatment of BMW @ Rs 10 per kg
2020	1173	353	6523	879	48.79	18.76
2031	1345	405	8146	1008	47.03	18.09

**See Appendix A17.2 for assumptions*
Source: NCAER's estimates

17.3.3. Sewerage network and treatment infrastructure costs to meet the requirements of the urban population of 2020 is estimated to be Rs 6,523 crore and that of 2031 Rs 8,146 crore at 2011-12 prices. Correspondingly, capital costs for solid waste management are projected to be Rs 1,173 crore and Rs 1,345 crore respectively. Operations and maintenance costs of sewerage management and solid waste management will also be substantial. The annual cost of treatment of biomedical waste based on conventional methods is projected to be Rs 48.8 crore in 2020 and Rs 47 crore in 2031 (Table 17.12). These figures are substantially reduced when the innovative Surat-based techniques are applied. In that case, the annual cost of treatment of BMW is projected to be about Rs 18.8 crore in 2020 and Rs 18 crore in 2031 as shown in the table.

17.3.4 Given the poor state of finances of the municipalities and local bodies, it is always a problem for them to find funds for capital expenditure, and operation and maintenance expenditure for disposal of urban waste.

The cost of industrial water pollution abatement

17.3.5 Table 17.13 quantifies industrial water pollution abatement costs. According to the estimate, Rs 200 crore was required in the base year (2010-2011) for industrial water pollution abatement, assuming that 50 per cent of the industrial establishments needed investments for water clean up. Clearly, if industrial GSDP increases, more finance will be required. Of course, non-industrial GSDP is also another source of water pollution. To that extent, the cost of water pollution abatement will rise. In this context, it may be noted that the cost of avoidance is much lower than the damage costs.[10] So, it is in everybody's interest that a 100 per cent water pollution abatement policy is adopted.

Table.17.13.
Cost of Water Pollution Abatement

Indicator	Gross State Domestic Product (GSDP) at Factor Cost	Assuming 50% of industrial GSDP need investment for controlling water pollution	Assuming 25% of industrial GSDP need investment for controlling water pollution
	2010-2011	2010-2011	2010-2011
	Rs Crore	Rs Crore	Rs Crore
Industrial GSDP (Manufacturing)	16014.96	8007.48	4003.74
Finance required for Clean-up		200.19	100.09

Source: Calculated by NCAER

Non-compliance

17.3.6 Finally, non-compliance with the stipulated environmental rules also appears to be a challenging issue (Table 17.14). It is noteworthy that the non-compliance rate was the highest in Kerala, with 16-18 per cent of firms not complying with the 'set-up standards' during 2009 and 2010.[11] The national average was 10-13 per cent. Tamil Nadu seems to have an edge, with the non-compliance rate being as low as 0-4 per cent. Thus, it seems that Kerala needs to improve the compliance rate also.

Table.17.14.
Status on Grossly Polluting Industries: Kerala vis-à-vis Selected States (Number)

Time period	Status	States/UTs				
		Karnataka	Kerala	Maharashtra	Tamil Nadu	India
July, 2009	Complying	114	25	367	190	1940
	Not Complying	7	9	61	0	296
	Closed	9	15	68	30	479
	Total	130	49	496	220	2715
December 2010	Complying	119	24	237	215	1924
	Not Complying	9	8	8	9	345
	Closed	12	17	69	9	339
	Total	140	49	314	233	2608

Source: IndiaStat.com

17.4 Government Initiatives

17.4.1 Kerala has been undertaking several green management initiatives, both at the state and the local government level. To highlight a few — the participatory resource mapping programme; regulatory support and services for pollution control; environment management initiative for various development sectors (for instance, agriculture, industry, tourism); protection of ecosystems of Kerala; and coastal zone management.

17.4.2 The Kerala State Environment Policy 2009 highlights the State's vision for upgrading its environment and has suggested the approach, strategies and action plan for achieving the implicit and explicit objectives for realising the vision. The vision of the policy is:

17.4.3 "To ensure clean air, water, soil and food to the people of Kerala and its sustainability for a healthy living condition."

17.4.4 It sets the following objectives:

- Ensure conservation of natural resources, including species, ecosystems and genetic wealth of the State.
- Ensure equitable access and sustainable use of resources, for all sections of society, particularly the poor, whose survival depends on the availability of natural resources.
- Optimise the efficiency in environmental resource use.
- Promulgate guidelines and policies for waste disposal, especially for those emanating from industrial and municipal sources.
- Integrate environmental concerns in economic and social development.
- Apply the principles of good governance (transparency, rationality, accountability, reduction in time and costs, participation and regulatory independence).
- Create environmental awareness for all sections of society.

17.4.5 It also proposes action plans to achieve the objectives. However, the proposed action plans are essentially implemented through project-mode operations. Further, the action plans are based on the 'end-of-the-pipe' approach. The way forward is 'environment mainstreaming', and this is the underlying principle of the environment strategy proposed in this document.

17.5 Environment Mainstreaming: The way forward

17.5.1 The proposed knowledge-driven sustainable development strategy seeks to identify and develop actions to enable Kerala to achieve continuous improvement in the quality of life of its people. It seeks to do this through the creation of sustainable communities that are able to manage and use resources efficiently, able to tap the ecological and social innovation potential of the economy and, in the end, able to ensure environmental prosperity.

17.5.2 The underlying principle of the new strategy is 'mainstreaming environment', that is the informed inclusion of relevant environmental concerns into sectoral development strategies, rules, plans, investment and action. It means systematically integrating environment concerns, based on informed trade-offs, into policies and strategies of all sectors. Environmental mainstreaming is a major, practical component of sustainable development. It results in a better understanding of the capabilities of environmental assets, the consequences of environmental hazards and the real or potential impact of development on the environment. This is a proactive way of addressing environment.

17.5.3 The Vision of the strategy is to:

17.5.4 "Achieve economic prosperity through 'ecosystem resilience' that is the capacity of an ecosystem to tolerate disturbance, without destabilising the environmental conditions. This means that Kerala will shift towards a resource-efficient, ecosystem-resilient and low-carbon economy which ensures clean air, water and living environment to both the present and future generations of the people of Kerala."

17.5.5 Thus, the mission is to achieve economic prosperity, which is enjoyed by both the present and future generations.

17.5.6 The Targets are to:

- Boost economic performance, while reducing resource use.
- Upgrade ecosystems, biodiversity and resources through sustainable production and consumption patterns.
- Increase energy efficiency to save 10 per cent of Kerala's energy and water consumption per unit of production by 2030.
- Maintain recycle targets of 60-75 per cent of waste generation, depending on the type of waste.
- Identify and maximise the use of sustainable resources (renewable energy, for instance).
- Protect wetlands and the coastal zone.
- Conserve the World Heritage biodiversity of the Western Ghats.

17.5.7 The Pillars of the strategy are:

- Clean production systems.
- Sustainable production and consumption patterns.
- Land planning and protection of ecosystems.
- Solid waste management.
- Climate change and carbon finance.
- Promotion of R&D and innovation.

Pillar 1: Clean production methods (Promotion of circular economy)

17.5.8 Cleaner production means an integrated production system, which reduces risks to humans and the environment. It includes conserving raw materials and energy, eliminating toxic raw materials

and reducing the quantity and toxicity of all emissions and waste before they leave a process. It is based on the principle of '3Rs' — reduce emission of pollutants and waste; reuse resources; and recycle by-products. It is implemented at three levels:

- **Enterprise level:** At the first level, increase resource efficiency within an enterprise to contribute to the goal of creating more value while using fewer resources. Cleaner production is achieved by applying know-how, by improving technology and by changing attitudes. Tools are developed to monitor, benchmark and promote resource efficiency, taking into account a life cycle perspective.
- **Local production level:** The second level is to reuse and recycle resources within industrial parks and clustered or chained industries, so that resources circulate fully in the local production system.
- **Regional level:** The third level is to integrate different production and consumption systems in a region, so that the resources are circulated among industries and urban systems. This level requires the development of municipal or regional by-product collection, storage, processing and distribution systems.

17.5.9 The economy based on the principle of 3Rs is known as the 'circular economy', where waste produced in one segment of the economy is the raw material for another segment. The Perspective Plan proposes strategic elements of cleaner production systems for each sector in the respective sectoral chapters. In a nutshell, these are:

- Integrated production systems for agriculture and allied sectors (Chapters 5-7).
- Clean production technology and eco-friendly parks for industries (Chapter 8).
- Waste management, energy and water conservation practices in tourism (Chapter 3).
- E-waste policies in ICT (Chapter 4).
- Energy saving and energy composition (Chapter 18).
- Water conservation, recycling and reuse (Chapter 19).
- Clean, compact and smart cities and rural areas through spatial strategies (Chapter 15).
- Reduce, recycle and reuse solid waste management strategy (Chapter 17).
- Green transportation in the transport sector (Chapter 16).

17.5.10 Capacity building initiatives will be undertaken for producers and other economic agents to optimise their production processes, reduce environmental impacts and make more effective use of resources, with effective coordination between the Department of Environment and other departments.

17.5.11 In order to fully tap its potential for improving resource efficiency of production processes, the action plan will be as under:

Regulatory instruments

- Mandatory take-back for enterprises
- Minimum recycled content standards
- Secondary materials utilisation rate requirements
- Energy efficiency standards
- Disposal bans and restrictions
- Materials bans and restrictions
- Product bans and restrictions

Economic instruments

- Advance disposal fees
- Higher taxes on new materials

- Removing subsidies for virgin materials
- Environmentally-preferable products' procurement

Direct measures

- Raising awareness through conferences and seminars
- Organising training for producers, with industrial organisations playing an important role
- Provision of cleaner production technology in all public facilities
- Development of eco-friendly parks to move to the second and third levels of the implementation of the 3Rs principle (as mentioned above)

17.5.12 There are international agencies such as the UNEP (UN Environment Programme) and the UNIDO (United Nations Industrial Development Organisation) that have produced a series of reports on government strategies and policies for cleaner production, as well as case studies of cleaner production world wide. UNIDO has also established a network of 24 National Cleaner Production Centres since 1994, including one in India. Gujarat has its own Cleaner Production Centre, which plays an important role in educating, and disseminating knowledge and expertise to tackle various environmental issues. It is actively engaged in the promotion of cleaner production (CP)/clean technology (CT) through its various activities such as orientation programme, CP assessment projects, CT assessment projects and so on. It has taken up demonstration projects in many industries belonging to various sectors such as dyes and dye intermediates, pharmaceuticals, textile, fish processing, petrochemicals and so on. The results of these projects are very encouraging. It is proposed that the Kerala government should also take proactive steps in this direction.

17.5.13 It also proposed that along with other environment-specific policies, there is a need to have a 'Clean Production Policy', with specific rules on resource efficiency and recycling, so as to promote a circular economy.

Pillar 2: Sustainable production and consumption patterns

17.5.14 The strategy aims at expanding the green economy by inducing environmentally sustainable production and consumption patterns. A range of policies are recommended to promote such patterns:

- **Set standards for energy efficiency:** Establish a framework for setting ecological design requirements for products that use energy and addressing specific aspects of the life cycle of products, such as waste. The scope of the directive on products that use energy will be extended to cover all energy-related products. Minimum requirements will be set for products with significant environmental impacts, focusing on key environmental aspects. To provide markets with information on best performing products, advanced benchmarks of environmental performance will also be identified. Periodic reviews of minimum requirements and advanced benchmarks will take place, to adapt them to technological change and provide businesses with a long-term perspective of the future regulatory environment. It is also important that the share of renewable energy is increased in total energy production (see the chapter on Power).
- **Public procurement of resource-efficient products:** Implement incentives and public procurement, to stimulate the production of resource-efficient products. For instance, implement regulations to encourage state authorities to purchase office equipment that meets specific levels of energy efficiency. Under the new NMP (National Manufacturing Policy), provisions have been made to use public procurement as a policy tool to encourage local value-addition in specific areas. Kerala can use this aspect to give a message to producers that policymakers prefer clean production processes or green goods, which are produced within Kerala. For instance, if public procurement from SMEs within Kerala was made conditional on their adoption of environment-friendly measures, they would have an incentive to control pollution.

- **Labelling of products:** Labelling will be used for indicating, on the one hand, energy consumption/savings and, on the other, any other relevant and significant environmental parameters of the product. It will act as a 'label of excellence', signalling to consumers that the product has taken into consideration many environmental criteria, over its life cycle. Labelling criteria will continue to cover a broad range of environmental aspects. Furthermore, 'eco label criteria' may also be developed to cover those products for which eco-design requirements have not yet been set. Labelling of products will include:
  - Seal-of-approval types of environmental labelling (Green Seal, Blue Angel)
  - Environmental information labelling (energy efficiency labelling, CFC use)
  - Product environmental profiles for the whole life cycle of materials
  - Product hazard warnings
  - Product durability labelling
- **Raising awareness among consumers and producers:** A range of other actions will be implemented together with retailers and producers to 'green' their own activities and supply chains, raise consumer awareness at large and make them more proactive.
- **Fiscal incentives:** A possible fiscal incentive mechanism may be developed, to encourage the production and consumption of green products.
- **Consistent data and methods on products:** To implement this policy, consistent and reliable data and methods are required to assess the overall environmental performance of products, their market penetration and to monitor progress. Data required on products and related environmental impact, collected using different tools should be shared, wherever useful. Such methods also need to be cost-effective and easy to apply for policymakers and for industry.
- **Work with retailers and consumers:** Retailers are in a strong position to influence more sustainable consumption through their own operations, supply chains and consumer behaviour. Retailers and producers are increasingly recognising sustainability as a considerable opportunity for their businesses to grow, compete and innovate. However, further effort is needed to reduce the environmental footprint of the retail sector and its supply chain, promote more sustainable products and inform consumers better. To achieve this, other stakeholders such as producers as well as consumers and non-governmental organisations also need to be involved.
- **Supporting eco-innovation:** Innovation in the area of environmental goods and services is central to the successful implementation of this plan, and plays a key role in its innovation policy. Innovation leading to reduced expenditure in this area will give an impetus to a clean environment. In this respect, one can learn from the experiences of other countries, particularly those in the developed world. One of the available indicators to measure the level of innovation is the number of patents in a certain area. According to the OECD, eco-innovation patents in the EU are on the rise, and the best-performing member states have been granting 3.5 patents per billion GDP (in Euro) annually. The S&T department of Kerala needs to initiate projects and collaborate nationally and internationally to promote green innovation.
- **Technology licensing:** It is also important that the Department of S&T scouts the globe to identify the best green technologies, acquires them and adapts them to Kerala's requirements. An Israeli company called Arrow Ecology Company, for example, has developed an ArrowBio system that provides the most innovative solution for waste disposal. This takes trash directly from collection trucks and separates organic and inorganic materials through gravitational settling, screening and hydro-mechanical shredding. The system is capable of sorting huge volumes of solid waste, salvaging recyclables and turning the rest into biogas and rich agricultural compost. The system is currently used in California in the US, Australia, Greece, Mexico, the UK and Israel. An ArrowBio plant that has been operational at the Hiriya landfill site since December 2003, serves the Tel Aviv area and processes up to 150 tonnes of garbage a

day. Given the scarcity of landfill sites in Kerala, this may be introduced in its big cities. Under the technology acquisition and development fund of the new NMP, green energy development and use of green equipment is encouraged. However, the awareness level of various aspects of this scheme is low. The Kerala government has a role to play in this respect.

- **Industrial policy initiatives for environmental goods and services producing industries:** The environmental goods and services sector (EGSS), also called 'environment industry' or 'eco-industries' consists of a heterogeneous set of producers of goods and services aimed at the protection of the environment and the sustainable management of natural resources. These industries contribute to improving the energy efficiency and environmental performance of the economy. To increase their uptake by other industries, initiatives will have to be developed to promote the former. For this purpose, a comprehensive screening of regulatory barriers and market failures that hamper the competitiveness of environmental industries, and their uptake by other sectors of the economy will be carried out. This will address issues such as the expansion of internal markets, better regulation, standardisation and access to finance. The potential of ICT to deliver sustainable solutions will be explored. Specific attention will be given to priority areas identified by the lead market initiative.
- **Helping SMEs:** Lack of information, insufficient expertise and scarcity of financial and human resources makes it difficult for SMEs to fully exploit the business opportunities offered by sound environmental management.

Pillar 3: Land planning: Protection to biodiversity and eco sensitive areas

17.5.15 Mainstreaming biodiversity

- Mapping of resources
- Creating data on biodiversity
- Raising awareness of biodiversity conservation
- Encouraging individuals and private organisations to participate in biodiversity conservation
- Integrating biodiversity into decision-making, so that it becomes everyone's business and is part of every relevant transaction, cost and decision

17.5.16 Land planning

- Integrate protection of biodiversity and wetlands in land planning, as suggested in Chapter13.
- Develop a Coastal Zone Protection Plan based on the categorisation of coastal zones under the CRZ (2011) notification (Also see Chapter 7 on Fisheries).

17.5.17 Enhance strategic investments and partnerships

- Cooperation between different parts of the community is essential for effective biodiversity conservation. Increasing investment in biodiversity conservation by the private sector and collaboration between government and other sectors will enable them to make best use of the financial and practical resources that are available to address biodiversity decline. Markets and market-based instruments also provide a way to value biodiversity, so that it can be considered alongside economic and social factors. These mechanisms are emerging as an effective means of creating incentives for long-term investments in biodiversity conservation, as a complement to regulatory measures.

Pillar 4: Solid waste management

17.5.18 Kerala needs to make a long-term plan and adopt policies and programmes with separate targets for household, municipal, medical, electrical/electronics, industrial, construction and demolition waste generated in massive quantities every year. This is essential in order to protect the highly fragile ecology of its coast, backwaters, rivers and forests, and also to protect human health. As already indicated, since waste is of different types and generated at different stages such as in production, distribution/transportation and consumption/usage, different approaches will be needed for their treatment, collection or disposal. Within the broad strategic framework prepared by the state government, the local government, based on the local urban needs, can undertake planning for solid waste management. Local governments need to be encouraged to undertake city-wide strategic planning, to design and implement integrated solid waste systems that are responsive to dynamic demographic and industrial growth. The strategy and action plan should identify a clear set of integrated actions; responsible parties; and the required human, physical and financial resources. This strategic framework should include the following strategic elements:

17.5.19 Engaging an affordable mix of appropriate technical options to Reduce, Reuse, Recycle and Reject

- Promotion of waste reduction at the source of generation
- Separation of waste at source of generation
- Take-back schemes
- Composting and home gardening
- Research into anaerobic digestion
- Scientific handling of clinical and hazardous waste
- Door-to-door collection of household waste
- Setting up ‘polluter pays system’ for special waste such as demolition waste, some hazardous waste and so on.

Water and waste management separately in urban and rural areas. Water and waste management go hand-in-hand. The principle of 3Rs is to be encouraged — recover, reuse and recycle. When townships and new buildings come into existence, they have to follow the 3Rs policy for water. Modern sewage treatment plants in urban areas such as Thiruvananthapuram are a must. Rural areas can join together for scale effects, and then STP can be developed for them. There should be water and sewage payments so as to encourage conserving and recycling water. Piped, metered water supplies are a must. By 2030, the sewage network should be extended to 100 per cent of urban areas.

Box No 17.1

Zero Waste Kovalam

In 1999, when Kerala's Department of Tourism proposed an incinerator to address the garbage crisis in Kovalam near Thiruvananthapuram, residents and environmental groups rose up in protest. The proposal was shelved, but the garbage and plastics problem remained. In response, Zero Waste Kovalam was born to not merely address the garbage problem, but to also change the mindset of regulators, the tourism industry and common people about the mistaken notion that discards are waste.

The programme began with a focus on resource recovery and material substitution. Resource recovery facilities were set up within existing institutions or in public areas to serve clusters of organisations. Each resource recovery facility had an anaerobic digestor with a drying yard for the slurry coming out of it, a storage room for recyclable discards and a compost pit. Organic material was converted to fuel-gas by the anaerobic digestion unit, while other discards were separated and sold as scrap. The integration of anaerobic digestion to produce clean energy from biodegradable discards is a salient feature of the Kovalam project.

Kovalam's material substitution programme aimed to extend the useful life of eco-friendly discards (paper, coconut shell, cloth waste) to displace products made using unsustainable material.

The livelihoods programme began in 2002 with a discussion involving about 100 women. Encouraged by the interest, a seven-day training programme for making paper bags, cloth bags (using tailors' cloth scraps), jute bags and bamboo products was organised, and more than 380 people participated. In the years that followed, several more training sessions were held on designing and making products from coconut shell, clay and terracotta; patchwork using tailors' waste; and organic household agriculture.

Marketing support and training ensured that entrepreneurs would find support for a limited time during which they were expected to become self-sufficient in terms of writing project proposals, book-keeping, work-planning and seeking markets.
Zero Waste Kovalam's livelihood programme follows a simple formula:

1. Assess opportunities for replacing products made using unsustainable material with locally available, locally made products.
2. Train local people in making these products and innovative new ones.
3. Provide them with training to access government funds and loans to set up entrepreneurial units.
4. Help them develop accounting and marketing expertise.
5. Continually expand the programme's circle of influence by organising vocational training sessions and general environmental and social awareness training for new audiences.

All of Zero Waste Kovalam's training programmes have resulted in important transformations in both waste management and livelihood opportunities. At least three entrepreneurial units, run solely by women, now make products out of coconut shell, paper and tailoring waste, employing dozens of women. These projects are so successful that other non-governmental efforts now seek Zero Waste Kovalam's expertise.

As a promising continuation of Kovalam's experience, the Government of Kerala adopted a policy for Solid Waste Management that follows most of the Zero Waste principles consolidated by Zero Waste Kovalam. The state policy focuses on participatory planning and capacity building, decentralised systems, waste reduction, source separation and resource recovery.

Source: www.zerowastekovalam.org accessed 18 March 2013

17.5.20 Involving all major stakeholders in implementation

- Creation of institutional mechanisms such as working groups and regular city consultations to involve residents individually and collectively.
- Conducting community-based civic education programmes.
- Setting up ward-level Environment Management Committees with the participation of residents' and shopkeepers' welfare associations.
- Setting up School Environment Committees to get involved in social mobilisation.
- Promotion of urban horticulture.
- Recognition and facilitation of the private informal sector.
- Engagement and facilitation of NGOs and CBOs.

Initiatives such as Zero Waste Kovalam need to be replicated to ensure that some of these objectives are achieved (see Box 17.1).

17.5.21 Promoting private sector-municipal partnerships

- Street beautification through private sector participation.
- Assistance to recycling industries.
- Stricter environmental appraisal of construction plans.
- Stricter fines for breaches of solid waste management (SWM) regulations.
- Promotion of social entrepreneurs in waste collection and reprocessing.
- Creation of a vigilance squad on environment.

17.5.22 Strengthening institutional solid waste management (SWM) capacity

- Capacity building for decentralised SWM.
- Staff mobilisation, training and education.
- Strengthening municipal powers.
- Publication of an Annual Report on the status of the city environment.
- Formulation and follow-up of a strategy implementation plan.
- Computerised complaints redressal system.
- Improved management and monitoring.

17.5.23 Enforcing laws and policy

This can be achieved by offering incentives to municipal authorities to deliver better services, recover more costs from users and cooperate with neighbouring municipalities to achieve economies of scale. Kerala may draw on the international experience. The EU, for instance, has an elaborate institutional set-up for the environment. Box 17.2 describes the institutional framework for solid waste management.

Box No 17.2

EU institutional framework for solid waste management

The Environment Action Programme of the EU proposes to 'decouple' waste generation from economic growth. EU legislations on waste generation and treatment started in 1975, and till date there are more than 20 pieces of legislation relating to waste management. These laws intend to bring about major changes in the traditional practice of widespread dumping of waste in landfills. Waste is now imaginatively exploited — reused, recycled or treated, to produce energy as well as organic compost. The 1999 Landfill Directive directed the member states to reduce the amount of biodegradable material going to landfills to 75 per cent by 2006, to 50 per cent by 2009 and to 35 per cent by 2016. The Waste Framework Directive of 2008 also contains specific targets: Member states have to take necessary measures 'designed to achieve' a target of recycling 50 per cent of waste from households by 2020 and a target of recycling, reusing or recovering 70 per cent of non-hazardous waste generated through construction and demolition by 2020. According to the 2002 Directive on Waste Electrical and Electronic Equipment (WEEE), and subsequent agreement in February 2012, member states, from 2016, must recycle 45 per cent and after 2019, 65 per cent of the weight of all EEE put on the market in the previous three years. WEEE generated from businesses and households amounts to about 11 kg per person in the UK

It was emphasised that higher landfill charges would reduce the amount of waste sent to landfills and would tend to push waste for recycling and composting. EU waste legislation is calculated to have the potential to generate 400,000 jobs, apart from substantial environmental cost reduction. In the EU27, according to the latest estimates, in 2010, around 38 per cent of municipal waste was landfilled, 25 per cent recycled, 22 per cent incinerated and 15 per cent composted. Recycling is most widely practised in Germany (45 per cent) and Belgium (40 per cent). The highest rate of waste treated by recycling and composting is found in Austria (70 per cent). Thus, EU waste legislations have resulted in significant successes. Further, in order to create incentives, annual awards or prizes to highlight and celebrate good waste management practices and progress were introduced, which motivated authorities to improve performance. In 2009, the Commission also introduced a central registry, called CHAP, for the registration and management of complaints from the public that would speed up the EU institutions' responses and improve their answerability to the public. All this has had a favourable impact on waste management.

Source: European Commission Web site. http://ec.europa.eu/environment/waste/

Pillar 5: Outcome-oriented R&D

17.5.24 This is the key driver of sustainable development. The government of Kerala has undertaken several initiatives to promote R&D in environment preservation. There are several R&D centres under the umbrella of the Kerala State Council for Science, Technology and Environment (KSCSTE) that have been assigned specific domains for their R&D work. Of them, five are directly related to the environment:

- The Centre for Earth Science Studies (CESS) was established to promote modern scientific and technological research and development studies in earth sciences — problems related to land, sea and atmosphere (It was recently transferred to the Government of India and is no longer under the KSCSTE).
- The Centre for Water Resources Development and Management (CWRDM) focuses on the field of water management.

- The Kerala Forest Research Institute (KFRI) was established to undertake research in areas like forestry, biodiversity and so on.
- National Transportation Planning and Research Centre (NATPAC) undertakes research and consultancy work in the fields of traffic engineering and transportation planning, highway engineering, public transport systems, inland water transport, tourism planning, rural roads, environmental impact assessment and transport energy.
- Jawaharlal Nehru Tropical Botanic Garden and Research Institute (TBGRI) works in conservation and sustainable utilisation of plant biodiversity.

17.5.25 Further, environmental education has been integrated into the curricula of various levels of education, as part of the capacity building programme. Finally, the KSCSTE also supports research projects in thrust areas under the scheme 'ecology and environment'.

17.5.26 However, there is no evaluation of these programmes. The outcomes need to be made more visible. It is proposed that the KSCSTE supports outcome-based research. It is further recommended that a Kerala Small Business Innovation Research (SBIR) programme be created to support the most competitive research proposals in thrust areas through competitive bids (see Chapter 11 for more). Awards under the scheme will be monitored throughout their life cycle and will be commercialised with the help of the KSCSTE.

Pillar 6: Climate change and carbon finance

17.5.27 A clean environment does not come cheap. Adopting a path of green growth concomitant with clean environment implies choosing clean technology in all spheres of life or adaptation of existing technology, so that the deleterious effects in the process of production or consumption become minimal. While air quality is not seriously degraded in Kerala, there has been evidence of climate change in Kerala in terms of rise in sea level and sea surface temperature and increasing monsoon variability.[12] This has had its impact on agriculture, coast erosion and aquatic life and has increased vulnerabilities related to climate change in the State.

17.5.28 A comprehensive clean production policy, as discussed above, will have to be enforced strictly to address the issue. Generally, these technologies are more costly than the existing ones, which are more polluting. The question is what will be the source of finance. Given the limited financing options for the state government, it is not possible for the State to subsidise these technologies. In this context, clean development mechanism (CDM) may be an avenue for stimulating growth of clean technology in Kerala.

17.5.29 India has been an active player in CDM projects since its inception under the Kyoto Protocol. The National Clean Development Mechanism Authority (NCDMA), under the union government's Ministry of Environment and Forests has, so far, approved 2,827 CDM projects in the country. Table 17.17 provides summary data of these projects for selected top implementing states, along with Kerala. The total Certified Emission Reductions (CER) credits earned by these are around Rs 72.3 crore. Of the total CDM projects approved in India, almost 13 per cent are based in Maharashtra, with Tamil Nadu and Gujarat close behind with over 12.5 per cent each. As this table shows, Kerala has performed miserably with respect to earning CERs, relative to these states. Only 18 of the CDM projects are located in Kerala, amounting to Rs 6.4 lakh of CERs.

Table.17.15.
Approved CDM Projects in India

Name of States/Country	No of Projects	CER up to 2012 (Rs Crore)
Maharashtra	369	6.2
Tamil Nadu	366	5.2
Gujarat	357	12.7
Karnataka	252	7.0
Rajasthan	225	6.3
Andhra Pradesh	209	8.7
Uttar Pradesh	163	3.8
Chhattisgarh	105	2.7
Kerala	18	0.1
Others	781	19.7
Total	2827	72.3

Source: : www.CDMindia.gov.in/reportslist

17.5.30 Table 17.16 provides the list of 18 approved CDM projects located in Kerala. As this table shows, barring one, all of them are small. Moreover, most are promoted by the private sector. While this has been the trend in other states, there is evidence that in some sectors, state bodies take the lead in promoting CDM projects. Notable among them is the area of waste handling and disposal. Most urban centres in India face difficulties in locating new landfill sites for waste disposal. The existing ones have limited spare capacity. In this context, many state bodies have promoted CDM projects with two objectives. First, they earn CERs from the projects and thus supplement their own finances. Second, in the process, part of the waste is converted to compost (organic manure), which is sold as fertiliser, earning them extra revenue. In most cases, methane gases are captured and supplied to units with additional value generation. Above all, this will create space in the existing landfill sites. Generally, more than 50 per cent of solid waste generated in landfill sites is of organic nature, which can be converted to compost. Most of the municipalities in Kerala are facing problems in finding land for waste disposal. Thus, it makes economic sense to develop CDM projects in waste handling and disposal in the large municipal bodies. Moreover, this helps to reduce water and air pollution, since untreated waste percolates through the soil leading to water pollution.

Table.17.16.
List of Approved CDM Projects in Kerala

Switching fossil fuel in an industrial facility at the Kerala Ceramics Ltd	Small
3 MW Iruttukanam Small Hydroelectric Project at Viyyat Power Private Ltd	Small
Methane recovery from wastewater generated at paper manufacturing unit of Sree Sakthi Paper Mills Ltd	Small
Vilangad Small Hydroelectric Project	Small
Kakkayam Small Hydroelectric Project	Small
Kollam Solid Waste Composting Project	Small
Waste heat based power generation at the carbon black manufacturing facility in Kochi	Large
Chathankottunada Stage II SHEP	Small
Renewable Electricity Generation Project in Kerala by Gensol Consultants Pvt Ltd	Small

Energy efficiency initiative of KDHP by replacing ICLs with CFLs in Munnar	Small
9.75 MW Bundled wind power project by Zenith Energy Services (P) Ltd	Small
Supply side energy efficiency improvement project implemented by KDHP in Munnar	Small
Bundled project for replacement of fuel oil and electricity with biomass gasifier for heat generation by Rubber Research Institute of India (RRII)	Small
Bundled methane recovery project from sheet processing effluent by Rubber Research Institute of India (RRII)	Small
2x3.5 MW Ullunkal Hydro Power Project in Chittar village, Pathanamthitta district.	Small
Fuel switch project from furnace oil to woody biomass at Nitta Gelatin India Limited, Kochi	Small

Source: www.CDMindia.gov.in/reportslist

17.5.31 Renewable energy is one area where a large number of CDM projects have been approved. It is seen from Table 17.16 that quite a few projects in this area, albeit of small size, have been approved.

17.5.32 Wind power is one area where Gujarat and Rajasthan have made considerable progress. Even though Kerala has wind speeds sufficient to generate power, the state government has not taken enough steps to tap the potential. This is one area where it is easier to earn carbon credits. Kerala can explore wind energy as it has a large potential in the hilly and coastal regions. In many countries and regions with strong winds, particularly in the coastal and hilly areas, electricity is generated by installing wind turbines. For instance, in Portugal, which has a long coastline and large hilly tracts, numerous wind turbines are installed. These meet a significant part of the country's electricity demand. Further, installations of turbine poles are made by private entrepreneurs on land owned by communes, who get rent for leasing out their land. This system helps local governments raise finances for local developmental work. Kerala can follow such a model, and additionally it can get further benefit through CDM.

17.5.33 The manufacturing sector has the maximum number of approved CDM projects. This is basically in the domain of the private sector. As the private sector is slow to tap CDM benefits, policymakers have to sensitise them regarding ways to earn CDM benefits.

17.5.34 Mass transport is one area where the government, semi-government authorities and bodies of other states have benefited from CDM finance. For instance, the Delhi Metro has earned CERs. Kerala does not have a mass rapid transport system yet. So it cannot earn CERs in this area. One avenue could be the introduction of biofuel in the transport sector in Kerala, which may help earn CERs along with reducing air pollution in urban areas. In this context, it may be noted that Kerala, unlike other states, has not made any effort to develop the biofuel sector in the State. It must be mentioned that India has decided to achieve 20 per cent blending target for biofuel by 2017 (Government of India, 2009).[13] According to the ADB's (2011) study, this will create an additional 33.3 million jobs by 2017 for unskilled workers in India. Most of these jobs will be created in the rural areas.[14] If Kerala does not make any effort to develop the biofuel sector in the State, it will forego a major source of job creation in rural areas, apart from not earning CERs from biofuel feedstock cultivation, production and use. Policymakers need to take note of this fact.

17.5.35 Green buildings are also a sure way to earn carbon credits. Though other states have made progress in this area, Kerala's progress has been slow. The policymakers need to educate the public about the benefits of green buildings. Since the climatic conditions in Kerala demand air-conditioning in private and government buildings, green buildings will help in reducing electricity bills. However,

given the shortages of skills in the construction of green buildings, the government has to undertake skill development of building engineers and architects.

17.5.36 To conclude, the action plan is to integrate environmental and sustainability considerations into the sectoral strategies, policies and programme formulation; to work in partnership with other agencies, businesses, community groups and individuals; and to work towards sustainability by balancing economic, social and environmental considerations for both present and future generations.

17.6. Implementation

17.6.1.1 There are two conditions for implementing environment mainstreaming:

17.6.1.2 Condition 1: Institutional framework

- Develop simple environmental guidelines or standards for each sector.
- Establish 'environmental units' for sectoral departments. These units will be responsible for mainstreaming environment in policies and rules, exploring environmental alternatives (Box 17.3) and implementing them along with the Department of Environment.

Box No 17.3

Environment alternatives: Trucks vs tractors

Waste hauling distances from towns to the final disposal sites are all quite short, typically 3 km to 10 km. Where haul distances are short, tractors have proven to be much more cost effective than trucks due to their lower capital and operating costs; lower fuel and maintenance costs; and longer life expectancy. Typically, it has been found in developing countries that tractors fitted with low loading height are more efficient than trucks where there are haul distances of up to 20 km or, even in some situations, 30 km. The annual cost (fuel, maintenance and depreciation) of a tractor is only about one-third that of a truck. Typically, the economic life of a truck is only 7-8 years, as compared to 10 years for a tractor. Moreover, the cost of a tractor is significantly lower than that of a truck..

