Domestic Water and Sanitation in Kerala
A Situation Analysis

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With inputs and guidance from K. Madhavan Namboodiri

WaterAid India

Chalakudy Puzha Samrakshana Samithi (Kerala State Resource Centre of the Forum)

Forum for Policy Dialogue on Water Conflicts in India

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FOREWORD

One of the important themes of work in this phase of the Forum for Policy Dialogue on Water Conflicts in India (Forum) is Right to Water and Sanitation in India (RTWS) which the Forum is doing in partnership with WaterAid India. As one of the many steps in this direction the Forum commissioned studies in two states – Kerala and Odisha – to understand the actual situation with regard to domestic water and sanitation. We chose Kerala and Odisha for this situation analysis primarily because the Forum had set up Resource Centres in both these states in its previous phase of work and the situation analysis would be a further add on to the work undertaken by the Resource Centers. Also, Kerala and Odisha represent the two extremes of the development continuum.

Forum commissioned Shri Rajeevan Chakrapani of INSPIRE to undertake this situation analysis. Shri K. Madhavan Namboodiri, an independent consultant, with vast experience in the water and sanitation sectors, agreed to guide and supervise this exercise. In this report the authors (since Shri Namboodiri's inputs and insights have been substantial we have used the word "authors") have tried to cover a large ground with regard to domestic water and sanitation in Kerala and the report does not stop with a critique of the policies and programmes but also offer constructive suggestions to restructure the sectors keeping right to water and sanitation at its core.

Many individuals and originations have provided valuable help in bringing out this report and we would like to express our gratitude to all of them. We are extremely thankful to Shri Rajeevan Chakrapani and Shri K. Madhavan Namboodiri for agreeing to undertake this exercise on behalf of the Forum and also for revising the drafts a few times in the light of the review comments and suggestions at various stages. In the peer review meeting to discuss the first draft of the report, the participants provided very valuable and critical suggestions to improve the report and we are thankful to all the participants of this meeting. Our special thanks to Dr. Ajaykumar Varma for reviewing the first draft and for providing extensive comments and suggestions. We also express our gratitude to Chalakudy Puzha Samrakshana Samiti (CPSS) for coordinating the peer review meeting and especially to S. P Ravi and A. Latha for providing valuable comments and suggestions on the drafts.

Neeta Deshpande copy-edited the report, Rohan Jhunja did the layout and Mudra Printers did the production. We are extremely thankful to all of them.

We acknowledge the financial support and encouragement provided by WaterAid, India. Our special thanks to Mamata Dash of WaterAid for her active participation and support in bringing out this publication. The views expressed in this report are that of the authors. We sincerely hope that all those who are concerned about the water and sanitation issues would find this report useful.

The Secretariat March 2014

Forum for Policy Dialogue on Water Conflicts in India

SECTION 1: INTRODUCTION

The management of drinking water supply in Kerala obtains importance at the policy level due to the state's paradoxical situation where there is scarcity in the midst of plenty, as well as the growing demand for water due to the high population density[1] and changing water use habits. Similarly, the high population density, unchecked urbanisation, rising rate of per capita waste generation, changing waste streams and poor waste handling habits have resulted in a complex waste management scenario in Kerala. In the water supply sector, there were a number of reforms from time to time on aspects of governance, planning principles, supply norms, implementation and management of schemes. Until the mid-eighties, the state's intervention in public water supply was confined to urban areas under the direct control of the Public Health Engineering Department (PHED) of the Kerala government. In April 1984, the PHED was recast into an autonomous body called the Kerala Water Authority (KWA), and the entire responsibility of planning, implementing and managing the revenue collection for maintenance of the water supply systems was entrusted to it.

The KWA is the largest institutional entity in the field of water supply, and implemented thousands of small, medium and large urban and rural piped water supply schemes. The failure of the KWA to sustainably manage its schemes to the satisfaction of the user on one hand, and the emergence of a people's plan campaign and new democratic initiatives in the state under the 73rd and 74th amendments on the other, prompted the state to initiate new water supply schemes under the decentralised governance system. By the early nineties, following the structural adjustment programme in the national economy and the implementation of neo-liberal policies, public investment in essential services has declined. India has been receiving large scale bilateral assistance from the European countries and multilateral assistance from the World Bank and other international banks, which has also influenced drastic policy changes at the national and state levels.

The new policy approach promoted pilot initiatives in demand-responsive, community-managed, decentralised water supply systems run by the joint efforts of the state, civil society and people. These initiatives were considered to be superior to KWA schemes not only in terms of sustainability, equity, user satisfaction, good governance and cost effectiveness, but were also replicable under the decentralised governance system of the state. As part of these initiatives, the Kerala Rural Water Supply and Sanitation Agency (KRWSA) was launched as a nodal agency to facilitate the implementation of rural water supply systems. Thousands of small, medium and large piped water supply systems completely managed by user communities were implemented. Besides, thousands of water supply schemes were implemented under the three-tier Panchayat system as well.

The evolution of programmes in the sanitation sector is equally interesting. What began as a programme to stop open defecation by providing heavily subsidised sanitary latrines to each and every household in the early eighties, soon evolved

1 Kerala's population density is one of the highest in the world. It is one of the smallest states in India encompassing only 1.3% of the total area of the country. However, it has a high population density, at 747 persons per sq. km, which is much higher than the national average of 267 persons per sq. km. The people in the state prefer a dispersed settlement pattern. Hence, the state requires large areas of land for housing. Residents of Kerala prefer houses on independent plots. This has resulted in large scale land reclamation. Blessed with an abundance of rainfall, about 3,000 mm annually, Kerala has 44 monsoon-fed rivers, of the shortest of which flows for 15 km. However, due to the undulating topography of the state, run-off is also quite high. This has resulted in an increased demand for water resources and acute shortages (Nisha, K.R.)

into an environmental sanitation programme, addressing solid and liquid waste management in rural and urban areas. Many centrally-sponsored and state-sponsored programmes are being implemented through various agencies such as the three-tier Panchayat system, the state sanitation mission, KRWSA, etc.

In spite of these concerted efforts by the government in the past few decades, the performance of the Water Supply and Sanitation (hereafter referred to as WATSAN[2]) sectors in Kerala is far below expectations in terms of service performance, sustainability, and equity and user satisfaction. While in the water supply sector, diminishing water resources, high level of water pollution, and growing water demand are the major problems, in the sanitation sector, the accumulation of wastes and the failure of sustaining comprehensive waste management systems significantly increases health hazards and the disease burden.

The Forum (Forum for Policy Dialogue on Water Conflicts in India) decided to undertake a situation analysis of the WATSAN sector of Kerala as part of its work on the Right to Water and Sanitation in India (RtWS).

OBJECTIVES OF THE SITUATION ANALYSIS

The main objectives of this situation analysis are as follows:

- To understand the unique bio-physical and socio-economic-political and cultural conditions of Kerala state in order to aid an understanding of the issues related to WATSAN in the state.
- To understand the current status of drinking water supply and sanitation in the state of Kerala. This included: a) the quantitative coverage of drinking water and sanitation in Kerala, b) the type of facilities available for sanitation and water supply in the state, c) quantitative analysis of spatio-temporal variations in water availability, d) the quality issues associated with drinking water, e) urban and rural divides in providing drinking water supply and sanitation facilities.
- To review and analyse the institutional and policy frameworks of Kerala's WATSAN sector, including the governance systems at various levels, with a view to assess its capacity to address issues that might come up if WATSAN is considered a human right.
- To analyse different water and sanitation programmes and schemes in the state - their content, mode of implementation, norms and processes.
- To review the cost effectiveness, sustainability and governance systems of the WATSAN programmes of Kerala, as well as the extent to which they achieve social justice from a human rights perspective.
- To articulate the imperatives of promoting WATSAN as a human rights concept, and trigger pertinent discussions on the bio-physical and socio-political-economic and cultural aspects of Kerala.

The draft report was peer reviewed in a consultation meeting held on 2nd April, 2013 at Thrissur. The document was also peer reviewed by a senior expert on WATSAN from Kerala. The secretariat of the Forum and the Chalakudy Puzha Samrakshana Samithi (CPSS) also sent the author detailed comments and suggestions. The author has tried to engage with most of the comments and suggestions from this extensive review process.

2 Although the author has reservations about the water supply and sanitation sectors being dealt with together as will be discussed later, the acronym WATSAN is used considering the popularity of the terminology.

STRUCTURE OF THE REPORT

Following this brief introduction, Section 2 brings out the limitations of the existing frameworks used to understand and analyse the WATSAN sector. This section also briefly discusses the methodology used for this review. The third section deals with the contextual factors that have a bearing on domestic water and sanitation issues in the state. The important contextual factors dealt with in this section include geography, demography, physiography and land use, change in land use pattern, climate and rainfall, surface water sources of Kerala, surface water quality, groundwater sources of Kerala and the "Kerala model" of development.

Sections 4 to 9 deal with the domestic water part of the report. Section 4 discuses the important issues of Kerala water supply sector. It discusses the current water crisis, the poor performance of state owned large piped water supply schemes, choice of inappropriate technology, limitations of the decentralised water supply schemes and so on. Section 5 analyses the policy context and discusses the relevant portions from both the state water policy and the national water policy. The different water supply programmes and coverage are discussed in Section 6. The water supply programmes include schemes undertaken by the Kerala Water Authority (KWA), Jeevadhara (Dutch assisted community managed WATSAN systems), Jalanidhi project (World Bank aided), Giridhara (community managed water supply in tribal areas), schemes implemented by the three-tier Panchayati Raj system and the Sector reforms programme (especially Swajaldhara). Section seven analyses the performance of all these schemes. The main focus of analysis is the demand driven, decentralised, community managed systems. Some of the important parameters used for performance assessment include regularity of water supply, adequacy, water quality, breakdown maintenance and operation and maintenance costs. Section 8 looks at right to water as a human right. Section 9 is the concluding section for domestic water and it has two sub-sections, namely, conclusions and way forward. The major insights form the various sections are brought together under some of the critical variables like water availability, reasons for supply demand gap, coverage, social justice (inclusion coverage), water quality and health, performance and governance systems. The sub-section on way forward deals with critical aspects like approach towards a sustainable solution, policy, planning/ design criteria of water supply schemes, the iterative planning process, technology choice, standards, local resource persons, community organisation, governance model, water quality, source sustainability, operation and maintenance and service delivery, information, education and communication, capacity building and cost sharing.

Sections 10 and 11 are about the sanitation part of the report. Section 10, titled as 'Sanitation - An Assessment' engages with some of the important concepts and issues like the concept of sanitation, sanitation as a human right, sanitation problems of Kerala, different types of waste generation, sanitation programmes of Kerala including the Kerala sanitation policy and the performance of sanitation systems and shortcomings of the current planning process. The last section, Section 11, is the concluding section and has a detailed sub-section on way forward woven around critical elements like iterative planning process, choice of appropriate technology, choice of appropriate governance/ delivery systems, attitudinal and behavioural changes in the public, use of plastic packaging material, school sanitation, community toilets and data management and monitoring.

SECTION 2:
LIMITATIONS OF THE EXISTING FRAMEWORKS USED TO ANALYSE THE WATSAN SECTOR

GENERAL APPROACH

An examination of the past efforts by the government in the WATSAN sector leads one to conclude that an absence of enabling policies, funds, projects and programmes have never been the cause for this sad state of affairs. What is it that ails Kerala's WATSAN sector then? There have been an umpteen number of sector studies by national, bilateral and multilateral agencies which throw light on this issue and recommend well-informed remedies. This review does not discuss them in detail, though they are referred to at appropriate places.

The author of this review is of the opinion that the framework of approaching the issue itself has been a limitation in past studies. All the past studies:

- Presuppose that water and sanitation together is a complete, if not independent development sector. This assumption tends to draw a sectoral system boundary around the issues of water and sanitation. This not only severely limits the recognition and identification of cross-cutting inter-sectoral issues, but also creates new ones. This makes it even more difficult to find sustainable solutions.

- Accept the sanctity of international and national protocols, targets and standards. Such standardisation often leads to technically, socially and culturally inappropriate solutions when applied to unique local situations.

- Continue to adopt a linear approach to problems and their solutions that attributes undue sanctity to project reports and does not recognise development as a continuous iterative process.

In such circumstances, the real causes of problems in the WATSAN sector can only be identified by adopting an entirely different approach.

MISLEADING TERMINOLOGY

Much of the terminology used in discussions about the water supply sector is highly misleading. An effective sectoral analysis cannot be achieved without recognising this fact. Some of the misleading and erroneous terms in use are explained below.

Coverage

It is one thing to 'cover' an area or region (ward, GP, block, district, state) by a service facility, but quite another to actually ensure that every deprived household in the region is now provided the facility as demonstrated by tangible indicators. Hence, 'coverage' is a highly misleading term used to create a false impression of accomplishments of the government institution.

For instance, consider the statement: *Kerala has achieved 100% coverage in water supply.* This can mean that:

- Everyone in Kerala has access to some quantity of water of some quality, within 0 to 1000 metres of his/her residence, from a river, pond, well, or public tap. This statement leaves the impression that the state is responsible for this 100% coverage, even though this apparent coverage is not achieved through public schemes, but by the presence of private, community or public sources.