- Strengthen the Department of Environment.
- Introduce new tools, especially policy changes to resolve a number of critical issues such as biofuels, waste management and new mining development. Recently, an innovative solution to garbage collection has been introduced in Taipei. The city government charges households and industries for the volumes of rubbish they produce. Waste will only be collected by the city council if it is disposed in government-issued rubbish bags. This policy has successfully reduced the amount of waste the city produces and increased the recycling rate.

17.6.1.3 Condition 2: Improve capacity for environment management

- The capacity of the environment authorities in Kerala needs to be strengthened, to enable them to collaborate with all other departments in mainstreaming environment and developing and implementing strategies.
- The capacity of the finance and planning ministries and the local governments needs to be strengthened as key 'entry points' for environment authorities to work with.
- Enable various sectors to integrate positive and negative environmental issues.

17.6.1.4 Green national accounting

Green National Accounting extends conventional national product measures by providing better indicators of economic welfare, as it takes into account the sustainability of the national product. Conventional national accounts measure the size of the market or commercial activities, but do not necessarily measure how these activities translate into welfare. Green national accounts are concerned with issues related to the environment. For example, production of certain goods that generate market value contributes to national income, but if the production generates undesirable pollution as a by-product, say air pollution, the contribution to welfare might actually be less. Conventional national accounts ignore the reduction in air quality, since air quality is not traded on markets and is, therefore, left out. There have been efforts to model 'sustainable development' through the green national accounting system. Substantial progress has been made in this direction. International agency UNESCAP has initiated a global project in this direction. Over the period of 20 years, Kerala will need to shift to a green accounting system to assess its economic prosperity.

17.6.1.5 Monitoring and evaluation

17.6.1.6 Effective governance and monitoring of progress are essential to ensure that Kerala achieves the targets it sets for itself. The governance and monitoring will take place within the framework of the strategy proposed in the Kerala Perspective Plan 2030 and will integrate the relevant elements of the Sustainable Development Strategy in order to ensure overall coherence. It will be based on an analysis of policies across various sectors. It will require baseline surveys, mapping and inventory of natural resources and a well-defined set of indicators to assess Kerala's 'environment policy framework'. The European Environment Agency (EEA) maintains an extensive set of over 200 environmental indicators. These may be examined. Some of them may be adopted to set targets to evaluate the performance of the policy.

Table.17.17.
Indicators of environment

Environment dimension	Indicator
Climate change	CO2 and greenhouse gas emission, intensity per capita
	CO2 and greenhouse gas emission, intensity per unit of GDP
Ozone layer	Ozone depleting substances: consumption of CFCs and halons
Air quality	SOx and NOx emission intensities (per unit of GDP)
Biodiversity	Threatened species: Birds, mammals and plants as a percentage of total varieties
Waste generation	Municipal waste generation intensities per capita and per unit of consumption
Freshwater quality	Waste water treatment
Freshwater resources	Intensity of use of water resources
Forest resources	Intensity of use of forest resources
Energy resources	Intensity of energy use

Source: European Environment Agency (EEA)

17.7 Conclusion

17.7.1 Although Kerala does not contribute significantly to the hazardous waste produced in India, it faces a serious deterioration in environment quality mainly due to land and water pollution. The biggest challenge to cleaning up the environment is the lack of adequate funding and non-compliance with stipulated environment rules. The State must, however, strive to improve the quality of its environment and that of the life of its people by 'mainstreaming environment' into its sectoral development initiatives. It must aim at achieving economic prosperity through concerted measures for creating 'ecosystem resilience'. The pillars of this strategy will include enabling clean production systems; sustainable production and consumption patterns; land planning and protection of ecosystems; solid waste management; outcome-oriented research and development; and promotion of R&D and innovation. In order to implement 'environment mainstreaming', the related institutional framework and the capacity of institutions to undertake environmental management has to be strengthened. Green National Accounting has to be adopted by the State. Also, effective monitoring and evaluation of the progress against specific targets has to be undertaken.

Appendix A17.1

Methodology for emission forecast (Table 17.11)

In emission terminology, it is customary to take into account emission of three important gases, namely CO2, CH4, and N2O. We have also assessed the pollution multiplier of various sectors in terms of these gases. Each sector has a direct emission coefficient, which is nothing but the amount of pollution generated for each level of output produced by the production activity. However, the production of any output requires various inputs whose production also gives rise to pollution. Thus, it is important to take into account both direct and indirect effects of emission in assessing the pollution multiplier of various sectors. The methodology for deriving these direct and indirect effects is described below:

Let A (nxn) be the input-output coefficient table of Kerala, X (nx1) be the matrix of sector-wise gross output and Y (nx1) be the matrix of exogenous final demand. So, we can write:

$$X = AX + Y \quad (1)$$

Or

$$X = (I - A)^{-1}Y \quad (2)$$

If we denote the (I–A)-1 matrix as M (nxn), then Equation (2) can be written as

$$X = MY \quad (3)$$

To link this multiplier with the environmental indicator, we have estimated the pollution trade-off multiplier. Here we have used the method described by Robert Koh (1975). The pollution trade-off multiplier measures the direct and indirect impact on pollution generation level due to exogenous changes in sectoral output, household income and so on. The mathematical expression of the pollution trade-off multiplier is given as follows:

$$E=P*X \quad (4)$$

Where, E (nx1) is matrix of sector wise emission,
P (nxn) is the sector-wise emission coefficient matrix, whose off-diagonal entries are zero and diagonal entries quantifies the amount of GHG emission in tons per unit of output
Replacing equation (2) into equation (4),

$$E=P*(I-A)^{-1}*Y \quad (5)$$

$$\partial E/\partial Y=P^* (I - A)^{-1}=T \quad (6)$$

Here T is the pollution trade-off multiplier matrix, which indicates the impact on emission due to any exogenous changes into the economy.

We have used for our analysis the input-output table prepared by Kolli (2012). The pollution coefficients are the author's estimate based on data from the Indian Network on climate Change Assessment (INCCA), Government of India (2010), and adjusted with appropriate weights as per sectors of Kerala's Input-Output Table. Of course, as mapping between sectors of input-output tables and INCCA is not one to one, we had to use our judgment using supplementary information of NATCOM, IPCC.

Table.A17.1.
GHG emissions Tonnes / lakhs of Rs of Output

Sectors	CO2 Emission	CH4 Emission	N2O Emission	Total CO2 Equivalent Emission
Food grains	3.06347	0.25217	0.00155	3.31718
Coconut	0.52525	0.01226	0.00192	0.53943
Tea	0.50259	0.0139	0.00192	0.51841
Coffee	0.53392	0.01157	0.00192	0.54741
Rubber	0.56054	0.00827	0.00193	0.57074
Fruits	0.63624	0.00467	0.00193	0.64284
Vegetables	0.6642	0.00645	0.00193	0.67259
Other crops	0.91835	0.01008	0.00197	0.9304
Livestock	2.51258	0.47996	0.00009	2.99263
Forestry and logging	0.47663	0.00115	0.00002	0.4778
Fishing	0.51885	0.00103	0.00003	0.51991
Mining	1.75827	0.00254	0.00006	1.76087
Food, beverages	3.24597	0.03244	0.00039	3.2788
Tobacco products	2.12801	0.00455	0.00012	2.13268
Textiles	3.00551	0.00628	0.0002	3.01199
Wood and paper	3.50018	0.01091	0.00013	3.51122
Leather apparel and tanning products	3.46429	0.01251	0.00025	3.47705
POL, rubber, plastic	3.16188	0.00357	0.00015	3.1656
Chemicals	3.58081	0.00752	0.00062	3.58895
Non-metallic mineral products	3.92421	0.00515	0.00013	3.92949
Other manufacture	4.13143	0.00475	0.00012	4.1363
Electronics and communication equip	4.60108	0.00519	0.00012	4.60639
Medical, precision & optical instruments	4.57526	0.0057	0.00014	4.58111
Gems and jewellery	3.00791	0.00292	0.00009	3.01093
Construction	3.07202	0.00429	0.00009	3.0764
Electricity, gas and water supply	55.48916	0.07619	0.00086	55.5662
Railway transport services	6.14926	0.00748	0.00037	6.15711
Land transport including via pipeline	4.12832	0.00536	0.00023	4.13391
Water transport	3.07261	0.00421	0.00015	3.07697
Air transport	11.85955	0.0037	0.00037	11.86362
Supporting and aux. tpt activities	5.06212	0.00784	0.00021	5.07016
Storage and communication	2.19061	0.00304	0.00005	2.19369
Trade	0.84581	0.00176	0.00003	0.8476
Hotels and restaurants	1.4841	0.02992	0.0002	1.51422
Financial services	1.17444	0.00243	0.00003	1.1769
Real estate and business services	1.12731	0.00224	0.00003	1.12958
Education and research	0.29275	0.00105	0.00002	0.29383

Medical and health	1.19498	0.00524	0.00015	1.20037
Other services	1.07743	0.00178	0.00003	1.07924
Public administration	0.00714	0	0	0.00714

Source: Authors Estimation

Table 17B.2 provides our estimates of GHG emission in Kerala over the period under observation — 2010-11 to 2030-31. As shown in the table, per capita emission of Kerala will rise from 1.5 tonnes in 2010-11 to 5.33 tonnes. The fall in share of hydroelectric power is partly responsible for this trend.

Table. A17.2.
Forecast of GHG emission in Kerala

Sectors	Emission in Preferred Scenario (Tons of CO2 Equivalent)				
	2010-11	2015-16	2020-21	2025-26	2030-31
Agriculture	1769082	1740978	1773540	1815612	1895856
Forestry & Logging	0	0	0	0	0
Fishing	57	61	67	71	72
Mining & Quarrying	12055	14111	16858	19200	21464
Manufacturing	6350430	8010863	11745053	17222067	26292341
Construction	2154	2717	3983	5840	8916
Communication	11433	14963	20575	27007	35856
Banking & Insurance	10558	13319	18827	26860	39886
Public Administration	6555	8269	10854	13595	17054
Other Services	15723	22131	34577	50235	78117
Electricity, Gas and Water supply	1678402	1519400	2405732	5343633	6472701
Railways	40113968	50130772	69937538	96290649	139240138
Transport by other means	66	83	116	159	230
Storage	27823	34771	48509	66788	96578
Trade, Hotel & Restaurant	17902	22372	31211	42972	62139
Real estate ownership, Business, legal	40113968	50130772	69937538	96290649	139240138
Total	50084439	61625092	86183590	121126830	174579604
Per Capita Emission	1.5	1.83	2.54	3.57	5.33

Note: Emission of CO2, CH4, are N2O accounted for.

Source: NCAER's Estimate

WHO has defined a permissible limit of concentration of nitrates of 45 mg/L of NO3, which is also accepted by the Indian Council of Medical Research (ICMR).

APPENDIX A17.2

Assumptions for forecasts in Table 17.12 on Investment requirement of waste management

Solid waste management

Assumption for Estimation:
Capital cost:

i. Per capita costs of collection and transportation = Rs 303
ii. Per capita cost of solid waste treatment = Rs 196
iii. Per capita cost of solid waste disposal = Rs 105
iv. Per capita total cost of solid waste management = Rs 604

The norms are drawn from RIUFS, 2011
O&M unit costs = Rs 1,405 per ton, of which Rs 1,171 is for collection and transportation and Rs 234 is for disposal

Sewerage

Assumptions for capital cost estimation:

i. Sewerage infrastructure drainage network cost per capita = Rs 3,615
ii. Per capita cost of Sewerage treatment plant = Rs 2,089
iii. Network plus treatment plant cost per capita = Rs 5,704

Backlog is assumed to be around 50 per cent (Source: RIUFS, 2011)
Per capita O&M cost of sewerage network and treatment plant is estimated at Rs 453.

Biomedical waste

Rao, Ranyal, Bhatia and Sharma (2004) have estimated capital costs per bed to be Rs 343 at 2001-02 prices or Rs 402 at 2011-12 prices[15]

** We have assumed international norm of 5 beds per 1000 persons

ii Corresponding to hospital beds, there are other biomedical waste generating organisations such as general dispensaries, pathological labs and collection centres. Considering all this, we have estimated BMW per bed per day to be 300 gm in Kerala (Source: Surat's study)
iii Daily treatment cost is assumed to be Rs 26, taken from Surat's study and this rate is still prevailing

Reference

1 *CPCB (2009) "National Inventory of Hazardous Wastes Generating Industries & Hazardous Waste Management in India," February*
2 *Sreekumar P R and and Nair A S K : Bio medical waste disposal and its status in Kerala http://210.212.24.72/~kscsteuser/digital-library/digital/KSC/ksc19/04-Health%20Science/04-GENERAL/04-20.pdf*
3 *http://www.spipa.gujarat.gov.in/images/bio_medical_waste_report_surat.pdf*
4 *www.indiastat.com*
5 *Under the Govt. of India's plan, 90 per cent quality affected habitations in these categories are covered through surface water alternate sources and 10 per cent through treatment by low cost technologies. In respect of iron, however, 30 per cent quality affected habitations will be covered by surface water sources and 70 per cent by treatment. In regard to nitrate-affected habitations, 100 per cent habitations are covered through surface water alternate sources.*

[6] *Urban habitats are generally provided by safe drinking water by municipalities.*

[7] *Murthy, M.N. and Kumar, Surenda (2011) "Water Pollution in India An Economic Appraisal," Chapter 19, India Infrastructure Report, 286-298.*

[8] *Murty, M.N. and U.R. Prasad (1999) 'Emissions Reduction and Influence of Local Communities in India', in M.N.Murty, A.J. James, and Smita Misra (eds), Economicsof Industrial Pollution Abatement: Theory and Empirical Evidence from the Indian Experience, Oxford University Press, Delhi.*

[9] *http://www.spipa.gujarat.gov.in/images/bio_medical_waste_report_surat.pdf*

[10] *Parikh, J. (2004), 'Environmentally Sustainable Development in India', available at http://scid.stanford.edu/events/India2004/JParikh.pdf last accessed on 23 August 2008.*
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[15] *Rao, Ranyal, Bhatia and Sharma (2004) "Biomedical Waste Management: An Infrastructural Survey of Hospitals," Medical Journal Armed Forces India, vol. 60, pp. 379-382.*

Chapter 18

POWER 2030

Chapter 18

Power 2030

18.1 Background

18.1.1 Efficient, reliable and competitively priced energy supply is a prerequisite for accelerating economic growth and human development. Energy is an important sector of the economy, which creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy. During the past decade, the energy industry accounted for about 2 per cent of the Gross State Domestic Product (GSDP) in Kerala. Further, it directly contributes to increasing productivity and improving quality of life and reducing poverty. Likewise, a lack of access to reliable energy is a severe impediment to the process of economic growth and sustainable social development. For any developing country, therefore, the strategy for energy development is an integral part of the overall economic strategy. Energy has different forms. This chapter focuses on electrical energy (the power sector).

18.2 Energy reforms in Kerala

18.2.1 The waves of power sector reforms that have swept the world and the rest of India, have also affected Kerala's power sector. Until 2001, these reforms were moderate. The government initiated some steps to change the work culture in the Kerala State Electricity Board (KSEB) to eliminate the inefficiency inherent in it. Besides, the Kerala State Power and Infrastructure Finance Corporation was set up for funding the power sector and other infrastructure projects. In August 2001, Kerala signed a memorandum of understanding (MoU) with the Ministry of Power, expressing its willingness to undertake power sector reforms. As per the MoU, KSEB was to be run on commercial lines and was also to securitise all its dues to the central public sector undertakings (CPSUs). The MoU required the state government to 'desegregate' KSEB to make it accountable with respect to its functions of generation, transmission and distribution. Accordingly, in April 2002, KSEB was divided into three 'independent profit centres' with separate administrative set-ups and accounts. However, the corporatisation of KSEB began only in 2011 and the three functions still remain with it. The State Electricity Regulatory Commission, with three members, was also set up in November 2002.

18.2.2 At present, Kerala's Department of Power has several line departments under it, which manage the power sector in the State:

- **Kerala State Electricity Board (KSEB):** KSEB, constituted by the Government of Kerala by an order dated 7 March 1957 under the Electricity (Supply) Act, 1948, is in the business of generation, transmission and distribution of electricity.[1]
- **Kerala State Power and Infrastructure Finance Corporation (KSPIFC):** KSIPFC is a government company promoted jointly by the Government of Kerala and KSEB to provide financial assistance for the development of the power sector and other infrastructure projects in Kerala.[2]
- **Kerala State Electricity Regulatory Commission (KSERC)[3]:** The KSERC determines the tariff for generation, supply, transmission and wheeling of electricity, wholesale, bulk or retail, as the case may be, within the State and regulates electricity purchase and procurement processes.

- **Energy Management Centre, Kerala[4]:** The Energy Management Centre-Kerala is an autonomous body under the Department of Power, Government of Kerala, devoted to the improvement of energy efficiency in the State, promotion of energy conservation and small hydro power and encourages the development of technology related to energy through research, training, demonstration programmes and awareness creation.
- **Agency for Non-conventional Energy and Rural Technology (ANERT)[5]:** ANERT is an autonomous organisation established in 1986, which now functions under the power department. The objective of the Agency is to promote non-conventional energy in the State. Its current policies to implement renewable energy include:
  - o Kerala Renewable Energy Policy 2002
  - o Wind Energy Policy 2004, including amendments in 2007 and 2008
  - o Renewable Purchase Obligation and Renewable Energy Certificates
- **Chief Electrical Inspectorate[6]:** The main function of this unit is to ensure safety of all electrical installations as per the provisions of Section 53 of the Electricity Act, 2003.

18.2.3 As of March 2011, Kerala is one of six states in India that has a state electricity board.[7] Kerala has two companies in the private sector, one in generation and another in distribution. That is the lowest compared to the three other Southern states, Andhra Pradesh (13), Karnataka (5) and Tamil Nadu (7).

18.2.4 There is a growing realisation that the future of the State's economy is mainly dependent on power and, hence, the cooperation of all sections of society is necessary to achieve these goals. On the one hand, attitudes towards privatisation/corporatisation of the distribution of electricity need to change and on the other hand, environmentalists need to be pragmatic and work with other stakeholders.

18.3 Situation Analysis

18.3.1 Direct contribution of gas and electricity to GSDP

Both electricity and gas services as a per cent of GSDP show increases over the last 40 years (Figure 18.1). The share of electricity has risen rapidly in the 2000s, from around 0.95 per cent during 1990−2000 to 1.55 per cent during 2000−2011.

Figure 18.1
Share of Electricity and Gas as a per cent of GSDP in Kerala (%): 1970−71 to 2010−11
(At Factor Cost by Industry of Origin in 2004–05 prices)

Note: 2010−11 data are quick estimates.

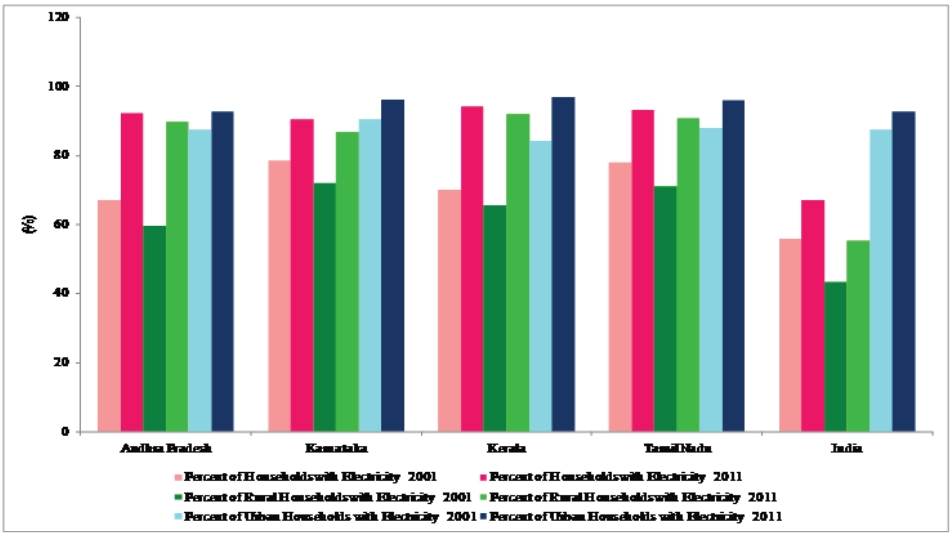
Source: Economics and Statistics Department, Government of Kerala

18.3.2 Electricity consumption patterns

Improvement in access to electricity

18.3.2.1 Kerala has shown tremendous improvement in providing access to electricity. The percentage of households that use electricity as their primary source of lighting has gone up from 70.2 per cent in 2001 to 94.4 per cent in 2011 in Kerala. The corresponding number for the whole of India was 67.3 per cent (Figure 18.2).[8] Overall, in terms of access to electricity Kerala is ranked tenth among 35 states and union territories (UTs).

Figure 18.2
Percentage of Total, Rural and Urban Households using Electricity as their Primary Source of Lighting: 2001 and 2011



Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011

Low per capita consumption

18.3.2.2 The per-capita consumption of electricity in Kerala is 567 kWh (kilowatt hour) as per the latest survey (2011–12). Latest available data till 2010–11 shows that India's per capita electricity consumption was 818.75 kWh.[9]

18.3.2.3 A note of caution is in order regarding the comparison of consumption numbers of electrical power in Kerala. Due to lower availability of electricity, Kerala had to regulate supply of power often to manage the sector. Lesser power was supplied to the industrial sector. Therefore, the official numbers are not precise because they are reflective of the curtailed demand rather than the actual demand. KSEB gave NCAER the precise figure of millions of units of power that they had switched off due to shortage of power for a whole decade. Because of the reforms in 2003, the data shows huge volatility thereafter, for a period of two to three years. Plus, the power that was switched off was the least in 2006−07 (1.19 MU). Soon after, Kerala suffered from two droughts in 2008−09 and 2012−13. The point is that, often, the sale of power to different sectors does not add up to the total electricity sold. The sale of power to the miscellaneous categories is volatile. Therefore, for consistency and to enable estimation, the 2006−07 numbers are taken as the base year. The latest numbers available before the last drought in 2012−13 is for 2011−12. The power that was cut in 2011−12 was 237 MU. The power that was cut to the industrial sector and total demand is included. Then, for each sector, the Compound Annual Growth Rate (CAGR) is calculated between 2006−07 and 2011−12 to

estimate the consumption of power in each sector and then the total for each year is summed up. The calculations may seem a little ad-hoc, but this also highlights the need for reliable data on the power sector in Kerala. While the policymaker may get reliable statistics from government departments for planning purposes, their estimates need to be independently verifiable. Especially since the goal of the Kerala Perspective Plan 2030 is to create a knowledge economy, reliable, consistent and logical statistics should be available in a transparent manner so that independent researchers around the State, country and the world can model the power sector of Kerala in a variety of ways and create knowledge in the power sector. This is especially needed in this very important sector because of the degree of uncertainty prevailing in the short to medium term in the State.

18.3.2.4 As per the official statistics, the growth rate of total consumption of electricity is highly volatile and in the four years between 2008−09 and 2011−12 shows 7.3 per cent growth. Similarly, growth of per-capita consumption of electricity is also highly volatile and shows growth above 9 per cent in 2010−11 and 2011−12 (Table 18.1). In contrast, the estimated numbers show that the total consumption of electricity went up by 6.2 per cent. It is more linear and smooth, but that is because of the nature of its construction. Growth rate may be smaller, but the total consumption of electricity for the years 2007−08, 2008−09, 2009−10, 2010−11 and 2011−12 are higher — 12,886, 13,697, 14,565, 15,492 and 16,419 MU, respectively.

Table.18.1.
Consumption of Electricity in Kerala: 2007−08 to 2011−12

Year	Total Consumption of Electricity (MU)	Growth Rate (%)	Per-capita consumption of electricity (kWh)	Growth Rate (%)
2007−08	12,050		477	
2008−09	12,414	3.0	490	2.7
2009−10	13,971	12.5	474	-3.3
2010−11	14,548	4.1	519	9.5
2011−12	15,981	9.9	567	9.2

Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

18.3.2.5 International comparisons show that India's per capita electricity consumption is lower than its peers (Table 18.2). One may interpret from this that Kerala's consumption is much lower than the national average; it is also below the emerging countries.

Table.18.2.
Per capita Electricity Consumption (kWh per capita): 2009

Indicators	India	USA	United Kingdom	Brazil	Russia	Mexico	China	Euro Area
Electric power consumption (kWh per capita)	818.75*	12,914	5,692	2,206	6,133	1,943	2,631	6,589

*Note: * this is 2010−11 data*
Source: World Development Indicators, World Bank

Patterns of energy consumption dominated by domestic consumers

18.3.2.6 Domestic customers are the largest consumers of power in Kerala (Table 18.3).

Table.18.3.
Electricity Consumption Patterns in Kerala (MU)

	Domestic	Commercial	Industrial LT	Industrial HT &EHT	Public Lighting	Agricultural	Others
2006−2007	5,213	1,812	934	3,083	229	220	636
2011−2012	7,706	2,141	1,097	3,829	294	286	828

Sources: NCAER Calculations from State Planning Board. 2013.Economic Review 2012.Government of Kerala, Thiruvananthapuram, Kerala.

Energy use and GDP

18.3.2.7 The energy intensity for total primary energy of India — the energy required to produce a unit of GDP — has come down from 1.09 in 1981 to 0.62 in 2011.[10] Table 18.4 compares India's energy consumption statistics with other countries. Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP$) is higher than many developed countries, but lower than Russia and China. The corresponding numbers for Kerala are not available.[11]

Table.18.4.
Energy Consumption in Selected Countries 2009−10

Indicators	India	USA	UK	Brazil	Russia	Mexico	China	Euro Area
Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP)	199	171	99	131	335	131	273	121
GDP per unit of energy use (constant 2005 PPP $ per kg of oil equivalent)	5	6	10	8	3	8	4	8
GDP per unit of energy use (PPP $ per kg of oil equivalent)	6	6	11	8	4	9	4	10

Source: World Development Indicators, World Bank

18.3.2.8 Instead, the final energy intensity is derived. It is the final energy consumption at a specific branch/variable per unit of activity level.[12] The final energy intensity in Kerala has remained the same in the period between 2006−07 and 2011−12 (Table 18.5). The aggregate final energy intensity for Kerala in 2006−07 and 2011−12 was 0.8 and 0.7, respectively. In 2012−13, the corresponding number for India was 1.6. Kerala is performing better than India, but then, the manufacturing sector is relatively smaller in Kerala. Table 18.5 shows this number for the major consumer sectors in Kerala.

Table.18.5.
Final Electrical Energy Intensity in Kerala by Sector: 2001–2011 (Mwh per Rs lakh)

Year	Domestic	Commercial	Industrial LT	Industrial ET and EHT	Public Lighting	Agricul-tural	Others
2006−07	0.34	0.12	0.06	0.20	0.02	0.01	0.04
2011−2012	0.34	0.10	0.05	0.18	0.01	0.01	0.04

Source: Source: NCAER

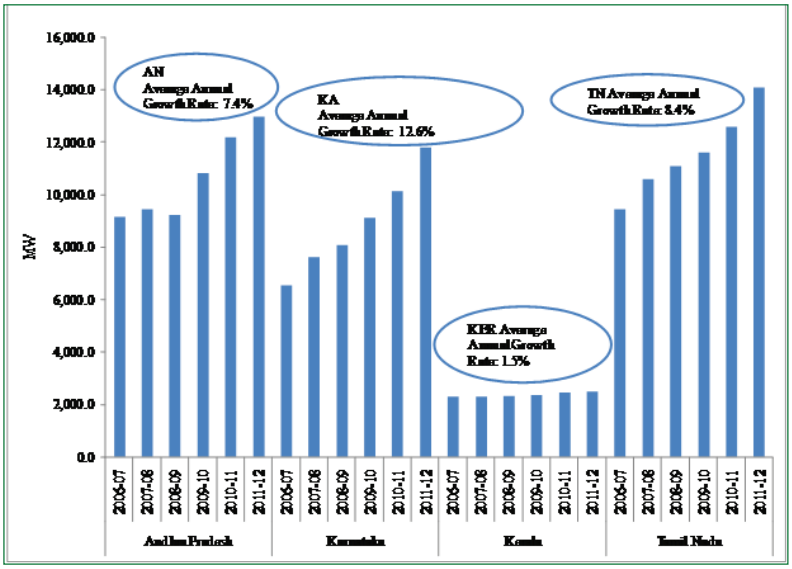
Low growth in generation capacity

18.3.3.1 Kerala has seen very low growth (average annual growth of 1.5 per cent) in installed electricity generation capacity in the last five years. Its regional neighbours have been growing at a faster rate (Figure 18.3).

18.3.3.2 The Economic Review 2012 explains that to meet the additional generation requirement of about 1,000 MW for the State during the 11th Five Year Plan Period, the KSEB had proposed to add about 610.50 MW of new hydel capacity generation, but achieved only 210.54 MW (34 per cent of target) at the end of the plan.[13] The main reason attributed to this shortfall is forest and environment clearance related issues including land acquisition.

18.3.3.3 However, it must be noted that the data published by the State Planning Board of Kerala in the Economic Review is slightly different when compared to the published statistics of the Central Electricity Authority (CEA). Overall, trends of both sources are similar. Therefore, when looking only at Kerala, data from the Economic Review has been used. However, for purposes of comparison with other states, this chapter uses data from the CEA. The discrepancies in the data set do not affect the analysis because, overall, the conclusion remains the same.

Figure 18.3
Installed Electricity Generation Capacity in Southern States : 2006−07 to 2011−12 (MW)



Note: MW stands for Megawatts

Sources: Central Electricity Authority. Southern Regional Power Committee. Annual Report 2011−12. Bengaluru and Central Electricity Authority. Southern Regional Power Committee. Annual Report 2010−11.

18.3.3.4 Table 18.6 shows the power system of Kerala. Including the installed capacity of the State from central sources — its share in joint and central sector utilities (35.4 per cent) — boosts Kerala's capacity significantly (Table 18.7). The percentage share of the generation capacity in Kerala is: central (35.4 per cent), state (59.5 per cent) and private (5.1 per cent).

18.3.3.5 In contrast, the other southern states' reliance on central sources is relatively low (Andhra Pradesh is 19.2 per cent, Karnataka 11.2 per cent and Tamil Nadu 19.8 per cent). The states' own percentage shares in generation capacity are quite high: Andhra Pradesh (56.2 per cent), Karnataka (54.3 per cent) and Tamil Nadu (32.6 per cent). Tamil Nadu (47.6 per cent) has the highest percentage share of the private sector followed by Karnataka (33.8 per cent) and Andhra Pradesh (24.5 per cent).

Table.18.6.
Installed Electricity Generation Capacity: Kerala, 2006−07 to 2011−12 (MW)

Year	2007−08	2008−09	2009−10	2010−11	2011−12
Installed Electricity Generation Capacity (MW)	2,662.24	2,694.75	2,746.19	2,857.59	2,872.79
Maximum Demand	12,414	3.0	490	2.7	2.7
(System)-MW	2,745	2,765	2,998	3,119	3,348
Generation per annum-(KSEB Own)-MU	8,703.60	6,494.50	7,240.40	7,412.60	8,350.70
Import per annum- MU	8,074.60	9,628.98	10,199.96	10,512.30	11,270.70
Export per annum-MU	1,346.80	463.33	53.9	130.24	201.1
Energy Sales within state per annum-MU	12,049.90	12,414.30	13,971.10	14,547.90	15,980.50

Notes: MU stands for million units

Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

Table.18.7.
Installed Capacity in Kerala: March 2012 (MW)

Ownership Sector	India				Nuclear	Hydro (Renewable	RES* (MNRE)	Grand Total
	Thermal							
	Coal	Gas	Diesel	Total				
State	0.0	0.0	234.6	234.6	0.0	1,881.5	162.66	2,278.8
Private	0.0	174	21.84	195.84	0.0	0.0	0.03	195.9
Central	897.92	359.58	0.0	1,257.5	95.6	0.0	0.0	1,353.1
Total	897.92	533.58	256.44	1,687.9	95.6	1,881.5	162.69	3,827.7

*Notes: *Renewable Energy Sources (RES) includes SHP, BG, BP, U&I, and Wind Energy*
SHP=Small Hydro Project, BG=Biomass Gasifier, BP=Biomass Power,
U&I=Urban & Industrial Waste Power, RES=Renewable Energy Sources
MNRE=Ministry of New and Renewable Energy
MW stands for Megawatts; MU stands for Million Units

Source: Central Electricity Authority. 2012. Monthly Sector Reports. http://www.cea.nic.in/reports/monthly/executive_rep/apr12/27-33.pdf. April

Hydel energy dominates electricity generation

18.3.3.6 The majority of Kerala's own installed capacity comes from hydel power (82.6 per cent). Table 18.7 shows that 53.4 per cent of the total installed capacity of Kerala (which includes shares from central and joint utilities) comes from renewable energy sources (hydel and others). Internationally, Kerala is similar to Brazil in structure (Table 18.8). However, Kerala's own installed capacity in hydroelectric power is not sufficient to meet the demands of the State.

Table.18.8.
Patterns of Electricity Production by Source (% of total), 2009

Country/State	Coal	Hydroelectric	Gas and oil	Nuclear	Renewable sources, excl. Hydroelectric
US	45	7	24	20	4
UK	29	1	45	19	5
Brazil	2	84	6	3	5
Russia	17	18	49	17	0
Mexico	11	10	71	4	4
China	79	17	1	2	1
Euro Area	21.6	10.2	27.0	30.8	9.1
India	68.2	11.5	14.1	2.1	4.2

Notes: 1. The international data are in kwh and the shares have been calculated from those.

Source: World Development Indicators, World Bank

18.3.3.7 Analogous to the generation capacity, most electricity generation in the State is hydel (Table 18.9).[14] The associated plant load factors (PLF), including auxiliary consumption, vary over time. Hydel generation, clearly, depends on the monsoon's performance every year. The State relies on thermal generation, generally more expensive, in years that the hydel generation is lower due to poor monsoons.

Table.18.9.
Electricity Generation in Kerala (MU)

	Hydel	PLF	Thermal	PLF	Others	PLF
2006−07	7,497	45%	449	7%	2	12%
2011−12	7,130	40%	1,627	23%	65	22%

Source: Central Electricity Authority

18.3.3.8 Data from the Economic Review 2012 shows that the share of hydel power in the total available power went down from 49.4 per cent in 2007−08 to 39.4 per cent in 2009−10 and then increased to around 44 per cent for both 2010−11 and 2011−12 (Table 18.10).

Table.18.10.
Details of Surplus/Deficit Power: 2007−08 to 2011−12

S.No.	Particulars	Internal Generation (MU)				
		2007−08	2008−09	2009−10	2010−11	2011−12
1.	Hydel Generation	8,327.5	5,839.28	6,466.3	7,095.7	8,058.01
2.	KSEB-Thermal Generation	374.14	653.54	592.3	315.4	290.7
3.	Wind	1.96	1.68	1.8	1.5	2.03
4.	Total Internal Generation	8,703.6	6,494.5	7,240.4	7,412.6	8,350.7
5	Less Auxiliary Consumption	55.9	54.1	50.8	55.1	60.9
6.	Power Purchase from CGSs	7,828.1	7,869.5	7,286.5	7.245.3	8,289.99
7.	Power Purchase from IPPs	388.4	979.6	1,926.03	1,393.31	715.66
8	Total Energy Availability	16,864.02	15,289.7	16,402.1	15,996.1	17,925.5
9.	Energy Requirement	15,065.2	15,293.5	16,978.04	17,227.8	18,946.3
10.	Surplus/Deficit	1,799.1	−3.8	−575.9	−1,341.7	−1,650.8

Notes: CGS: Central Generating Stations; IPPs: Independent Power Producers
Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

18.3.3.9 It is often recognised that increasing capacity with an overwhelming reliance on hydel is a challenge given the delays in land acquisition and environmental impacts. There are now attempts at diversifying electricity sources by installing petcoke and gas-based generation by building import infrastructure for these fuels in Kerala. It is important to note, however, that there is a guidance against gas-based generation on account of the expectation of higher LNG prices, the likely increase in the price of domestic gas and the increased demand for natural gas from high-value industrial processes.

Relatively lower transmission and distribution loss

18.3.3.10 Kerala's transmission and distribution (T&D) losses (19.9 per cent in 2008–09) are lower than the India average. In 2011–12, this further come down to 15.7 per cent. However, the T&D loss of India, at 24 per cent, is much higher than in many other countries. Table 18.11 shows that Kerala is similar to Brazil in terms of T&D loss and their losses are significantly higher than that of China, the EU, the UK and the US.

Table.18.11.
Electric Power Transmission and Distribution Losses in Selected Countries in 2011−12 (% of output)

Indicators	India	Kerala	US	UK	Brazil	Russia	Mexico	China	Euro Area
Electric power transmission and distribution losses (% of output)	24	15.7	6	7	17	11	16	5	5.13

Source: World Bank Indicators

Deficit in electricity

18.3.3.11 Table 18.10 shows that the gap between the requirement and the availability of electricity is increasing over time.[15] This situation is likely to persist in the absence of significant accretion to the electricity generation infrastructure.

18.3.3.12 Despite the State's power quota from the central pool increasing from 900 MW to 1,267.64 MW, Kerala suffered a shortfall in 2011−12. The Economic Review 2012 states "The poor yield from hydel reservoirs, high cost for thermal power and increased demand for power created a situation of 'negative surplus power' during 2011−12. The negative situation occurred mainly due to the drastic reduction in the purchase of power from Independent Power Producers (IPPS) and decline in thermal power generation. At the same time the total requirement increased to 18,946.29 MU in 2011−12 from 17,337.79 MU (9.3 per cent growth) in the previous year against the power availability of 17,295.54 MU resulting in a negative surplus of 1650.75 MU."[16]

18.3.4 Average tariff

18.3.4.1 Table 18.12 shows consumer category-wise average tariff. It shows that the State charges the lowest price for irrigation and dewatering, but has the highest rate for the commercial sector. In 2011−12 prices went down further for irrigation and dewatering. This implies a high degree of reliance on cross subsidies to achieve financial viability.[17] However, high tariffs may have a negative impact on commercial activity. Given its macroeconomic consequences, its long-term sustainability is suspect.

Table.18.12.
Average Realisation Rate from Tariff: 2007−08 to 2011−12

S.No.	Consumer Category	Average Tariff in (Paise/Unit)				
		2007−08	2008−09	2009−10	2010−11	2011−12
1.	Domestic	172.1	191.71	191.46	198.32	201.54
2.	Commercial	668.2	743.65	702.39	722.86	745.97
3.	Public Lighting	190.15	200.31	191.64	211.82	217.01
4.	Irrigation & Dewatering	105.45	135.35	109.9	115.11	110.3
5.	Industry (LT)	414.75	459.81	426.41	437.17	421.87
6.	Industry (HT & EHT)	401.24	479.77	414.47	424.58	418.02
7.	Railway Traction	359.04	475.84	397.87	412.16	399.25
8.	Bulk Supply	286.65	455.72	347.05	364.77	388.3
	Average	312.64	358.97	335.06	347.78	345.88
9.	Sale to NVVN to PTC	966.36	947.03	1,259.31	0.00	0.00
10.	Inter-State	397.67	0	851.5	1,207.34	1,144.00
11.	Sale through Power Ex-change	0.00	0.00	715.96	1,071.85	1,075.78
12.	Overall Average	350.81	380.14	338.03	354.24	347.39

Note: LT stands for Low Tension, HT stands for High Tension and EHT stands for Extra High Tension
Source: State Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram

18.3.5 Renewable energy sources (RES)

18.3.5.1 Kerala continues to lag behind the other Southern states in renewable energy generation. Other states have seen double digit growth in this sector. The percentage share of renewable energy, excluding hydroelectric from the total of central, state and private installed capacity, shows that Tamil Nadu has the highest share (41.7 per cent) followed by Karnataka (23.8 per cent), Andhra Pradesh (5.5 per cent) and Kerala at 4.25 per cent.
18.3.5.2 Some salient points on Kerala's RES as of 31 March 2012[18]:

- As of March 2012, Kerala had 35.1 MW of wind power that was grid interactive.
- Installed capacity of grid interactive renewable power — 149.67 MW of Small Hydro Power (SHP) and 0.84 MW of Solar Power.
- Off-grid/decentralised renewable energy systems/devices include:
  - Number of biogas plants: 133,887
  - Number of water pumping wind mills: 79
  - Number of solar photovoltaic pumps (SPV): 810
  - Solar photovoltaic:
    - Street lighting systems (No.): 1,735
    - Home lighting systems (No.): 32,327
    - Solar lanterns (No.): 54,367
    - Power plants (kilo watt peak): 57.7
    - Aerogen hybrid system: 8 KW
    - Solar cookers: 0.03 MW
    - Remote village electrified hamlets: 607

18.4.Projections

18.4.1 Electricity demand projections (MU)

18.4.1.1 It is important to forecast demand as it helps in planning for resources. There are five methodologies to forecast demand in this sector as listed below. Either one method or a combination of methods is used to forecast energy demand. In this chapter, 18th Electric Power Survey (EPS) projections are used. Trend analysis is used as the alternative NCAER demand projections. Plus projections using higher GSDP are also shown (labelled as preferred).

- Econometric Regression Method: Econometric regression analysis uses historical annual energy and economic data to determine customer elasticities. Elasticity is a measure of how a customer will change a purchasing pattern in response to a change in price, convenience, reliability and other factors. Based on customer elasticities and assuming that these elasticities do not change over time, a demand forecast is made.
- Appliance Saturation Method: The appliance saturation method is an 'engineering' type methodology. Load research surveys are made to determine the number of customers with a certain appliance (for example, a refrigerator) and the typical annual energy used by the appliance. Then, on the basis of a forecast of the number of appliances expected in the future, together with the forecast of how the annual energy usage per appliance will change, the energy demand forecast is made.
- End use Energy Method: The end use energy method is similar to the appliance saturation method, except that instead of using an appliance as the basis for forecasting, the basis is the end use process. The floor space and kilowatt-hour energy consumption of the principal electric devices per square foot (space heating and cooling, lighting and auxiliaries) is determined on

the basis of a load research survey. Based on a forecast of the floor space, the energy sales forecast is developed.

- Time Series Analysis: This method of forecasting future values of a variable involves the fitting of a trend line to historical data of a certain variable, using a method of least squares. The method uses auto regression — previous values of a variable are used to predict the future values.
- Trend Analysis: This method falls under the category of non-causal models of demand forecasting that do not explain how the values of the variable being projected are determined. Here, the variable to be predicted is expressed purely as a function of time, rather than by relating it to other economic, demographic, policy and technology variables. This function of time is obtained as the function that best explains the available data, and is observed to be most suitable for short-term projections.[19]

18.4.1.2 The 18th Power Survey demand projections by sector are shown in Table 18.13. Table 18.14 shows the long-run forecasts, but that is done in aggregate form

Table.18.13.
18th Electric Power Survey Forecast (MU)

Year	Domestic	Commercial and Miscellaneous	Industrial LT	Industrial HT &EHT	Public Lighting	Agri-cultural (Irriga-tion)	Others
2011−12	7,616	3,033	1,247	3,075	346	285	609
2016−17	10,472	4,893	1,802	3,702	422	341	778
2021−22	13,725	7,270	2,320	4,474	504	376	1,095

Source: Central Electricity Authority. 2011. Report on 18th Electric Power Survey of India. New Delhi, December

Table.18.14.
18th Electric Power Survey Forecast Long-term Forecasts

Year	Electrical Energy Requirement at Power Station Bus Bars in MUs (Utilities only)	Peak Electric Load at Power Station Bus Bars in MW (Utilities only)	Energy Consumption in MUs
2021−22	34,691	6,093	29,765
2026−27	46,049	8,150	39,533
2031−32	61,125	10,903	52,506

Note: Compound Annual Growth Rate (CAGR) has been used to forecast.
Source: Central Electricity Authority. 2011. Report on 18th Electric Power Survey of India. New Delhi, December

18.4.1.3 In the case of electricity demand, the final electricity intensity for each consumer category has been projected until 2031 as a linear time trend (Table 18.15) assuming the current patterns of electricity consumption continue. Comparing the long-term 18th EPS forecasts (Column 3) of Table 18.14 to Table 18.15 forecasts, the NCAER trend forecasts tend to be lower

Table.18.15.
Baseline Electricity Demand Projections (MU): 2016−17 to 2029−30

Year	Domestic	Commercial	Industrial LT	Industrial HT &EHT	Public Lighting	Agricul-tural	Others	Total
2016−17	12,225	2,570	1,304	5,652	402	422	1,131	23,705
2021−22	18,605	2,761	1,379	7,507	519	620	1,471	32,862
2026−27	27,110	2,457	1,183	9,448	630	874	1,804	43,505
2029−30	42,318	7,368	4,387	1,807	732	1,402	8,155	51,725

Source: NCAER

18.4.1.4 Table 18.16 presents the Perspective Plan scenario. The demand for energy will be higher due to sustained growth in both agriculture and industry. These are consistent with the projected growth rates laid out in Chapter 2. This time, the total forecasts are slightly above the 18th EPS. In this scenario, Kerala's total demand reaches near 52,000 MU in 2029−30 whereas in the EPS it reaches that mark two years later.

Table.18.16.
Preferred Electricity Demand Projections (MU): 2016−17 to 2029−30

Year	Domestic	Commer-cial	Indus-trial LT	Industrial HT &EHT	Public Lighting	Agricul-tural	Others	Total
2016−17	11,835.93	2,488.10	1,262.87	5,471.66	388.76	408.30	1,095.00	22,951
2021−22	18,289.16	2,714.12	1,355.24	7,379.28	509.79	609.64	1,446.47	32,304
2026−27	27,504.21	2,492.39	1,200.03	9,585.27	638.82	886.90	1,830.10	44,138
2029−30	34,727.21	2,004.60	912.79	11,015.64	714.70	1,098.31	2,062.60	52,536

Source: NCAER

18.4.2 Generation projections under baseline (MU)

18.4.2.1 Supply side projections for electricity are fraught with uncertainties (more than even the demand side). Over the last two years (while KPP 2030 was being prepared), hydel power projects have come under even greater uncertainty in Kerala due to the Gadgil and Kasturirangan reports (discussed elsewhere). Uncertainties about the pricing of natural gas in India have now made it unviable for Kerala to invest in those projects. The year 2012−13 was a drought year in Kerala and at the time of preparing this report, it was predicted that the El Nino might affect the monsoon in 2014. This affects Kerala significantly as it is dependent on hydel power. Given these uncertainties, KPP 2030 starts the onerous task of making projections of power generation in Kerala over the next 15 years. These projections are a product of intense discussions with the KSEB, ANERT and EMC. The risk remains that the supply projections may become irrelevant over the years as projects become unviable or they stall. Therefore, this process has to be a regular practice, requiring realistic assessment of power projects against the various demand side projections.

18.4.2.2 Kerala has three options to source its energy requirements — own generation, central allocation and power purchase agreements with other states. It has contracted power in various inter-state generation projects. Own generation from conventional sources includes hydel and thermal. Appendix 18A.1 lists the accretions, power purchase agreements regarding the electricity supply infrastructure. Wherever, KSEB has expressed concern about the viability of projects, they have not been used for projections. It is assumed that all projects are implemented on time. Based on the additions to generation capacity listed in the Appendix 18A.1 and assuming the PLFs listed below, the generation of electricity possible from each fuel is listed in Table 18.17. PLF assumptions have

been made based on the past trends for the aggregate generation capacity in the State, the potential for improvements, CEA statistics and discussions with the KSEB.

Table.18.17.
Generation Projections under Baseline and Preferred (MU): 2016−17 to 2029−30

Year	Hydel	plf	Thermal	plf	Nuclear	plf	Others (asuming-Zlargelygas)	plf	Total
2016−17	9,272	42%	13,802	85%	1,421	61%	74	25%	26,948
2021−22	9,659	42%	19,693	85%	1,421	61%	1,169	25%	35,760
2026−27	9,659	42%	19,693	85%	1,421	61%	1,169	25%	37,590
2029−30	9,659	42%	19,693	85%	1,421	61%	1,169	25%	38,855

Source: NCAER

18.4.2.3 Table 18.18 shows the demand-supply gap in a 'business as usual' scenario. Assuming that all contracts get through and projects are implemented, Kerala will have surplus power till 2021−22, but goes into a massive deficit after that.

Table.18.18
Demand-Supply Gap: 2016−17 to 2029−30

Year	Generation	Demand			Surplus/Deficit		
		18th EPS	NCAER Baseline	NCAER Preferred	18th EPS	NCAER Baseline	NCAER Preferred
2016−17	26,948	22,410	23,705	22,951	4,538	3,243	3,997
2021−22	35,760	29,765	32,862	32,304	5,995	2,898	3,456
2026−27	37,590	39,533	43,505	44,138	−1,943	−5,915	−6,728
2029−30	38,855	52,506	51,725	52,536	−13,651	−12,870	−13,681

The question that then arises is whether the gap in the latter period of KPP 2030 can be filled by non-conventional energy sources. The solar power potential is from ANERT's estimation from their Solar Policy 2013 (Table 18.19).

Table.18.19
Non-Conventional Electricity Generation Potential as of 2012 (MW)

Solar Power	Wind power	Small hydro power	Biomass power	Waste to Energy
1,500	790	704	1,044	36

Source: NCAER

It is assumed that 50 per cent of the potential is met by 2021 and 100 per cent of the potential by 2030 in an alternative scenario that is called the 'renewable energy scenario'. A PLF of 20 per cent is assumed in this case (Table 18.20). Again, it is seen that the surplus goes down over time. Further, it is only in the last two to three years, that a deficit in energy is seen.

Table.18.20
Renewable Energy Scenario (MU)

Year	Renewable	PLF (renewable)	Surplus/Deficit		
			18th EPS	Baseline	Preferred
2016−17	2,379	20%	13,217	11,923	12,677
2021−22	3,817	20%	14,675	11,578	12,136
2026−27	5,648	20%	6,737	2,765	2,132
2029−30	6,912	20%		−4,190	−5,001

Source: NCAER

18.4.3 Energy efficiency measures

18.4.3.1 Demand management measures will also help in reducing the energy deficit as well. The working group of the 12th Five Year Plan documents measures that will save approximately 5 per cent of the total generation during the Plan period. Assuming Kerala achieves savings of 10 per cent in the longer period extending to 2030, the deficit levels will be lower. This is referred to as the 'energy efficiency scenario'. Table 18.21 shows the projected electricity surplus/deficit if the two scenarios of 'renewable energy' and 'energy efficiency' are combined. In the preferred scenario, the deficit stays in the last year, but in the baseline and 18th EPS scenario, the deficit disappears. The next section is about recommendations to boost energy supplies.

Table.18.21
Energy Efficiency and Renewable Energy Scenario

Year	Electricity surplus/deficit in Energy Efficiency case (MU)		
	18th EPS	Baseline	Preferred
2016−17	13,716	12,450	13,187
2021−22	16,163	13,221	13,751
2026−27	9,812	6,149	5,565
2029−30		695	−39

Source: NCAE

18.5. The Way Forward

18.5.1 Vision

Economically affordable and environmentally clean power to all.

18.5.2 Mission

1. To use innovative approaches to promote energy production and increase the self-sufficiency ratio in energy production.
2. Develop innovative methodologies and techniques and devise programmes for efficient energy management.
3. Identify barriers to improving energy efficiency and propose appropriate remedial approaches including policy measures and financial incentives.
4. Carry out, support and/or promote research studies on energy management.
5. Promote energy consultants in the State to advise the various sectors on energy conservation methods.

18.5.3 Targets

- Exploit the full potential of hydroelectric generation.
- Assess and capture the full potential of non-hydro renewable energy.
- Reduce the transmission and distribution losses in the electricity sector to 9 per cent from the current 15.7 per cent.
- Improve energy conservation by 10 per cent from lower energy use,
- 100 per cent electrified households with 24x7 availability of electricity.

18.5.4 Kerala has done extremely well in providing electricity to a majority of households, lowering transmission and distribution losses and using the cleanest source of traditional energy, hydel power. However, there is a demand-supply gap. The supply side carries more challenges for Kerala. The long-term goal for the Sate is to achieve energy security, which involves ensuring uninterrupted supply of energy to support the economic and commercial activities necessary for sustained economic growth.[20] On the demand side, the challenge in this sector is to provide quality power to all, at affordable rates. The above analysis shows that over the long term, Kerala will have to increase its generation of electricity. Given uncertain weather patterns affecting the monsoon and uncertainty caused by climate change, Kerala cannot be expected to rely on hydel energy alone. Given that the price of traditional and non-renewable energy is going up, to provide energy at affordable rates, while keeping KSEB afloat is a challenge. Supply has to be increased, but the move should be towards using larger proportions of renewable energy over time. These changes have to be made with changes in governance.

18.5.5. An integrated approach is needed for the future. The strategic framework has been divided into four sub-areas — institutional changes, increase generation capacity, increase in the production of renewable energy and demand management and conservation. The actions are given below:

Pillar1: Institutional changes

18.5.5.1 Coordination between agencies

- Coordination committee: Close coordination between the line departments is required. They should explore the possibility of forming a coordination committee for integrated action.
- Capacity building: There is a need to build capacity in energy related disciplines and inter-disciplinary capacity in this area (Box A. 18.2).
- Environment mainstreaming: Close coordination is required to examine the costs and benefits of power projects. This should not only be in terms of economic costs, but environmental costs too. Environmental costs have to be brought into the mainstream.

Environment of experimentation and innovation

18.5.5.2 A unit devoted to documenting the technological changes relating to energy around the world is a must for policymakers in Kerala to keep abreast of what is happening in the sector and what can be adapted, both on the demand and supply side, to Kerala. Both supply and demand side management techniques need to be experimented with. The State should create an environment that enables technological and economic inventions in the energy industry to take place in Kerala itself. A free flowing environment is the need of the hour, where there is continuous exchange of ideas and innovation as there is no room for complacency.

18.5.5.3 For demand management, KSEB and the Energy Management Centre (EMC) have started a programme in schools to educate children about conserving energy. Further, various agencies can educate the public through ‘residents’ welfare organisations’ on conserving energy. If Kerala’s

residents place a greater emphasis on their environment, then the State will have to concentrate more on renewable energy.

Transformation to smart grids

18.5.5.4 A 'smart grid' is the confluence of information, communication and electrical/ digital technology. A 'smart grid', apart from facilitating real time monitoring and control of power systems, will help in the reduction of aggregate technical and commercial (AT&C) loss, peak load management/demand response, integration of renewable energy, power quality management, outage management and so on. It will act as a backbone infrastructure to enable new business models such as smart cities, electric vehicles and smart communities, apart from a more resilient and efficient energy system and tariff structures. The evolution of smart grids has been triggered by the increasing complexity and management of power systems; increasing penetration level of renewable sources; growing demand; expectations of service quality at a reasonable price in terms of system reliability; and efficiency and security, in addition to environmental energy sustainability issues. Such grids will be able to coordinate the needs and capabilities of all generators, grid operators, distribution utilities, end users and electricity market stakeholders in such a way that it can optimise asset utilisation, resource optimisation, control and operation as well as reduction in losses. In the process, smart grids minimise costs, AT&C losses, improve energy efficiency and environmental impacts while maintaining system reliability with improved quality and customer participation in energy efficiency measures. Technologies in the field of monitoring and measurements, communication, control and automation, advanced meters, IT infrastructure, energy storage, renewable energy generation and so on play a prominent role in the successful development of the smart grid.[21]

18.5.5.5 Kerala is piloting smart grid technology among its low tension industrial category consumers.

18.5.5.6 Grid interactive system may also be adopted and is especially useful for solar-powered systems.[22]

18.5.5.7 Implement the central scheme, Restructured Accelerated Power Development and Reforms Programme (APDRP) for all eligible cities. Projects under the scheme are taken up in two Parts. Part-A includes projects for establishment of baseline data and IT applications for energy accounting/ auditing and IT-based consumer service centres. Part-B includes regular distribution strengthening projects.

18.5.5.8 The National Grid in India has become operational. While on paper this should ease supply, ground realities do not change owing to issues related to the laying of cables. Right of way is a problem in Kerala. Plus, geography and forests work against it. Some ideas to overcome geographical, environmental and land acquisition barriers are discussed in the transmission section.

Pillar 2: Augmentation of supply and supply side management

18.5.5.9 The supply side augmentation has to be divided into three parts — generation, transmission and distribution.

Increase hydel power capacity

18.5.5.10 The importance of hydel power cannot be overemphasised in Kerala given that it is the cheapest power source for the State. It is the backbone of Kerala's energy sector.

18.5.5.11 Hydro power plants can dramatically change rivers' biodiversity. This requires economically

viable and environmentally sustainable solutions. In many countries these solutions are being worked out (Box 18.1). International collaborations may be a step in the right direction. However, given environmental concerns, expansion in this sector will be limited. Therefore, the State has to start examining other options to be energy secure.

Box No 18.1

Hydroelectric plants

As nuclear power production is phased out in several countries in the wake of the accident at the Fukushima nuclear power plants, renewable energy is expected pick up much of the slack in Europe. Switzerland expects a 10 per cent increase in its hydro power capacity by 2050 by expanding its existing hydro power installations and authorising the construction of hundreds of new mini hydro power plants, leaving few river courses untouched. It is planning to install 800 power projects of less than 10 MW capacity each. This may affect the biodiversity of the river system in the country. To limit the environmental impact, measures have been put in place to ensure that rivers never dry up. But the problem is that these measures kill the natural biodiversity of rivers. The challenge is the conciliation of river management from an ecological and an economic point of view. The country has adopted a dynamic redistribution policy to meet the challenge.

Source: http://phys.org/news/2013-04-hydropower-capacity-straining-environment.html#jCp

18.5.5.12 Along with hydro power, there is a need to emphasise small hydro power and the Small Hydro Power Policy of 2012 is a first step in this direction.[23]

- It is applicable to projects with installed capacity up to 25 MW.
- This policy sets a goal of commissioning 150 MW additional capacity from Small Hydro Power Projects (SHPs) by 2017 through private participation.
- Private developers will develop the project on build-operate-transfer (BOT) basis for 30 years, when they will transfer it back to the government.
- ANERT has already identified thirteen districts for such projects and the SHPs will be managed at the local level. This should be implemented in fast track mode.
- The disadvantage of SHPs is that like hydel power, it is dependent on the monsoon.

18.5.5.13 Detailed studies will be done, starting from the gram panchayat level, about economically feasible hydro energy in the area that can be harnessed.

Thermal-Coal

18.5.5.14 As laid out in the projections section, Kerala is asking for higher allocation of power from the centre and is tying up with other states to become energy secure in the future. This is a dominant strategy for Kerala.

Renewable energy other than hydel[24]

18.5.5.15 Kerala needs to have an amalgam of energy choices so that it has a back-up plan in case one option does not work out. Hydel energy is good, but in a bad monsoon year, such as 2012−13, there should be a back-up plan. Plus, the impact of the drought of 2012−13 will have repercussions for the next four to five years. All options for renewable energy need to be explored.

18.5.5.16 The Power Grid Corporation of India Ltd in a report in 2012 on envisaged renewable capacity does not identify Kerala as one of the renewable energy-rich states.[25] However, a recent report provides an alternative view of Kerala's RE potential and lays out the possibility that Kerala can achieve 100 per cent dependence on renewable energy by 2050. Appendix 18A.3 shows the summary of Kerala's RE potential. Therefore, Kerala needs to explore its options or have tie-ups with other states. Further, encouraging private participation in the RE sector will have a multiplier impact on the economy by encouraging science and innovation and entrepreneurship in the area of energy and environment. A decentralised approach to renewable energy is required, with ANERT possibly working with KSEB to create a bottom-up approach to assess RE potential and options from the gram panchayat level.

18.5.5.16.1 **Wind energy:** Offshore wind energy is not viable for Kerala because of the presence of the Western Ghats and the depth of the sea off Kerala. Evidence in literature, however, shows that Kerala has a wind power potential of 1,171 MW. ANERT has identified 17 locations in Kerala with a capacity of nearly 600 MW. The particular places where wind energy may benefit Kerala are Idukki and Palakkad.

18.5.5.16.2 **Solar energy:** Solar energy is especially useful for buildings and traffic lighting. Parking meters on roads can also be powered by solar energy. Storage is, however, a problem.

- ANERT created a Solar Policy in 2013, which will bring all the initiatives in one place.
- Both 'solar photovoltaic programme' (SPP) and 'solar thermal programme' (STP)[26] are implemented by ANERT. Under the SPP, ANERT has distributed solar PV devices such as solar lantern, solar home lighting systems, solar street lighting systems, solar TV power pack, solar water pumping systems (for deep and shallow wells), solar fencing energisers, solar vaccine refrigerator, solar fishermen pack, SPV demo kits for schools, PV insect light traps, PV rubber tapper's light, PV modules of 3,570 and 90W and so on.
- The Solar Thermal Energy Programme of ANERT is aimed at supplementing thermal energy requirements at various temperatures for different applications such as cooking, water heating, industrial process heating, crop drying, space heating, water desalination and so on by harnessing solar energy and converting it into heat using various solar thermal devices and systems.
- Kerala's 'solar rooftop power plants scheme' for 2012–13 was launched on 1 September 2012. The programme's highlights are:
  - Power plants (solar array) shall be of 1 kWp capacity.
  - Only off-grid power plants are covered under this programme.
  - State subsidy of Rs 39,000 per system.
  - Central government subsidy of Rs 81,000 or 30 per cent of the cost of power plant (whichever is less) is expected.
  - Applicants should be willing to meet the remaining expenses of around Rs1 lakh
  - 10,000 such systems totalling 10 MW solar PV capacity.
  - Installation of systems that fully meet Government of India specifications and guidelines through empanelled vendors.
- Float-mounted solar panels (Flotovoltaics) in the water bodies of Kerala may be installed, but with care.
- Other ways of harnessing solar energy include putting solar panels over railway lines.
- A German company, Heliatek, has developed technology in which tinted windows may be used to harvest solar energy (Box 18.2).

Box No 18.2

Harvesting Solar Energy from windows

Heliatek, which is based in Dresden, Germany, has modified techniques used to make touchscreens to create a translucent solar cell that can be used as a tinted window.

Heliatek's new transparent solar panels are very similar in design to OLED displays. Both rely on a thin layer of organic molecules deposited on a flexible backing. The idea of printing organic solar cells like this isn't new, but past cells printed in this manner tended to have very short lifespans. Heliatek is getting around that problem by using shorter chains of molecules, known as oligomers, instead of more fragile polymers. The result is a panel with a usable life more like that of conventional silicon solar cells

Source:http://www.extremetech.com/extreme/126449-german-firm-develops-tinted-windows-that-generate-electricity

18.5.5.16.3 **Biogas:** Kerala's waste management problem can be converted into an asset for the State. The average person generates about 4.5 pounds of waste per day. It can be reused to generate clean, renewable power. There are three main methods to convert organic waste material to energy — thermochemical, biochemical and physicochemical.

- Thermochemical conversion, characterised by higher temperature and conversion rates, is best suited for lower moisture feedstock and is generally less selective for products. The bio-chemical conversion processes, which include anaerobic digestion and fermentation, are preferred for waste having a high percentage of organic biodegradable (putrescible) matter and high moisture content. There has been an increasing focus on plasma-assisted gasification applied to the treatment of municipal solid waste (MSW). It may be a new way to increase waste-to-energy (WTE) systems worldwide. However, its benefits are not proven and there are on-going studies on this technology.
- Anaerobic digestion can be used to recover both nutrients and energy contained in organic waste such as animal manure. Solid waste such as coconut shell, husk, coir pith, rice husk, firewood, coffee husk and other industrial wastes can be converted into producer gas by the gasification route according to the ANERT Web site. This produces gas that can be used for heating and generating electricity. In 2012-13, ANERT installed a 2.5 lakhs kCal (Kilocalories) capacity coconut shell-based gasifier at Thiruvampady, Kozhikode for drying copra with MNRE assistance and beneficiary share. The struggling coir industry can be linked to this, and it can have a beneficial impact for the women employed in the coir industry.
- The physicochemical technology involves various processes to improve physical and chemical properties of solid waste. The combustible fraction of the waste is converted into high-energy fuel pellets, which may be used in steam generation. Fuel pellets have several distinct advantages over coal and wood because it is cleaner, free from incombustibles, has lower ash and moisture contents, is of uniform size, cost-effective and eco-friendly.

A range of bio-based chemicals: These chemicals can be sold to a wide variety of end use markets. Wood chips are an option. Given Kerala's rich forest resources, this may be used as a potential source of energy.

18.5.5.16.4 **Energy from plastic waste:** Waste plastics are becoming a major stream in solid waste. After food and paper waste, plastic waste is the third major constituent of municipal and industrial

waste in cities. This increase has turned into a major challenge for local authorities responsible for solid waste management and sanitation. Plastic waste recycling can provide an opportunity to collect and dispose plastic waste in the most environment friendly way, and it can be converted into energy. Some of the developed countries have already established commercial-level energy conversion recovery from waste plastic. Kerala can learn from these experiences and the technology available to them. It will require assessment and selection of environmentally sound technologies (EST) suitable for local conditions. Some international agencies such as the United Nations Environment Programme (UNEP) have started integrated programmes on such technologies, which can help policymakers explore these possibilities. More important, these technologies can be identified, transferred and adapted to local conditions.

18.5.5.16.5 **Hybrid energy:** Hybrid energy systems, especially for hilly areas, can be explored. According to a study, in a farming village in the Western Ghats of Kerala, a community of 120 families with a population of 600 gets its electricity from a community-based diesel generator that supplies power to about 35 per cent of the population.[27] The generator operates six hours a day during peak hours. Individuals have their own independent diesel units for typical household applications. With that set-up, approximately 40 per cent of the population is deprived of electricity. This study observes that a micro-hydro/wind hybrid energy system is the optimal combination for the rural community. This will provide 24-hour electricity supply to every household in the village at a unit cost of Rs 6.5/ kWh. Another study finds a hybrid energy system useful for remote villages in Uttarakhand. This is an avenue that may be explored in Kerala for its remote villages. However, all these modelling methods need to be evaluated for Kerala. Most of these exercises are theoretical. Nonetheless, they provide some guidance to practical approaches.

Encourage captive power

18.5.5.17 Captive power projects can be encouraged for large industries in Kerala through public-private partnerships. Again, it should be explored whether a portion of this can come from renewable energy sources. Nevertheless, given the low level of HT (high tension) consumption in the State, the amount of electricity displaced by captive power will be limited. In addition, this segment of consumers pay the highest tariff amongst all consumers. And with this segment moving towards captive generation, the ability of KSEB to cross subsidise will be even more limited. Ernakulam, with its massive natural resources, should definitely explore this idea. Kerala State Industrial Development Corporation (KSIDC) is starting the first stage of preparing feasibility reports for captive power projects in three of its industrial areas in Valiyavelicham, Kannur; Kinalur, Kozhikode; and Cherthala, Alappuzha.

Transmission

18.5.5.18 Generation is only the first part of the value chain process in the supply of power. The main challenge in transmission is land acquisition. Kerala's connectivity with the National Grid is constrained due to land acquisition issues. There are several suggestions:

- Land acquisition issues have been extensively discussed in Chapter 13 on Land. Rehabilitation and resettlement have to be a part of any package.
- Underground cables through forests are the best option, but may be prohibitively expensive. If overhead cables are the only option, then rehabilitation of forests is a must. Given that the Western Ghats is such a sensitive ecological zone, the impact has to be carefully analysed. Knowledge generation in this area is needed, with synergy between the departments of forests, power and biodiversity.

- Kerala is on India's west coast. The State can connect to its northern neighbours on the west coast through submarine power cables.[28] This may overcome land acquisition or forestry issues. The technology exists, but it may be expensive. Kerala needs to generate knowledge or at least explore this option such that costs may come down over time and accessing the National Grid becomes relatively cheap.
- Within the State, depending on geography and relative urbanisation, laying underground cables may be a good idea. Even if it is costly in the short term, the long-term benefits may be higher.

Distribution

18.5.5.19 Along with the 'smart grid', Kerala needs 'advanced distribution automation'.[29] This is a lofty goal considering that the US, one of the more advanced countries, is also working towards it. However, the vision should be there and steps should be taken so that this can be achieved over the long term.

Pillar 3: Demand-side management

18.5.5.20 Pricing strategies

- While load shedding is one mechanism for ensuring that consumers pay the price for electricity and are not subsidised, it is not effective due to the widespread use of invertors and generators.
- Price may be a more effective mechanism in moderating demand. Other pricing options can be examined for domestic consumers since they are the largest group that consume electricity in Kerala. As pointed out earlier, Kerala charges the lowest price among the Southern states for this category of consumers.
- There should be an exploration of what the consumer is willing to pay for 24/7 electricity. This will also encourage research in the area of electricity and power and increase the knowledge base.
- While charging market prices to everybody, direct cash subsidies may be given to the bottom deciles. Typically, a slab system is used in the electricity sector, which may be designed to address this issue.
- A 'green power fund' can be created by imposing a cess on electricity charges. Alternatively, they can also be tied to the Kerala Energy Conservation Fund. This fund can then be used to explore renewable energy sources or conservation of energy. Even while the government makes this compulsory, there can be a provision for voluntary contributions, which may make consumers more conscious. It can be tried as a pilot project in urban areas only.
- Industry and commercial: Pricing mechanisms have to be developed for industrial and commercial users, with additional incentives for development and usage of renewable energy.

Energy efficiency strategies

18.5.5.21 In this particular arena, Kerala should strive to be a leader especially in the buildings sector and set an example, not only other states in India, but also for the rest of the world. The energy efficiency strategies adopted in various sectors are:

18.5.5.21.1 **Lighting:** The Bureau of Energy Efficiency (BEE) has a programme called the 'Bachat Lamp Yojana' (BLY). Under this scheme, a good-quality long-life compact fluorescent lamp (CFL) is distributed to grid-connected residential households in exchange for an incandescent lamp and Rs 15. At the all India level, there are no mandatory requirements to adopt CFL. Kerala may be the first state to make it mandatory, especially for residences that use a certain minimum level of energy. It is also necessary to educate people about this.