- There are water supply pipe lines at a distance of 0 to 1000 metres from every household. The claim of 100% coverage in water supply thus does not make any statement about the water availability for each household.

Despite the reality, we continue to invest massively in water supply schemes every year because people continue to seek more and more water of better quality at their homes on the one hand, and the water supply schemes continue to fail on the other.

The term 'coverage' is thus highly misleading. Before commenting on the adequacy of coverage of water supply schemes in Kerala, there is a need to conduct a house-to-house census that compiles data on the seasonality of the source, the regularity of supply, its rate, quality, the distance from the source, the type of water source or scheme, and the name of the supply agency and scheme.

TABLE 1: COVERAGE OF HOUSEHOLD (HH) WATER SUPPLY IN KERALA

Total no. of HHs	Tap water from treated sources	Tap water from untreated sources	Covered wells	Uncovered wells	Hand pumps	Tube/ bore wells	Springs	Rivers	Tanks/ ponds/ lakes	Others
7,716,370	1,802,341 (23.35%)	461,372 (5.98%)	1,129,397 (14.64%)	3,657,463 (47.4%)	38,402 (0.5%)	285,394 (3.7%)	108,527 (1.4%)	15,215 (0.2%)	55,793 (0.7%)	162,466 (2.1%)

Source: 2011 census

Demand responsiveness

This phrase is used as an indicator of the actual assessment of need. However, need is different from demand. While demand varies with the level of motivation to avail of more or better facilities, a better price, superior quality and after-sale service for the product, the need defines the requirement for survival which varies based on the socio-cultural traditions of the user community. While need is felt when scarcity occurs, which is caused by the over-exploitation or improper use of resources, demand is virtually generated by marketing techniques.

This is why the World Bank supported Jalanidhi project considers that very poor people who actually 'need' water do not 'demand' it, because even 10% or 5% of the capital cost which is their share according to the project developers, is unaffordable for them. Similarly, many households which own water sources and do not 'need' external supply 'demand' a pipe connection because the price is very low. This situation indicates that more appropriate terms should be used to define need.

Minimum standards

We assign standards (global, national, or state) for every service offered by the state and the private sector. While standardisation may be necessary to assess the level of achievement of projects, it has adverse consequences as well. Each system has its own unique characteristics and values which evolve naturally and vary with time and space. None are superior or inferior. It is not wise to evaluate them on an absolute scale.

There are standards for choice of technology and system design as well. Standardisation not only leads to a total neglect of situation-specific data for designs

and obviously results in inappropriate designs (e.g. standard per capita daily demand, water quality standards, non-usage of local materials and know-how), but also leads to expensive designs as well as ones which are more extensive in scope than required. The scope of creative innovation is also curtailed.

There are several standards prescribed for quantity, quality and ease of access (distance from source, type of source, regularity/duration of supply, etc.), which keep changing from time to time. It is very hard to understand why the standards vary for different schemes. Table 2 lists the different standards for three important drinking water programmes:

TABLE 2: DIFFERING MINIMUM STANDARDS FOR DRINKING WATER SUPPLY

Name of Scheme/Agency	LPCD	Distance	Type/Number of source	Quality
ARWSP*	40 for non-desert and 70 for desert	1.6 km in plains and 100 m elevation in hilly areas	A tap, hand pump or well for 250 persons	National standard
NRDWP**	Do	500 m and 50 m respectively	Any public/community source	Not defined
Jalanidhi	55 -70	Within 50 m	Piped supply	National standard

* Accelerated Rural Water Supply Programme ** National Rural Drinking Water Programme

Supply-demand gap

It is often impressed upon us that one of the reasons for the supply-demand gap is a reduction in the water available. Although studies show a slight decline in the south-west monsoon in the past 100 years, there is a slight increase in non-monsoonal rains, such that the total rainfall has not been affected. While one can clearly observe the variability in the distribution of rainfall, it is not significant enough to cause a decline in the available water resources.

However, there is of course a gap between supply and demand, and the singular reason for this gap is the increase in demand (not need), much beyond the net available water. We tend to conveniently obscure the fact that all natural resources, including renewable sources, are finite, and that unless we control the demand there is no way of matching demand and supply.

METHODOLOGY OF THE REVIEW

Considering water supply and sanitation separately

The water supply sector has been included in the field of public health (later called 'sanitation', and now called 'environmental sanitation') ever since the sector was brought under municipal governance. This was justified on the basis of the following arguments:

- The availability of safe and adequate water on the one hand and the disposal of waste water on the other are important imperatives for ensuring public health As plenty of water is required to flush toilets, remove septage and treat waste water, the field of public health needs to be integrated with water supply.

- Open defecation, latrine pits, poor waste management, etc. lead to surface water and ground water contamination. Unless environmental sanitation is integrated with water supply, the objective of providing safe drinking water cannot be achieved.

- Safe drinking water is provided to ensure community health. Sound personal and environmental hygiene is also essential for this purpose.

These arguments are short-sighted because:

- Poor community health is a multi-causative phenomenon of which poor personal/ environmental hygiene is only one, although very important, cause. Personal and environmental hygiene is very critical for community health, and therefore, bringing it under the water supply sector results in a loss of focus.

- Technology, skills and governance systems required for planning, implementing and maintaining water supply and environmental sanitation systems are fundamentally different.

- If ensuring an integrated development approach was the objective, then there are many more critical sectors that need to be integrated such as land use, water resource management, preventive health care etc., to name a few.

If we look at the way WATSAN is implemented, there is hardly any integration other than that the water supply agencies also implement latrine programmes (e.g. KRWSA). However, a major part of the environmental sanitation programmes are being implemented by the local self-government department under programmes sponsored by the state or centre.

This either implies that water supply and sanitation should be dealt with independently and separately, or that they should be included in a more holistic and comprehensive sector which includes as many relevant sectors as possible. Since the scope of this review does not permit such an integrated approach, the authors decided to discuss water supply and sanitation separately.

Desk studies

It was decided to study the existing documents that throw light on the performance of the WATSAN sector in Kerala. These documents can be divided into four categories:

1. Documents that elaborate on the geographical, demographical, socio-cultural and socio-economic conditions of Kerala, particularly from the point of view of WATSAN

2. Policy and historical documents that elucidate the socio-political evolution of WATSAN sector policies in Kerala

3. Documents that highlight the salient features, number, type, coverage, investment costs, unit costs, cost/benefit analysis, service delivery status, performance, and governance/management systems of various WATSAN programmes implemented under various delivery systems

4. Review/evaluation reports by reputed institutions

ANALYSIS

Since the available, quantitative information is very meagre and inconsistent, no scientific analytical tools are applied. Only qualitative discussions are resorted to.

SECTION 3:
CONTEXTUAL ANALYSIS

FIGURE 1: GEOPOLITICAL MAP OF KERALA

GEOGRAPHY

Kerala, with an area of 38,863 km² (1.18% of India's landmass) is wedged between the Arabian Sea to the west and the Western Ghats to the east. Kerala's coast runs some 580 km in length, while the width of the state varies from 35 to 120 km. Kerala lies between north latitudes 8°18' and 12°48' and east longitudes 74°52' and 72°22', and is bound by Tamil Nadu in the East and Karnataka in the North.

The state of Kerala is divided into 14 revenue districts. On the basis of geographical, historical and cultural similarities, the districts are grouped into: 1) Malabar Region (North Kerala) – Kasargod, Kannur, Wayanad, Kozhikode, and Malappuram districts, 2) Kochi Region (Central Kerala) – Palakkad, Thrissur, and Ernakulam districts, and 3) Travancore (South Kerala) – Thiruvananthapuram, Kollam, Alappuzha, Pathanamthitta, Kottayam and Idukki districts.

The 14 districts are further divided into 63 taluks, 1453 revenue villages, 978 GPs, 60 municipalities and 5 municipal corporations. Figure 1 is a geopolitical map of Kerala with its district boundaries.

DEMOGRAPHY

According to the 2011 census, Kerala's population is 33.38 million persons which include 16.02 million males and 17.36 million females. Although Kerala accounts for only 1% of the total area of India, it contains about 3% of the country's population. The population density of the state is about 859 people per sq. km, which is three times the national average.

TABLE 3: KERALA STATE DISTRICT WISE POPULATION

District	Population	Males	Females
Thiruvananthapuram	3,307,284	1,584,200	1,723,084
Kollam	2,629,703	1,244,815	1,384,888
Alappuzha	2,121,943	1,010,252	1,111,691
Pathanamthitta	1,195,537	561,620	633,917
Kottayam	1,979,384	970,140	1,009,244
Idukki	1,107,453	551,944	555,509
Ernakulam	3,279,860	1,617,602	1,662,258
Thrissur	3,110,327	1,474,665	1,635,662
Palakkad	2,810,892	1,360,067	1,450,825
Kozhikode	3,089,543	1,473,028	1,616,515
Wayanad	816,558	401,314	415,244
Malappuram	4,110,956	1,961,014	2,124,942
Kannur	2,525,637	1,184,012	1,341,625
Kasargod	1,302,600	626,617	675,983
Total	33,387,677	16,021,290	17,366,387

Source: 2011 census

Kerala is one of the most densely populated states in the country. It recorded a decadal population growth of + 9.42% (2,740,101 persons). By the year 2050, the population of Kerala is likely to grow to almost two times – from about 33 million to 64 million.

Decadal growth rate

As per the 2011 provisional population figures, the rural population of Kerala is 17,455,506. Of this 8,403,706 are males and 9,051,800 are females, whereas the urban population in the state is 15,932,171. Of this, 7,617,584 are males and 8,314,587 are females. The decadal decline in rural population was -25.96%, whereas the urban population has grown by 92.72%.

The child population in Kerala has shown a declining trend. The final population totals for the 2011 census issued by the Directorate of Census Operations reveal a negative growth rate of the child population in the state (-8.44%). The census figures show that the child (0-6 years) population is declining in all districts except Malappuram. The total number of children in Kerala is 3,472,955, with the highest number (574,041) in Malappuram and the lowest (92,324) in Wayanad. Malappuram also has the highest growth rate of child population (4.08%), while Pathanamthitta has the lowest (-23.76%). The census assesses the child sex ratio in Kerala as 964. Pathanamthitta district with 976 has the highest and Thrissur with 950 has the lowest child sex ratio. Child sex ratio in respect of the 0-6 age population in Kerala is 959. In rural areas it is 960, whereas, the child sex ratio of the 0-6 age population in urban areas is 958.

The urban population in Kerala has grown to 47.7% of the total, representing a decadal increase of 21.74% since 2001. As many as 15,934,926 persons in the state are living in urban areas, while the rural population is 17,471,135, representing 52.3% of the total. The highest percentage of urban population (68.07) is reported from Ernakulam district and the lowest (3.86) from Wayanad.

The decadal growth of population in Kerala from 2001 to 2011 is 4.91%, which is almost half the growth of 9.43% during the previous decade. Malappuram district has reported the highest growth rate of 13.45%, while the lowest as well as negative growth rate is reported from Pathanamthitta district (-2.97%). Idukki also has a negative growth rate (-1.79%). As many as 12 taluks spanning four districts in the central Travancore area have shown a fall in population.

Scheduled tribes

The scheduled tribe (ST) population of Kerala State is 364,189 as per the 2001 census, constituting only 1.14% of the total population of the state. The decadal growth of the ST population has been 13.5%, which is 4.1% higher than the growth of the total population in 1991-2001. The state has a total of thirty-five (35) scheduled tribes, and all of them have been enumerated during the 2001 census.

The scheduled tribes are overwhelmingly rural as 96.1% of them reside in the villages. The district-wise distribution of the ST population shows that Wayanad district has the highest proportion of STs (17.4%), followed by Idduki (14%). Alappuzha district has the lowest proportion of STs (0.1%), followed by Thrissur, Kollam and Kozhikode (0.2% each).

The Work Participation Rate (WPR) of the ST population is 46.3%, which is lower than that of all STs at the national level (49.1%). There is a slight accretion of 0.3% to the WPR registered in the 1991 census. The WPR of males (57.5%) is higher than that of females (35.4%).

Scheduled castes

The scheduled caste (SC) population of Kerala State is 3,123,941 as per the 2001 census, constituting 9.8% of the total population (31,841,374) of the state. The growth of the SC population has been 8.2%, which is 1.2% lower than that of the total population (9.4%) in 1991-2001. The state has a total of sixty-eight (68) SCs, and all have been enumerated during the 2001 census.

The SCs are overwhelmingly rural, with 81.8% residing in rural areas. Among the districts, Palakkad district has the highest proportion of SCs (16.5%), followed by Idukki (14.1%), Pathanamthitta (13.1%) and Kollam districts (12.5%). Kannur district has the lowest percentage of SC population (4.1%), followed by Wayanad (4.3%) and Kozhikode (7%).

Migration

As of 2011, a total of 2.28 million Keralites resided outside India. The majority of them are Muslims (44.3%), although Hindus (36.4%) and Christians (20%) are also significant in population (Zachariah and Rajan, 2012). The largest populations of Keralites abroad are found in the United Arab Emirates (912,000) and Saudi Arabia (574,739). Emigrants are largely found from the northern districts of Kerala, namely, Malappuram, Kanur and Kasaragod.