18.5.5.21.2 **Buildings:**

- It is imperative that buildings are constructed in a manner that saves energy. The Energy Conservation Building Code (ECBC) was launched in 2007 and the status update from BEE shows that Kerala has done little in this direction. Gujarat has taken major initiatives in this area and Kerala needs to follow it.
- The EMC audited 22 government buildings that were chosen to be part of the Investment Grade Energy Audit (IGEA) under the nationwide programme of the BEE. The energy audits were conducted in 2008−09. The major savings identified were in lighting, air-conditioning and electrical distribution systems. Several measures such as retrofitting with T5 lamps, replacement of incandescent lamps, retrofitting with electronic regulators, providing variable frequency drives, power factor improvement and so on were identified. The total savings to be achieved in all these 22 buildings were nearly 18 per cent of the present level of energy consumption and a payback of less than 1.5 years was envisaged for the energy saving project investment.[30] Clearly, energy audits should be conducted regularly on all buildings and recommendations strictly implemented, even in government buildings, with fines for violations. Awards, either in the form of tax credits or public recognition, should be used to reward departments/offices/buildings that implement these codes, which will induce a competitive spirit and lead to the adoption of these practices.
- EMC recommendations:
  New Buildings
  - o Implementation of Energy Conservation Building Code
  - o All new buildings should be net zero energy buildings

  Old Buildings
  2015
  - o 25 per cent of all buildings to be energy star rated
  - o 50 per cent of the energy needs of 25 per cent of residential buildings to be met from renewable energy

  2018
  - o 5 per cent of all buildings to be net zero energy buildings

  2020
  - o 50 per cent energy intensity reduction of buildings
  - o 25 per cent of all buildings to be net zero energy buildings
  - o 50 per cent of government buildings will be carbon neutral buildings
- **Green buildings:** Making a green building is an integrated design process. For example, interrelationships between the building site, site features, the path of the sun and the location and orientation of the building and elements such as windows and external shading devices have a significant impact on the quality and effectiveness of natural day lighting. Similarly, roofing and walling have a significant impact on the absorption of electricity and resource use. These elements also affect direct solar loads and overall energy performance for the life of the building. Without considering these issues early in the design process, the design is not fully optimised and the result is likely to be a very inefficient building. There are five elements to a green building project:
  - o Sustainable site design
  - o Water quality and conservation
  - o Energy and environment
  - o Indoor environmental quality
  - o Minimising the use of non-renewable construction material

- India follows the LEED (Leadership in Energy and Environment Design) assessment system. The EMC can develop a 'green building code', which then will be implemented in Kerala as soon as possible. The code should be reviewed every three years. The code will be implemented in both domestic and commercial buildings, especially since construction is a driver of Kerala's economy and buildings do consume a lot of electricity. Plus, given the vision of a knowledge intensive economy, all new buildings must be required to follow green building codes, even industrial estates, schools, colleges, hospitals, hotels, airports and railway stations. All new housing complexes or houses above a certain area should attempt to use renewable energy. Net zero emissions of carbon should be the ultimate benchmark that must be followed. Several SEZs, industrial parks and technology parks are already based on green building concepts.

18.5.5.21.3 **Appliances:** These are selected for labelling by the BEE. It is compulsory to label frost-free refrigerators, TFL, AC and transformation distributors. Appliances where labelling is voluntary include direct cool refrigerators, general purpose industrial motors, moonset pumps, open well pump sets, submersible pump sets, ceiling fans, domestic gas stoves, stationary storage type water heaters, colour televisions and washing machines. Clearly, labelling should be made compulsory for all appliances and consumers should be encouraged to buy these appliances. Service tax reductions can be offered to people who buy energy labelled products, with higher deductions for products with higher energy stars.

- **Agriculture:** The energy audit of all pumps will be carried out and farmers will then get BEE star-labelled pumps and motors free of cost.
- **Municipalities:** Motion-sensitive street lighting systems can bring down energy costs in an increasingly urbanised situation. Box 18.3 shows successful energy management of street lighting in Maharashtra. Solar LED street lights may make a lot of sense for Kerala. The BEE has done a comprehensive study on street lights where they show how street light poles can be mounted, dimming systems installed, operations and maintenance and so on, which can be implemented in Kerala.
- The BEE has discussed energy efficiency in small and medium enterprises. They are given subsidies to improve energy efficiency. It also lists energy saving equipment that such businesses can use.
- In Kerala, tourism is a major contributor to GDP and the State has a large hospitality sector. Kerala can adopt energy saving practices in the tourism sector. It has adopted Responsible Tourism, but more needs to be done. For instance, rationalising the use of air-conditioners in hotels and guesthouses that are not five-star and conservation of water and energy by offering laundry and cleaning services only on demand are options that can be considered.
- Energy intensity also needs to be brought down to 1 by the end of the year.
- An integrated inter-modal transport system is needed to bring down demand for petrol and diesel.

Box No 18.3

Street lighting in Maharashtra

Case Studies

Akola Municipal Corporation, India: T5 Lamps Yield Payback of Less than One Year

In Akola Municipal Corporation (AMC), an Urban Local Body in the state of Maharashtra, more than 11,500 conventional street lights (standard fluorescent, mercury vapor, and sodium vapor) were replaced with efficient, T5 fluorescent tube lamps. The project, which was implemented using an energy savings performance contracting approach, has resulted in energy savings of 2.1 million kWh per year – a 56% reduction in the ULB's energy use for street lighting. These energy savings have resulted in cost savings of about INR 6.4 million per year, and the project paid for itself in only 11 months. The project's success has already led to the implementation of similar projects in Maharashtra and Madhya Pradesh. (ESMAP 2009)

Source: http://beeindia.in/schemes/documents/ecbc/eco3/DSM/Energy%20Efficient%20Street%20Lighting%20Guidelines.pdf.

18.6 Monitoring

18.6.1 Kerala should develop a detailed database for monitoring progress in the electrical energy sector. The recommended list of indicators adapted from the European Commission is given:

- Energy statistics — main indicators[31]
  - o Market share of the largest generator in the electricity market
  - o Energy intensity of the economy
  - o Electricity generated from renewable sources — annual data
  - o Primary energy consumption savings in per cent — annual data
  - o Primary energy consumption — annual data
  - o Supply of electricity — monthly data
- Energy statistics — quantities, annual and monthly data
  - o Energy statistics — supply, transformation, consumption
    - Supply, transformation, consumption — all products, annual and monthly data
    - Supply, transformation, consumption — solid fuels, annual and monthly data
    - Supply, transformation, consumption — oil, annual and monthly data
    - Supply, transformation, consumption — gas, annual and monthly data
    - Supply, transformation, consumption — electricity, annual and monthly data
    - Supply, transformation, consumption — renewables and wastes (total, solar heat, biomass, waste), annual and monthly data
    - Supply, transformation, consumption — renewables (hydro, wind, photovoltaic), annual and monthly data
    - Supply, transformation, consumption — renewables (biofuels), annual and monthly data
- Energy statistics — infrastructure
  - o Infrastructure — electricity, annual data

- Energy statistics — imports (by state of origin)
  - o Imports (by state of origin) — all products, annual and monthly data
  - o Imports (by state of origin) — solid fuels, annual and monthly data
  - o Imports (by state of origin) — oil, annual and monthly data
  - o Imports (by state of origin) — gas, annual and monthly data
  - o Imports (by state of origin) — electricity, annual and monthly data
- Energy statistics — exports (by country of destination)
  - o Exports (by state of destination) — electricity, annual data
- Energy statistics — gas and electricity prices
  - o Gas — domestic consumers - bi-annual prices
  - o Gas — industrial consumers - bi-annual prices
  - o Electricity — domestic consumers - bi-annual prices
  - o Electricity — industrial consumers - bi-annual prices

18.7 Conclusion

18.7.1 Kerala has succeeded in providing electricity to a majority of its households. However, the 2012 monsoon has exposed the State's vulnerabilities. Kerala is an energy deficient state and will remain so till 2025 if it is 'business as usual' under the optimistic supply side scenario. Kerala will have to expand its electricity generation capacity on a continuous basis. Further, it needs to develop a portfolio of energy options on the supply side. It is necessary to increase the share of non-hydro renewable energy as much as economically feasible, while developing hydel generation as well. There is a need for continuous research, both on technology and the marketing side. Pricing schemes should be experimented with. Further, buildings, street lighting, hospitals and industries should be examined through the lens of energy conservation. Where possible, captive power sources can be set up with renewable energy, which can then, perhaps, be linked to the grid. In a dynamic environment, innovation is the key to ensuring energy security.

Appendix 18A.1: Electrical Energy Supply Infrastructure

From the CEA statistics, it is known that 897.2MW is going to come from coal and 359.58 MW from gas. Assuming 91.88 per cent PLF (from the Andhra Pradesh CEA statistics) for coal and 51 per cent for gas, the total MU from the central sector is estimated to be 8,680. Since this remains the same and there is no increase, this is added to the State's generation. The energy deficit disappears around 2020−21 using the total supply including the central sector and demand projections from the 18th EPS.

Table A18.1
12th PLAN PROJECTS: Installed Capacity in MW

Sl No	Name of Project	Annual Gen. in MU	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
			MW				
ONGOING HYDEL PROJECTS							
1	Pallivasal Extension	153.9				60	
2	Thottiyar	99				40	
3	Sengulam Augmentation	85.00					
4	Vilangad SHP	23.63		7.5			
5	Chathankottunada II	14.76		6			
6	Barapole	36.00		15			
7	Peechi	3.21	1.25				
8	Chimmony	6.70		2.5			
9	Kakkayam	10.39		3			
10	Poringalkuthu SHEP	45.02			24		
11	Perumthenaruvi	25.77		6			
12	Anakkayam	22.83				7.5	
13	Vellathooval SHEP	12.17			3.6		
14	Adyanpara SHEP	9.01			3.5		
	Sub-total	547.39	1.25	40.00	31.10	107.50	0.00
NEW HYDEL SCHEMES							
1	Chinnar	76.45					24
2	Upper Kallar	5.14			2		
3	Olikkal	10.18				4.5	
4	Poovaramthode	5.88				2.7	
5	Chembukadavu III	14.92				6	
6	Peruvannamuzhi	24.70					6
7	PazhassiSagar	42.14					15
8	Peechad	3.74				4	
9	Western Kallar	17.41					5
10	Marmala	20.25					7
11	Ladrum	12.13				3.5	

12	Chathankottunada I	7.98					3.5
13	Thumboormuzhi	19.77					7
14	Upper Sengulam	59.20					24
	Sub Total (ii)	260.69					
Grand Total 12th Plan Projects		1.25	40	33.1	28.2	91.5	

Hydel Schemes starting in 12th plan and completing in 13th plan

Sl No	Name of Project	Annual Gen. in MU	2017-18	2018-19	2019-20	2020-21	2021-22
			MW				
1	Maripuzha	10.85				5.00	
2	Valanthode	17.67	8.00				
3	Kakkadampoil I	55.00					20.00
4	Kakkadampoil II	15.00					5.00
5	Penki						3.00
6	Anakkampoil	22.00		7.50			
7	Thoniyar	6.57			4.00		
8	Thommankuthu	6.02		4.50			
9	Meloram	15.89				3.60	
10	Narangathode					9.00	
11	Poringalkuthu II SHEP			24.00			
12	Palchuram II				6.00		
13	Palchuram III	13.66					3.75
14	Moorikkadavu	5.92			2.00		
Total			8	36	12	17.6	31.75

Source: KSEB

Table A18.2
Contracted Power in Various Inter-state Generation Projects

Project	MW	State	Type	Date of Commis-sioning	Comments
Kudankulam	266	Tamil Nadu	Nuclear	1st unit - 133 MW, 2nd unit 2014-15	
NLC Expansion	70	Tamil Nadu	Lignite	2014-15	
NLC New	32.38	Tamil Nadu	Lignite	2018-19	
NLC Stage 1 Expansion	58.8	Tamil Nadu	Lignite	2018-19	
Tuticorn	122	Tamil Nadu	Coal	2014-15	
Cheenmeni			Coal		Uncertain
Kudgi	600	Karnataka	Coal	2016-17	
Pudimadaka	400	Andhra Pradesh	Coal	2018-19	Uncomfortable

Damodar Sanjeevani	100	Andhra Pradesh	Coal	2014-15	
Maithon	150	Tata, Jharkhand	Coal	2016-17	Evacuation lines are not there
Kalpakam	40	Tamil Nadu	Nuclear	2014-15	fuel problems
UMPP					
Cheyyore	300	Tamil Nadu	Coal	2019-2020	
AP	75		Coal		Uncomfortable
Odisha	190		Coal		Uncomfortable
Brahmapuram	400		Gas	2018-19	Uncomfortable
RGCCPP Expansion	1050		Gas		Uncomfortable
Petronet	1200		Gas	2018-19	Uncomfortable

Source: KSEB

Additionally there is the Petcoke project, which is expected to be commissioned in 2017−18.

Appendix A.18.2: Examples of Capacity Development

Box No A 18.1

Examples of Degrees in Energy Management: Germany and the US

The Science, Innovation and Technology Policy along with the dynamic education sector will converge to ensure an environment where technological inventions in the energy industry happen in Kerala itself. This will further establish Kerala as an energy education hub, which will attract students from all over the country and the world (Box A.18.1 shows an example of a M.S. degree in Global Energy Management in the University of Colorado, Denver).

Global Energy Management MS, University of Colorado, Denver, the US

The Master of Science in global energy management (GEM) prepares individuals for leadership careers in the energy industry. This degree is particularly appropriate for individuals seeking to advance their existing careers in the energy field. Prior work experience within the field is preferred, but not required. The programme consists of two components: the core curriculum and the more advanced and specialised elective courses. The MS GEM programme requires the completion of the following core classes as well as four elective courses from the selection listed below.

Required Courses

- GEMM 6000 - 21st Century Global Energy Issues and Realities.
- GEMM 6100 - Global Energy Economics and Geography.
- GEMM 6200 - Environmental, Regulatory, Legal & Political Environment in the Energy Industry.
- GEMM 6300 - Renewable and Alternative Energy: Opportunities & Challenges.
- GEMM 6400 - Leadership and Decision Making in the Global Energy Environment.
- GEMM 6500 - Energy Accounting in Global Markets.
- GEMM 6600 - Financial Management and Hedging in the Global Energy Markets.
- GEMM 6410 - People Management in the Global Energy Environment.

Elective Courses: Choose four of the following courses.

- GEMM 6210 - Land Management and Energy Contracts.
- GEMM 6430 - Organisational Behaviour in the Energy Industry.
- GEMM 6450 - Strategic Management of the Energy Industry.
- GEMM 6460 - Integrated Information Management for Energy Firms.
- GEMM 6470 - Energy Marketing.
- GEMM 6610 - Advanced Financial Management in the Energy Industry.
- GEMM 6620 - Energy Asset Management.
- GEMM 6630 - Production and Supply Chain Management for the Energy Industry.

M.Sc. Renewable Energy Management (REM), Albert-Ludwigs-Universität Freiburg, Germany

The M.Sc. REM programme is designed to close the strategic gap between the technical aspects of renewable energy and the vision of sustainable development.

The course is not composed deductively from existing university structures and study programmes, but inductively from analysis of the potential, international employment market and the qualifications it requires. Providing pivotal management skills for practical business purposes, the REM programme offers application-oriented specialisations in four different fields of renewable energy: solar energy, geothermal energy, biomass or energy efficiency.

Graduates will have the ability to plan projects and facilities for the utilisation of renewable energy and to implement them while taking account of economic, political and societal concerns. Thus, the curriculum is designed to enable unique career prospects in the vocational fields of planning, engineering, consultancy and investment of renewable energy.

Faculties and Partners
The M.Sc. REM programme is organised in cooperation with the Faculty of Forest and Environmental Sciences. Six other Faculties of Freiburg University and four external partners are involved. The partners include Forest Research Institute Baden-Württemberg, Fraunhofer Institute for Solar Energy Systems, Offenburg University of Applied Sciences, Öko-Institute.V. (Institute for Applied Ecology) and Endowed Chair of Wind Energy (SWE).

Sources:http://catalog.ucdenver.edu/preview_program.php?catoid=1&poid=850&returnto=59 and http://www.zee-uni-freiburg.de/index.php?id=37

Appendix A18.3 Assessed Renewable Energy Potential of the State

Technology	Supply Potential (2050)	Remarks
Electricity	Billion Units	MW (Capacity Utilisation Factor)
Grid Tied Solar PV (Wasteland)	5.99	4,273 (16%)
Grid Tied Solar PV (Grassland)	3.56	2,543 (16%)
Floating PV Panels	5.39	3,845 (16%)
Rooftop PV (Domestic)	18.33	13,079 (16%)
Rooftop PV (Institutional)	25.32	18,066 (16%)

Solar Water Pumping		304 (400 hours)
Onshore Wind (Farmland) (WPD>200)	5.98	3,103 (22%)
Onshore Wind (No Farmland) (WPD>300)	0.86	447 (22%)
Onshore Wind (Plantations) (WPD>200)	8.60	4,465 (22%)
Offshore Wind (WPD>250)	29.4	13,447 (25%)
Biomass Gasification	0.21	37.2 (65%)
Biomass Combustion	0.62	101 (70%)
Existing Hydro (Large and Small)	11.2	1,998 (65%)
Small Hydro	2.55	583 (50%)
Wave	0.37	420 (10%)
Total	107	

Source: WWF-India and WISE. 2013. The Energy Report- Kerala: 100% Renewable Energy by 2050

Reference

1 *Kerala State Electricity Board Website.www.kseb.in.*

2 *Kerala Government Portal. http://www.kerala.gov.in/docs/pdf/kspifc.pdf.*

3 *Kerala State Electricity and Regulatory Commission Website. http://www.erckerala.org/commission.aspx.*

4 *Energy Management Centre Website. http://www.keralaenergy.gov.in/pdf/Organisation_function.pdf.*

5 *Agency for Non-conventional Energy and Rural Technology Website. http://anert.gov.in/index.php/citichart.*

6 *Kerala Government Portal. http://www.kerala.gov.in/docs/pdf/cei.pdf.*

7 *Central Electricity Authority (CEA), Ministry of Power, Government of India. 2012. All India Electricity Statistics: General Review. July.*

8 *The Annual Status of Education Report (ASER) 2012 survey is a sampling study undertaken in all the rural districts of India. The survey is designed to be a household survey. Within each district, 30 villages are randomly chosen and in each village, 20 households are randomly picked for a total of 600 households per district. For Kerala, the ASER 2012 reports that 97.2 per cent of households had electricity and 95.5 per cent of households interviewed had electricity on the day of the interview which indicates that the quality matches quantity in delivery of electricity in rural areas. The corresponding numbers for India are 74.5 per cent and 65.7 per cent, respectively.*
ASER. 2013. Annual Status of Education Report (Rural) 2012. ASER Centre, New Delhi.

9 *The CEA (2012) also shows that energy consumed per thousand population in Kerala is 4,36,555 kWh, which is the smallest among the four southern states. Energy consumed per square kilometre is 3,87,238 kWh, which is higher than Andhra Pradesh (2,62,879 (kWh) and Karnataka (2,25,395 kWh) but lower than Tamil Nadu (5,26,240 kWh).*
Central Electricity Authority (CEA), Ministry of Power, Government of India. 2012. All India Electricity Statistics: General Review 2012 (Containing data for the year 2010−11). July.

10 *Planning Commission, Government of India. Twelfth Five Year Plan 2012−17. http://planningcommission.nic.in/plans/planrel/fiveyr/welcome.html.*

[11] *Using the 2006–07 current GSDP numbers of Kerala, the Indian conversion rate and the total energy consumption of Kerala (includes electrical energy and consumption of petroleum products), we derive the corresponding energy use of Kerala. It was 35.96 in 2006. The corresponding number for India was 206 in 2006. Kerala's energy use is really low in comparison to the rest of the world.*

[12] *Energy Community website. http://energycommunity.org/WebHelpPro/Demand/Final_Energy_Intensity.htm.*

[13] *Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram.*

[14] *Using the Economic Review 2012 data, one finds that the share of hydel power in the total available power went down from 49.4 per cent in 2007−08 to 39.4 per cent in 2009−10 and then increased to around 44 per cent for both 2010−11 and 2011−12.*

[15] *The CEA statistics show that there was a 5 per cent deficit in 2011−12 in meeting peak demand in Kerala. Still that was the lowest compared to other states – Andhra Pradesh, 6.34 per cent, Karnataka, 7.3 per cent and Tamil Nadu, 11.02 per cent.*
Central Electricity Authority (CEA), Ministry of Power, Government of India.2012 and previous reports. All India Electricity Statistics: General Review. July.

[16] *Planning Board. 2013. Kerala Economic Review 2012. Government of Kerala, Thiruvananthapuram.*

[17] *Planning Commission data from 2011−12 data show that all states are subsidising the domestic and irrigation sectors.*

[18] *Central Statistical Office, Ministry of Statistics and Programme Implementation, Government of India. 2013. Energy Statistics 2013. New Delhi. March.*

[19] *Bureau of Energy Efficiency Web site. http://bee-dsm.in/Tools_3.aspx.*

[20] *Planning Commission, Government of India. Twelfth Five Year Plan 2012−17. http://planningcommission.nic.in/plans/planrel/fiveyr/welcome.html.*

[21] *Power Grid Website.*

[22] *Cerasuolom, M. 2013. Grid-Tied Vs. Grid-Interactive Photovoltaic Arrays. Solar Industry. http://www.solarindustrymag.com/e107_plugins/content/content.php?content.12007. 1(1).Feburary 14. http://www.solarindustrymag.com/e107_plugins/content/content.php?content.12007*

[23] *Ministry of Power, Government of Kerala. 2012. http://www.kerala.gov.in/docs/pdf/3942_12.pdf.*

[24] *Two options of Tidal Energy and Pumped Hydro Storage are not mentioned because they are considered commercially unviable for Kerala. Tidal energy plant is not advisable for Kerala due to geographic limitations. The Pumped Hydro Storage is relevant only if the generating station is near the primary reservoir and the turbine is not running continuously due to limitation of available water shortage. This process is deemed as inefficient and uneconomical especially when one considers the power losses in pump, turbine, penstock, alternator etc. involved in the operation, which amounts to more than 50 per cent.*

[25] *Power Grid Corporation of India Ltd. 2012. "Transmission Plan for Envisaged Renewable Capacity, A Report, Vol. 1". July. Accessed January 1, 2013.*

[26] *www.anert.gov.in.*

[27] *Ashok, S. 2007. "Optimised model for community-based hybrid energy system". Renewable Energy. 32. 1155–1164.*

[28] *International Cable Protection Committee. http://www.iscpc.org/publications/About_SubPower_Cables_2011.pdf.*

[29] *Day, R. 2013. Smart Grid and Advanced Distribution Automation: How Advanced Distribution Automation can become a Reality for any Utility. A TRC White Paper.*

[30] *Energy Management Centre, Department of Power, Government of Kerala. 2010. "Investment Grade Energy Audit in Government Buildings in Kerala". http://www.keralaenergy.gov.in.*

[31] *http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database.*

Chapter 19

WATER SUSTAINABILITY: RECOVER, RECYCLE AND REUSE

Chapter 19

Water Sustainability: Recover, Recycle And Reuse

19.1 Background

19.1.1 The water situation in Kerala is marked by contrasts. On the one hand, Kerala has plenty of rivers, lakes, ponds and brackish water bodies and receives two monsoons, but on the other hand, it is a water-stressed state with poor water availability per capita.

19.1.2 Kerala has 44 rivers, though none of them are major rivers and only four are classified as medium rivers. All these rivers are rain-fed (unlike rivers in North India that originate in the glaciers), which means that Kerala is heavily dependent on the monsoon. Fortunately, Kerala receives two monsoons — one from the south west and the other from the north east distributed between June and December — except in the northern districts of Kannur and Kasaragod where the rainfall is dominantly uni-modal. Two-thirds of the rainfall occurs during the south west monsoon from June to September.

19.1.3 The water availability per capita in Kerala is one of the lowest in the country and has been declining over time. Part of the problem is the geography of the State. A distinctive feature of the rivers flowing across Kerala is their short length and the difference in elevation between the high and low lands, which causes the rapid flow of water that is then quickly discharged into the sea.[1] Therefore, the State has not been able to utilise its river water sources to a major extent. The major portion of the run-off through the rivers takes place during the monsoon seasons. The high intensity rainfall occurring during a short span of time, leads to soil and water erosion, along with occasional landslides in the hills and floods in low-lying land.

19.1.4 Although Kerala has low groundwater potential because of its geography, most of its domestic and agricultural needs are met only by groundwater. Kerala has the highest density of wells in India.[2] The concern is that indiscriminate use of groundwater without proper monitoring and management has translated into declining groundwater tables. The goal for Kerala over the next 20 years is to be water secure. The State should be able to supply treatable drinking water and provide sanitation facilities to its entire population. All this should be achieved while maintaining the delicate ecological balance between development and the environment.

19.2. Institutions

19.2.1 The Department of Water Resources is the nodal department in the State to manage water. The departments and organisations concerned with managing the water sector in the State and some institutional mechanisms are:

- Centre for Water Resource Development and Management: This is an autonomous body for the research and development needs of water management in Kerala.
- Kerala Water Authority: It was established on 1 April 1984 as an autonomous body of the Government of Kerala by converting the Public Health Engineering Department. It manages the development and regulation of water supply and wastewater collection and disposal in the Kerala.

- Jalanidhi: Is Kerala's rural water supply and sanitation agency.
- Department of Irrigation: Command Area Development Authority (CADA) looks after major and medium irrigation projects in Kerala and areas beyond the catchment area.
- Groundwater Department: Handles the development of groundwater.
- Coastal Shipping and Inland Navigation: Looks after inland water transport.

19.2.2 The Kerala Irrigation and Water Conservation Act (2003) consolidates and amends laws relating to the construction of irrigation works, conservation and distribution of water for irrigation and levy of betterment contribution and water cess on lands that benefit from irrigation projects. It provides for the involvement of farmers in managing the water utilisation system.[3]

19.2.3 The Kerala Ground Water (Control and Regulation) Act, 2002 provides for the conservation of groundwater and for the regulation and control of its extraction and use in Kerala.[4]

19.3 Situation Analysis

19.3.1 Water resources in Kerala (Supply)

19.3.1.1 Estimates of the water availability in Kerala have been prepared by several agencies and often do not converge. The only comprehensive source of all water resources in Kerala (Appendix A.19.1) is unreliable as per discussions with state government officials. This is a serious lacuna, which needs to be addressed. As per the estimates of the state Public Works Department (1974), all 44 rivers together yield 77. 9 billion cubic meters (bcm) of water, of which about 70.2 bcm is available in the State, with a total utilisable water yield of 42.7 bcm. The rest of the water is lost as run-off. Table 16.1 provides the water scenario in Kerala and a comparison with the all-India situation. Alternative estimates by the State Development Report 2008 say that the total amount of utilisable water resources in the State is 50 bcm per year, with the surface and groundwater contributions being approximately 42.7 and 5 bcm/year, respectively.[5]

Table.19.1
Water Resources of Kerala as Compared to India

Parameters	Kerala	India
Geographical area (square km)	38,863	32,87,732
Population 2001 Census (million)	33.39	1210.19
Total rainfall and snowfall (bcm, 2003)	88.45	4057.35
Surface and replenishable ground water (bcm)	70.17	1,869
Water that can be put to beneficial use (bcm)	42.67	1122
Of which: surface flow (bcm)	34.77	690
Replenishable ground flow (bcm)	7.90	432
% total water that can be put to beneficial use	60.82	60.03
Per capita annual availability of utilisable water (m^3)	1,248	927

Source: Lathika, M. 2010. Water Management for Irrigation in Kerala, Economic and Political Weekly..XLV (30):73−80. July 24, modified by the author

19.3.1.2 Although the per capita annual availability of water appears to be higher for the State, there are apprehensions that these estimates are higher than the actual availability. This is because about 10 per cent of the total precipitation is stored in reservoirs and about 7.9 bcm is used for

groundwater recharge, thereby reducing the surface run-off to 41 bcm. Also, in order to sustain rivers and ecosystems, the water flow should be at least 40 per cent. After accounting for all these, the utilisable surface water is reduced to about 24.5 bcm. An equally disquieting fact is the decline in per capita water availability over the years (Table 19.2).

Table.19.2
Trends in Per Capita Availability of Water in Kerala

Year	Population (crore)	Per capita water availability (litre/day)			
		Rain	Surface water	Groundwa-ter	Total
1901	0.64	49,609	6,556	3,095	59,260
1911	0.71	44,718	5,909	2,790	53,417
1921	0.78	40,705	5,379	2,539	48,623
1931	0.95	33,421	4,416	2,085	39,922
1941	1.10	28,863	3,814	1,801	34,478
1951	1.35	23,518	3,108	1,467	28,093
1961	1.69	18,786	2,482	1,172	22,440
1971	2.13	14,906	1,969	930	17,805
1981	2.45	12,500	1,672	780	14,952
1991	2.95	10,762	1,422	672	12,856
2001	3.36	9,450	1,022	590	11,062

Source: Devi, I. P. 2012. Micro-irrigation: Economics and outreach in Kerala. In K. Palanisami, S. Raman and K. Mohan (Eds.), Micro- Irrigation: Economics and Outreach. Delhi: Macmillan

19.3.1.3 It is worth noting that the entire water supply — surface water, utilisable groundwater and storage in reservoirs — in any given year depends solely on rainfall. The seasonal and spatial variation in rainfall is high. Although the highest incidence of rainfall occurs in north Kerala, the effective rainfall amenable for storage is higher in the southern parts, due to more even distribution. This highlights the importance of water storage structures for the State. Another issue that has not attracted the attention it deserves is the need for proper drainage systems. Given the undulating topography, intense rainfall and high rate of run-off, several localities in the low-lying regions accumulate water, which necessitates a system for proper drainage.

19.3.2.1 Rainfall

Changing rainfall patterns

19.3.2.1.1 The main source of water in Kerala is rainfall, which has undergone a change. In 18 years, Kerala suffered a deficit in 14 years (Table 19.3). Further, Krishnakumar, Rao and Gopakumar (2009), based on the analysis of rainfall in Kerala between 1871 and 2005,[6] noted that a significant decrease in rainfall has occurred in June and July with an increasing trend in January, February and April. Post-monsoon rainfall has also increased

Table.19.3
Per cent Departure of Rainfall from Normal in Kerala: 1990 to 2008

Year	Annual	South-West Monsoon	North-East Monsoon
1990	−28	−25	−4
1991	−39	18	−21
1992	−37	15	35
1993	−8	−12	32
1994	11	15	13
1995	−6	−6	−22
1996	−13	−8	2
1997	3	6	31
1998	0	2	30
1999	−8	−25	23
2000	−21	−18	−27
2001	−6	−13	0
2002	−14	−33	32
2003	−14	−24	5
2004	−3	−19	12
2005	0	−2	2
2006	−2	−7	22
2007	20	27	−5
2008	−20	−22	−11

Source: State Planning Board via indiastat.com

Seasonal variation in rainfall

19.3.2.1.2 Latika (2010) analysed the average seasonal rainfall for the State as well as for India over 135 years; she found that the rainfall is characterised by higher variability during all seasons and at the aggregate level, compared to that noted for the all-India level.

Table.19.4
Rainfall in Kerala and its Distribution Across Seasons (mm)

Season	Seasonal rainfall		Monthly rainfall	
	Kerala	India	Kerala	India
Kharif	2,168	901	434	181
Rabi	491	132	123	33
Others	164	54	55	18
Total	2,822	1,088	236	91

Source: Lathika, M. 2010. Water management for irrigation in Kerala, Economic and Political Weekly, July 24, Vol XLV (30):73−80, modified by the author

Spatial variation in rainfall in Kerala

19.3.2.1.3 The rainfall pattern in Kerala also has a spatial dimension that is characterised by large inter-district variation. "The Western Ghats region of Wayanad district receives rainfall higher than the State average (about 3,588 mm), whereas it is only 2,329 mm in Palakkad district. The regions such as Attapady in Palakkad district receive rainfall less than 1,000 mm."[7] A gradual decline in rainfall is noted in the State and is more pronounced in the northern districts.

Retention capacity

19.3.2.1.4 Although rainfall is high in Kerala, water cannot be conserved effectively due to the poor retention capacity of the soil (notably of the dominant laterite and red soils), relatively high surface slope and high degree of land degradation. The thick forest cover and vegetation that characterised the State had facilitated relatively high percolation of rainwater, but the situation is rapidly changing due to large-scale encroachment of forest land, destruction of forests, reclamation of natural ecosystem buffers such as ponds, wetlands and paddy fields and changes in the cropping pattern. The conversion of vast stretches of cultivated land for non-agricultural purposes such as dwellings and roads and the increasing imperviousness of the soil because of the construction of concrete courtyards, pavements and so on exacerbate the problem.

19.3.2.2 Surface water

Rivers, private water resources and reservoirs dominate supply of water

19.3.2.2.1 In Kerala, the surface water consists of fresh water as well as brackish water, which is a mixture of fresh water and saline water. Available data, though limited, shows that surface water forms the highest share of utilisable water in Kerala. Estimates for utilisation of water range from 34.7 to 42 bcm per year. The State Development Report 2008 says that the majority of rivers suffer from saltwater intrusion, especially during the summer months, with seawater reaching up to about 26 km upstream of the river mouths. The rivers are polluted from industrial and domestic waste, pesticides and fertilisers.

19.3.2.2.2 Even though the source is unreliable, Appendix A.19.1 indicates that a major source of fresh water in Kerala is private ponds (other than rivers and reservoirs) followed by panchayat ponds. Their importance can be seen in a paper by J. Krishnan (2010), which discusses the case of Palakkad where re-distribution of land led to the re-distribution of water commons; this affected the traditional water network and, in turn, affected farming.[8]

19. 3.2.3 Groundwater

Kerala is dependent on groundwater

19.3.2.3.1 Groundwater is a major source of water in Kerala. Census 2011 shows that 65 per cent of rural and 59 per cent of urban households have wells; the density of wells is the highest in the country (perhaps even in the world) and is higher in the coastal regions.[9] In addition, 50 per cent of irrigation needs are met through groundwater as per the Economic Review 2012. However, recently, problems of a decline in the water table, contamination of groundwater, seawater intrusion and so on are being reported in several places.[10]

Limited groundwater potential in Kerala

19.3.2.3.2 The groundwater potential of Kerala is limited, because 88 per cent of the total geographical area of the State is underlain by crystalline rocks devoid of any primary porosity.[11] There are 10 different principal aquifer systems in Kerala. Groundwater in Kerala has a potential of 34-601 metres below ground level (mbgl) and the yield varies between 0.1–38 lps (litres per second) depending on the area. Alappuzha, Kollam and Kozhikode witnessed the highest depth level. The discharge range is higher in Palakkad, Alappuzha and Pathanamthitta districts of Kerala (Table 19.5).

Table.19.5
Groundwater Exploration by District as of March 2011

District	Area (sq km)	Depth range (mbgl)	Dis-charge range (lps)	Dug Wells	PZ (Piezometer)	Total Col (5)+ Col. (6)=(7)
1	2	3	4	5	6	7
Alappuzha	1,414	200–601	1 to 33	38	29	67
Ernakulam	3,068	130–296	1 to 20	34	17	51
Idukki	4,358	34–233	0.1–14	20	9	29
Kannur	2,966	86–200	0.2–14	16	17	33
Kasaragod	1,992	60–200	0.5–7	31	24	55
Kollam	2,491	114–416	0.3–20	57	17	74
Kottayam	2,208	86–200	0.5–20	16	11	27
Kozhikode	2,344	114–200	0.2–17	17	21	38
Malappuram	3,550	89–300	0.3–15	28	33	61
Palakkad	4,480	59–300	0.5–38	58	36	94
Pathanamthitta	2,637	44–257	0.5–29	50	8	58
Thiruvananthapuram	2,192	52–200	0.2–20	40	23	63
Thrissur	3,032	69–301	0.2–24	40	13	53
Wayanad	2,131	60–200	0.3–11	17	9	26
Total	38,863	34–601	0.1–38	462	267	729

Source: Central Ground Water Board, Ministry of Water Resources, Government of India. 2012. Aquifer systems of Kerala.

Note: Standpipe piezometers are used for long term monitoring of ground water tables. mbgl= metre below ground level; lps-litres per second.

Relatively low levels of groundwater development

19.3.2.3.3. The annual replenishable groundwater resources of Kerala have been reassessed at 6.7 bcm as of March 2011. The main source of groundwater is recharge from rainfall, which contributes about 82 per cent of the total annual replenishable resources. The annual groundwater draft in the State as of March 2011 is about 2.8 bcm. The stage of groundwater development for Kerala as a whole has been computed as 47 per cent. The utilisation pattern is, however, uneven across the State, with groundwater stressed conditions in some parts and sub-optimal groundwater development in others. Despite the relatively low level of groundwater development in Kerala, problems related to shortage, mainly for drinking and domestic uses, and contamination of water due to natural and anthropogenic causes are felt in different areas of the State.

19.3.2.3.4 The groundwater levels during November 2012 are compared to average water levels for the past decade (decadal refers to November 2002−2011). Table 19.6 shows that 43 per cent of monitored wells have registered a decline in water level, while around 57 per cent of the wells have shown a rise in water levels.

Table.19.6
Decadal Groundwater Level Fluctuation with Mean [November (2002 to 2011)] and November 2012

Item	Details		Kerala	India
No. of wells analysed			677	10,356
Range in metre	Rise	Min	0.01	
		Max	6.7	
	Fall	Min	0.02	
		Max	10.56	
Rise	0−2 metre	No.	331	3,966
		%	48.89	38.3
	2−4 metre	No.	34	842
		%	5.02	8.13
	>4 metre	No.	23	436
		%	3.4	4.21
Fall	0−2 metre	No.	231	3,564
		%	34.12	34.41
	2−4 metre	No.	42	879
		%	6.2	8.49
	>4 metre	No.	16	669
		%	2.36	6.46
Rise		No.	388	5,244
		%	57.3	50.6
Fall		No.	289	5,112
		%	42.7	49.4

Source: Central Ground Water Board, Ministry of Water Resources, Government of India. Ground Water Level Scenario in India November 2012. http://cgwb.gov.in/documents/GROUND%20WATER%20LEVEL%20SCENARIO_November−12.pdf

Poor quality of groundwater

19.3.2.3.5 Water quality in Kerala has been steadily degraded by a combination of factors including saline intrusion, sewage, industrial effluents and urban and agricultural run-off. Groundwater in the State is highly affected by high levels of fluoride, saline, iron and nitrate content, which are above the permissible limits in certain pockets of the districts (Table 19.7). The permissible iron concentration in groundwater is less than 1.0 mg/litre for drinking water as per the BIS standard and for nitrates it is less than 45 mg/litre, but Kerala is among the top five states in terms of the presence of iron and nitrates in groundwater.[12] In terms of salinity and fluoride, only Palakkad district in the State has high levels in the groundwater.

Table.19.7
Districts affected by Different Constituents of Groundwater in Kerala

Indicators	Districts
Parts of districts having electrical conductance (Salinity) > 3000 µS/cm	Palakkad*
Parts of districts having fluoride > 1.5mg/ litre	Palakkad
Parts of districts having iron> 1.0 mg/litre	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thiruvananthapuram, Thrissur, Wayanad
Parts of districts having nitrates > 45 mg/ litre	Alappuzha, Idukki, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thiruvananthapuram, Thrissur, Wayanad

*Note: * Present in minor/ local spots.*
Source: Central Ground Water Board, Ministry of Water Resources, Government of India. 2010. Ground Water Quality in Shallow Aquifers of India. Faridabad. February

19.3.3. Demand for water

19.3.3.1 The demand for water emanates from irrigation, domestic use for humans and animals, industrial use and environmental purposes such as removal of soil salinity. The demand and supply position of water in Kerala as given in the Kerala Development Report for the entire year and for the summer season is provided in Table 19.8. Although the figures for the annual water balance indicate a surplus of about 8.5 bcm, the State faces acute water stress during the summer months, amounting to 7.1 bcm. This indicates that the summer period receives only about 15 per cent of the annual water, whereas the demand during this period is as high as 75 per cent of the annual requirement.

19.3.3.2 Table 19.8 shows that the major demand for water comes from irrigation, followed by demand from industry, conservation of *kari* land and domestic demand.

Table.19.8
Demand–Supply Balance of Water across Different Uses During a Year and for the Summer Period (bcm): 2001

Water source/sector	Annual		Summer	
	Availability	Demand	Availability	Demand
Surface water	2.4	–	3.7	–
Groundwater	5.1	–	5.1	–
Stored surface water	5.5	–	5.5	–
Domestic demand	–	1.2	–	0.8
Birds and animals	–	0.4	–	0.3
Industrial demand	–	6.4	–	3.2
Conservation of kari land	–	5.0	–	3.5
Irrigation	–	13.7	–	13.7
Total	35.2	26.7	14.3	21.5
Surplus/deficit	+8.5	–	–	–7.1

Note: Summer lasts from end–February to May.
Source: Planning Commission, Government of India. 2008. Kerala Development Report. www.planningcommission.nic.in

19.3.3.1 Irrigation

19.3.3.1.1 Irrigation began in Kerala at the end of World War II and accelerated after Independence. It started with major and medium irrigation projects and has since then received significant fund flow throughout the Five Year Plans (about 15 per cent in all the Plans). However, the long-term returns that could be realised from this investment are under serious reconsideration, both in terms of the financial recovery of the projects and in terms of the intended crop benefits. This is mainly due to the continuing decline of the area under paddy, the reported not-so-significant yield difference between irrigated and un-irrigated paddy, the shift to cultivation of plantation crops that do not require the intensive irrigation paddy does, lower financial returns from the irrigation schemes, inordinate delays in completion of the projects and the associated escalation in economic and financial costs, among others.

Insufficient and misdirected irrigation

19.3.3.1.2 Table 19.9 provides a glimpse of the irrigation development of the State. The gross irrigated area during 2009−10 was about 4.55 lakh hectares, which accounted for only 17 per cent of the gross cropped area and about 16 per cent of the net cropped area. Despite the continued efforts to irrigate crops through both major and minor irrigation programmes, only about one-sixth of the total area could be brought under irrigation. A close examination shows that the gross irrigated area has remained almost stagnant in the past decade. The latest data for 2012−13 shows a 6.7 per cent decline in gross irrigated area.[13]

Table.19.9
Trends in Irrigated Areas in Kerala (lakh ha): 1998−99 to 2005−06

Year	Based on Gross Cropped Area			Based on Net Cropped Area		
	Gross irrigated area (GIA)	Gross cropped area (GCA)	% of GIA to GCA	Net irrigated area (NIA)	Net cropped area (NCA)	% of NIA to NCA
1998−99	4.21	29.17	14.43	3.75	22.59	16.60
1999−00	4.71	30.02	15.69	3.80	22.39	16.97
2000−01	4.58	30.22	15.16	3.81	22.06	17.27
2001−02	4.32	29.92	14.44	3.77	21.91	17.21
2002−03	4.47	29.70	15.05	3.93	21.89	17.95
2003−04	4.27	29.54	14.45	3.81	21.90	17.40
2004−05	4.55	29.96	15.19	3.93	21.55	18.24
2005−06	4.65	29.86	15.57	4.00	21.32	18.76
2006−07	4.75	29.17	16.28	3.90	21.01	18.56
2007−08	4.55	27.61	16.48	3.87	20.89	18.53
2008−09	4.58	27.02	16.95	3.99	21.06	18.95
2009−10	4.55	26.69	17.04	3.86	20.79	16.34

Source: Planning Board, Government of Kerala. 2013 and previous reports. Economic Review 2012. http://www.spb.kerala.gov.in/images/pdf/er12/Chapter2/chapter02.html#Water

Private sources of irrigation dominate

19.3.3.1.3 The major source of irrigation in the State are private wells, which account for about one-third of the total area under irrigation, followed by government canals, which constitute about 25 per cent (Table 19.10). Despite the investments in canal irrigation, the area under this system has not increased much. However, the canal system has also contributed to the water levels in the soil through water seepage and supported ground and other surface water irrigation. Tanks, though not as important for the State as they are for the other Southern states, still contribute to 10 per cent of the total area irrigated. Kerala has about 995 tanks/ponds, mostly in need of restoration. The major 'other sources' include getting water from rivers and lakes, natural streams (as noticed in Wayanad) and horizontal borings such as *surangams* in north Kerala. The dependence on canal irrigation is the highest (in terms of area) in Palakkad, Thrissur and Ernakulam districts; wells (open and bore) in Palakkad, Thrissur and Kasaragod districts; and ponds in Kasaragod, Idukki, Palakkad and Malappuram districts. The ponds for irrigation are mainly under private ownership.

Table.19.10
Net Area Irrigated in Kerala by Source (ha)

Year	Government Canals	Private Canals	Tanks	Wells	Other	Total
1998–99	94,643	2,482	47,532	1,07,213	1,22,639	3,74,509
1999–00	81,231	4,803	52,932	1,21,605	1,19,472	3,80,043
2000–01	1,00,926	4,041	49,972	1,15,703	1,10,399	3,81,041
2001–02	95,270	4,413	49,945	1,16,746	1,10,788	3,77,162
2002–03	1,01,139	4,272	66,729	1,17,490	1,03,541	3,93,171
2003–04	94,859	5,754	47,856	1,09,360	1,23,469	3,81,298
2004–05	1,01,397	4,729	43,983	1,08,445	1,34,802	3,93,356
2005–06	1,04,669	4,965	45,062	1,10,000	1,35,227	3,99,923
2006–07	98,664	4,300	42,064	1,14,477	1,25,900	3,85,405
2007–08	88,318	4,324	41,580	1,31,002	1,22,321	3,87,545
2008–09	95,956	6,318	39,752	1,33,312	1,23,915	3,99,253
2009–10	94,813	2,656	40,851	1,25,892	1,22,050	3,86,262

Source: State Planning Board. Kerala Economic Review (various issues).

Irrigation good for paddy production

19.3.3.1.4 The crop-wise irrigation development in the State is summarised in Table 19.11. About three-fourths of the area under paddy and banana is irrigated, but it is as low as 21 and 36 per cent in the case of coconut and areca nut, respectively, and irrigation coverage of tubers and vegetables is also minimal. Within the gross irrigated area, the shares of coconut (35.9 per cent) and paddy (32.1 per cent) dominate.[14] Although the area under paddy in the State has declined considerably, the decline has been pronounced only in the case of rain-fed paddy. The total loss of area under paddy from 1998-99 to 2010-11 was about 1.4 lakh ha, but the area lost from irrigated paddy was only about 33,000 hectares.

Wasteful irrigation methods

19.3.3.1.5 The methods of irrigation vary significantly across crops. While paddy is irrigated through the flood system, plantation crops are mainly irrigated through basin or ring irrigation systems. In homesteads, where many crops are grown together, the flood system is common. The furrow system

of irrigation is used to cultivate vegetables and bananas. All these irrigation systems lead to a high level of water wastage. These methods reduce water productivity, that is, the quantity of produce per unit quantity of water.

Table.19.11
Crop−wise Irrigated Area and Total Area under Crops in Kerala (lakh ha)

Year	Paddy		Coconut		Banana		Areca nut	
	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total
1998−99	1.92	3.53	1.52	8.82	0.12	0.77	0.27	0.81
1999−00	2.09	3.50	1.70	8.99	0.19	0.92	0.32	0.82
2000−01	2.08	3.47	1.66	9.26	0.19	0.99	0.31	0.87
2001−02	1.84	3.22	1.58	9.06	0.24	1.06	0.31	0.93
2002−03	1.84	3.10	1.54	8.99	0.29	1.10	0.34	0.97
2003−04	1.70	2.87	1.59	8.99	0.28	1.09	0.33	1.03
2004−05	1.84	2.90	1.58	8.99	0.30	1.13	0.37	1.08
2005−06	1.75	2.76	1.59	8.98	0.34	1.17	0.35	1.09
2006−07	1.73	2.64	1.78	8.73	0.41	1.12	0.35	1.02
2007−08	1.94	2.29	1.71	8.02	0.42	0.56	0.34	1.01
2008−09	1.69	2.34	1.57	7.9	0.35	NA	0.34	NA
2009−10	1.69	2.34	1.52	7.8	0.36	0.51	0.34	0.99
2010−11	1.59	2.13	1.61	7.7	0.42	0.59	0.36	1.00

Source: State Planning Board. Kerala Economic Review (various issues).

Impact of irrigation

19.3.3.1.6 There has been a lot of debate among researchers on the relevance of irrigation in Kerala. The evidence shows that rice yield is positively affected by irrigation, which supports the rationale for providing it. The yield of irrigated rice fields was always higher than that from un-irrigated conditions, irrespective of the season. Data for 2007 shows that irrigation pushes up the rice yield to about 840 kg/hectare (ha) during the summer season, 360 kg during the winter season and about 120 kg during the autumn season (when sufficient rainfall is available for crop cultivation), clearly indicating the role of irrigation in increasing rice yields in the State. It is also noted that irrigation for crops such as coconut increase the yield by between 30 and 300 per cent, depending on the stage of the variety of the palm, physiography of the region and soil type.

Development of irrigation infrastructure

19.3.3.1.7 The major thrust in irrigation development in the State was provided for major and medium-sized irrigation projects, keeping in mind the need to produce sufficient paddy for Kerala to be self-sufficient. Crops other than paddy were considered for irrigation only after the 1970s. Kerala has 18 dams intended for irrigation, of which 13 have storage and 5 are barrages. Out of a cumulative investment of Rs 4,638 crore made from the 1st Plan to 2009-10, about 69 per cent has been towards constructing major and medium irrigation facilities (Economic Review, 2010). Table 19.12 provides Plan-wise expenditure on investment in irrigation and allied sectors in Kerala. However, such huge investments were unable to bring a correspondingly high area under irrigation. As irrigation development was paddy-centric, the distribution structures developed were not suitable for irrigating other crops such as coconut, areca nut and banana.

Table.19.12
Expenditure on Irrigated and Allied Sectors during Various Five−Year Plans: (in Rs million)

−Year Plans, (in Rs million) Plan	Irrigation Expenditure at current prices							Total irrigation project (at 1993−94 prices)	% of expenditure of India (at 1993−94 prices)
	Major & Medium	Minor−SWD	Minor−GWD	Flood control	Anti−sea erosion	CAD	Total irrigation project		
I (1951−56)	51.1	−	−	−	−	−	51.1	791.13	1.16
II (1956−61)	89.24	22.62	−	−	18−94	−	111.86	1,553.6	2.07
III (1961−66)	103.1	56.47	−	6.3	45.7	−	159.57	1,817.4	1.57
Annual Plans (1966−69)	101.5	65.3	−	10.98	12.37	−	166.8	1,309.9	1.69
IV (1969−74)	289.2	112.2	1.08	15.8	54.01	−	402.5	2,521.78	1.67
V (1974−78)	751.3	126.67	7.34	22.8	45.4	−	885.3	3,478.6	2.16
Annual Plans (1978−80)	723.5	105.53	5.25	31.3	36.9	−	834.3	2,886.8	2.55
VI (1980−85)	2,602.7	340.9	58.44	53.1	126.03	8.36	3,020.04	7,102.6	2.63
VII (1985−90)	3,019	357.22	89.08	81.3	98.2	147.58	3,465.3	5,921.6	1.93
Annual Plans (1990−92)	1,345.9	283.57	66.15	61.3	95.3	151.05	1,696.02	2,157.2	1.64
VIII (1992−97)	5,869.3	1,286.49	313.99	406.01	725.9	477.8	7,469.8	6,745.3	2.33
IX (1997−2002)	7,033	2,258	328.92	338.4	500.9	328.1	9,619.9	6,536.7	1.58
X (2002−07)	6,000	2,050	−	−	500	−	8,050.0		
Total (Up to X Plan)	2,7996.8	5,220.4	870.25	−	2,837.1	1,112.8	34,087.5		

Note: SWD: Surface water development, GWD: Groundwater development.

Sources: Economic Review, various issues; Lathika, M. 2010. Water Management for Irrigation in Kerala, Economic and Political Weekly. XLV (30):73−80. July 24.

Minor irrigation development in Kerala

19.3.3.1.8 Minor irrigation possesses distinct advantages over major irrigation. They include lower investment needs per hectare, shorter payback period, easier management, reduced environmental damage and better suitability to agro-ecologies. Minor irrigation started receiving more attention since the 7th Five Year Plan and investment in this sector accelerated from the 9th Five Year Plan, both from national agencies such as NABARD and through international aid. The availability of a large number of water bodies in the form of rivers, rivulets and ponds, and the ease of institutional intervention through user groups makes minor irrigation the preferred option for irrigation development in the State. Minor irrigation schemes generally take up works that involve construction of check dams, construction and renovations of tanks, vented crossbars, weirs and so on. The operation and maintenance of minor irrigation is vested with the Panchayati Raj and Nagarpalika institutions, which provides an opportunity for better management. However, the area under lift and minor irrigation is minimal in most districts, except Ernakulum and Malappuram. Despite the advantage in terms of unit costs, their poor coverage calls for deeper exploration.

Minor irrigation not achieving its potential

19.3.3.1.9 A survey to assess the performance of minor irrigation in Kerala indicated that minor irrigation initiatives were able to achieve only a little over 53 per cent of the targeted area coverage, the actual area irrigated is only half the potential created (as of 2004−05) and they support 5 lakh beneficiaries as against the proposed 7.9 lakh. One problem with minor irrigation has been the significant number of non-functioning schemes. About 16 per cent of the minor irrigation schemes are not functioning due to physical damage, changes in agricultural methods in the locality and scarcity of water, among others (Government of Kerala, Minor Irrigation Survey, 2005). Scarcity of funds has been identified as the reason why several proposed minor irrigation schemes were not initiated. The highest proportion of 'not functioning' schemes identified are those constructed against saltwater intrusion, followed by IPD (intensive paddy development) *yelah* schemes, whereas the lowest failures are in the case of lift irrigation (Tables 19.13 and 19.14).

Table.19.13
Distribution of Minor Irrigation Schemes by Project Class: 2004−05

Class	Total Number Installed	Not Working	Percentage Not Working
Class I Works	558	91	16.31
Class II Works	7,749	1,395	18.00
Saltwater exclusion	832	219	26.32
Community irrigation	1,394	157	11.26
IDP Yelah	1,877	393	20.94
Lift irrigation	1,952	186	9.53
Others	6,424	828	12.89
Total	20,786	3,269	15.73

Notes: Class I works having area of 50 hectares up to 2000 hectares will be classified as Minor Irrigation class I projects. Class II works have area less than 50 hectares. IDP Yelah: Aims to provide minor irrigation facilities to selected areas, where Intensive Paddy Development schemes of Agricultural department are implemented. area of not less than 40 hectares.

Source: Compiled from Report of the Minor Irrigation survey, Government of Kerala

Table.19.14
Distribution of Minor Irrigation Schemes by Project Type: 2004−05

Type	Total Number Installed	Not Working	Percentage Not Working
Well	1,108	77	6.95
Tube wells	141	12	8.51
Ponds	4,103	650	15.84
Lift irrigation	1,952	186	9.53
Side protection wall	3,817	479	12.55
Minor dams	4,791	1,158	24.17
Saltwater intrusion	832	219	26.32
Other	4,042	488	12.07
Total	20,786	3,269	15.73

Source: Compiled from Report of the Minor Irrigation survey, Government of Kerala

19.3.3.1.10 The latest Minor Irrigation Survey of 2006−07 shows that 99.3 per cent of the total schemes are being used.[15] Most of the schemes are in groundwater. Of the groundwater schemes, 99 per cent are in use and 97.2 per cent of the surface water schemes are being used.

The potential of micro irrigation

19.3.3.1.11 In the context of water scarcity and the need to increase water use efficiency, micro irrigation is getting widely adopted. In this context, it is worth noting that the entire irrigated area in an arid country such as Israel is under micro irrigation. The need to popularise micro irrigation has also been acknowledged by the Government of India. The task force to assess the feasibility of micro irrigation has estimated that about 42 million ha of cultivated land has the potential to be brought under micro-irrigation (Table 5.9 in Chapter 5). Against this potential, the actual achievement at the national level is only 9 per cent. All the Southern states barring Kerala have achieved relatively better coverage of micro irrigation. In Kerala, it was only about 7.8 per cent, which is well below the national average. Kerala has the potential for about 2.1 lakh ha to be covered under micro irrigation — 1.8 lakh ha under drip irrigation and the remainder under various types of sprinkler irrigation. Studies conducted by the Centre for Water Resources Development and Management (CWRDM) on coconut and areca nut have revealed an increase in yield following micro irrigation.

19.3.3.2 Industrial water

19.3.3.2.1 After agriculture, industry is the second biggest consumer of water in the State. Demand for industrial water is poised to become a pressing problem in the near future. But there is not much information on the volume of water used by industry. Metering of industrial water is the first step that can be implemented to track water use so that consumption is paid for. The second important issue related to industrial use of water is water pollution. Table 17.4 (in the Environment chapter) shows the Comprehensive Environment Pollution Index (CPI) for industrial clusters in South Indian states. Only Kochi features in that. Generally speaking, the CEPI score of more than 60 shows a critical level of pollution in the respective environmental component, whereas a score in the range of 50–60 shows a severe level of pollution with reference to the respective environmental component. Kochi's CEPI score in case of water is 64, indicating critical level of pollution.

19.3.3.3 Domestic water

Well water is the main source of domestic water

19.3.3.3.1 In Kerala, people switched from traditional sources of water to piped water, but with the failure to deliver water, people have returned to traditional sources. Currently, a combination of traditional and modern methods is used to supply water in rural and urban areas, with a wide gap between rural areas (Table 19.15) and urban areas (Table 19.16). Approximately 65 per cent of households depend on wells for drinking water, with 51 per cent using uncovered wells. The second most important source is tap water; in urban areas only 35 per cent of households use tap water for drinking purposes (70.6 per cent for India) and 58.9 per cent use water from wells, with 43.9 per cent using water from uncovered wells.

19.3.3.3.2 Census 2011 reveals a unique pattern in Kerala — its dependence on both well water and groundwater (hand pump/tube well/bore hole water) for drinking.

Table.19.15
Distribution of Households by Availability of Drinking Water Facility (Rural %): 2011

(Rural %), 2011 Districts/India	Well water			Tap water			Hand pump/ Tube well/ Bore hole water	Other source of water	Total
	Un-covered well	Covered well	Total	From treated source	From un-treated source	Total			
Kasaragod	61.9	3.5	65.4	7.1	3.6	10.7	11.3	12.6	100
Kannur	68.5	7.2	75.7	5.8	5.7	11.5	3.2	9.5	100
Wayanad	58.9	7.1	66	14.4	7.9	22.3	3.3	8.5	100
Kozhikode	64.3	8.9	73.2	11.4	6.4	17.8	1.5	7.6	100
Malappuram	65.4	11.3	76.7	10.8	4.4	15.2	3.6	4.5	100
Palakkad	43.9	7.2	51.1	28.2	11	39.2	5.9	3.8	100
Thrissur	45.3	16.6	62	23.5	5.6	29.1	6.9	2	100
Ernakulam	42.8	15.4	58.2	31.7	6.7	38.4	0.6	2.8	100
Idukki	33	6.9	40	17.1	12.2	29.3	4.2	26.5	100
Kottayam	38.7	32.2	71	16.3	3.9	20.2	1.9	7	100
Alappuzha	33.7	12.9	46.6	26.4	8.9	35.3	11	7.1	100
Pathanamthitta	45.1	30.6	75.7	13.4	4	17.3	1.4	5.5	100
Kollam	55.5	17.1	72.6	12.5	9.9	22.4	0.8	4.3	100
Thiruvananthapuram	56.3	14.2	70.5	14.4	8.6	23	2.5	4	100
Kerala	50.5	14.3	64.8	17.2	7.3	24.5	3.9	6.9	100
India	11.8	1.5	13.3	13	30.8	51.9	51.9	4	100

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011

Table.19.16
Distribution of Households by Availability of Drinking Water Facility (Urban %): 2011

India/State/District	Well water			Tap water			Hand pump/ Tubewell/ Borehole water	Other source of water	Total
	Un−covered well	Covered well	Total	From treated source	From un−treated source	Total			
Kasaragod	54.1	3.9	58	13.8	4.8	18.6	21.4	2	100
Kannur	75.7	8.7	84.5	10.3	1.6	11.9	2.1	1.6	100
Wayanad	60.1	3	63.1	25.5	4.7	30.2	2.3	4.4	100
Kozhikode	54.7	17.9	72.6	19.1	3.6	22.7	2.4	2.3	100
Malappuram	65.8	14.9	80.6	11.5	2.9	14.4	3	2	100
Palakkad	31.9	7.9	39.8	49.5	5	54.5	5	0.7	100
Thrissur	43.6	20.2	63.8	21.6	5.1	26.7	8.3	1.3	100
Ernakulam	20.3	11.7	32	63.2	3.1	66.3	1.1	0.7	100
Idukki	21.4	26.7	48	46	3.4	49.4	1.7	0.8	100
Kottayam	32.3	35	67.3	26.5	3.2	29.7	0.8	2.2	100
Alappuzha	34.1	11	45.1	25.2	9.5	34.7	17.2	3	100
Pathanamthitta	29	34.3	63.2	30.2	3.6	33.8	0.7	2.2	100
Kollam	42.8	21.4	64.2	24.2	9	33.2	0.8	1.8	100
Thiruvananthapuram	33.8	11	44.7	47.5	4.2	51.7	1.8	1.8	100
Kerala	43.9	15	58.9	30.4	4.5	34.9	4.6	1.7	100
India	4.5	1.7	6.2	62	8.6	70.6	20.8	2.5	100

Source: Census of India Web site: Office of the Registrar General and Census Commissioner of India. 2011

Poor sanitation and polluted water

19.3.3.3.3 Census 2011 shows that 95.2 per cent of households in Kerala have latrine facilities inside their premises. Only 12 per cent have piped sewer systems and 50.3 per cent of households have a septic tank. The share of houses that have a bathroom inside the premises is 81 per cent and 53.6 per cent of households have no drainage facility.

19.3.3.3.4 Sanitation facilities can affect the quality of groundwater. The appropriate distance between an open well/bore well and a septic tank should be 50 feet given the terrain in Kerala[16], but it can be 20–30 feet in lateritic areas. There are about 4.5 million open wells in the State, with a density of 150−200 wells/sq km (State Development Report, 2008). In coastal areas, where the population density is the highest, the well density rises to 400 per sq km. If the wastewater is not treated, it can threaten the natural water bodies of Kerala (Harikumar and Mol, 2012).[17]

Water tariffs

19.3.3.3.5 Table 19.17 shows the water tariff rates in Kerala. The rates are nominal and do not reflect the scarcity value of water in Kerala.

Table.19.17
Water Tariff Rates in Kerala

Type of Connection	Tariff from September 1, 2008
A. Domestic	
Up to 5,000 L	Rs 20/−
5,000 to 10,000 L	Rs 20/− plus @ Rs 4.00 per every 1,000 L in excess of 5,000 L
10,000 to 20,000 L	Rs 40/− plus @ Rs 5.00 per every 1,000 L in excess of 10,000 L
20,000 to 30,000 L	Rs 90/− plus @ Rs 6.00 per every 1,000 L in excess of 20,000 L
30,000 to 40,000 L	Rs 150/− plus @ Rs 10.00 per every 1,000 L in excess of 30,000 L
40,000 to 50,000 L	Rs 250/− plus @ Rs 14.00 per every 1,000 L in excess of 40,000 L
Above 50,000 L	Rs 390/− plus @ Rs 25.00 per every 1,000 L in excess of 50,000 L
B. Non−domestic	
Up to 15,000 L	At the rate of Rs 10/− per 1,000 L and Rs 125/− minimum charge
15,000 to 50,000 L	Rs 150/− plus @ Rs 14.00 per every 1,000 L in excess of 15,000 L
Above 50,000 L	Rs 640/− plus @ Rs 25.00 per every 1,000 L in excess of 50,000 L
C. Industrial	
For consumption in a month	At the rate of Rs 25/− per 1,000 L and Rs 250/− minimum charge
D. Local Bodies	
Municipal Taps	Rs 5,256/− per year
Panchayat Taps	Rs 3,500/− per year

Source: Kerala Water Authority

19.3.4 Other water-related issues

Flood management

19.3.4.1 Four rivers — Chaliyar, Bharathapuzha, Periyar and Pamba — together drain about 35 per cent of the State's total area and carry about 45 per cent of the total surface water. Structural and non-structural measures have been adopted to prevent bank erosion and flooding.

Coastal zone management

19.3.4.2 Construction of sea walls is a popular method for stabilising and protecting the shores. Of the identified coastline of 478 km that needs protection, 354.29 km of seawall has been newly constructed. The remaining length of new seawall to be constructed is around 123.71 km. In the area of seashore protection, modern technology such as geo textiles, polyethylene fabrics/sheets and nourishment of the foreshore with biomaterials are emerging.

Groundwater management

19.3.4.3 The National Water Policy of the Government of India states that traditional water conservation practices such as rainwater harvesting and non-conventional methods such as artificial recharge of ground water need to be practised to increase the utilisable water resources. Rainwater harvesting can be achieved by in situ harvesting. The best method for rainwater harvesting is groundwater storage, because it not only involves filtration of surface water, but is also safe from evaporation losses, natural catastrophes and so on. Artificial recharge of ground water is the process of diverting surface water into suitable geological formations. The common structures are percolation tanks, khadins, check dams/anicuts, sub-surface dams and injection wells.

19.3.4.4 The Central Ground Water Board has implemented various artificial recharge schemes in Kerala such as surface dykes and percolation tanks, as well as rooftop rainwater harvesting. Four sub-surface dams were constructed in Palakkad district (Anaganadi, Bhabaji Nagar, Alanallur and Ottappalam), one in Ernakulam (Odakali), one in Kottayam (Neezhir), one in Kollam (Sadanandapuram) and two in Thiruvananthapuram district (Mampazhakara and Ayiolam). The board has constructed two percolation tanks, one at Chirakulam in Kottayam district and another at Kadapallam in Kasaragod district. Rooftop rainwater harvesting schemes have been implemented in Ezhimala and Mayyil colony in Kannur district. The artificial recharge structures have given satisfactory results and the groundwater condition in those areas has improved considerably.

Water pollution, environmental degradation and disasters

19.3.4.5 Water pollution is the main issue facing the State and has been discussed in detail in Chapter 17 on the Environment.

19.4 Challenges

19.4.4.5 In sum, the challenges that Kerala faces on water are:

- Weather patterns have become uncertain, which directly affects the monsoon.
- Kerala's geography reduces its groundwater potential and water tables are declining because of increased demand.
- Energy and water are simultaneously affected because of the monsoon.
- Deforestation and encroachments have affected traditional supplies of water.
- Most water is used for irrigation, but the irrigation infrastructure is misdirected at paddy, which has a very small share of Kerala's total agricultural output.
- Drinking water comes from polluted ground wells, partially because piped drinking water and piped sewage are not available.
- Water is highly polluted.
- Water is a necessity, but it is scarce. How can it be managed in a sustainable manner?

19.5 Forecasts

19.5.1 With very limited data on water demand and its uses, the estimates of water demand in various sectors are at best indicative of future demand. Demand for water is divided into four major categories — irrigation, industrial, drinking water and management of salinity (Table 19.18).

19.5.2 Irrigation: As of now, the demand for water for irrigation is about 13.7 bcm. As there is no firm basis to project the likely increase in irrigated areas and there is a need to conserve irrigation water, a modest increase in the water required for irrigation by 2 per cent per year has been considered for the future.[18] This is a reasonable assumption to make based on two papers. The NCAER had modelled emerging scenarios for the Indian economy for the 12th Five Year Plan. In that it is assumed that the gross irrigated area is growing at 2 per cent per annum.[19] Chand et al. (2011) shows that Indian districts with 50 per cent and above net irrigated area tend to have average and above average productivity.[20] From Table 16.10, it is known that in 2009−10, the net irrigated area as a percentage of net cropped area in Kerala was 16.34 per cent. If the State wants to reach the goal of 50 per cent net irrigated area, it has to grow at the minimum rate of two per cent. As per these estimates, by 2021, the irrigation requirement of water is projected to increase to about 20 bcm.

19.5.3 Industrial: Water is an input in some industries and is also used to remove industrial effluents and pollutants. The discharge of water from industry is a major pollutant of the rivers in the State. Water demand for industrial uses has been projected for India till 2050. The Compound Annual

Growth Rate (CAGR) works out to be 4.1 per cent.[21] Using the same rate, water demand for industry is projected.

19.5.4 Drinking water: Rural water demand is assumed to be 70 litres per capita per day (lpcd) as per the Planning Commission. According to Chapter 15 on Urbanisation, an expert committee has estimated the average of 168 lpcd for all size classes of cities.[22] Using the per capita requirements and population projections, the demand for domestic use of water in Kerala can be predicted.

19.5.5 Another potential source of water demand is for environmental cleansing. Almost all rivers in the State suffer from saline water intrusion. Paddy cultivation in certain tracts, notably in *kari* soils, is done after the saline water that has intruded is removed. The brackish water spread in the lakes and canals is over an area of 2,400 sq km. Of the seven lakes in the State, all but two are affected by saline water intrusion. Therefore, a large quantity of fresh water flow into the backwaters is required during the summer months to flush out the salinity. Often, the water that flows through the rivers is insufficient for this purpose and water from ponds has to be diverted there. It is estimated that by 2021 the fresh water requirement for salinity management will be about 7.2 bcm and that for reclaiming waterlogged areas and backwaters will be 5 bcm, which together constitute 12.2 bcm annually. Using CAGR, the projections are extended to 2031.

Table.19.18
Demand for Water in Kerala

Source	2001		2021		2031	
	Volume of demand (bcm)	% share	Amount (bcm)	% share	Amount (bcm)	% share
Drinking water	1.7	6.3	1.71	5.43.8	2.10	5.03.9
Irrigation	13.7	51.1	16.43	52.237	24.819.6	56.436
Industrial	6.4	23.9	14.02	11.131.6	4.220	9.536.7
Management of salinity	5.0	18.7	12.2	31.427.5	12.8	29.123.4
Total Demand	26.8	100	38.944.36	100	4454.5	100

Source: Computations by NCAER

Irrigation and industry will be the major sectors that will demand water. On the other hand, the projected utilisable water supply during this period will be about 47.3 bcm, consisting of 42 bcm of fresh water and 4.7 bcm of groundwater. This points to a situation of water deficit by 2031. It should be noted that the available water supply is estimated with an optimal outlook of no change in rainfall, water storage capacity and full utilisation of the available ground water. It also does not take care of the minimum water supply to be maintained in the rivers. If these factors were taken into consideration, then supply figures would be much lower. The situation calls for effective conservation and efficient utilisation of both surface and ground water. Lastly, the forecasts are estimates based on very limited data. Even if one chooses to not believe the estimates, the fact remains that the gap between supply of and demand for water remains precarious. There needs to be a paradigm change and the next section discusses that in detail.

19.6 The Way Forward

19.6.1 The strategy should be one of sustainable management.

19.6.1 Vision

19.6.1.1 Water for all: Conserve, Value, Enjoy

19.6.2 Targets

a. Drinking water and sanitation:
   - Provide treated water supply to 100 per cent of households.
   - Urban households: 100 per cent underground piped sewer systems.
   - Rural households: Recover, recycle and reuse
   - Households that have toilets within the premises – 100 per cent.
   - Urban households that have closed drainage – 100 per cent.
   - Wastewater treatment plants for all urbanised areas.

b. Irrigation:
   - 100 per cent of the potential area under appropriate irrigation schemes with emphasis on:
     - Continued full usage of the created infrastructure.
     - Conservation of water.

c. Sustainable use of water
   - Increase overall efficiency of water use by 5 per cent.

19.6.3 Strategies

19.6.3.1 Kerala needs to adopt a holistic approach to the management of water in the State. It needs to adopt an integrated approach to solve the issues of providing water and sanitation to its residents, providing water to various economic sectors, water pollution and maintaining balance of groundwater levels. The overarching strategy should shift from merely providing water to providing water, conserving it and promoting the '3Rs' — recover, reuse and recycle. Therefore, the framework should be based on the principle that water and waste management and sanitation have to go hand-in-hand rather than being about one or the other.[23]

Pillar 1: Restructure institutions

19.6.3.2 Element 1: Coordination between various departments is the first step in the development of this key sector in Kerala. Related departments such as the land department, fishing, forestry, water transport and pollution control board need to be included in the discussion too. It is proposed that a Water Coordination Committee be formed under the aegis of the Department of Water or the State Planning Board.