There are more than 1,000,000 migrants living in Kerala, mostly from Bangladesh and West Bengal, constituting more than 3% of the population. Most of these migrants are domestic migrant labourers (DML). A study shows that 75% of DML come from other states in India, namely, West Bengal, Assam, Bihar, Uttar Pradesh and Orissa (Minister of Labour, Govt. of Kerala). In some places like Perumbavoor, the migrants outnumber the locals. They contribute about 4 % to the state's GDP. Although this helps to address the significant unavailability of labour for agriculture and other purposes, an unchecked growth of migrant labourers would create a massive problem of housing, drinking water supply and sanitation.

PHYSIOGRAPHY AND LAND USE

Broadly, Kerala is divided into three physiographical regions (Figure 2), namely, 1) Highlands, 2) Midlands, and 3) Lowlands

The highlands slope down from the Western Ghats (also known as the Sahyadris) which rise to an average height of 900 m, with a number of peaks well over 1800 m in height. It is 1,860 sq. km in area and accounts for 48% of the total land area of Kerala. This is the area of major plantations like tea, coffee, rubber and various spices.

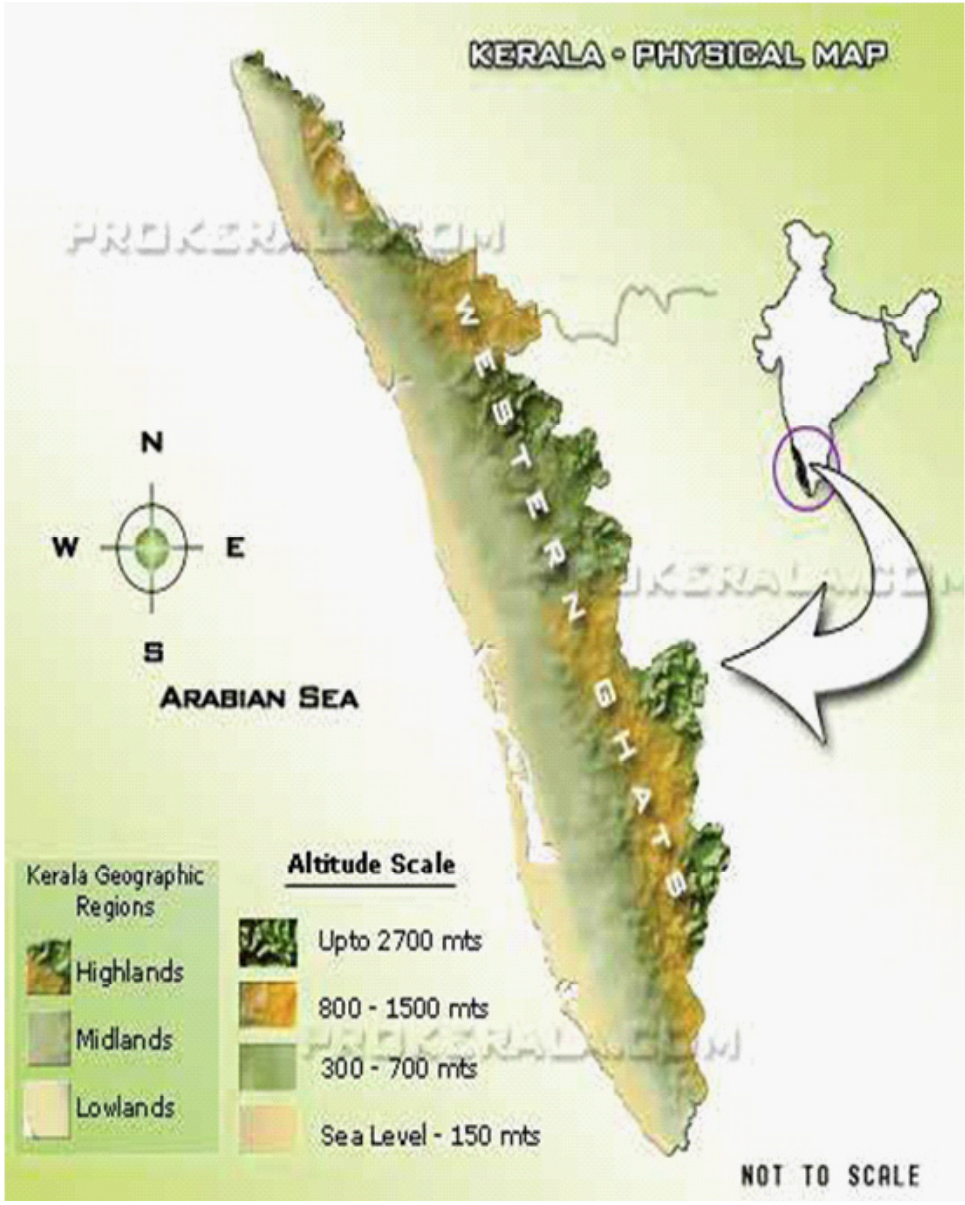
The central part of this area is also known as Cardamom Hills. This region is one of the largest producers of many spices, especially cardamom, from which it earns its name. Anaimudi (2,694 m) is the highest point in South India, and also the highest point in India outside the Himalaya-Karakoram mountain range. Most of the rivers in Kerala originate from the Western Ghats.

The midlands, lying between the mountains and the lowlands, constitute undulating hills and valleys. It is 16,200 sq. km in area, i.e., about 40% of the total land area. This is an area of intensive cultivation. Cashew, coconut, areca nut, tapioca, banana and vegetables of different varieties are grown in this area.

The lowlands are also known as the coastal area, spread across 4000 sq. km. With numerous shallow lagoons known locally as kayels, river deltas, backwaters and

shores of the Arabian Sea, it is essentially a land of coconuts and rice. This area is very fertile, and most of the paddy cultivation is along this area. The Kuttanad region of Kerala is one of the few places in India where cultivation is done below the sea level. Water is one of the dominant modes of transportation in these areas.

FIGURE 2: PHYSIOGRAPHIC MAP OF KERALA



CHANGE IN LAND USE PATTERN

The land use pattern shows that only wetlands and the most fertile and convenient regions had been brought under cultivation. Rice, coconut, pulses and vegetables accounted for major crops. Cultivation was mainly for subsistence or for local trade and commercialisation of agriculture commenced in the late 19th century, with the entry of the plantation sector, mainly tea, coffee, rubber and cardamom. Rise in the agricultural sector, led to growth of the population and investments in irrigation, communication and transport, which in turn increased the land prices. This led to the inflow of finance from outside agrarian society, through urban traders and moneylenders (Cheriyan, 2004).

After the formation of Kerala state, there has been diversification in the cropping pattern. In addition to rice and tapioca, a number of other land crops have contributed to the state's food supply. As regards to cash crops, cultivation of pepper, ginger and other traditional export crops has virtually stagnated. Cardamom and tea have not shown any substantial increase in their cultivation area whereas areas under coconut and coffee have increased slightly. The area under rubber crop has increased four-fold in the past 30 years due to institutional promotion and guidance given to farmers to adopt rubber cultivation. In consequence, rubber cultivation spread from the high ranges to the midlands and even to marshy coastal lands (ibid).

Even though rice is the single largest crop grown in Kerala even today, its area under rice cultivation has gone down by 150% (Cheriyan, 2004) in the past three decades. Rising cost of cultivation, stagnating rice prices and lucrative alternative uses of paddy lands are the main reasons for the decline.

Changes in land use patterns during the past 30 years bring out three important patterns. Firstly, the area put to non- agricultural purposes has increased mainly due to population pressures and emerging lifestyles. Secondly, the area under forest cover has diminished due to the expansion of plantations, river valley projects and encroachment of farmers into forestlands. Thirdly, consequent to the rise in the cost of cultivation of traditional crops, more land is either left fallow or used to grow less labour absorbing crops (Ibid).

CLIMATE AND RAINFALL

Kerala is bestowed with a pleasant and calm climate throughout the year. It enjoys a moderate weather almost all through the year. It is neither too cold in the winter months nor too hot in the summers. The warmer (>32°C) months are March-May and September-October. Mid-May to August is the monsoon period. The humidity is rather high in Kerala. The average annual rainfall in the state is 3000 mm. However, the spatial and temporal variation in rainfall influences the hydrological characteristics of Kerala, especially the frequent floods and droughts in the state (Jalanidhi, 2011).

The average annual rainfall in the lowlands of Kerala ranges from 900 mm in the south to 3500 mm in the north. In the midlands, annual rainfall ranges from 1400 mm in the south to 4000 mm in the north. In the highlands, annual rainfall varies from 2500 mm in the south to about 6000 mm in the north. About 60% of the annual rainfall in the state is received during the south-west monsoon (June-August), 25% during the north-east monsoon (September - November) and the remaining during the summer months (ibid).

Generally, the high ranges receive more rainfall than the other zones. However, there are certain areas in the Attappady valley with only 600 mm annual average rainfall. Areas on the eastern side of the Western Ghats receive less rainfall and are called rain-shadow areas; the rainfall in the regions close to the gaps, such as Palghat Gap, is also comparatively less due to the escape of moisture-laden clouds through the gaps. While the temporal distribution of rainfall depends on the monsoon winds to a great extent, the spatial distribution depends on the configuration of land, especially the undulating topography of the Ghats.

Rainfall is the major source of ground water recharge, and the rainfall pattern significantly impacts the water levels in the sub-surface aquifers as well as the deeper aquifers.

Interestingly, it is noticed that there is a slight decrease in the annual total rainfall in different locations of Kerala in the past century (See Box 1).

BOX 1: REDUCTION IN RAINFALL ACROSS KERALA OVER THE PAST CENTURY

(in mm)

Annual rainfall at select stations in Kerala over past century			
Station Name	**1901-1950**	**1951-2000**	**Difference**
Thiruvananthapuram	1812.1	1792.0	-20.1
Kollam	2398.1	2357.8	-40.3
Alappuzha	3274.8	3006.1	-268.7
Kozhikode	3178.1	3175.8	-2.3
Kannur	3274.4	3256.2	-18.2
Palakkad	2019.4	1999.1	-20.3
Munnar	3815.9	3744.3	-71.6
Peerumade	5164.8	4427.7	-737.1
Punalur	3159.4	2760.6	-398.8
Thrissur	3096.4	3082.3	-14.1
Kottayam	3261.5	2858.0	-403.5
Tiruvalla	3093.0	2732.2	-360.8
Neyyattinkara	1653.9	1622.6	-31.3

Peerumade, Kottayam, Punalur, Tiruvalla and Alappuzha are those stations in the State which have witnessed significant reduction in rainfall during the last century. Y.E.A. Raj, Deputy Director-General, Regional Meteorological Centre, Chennai, revealed this during a special address at the Kerala Environment Congress 2012 here.

The topic of his address was 'Extent of climate change over India and its projected impact on Indian agriculture.' Climate change in respect of individual stations manifests with mixed trends with positive and negative changes, he said. For instance, positive trends are available from stations such as Kochi (100.6 mm) and Kasaragod (153.5 mm) in the State.

"It must be stated here that rainfall series for individual months/seasons in some of the series may have shown a significant trend. In some other cases, these trends would have manifested only recently. A more detailed analysis of time series must be performed to detect and analyse such incidence," Raj said.

(This article was published in Business Line, The Hindu, on 19th August, 2012)

SURFACE WATER SOURCES OF KERALA

Rivers

Kerala is a land abundant in water resources, which include rivers, lakes, backwaters, and big and small ponds. A major share of the state's water needs is supplied by its rivers. Kerala has 44 rivers of which 41 are west-flowing and three are east-flowing. The west-flowing rivers join the Arabian Sea or the backwater lakes which open into the sea. Many of these rivers serve as inland waterways, especially in the coastal part of the state. Water from these rivers is used for irrigation, drinking, hydro-electric power production, etc. They also serve as grounds for inland fishing.

The rivers of Kerala are entirely rain-fed and the flow during the summers is very meagre affecting dependent water supply schemes. These rivers are comparatively small and many of them shrink into rivulets or dry up at places during hot seasons.

FIGURE 3: RIVERS AND LAKES OF KERALA

As per the national norm, rivers with drainage areas of more than 20,000 sq. km and 2,000 sq. km are called major and medium rivers respectively. Rivers with less than 2,000 sq. km of drainage area are termed as minor rivers (Rao, 1979). With this national norm, Kerala does not have a single major river and has only four medium rivers (Chaliyar, Bharathapuzha, Periyar, Pamba), with a total drainage area of 8,250 sq. km. The remaining 40 rivers are only minor rivers with a total catchment area of 9,489 sq. km. The total runoff of the rivers of the state amounts to about 77,900 MCM (million cubic metres), of which 70,200 MCM is from Kerala catchments, and the remaining 7,700 MCM is from Karnataka and Tamil Nadu catchments (Jalanidhi, 2011).

Reduction in river flows

Recent data from the Central Water Commission indicates a trend of reduction in the flow of Kerala rivers (See Table 4 and Figure 4).