19.6.3.3 The Committee's first task should be to draw a reliable, comprehensive database of water resources on the lines presented in Appendix A.19.1. Work on this has started already with the 'Wetlands Atlas'. However, a complete resources database including all private and public water bodies is a must. The technology recommended is GIS (Geographical Information Systems). Along with this top-down approach, a bottom-up approach is needed. Panchayats need to draw up a list of water bodies in their areas, including groundwater, surface water, rainwater and seawater (where applicable) sources. Previously there were Watershed Appraisal Reports (WARs) prepared at the district level. The focus needs to be broader now, and all the information should be available online. This information needs to be passed to the Committee, which will then consolidate it and recompile the list. This needs to be done every five years so that policymakers have a complete idea of what is going on across the State in this sector.

19.6.3.4. A decentralised approach needs to be taken. There should a clear distinction between the urban and rural bodies. This will require reorganisation and restructuring of departments. One specific suggestion is to reform Kerala Water Authority along the lines of Kerala State Electricity Board

(KSEB). The urban divisions/bodies will have a clear-cut focus on providing water and sanitation, liquid waste management and industrial management of water, with KWA restructured so that each urban agglomeration gets its own water authority. The rural agencies' focus should be on irrigation, providing drinking water, sanitation and waste management.

19.6.3.5 Urban areas should have water maps that trace water from its source to its transmission and distribution. ICT should be adopted to improve water supply. For example, "the Nagpur Municipal Corporation has adopted a water distribution management system (WDMS). A central monitoring station is located at head office. Local monitoring at each Water Treatment Plant and pumping location of entire water distribution and supply components is being done. The intention was to measure, record and monitor the parameters like flow, level, pressure, residual chlorine, pH, turbidity, kWh consumption, voltage, current, power factor and so on of existing and proposed WTPs and pumping stations of Nagpur Water Supply, for which necessary PLC, input and output signals, sensors and transmitters shall be provided along with suitable telemetry monitoring system based on radio frequency (RF) technology. Thus, the initiative taken by NMC to set up central monitoring system for water supply, which shall be open to the public via a centralised system and through Web-enabled facility."[24]

19.6.3.6 In rural areas, Kerala's successful Jalanidhi water scheme should be extended. "The Jalanidhi water scheme sought to help villages plagued by chronic water shortages, making special provisions to include vulnerable people such as tribals, Scheduled Caste communities as well as fisher folk within the project's ambit. Small groups of households who wanted better water supply were helped to come together to build and run their own water supply schemes. They were helped to dig new wells (to tap into the upper layers of water), drill bore wells (to tap into deeper aquifers) or build systems to draw water from the State's numerous springs, streams, rivers and lakes. They were also helped to build storage tanks and lay down pipes to distribute water to village homes. While the state government bore the lion's share of capital expenditure (75 per cent), the gram panchayat paid 10 per cent and the beneficiaries, themselves, 15 per cent. The operations and management also lies with the beneficiary groups. Community groups determined the timings and duration of water supply to member families and levied service charges to meet their operation and maintenance expenses. A number of communities installed water meters to curb consumption."[25]

19.6.3.7 However, one has to be careful with complete decentralisation at the rural level. Discussions with government officials revealed that in some cases while officials at the local level express enthusiasm to take on the responsibility of water projects, the operations and maintenance part is later found to be challenging. Then, the local government decides to give the project back to the KWA. Therefore, while the idea of decentralisation is good, capacity needs to built at the local level. For example, it might be more cost efficient to supply water at a larger scale and, therefore, communities may be merged to create a single water provider. Either way, the transition needs to be done carefully.

Element 2: Adopt integrated water resource management (IWRM)

19.6.3.8 IWRM is defined by the Global Water Partnership (GWP−2000) as: "A process which promotes the coordinated development and the management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."[26] It is implemented at the river basin level. Here are the basic conditions for adopting IWRM:

- Basin management plan and clear vision.
- Participation and coordination mechanisms, fostering information sharing and exchange.
- Capacity development.
- Well-defined, flexible and enforceable legal frameworks and regulations.

- Water allocation plans.
- Adequate investment, financial stability and sustainable cost-recovery.
- Good knowledge of natural resources present in the basin.
- Comprehensive monitoring and evaluation of the river basin.

19.6.3.9 Kerala may adopt an integrated regional water resource management strategy that accompanies its spatial strategy or is a part of it. Depending on the type of soil, water usage, availability, urbanisation rate and agricultural patterns, a suitable water strategy may be adopted that caters to the needs of all sectors and stakeholders.[27] With institutions being created at the local level, it will be easier to implement such a strategy.

19.6.3.10 In essence, the adoption of IWRM in Kerala will involve both a top-down and bottom-up approach. It includes:

- Adoption of integrated river basin management.
- Develop an integrated hydrologic-agronomic-economic model specifically for Kerala and then apply it to the main rivers. The Centre for Water Resources Development and Management can be the nodal agency for this. The World Bank also has an interactive tool for river basin management.[28]

The Kerala 12th Plan Working Group Report on Water Management and Watershed Management notes the two cases of rivers — Periyar and Bharathapuzha — and mentions plans to restore them. This should be done on a holistic basis. A pilot project has also been planned for the Pamba River. Cleaning up existing water bodies should be part of the plan. Similarly, the public should be involved in creating community spaces such as walking paths alongside water bodies. Schools and colleges can be encouraged to organise river clean-ups as a part of their voluntary activities. Unless and until the public decide to take ownership of water bodies as a necessary part of their existence, the authorities at the state level can only do so much.

- Block-level integrated watershed management as specified in the Kerala Twelfth Working Group Report on Water Management and Watershed Management.
  - Preparation of block-level watershed appraisal report: This will be part of the bottom-up approach to get an assessment of water resources.
  - Preparation of micro-watershed development report.
  - Preparation of water management and micro-watershed action plan.
  - Preparation of block-level water management and watershed development plan.
  - The smaller rivers, especially those that are rain-fed, need to be restored and rehabilitated.
- A carrot and stick policy should be used to make sure that the water and watershed management plan is adhered to.
- All reports and plans should be integrated with the latest technology to enable State-to-district-to-block-to village plans.
- As discussed in Chapter 13, detailed plans for wetlands need to be developed and integrated with spatial planning.
- Encourage fish populations in streams and rivers.
- Waste and water management in urban areas should be separated from that in rural areas. Water and waste management go hand-in-hand. The 3Rs principle, recover, reuse and recycle, should be encouraged. When townships and new buildings are constructed, they must follow the 3Rs policy for water. Modern sewage treatment plants in urban areas are a must, as in Thiruvananthapuram. By 2030, the sewage network should be extended to all (100 per cent) urban areas in Kerala. Rural areas can join together to enjoy the benefits of scale and STPs can then be developed for them. There should be water and sewage payments so as to encourage conserving and recycling water. Piped, metered water supply is a must.

- The centre's 12th Plan report emphasises participatory management of water, rather than an engineer-centric approach. Community management of water is important, with appropriate guidance from the state level.
- Sustainable irrigation methods need to be used.
- Appropriate technology to be used for monitoring both water usage and disposal by industry.

Element 3: Water is a common resource

19.6.3.11 As mentioned earlier, during the land reforms process, water bodies were also divided up without much thought about a strategy for them. Data shows that private ponds dominate Kerala. Rural water bodies need to be assessed and developed, and if concentrated in private hands, a process should be created to combine water resources. There are several ways of doing that. For example, each person in a village may own a share equivalent to their present holding of water. Shareholders will be able to sell their shareholding only to fellow villagers, and the water can be managed by a committee.[29]

Element 4: Water metering

19.6.3.12 Metering is crucial for monitoring the usage of water. Industrial usage of water and waste disposal needs to be strictly monitored and tracked.

Element 5: Pilot projects to supply water 24x7

19.6.3.13 Data from various pilot projects across the country suggests that for the current population, 24x7 water supply can be designed with the existing levels of per capita supplies of source water (Karnataka, Punjab, Maharashtra).[30] Appendix A.19.1 in Chapter 15 on Urbanisation has detailed requirements about the infrastructure and financing required to provide drinking water, sewerage and solid waste management.

Element 6: Knowledge Economy

19.6.3.14 Launch undergraduate and extension courses in the domains given below. This will both create expertise and knowledge in this sector and develop innovators, entrepreneurs and consultants, who can invent/innovate technologies and also market them by working closely with stakeholders at various levels. Some of the specific areas that need expertise are:

- Hydrology and water quality
- Forestry and watershed management
- Watershed management
- Urban watershed management
- Become a hub for water innovation and research

Pillar 2: Supply management

Element 1: Protection of forests, wetlands and ecologically fragile areas for water sustainability

19.6.3.15 The overall strategy mentioned in the Kerala Perspective Plan 2030 is that a detailed spatial strategy will use zoning, to safeguard certain lands from conversion.

19.6.3.16 The importance of wetlands can be seen in the example of Bayawan City in the Philippines, which is developing wetlands for wastewater treatment.

Watershed management

19.6.3.17 This is a key part of IWRM and can play a crucial role in Kerala.[31] A watershed is defined as a geo-hydrological unit draining to a common point by a system of drains. Singapore has applied this for urban areas. Watersheds combine land management, water management and biomass management. Water management consists of the topics discussed earlier — rainwater harvesting, ground water recharge, maintenance of water balance, preventing water pollution and economic use of water. Kerala can learn and adapt from Singapore's intelligent watershed systems. Also, it can learn from successful community watershed management systems in Gujarat and Brazil (Box 19.1). Watersheds can be of various types: macro watershed (> 50,000 ha), sub−watershed (10,000–50,000 ha), milli−watershed (1,000–10,000 ha), micro watershed (100–1,000 ha) and mini watershed (1–100 ha). In the 12th Five Year Plan, there is a move towards a community participation approach to watershed management rather than an engineer-centric approach.

Box No 19.1

Community-based Watershed Management in India and Brazil

Examples of community-based watershed management systems in countries such as India and Brazil provide evidence of the value of involving women's groups in maintaining and protecting their water sources. In the semi-arid areas of Gujarat, the Self-Employed Women's Association (SEWA) created its Women, Water and Work campaign in 1995 to sustain and protect traditional water sources through water harvesting, watershed management and repair and maintenance of pipelines and equipment. SEWA's collective action approach for women combines the presence of a strong grassroots institution and the establishment of a technical cadre of women. SEWA's membership has increased greatly due to the success of the water campaign. Women have benefited in terms of increased income, reduced drudgery, improvements in the livelihoods of their families, reduced migration of both women and men and increased participation in SEWA's other programmes. SEWA is a powerful non-governmental organisation with the capacity to negotiate in the water management area previously occupied only by men (Panda, 2007).

In the community of São João D'Aliança in central Brazil, the local Union of Rural Workers in collaboration with the University of Brasília (UnB) designed a community water project to stop pollution of the das Brancas River and to rehabilitate original vegetation along the riverbanks. In the women-led initiative, called the 'Water Women' project, each group of women adapted environment-friendly practices to their daily activities. Community education taught local people not to dump their sewage into the river and how to plant native species of trees along the riverbanks. As a result, there is a visible absence of waste in the river, a considerable growth of new vegetation of native species on the riverbanks and decreased soil erosion. Women's political participation was strengthened, and public perceptions regarding their leadership capabilities were changed (Souza, 2006).

Source: UNESCO. 2012. United Nations World Water Development Report: Managing Water under Uncertainty and Risk.

19.6.3.18 Forestry, mountains and watershed management programmes have been adopted in the developed countries to preserve all three. There is a need to institute watershed processes in forested ecosystems and understand the impacts of management activities on these processes.[32] The Food Agriculture Organisation is working with several developing countries around the world, with similar geographies as Kerala, to manage resources, especially given the context of global warming.[33] In the context of Kerala, it is important to identify how to manage water originating in the forests and restore forests, which, in turn, have a positive effect on water resources. It has to be more

than just reforestation activities. Also, given the quick run-offs during the monsoon season, Kerala needs to develop water management techniques in such a manner that the water run-offs during the monsoon can be stored and used later.

19.6.3.19 Urban watershed forestry[34]: This is a problem that will evolve over the next fifteen years as Kerala urbanises even further. Kerala will need to think ahead about this issue and be prepared in terms of urban planning. Urban watershed management needs to focus on managing the effects of run-off and associated pollutants from roads, buildings, parking lots and other hard surfaces. The extent of these 'impervious surfaces' collectively has been viewed as an important indicator of the health of a watershed. More recently, researchers and managers have turned their attention to the role of trees and forests as indicators of watershed health based on their ability to moderate the impacts of urbanisation. This spurred the creation of a 'new' field called 'urban watershed forestry', which tracks and manages forest cover at the watershed scale and acknowledges the importance of trees and forests in protecting water resources. Forests, particularly healthy ones, contribute greatly to the health of a watershed by reducing run-off, improving air quality, reducing erosion, removing pollutants, providing habitat, and moderating temperature. More research is needed, but it appears that watershed forest cover, particularly streamside forest cover, may be able to minimise the impacts of land development to a certain extent.

Element 2: Increase investment in water and sanitation

19.6.3.20 Increase investment in water and sanitation activities to 2 per cent of GSDP.

Element 3: Strengthen physical infrastructure

19.6.3.21 Augment physical infrastructure in each sector. Physical leakages should be plugged with appropriate technology. Regular maintenance is also important.

Element 4: Adopt rainwater harvesting in all areas

19.6.3.22 Rainwater harvesting should be mandatory in urban areas, with hefty fines for both buyers and builders if it is not implemented. It can be adopted in rural areas too. In rural areas, the traditional system of storing water in tanks can be revived. There are several technologies for rainwater harvesting:

- Roof water harvesting is recommended for urban areas.
- Rainwater syringe (coastal areas)[35]: Rainwater is collected from the rooftops of houses and stored in a pressure tank in the ground, and with the help of PVC pipes this water is lowered below sea level (up to 16–24 feet). The water is retained in the underground water column and this harvested water can subsequently be collected by a simple piston pump or motor by constructing a tube well in the vicinity before it gets mixed with saline water. Through this method, 500 to 2,500 litres of water can be drawn daily and used for both drinking and minor irrigation.

Element 5: Irrigation

19.6.3.23 Analysis shows that major and medium irrigation systems have not expanded over the past 10 years and there is significant under spending in that area. The strategy should be to focus on operating and maintaining the already existing major and medium irrigation systems and focus on developing minor and micro irrigation systems in Kerala. They conserve water while achieving results.

19.6.3.24 Check dams for irrigation in rural areas: A check dam is a small dam built across a minor channel or drainage ditch and caters to the temporary or permanent needs of a few hectares of land.

The construction cost of a check dam is only a few lakh rupees. Their major advantages are that they reduce erosion and gullying in the channel, slow the speed of the water flow, allow sediment and pollutants to settle and facilitate groundwater recharge. Since the State has a number of rivulets, this technique can be widely adapted. This will help sustain water flow in the rivers as well as the biotic wealth. In India, the most successful example of check dams can be found in the Kutch and Saurashtra regions of Gujarat. These regions saw an unprecedented drought in the year 2000. The government of Gujarat invested more than Rs 118 crore to construct 10,708 check dams in Saurashtra, Kutch, Ahmedabad and Sabarkantha regions under the Sardar Patel Sahakari Jal Sanchaya Yojana. These works were carried out with the direct and indirect financial participation of the beneficiaries, with 40 per cent of the estimated cost contributed by beneficiaries while the government paid the remaining 60 per cent. An independent evaluation of the project by the Indian Institute of Management-Ahmedabad found that localised rain water harvesting systems in the form of check dams in Saurashtra were a solution to water crises by recharging rainfall run-off into underground aquifers, decentralised drought-proofing systems and people's involvement in critical water management tasks using simple, local, skill-based, cost-effective and environment-friendly technology. Similarly, Gulati et al. (2009) found that the water strategies adopted in Gujarat helped raise agricultural productivity. In 2009-10, the agricultural economy in Gujarat grew at the rate of 9.6 per cent per year and the growth was not led by the canal irrigated areas, but by dry Saurashtra, Kutch and north Gujarat. China is also a leader in the check dam system. With advantages such as drought-resistance and fertile and good yields on dam farmland, about 100,000 check dams were built in the late 1960s and the 1970s.

19.6.3.25 Traditional water systems: Revive traditional methods of water conservation. In Tamil Nadu, *ooranis* or ponds were revived under a pilot pond innovation programme, which resulted in supply of water throughout the year to villages, while water pollution has gone down.[36] Kerala should also explore, on a pilot basis, ways to revive the *kulams* in Palakkad district to assess if this makes any difference and, if it does, to extend the scheme to other places with a similar geography. In general, the tanks and ponds in Kerala should be revived for irrigation given their positive economic and ecological benefits. The report of the Kerala 12th Plan Working Group on Water Management and Watershed Management notes how *kattas* (check dams) and *surangams* (water tunnels) in Kasaragod district enhance water status and contribute to agricultural production. However, there has been a decline in the construction of these traditional mechanisms and they are increasingly being substituted by bore wells. Of course, this has a detrimental effect on groundwater levels. Therefore, the agriculture and groundwater departments need to work together to limit bore wells and, instead, encourage traditional water systems as they boost the use of water in a sustainable fashion.

19.6.3.26 Adopt drip irrigation/micro irrigation or localised irrigation: Drip irrigation is the targeted, intelligent application of water, fertiliser and chemicals, which, if used properly, can provide great benefits. Farmer-driven irrigation methods are better than public irrigation. For example, drip irrigation in Israel uses plastic pipes that release water directly onto the roots of the plants without flooding the entire field and recapture any excess water for reuse.[37] Overhead drip irrigation systems can be used for coconut too. The government can give subsidy to small and marginal farmers for adopting this technology. Plus, it might be especially appropriate for homestead farming that is so prevalent in Kerala. Another option is the rain gun irrigation system.[38] The sprinkler rain gun irrigation system gives complete coverage of water in all areas, which helps the perfect functioning of roots to absorb all manure. So cultivation of intercrops such as banana, grams and fodder is very easy. This type of irrigation system creates a microclimate that is favourable for earthworm growth, which helps natural organic farming activity. The disadvantage of the rain gun water jets is that they are hidden by trees, which affects the uniform distribution of water

Element 6: Recycle and reuse water

Changes in building norms in urban areas

19.6.3.27 Recycling and reuse of water should be progressively made compulsory for residential buildings to conserve water.

19.6.3.28 The 3Rs principle should also be adopted for industrial use of water.

Water and waste management are complementary

19.6.3.29 Water supply and liquid waste management schemes should be implemented together, with the same organisation managing both. Some examples from around the world are[39]:

- Singapore recycles 'grey water' to drinking quality standards by using new filtration technology (Box 19.2).
- Wastewater treatment plants can be used to generate electricity. There are 24 sewage treatment plants (STPs) in Oregon in the US that generate electricity by burning methane. There is research going on about more efficient ways to generate electricity from wastewater. Anaerobic digestion of sludge, along with a combined heat and power approach is a technically and financially viable option to reduce operating costs through the production of biogas and its utilisation in combined heat and power systems.[40]
- In Ashkelon, Israel, a new desalination plant on the Mediterranean Sea, just north of Gaza, delivers fresh water at US$0.50 per cubic meter, down from US$2.50 in the early 1990s. This was achieved by an improved reverse osmosis system requiring less energy to drive seawater through the desalination unit.
- A modern paper mill in Finland has reduced the amount of water used per unit of output by over 90 per cent over the last 20 years by switching from chemical to thermo-mechanical pulp and installing a biological wastewater treatment facility that permitted recycling of water.
- A textile firm in India reduced its water consumption by over 80 per cent by replacing zinc with aluminium in its synthetic fibre production and by reducing trace metals in wastewater, which enabled reuse. It also used the treated water for irrigation by local farmers.
- A plant converting sugarcane into sugar in Mexico reduced its consumption of water by over 90 per cent by improving housekeeping and segregating sewage from process wastewater.

Coexistence of modern and traditional methods

19.6.3.30 Treatable tap-piped water should be delivered to 100 per cent of urban and 80 per cent of rural households. In rural areas, traditional methods should also be examined to boost water supply for purposes other than drinking

Box No 19.2

Public Utilities Board in Singapore

Singapore presents a challenging environment for water resources management, as it is a small but densely populated island city-state. The Public Utilities Board (PUB) is the national water agency, charged with water, wastewater and storm water management in the city-state. The public agency services about 4.5 million people and several major industries. The development and implementation of the complete management system is on going, but has taken over 40 years. PUB's holistic approach has resulted in a lower dependence on external water sources by diversifying its water sources, including water reuse, desalination, storm water storage in new water storage units and supply of very high-quality recycled water to industry, with some internal reuse of this supply. In its own operations, the PUB has significantly reduced water losses due to leakages in pipes and inaccurate meters. Its services cover 100 per cent of the population with water and wastewater services, and strong political and public acceptance of its policies and services. This has been accompanied by a major change in its water pricing and access policy that aims to use the rate structure to encourage more efficient use of water. The PUB has been able to deliver water of higher quality to industry and the community at lower costs. Reclaimed water, branded NEWater, in Singapore is recognised for its high quality. Singapore has also been able to maintain low water costs for households on the lowest tariff plans, despite the major capital investments in new equipment and systems. Its household-directed campaign of 'Water efficient homes' helps residents save water at home and reduce their water bills. Through an extensive partnering programme with the water industry in all aspects of implementation, it has become a model of outsourcing skills. From this, it has developed an industry capable of transferring this knowledge and skill to the region, as well as attracting a broad rage of industry skills and capabilities as well as research in Singapore. The PUB, which won the prestigious 2007 Stockholm Industry Water Award, is used as a case study in the education of water managers.

Source: PUB. 2013. Innovation in Water Singapore. http://www.pub.gov.sg/mpublications/Innovation/Pages/default.aspx. 4. April 10

Management of sewage water

19.6.3.31 Pipes should be laid to channelise the run-off water so that it can be treated and reused. Storm water drains should be developed (Box 19.2). To start with, all cities/hubs should get wastewater treatment plants.

Smart water planning

19.6.3.32 Smarter maps can support better water planning. A new computational strategy promises to boost the efficiency of sewer network planning as Kerala continues to grow.

Management of groundwater

19.6.3.33 Groundwater needs to be monitored, managed and recharged.[41] In areas where groundwater withdrawal is higher than the recharge, artificial recharging of the aquifers can be practised on a long-term basis to maintain the quantum of groundwater and to combat its progressive decline. The available techniques are:

- Direct surface techniques: Flooding, basins or percolation tanks, stream augmentation, ditch and furrow system and over-irrigation.

- Direct sub-surface techniques: Injection wells or recharge wells, recharge pits and shafts, dug well recharge, bore hole flooding and natural openings and cavity fillings.
- Combination of surface and sub-surface techniques: Basin or percolation tanks with pit shaft or wells.
- Indirect techniques: Induced recharge from surface water sources and aquifer modification.

Adopt technology

19.6.3.34 The State can adopt, adapt and develop innovative technology that will optimise the water treatment processes in Kerala for the production of safe drinking water rather than depending solely on river water. The State can adopt techniques in desalination such as multi-state flash desalination, multi-effect distillation, reverse osmosis (RO), NIOT's low temperature thermal desalination and variable desalination plant. Other technologies to treat water include emulating tongue-to-screen water quality, using peat to treat microbes and membrane technology. Also, seawater can be used after it is desalinated.

Pillar 3: Water Demand

Element 1: Training and education

19.6.3.35 Educate people on the sustainable use of water: The Andhra Pradesh Farmers Ground Water Management System (APFAMGS) is an example of a community-based project involving over 28,000 men and women farmers in 638 villages across 7 drought-prone districts.[42] The project focuses on developing the capacity of groundwater users to manage the resource in a commonly sustainable way. The project adopted a demand-side approach to groundwater management, in which farmers are made to understand how their groundwater system functions so that they can make informed decisions about their water use. The core concept or belief of APFAMGS is that sustainable management of groundwater is feasible only if users understand its occurrence, cycle and limited availability, and they accept that groundwater conservation through collective decisions is ultimately to safeguard their own interests.

Element 2: Price

19.6.3.36 A modest cost recovery may help the water authority invest more in current technology and also in research and development activity. Further, pricing water educates people to conserve water. Selin et al. (2012) evaluated the domestic water tariff in Kerala and the analysis suggests that it is 5.7 times less than what it would have been if it matched the consumer price index and electricity rate[43]. Devi found that the majority of farmers would be willing to pay for water for irrigation.[44] The evidence indicates that there is a willingness to pay for better service. Further, prices should be charged for both water and sewage. Strategies need to be in place for the economically weaker sections. Cash subsidies might be a good option. Public taps may also prove to be useful, especially in urban slums. In rural areas, community water participation may help those who are less well-off. Also, consumers may be encouraged to pay more (or contribute) to a water conservation fund or water R&D activities. Dynamic pricing methods may also be thought of for water use. Sanitation charges should also be included. Further the 'polluter pays principle' should be implemented for water pollution. Industry and the commercial sector should pay market rates for water use. Therefore, it is very important to track and monitor use.

Element 3: Technology to manage demand

19.6.3.37 Some examples of technology used to manage demand are:

- Domestic waste management: Compost toilets are an alternative to pits and septic tanks, especially in waterlogged or coastal areas.[45] The UK is the leader in dry compost toilets that require no water or electricity and China has been using them for centuries. By using compost

toilets, cities and peri-urban areas do not need to extend capital-intensive sewerage networks and sewage treatment plants, and they avoid the recurring cost of maintaining additional infrastructure. Both these factors represent a huge saving. Also, in areas where toilets are flushed with municipal water there is an enormous saving in water requirements. Cross-contamination between water mains and sewers is eradicated because compost toilets are well established as the standard sanitation technology. Soils are steadily improved by the regular addition of good quality compost.

- Groundwater monitoring is also very important, especially in industrial use. Industry should pay a charge for withdrawal of groundwater too. Industries that use large quantities of water should have mechanisms for recycle and reuse of water.

19.7 Monitoring

19.7.1 The data on water is outdated and insufficient. Data needs to be collected on various parameters such as per capita water consumption by cities and villages and how much water each sector uses, particularly the agriculture sector. Groundwater needs to be monitored regularly — water tables, pollution levels and so on. For water conservation, water efficiency measures need to be calculated. Further, methods are required to assess how much water each sector uses and returns. There are five major indicators that need to be monitored[46]:

- Water availability:
  - Total actual renewable water resources per capita.
  - Per cent of freshwater resources withdrawn.
- Water use and sustainability:
  - Intensity of use of water resources: Total water withdrawals over total actual renewable water resources (TARWR).
  - Sectoral withdrawal as a percentage of total withdrawal (agricultural, industrial, municipal).
- Water use effectiveness:
  - Percentage of population with access to improved water sources.
  - Percentage of population with access to improved sanitation.
- Economic performance of water:
  - Change in water productivity in irrigated agriculture.
  - Water productivity in the industrial sector.
- Environment performance:
  - Change of quality in freshwater systems.
  - Urban wastewater treatment connection rates.

19.8 Conclusion

19.8.1 Kerala cannot be complacent about water and sanitation. This has been a neglected social sector, which is now hurting the State because of uncertain weather patterns that are here to stay. The path forward is about how to manage water. Kerala has to advance by changing institutions and managing demand and supply. The State has to conserve water, which means following the 3Rs principle. Also, consumer behaviour needs to be modified, and price acts as an incentive to do that. It is always going to be a challenge, and flexibility and continuous innovation are key elements in this process.

Appendix A.19.1

Water Resources in Kerala: 2010

Type of Water	Type of water body	Number	Area (ha)
Freshwater resources	Private ponds	35,763	21,986
	Panchayat ponds	6,848	1,487
	Quarry ponds	879	341
	Holy ponds	2,689	480
	Village ponds and other water holds	185	496
	Irrigation tanks	852	2,835
	Public sector freshwater fish farms	13	85
	Freshwater springs	7	NA
	Freshwater lakes	9	1,620
	Waterfalls	11	NA
	Rivers	44	85,000
	Check dams	80	259
	Bund/Barrier/Anicut/Shutter waterholds	70	879
	Reservoirs	53	44,289
	Kole lands		17,000
	Kuttanad Padasekharams		35,000
	Paddy fields in Palakkad		1,20,000
Brackish water resources	Brackish water area		65,213
	Backwaters	53	46,219
	Prawn filtration fields	234	12,873
	Public sector brackish water fish farms	12	227
	Estuaries (Azhi/Pozhi)	84	NA
	Mangrove areas	NA	1,924

Source: Department of Fisheries. 2012. Kerala Inland Fisheries Statistics 2010. Government of Kerala, Thiruvananthapuram

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[29] *Australia has used another solution. It has opened the market for water, i.e., to facilitate trade in water entitlement. Irrigators can purchase temporary or permanent entitlements, or if they hold these entitlements they can sell them to other users, but this requires the government to intervene and buy water rights in the open market and also take care of the negative externality. For example, take an irrigator who is currently producing a commodity that is a relatively low−value water−intensive crop. This irrigator could, in dry periods, choose to sell his water allocation to a farmer producing higher−value crops and thereby earn extra income by trading the water. In this way, income can be generated for farmers and the problem of over−allocation of river water that exists in many locations can be reduced.*

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Chapter 20

MANAGEMENT OF ECOLOGY AND ENVIRONMENT

Chapter 20

Management Of Ecology And Environment

20.1 The Kerala Context

20.1.1 Kerala is a narrow strip of land sandwiched between the Western Ghats mountain range on the east and the Arabian Sea on the west, with about 4 per cent of the State's geographical area being wetlands. The total land area of the State is 38,863 square kilometres. As per the High Level Working Group (HLWG) report on the Western Ghats, the natural landscape of the State is 12,477 sq km (32.1 per cent of Kerala's total land area), and protected areas and World Heritage Sites is 4,913 sq km (12.6 per cent), the two together adding up to 44.7 per cent of total area of the State. Together with the wetland area, estimated at 1,605.90 sq km and the coastline of 587.8 km, Kerala has a complex ecosystem rich in biodiversity.

20.1.2 The extent of forests in Kerala is 29 per cent of its geographical area. Concerted steps have been taken to maintain and protect the forests. The total recorded forest area of the State in 2005 was 11,265 sq km. This has now increased to 11,305 sq km. The State stopped the clear felling and selection felling of natural forests from the mid-1980s. Further, in order to maintain the biodiversity and the environmental stability of the region, the State is not harnessing its full hydel energy potential.20.1.3 The tropical forests of Kerala are valuable not only for its carbon sequestration ability, but also for its water holding capacity. It is this capacity of the forest ecosystem that makes the flow of Kerala's 44 rivers perennial. Water in these rivers is used not only by Kerala, but also by neighbouring states such as Tamil Nadu and Karnataka. Kerala represents the epitome of the biodiversity profile of India's Western Ghats.

20.1.4 There are 30 World Heritage Sites in India that are recognised by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) as of 2013. These are places of importance of cultural or natural heritage as described in the UNESCO World Heritage Convention, established in 1972. In the Western Ghats, one of the world's ten 'hottest biodiversity hotspots' (sub cluster nomination), a total of 39 properties (including national parks, wildlife sanctuaries and reserve forests) were designated World Heritage Sites — 20 in Kerala, 10 in Karnataka, five in Tamil Nadu and four in Maharashtra.[1]

20.1.5 Three of the 26 Indian Ramsar Sites are located in Kerala, accounting for 213,023 hectares of the total 689,131 hectares in India (30.9 per cent): Asthamudi Lake (61,400 ha), Sasthamkotta (373 ha), and Vembanad Kole Wetland (151,250 ha). Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic material (www.ramsar.org).

20.1.1. The key issues

20.1.1.1 There is a growing recognition all over the world that the ecological environment is vital for sustaining the life support systems on earth. Concerns over climate change, escalating energy prices and widening water deficits have moved environment into the spotlight of global and national development. However, to manage environmental resources for sustainable development, they need to be recognised as complex, dynamic and highly interconnected multiple use ecosystems. Among the environmental resources, forests play an important role in economic and social development in terms of their contribution to Gross Domestic Product (GDP), employment and livelihood of the marginalised groups of people. Besides, they are also the main source of meeting the food, fuel, fodder and timber requirements of the forest dwellers. Some of the growing sectors of the economy such as tourism and construction too draw heavily on environmental resources. Thus, the following fundamental characteristics of forests, wetlands and coastal zones need to be considered in sustainable development approaches.

20.1.1.2 All types of natural forests and environmental resources must be managed for their ecological, environmental, biodiversity and germ-plasm values. Therefore, within them, conservation, augmenting, nurturing and protection activities alone need be done. Forests must be viewed and managed at the landscape level, wherein relationship between forests, agricultural lands and plantations as well as various mutually interacting and interdependent biotic and abiotic factors have to be considered in a holistic manner. Whereas almost all the economic forest products for the sustainable development of all wood and non-wood using sections must be largely obtained from man-made plantations, agroforestry and trees outside forests. For sustainable management of all special ecosystems, fragile ecosystems, refractory sites, wastelands, vulnerable ecosystems and rare, endangered and threatened (RET) species of flora and fauna both within and outside forests, participatory approaches may be adopted.

20.2 An assessment of Forest Resources

20.2.1 Historical review

20.2.1.1 Kerala has a long history of forestry, which started from the 19th century. Initially, the British came to the region for timber, especially teak and rosewood, and cardamom to export it to the UK.[2] The British appointed the first conservator in 1840 to extract timber and introduced a tax on forest products such as cardamom and wax. The Indian Forest Act was enacted in 1865 and a forest school was set up in Dehradun in 1878. The Travancore Forest Act came into force in 1887. Konni in Pathanamthitta district was declared the first 'reserved forest' in 1888 (October 9) under this Act. More areas were declared as reserved forests in 1889. T. F. Bourdillon was appointed as Conservator in 1891 and prepared the *Report of the Forests of Travancore* in 1892. Large scale planting of teak was started during this period.

20.2.2 Forest area

20.2.2.1 An area of land recorded as forest in revenue records or proclaimed to be forest under a forest law or Act is defined as forest. This is officially documented as 'recorded forest area'. The recorded forest area is categorised into 'Reserved Forest', 'Protected Forest' and 'Un-classed Forest'. While reserved forests are fully protected, protected forests are accorded partial protection. An un-classed forest is an area recorded as forest, but not included in reserved or protected forest category. Ownership status of such forests varies from state to state.

20.2.2.2 The measurement of forest area differs between the central and state governments, partly because of measurement issues. Impreciseness and inconsistency in measurement results in a

policy quandary because it has different policy implications. The central government measurements cannot be ignored because they are required for national comparisons. Clearly the state government needs to clarify measurement issues with the central government or at least report both sets of data in its reports, reconciling them for the convenience of both academics and policymakers.

20.2.2.3 The Forest Survey of India (FSI), a central government institution, has been undertaking assessment of forest area and forest cover in the country since 1987 on a two-year cycle. It shows that the total recorded forest area at the national level increased between 2001 and 2011, by 1,102 sq km from 768,436 sq km to 769,538 sq km (Table 20.1). An important observation to be made is that at the national level almost 55 per cent of the total forest area is reserved, while 28 per cent area is protected. The rest comes under un-classed forests. In Kerala, over 98 per cent of the forest area is recorded as reserved forests. There are no un-classed forests. The final observation is that the increase in forest area at the national level over the past decade was essentially due to an increase in un-classed forests. The area of both protected and reserved forests declined. In contrast, in Kerala, the expansion in forest area was due to growth of reserved forests.

Table.20.1
Recorded forest area in Kerala versus All India: 2001 and 2011

Region	Year	Total area (km2)	Reserved (km2)	Protected (km2)	Un-classed (km2)	Total recorded (km2)	Share in total area (%)
Kerala	2001	38,863	11,038	183	0	11,221	28.87
	2011	38,863	11,123	142		11,265	28.99
India	2001	32,87,263	4,23,311	2,17,245	1,27,882	7,68,436	23.38
		32,87,263	4,22,536	2,13,982	1,33,020	7,69,538	23.41

Source: Forest Survey of India

20.2.2.4 Table 20.2 shows the composition of forest area in Kerala. Plantations form a significant share (37.9 per cent) and its share is increasing over time. (This is different from what has been shown by the state government, see below).