TABLE 4: FLOW IN KERALA RIVERS

SN	Site name	River	Season	Flow in Million Cubic Metres										
				1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1	Ambaram palayam	Aliyar	Monsoon	115	181	115	131	105	81	151	150.	99	194	123
			Non Monsoon	384	182	182	155	159	121	228	247	197	217	142
			Annual	499	363	297	286	264	202	379	397	296	411	265
2	Arangaly	Chalakudy	Monsoon	2245	1762	1088	1185	1162	1022	1456	1870	1443	3038	1108
			Non Monsoon	418	189	27	221	495	401	226	230	225	139	246
			Annual	2663	1951	1115	1406	1657	1423	1682	2100	1668	3177	1354
3	Ayilam	Vamanapuram	Monsoon	616	522	368	405	261	241	563	508	638	699	396
			Non Monsoon	304	218	168	130	170	177	229	301	217	151	126
			Annual	920	740	536	535	431	418	792	809	855	850	522
4	Erinjipuzha	Payaswani	Monsoon	2214	2111	1708	1974	1239	1754	1740	2079	2135	2806	1665
			Non Monsoon	267	160	109	159	131	127	100	226	212	224	102
			Annual	248	2271	1817	2133	1370	1881	1840	2305	2347	3030	1767
5	Kalampur	Kaliyar	Monsoon	1325	1138	910	1113	734	806	891	1309	1118	1337	764
			Non Monsoon	252	100	35	138	106	71	40	187	160	82	31
			Annual	1577	1238	945	1251	840	877	931	1496	1278	1419	795
6	Kallooppara	Manimala	Monsoon	1751	1352	1186	1528	930	1189	1064	1595	1394	1823	1172
			Non Monsoon	445	122	130	406	231	360	184	465	386	190	60
			Annual	2196	1474	1316	1934	1161	1549	1248	2060	1780	2013	1232
7	Karathou	Kadalundi	Monsoon	1099	930	740	870	748	536	919	1152	1808	2461	818
			Non Monsoon	96	589	66	131	110	36	44	252	188	177	75
			Annual	1195	1519	806	1001	858	572	963	1404	1996	2638	893
8	Kidangur	Meenachil	Monsoon	1846	1634	1212	1311	963	1095	1015	1691	1364	1893	1383
			Non Monsoon	465	118	122	370	243	342	145.	462	306	281	119
			Annual	2311	1752	1334	1681	1206	1437	1160	2153	1670	2174	1502
9	Kumbidi	Bharathpuzha	Monsoon	4361	3310	2309	3386	2435	1766	3592	4808	5343	7551	2537
			Non Monsoon	1088	304	336	840	329	378	309	767	738	853	297
			Annual	5449	3614	2645	4226	2764	2144	3901	5575	6081	8404	2834
10	Kuniyil	Chaliyar	Monsoon	4832	4332	2971	2917	1941	1719	3594	5011	4709	6735	3078
			Non monsoon	943	531	435	711	163	408	224	1150	402	260	112
			Annual	5775	4863	3406	3628	2104	2127	3818	6161	5111	6995	3190
11	Kuttyadi	Kuttyadi	Monsoon			810	844	714	645	896	1086	1150	1516	956
			Non Monsoon		5	62	89	72	94	114	228	232	171	124
			Annual		5	872	933	786	739	1010	1314	1382	1687	1080
12	Malakkara	Pamba	Monsoon	3916	3245	2862	2892	1678	1927	2510	3615	3248	3741	2036
			Non Monsoon	1379	484	596	703	291	514	920	1489	1004	794	199
			Annual	5295	3729	3458	3595	1969	2441	3430	5104	4252	4535	2235
13	Mankara	Bharathapuzha	Monsoon	1163	947	382	245	237	147	349	636	647	1451	381
			Non Monsoon	495	98	54	81	53	31	58	226	161	200	57
			Annual	1658	1045	436	326	290	178	407	862	808	1651	438
14	Neeleeswaram	Periyar	Monsoon	6839	4778	5124	5212	4158	3517	5307	6816	4783	7702	4193
			Non Monsoon	1923	999	1129	1680	1161	1161	1319.	2505	2240	2365	1409
			Annual	8762	5777	6253	6892	5319	4678	6626	9321	7023	10067	5602
15	Pattazhi	Kallada	Monsoon	1312	1196	947	810	483	344	593	618	554	689	311
			Non Monsoon	742	515	427	494	505	424	384	521	383	306	232
			Annual	2054	1711	1374	1304	988	768	977	1139	937	995	543

SN	Site name	River	Season	Flow in Million Cubic Metres										
				1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
16	Perumunnu	Valapattanam	Monsoon	3986	3800	2711	2858	2828	2396	3528	4389	4477	5373	2954
			Non Monsoon	324	176	195	170	149	212	129	461	266	166	140
			Annual	4310	3976	2906	3028	2977	2608	3657	4850	4743	5539	3094
17	Pudur	Kannadipuzha	Monsoon	189	180	99.	117	90	71	144	236.	203	484	144
			Non Monsoon	238	34	41	37	27	17	57	139	72	116	25
			Annual	427	214	140	154	117	88	201	375	275	600	169
18	Pulamanthole	Thootha	Monsoon	1876	1730	1155	1281	871	603	1297	1757	1887	2587	1146
			Non Monsoon	321	161	156	342	171	175	148	369	289	207	106
			Annual	2197	1891	1311	1623	1042	778	1445	2126	2176	2794	1252
19	Ramaman-galam	Muvattupuzha	Monsoon	4404	3722	2594	3447	2632	2639	2967	4091	3256	4278	2644
			Non Monsoon	2300	1492	1301	1973	942	1218	1372	2028	1668	1934	947
			Annual	6704	5214	3895	5420	3574	3857	4339	6119	4924	6212	3591
20	Thumpamon	Achankoil	Monsoon	1201	1047	920	929	441	519	814	899	1026	1076	651
			Non Monsoon	412	148	171	330	197	291	104	347	302	201	69
			Annual	1613	1195	1091	1259	638	810	918	1246	1328	1277	720
21	Vandiperiyar	Periyar	Monsoon			175	139	84	95.	167	297	161	218	98
			Non Monsoon			5	18	16	27	18	38	108	47	9
			Annual			180	157	100	122	185	335	269	265	107

Source: Central Water Commission (CWC), 2012, Integrated Hydrological Data Book (Non-Classified River Basins)

According to Table 4 and Figure 4, which compiles river flows observed in 21 rivers of Kerala for a period of 10 years (1999-2009), one can make the following observations:

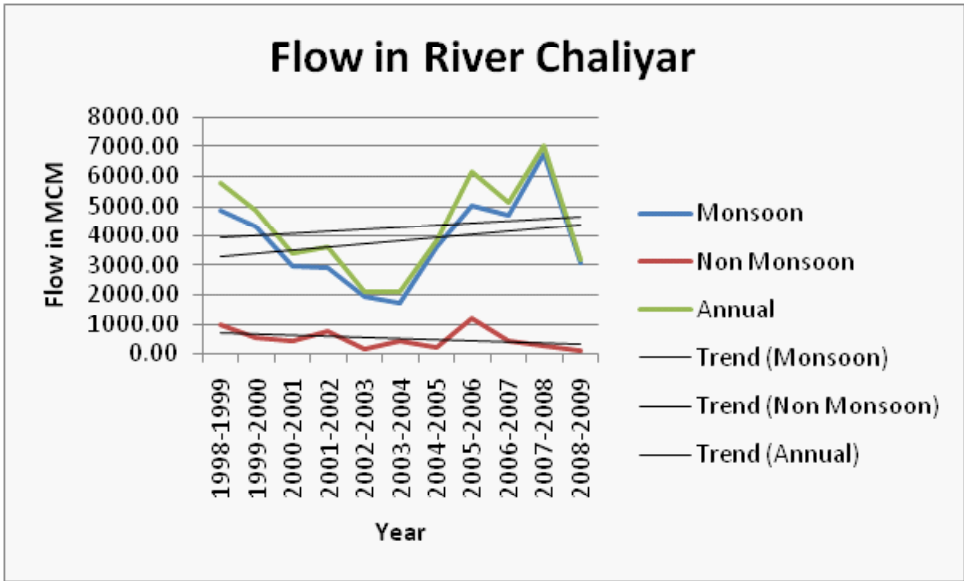
- There is a prominent reduction in non-monsoon flows of all rivers
- The monsoon flows have increased in most of the rivers, more or less compensating for the reduction of non-monsoon flow

The reduction in the non-monsoon flows and corresponding increase in the monsoon flows probably indicate a steady decline in the storage capacity of catchments primarily caused due to massive deforestation in the upper catchments. The reason for the reduction in both the monsoon as well as total flow could probably be attributed to either inter-basin/state diversion of large quantities of water, or large scale extraction in the upstream.

Backwaters or lagoons

These are shallow bodies of water separated from the open sea by land. Backwaters are one of the most alluring and economically valuable features of Kerala. These include lakes and ocean inlets, which stretch irregularly along the coast. The biggest backwater is the Vembanad lake with an area of 260 sq. km, followed by the Ashtamudi lake with an area of 55 sq. km. The Sastamkota lake is the largest natural fresh water lake in the state. It extends over an area of four sq. km. Other important backwaters are Veli, Kadhinamkulam, Anjuthengu (Anjengo), Edava, Nadayara, Paravoor, Kayamkulam, Kodungallur (Cranganore) and Chetuva. The deltas of the rivers interlink the backwaters, providing excellent inland waterways along the lower and coastal areas of the state (Jalanidhi, 2011).

FIGURE 4: FLOW IN RIVER CHERIYAR



Ponds and fresh water lakes

While a majority of the people of Kerala traditionally depended on well water for drinking and cooking purposes, the innumerable tanks and ponds - both in homesteads and public places – are used for bathing, washing clothes and meeting the requirements of domestic animals. In fact, dug wells and ponds cater the domestic water requirement of the people of Kerala for the past 2-3 decades.

Many of the homesteads had their own ponds and tanks. If a family did not have them, they depended on their neighbour's ponds or tanks. Those who did not have this water source nearby depended on the public ponds or tanks or those attached to places of worship.

TABLE 4: FRESHWATER BODIES AND RIVERS OF KERALA

Sr.No.	Type of water body	Nos.	Area (Ha)
1.	Private ponds	35,763	21,986
2.	Panchayat ponds	6,848	1,487
3.	Quarry ponds	879	34
4.	Temple ponds	2,689	480
5.	Village ponds and other water holds	185	496
6.	Irrigation tanks	852	2,835
7.	Public sector freshwater fish farms	13	85
8.	Freshwater lakes	13	85
9.	Rivers	44	85,000
10.	Check dams	80	259
11.	Bunds/Barriers/Anicuts/Shutter water holds	70	879
12.	Reservoirs	53	42,890
	Total		158,358

Source: Department of Fisheries, Govt. of Kerala

Thus, the traditional 'well-pond' system worked well in this humid tropical region with seasonal rainfall. In places where these sources were not available, the inhabitants depended on the flowing streams for meeting their demands.

The ponds and tanks of Kerala not only catered to the domestic water requirements of the people and their needs at places of worship, but also served as sources for irrigation. Some of them also acted as percolation tanks helping in the recharge of the groundwater table. The elas or small watersheds of Kerala had a pond or kulam at the upstream or higher elevation known as thalakulam, which not only facilitated gravity flow to the lower elevations and valleys but also helped in recharging the groundwater and maintaining the soil moisture. These thalakulams are seen even today in certain parts of Palakkad district. In the erstwhile Cochin state, attempts were made to interconnect several tanks so that a cascading system was developed. This helped in storing water, regulating the levels and achieving optimal use of water for irrigation purposes. The remains of these 'tank systems' are still found in this area. On larger plots of land, especially in the lower part of the midlands and lowlands, there were several ponds in the compound which were interconnected. The network of canals and ponds helped in draining away the flood waters as well as in recharging the groundwater table. In that sense, the traditional 'well-tank' system can be considered as an integrated system. Such a system was sustainable, and even today there are several lessons that can be learnt from these traditional practices by water management experts.

The ponds of Kerala, according to some of the studies being conducted, are unique ecosystems with a high degree of biodiversity. The fluctuating hydro period, unique water balance components and the hydric soil at the bed have been responsible for the unique flora and fauna in these water bodies.

SURFACE WATER QUALITY

By a rough estimate, the source-wise dependence of rural households for domestic water supply on traditional ground water systems is 80%, 10-15% use piped water supply systems and 5% use traditional-surface and other systems.

Chemical contamination

The environmental monitoring report on the water quality status in Kerala (2005) prepared by the Kerala State Council for Science Technology and Environment (KSCSTE) points out that the rivers in the state are being increasingly polluted by industrial and domestic waste, pesticides and fertilisers used in agriculture. The State Environment Report, Kerala, 2005, published by the Council also pointed out that the condition of the Periyar and Chaliyaar rivers exemplified the pollution of water bodies due to industrial effluents. According to the report, nearly 260 million litres of trade effluents are dumped into the Periyar estuary every day from the industrial belt in Kochi. From mercury to insecticides such as DDT and BHC, copper, sulphides, ammoniac nitrogen, zinc, lead and phosphates are flowing into the Periyar from major industries in the industrial zone.

The report also pointed out that incidents of fish kills had also become common in major rivers such as the Periyar, Chitrapuzha, Chaliyar, and Kallada, and the Vembanad and Ashtamudi lakes. The presence of radioactive waste materials has also been reported from these areas.

Bacterial contamination

Although bacterial contamination is very high at a few places along the rivers where

large numbers of pilgrims gather, by and large the general bacterial quality of rivers in Kerala is satisfactory, with a BOD less than 5 mg/l, DO more than 5 mg/l, bacterial load less than 2000 No/100 ml, and faecal coliforms less than 500 No/100 ml.

However, the water bodies near the coast are heavily polluted. Coconut fibre retting (which has declined significantly now), effluents from prawn peeling units, direct discharge of sewage from toilets into water bodies (due to water logging, soil leaching is not possible) and stagnation of tidal canals and channels due to the dumping of solid wastes adds to the biological contamination of coastal water bodies. About 1 MCM waste is generated daily in the coastal areas of the state, and 30,000 m^3 of it reaches the surface water bodies in the coastal areas.

Industrial pollution of coastal areas

It is estimated that nearly 300 medium and large-scale and about 200 small-scale industries are discharging effluent directly into saline or freshwater bodies. According to the report, the northern and southern arms of the Kochi backwaters receive wastewater from industries. It is estimated that about 53,000 to 80,000 m^3 of industrial effluents are discharged each day into the Kochi backwaters. These discharges contain hazardous concentrations of phosphates, sulphide, ammoniac nitrogen, fluorides, heavy metals, etc. The report cited that the coastal environment of wetlands, mangroves, mud-banks, beaches, estuaries and cliffs are in various stages of degradation.

While wetlands are increasingly being altered for undesirable uses, mangroves are destroyed for facilitating urbanisation, construction of ports and shrimp farms. Unabated reclamation, silting and pollution from industries and human wastes are damaging the estuarine and backwater ecosystem, the report said. After monitoring the levels of various marine pollutants in the coastal and offshore waters in the state, the report identified the Kochi backwaters, Alapuzha, Kayamkulam, Kollam, Paravur and Veli as some of the hotspots in the state.

Saline intrusion

The fast-flowing, monsoon-fed rivers of Kerala often encounter salinity intrusion into their lower stretches during the summer months. When the freshwater flow reduces, two major problems can occur in these water bodies: (i) salinity spreads to the interior of the river and (ii) the flushing of the system becomes less effective. The pollution of the rivers is more severe in the downstream.

GROUNDWATER SOURCES OF KERALA

Geologically, 88% of the state is underlain by crystalline rocks of the Archaean age comprising Charnockites, Khondalites, gneisses and schistose formations. All these formations are intruded by dykes of younger age. Along the western part of the state, the crystalline rocks are overlain by the sedimentary formations of the Tertiary age. The tertiary formations comprise of four distinct beds, viz., Alleppey, Vaikom, Quilon and Warkali, the age of which ranges from Eocene to Lower Miocene. Of these, only Vaikom and Warkali are potential aquifers, whereas, Alleppey beds have brackish water and Quilon beds are poor aquifers (Kerala ENVIS Centre, 2013a). Laterites of sub-recent age derived from the crystalline as well as sedimentary formations are seen all along the midlands. The midland areas have medium capacity dug wells, which can be used for irrigation. Along the coastal plains, sedimentaries and laterites are overlain by alluvial formations of recent age. In hard rock terrain comprising weathered crystallines and laterites, groundwater occurs under phreatic conditions

in the weathered residuum and the shallow fractures hydraulically connected to it, whereas it is under semi-confined to confined conditions in the deep fracture zones. In the alluvial terrain, groundwater in the shallow aquifer systems is in phreatic condition. Granular zones in the Tertiary sedimentary formations at deeper levels form potential confined to semi-confined aquifers. (CGWB, 2009; Kerala ENVIS Centre, 2013a)

Ground water availability

The Ground Water Estimation Committee, constituted periodically in the state, estimated the dynamic groundwater resource situation of Kerala, and their latest report for 2008-09 was brought out in 2011 (CGWB, 2011). This Committee has the representation of the Central Ground Water Board, State Ground Water Department, Centre for Water Resources Development and Management, State Water Resources Department, Agricultural Department, KWA, etc. They have estimated the groundwater potential of the state based on an approved procedure considering the water level fluctuations monitored in 941 wells distributed all over the state and the hydrogeological characteristics of various aquifers. As per this estimation, the net groundwater availability of the entire state is 6,029 MCM. Though this estimate provides an overall picture of the regional groundwater availability, further effort is required for understanding the groundwater scenario at the micro level. This is a serious limitation of all the micro-level planning.

Ground water utilisation

Out of 152 numbers of assessed blocks, one block is Over-exploited (> 100%), 3 blocks are Critical (90 – 100%), 22 are Semi-critical (70- 90%) and 126 blocks are Safe (<70%). The long-term water level trends of pre and post-monsoon were taken to categorise the blocks. Some of the blocks have shown a lesser stage of development, but the groundwater level is showing a sharp decline, at times more than 10 cm/year. Although the overall groundwater scenario looks satisfactory, few hotspots indicate the impending threat of groundwater depletion.

Ground water quality

More than 60% of households in Kerala use well water for drinking (Kerala ENVIS Centre, 2013b) and other domestic use. Quality of groundwater in Kerala is by and large potable. However, many water-borne diseases related to the gastrointestinal system (Harikumar and Chandran, 2013), diarrhoea, dysentery, typhoid, worm infestations and infectious hepatitis (Kunhikannan and Aravindan, 2000) and high rise of faecal contamination are attributed to groundwater contamination (Harikumar and Chandran, 2013; Kerala ENIVIS Centre, 2013b; KSCSTE, 2009). While chemical contamination occurs in areas due to heavy industrialisation and heavy application of chemical fertilisers and pesticides, there are exceptions of *in situ* chemical contamination (iron, fluoride) due to the inherent chemical qualities of soil/geological formations. Bacterial contamination is predominant in thickly populated areas with poor sanitation, and in the vicinity of bio-polluting industries and water-logged areas where stagnation of surface and ground water occurs.

Saline intrusion is common in coastal lands and lands surrounding estuaries and backwater lagoons of Kerala. This is aggravated due to a lower inflow from the rivers and over pumping of coastal aquifers. But for these isolated patches of lands with heavy pollution, by and large, the quality of groundwater in Kerala is fairly satisfactory.

THE KERALA MODEL

The 'Kerala model' of development is considered to be one of the most successfully experimented models (which later became part of the global development discourse) of the mid 1970s. The Kerala state which was once reported to have high infant mortality, low income, and high population growth rate, underwent a radical transformation due to social reforms and policies introduced by the state government and large public movements (CDS, 2006; Veron, 2001; Parayil, 1996). The main elements of the Kerala model include high literacy rate giving opportunity to the lower classes to attain higher education including women, reduced mortality and lower birth rate and increase in the life expectancy, despite low per capita income (ibid). These elements are explained in detail below.

Health care

Improved health care facilities in Kerala like government facilities and trained doctors and nurses, along with implementation of health policies have improved the life expectancy of people and reduced mortality rates in Kerala. The rise in the private health infrastructure has also aided in the development of health sector in Kerala. Table 5 shows the different health indicators of Kerala state in comparison with the rest of the Indian states. The life expectancy of people in Kerala is 74 as against 63 for the rest of India. The table also clearly indicates that Kerala is far better in terms of reduction in the infant mortality rate and fertility rates. This is attributed to better maternal health care facilities and child care (CDS, 2006) including state nutrition programme especially for pregnant women.

TABLE 5: HEALTH DEVELOPMENT INDICATORS, KERALA AND INDIA IN 2012

Indicator	Kerala	India
Life Expectancy at Birth (years)	74	63
Crude Birth rate per 1,000 people	14.8	22.1
Crude Death rate per 1,000 people	7	7.2
Maternal Mortality Rate per lakh live births	81	212
Infant Mortality Rate per 1,000 live births	13	47
Total Fertility Rates (no. of births per women)	1.7	2.6

Source: Economic Review, 2012, Kerala State Planning Board

Education

Kerala had been a notable centre of Vedic learning, having produced one of the most influential Hindu philosophers, Adi Shankaracharaya. The Vedic learning of the Nambudiris is an unaltered tradition that still holds today, and is unique for its orthodoxy, a fact unknown to other Indian communities. However, in feudal Kerala, though only the Nambudiris received an education in, other Vedam castes as well as women were open to receive education in Sanskrit, Mathematics and Astronomy, in contrast to other parts of India.

Like health care, social reforms were responsible for bringing about a change in the education system in Kerala (CDS, 2006). In 1957, the first elected communist government of Kerala brought in radical social reforms, and the highest priority was placed on education. By 1981, the general literacy rate in Kerala was 70%, almost twice the all-India rate of 36%. The rural literacy rate was almost the same, and

female literacy, at 66%, was not far behind. The government continued to push for total literacy. In 1990, the total literacy campaign was launched first in the Ernakulum district, which was a turning point in the education reform in Kerala and inspired other districts to follow suite (Kumar, 1993).

TABLE 6: LITERACY RATE FROM 1951 - 2011

Year	Persons	Males	Females
1951	47.18	58.35	36.43
1961	55.08	64.89	45.56
1971	69.75	77.13	62.53
1981	78.85	84.56	73.36
1991	89.81	93.62	86.17
2001	90.92	94.20	87.86
2011	94.59	97.10	92.12

Source: Kerala Govt., India www.kerala.gov.in

Radical land reforms

In 1957 Kerala elected a communist government headed by EMS Namboodiripad, who introduced the revolutionary Land Reform Ordinance. The Land reform was implemented by the subsequent government, which had abolished tenancy, benefiting 1.5 million poor households. This achievement was the result of decades of struggle by Kerala's peasant associations. In 1967 in his second term as Chief Minister, Namboodiripad again pushed for the reform. Apart from the land reform initiative that abolished tenancy and landlord exploitation, some of the other important reforms include: 1) effective public food distribution that provides subsidised rice to low-income households, 2) protective laws for agricultural workers, 3) pensions for retired agricultural labourers, and 4) high rate of government employment for members of erstwhile lower caste communities.

Limitations of the Kerala model

However, despite such positive trends in equitable social development through policy interventions, the model has certain limitations too. High rate of unemployment, stagnant agriculture growth, industrial backwardness and poverty especially among the fishing community and tribal population have been observed (Veron, 2001). The high rate of education in the region has resulted in a brain drain, with many citizens migrating to other parts of the world for employment as they are unable to find jobs which suit their capability. The overall job market in Kerala is also very depressed, forcing many to relocate especially to the "Gulf" countries.

Kerala may continue to receive remittance only till the migrated people have ties with Kerala. This scenario is also changing as many migrants are now compelled to return due to competition in the labour market and rapid and radical policy changes in the host countries to encourage employment opportunities for the domestic people. Alternatively, once these youngsters start settling down at their place of work outside Kerala, the state will become a 'retirement home' without working youth and inward remittances.

There is a school of economists who believe that the Kerala model is unsustainable

as the ‘state does not have enough fiscal capacity to support the social redistribution system and it lacks a strong manufacturing sector’ (Bhat and Jain, 2004; Tsai, 2007).

Anyone interested in Kerala’s development today cannot ignore the question of why its people show such a collective inability to run economic enterprises or to produce commodities (agricultural or industrial) with the minimum of efficiency required to be competitive in the Indian, Asian or world market without protection and subsidies. This is, indeed, a cultural and human problem for people who have achieved relatively high levels of human development.