Table.20.2
Composition of Forest Area in Kerala (%)

Type of Forest	2009	2011
Tropical Ever Green	26.21	23.19
Tropical Semi Green	22.86	20.20
Tropical Deciduous Moist	18.14	16.15
Dry	2.29	2.05
Plantations	29.97	37.92
Others	0.53	0.50
Total	100	100

Source: Forest Survey of India

20.2.2.5 The FSI reports that in 2011 the protected areas in Kerala included six National Parks, 15 Wildlife Sanctuaries, two wetlands and part of the Nilgiri Biosphere Reserve.

20.2.2.6 Kerala Statistics

20.2.2.6.1 The forest area under the administrative charge of the Kerala Forest Department is 11,309.38 sq km. Using these statistics, the total forest area formed 29.1 per cent of the total geographical area of Kerala in 2010-11. Box 20.1 explains the distribution of forest areas as per the legal status.

20.2.2.6.2 Other than the legal status as defined in Box 20.1, the state government also classifies forests as per type and utilisation. Table 20.3 shows the classification of forest types as on 31 March 2011 and Table 20.4 shows the classification of forest area according to utilisation. In contrast to the FSI statistics, the Kerala statistics show that plantations only form 13.2 per cent of Kerala's forests. If plantations are excluded, the total forest area in Kerala comes to 25.3 per cent of the total land area. While better than the national average, clearly the forest area is overstated in Kerala due to the presence of plantations.

20.2.2.6.3 Further, the Kerala Forest Statistics shows that as of March 2011 there were five National Parks — Silent Valley National Park, Eravikulam National Park, Pambadum Shola National Park, Anamudi Shola National Park and Mathikettan Shola National Park. Apart from this, there were 17 Wildlife Sanctuaries, one Community Reserve and two Biosphere Reserves. They are not necessarily distinct from each other; for example, the Silent Valley National Park is a part of the Nilgiri Biosphere Reserve. Even the assessment of the number of National Parks differs between the central and state agencies.

Box No 20.1

Forest Area, Kerala Methodology

The State's forest department uses detailed statistics at the local level to assess forests. Kerala's forests are legally classified in the following manner:

- **Reserve forests:** The forest reserved under Section 19 of the Kerala Forest Act includes forests notified under Section 4 of the said Act. It comprised 81.14 per cent of total forest area in 2010-11 - 9,176.3 sq km. There is an additional 295.4 sq km of land that is proposed as reserve forests. It accounted for 2.6 per cent of the total forest area in 2010-11.
- **Vested forests:** Is any forest vested in the government under Section 3 of the Kerala Private Forest (Vesting and Assignment) Act, 1971.
- **Ecologically Fragile Land (EFL):** EFL means any portion of land held by any person and lying contiguous to or encircled by a reserve forest or vested forests or any other forest owned by the government and predominantly supporting natural vegetation, and any land declared to be EFL by the government by notification in the official Gazette under Section 4 of the Kerala Forest Act.
- **Vested Forests and EFL** together accounted for 1,837.8 sq km or 16.3 per cent of the total forest area in Kerala in 2010-11.

Therefore, Kerala Forest Statistics 2011 show that forest area (11,309.5 sq km) forms 29.1 per cent of the geographical area. There are eight divisions out of which the southern division headquartered in Kollam has the highest share of forest area (21.7 per cent).

Source: Kerala Forest Department. 2012. Forest Statistics 2011. Government of Kerala

Table.20.3
Classification of Forest Types as on March 31, 2011

Sl.No.	Type	Area (km2)	% of total
1	Tropical Wet Evergreen and Semi Evergreen	3,877.44	34.28
2	Tropical Moist Deciduous	3,615.98	31.97
3	Tropical Dry Deciduous	391.36	3.46
4	Montane Sub-tropical Temperate shoals	386.42	3.42
5	Plantations	1,492.92	13.20
6	Grasslands	501.09	4.43
7	Others	1,044.26	9.24
Total		11,309.48	100

Source: Kerala Forest Department. 2012. Forest Statistics 2011. Government of Kerala

Table.20.4
Classification of Forest Area according to Utilisation as on March 31, 2011

Sl.No.	Type	Area (km2)	% of total
1	Dense Forest/Degraded Forest	8,982.97	79.43
2	Plantations	1,492.92	13.20
3	Area under Lease	423.23	3.74
4	Forest Land diverted under Forest Conservation Act	410.36	3.63
Total		11,309.48	100

Source: Kerala Forest Department. 2012. Forest Statistics 2011. Government of Kerala

20.2.3 Forest cover

20.2.3.1 Forest cover consists of all land having tree canopy density of more than 10 per cent. This can be interpreted from satellite data. Forest cover in this assessment is interpreted from digital data obtained from remote sensing satellites IRS 1C/1D. The area included within forests, therefore, is determined by the resolution and limitations of the satellites' sensor. Taking into account the spatial resolution of the data from the satellites' sensor and technical limitations inherent in data processing, forest cover up to 25 ha could be included prior to 2001. Since 2001, there has been a technology upgrade and forest cover down to 1 ha can be assessed. Thus, the forest cover since 2001 includes all land that has a tree canopy density of more than 10 per cent when projected vertically on horizontal ground with a minimum area extent of 1 ha. It covers all land irrespective of its ownership, land use and legal status. Thus, all land with tree crops such as agro-forestry plantations, fruit orchards, tea and coffee estates have been included in forest cover.

20.2.3.2 The forest cover at the central level is classified into three major categories: dense forests, medium/moderate and open forests. These are defined below:

- **Dense forests:** Dense forests include all land with a forest cover of trees with a canopy density over 70 per cent.
- **Moderate forests:** These forests include all land with a forest cover of trees with a canopy density between 40 and 70 per cent.
- **Open forests:** All land with a forest cover of trees with a canopy density between 10 and 40 per cent is covered under open forest.

20.2.3.3 Table 20.5 shows state-wise forest cover by type and magnitude as reported in the biennial reports of the Forest Survey of India. Forest cover of India as per the 2001 report was 675,538 sq km, which increased to 692,027 sq km by 2011. In Kerala, an average of 40 per cent of the area is under forest cover against the national average of 20.5 per cent. And in 2011, it was 44.52 per cent. The National Forest Policy (1988) has laid a target of 33 per cent of the geographical area to be brought under forest cover and the State has far exceeded this target. A sudden jump in the area under forest cover between 2005 and 2007 can partly be attributed to improvements in the assessment methodology. While at the national level it increased from 20.6 per cent to 21 per cent, in Kerala it jumped by 4.6 percentage points from 40 per cent to 44.6 per cent. Notably, however, Kerala's share of open forest is almost twice that at the national level.

Table 20.5
Forest cover: All India versus Kerala, 2001 to 2011

Source	All India				Kerala			
	Area under forest (km2)	Dense and moderate (% share)	Open forests (% share)	Total (% share)	Area under forest (km2)	Dense and moderate (% share)	Open Forest (% share)	Area under forest (% share)
2001	6,75,538	12.68	7.87	20.55	15,760	30.29	9.75	40.04
2003	6,78,333	11.88	8.76	20.64	15,577	24.77	15.31	40.08
2005	6,77,088	11.78	8.81	20.60	15,595	24.86	15.27	40.13
2007	6,90,899	12.25	8.77	21.02	17,324	27.93	16.65	44.58
2009	6,92,394	12.28	8.78	21.06	17,324	27.93	16.65	44.58
2011	6,92,027	12.30	8.76	21.05	17,300*	27.88	16.63	44.52

*Note: * Adding scrubs (58 square km) and non-forest area of 21,505 square km to 17, 300 square km brings the total State area to 38,863 square km.*

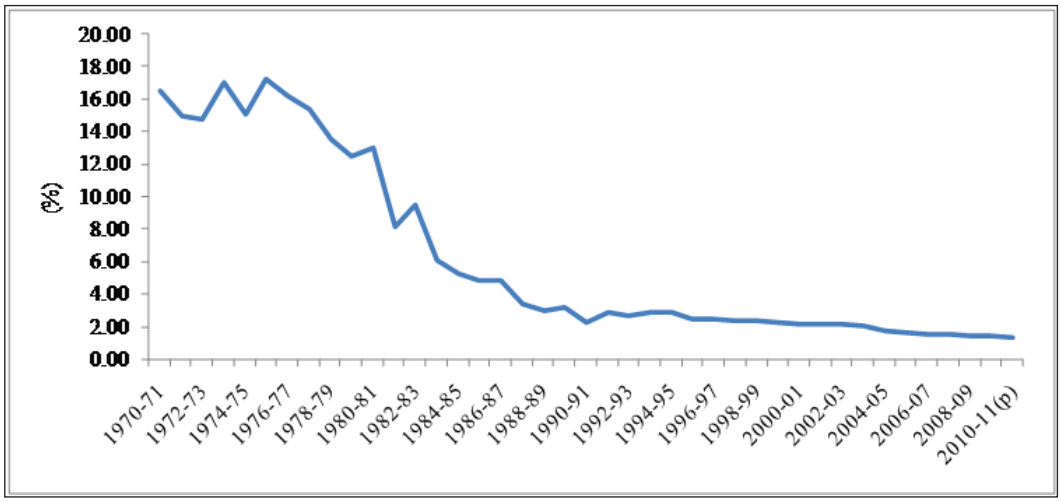
Source: Forest Survey of India, various issues

20.2.3.4 Over 51 per cent of the total State forest cover is in the southern districts and the remaining 49 per cent is in the central and northern regions. Wayanad, Idukki and Pathanamthitta districts have the largest area under forest cover. Alappuzha is the only district with little area under forest cover. Much of the forest cover of Kerala is spread over the Western Ghats. The Western Ghats, a sizeable portion of which is in Kerala, is one of the 34 global biodiversity hotspots and is considered to be a repository of endemic, rare and endangered flora and fauna. There are about 550 species utilised as non-wood forest products (NWFP). Teak and eucalyptus have been the principal forest plantation species.

20.2.4 Value added from forests

20.2.4.1 Forests produce is vital for ecological stability and important for the well being of an economy. In Kerala, value addition from forestry grew at a negative rate from 1970-71 to 1989-90. In 1990-91, its growth shot up to 32 per cent. Since then it has been growing at a rate of over 2 per cent. However, since the growth rate in the rest of the economy is rather high, the share of forestry has been declining continuously. Its contribution was as high as 16.5 per cent of GSDP in 1970-71, which declined to a mere 1.3 per cent by 2010-11 (Figure 20.1).

Figure 20.1
Contribution of Forestry and Logging to Kerala's GSDP (%): 1970−71 to 2010−11



Source: Directorate of Economics & Statistics, Kerala

20.2.4.2 The GSDP for the forest sector is based on the commercial value of the saleable products from forests, such as timber, firewood and minor forest produce, and forest services. All the intangible benefits such as carbon sequestration, soil and water conservation, biodiversity and so on are presently not accounted for in the computation of GSDP and, thus, the contribution from forestry remains underestimated.

20.2.4.3 The share of the forestry sector in the value of output of agriculture and allied services at the Kerala level went up from 10.6 per cent in 2004−05 to 17.4 per cent in 2008−09 before coming down to 12.4 per cent in 2010−11 at constant 2004−05 prices.[3] The share in the value of output from the forestry sector of agriculture and allied services has stayed stable at the national level: 9.8 per cent in 2004−05, 9.2 per cent in 2008−09 and 8.9 per cent in 2010−11.

20.3 The Success Factors

20.3.1 The legal framework

20.3.1.1 Clearly, India, particularly Kerala, has shown impressive achievements in terms of forest conservation. This could be attributed to government efforts both at the centre and state levels. The Constitution of India assigns fundamental duties to the citizens of the country and directs states for conservation and protection of forest, wildlife and the environment. A well-developed legal framework is in place at the national level. In addition, most states in the country have promulgated separate legislations to meet their specific requirements.

20.3.1.2 In India, a formal Forest Policy for protection, conservation and management of forests has been in effect since 1894. It has been subject to revision from time to time. Early forest policies tended to consider timber production as the primary function of the forest. The Forest Policy 1952 recognised the protective role of forests and stipulated that the country should aim at having at least one third of its total land area under forests. However, development imperatives after Independence resulted in large-scale diversion of forests for agriculture and other developmental activities. In the early 1960s, the imperative for industrial development prompted governments to boost investment in large-scale industrial plantations for ensuring supply to wood-based industries. This diverted

vast natural forests to fast growing pulp, matchwood, plywood and other economically important hardwood species. In the mid-1970s, 'Forest' was shifted from the State List to the Concurrent List in the Constitution of India due to emerging ecological needs. On the recommendations of the National Commission on Agriculture in 1976, increasing productivity and the concept of social forestry emerged as the major objectives. The diversion of forests was restricted in 1980 when the Forest (Conservation) Act 1980 was enacted. It is a regulatory Act and maintains a balance between development and conservation. It establishes the primacy of the environmental and social service functions of forests, while placing clear restrictions on commercial logging. It was a milestone step in the direction of forest conservation in the country. Since the 1980s, the Government of India has promoted plantations under agroforestry and social forestry plantation schemes. The plantation area in India is 32.57 million ha, which accounts for 17 per cent of global forest plantations and is the second largest in the world after China. The Constitution of India puts the responsibility of social forestry on local governments.

20.3.1.3 India undertook a revolutionary shift in forest management from a regulatory to a participatory approach with the promulgation of the National Forest Policy 1988. With this, ecological security became the prime objective and the focus was on providing livelihoods for forest dependent communities. It called for stopping timber supply to the forest industry at a concessional price and recognised the rights and concessions of the communities living within and around forest areas, specifically the tribal people. This policy reintroduced the concept of community-based forest management institutions. Under the policy, local communities were involved in the conservation, protection and management of forests through Joint Forest Management (JFM) institutions. In Kerala, the Joint Forest Management Councils at the village level are known as 'Vana Samrakshana Samithis' (VSS).

20.3.1.4 In 1996, through a landmark judgement on the diversion of forests by the Apex Court, all matters related to diversion of forests, irrespective of ownership, came within the purview of the government. Besides, for any land use change from the forest category, prior concurrence of the central government was made mandatory. The stipulated mandatory provision of compensatory afforestation and payment of net present value has made the diversion process more stringent.

20.3.1.5 The Environment Protection Act was enacted in 1986 for improving the environment of the country. A legal regime for biodiversity conservation came into force with the promulgation of national level legislation — the Biological Diversity Act 2002. Another milestone was achieved in 2006 with the enactment of the Forest Rights Act 2006. It strengthened the institutional framework of village forest institutions by restoring traditional rights of forest dwellers and maintaining the ecological balance with a view to provide sustainable livelihood options.

20.3.1.6 Thus, the forestry sector has been undergoing distinct stages of transition. During the 1960s, wood production was much higher due to large-scale conversion of natural forests to plantations as part of the Five Year Plans. The 1980s showed a rapid decline in production due to stoppage of clear felling and selection felling from natural forests. Production caught up later, as plantations created around four decades earlier started maturing.

20.3.2 Vana Samrakshana Samithis (VSS): Village forest councils

20.3.2.1 India's National Forest Policy (NFP) of 1988 created space for community participation and establishment of village forest councils (VFCs) in the management of forest resources of the country. An increasing focus on people-centred policies, bottom-up planning processes and decentralised governance are some of the key characteristics of this new paradigm. In many Southern states of India, including Kerala, the VFCs are called Vana Samrakshana Samithis (VSS). Each village (hamlet/settlement) forms a VSS bearing the same name as that of the village. These *samithis*

function under the Forest Development Agencies (FDA). In Kerala, these FDAs are registered under the Travancore-Cochin Charitable Societies Registration Act of 1955.

20.3.2.2 The government retains the main authority, but shares certain responsibilities with local communities under state-specific arrangements. The VFCs in Kerala are responsible for the management and protection of forests; harvesting of forest produce; prevention of grazing, fire, theft or damage; reporting of forest offences to the forest department; assisting forest officials in distribution of returns from forestry operations; maintaining and operating a village account; undertaking development activities using financial resources generated from forestry activities; and so on. VSS, along with the forest department, nurture degraded forests and take up conservation activities under long-term agreements. Apart from gaining employment, the VSS members are permitted to share the benefits of forest produce under the State Forest Policy. They pool a share of their profits raised through ecotourism and sale of non-timber forest produce (NTFP) and spend them for the development of their village. In Kerala, all the members of the village community are members of the VSS. However, VSSs are run by an executive committee elected by the village community. The VFCs are emerging as an important mechanism for addressing forest health as well as the well being of forest inhabitants. This is discernible from the acceleration in the growth rate of forestry GSDP in the post 1990-91 period.

20.4 Challenges

20.4.1 The challenge for Kerala is that it is a relatively small state, with a particular geography (north-south axis), fragile ecology (Western Ghats and majority of rivers originating in it), increasing demands for land due to increasing economic growth, urbanisation and transport and energy requirements, which makes management of forests particularly challenging. In Kerala, and for that matter for the whole of India, forests cannot be thought of in isolation because there are people who dwell in them along with other species of animals and plants. Maintaining the biodiversity of Kerala is important for its environmental health. The key issue in Kerala is of managing forests in an economically, environmentally and socially sustainable manner. While Kerala has done a better job than other Indian states in sustaining them, significant challenges remain.

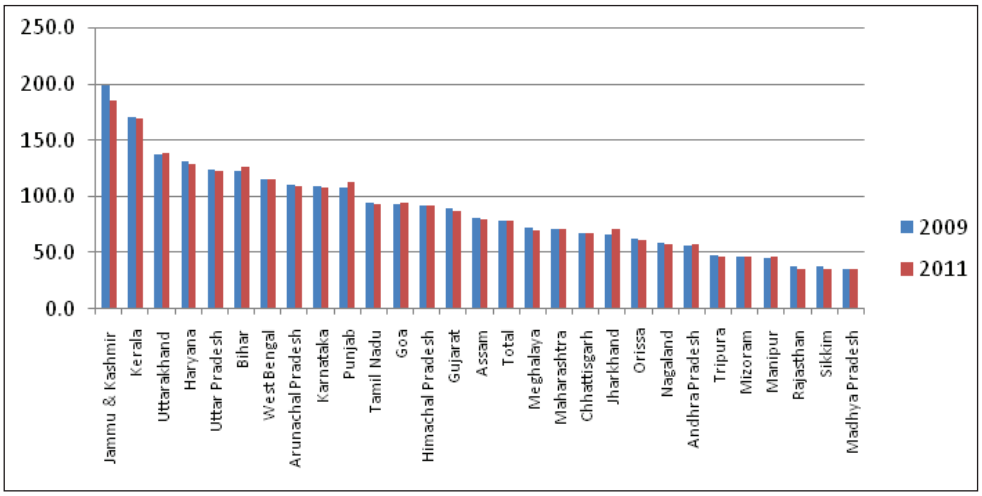
A high share of plantations

20.4.2 During the 1960s, there was a large-scale conversion of natural forests to plantations as part of the Five Year Plans. The share of plantations in total forests, at 13 per cent, for Kerala is relatively high compared to the national average of 5 per cent. Plus, the share of plantations is increasing over time in Kerala.

Decline in the ‘growing stocks’

20.4.3 The ‘growing stock’ is a fundamental element in determining the productive capacity of the forest area. The knowledge of growing stock and how it changes over time is central to considerations of a sustainable supply of wood for the economy and the sustainability of the overall ecosystems that provide them. The growing stock (wood biomass indicating growing capital) of Kerala in forests/trees was estimated at 192.8 million m3 with an average yield of 171 m3/ha in 2009; it declined to 191.6 million m3 (with average yield equal to 170m3/ha) in 2011. In 2010, the estimated total growing stock in the world’s forests amounted to 527 billion m3 with an average yield of 153 m3, which is lower than that in Kerala. However, in some European and South American countries, it is as high as over 340 m3/ha. More worrisome is the fact that it has shown a declining pattern, which is mainly due to non-recycling of biomass in forest soil, forest fires, grazing, over-exploitation and so on.

Figure 20.2
State-wise Growing Stock in India 2009 and 2011(million m3)



Source: Forest Survey of India, 2011

Low production of timber

20.4.4 Forest productivity in terms of annual production is also low. According to the Forest Survey of India Report, 2011, the total wood production from forests and outside forests is 1.7 million m3 in Kerala, compared to a demand of 18.5 million m3 (9 per cent). Similarly, only 15 per cent of the demand for fuel wood is met from forests. Wood comes from all parts of the world, even from South America, to meet the excess demand. But the majority of the imported wood is sourced from Myanmar. Pincoda wood constitutes most of the import. People in north Kerala prefer this wood. In the south, people prefer another variety called Violet.

Stagnation in the forest-based industries

20.4.5 Major wood-based industries are sawmilling, plywood, splints and veneers, pulp and paper and so on. Of the total number of 2,214 registered units, 93 per cent are small-sized, employing less than 10 workers. Examination of the years of inception of a cross section of these units showed that there has been stagnation in the growth of the industry, with little or no addition in the number of units in recent times. This is largely because the forest department has stopped issuing no objection certificates (NOC) to new entrepreneurs. The recent liberalisation of rules on restricted felling of trees from homesteads has opened up avenues for more agro-forestry options in the State. Home gardens and estates, particularly rubber plantations, form the major source of wood supply in Kerala.

Shortcomings of VSS in Kerala

20.4.6 While VSSs have made a substantial contribution to the health of forests in Kerala, the ambiguity regarding their recognition and legal status is considered a threat to institutional sustainability in the long run, as they are treated as unregistered entities under prevailing laws. VSSs are registered under the Forest Development Agency (FDA), which are legally recognised bodies with more administrative and bureaucratic representation than village community participation. As of now, community stability depends mainly on economic benefits that are at the disposal of community members. The gender difference in benefit distribution may also hinder the institutional sustainability in the long term. It has also been observed that despite the increasing social harmony within the VSS, the social cohesion between villages has declined due to boundary conflicts arising over demarcation of VSS land.

20.4.7 Kerala's strategy for the future must recognise forests as a living being, vital for the sustainability of the State and the nation. Key sectors such as agriculture, tourism, energy and water are linked to it. Therefore, the strategy needs to be dynamic for the economic, ecological and social empowerment of forests and all creatures dependent on it. Essentially, the integrated forests policy will focus on management of forests that will fit the four elements of the mission of the Kerala Perspective Plan 2030 —— economic, human, social and environmental.

20.5 Sustainable forestry

20.5.1 The General Assembly of the United Nations adopted in December 2007 the most widely, inter-governmentally agreed definition of Sustainable Forest Management (SFM): "Sustainable forest management as a dynamic and evolving concept aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. It is characterised by seven elements, including: (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socio-economic functions of forests; and (vii) legal, policy and institutional framework."[4]

20.5.1 Vision

20.5.1.1 The image of the forest sector tends to be that of a static, natural resource-intensive, mature sector. That vision will be replaced by a more dynamic approach. Kerala needs to adopt the principles of SFM. Forests will be a sunrise sector contributing to the production of a continuous flow of desirable forest products and services without undue reduction of its inherent values and future productivity and without adverse impact on the physical and social environment. It is also desirable to link forests with the knowledge economy that is envisioned for Kerala in KPP 2030. Forests will sustain only if they are linked to the productive processes of Kerala and it is in the interests of residents to maintain them, and not just for their existential value.

20.5.2 Goals

- Increasing the economic, human and social empowerment of forest dwellers.
- Protecting the sustainability of forests and the ecosystem services they provide, including water, wildlife habitat, recreation and wood.
- Increase the share of forestry in GSDP to 0.5 per cent.
- Increase the productivity of forests through improved management of resources.
- Improve forest resources in terms of increase in growing stocks to 345m3/ha.
- Combat the greenhouse effect and absorb carbon dioxide.
- Identify new technologies and implement them to make the sector dynamically more productive.
- Facilitate the development and use of renewable 'green' materials and energy.
- Expand the understanding and value of forests to society, especially in urban environments.

20.5.3 Strategic elements

20.5.3.1 The strategy will draw on the principle of sustainable forestry development. The key elements of the strategy will rest on four pillars.

20.5.3.2 Pillar1: Preservation, rehabilitation, regeneration of forests and maintaining forest health

20.5.3.2.1 KPP 2030 has proposed in the chapters on Land (Chapter 13), Environment (Chapter 17) and Urbanisation (Chapter 15) that a Regional Spatial Strategy needs to be developed, which will zone reserved forests and environmentally fragile land, with no conversion allowed. This is in consonance with the Kerala State Forest Policy 2009. Further, a majority of the forests in Kerala lie in the Western Ghats. With the recent reports of the Gadgil and Kasturirangan committees on the Western Ghats and further work by the Biodiversity Board of the State, the zones have been demarcated. Essentially, the forests have to be divided into inhabited and uninhabited or natural forest areas. Natural forests have to be preserved in their natural state.

20.5.3.2.2 The natural forests of Kerala are at different stages of degradation due to biotic impact. One of the important functions and product of the natural forests is capturing, storing and releasing rainwater through streams and rivers. Due to degraded conditions of forests, this function along with other benefits such as availability of various non-wood products from forests has greatly reduced over time. Improving the quality and quantity of biomass will require planting local natural species in the available gaps and degraded portions of natural forests and assisting natural regeneration.

20.5.3.2.4 One of the principal deficiencies that has set in is with regard to soil moisture conservation capacity of natural forests in Kerala. Consequently, over the years, run-off of rainwater has increased, dams have silted prematurely and floods and droughts have been occurring with increasing frequency in the State. There is need to take up regeneration activities to augment these natural forests as well as carry out soil moisture conservation activities in such forests. These will call for gully plugging, contour bunding, building of check dams and river bank protection.

Programme to conserve important trees and other plant species including medicinal plants

20.5.3.2.5 Over the years, several important trees and other plant species have either become rare or threatened or even become extinct in many natural forest areas (such as *Gluta travancorica Bedd., Garcinia travancorica, Cinnamomum travancoricum, Aglaia malabarica, Myristica fatua, Syzygium chavaran, Syzygium travancoricum and Anacolosa densiflora*). Therefore, there is a need to launch programmes to save, conserve and multiply such important trees and other plant species to maintain the original biodiversity and importance of valuable Western Ghats species and prevent further degradation.

Conservation of special sites

20.5.3.2.6 Besides, in Kerala's forests a few special biodiversity regions and several unique (endemic) species are present, which require focus and appropriate concerted management strategies. Among the special regions, grasslands, sholas, undisturbed evergreen forest patches, sacred groves and sandal wood forests are some of the unique types of vegetation in the natural forests. These regions require special attention as their present status represents the cumulative impact of natural evolution and socio-economic interaction with them by humans over millennia. Most of them are, in general, in different stages of degradation. Consequently, much valuable biodiversity has been lost, resulting in negative impacts on ecological services available from these resources to the local populations at present, as well as long-term ill effects from the loss of valuable germ-plasm for future generations. Therefore, there is an urgent need to take up rehabilitation of the above areas through in-situ and ex-situ conservation and subsequent protection and maintenance on a regular basis. At present, occasional and isolated efforts have been made, which are not providing the desired results.

20.5.3.2.7 To identify all endangered species of flora and fauna in the forests, there is a need to undertake regular surveys of their environs and habitats to discover their current status and the nature of threats. Moreover, periodic reviews of flora and fauna species status need to be carried out and to be correlated with the 'IUCN Red List' every three years.

Sandal wood conservation

20.5.3.2.8 Kerala has the distinction of having the only large-scale natural sandal growing area in the country at Marayoor. With sustained effort, the forest department has been able to prevent large-scale, illicit felling, which was a regular feature for several years till 2005–06 when it was brought to an almost negligible level. However, natural regeneration of this species is not occurring, resulting in slow but regular degradation of existing areas whenever an existing tree dies or is illegally cut, causing the threat of losing this crop in the future. Therefore, it is essential that a concerted comprehensive programme of large-scale artificial propagation of sandal trees be taken up both within and outside forest areas. The forest department has not been able to take up this activity so far, partly due to the lack of expertise in artificial regeneration of sandal wood species. However, certain research institutes such as Institute of Woods Science Technology (IWST), KFRI and so on have such technology. With the assistance of these institutions and after suitably modifying the harvesting and marketing rules of sandal, this objective can be achieved.

20.5.3.3 Pillar 2: Increase productivity through improved management of resources

20.5.3.3.1 Public or private, reserved or non-reserved, inhabited or non-habited forests, all need to be managed in a scientific manner. For example, forest fires are common in Kerala. Table 20.6 shows the area destroyed and financial loss associated with it. Using satellite data, the Decision Support Centre established at the National Remote Sensing Centre (NRSC) as part of the Disaster Management Support Programme of the Department of Space (DOS) reported in 2004, that forest burning mainly happens in March.[5] In March 2005, it was observed that 17,922.24 ha was burnt, which was 17 per cent of the total Western Ghats area. (Noticeably there is considerable difference between the data reported by the NRSC and Kerala Forest Statistics.) The reduction in April could be due to recovery of biomass in the burnt forest areas as observed by the satellite. Plus, the deciduous forests and grasslands contributed to 92.08 per cent of the total burnt area. The report also noted the dearth of fire watchtowers.

Table.20.6
Forest Fire Incidents: 2007−08 to 2010−11

Year	Number of Incidents	Area destroyed by Fire (ha)	Financial Loss (Rs)
2007−08	344	2,381.54	55,371
2008−09	871	5,473.86	83,580
2009−10	596	2,333.82	59,700
2010−11	489	2,364.41	67,895

Source: Kerala Forest Department. 2012. Forest Statistics 2011. Government of Kerala

20.5.3.2.2 Therefore, in the short term, the Kerala Forest Department needs to work with the NRSC and generate detailed GIS maps of Kerala's forests. It should tie-up with the NRSC and use available technology to better manage forests in the short run. The NRSC even offers mitigation planning for forest fires.[6] In-house capacity in the usage of GIS within the Kerala Forest Department should also be built up. The department can tie up with central agencies to utilise available technology for better management of forests. The Kerala Forest Research Institute (KFRI) is also developing a

database for Kerala's forestry sector, a decision support system and forest sector analysis. All these efforts between various agencies should be integrated to improve the capacities of the Kerala Forest Department. Further, the Kerala Forest Department can also work with KFRI and the soil survey and water departments to develop soil and watershed maps of forests. The rest of this section recommends other medium to long-term strategies to improve management of forests in Kerala.

Action Plan 1: Promote new technology to improve processes to use the potential of forests

20.5.3.2.3 The vision should be to expand, not reduce, timber supply through a combination of enhanced productivity, improved forest management regimes and commercial programmes for private wood-lot owners, notably energy-intensive ground wood pulp and paper mills. A wider perspective for forest biotechnology is needed that takes into account the huge challenges put forward regarding biodiversity and climate change. The three technologies —ICT, biotechnology and laser technology — in inventory and monitoring are likely to have revolutionary implications for the whole forest sector. Technological changes may alter forest industries, as well as forest management, utilisation and growth. In North America and the European Union countries, new forest sector-related technology programmes have been started in recent years. Forest bio-refinery products and the merging of wood fibre manufacturing with ICT and nanotechnology can provide opportunities for new products, such as forest biomass-based biodiesel and wood fibre-based hybrid media products. Biotechnology has the potential to improve the quality and quantity of wooden raw material supplies from a long-term perspective and could also have a radical effect on pulping processes, waste-to-energy systems and other aspects of the manufacture and use of forest products. Reduced costs and increased yields are the potential economic benefits of biotechnology, which implies that society could get more output from its expenditure on inputs.

20.5.3.2.4 New technology and innovation applied to the forest sector are increasingly needed to enhance sustainability through industrial transformation and technological transitions. The emphasis is on the development of new policies, institutional changes and wide-reaching system changes that transform societies away from unsustainable patterns to sustainable ones. In North America and the European Union countries, new forest sector-related technology programmes have been started in recent years. The forest sectors in these countries seek to innovate and redirect their businesses in ways that provide new benefits from their forests. Typically, new technology is, to a great extent, developed in high income countries, which are better placed for this development in terms of financial resources and scientific and technical know-how. That requires, in practice, a favourable institutional setting that encourages and endorses the flow of new knowledge and innovation through proper information channels, education and training, commercialisation by market mechanisms and human and/or material resources support. This also highlights the need for studying and analysing technological development in developed countries. This is particularly relevant in the context of technology transfer from industrialised countries to developing countries. However, there is a clear need in emerging countries to enhance their own technological capacity-building and, thus, develop robust and competitive industries at the world level to allow them to face the challenges of building successful industrial branches and activities.

Action Plan 2: Better forest management

20.5.3.2.5 Coming under greater pressure, forests require more and more efficient means of growth and management. The forest service needs to be charged with protecting the inherent capacity of the soil to sustain plant growth and to monitor the consequences of forest practices to ensure that this capacity is not endangered. Biotechnology applications using clone propagation, markers-aided selection and breeding, gene transfer and beneficial microbes are already having an impact on how

some trees are being bred, propagated, developed and managed. It can contribute to increasing the efficiency with which forest tree resources are produced and used and, thereby, help make sure this resource is available for future generations. The transgenic method to improve plant growth, wood quality and other aspects to be improved is one technique. Trees can be planted and consequently utilised in a much more effective way when their associated microbes are recognised to improve growth and ecological functions. Technological changes are having important impacts on the way forests are managed and on the various environmental and social services that forests provide. For example:

- **Biotechnology** has the potential to improve the quality and quantity of wooden raw material supplies in the long term and could also have a radical effect on pulping processes, waste-to-energy systems and other aspects of the manufacture and use of forest products. Biotechnology could also have environmental benefits. Plants can be multiplied by clonal propagation and improved through gene transfer of valuable genes and the plant-microbe system. Thus, technological innovation has made it possible to change the way in which, and where, tree species are grown. Increased use of biotechnology enables increased forest growth, introduces more climate-adaptable species and facilitates pest management.
- **Phytotechnology** is beginning to offer efficient tools and environment-friendly solutions for the clean up of contaminated sites, the development of renewable energy sources and for contributing to sustainable land management.
- **Phytoremediation** is a way to remediate polluted environments by using plants to degrade, stabilise and remove soil contaminants. A combination of phytoremediation and microbial remediation, defined as rhizo-remediation, is used to treat hydrocarbon-polluted soils. Phytoremediation and rhizo-remediation use woody plants to improve soil quality and represent a more environmentally compatible and less expensive method to site restoration, compared to traditional approaches. The management of today's forests has become increasingly complex. In addition to timber production, new objectives of forest management have been introduced such as preserving biodiversity, carbon sequestration, deforestation estimates and creation of recreational opportunities, hunting considerations and many others. Forest management decision support systems (DSS) have been developed to aid forest managers in their difficult tasks. At least 82 genera have been detected from a broad range of plants, including woody plants, that contribute to the well being of the plant, acting as growth promoters synthesising phytohormones and enzymes and by fixing atmospheric nitrogen. Potentially, they can protect the plant from pathogenic fungi by their anti-fungal activity.
- **ICT**, which includes the design, development, implementation, support and management of computer-based information systems, also facilitates better forest management. In essence, the application of ICT deals with the use of computers and software to convert, store, protect, process, transmit and retrieve information.

20.5.3.2.6 These and other technologies and innovations, along with their adaptation in the forest sector, have been closely related to general socio-economic development in recent times. There has been a growing need for these innovations and their adaptation was encouraged by research and development (R&D) investments, policies and entrepreneurial activities. Thus, the forest sector is continuously changing because of technological development and innovation. Technological development commonly increases productivity, that is, an increase in output per unit of input. This has been the case, for example, with the chainsaw (higher number of trees felled per man hour) and genetic engineering (higher tree growth per unit of land). However, technological processes may also produce unwanted results such as loss of biodiversity, increased deforestation and pollution. Another essential feature of technology is its dynamic nature. Forest management, therefore, needs to be updated.