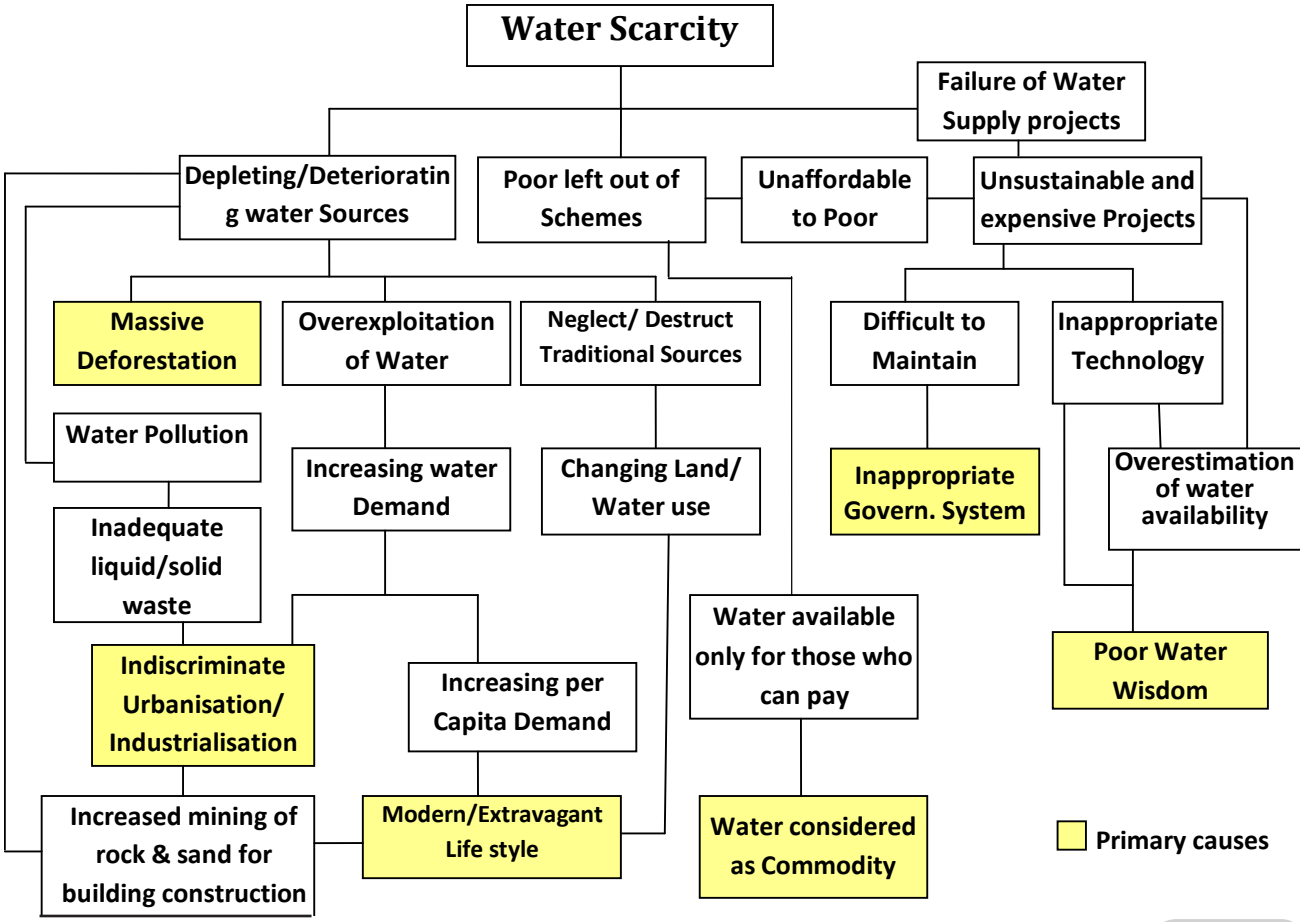
There is something precarious and intrinsically unsustainable about the lifestyle of people of Kerala, which is a banal expression of conspicuous consumerism. In fact extravagance and indiscriminate consumption is encouraged to “boost demand, production, and hence employment potential”. In fact this peculiar socio-economic, socio-cultural and socio-political situation is also responsible for the crisis in Kerala’s natural resource and environment management.

SECTION 4:
ISSUES OF KERALA WATER SUPPLY SECTOR

BEGINNING OF CURRENT WATER CRISIS

Urbanisation and modernisation were introduced subsequent to the invasion of the British and other colonial rulers. Large dams, piped water supply, motorised pumps, etc., are a few examples of these. The increasing material prosperity and disintegration of the traditional joint family structures led to divided households, a consequent division of property, and a need for more water sources. Due to increased pressures on the land, people not only started reclaiming old ponds and paddy fields for construction of buildings but also started replacing open dug wells with bore wells. These phenomena resulted in a gradual overexploitation of ground water on the one hand and a collapse of the traditions of conservation of water on the other, contributing to the current water crisis. Adoption of modern consumer culture and heavy urbanisation resulted in environmental pollution, which included the pollution of water sources. This also led to an increased demand for construction materials resulting in massive deforestation, sand mining, and quarries, all of which adversely affected water sources.

FIGURE 5: PROBLEM TREE OF KERALA WATER CRISIS



According to the dominant development philosophy, all natural resources are commodities which can be sold and bought, and only those with the ability to pay will have access to these resources. This is how the concept of 'demand' became a precondition for eligibility for availing drinking water. Demand is measured as a willingness and ability to pay. Besides, the choice of inappropriate technology has made schemes expensive and unaffordable to the poor. Thus, poor people who cannot afford to pay are left behind, unable to access water from supply schemes.

Poor water wisdom led to a poor choice of technology. Poor construction and shoddy maintenance aggravated the situation resulting in a failure of the public water supply systems. In the name of rapid growth and modernisation, the adoption of unsustainable, inappropriate and expensive technologies is spreading. This alarming development may be the reason for which our rural communities believe that pumps, pipes and tanks can solve their drinking water problems.

POOR PERFORMANCE OF STATE OWNED LARGE PIPED WATER SUPPLY SCHEMES

In 1998, the Operation and Maintenance Improvement Programme (OMIP)[3], a Dutch Danish supported project to assist the KWA to improve the operational efficiency of its piped water supply schemes concluded that large state owned pipe schemes are inappropriate for most rural areas of Kerala, because:

- The majority of rural Kerala depends on open dug wells. Therefore, problems of water availability in the villages of Kerala are due to the seasonal scarcity and bacterial contamination in these wells. There are a few isolated patches consisting of 30 to 40 families facing acute water scarcity, for whom small piped water supply schemes are adequate. A case can, however, be made for improving the yield and quality of wells.

- The KWA schemes are poorly planned particularly in the areas of source sustainability, technology choice and design optimisation resulting in source and system failures.

- The Operation and Maintenance (O&M) efficiency of large KWA schemes is very poor, and there is very little scope for improving them because of a lack of corporate will, and poor cost recovery. This leads to a vicious cycle of poor O&M budgets and a neglect of O&M, leading to a high rate of system failure.

FAILURE TO QUANTIFY THE PROBLEM

Everybody talks about the water crisis in Kerala. There have been an umpteen number of workshops, seminars, and conferences on the subject. Several articles have been written and published on Kerala's water crisis. Unfortunately, most of these presentations only deal with the qualitative aspects of the problem, leading to highly generalised conclusions.

An absence of reliable primary data is the main problem. As far as the collection of primary data is concerned, the picture is utterly dismal. Very little effort is made to collect reliable data such as river flow data, soil erosion data, hydro-chemical/ hydro-biological data, hydrological characteristics of watersheds/river basins, hydro-geological data such as water table fluctuations, hydraulic parameters of various aquifers, etc. Thus, even so-called 'expert reports' resort to wild assumptions while conducting water balance studies. Besides, the methodologies used in data collection, if at all, are mostly outdated. Those who have access to the available data use them

3
Concluding Report, OMIP, 1998

selectively to suit their convenience or to prove their prejudiced point of view. One classic example is the use of 'monthly averages' while calculating available water for a river-pumping scheme. Even if the flow in a river is for a few days (not uncommon during the summers), the monthly average will 'redistribute' the flow over thirty days and give us an impression that one can pump water from the river even in the summer.

CHOICE OF INAPPROPRIATE TECHNOLOGY

Since choice of technology is dependent on multiple local factors that change in time and space, a standardised approach will not yield sustainable results. The complexity of the problems is so vast that ready-to use prescriptions are neither possible nor desirable. Giving undue importance to large piped water supply is a classic example. While this may be the only solution for urban areas, for rural areas, this is only one of multiple options available.

LIMITATIONS OF DECENTRALISED WATER SUPPLY SCHEMES

By the early nineties, the national policy on the water supply sector changed radically, and it was widely accepted that decentralised community managed water management schemes are ideally suited for rural areas. Although the opinion on the need for decentralisation and community participation was unanimous, it has not been possible to achieve these results. Encouraged by a few community initiatives to decentralise the water supply sector in the Malabar region, (e.g. Olavanna[4], Chekode[5]), by the late nineties, a number of institutional delivery models for up-scaling community managed water supply systems such as Panchayat, Jalanidhi, Rajiv Gandhi Sector Reforms, etc., began to emerge in Kerala. While these models are far superior to the centralised KWA model, as far as community participation is concerned, they continue to adopt the 'project' approach. The following serious limitations were observed in these models:

- In a majority of cases, piped water supply schemes which pump water from wells were implemented. An absence of proper yield tests led to over pumping resulting in the premature drying of the source and neighbouring wells.
- Measures to conserve/recharge water sources were limited.
- The chosen technology was expensive and seldom optimal because of the dependence on standardised manuals and guidelines.
- The scope for the revival of traditional systems did not get adequate attention. On the contrary, an overemphasis on piped water supply resulted in a total neglect of traditional water sources.
- Multiple options were seldom considered, and an impression was created that piped supply to houses was the best option.
- Issues related to equity and social justice were entirely neglected, and community participation was restricted to those who can afford to pay.
- For this reason, vast sections of the community who could not afford the cost and/ or preferred different technology options were left behind.
- The model failed to empower and improve the capacity of Panchayati Raj institutions and the local community.

4 In Olavanna Panchayat near Kozhikode, in the early nineties, the community under the leadership of a local plumber implemented numerous small water supply schemes without any assistance from the government or external funding. These schemes are completely owned and managed by the community.

5 In Chekode Panchayat of Malappuram district, during 1998-2003, about 42 small communities managed the water supply schemes under the Panchayat Plan with the technical and notional financial support of the Dutch government. The community contributed between 20 to 45% of the capital cost, and took a lead role in technology choice, planning and implementation. The schemes are owned by the community, and O&M is completely managed by the people who share its full cost.

- The model failed to develop 'process models' that perfected the choice, application and management of appropriate and environmentally compatible/sustainable technologies to suit different unique, geographical, cultural, and socio-economic situations.

CONTRADICTIONS

Kerala, unique in many ways, is a state with highly contrasting if not contradictory situations. The following paradoxes in the water supply sector demonstrate this unique nature of Kerala:

1. Scarcity amongst plenty: Kerala with very high rainfall and natural water resources has the lowest per capita share of fresh water.[6]

2. Highest density of private wells, but high demand for piped supply: Even where traditional wells supply adequate good water, people tend to demand piped supply.

3. Very high frequency of breakdown of public water supply systems, but very low public protest: We can see leaking pipes everywhere but people hardly protest. This is because almost everyone has an alternate water source. Only when the problem is acute, there are mass protests.

6
State of Environment Report (2005) for Kerala, http://www.kscste.kerala.gov.in/pgm_soe.htm

SECTION 5:
POLICY FRAMEWORK

Water is primarily a state subject, i.e., the task of policy formulation in the water sector is the responsibility of the states. However, the national government also promulgates water policies from time to time which are the guidelines for planning and managing the water sector of the country. Very often, the states need to adhere to these policies, particularly when they avail of central assistance.[7] Thus, in order to investigate how far the water policy framework of Kerala is conducive to promote WATSAN as a human right, one has to review both the national and Kerala state water policies.

KERALA WATER POLICY, 2008

In the year 2007, the state government brought out a draft water policy. Due to popular demand, this policy was subjected to several formal and informal public debates, in which the press, eminent environmentalists, elected representatives, representatives of civil society, government experts and academics participated. Eventually, as per GO (P)No.31/2008/WRD dated 19th July 2008, the Kerala government promulgated the Kerala Water Policy, 2008.

Interestingly, this document has all the right words - sustainability, equity, social justice, inclusion, water as a human right, etc., that satisfy almost all stakeholders. However, the document may disappoint the traditionalists who want to perpetuate the dominance and interest of government departments in natural resource management and promote mega schemes at any cost that attract massive investments with obvious ulterior motives. Even from the human rights perspective, which is seldom considered in such documents, the Kerala Water Policy 2008 has taken path-breaking positive positions.

The policy acknowledges water as a public resource and asserts the right of citizens to access it. Water could indeed become a very scarce commodity in the future due to global warming and consequent climate change. No longer can the abundant availability of water be taken for granted. Conserving all water resources in the best possible way, coordinating the efforts of various government agencies and involving the people themselves in the task is now a crucial necessity according to the policy document.

The policy conceives the necessity of conservation, development and management of water resources based on the concept of watershed as inevitable for maintaining the ecosystem integrity of rivers and river basins of Kerala. The policy stipulates treating each river basin as an integral unit of various watersheds for planning water conservation measures and deciding how the resources on hand shall be apportioned among various consumer groups. Domestic consumers are the first priority, followed by farmers, power generation, the agro-processing sector and industrial or commercial customers, in that order. The commercial use of water is to be subjected to stringent regulations.[8]

7 There have been exceptions. For example, in the Maharashtra State Water Policy of 2003, the second priority of use was given to industries, and the third to agriculture, whereas in the National Water Policy, it was the other way round. In 2012, the Government of Maharashtra had to change this and accord second priority to agriculture through a Government Resolution (GR) because of civil society action.

8 The policy in its draft form had an innovative feature of allowing flexibility to the various river basins in Kerala to have their own order of water use prioritisation, after the first two priorities of domestic water and agriculture, as per the specific situation existing in the basins. However this flexibility was removed in the final policy.

The existing laws and rules on the use of water required a thorough review in the light of the policy formulated by the government after several rounds of discussions with experts and stakeholders. The policy proposes new laws for setting up a River and Wetland Authority and regulating groundwater exploitation. The policy specifies measures against the delays that have become a norm in the execution of drinking water and irrigation projects in Kerala. It says that more large irrigation projects are not advisable for the state. The focus henceforth shall be on small projects, especially lift irrigation schemes that can reduce water wastage. Rainwater harvesting, protection of forest cover, preventing water pollution with stringent penal provisions against the polluters, checking saline water intrusion into inland water sources, and strengthening research are some of the other focus areas mentioned in the water policy.

NATIONAL WATER POLICY, 2012

The National Water Policy, 2012 (MoWR, 2012) is one of the most debated documents in recent times. Hundreds of eminent individuals and institutions have already expressed their strong points of view about the policy. Some general observations are:

- The document lacks a systematic development based on a logical and objective analysis. Instead, this is a compilation of contradictory and vague statements without any focus.
- The document does not discuss the fate of past water policies, and the advantages of the current water policy compared to earlier policies.
- Some of the basic assumptions and positions in the document are not explained.

Water scarcity and climate change

"There is an increasing scarcity and unequal spatio-temporal distribution (floods, droughts) of water caused due to climate change." (1.1, 1.2.3, 1.2.4, 1.3.10)

Although there are indications of climate change and a slight decreasing trend in rainfall, it is not so significant yet, and is a manmade phenomenon caused by deforestation, construction of large dams, inappropriate land use and overexploitation of water.

Water scarcity and economic value of water

> *"Lack of public awareness of water scarcity and economic value of water is the reason for wastage, inefficient use and overexploitation of water." (1.1, 1.2.13, 1.3.4, 3.3)*

This is not fully true, because in a water scarce area, a rich man can still pay a high price for filling his swimming pool, fountain, irrigating his lawn, etc. and a rich farmer can pay high prices and overexploit water for intensive irrigation of cash crops. Wastage in the public water supply system occurs because the users did not participate in the planning, particularly in the choice of technology, and have no sense of ownership of the system.

Technology choice

> *"The lack of .....utilizing modern techniques_..... constrains good water management" (1.2.14).*

This is not true. Instead, technology that is socially, culturally, environmentally, technically and economically inappropriate leads to poor water management.

Demand concept

> *"Planning, development and management of water resources need to be governed by …economic needs (1.3.1).*

This is not true because it is difficult to meet 'economic needs'

> *"Given the limits …… meeting the future needs will depend more on demand management, (a) evolving an agricultural system which economizes on water-use and maximizes value from water, and (b) bringing in maximum efficiency in useof water and avoiding wastages." (1.3.8)*

This is a very narrow perspective of Demand Management and conveniently overlooks the need to massively curtail the consumption of industries, urban complexes, water theme parks, hotels etc. and restrict the per capita domestic consumption, particularly by the upper class people.

Ownership/control of water resources

> *"Water needs to be managed as a community resource held by the state under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all." (1.3.4, 2.2, 3.6, 5.4, 8.4,12.3)*

This is a welcome move to curb mismanagement and overexploitation of water by individual and corporate owners, as long as it does not take away the right of a community to make the correct decisions and oppose wrong political decision on water related interventions. The notorious example of the erstwhile Madhya Pradesh government 'awarding' a portion of the Sheonath river (presently in Chhattisgarh) to a business lobby is a case in point. There are also numerous examples of states allocating a large share of water to industries and business lobbies "in the best interest of the people".

Use of water by industry

> *"Industries in water short regions may be allowed to either withdraw only the makeup water or should have an obligation to return treated effluent to a specified standard back to the hydrologic system. Tendencies to unnecessarily use more water within the plant to avoid treatment or to pollute ground water need to be prevented" (11.6)*

Industries and commercial systems are the main culprits which cause severe deterioration of the quality and a reduction in the quantity of water in water sources. For this reason, no industries or commercial complexes which require large quantities of water should be allowed in water scarce areas. Besides, strict penal action (like in the western countries) needs to be initiated against those industries and commercial complexes which violate the effluent treatment standards.

Industrial pollution

> *"Subsidies and incentives should be implemented to encourage recovery of industrial pollutants and recycling / reuse, which are otherwise capital intensive" (11.7)*

This is unnecessary. Industries do not need any subsidies or incentives to ensure water conservation and effluent treatment, because they can afford these systems

which are in their own interest.

Public private partnership

> *"The water related services should be transferred to community and / or private sector with appropriate Public Private Partnership mode with penalties for failure, under regulatory control on prices charged and service standards with full accountability to democratically elected local bodies" (12.3)*

This is a dangerous move by the state to withdraw from service provisioning and privatise services in the name of expediency. If this is read in the context of the commodification of water and demand responsiveness in water supply, one can easily conclude that in the future access to water will be limited only to those who can pay for it. This will leave millions of poor people without access to water service facilities.

One needs to clearly distinguish between not-for-profit civil society organisations and private companies. Similarly, urban and rural contexts also need to be distinguished. Reasons for private companies participating in water governance are not stated. There are thousands of successful community/user managed systems in India. Perhaps the PPP model can be tried in the urban water supply sector with certain non-negotiable conditions like equitable access, affordable pricing, transparent processes, and grievance redressal systems.

Important missing points in the National water policy

Prioritisation of water use

Although there is some mention about according top priority to drinking water and ecosystem needs, what will happen to the remaining water is not explicitly stated. Thus, proper prioritisation of water is crucially missing from the draft document. If this aspect is left to the politicians, an ill-informed public may be easily misled to choose urbanisation/ massive industrialization instead of improving rural livelihood systems, and commercial/water intensive chemical agriculture instead of sustainable agriculture and food security (in terms of both quality and quantity). Such choices will lead to a further deterioration of natural resources.

Water allocation

- While the policy mentions that minimum supply to all will be ensured, it does not discuss an upper limit, nor does it assure minimum supply as a human right.

- The policy does not mention the earmarking of an adequate quantity of water for future generations, conveniently ignoring the fact that all natural resources, including renewable ones, are finite.

Therefore, it is clear that while the Kerala State Water Policy, 2008 is well positioned in terms of the financial and institutional efficiency of the governance system, equity, right to water, sustainability and environmental stability, the National Water Policy, 2012 needs a lot of work. The possibility of elevating the right to water to the status of a human right is much greater under the Kerala State Water Policy, 2008 than under the National Water Policy, 2012.

SECTION 6:
WATER SUPPLY PROGRAMMES AND COVERAGE IN KERALA

The major implementing agencies of drinking water supply schemes in the state are the KWA, the KRWSA and Local Self Government Institutions (LSGIs). The KRWSA and LSGIs are ensuring community participation in the implementation of water supply schemes by sharing the financial costs and undertaking responsibility for management, operation and maintenance, to some extent. Besides these agencies, the Department of Urban Development and the Department of Town and Country Planning also act as nodal agencies for water supply schemes.

Besides, the Socio Economic Unit Foundation (SEUF), an accredited NGO started with Dutch and Danish support in the mid-eighties also assumed a leading role in implementing various community managed water supply projects in close association with the three-tier Panchayat system.

KERALA WATER AUTHORITY

The Kerala Water Authority , an autonomous body under the state government, was launched to plan, implement and manage piped water supply systems in the mid-eighties. The KWA at present has 86 on-going Accelerated Rural Water Supply Schemes (ARWSS) which are in various stages of execution, 74 of which are funded by the central government, and 12 by the state government. 427 schemes under this category have been completed, while 108 schemes are in the implementation phase.

TABLE 7: WATER SUPPLY COVERAGE IN THE STATE

Total Households (HHs)	7,716,370
HHs with tap water from treated sources	1,802,341
HHs with tap water from untreated sources	461,372
HHs with covered well water	1,129,397
HHs with uncovered well water	3,657,463
HHs with hand pumps	38,402
HHs with tube or bore wells	285,394
HHs with spring water	108,527
HHs with river or canal water	15,215
HHs with pond or lake water	55,793
HHs with other sources	162,466

Source: Census 2011

BOX 2: MAJOR PIPE BURST ROCKS KOCHI

Kochi: A vast area of the city will go without drinking water for the next two days after a major pipeline, where a leak was detected by the Kerala Water Authority (KWA) over a week ago but took no action, burst at the Kaloor-Kathrikadavu Road on Saturday morning.

According to KWA officials, around 15% city areas including Kaloor, Kathrikadavu, Elamakkara, Chitoor, Vadutala, Pachalam, North and Mulavukadu will be affected till Monday. Water resources minister P.J. Joseph said he had directed that the repair works be completed before Sunday noon but it would take 48 hours to completely restore water supply. Earlier, the 700 mm pipe supplying water to Vaduthala section burst at 8.30 a.m., with water gushing out with great force, flooding nearby shops and resulting in a portion of the St Francis Xaviers convent, which is nearby, caving in.

“We had detected the leak last week after the locals informed us of water spraying out. But we decided to start the repair work after ‘Vishu’ festival as it would take at least 48 hours to replace the pipe there. However, as a safety measure, we had reduced the valve turn at Kaloor side from 28 to 10 which saved the day,” said assistant executive engineer, Kaloor, K.V. Mohan. Meanwhile, Mayor Tony Chammani demanded strict action against the Kerala Water Authority as KWA officials failed to carry out timely repair despite the locals informing them about the leak over a week ago.

Source: Deccan Chronicle, 12thAugust, 2013

By the late nineties, the KWA attracted severe criticism from international funding agencies, media and civil society about the deterioration of its water delivery, governance, service performance and user satisfaction. This is discussed in detail later. As a last attempt to improve the overall efficiency of the KWA, a joint Dutch-Danish supported project called the Operation and Maintenance Improvement Project (OMIP) was implemented between 1995 and 1998. The OMIP carried out a detailed performance evaluation of one selected KWA scheme, and observed serious defects in the overall scheme management, particularly in the O&M.

These observations[9] had far reaching implications for the future of the water supply sector of Kerala. In a follow-up effort, advantages of introducing technical and managerial improvements in the operational management of KWA schemes were demonstrated through participatory and practical processes. However, the KWA unfortunately refused to accept any of the recommendations of the OMIP.

JEEVADHARA - DUTCH ASSISTED COMMUNITY MANAGED WATSAN SYSTEMS

Towards the late nineties, the final years of the WATSAN projects implemented by the KWA and supported by Dutch and Danish governments, it was realised that for a variety of reasons, the social justice, sustainability, operational efficiency and cost effectiveness aspects of large state owned piped water supply schemes were poor and therefore these schemes need not be supported any more. Instead, on a pilot basis, five decentralised, community-managed, need-based (not demand-responsive as later qualified) water supply systems were introduced in the Chekode Panchayat in Malappuram District to be implemented by the SEUF, which would act as the nodal agency under the decentralised governance system of the Kerala government, known as the Peoples' Planning Campaign. This was a great success and received wide political acceptability. Subsequently, on its own initiative, the Chekode Panchayat implemented about 43 community managed schemes, each covering 20 to 50 families, under the decentralised governance system of Kerala. These schemes were financially supported by the community (25%), the Panchayat (40%) and the Dutch Government (35%). The community chose a variety of technologies (gravity scheme, pumping scheme, rainwater harvesting, etc.) suitable for local conditions.

Since a lot of focus was laid on capacity building, institutional and operational sustainability was ensured. These pilot projects were not only highly successful and attracted wide political patronage, but were also replicable for the same reason. In fact, this was a pioneering initiative that introduced the concept of decentralised, community managed water supply systems under decentralised governance. These experiences led to the formulation of technical, financial and institutional guidelines for decentralised community managed water supply systems in Kerala.

Encouraged by this high success, by 2000, the project was extended to Idukki and Alappuzha districts representing highlands and coastal areas. 115 community water supply schemes and 300 rainwater harvesting units were implemented in Idukki. In Alappuzha, 157 community schemes, 191 filter point wells, 1,241 household filters and 1,651 rainwater harvesting structures were implemented. Source recharge was one of the main features of this programme. 15% of the total capital cost was met by the community and 10% by the Gram Panchayat (GP). There were instances where up to 50% of the capital cost was met by communities through labour and local resource mobilisation.

WORLD BANK AIDED JALANIDHI PROJECT

Encouraged by the success of various decentralised community managed WATSAN projects, particularly the Chekode experience, the World Bank assisted Kerala Rural Water Supply and Environmental Sanitation Project (later named Jalanidhi), conceived in mid-1999. The Kerala Government created an autonomous institution - the KRWSA to implement this project. The project has been designated as a demand responsive project with a community driven development approach in implementation. The project integrates water supply with sanitation, health promotion, and ground water recharge measures.

9 Performance Assessment of Edappal CWS Scheme, OMIP 1998 and Conclusion Report of OMIP, 1998

BOX 3: FROM OLAVANNA TO CHEKODE -THE FORERUNNER OF INTRODUCING DECENTRALISED, COMMUNITY OWNED AND MANAGED WATER SUPPLY SYSTEMS UNDER THE DECENTRALISED GOVERNANCE SYSTEMS IN KERALA

By the late eighties, there was an increasing awareness among the rural population of Kerala about the irrelevance and futility of large state-owned water supply systems, because they could not sustainably solve the rural drinking water problems. People also knew that they had very little voice in planning and designing these systems and for this very reason most such schemes were forced upon them.

On their own initiative, people began looking for an alternative. One of the most popular initiatives is the 'Olavanna' initiative in which people of Olavanna village, situated about 15 km east of Kozhikode, collected contributions, installed and are collectively managing many small piped water schemes benefitting 30 to 40 families each, under the leadership of a local plumber. This experiment received a lot of publicity, not only because it was a viable alternative to the KWA model but also because of the bold introduction of a civil society movement. While the people's initiative was highly applauded, the Olavanna model still raised questions about equity, inclusion and replicability under decentralised state governance.