Action Plan 3: Monitor the quantity and quality

20.5.3.2.7 Laser technology and precision forestry provide means to more accurately, more objectively and more efficiently measure and monitor the quantity and quality of forest biomass. Precision forestry can be applied to increase the efficiency and information basis of existing national forest inventories and operational forest management planning. In addition, precision forestry allows certification of wood origin, since the location of every stem is recorded by forest inventory and logging machines and updated onto maps. Accurate information on stem dimensions and quality will aid in optimal cutting of stems, maximising the value of the stem for both forest owners and raw material buyers, and result in better knowledge of the value of forest resources, both as a source of industrial raw material and as a provider of other services. Information obtained by laser scanning and digital photogrammetric images will be increasingly utilised. New technology allows a 'Precision Forestry' approach. Precision forestry is a combination of methods by which it is possible to accurately determine the characteristics of forests, treatments, biodiversity preservation or recreational opportunities at the stand, plot or individual tree level, and to use individual tree level assessments for simulation and optimisation models of forest management. During the past ten years, three dimensional (3D) methodologies based on digital photogrammetry and laser scanning have experienced a major leap in conducting forest inventories and for evaluating their economic valuations, biomass and forest damage variables. Airborne laser scanning (ALS) has been shown to be an accurate remote sensing technique for stand-wise forest inventories. The current data acquisition and processing cost is less than that of conventional stand-wise field inventory. In addition to ALS, terrestrial laser scanning (TLS) and vehicle-based laser scanning (VLS) methods may provide measurements on individual trees in larger forest areas in the future.

20.5.3.2.8 Precision forestry technology is, however, comparatively expensive and its implementation requires human resources and institutions with the appropriate knowledge to use the technology, all of which may be lacking in developing countries. Thus, technology transfers may be encouraged at the state level.

20.5.3.3 Pillar 3: Exploit economic opportunities

Action plan 1: Create new products

20.5.3.3.1 Forests have the potential to produce a wide range of bioenergy and biochemical products, and most of these opportunities will be a commercial reality in the near future. The need is to take a strategic vision that forest products' manufacturing is an economically and environmentally sustainable growth industry. Forest products are a sunrise and not a sunset industry. Kerala can capture the greatest benefits from these opportunities related to bioenergy/biochemicals by promoting the forest industry. Management of biomass to reduce forest fires may then be used to produce bioenergy. Wood pellets can be used to produce renewable energy and a chronically energy deficit state like Kerala can benefit from this. Biochemical products include acidulants, adhesives, agrochemicals, cosmetics, electronic chemicals, emulsions, flavours and fragrances, food additives, industrial chemicals, pharmaceuticals, plasticisers, plastics, research chemicals, solvents, surfactants and petrochemicals fuel.[7] A bio-refinery is capable of producing one or several low volume, but high value chemical products and a low value, but high volume liquid transportation fuel or pulp product, while generating electricity (Box 20.2). It can process heat not only for its own use, but also for sale of electricity. Other innovative products include lumber, medium density fibreboard (MDFs), particleboard, engineered lumber, fabricated structural building components, second-generation engineered wood product (EWPs) and third-generation mechanical publication papers.

Box No 20.2

Forest Bio-refinery: An Example of Policy-driven Technology

The forest bio-refinery (FB) is a facility that integrates biomass conversion processes and equipment to produce fuels (ethanol and biodiesel), electricity, power and chemicals (polymers, acids), along with conventional forest products (pulp, paper, sawn wood and so on.). The FB can use multiple feedstock, including harvesting residues, extracts from effluent, fractions of pulping liquors, as well as agri-biomass, recycled paper and municipal and industrial wastes. It can be a large-scale industrial facility integrated into a pulp and paper mill or a medium or small-scale facility integrated into a sawmill or plywood mill. Most discussions have focused on the former case. An essential part of the FB is the objective to more efficiently utilise the various fractions of woody biomass. This biomass is lignocellulosic material, which is made up of three primary chemical fractions: hemicellulose, cellulose and lignin. All of these can be converted to carbon-neutral renewable energy or chemicals. Some of the conversion technologies are already mature and commercial; others require development to move to commercial applications. Bio-refineries are seen as a potentially important development that could enhance the profitability and viability of operations in the big forest sector countries. They generate renewable energy, addressing the issues of greenhouse gas emissions and concerns over energy import dependence. Forests and bio-refineries are, thus, seen as potentially important sources and producers of carbon-neutral energy. There have been large-scale R&D efforts in developing technology and pilot projects that promise to open up new and more efficient ways to utilise forests and wood fibres in energy production. Within the forest bio-refinery platform, there are a number of different output mix and technology possibilities. First, policies are necessary to make the production of biofuels viable in current circumstances. Without subsidies, tariffs or other forms of policy regulation, there will be very little or no national production of biofuels in most countries. Countries may give subsides anywhere in the value chain — from growing the raw material (agri or forest-biomass) to setting mandatory requirements for biofuels usage in transportation. The interest in forest bio-refineries is a very recent phenomenon. Thus, more research is needed to understand the implications of FBs for the forest sector.

Source: Finnish Forest Research Institute Web site (METLA). http://www.metla.fi/pp/LHet/hetemaki_Biorefinery_Box_161-162.pdf

Tourism

20.5.3.3.2 Ecotourism is already linked to Kerala's forests. According to the Kerala Forest Statistics 2011 there are 60 ecotourism sites, but the Ecotourism Directorate's Web site (http://www.ecotourismkeralam.org/) lists only 16 locations. This variance may possibly be due to the lack of certification for many of the sites. It is, therefore, important to get all 60 sites certified, and to ensure that any new ecotourism destinations are also certified. The tourism and forest departments should collaborate to develop consolidated offerings that draw visitors. The various ecotourism sites can be linked together and developed in a hub and spoke model to attract environmentally conscious, high-value tourists. The ecotourism Web site also needs to be improved with features such as maps of hiking trails and so on. Visitor fees in these destinations are collected based on 'polluter pays principle'. The quantum of visitor fee collected is Rs 15 crore, which is invested in the rural economy of the State. The VSSs have taken up the responsibility of cleaning the forests and benefit from the ecotourism policy. Ecotourism may further be linked to forests and wetlands tourism.

20.5.3.3.3 One of the issues with tourism based on location and nature is the possibility of adverse impacts of tourism activity on biodiversity and vegetation and a reduction in ecological services providing capacity of the destination. Since there are hardly any comprehensive studies of carrying capacity in tourism, there is an urgent need to develop databases on this aspect, especially in ecotourism destinations.

20.5.3.3.4 Kerala's forests have many sites that are rich in biodiversity, visually appealing or are significant in a historical, archaeological, anthropological or mythological sense. However, tourist visits to these sites are often unmonitored, resulting in damage, either accidental or deliberate, to these sites. Therefore, attempts must be made to identify such sites and develop them as scientifically managed centres of ecotourism. Accordingly, nature-based tourism beneficial to local communities should be promoted in forest areas to the extent that it does not degrade and damage such areas and their ecological status and values.

20.5.3.3.5 Identify sites that can potentially be declared as Conservation Reserves and Community Conserved Areas under the Wildlife (Protection) Act, 1972 within three years. Preparation of scientific, ecologically-sound protected area (PA)-specific management plans by teams of officials, experts and local community representatives, incorporating case studies of past management successes and failures. Strict conservation zones and degraded habitats to be identified for each PA and special management measures to be formulated for these areas. Restoration and enhancement of water sources should be done in all terrestrial PAs. Listing of streams and rivers in these terrestrial PAs, with estimates of flow and seasonal duration must also be done. Seasonality of water sources and judicious future distribution of water sources needs to be done in all the forest areas of Kerala.

20.5.3.3.6 There is a need to prepare a 'Tourism Management Plan' for each Protected Area, providing due safeguards against the negative impacts of tourism. Regular monitoring of the impact of tourism should be carried out on soil, water resources, vegetation, animal life, sanitation or waste disposal, natural surroundings and cultural environments. The 'Wildlife Tourism' component of the PA management plan should also include PA interpretation and visitor centres. As far as possible, such facilities should only be provided in buffer areas or adjacent to PA boundaries. Special care and resources should be invested in protecting habitats that harbour highly endangered species, especially those having single populations and a high degree of endemism.

20.5.3.3.7 The other niche product that can be created in the forestry sector is knowledge about this sector and all things related to it. However, this is expanded on later.

Action Plan 2: Support for sustainable commercial production of forest and wood products

20.5.3.3.8 Focus on creating economic opportunity and private investments in Sustainable Forest Management (SFM) and conservation, and rural forest industries. The State will promote catalytic investments in the full range of goods and environmental services available from well-managed forests. These investments will include sustainable timber harvesting and management, but only in areas outside critical forest conservation areas, and in situations that can be independently monitored through a system of independent verification or certification that meets nationally agreed and internationally acceptable standards. Kerala should also harness the opportunities offered by:

- Silviculture or the practice of controlling the establishment, growth, composition, health and quality of forests to meet diverse needs and values.
- Smallholder supply to pulp and timber mills, palm oil and rubber processors.
- Agroforestry
- Natural forests and plantations.

20.5.3.3.9 The State will emphasise the development of new markets and marketing arrangements for the full range of goods and environmental services available from well-managed forests. The major focus will be on supporting private investments in SFM, conservation and rural forest industries. The clear potential to reduce emissions from forest land and to use forest land to sequester carbon stored in the atmosphere has led to considerable interest from some countries and companies in sponsoring forest conservation and management projects to offset their carbon emissions. However, while these offset projects could provide useful funds for forest conservation and management, they remain controversial.[8] Many environmentalists fear that offset projects might encourage bad forestry practices. This requires a strong institutional framework.

20.5.3.3.10 Action Plan 3: Diversify the sources of wood

Since substitutes for wood have their limits as far as practical applications are concerned, newer sources of wood may be promoted. In this context the importance of rubber wood is to be seen as a reasonable and renewable alternative raw material for wood. It has been found[9] that rubber wood has higher linkages than natural rubber in the State due to the presence of wood mills in Kerala. Further, there has been expansion in area under rubber in the State. There is a need to promote the market for rubber wood and promote its usage through R&D, marketing and branding.

20.5.3.3.11 Bamboo and reed are among the major forest produce of Kerala. Bamboo and reed and products made from them can be a major revenue earner for Kerala and need a major push in R&D and marketing. The Kerala State Bamboo Corporation Ltd, a government of Kerala undertaking, established in 1971 is involved in the development of the bamboo industry with a particular focus on bamboo workers. It will need to give greater emphasis to R&D. A visit to the corporation's Web site shows that its focus is on bamboo boards, mats, flooring tiles and houses. In contrast, a simple search on the Internet shows at least 1,000 products that can be made from bamboo.[10] Bamboo has uses in forestry, wood industry, pulp and paper industry, textiles, bioenergy, food and beverages, automotive, sports and recreation, electronics, high-tech and farming industries.[11] There are people who are willing to pay well for high-end eco-friendly products. Combining the craft skills of local artisans in Kerala with the stamp of sustainable labour practices can double the value of products made from bamboo and reed. Home-grown entrepreneurs innovate to sell home-made products (possibly using e-commerce), creating a virtuous cycle of economic growth for all stakeholders.

20.5.3.3.12 Action Plan 4: Non-wood forest produce (NWFP) or minor forest produce (MFP)

Minor forest produce consists of ayurvedic herbs, spices, fibre, grass other than fodder, incense plants, honey and bee's wax. In 2010–11, Kerala Forest statistics reported that the total value of MFP sold was Rs 2.5 crore. This is pretty low. Honey and bee's wax are used in high-end cosmetics for environmentally conscious people. Kerala needs to do R&D on the MFP too and their various uses. Ayurvedic herbs also matter because of the ayurvedic medical industry in India. Given that there are plans to open several Centres of Excellence in health in Kerala, ayurvedic herbs should be harvested in a sustainable manner. Agro-forestry with, a focus on ayurvedic herbs may be a significant revenue earner for the VSSs. Branding and better marketing of these products is recommended. Of course, this has to be managed in a sustainable manner.

NWFP collection, value addition and disposal

20.5.3.3.13 The forest department could support the causes of tribals in multiple ways. Such support can be for activities in which the tribal population is already engaged in or for new ventures that could provide employment and build capacity. One of the challenges with the activities the tribals

are already engaged in is that their contribution in terms of extent of involvement and degrees of success varies a great deal across the State. This is largely due to factors by which contradictory schemes or limited aim schemes, which cause dependency on government schemes, are run by departments other than the forest department. This makes foresters less enthusiastic in their efforts to involve tribals for their betterment through forest management practices. It is, therefore, suggested that all schemes of — other departments — for the development of tribals within forests, be carried out by foresters alone, both in planning and actual implementation, with active participation of local governments and tribal community groups.

Development and adoption of modern methods of NWFP collection

20.5.3.3.14 At present, the collection methods for NWFP by tribals are not only traditional, but at times quite harmful to the resource base. In fact, it is now well known that several valuable medicinal plants have either become threatened, rare or endangered due to such practices. Consequently, many important medicinal plants used for preparing medicines in the State, are either imported or fake. Therefore, steps have to be taken to develop and infuse modern technology in the collection and storage of NWFP.

Value addition of NWFP

20.5.3.3.15 At present, very little value addition is done to the various NWFPs collected from the forests. Funds, training and technology need to be provided to the forest department for ensuring that most of the NWFP collected is marketed only after value addition.

Distribution of NWFP

20.5.3.3.16 Although a beginning has been made to distribute valuable NWFP collected by tribals and VSSs after value addition through their own distribution centres called 'Vanasree', a lot of work is needed to strengthen this activity. In fact, tribals have been at a disadvantage due to lack of knowledge and support for marketing various NWFP collected by them. Thus, capacity building of tribals should become a priority to enable them to directly market the NWFP they collect and, thus, earn better returns and improve their livelihoods.

Involvement of tribals in ecotourism

20.5.3.3.17 The Kerala Forest Department has made substantial progress in involving forest tribes in various conservation and management activities. For example, people who were once forest offenders now work in popular tourist sites as guides, watchers, salesmen and entertainers. This has been a major success story in Kerala at the Periyar Wildlife Sanctuary, Vazhachal, Palaruvi and so on. This activity can be strengthened and broadened in the future. For this, it is essential to recruit many more tribal youth in the forest department, both as permanent staff and as members/important functionaries in various participatory (joint forest management based) activities.

Starting plant nurseries run by tribals

20.5.3.3.18 Many traditional tribal communities are aware of the medicinal values of herbs, shrubs and trees of the forest. It, therefore, makes sense to train tribals, especially women, to raise nurseries of medicinal plants and other natural species to be planted in forest areas to improve the degraded forests.

Tribals in specialised activities

20.5.3.3.19 Due to their knowledge of and proximity to certain issues regularly confronted by the forest department, tribals can be engaged in such activities more effectively than other segments of the population. For example, tribals can be deployed in:

- Creation of squads to drive wild elephants away from inhabited areas.
- Maintenance of existing solar power fences.
- Rescue and rehabilitation of wild animals.

Training and knowledge in organic farming

20.5.3.3.20 Usually, tribals cultivate crops in an environment-friendly way. Therefore, they can be trained to use organic materials and inputs for enhancing their farm productivity and can be supported to obtain organic certification for their farms.

20.5.3.4 Knowledge economy

20.5.3.4.1 The Kerala Forest Research Institute (KFRI) is a multidisciplinary team of experts conducting research on tropical forests and forestry.[12] It contributes to research in tropical forestry and biodiversity conservation. Founded in 1975, KFRI was envisioned as a centre of excellence in tropical forestry to provide scientific support for decision making on matters related to forestry, with a particular emphasis on conservation, sustainable utilisation and scientific management of natural resources. KFRI became a part of the Kerala State Council for Science, Technology and Environment (KSCSTE), along with five other R&D centres of the State, when the KSCSTE was constituted in 2002. Its eight research programme divisions are: sustainable forest management, forest genetics and biotechnology, forest ecology and biodiversity conservation, forest protection, wood science and technology, forestry and human dimension, forestry management information system and extension and training.

20.5.3.4.2 The good news is that Kerala does not need to create a 'new' institution. However, the KFRI needs to be upgraded. It needs to develop a vision for the 21st century. Linking the KFRI with the Indian Council of Forestry Research and Education will ensure its prominence. There are 12 institutes all over India currently under the Council, but KFRI is not one of them. The goal is to transform KFRI into an institute of choice for forest research in India and, eventually, the world. Further, KFRI should offer both undergraduate and post-graduate education in forestry. The Oregon State University offers a Bachelor of Science in Renewables. Similarly, KFRI may develop innovative undergraduate courses. It needs to significantly expand its areas of research to include agro-forestry and forest and watershed management. The latter may include "understanding watershed conditions and processes in forested ecosystems and the effects of management activities; evaluating and improving soil and water quality and related practices and policies for forest operations."[13] KFRI may open a Wood Innovation/Incubator Centre under its Wood Science and Technology Programme, which may encourage students to develop innovative products in wood and other non-woods such as bamboo and reed. This may help the Kerala Bamboo Development Corporation. KFRI should also start research on urban forests given the large-scale urbanisation forecast for Kerala. The Kerala State Electricity Board, Kerala Forest Department and KFRI should look at collaborations, not only for bioenergy, but also on how to lay electric cables without harming the forests or its inhabitants. The generation of knowledge alone can help Kerala find sustainable policy solutions. Further, it should start programmes that will educate the general public about forests. An important contribution that a centre of excellence makes to a regional economy is extension services. Extension services in KFRI include training and consulting activities. However, knowledge centres in leading countries such as the US have activities that involve researchers working extensively with communities. Forests involve ecological and social systems and the interactions between them. This aspect needs to

be significantly strengthened in KFRI. For that reason, perhaps, a linguistics department, which will work on the languages of Kerala's forest dwellers, will be an added boon. The rationale is that teaching, research and interaction with the local communities goes hand-in-hand with the process of knowledge creation and dissemination. Kerala has to build such an interactive model for the betterment of its human, physical and ecological capital.

20.5.3.5 Pillar 4: Institutional change

20.5.3.5.1 The Department of Natural Resources should ensure that the forest industry has the right of first refusal in using excess biomass. It should continue to remove impediments, such as appurtenancy rules and administratively determined timber allocations. The department should also allow market prices and competition between private sector mill and plant operators to determine the best product market for the province. But, it should retain a key long-term role in provincial timber supply by re-affirming that the government is committed to being in the tree growing business. The government will place a high priority on facilitating the process of bio-energy generation by removing various impediments.

20.5.3.5.2 The Kerala Forest Development Corporation (KFDC) (a collaboration between the central and state governments) was created to raise finance to nurture man-made forests so as to meet the domestic and industrial needs of forest produce and reforest degraded forest areas and bring them under productive use.[14] The core activities of KFDC include — acquire, purchase or take over on lease or otherwise reserved forest, unreserved vested forests and other lands from the Kerala government and others either with tree growth or not and to develop such areas and raise plantations for industrial use; to cultivate plantations of rubber, pepper, cashew, cocoa, cardamom and so on and to buy, sell, export, import, process, distribute, deal in all kinds of forest plants, trees and agricultural crops; acquire, purchase or take over on lease or otherwise and manage forests to maximise production of timber and other produce; carry on business of foresters, planters, cultivators, sellers, dealers in timber and industrial woods, firewood, charcoal and so on and to manufacture and dispose of, sell and deal in forest produce; and to carry out tourism activities including ecotourism, limited to creation of temporary infrastructure to meet only the basic necessities of ecotourism.

20.5.3.5.3 KFDC should collaborate more with other departments such as agriculture and tourism so that there is no overlapping of work. Its main priority should be to work with industry to build up analytical capacity, with an emphasis on market and strategic issues. KFDC must take up branding, particularly of Kerala's forest produce. Priority should be given to developing this capacity in the local government and private wood lot segment. Institutional capacity needs to be strengthened at the Kerala Forest Department for the following:

- To reduce losses from illegal logging and support for forest legal and regulatory reform and enforcement.
- To establish forest certification principles and criteria to assess the adequacy of different certification systems in relation to recognised standards of economically, environmentally and socially sustainable development.
- Price setting and taxation for forest valuation.
- For trade policy related to forest products.
- Urban forestry needs to be encouraged with increasing urbanisation.
- Communication to the public on the importance of forests.

20.5.3.5.4 Institutional change in VSS

After an era of rich experience with local knowledge, social forestry and the characteristics of forest use and management by local communities, more emphasis should be given to the superordinate

institutional framework. Therefore, implementation of government-driven institution building and capacity empowerment initiatives for the VSSs could prove fruitful and effective in enhancing the effectiveness of sustainable utilisation of natural resources and, in turn, forest management. Chapter 23 on Planning for the Socially Marginalised Groups talks extensively about the economic and social empowerment of the Scheduled Castes and Tribes living in the forests. The VSSs have not been very successful. Therefore, one option is to create Hamlet Development Committees (*Ooru Vikasana Samithi* or OVS) and create special welfare officers (Tribal Welfare Officers or TWOs) dedicated to each SC or ST dwelling in the forest in each geography. The Kerala Forest Statistics have detailed data on that. The OVSs will work closely with the TWOs on administration, issue of certificates, land and so on. Further, the TWO and OVSs may jointly be responsible for all institutions such as residential schools, anganwadis, health centres and so on. The OVSs on their own may not have the local capacity and have to be paired with TWOs for guidance and help. The main issues of the forest dwellers are:

1. Identification: An outline for identification is mentioned in Chapter 23. The TWOs and OVS will work together to identify tribes. A carrot and stick policy will be used to deter wrongful claims. The Unique Identification Authority's 'Aadhar card' will be given to all.
2. Empower forest dwellers in their habitat and culture.
3. Health: Mobile health clinics are necessary to ensure healthcare and regular monitoring of forest dwellers. Anaemia is a common problem, especially among women, which should be monitored. Emergency services should be provided. Special residences for economically or socially different sections may be provided, for easy healthcare in urban areas.
4. Education: Participation in early childhood education is vital for every child's development and to prepare children for future learning. Early childhood education can support future educational achievement. Currently, children from forest tribes participate in early childhood education at a lower rate than the general population.
    - The Ministry of Education will need to develop partnerships with communities and identify successful models of schooling:
        - Expand schooling based on models adapted to suit their requirements.
        - Identify successful models.
        - Target greater transition from school to tertiary level education.
        - For improving the performance of SC/ST students, focus on them and offer them better public services; hold schools accountable for their performance.
        - Engage counsellors and mentors to work with SC/ST students. In the US, colleges establish special centres for communities such as South Americans, African Americans and so on. Essentially, these centres provide peer tuition, career guidance and counselling to students with challenges. Similar centres for diversity may be established in schools/colleges/universities for guidance of SC/ST students. These centres should be suitably named so that students are not discouraged from approaching them. For example, instead of calling a centre by a specific community's name, it could have a name that is inclusive.
        - For SC/ST children, the government should partner with NGOs, specific organisations and educationists and design an appropriate curriculum and medium of training. Further, teachers should also be trained in a particular way. The goals of schools in backward areas should not be limited to just teaching, but inculcating a learning culture and survival skills. For example, it is not about just studying but 'how to study' that needs to be taught to students. Oral traditions of the particular community can be leveraged in the curriculum. This will indirectly encourage parents to participate more in the learning process. Peer teaching, inviting guest lecturers and role models from that particular, or a similar, community can inspire students to learn. Further, for students studying in mainstream schools, special classes for those with 'weaker' abilities may help improve learning. Based on their natural abilities, geography and surroundings, children may

be channelised to specific sports. Monitoring and evaluation of learning outcomes is a must at every stage for curricula and pedagogy to evolve. Further, infrastructure such as mobile libraries can be sent to backward areas to increase access for students.

- The TWOs in the district may work with other departments to establish and monitor tribal welfare hostels, tribal welfare Ashram Schools, residential schools for STs, special hostels opened for the post-matric ST students, student managed hostels and single teacher schools. Schools may be the nodal agencies to work with ST children to reduce the problem of malnutrition. In tertiary education, tribal studies may be established as an area of study and students could be encouraged to take classes in tribal studies. The University of Calicut offers folklore studies, which can be connected to tribal studies too. Every TWO should have taken at least a few classes in tribal studies. Those in folklore studies should also work with tribal departments to preserve oral traditions.

5. Economic empowerment: The goal should be to link forest dwellers with the primary economic sectors while maintaining their unique identity. Community participation in forests has been fairly successful and Kerala has especially proved its mettle here. Land may be distributed, but it needs to be accompanied by training in farming. Agro-forestry techniques, possibly concentrating on ayurvedic herbs and bamboo, are other options. Economic empowerment may also occur if the youth are connected with the tourism industry. It should be in the interests of the people living in forests to protect them and, therefore, any strategy needs to take that into account. The Forest Services may use the communities to prevent illegal activities like poaching or logging. The KFRI may learn traditional techniques from tribes and combine that with scientific knowledge to maintain and increase the health and conservation of forests. Box 20.3 summarises some good practices from across the world. This is not to deny that Kerala also has done a commendable job in this regard.

Box No 20.3

Good Practices in Sustainable Forest Management

Indonesia: The World Agroforestry Centre (ICRAF) in partnership with local NGOs, WARSI and Gita Buana, implemented an action-research project in Bungo district in Jambi, Sumatra on reward mechanisms for conservation of traditional rubber agro-forests. Agreements to conserve 2,000 ha of jungle rubber were made with four villages. Intermediate rewards in the form of support to establish micro-hydro power generators, local tree nurseries and model village forests were provided. The conservation agreements also set the stage for potentially pursuing eco-certification as an approach that can benefit jungle rubber farmers for the biodiversity services they provide. Eco-certifiers guarantee consumers that producers have followed a set of standards that offers ecosystem protections. One important step towards certification has been made through the communities' commitments and the identification of their conservation practices.

Africa: The Novella Africa Initiative is a public-private partnership formed in 2002 by Unilever, The World Agroforestry Centre (ICRAF), IUCN and the Netherlands Development Organisation (SNV), and involves UNDP and a number of governmental organisations and NGOs in Africa. The initiative is undertaking commercial scale collection and extraction of oil from seeds of the *allanblackia* (AB) tree, which is native to tropical forests of West, Central and East Africa. This edible oil is used by Unilever to make food products such as spreads and detergents such as soaps. The project is unique in its goals to sustainably use non-timber forest products on a commercial scale, undertake forest reforestation through planting of AB trees and provide significant employment benefits to subsistence farmers.

Costa Rica: Costa Rica's Pagos por Servicios Ambientales (PSA) programme is recognised as a pioneering example of a large-scale payment for environmental services initiative. The PSA programme is based on Forest Law No 7575, which provides for contracts to be made with landowners for services provided on their lands and establishes the National Fund for Forest Financing (Fondo de Financiamento Forestal or *FONAFIFO*), which manages the programme. The law recognises four environmental services provided by forest ecosystems: mitigation of greenhouse gas emissions, hydrological services, biodiversity conservation and provision of scenic beauty for recreation and ecotourism. Funding for the PSA programme has come from a 3.5 per cent fossil fuel sales tax, loans and grants from various donor agencies and from payments by beneficiaries for environmental services. In order to participate, landowners must submit a sustainable forest management plan prepared by a licensed forester, describing plans for preventing poaching and illegal harvesting, outlining monitoring schedules and so on. Once approved, landowners receive payments at a rate of US$64/ha/year for forest conservation plans and US$816/ha over 10 years for plantations. As of 2005, about 270,000 ha of land were in the programme, primarily as forest conservation contracts. The PSA programme has been partly credited with helping Costa Rica, which once had some of the world's highest deforestation rates, achieve zero net deforestation by the early 2000s.

UN 2008, Resolution 62/98 cited in Secretariat of the Convention on Biological Diversity. 2009. Sustainable Forest Management, Biodiversity and Livelihoods: A Good Practice Guide. Montreal, 47 + iii pages

20.6 Evaluation and monitoring

20.6.1 Following discussions and commitments at the United Nations Conference on Environment and Development (UNCED), 160 countries developed sets of criteria and indicators (C&I) for sustainable forest management (SFM) through nine regionally and internationally recognised processes, that were specific to various forestry scenarios of the world. The Indian initiative to develop a national set of C&I for SFM was in the form of the Bhopal-India (B-I) process. The B-I process developed a national set of eight criteria and 43 indicators. This set of C&I prepared at the national level is specifically relevant to the current forestry scenario in India. It was accepted and validated by the National Task Force appointed by the Government of India, which also recommended it for adoption and implementation by all the respective state forest departments in the country.

20.6.2 Monitoring and evaluation requires a set of related indicators, which is a quantitative, qualitative or descriptive attribute that, when measured or monitored periodically, indicates the direction of change within the criterion. The purpose of C&I is to provide a tool for monitoring, assessing and reporting changes and trends in forest conditions and management systems at the national and also at the forest management unit level. By identifying the main prerequisites of SFM, the C&I provide a means of assessing the progress towards SFM. The conceptual framework of SFM includes sustainability principle, criteria, indicators and verifiers. The definitions of these terms are as under. The state forest department needs to maintain data based on the following indicators for evaluation of performance (Table 20.7).

Table.20.7
List of criteria and indicators for monitoring the forest sector

Criteria	Indicators
Increase in the extent of forest area/cover	1.1 Area and type of forest cover under natural forest and man-made forest 1.2 Forest area officially diverted for non-forestry purposes 1.3 Forest area under encroachment 1.4 Area of dense, open and scrub forests 1.5 Trees outside forest area
Maintenance, conservation and enhancement of biodiversity	2.1 Protected Areas 2.2 Number of animals and plant species 2.3 Number and status of threatened species 2.4 Status of locally significant species 2.5 Status of species prone to over-exploitation 2.6 Status of non-destructive harvest of wood and non-wood forest produce
Maintenance and enhancement of ecosystem function and vitality	3.1 Status of natural regeneration 3.2 Incidences of forest fires 3.3 Extent of livestock grazing: (a) Forest area open for grazing (b) Number of livestock grazing in forest 3.4 Occurrence of weeds in forest: (a) Area (b) Weed type 3.5 Incidences of pests and diseases

Conservation and maintenance of soil and water resources	4.1 Area under watershed treatment 4.2 Area prone to soil erosion 4.3 Area under ravine, saline, alkaline soils and deserts (hot and cold) 4.4 Soil fertility /site quality 4.5(a) Duration of water flow in streams (b) Groundwater in the vicinity of the forests
Maintenance and enhancement of forest resource productivity	5.1 Growing stock of wood 5.2 Increment in volume of wood species 5.3 Efforts towards enhancement of forest productivity: (a) Technological inputs (b) Area under high-tech plantations (c) Area under seed production areas, clonal seed orchards
Optimisation of forest resource	6.1 Recorded removal of wood 6.2 Recorded collection of non-wood forest produce 6.3 Efforts towards reduction of wastages utilisation 6.4 Aggregate and per capita consumption of wood and non-wood forest produce 6.5 Direct employment in forestry and forest-based industries 6.6 Contribution of forests to the income of forest-dependent people 6.7 Demand and Supply of wood and non-wood forest produce 6.8 Import and Export of wood and non-wood produce
Maintenance and enhancement of social, cultural and spiritual benefits	7.1 (a) Number of JFM committees and area(s) protected by them (b) Degree of people's participation in management (c) Level of participation of women 7.2 Use of indigenous technical knowledge: Identification, documentation and application 7.3 Quality and extent to which concessions and privileges are provided 7.4 Extent of cultural /sacred protected landscapes: forests, trees, ponds, streams and so on: (a) Type and area of landscape (b) Number of visitors
Adequacy of Policy, Legal and Institutional framework	8.1 Existence of policy and legal framework 8.2 Number of forest-related offences 8.3 Level of investment in Research and Development 8.4 Human resource capacity building efforts 8.5 Forest Resource Accounting: (a) Contribution of forestry sector to GDP (b) Budgetary allocations to the forestry sector 8.6 Monitoring and Evaluation mechanisms 8.7 Status of information dissemination and utilisation

Source: Bhopal-India (B-I) process

20.7 Conclusion

20.7.1 Kerala's complex ecosystem with large forest cover and wetlands rich in biodiversity will be protected and regenerated with environmental sustainability as the central focus. Environmental resources will play a crucial role in Kerala's economic drivers such as tourism and construction, but with sustainability as the top concern.

20.7.2 In forestry, there is low production of timber and forest-based industries are stagnating. Forests in Kerala are dominated by plantations. It is important to view forests from a different perspective. Preserve the reserved forests and manage the others in a sustainable fashion. There is a need to create new products, and branding them will add further value to the product. The emphasis is on the importance of the multifunctional role of forests and sustainable forest management by leveraging emerging technology for development.

Reference

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3. *Central Statistical Office, Ministry of Statistics and Programme Implementation, Government of India. 2013. Statewise Estimates of Value of Output from Agriculture and Allied Activities 2013.www.mospi.nic.in.*
4. *UN 2008, Resolution 62/98 cited in Secretariat of the Convention on Biological Diversity. 2009. Sustainable Forest Management, Biodiversity and Livelihoods: A Good Practice Guide. Montreal, 47 + iii pages.*
5. *Decision support Centre, National Remote Sensing Centre Web site. http://www.dsc.nrsc.gov.in/DSC/ForestFire/index.jsp?Aa=Case%20study.jsp.*
   "The Decision Support Centre (DSC) is established at National Remote Sensing Centre (NRSC) as part of Disaster Management Support Programme of Department of Space (DOS), for working towards effective management of disasters in India. Considering the importance of forest fire management in India, a comprehensive Indian Forest Fire Response and Assessment System (INFFRAS) is invoked under DSC activities of NRSC, which integrates multi-sensor satellite data and ground data through spatially and temporally explicit GIS analysis frame work." National Remote Sensing Centre, Indian Space Research Organisation Web site. http://www.nrsa.gov.in/.
6. *Decision Support Centre, National Remote Sensing Centre website Web site. http://www.dsc.nrsc.gov.in/DSC/ForestFire/index.jsp?Aa=Mitigation_planning.jsp.*
7. *Natural Resources Canada Web site lists some common household products that are made from wood components: bath towels, nail polish, make up, disinfecting wipes, medications, paints, LCD screens and ping-pong balls. http://cfs.nrcan.gc.ca/pages/340.*
8. *"How can timber extraction ever be sustainable, compared to the pre-harvest condition? Can forests ever recover completely to their natural state? Can commercial forestry ever be profitable with stringent environmental standards? Zimmerman and Kormos revisit these arguments and conclude that 'industrial scale' Sustainable Forest Management (SFM) is unsuitable as an element of national REDD+ strategies. However, they also conclude that SFM at the 'local-community scale' is indeed possible. In a critical response to the original article, Plinio Sist and colleagues point out some flaws in these conclusions. First, the categories of 'industrial scale' and 'community scale' are not well-defined, and overlap to a certain extent. Second, in terms of both carbon stock and biodiversity, logged forests can indeed recover, with appropriate post-harvest management. And third, to write off the entire tropical timber industry as a lost cause, rather than incentivizing improved practice, is likely to undermine, rather than reinforce, conservation efforts."*

UN-REDD Programme. 2013. REDD+ and the Fundamentals of Forest Management Science: Is Sustainability Ever Possible? www.unredd.net. Special Issue # 5. February.
This quotation is to support the statement that there are alternative ways to think about forest management and one should adopt scientific ways of thinking about a very important topic such as forestry. Clearly Kerala needs to develop research and development on the subject to answer the question as to what approach or mixed approaches work for the state.

[9] *Oommen, Z. 2011. Performance and linkages of rubber wood industry in Kerala. International Journal of Multidisciplinary Research. 1(8). December.*

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