A small pilot initiative to introduce decentralised community managed water supply systems under the Panchayat governing system was made in Chekode Panchayat on the banks of Chaliyar river in Malappuram district by SEUF (Socio Economic Unit Foundation), an NGO with the financial, technical and institutional support from the Royal Netherlands Embassy in 1998. This initiative had the following unique features:

- It adopted an iterative model in spatial and temporal steps which observed and incorporated social, cultural, economic, environmental, governance and political dimensions at every step.
- The initiative was implemented with an open mind, and standards were evolved rather than imposed. For instance, according to the suggestion of an old woman, the per capita supply was based on the available water in each subsystem after earmarking adequate reserve for the next generation. The old woman's suggestion was used to design a computer model for planning and designing systems to meet this requirement.
- Many creative technical innovations (e.g. use of ferro-cement Overhead Service Reservoir (OHSR), using plastic coins with varying perforations in supply pipes, computer programme for network analysis and planning water supply systems) and alternative location specific technology options for source, (e.g. various roof water harvesting models, spring based gravity schemes) were implemented.
- School children were involved in data collection, planning and design.

The high level of social and political acceptance of this community model in spite of the fact that the KWA had offered a large piped water supply scheme here, was reason for the Panchayat to expand the scope of the project to cover the entire Panchayat with 43 piped water schemes benefiting about 1500 families, hundreds of individual and school roof water systems. By early 2000, the people of Chekode Panchayat offered this Chekode model to the policy makers of Kerala for replication. All the subsequent community managed decentralised water supply systems of Kerala, including the World Bank assisted Jalanidhi project, are based on the Chekode experience.

The Jalanidhi-1 project was initially targeted to cover 112 GPs for improving the quality of rural water supply and environmental sanitation service delivery to achieve sustainability of investments. After its midterm review, the project cost was revised to Rs. 381.50 crores since impressive achievements were attained with a lower cost than that estimated. Jalanidhi-2 aims to cover 200 GPs with an outlay of Rs.1000 crores.

As per the revised plan, 92 GPs spread over Thrissur, Palakkad, Kozhikode and Malappuram districts and 18 GPs spread over the remaining nine districts excluding Alappuzha were taken up. Two GPs in each district have been covered by the project on an experimental basis. Besides, two GPs of Kollam District were selected to implement the Tsunami rehabilitation water supply project. Thus, the Jalanidhi project covers 112 GPs through 122 projects. Of these projects, 10 are tribal projects.

There are 3,282 small and 16 large new water supply schemes under the Jalanidhi project which covers a population of 9 lakhs. Moreover, 148 KWA schemes and 253 GP schemes were rehabilitated under this project. Of the families participating in the Jalanidhi project, 52% live below the poverty line (BPL) and 16 percent belong to the scheduled castes or tribes. 5.07 lakh people were benefited by the construction of latrines through the Jalanidhi project. Besides, a large number of people were trained in various sanitation and hygiene practices, project management and skill development.

Out of the 3,696 schemes taken up under Jalanidhi-1, all schemes have already been completed and communities have been empowered to carry out operation and maintenance.

All the functional water supply schemes are operated and maintained by the beneficiary groups. As on 30th September 2010, about 10.09 lakh people are getting water through Jalanidhi schemes (170,253 households and 175 institutions). 148 KWA's single Panchayat schemes and 253 GP schemes were rehabilitated and handed over to the beneficiary groups. Of the commissioned schemes, 162 are in tribal areas benefiting about 35,000 tribes (6,755 households).

It is important to note that 12% of the Jalanidhi schemes are using rain water as the main source for water supply, which could have a considerable impact on the Government of Kerala's initiative to promote rainwater harvesting in a big way.

One must realise that scaling up a concept costs more when it is put through a linear straight-jacketed project model, in spite of the periodical reviews and evaluations. Primarily, it overlooks the thematic and location specific realities that arise during planning and implementation.

There are critiques of the Jalanidhi schemes which state the following:

- For a variety of reasons, such as serious management issues, conflict resolution problems, and O&M problems, the Jalanidhi project should not have promoted large comprehensive piped water supply systems in tribal areas.

- The implementation did not take into account the socio-cultural and socio-economic characteristics of tribal communities. Real participation cannot be ensured merely by reducing their financial contribution to the project.

- Concepts of safe drinking water (standards) and personal hygiene should have been thoroughly reviewed in the context of the socio-cultural realities of tribal communities, their immunity levels, and the infrastructural setting of tribal areas.

For instance, even if chlorinated water is provided to the tribal areas, a tribal person will never drink it.

A study by the KWA[10] states that since the water is not 'treated' it is unsafe. We are not surprised by this because the KWA cannot accept any non-chlorinated water as safe. Instead, one needs to conduct exhaustive studies to understand the quality of the water sources used by tribal people, and design the most appropriate methods to maintain their purity keeping the socio-cultural and immunity aspects of tribal communities in mind.

GIRIDHARA (COMMUNITY MANAGED WATER SUPPLY IN TRIBAL AREAS)

The project was implemented in the Wayanad district by the SEUF with assistance from the Government of India (GoI) under the Special Component Plan. The project aimed to provide adequate safe drinking water in tribal habitats and encourage initiatives to develop women's capacities as well as self-help groups. It is a community driven and demand responsive project, for which the community is expected to mobilise 10% of resources towards the partial capital cost for implementing water supply schemes. The project benefited 10 selected GPs in the Wayanad district. Each GP implemented 15 to 20 water supply schemes per Panchayat, and 600 families benefited from the scheme. Under Giridhara, a total of 3,317 tribal families were covered through 203 community managed water supply schemes.

SCHEMES IMPLEMENTED BY THE THREE-TIER PANCHAYATI RAJ SYSTEM

Since the late eighties, under the people's planning campaign, Zilla, Block and GPs, implemented many small piped water supply schemes using the plan funds. Beneficiaries contribute 10%, and the remaining 90% funds are obtained from the plan fund. The schemes are designed and implemented according to the guidelines of the LSGD from time to time. The actual coverage is as follows:

TABLE 7: SCHEMES IMPLEMENTED UNDER THE THREE TIER PANCHAYATI RAJ SYSTEM

LSGD	Number of Schemes
Rural	509 - Swajaldhara Zilla Parishad
Rural	3500 -GP
Urban	46 – Thrissur Corporation

Due to a variety of reasons, mainly the absence of community participation and poor operation and maintenance, the performance of these schemes is far from satisfactory compared to other community managed schemes.

SECTOR REFORM PROGRAMMES

In April 1999, the GoI launched the sector reforms programme by earmarking 20% of the ARWSP funds. The hardware support is being supplemented by other support programmes like social mobilisation, capacity building, Information Education and Communication (IEC), Human Resource Development (HRD) and Management Information System (MIS). The main objective of the programme is to institutionalise community participation and demand responsive approaches in order to ensure sustainability of drinking water systems and sources.

This programme would strive to achieve the objective of institutionalising community participation and demand responsive approaches with a focus on improving the institutional and professional capacities at various levels of the decentralised

10 Evaluation study by the Investigation, Planning and Design wing of the KWA on the performance of 'Jalanidhi' schemes in Attappady, available at http://www.stateofkerala.in/blog/2013/07/30/attappady-water-schemes-wasted-study/

governance systems of the states in planning, implementing and managing decentralised, community managed WATSAN systems. The sector reform programme is implemented through the institutional framework comprising of the District Panchayat, GPs, and the GP Volunteer Resources Team (GVRT). The community contributes 10% of the cost, the rest of which is met by the GoI.

Swajaldhara

The Government of India has been emphasizing the need for taking up community based rural water supply programmes and with this end in view a beginning was made in 1999 by sanctioning Sector Reform Pilot Projects on experimental basis. With the experience gained, the reform initiatives in the rural drinking water supply sector has now been opened up throughout the country by launching the Swajaldhara Programme on 25 December, 2002. The Swajaldhara Programme is being implemented by DRDA with the active participation of the PHED of the district.

In Kerala, out of 509 schemes taken up under Swajaldhara, it was noticed, as will be discussed later in Section 7, that the performance of the Swajaldhara schemes are better than that of normal Panchayat schemes, thanks to the institutionalisation of community management.

WATER SUPPLY COVERAGE IN KERALA

According to a survey conducted by the Rajiv Gandhi National Drinking Water Mission, there were 9,776 identified habitats in Kerala. Of these habitats, 1,994 habitats were fully covered, 6,964 were partially covered, 805 were not covered and 13 were in forest areas during 2001. The present status of these habitats is provided in Table 9.

TABLE 9: HABITATION WISE QUANTITY OF WATER SUPPLY

Quantity of water supply	No. of habitations(as of March2010)
Below 10 LPCD or not covered	Nil
Between 10 LPCD and 40 LPCD (partially covered)	Nil
Above 40 LPCD (fully covered)	11,883
Forest areas not covered	Nil
Total habitations	11,883

Source: Adapted from Jalanidhi report, 2011

This gives the impression that 100% rural habitations are covered by schemes implemented by the state, which is highly misleading because the 'coverage' includes about 80% of habitations where people own wells. All habitations within the administrative boundary of the location (ward) of a pipeline are considered to be 'covered' irrespective of whether the schemes are functioning or not, and if functioning, whether all the 'covered habitations' use these systems or not. Hence such information is highly unreliable.

The National Sample Survey Office (NSSO) report on drinking water (1999) shows that the population covered by piped water supply in Kerala is merely 11.5%, which is much lower than the estimate of the KWA. However, a majority of households (85% according to NSS data) in Kerala traditionally depended on open wells for their household water needs.

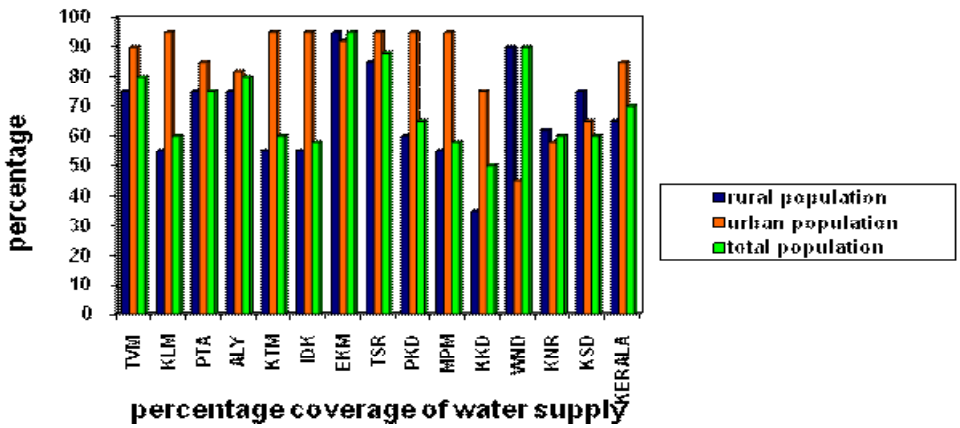
TABLE 10: DISTRIBUTION OF HOUSEHOLDS (%) HAVING SUFFICIENT DRINKING WATER THROUGHOUT THE YEAR

Principle Source	Kerala	India
Tap	7.63	14.80
Tube well/hand pump	1.15	46.50
Well	58.80	21.30
Tank/pond restricted for drinking	1.10	0.90
Other tank/pond	0.40	0.50
River/canal/lake	0.07	1.04
Spring	0.20	1.60
Tanker	--	0.20
Others	0.21	0.18
All	69.60	87.00

Source: Adapted from Nisha, K. R. (based on the 54th Round Survey on Drinking Water and Sanitation conducted by NSSO (1999))

However, among the people depending on wells as the principal source of water, nearly 59% are getting sufficient water throughout the year (Table 10). It is in Kerala that the highest percentage (30.4) of households reported that they did not receive sufficient drinking water in some part of the year. This seasonality in water availability was an important dimension of the water supply problem in Kerala. Besides, the dependants of well around 51% households were obtaining water at their household premises.

FIG. 6: COVERAGE OF STATE PUBLIC WATER SUPPLY AS PER DISTRICTS



SECTION 7:
PERFORMANCE OF THE WATER SUPPLY SECTOR

As stated earlier, it is one thing to 'cover', but quite another to ensure and sustain satisfactory performance of schemes. For assessing the performance of public water supply systems in the context of Kerala, they are divided into the following institutional categories in which they are implemented and managed.

- Supply driven, centralised, state owned/managed systems
- Kerala Water Authority/PHED
- Old Municipal/Town Administration
- Demand driven, decentralised, community managed systems, under PRI (Reform Model)
- Swajaldhara (demand responsive, community managed systems implemented by the KWA)
- Jalanidhi
- Local Self Government Department (LSGD)
- Sector Reforms (Rajiv Gandhi Drinking Water Mission)
- Schemes supported by funds from the Dutch Government

Before we analyse the performance of schemes under the above delivery systems, it is necessary to clearly distinguish between the two kinds of broad institutional systems.

SUPPLY DRIVEN, CENTRALISED, STATE OWNED/MANAGED SYSTEMS

Although the reliable data on the financial, institutional and social dimensions of these systems is not available, it is obvious that they are riddled with the following problems:

- The KWA's schemes are always piped water systems using age old technical norms and designs. There are no attempts to investigate multiple options in the choice of technology and optimise designs. The schemes are inappropriate and not cost effective.
- The frequency of breakdowns is very high and there are long delays in repairs.
- The loss due to leakage/unaccounted flow is as high as 40% (KWA Reports) to 78% (OMIP report[11]).
- The O&M cost is very high.
- Cost recovery is very poor due to a variety of reasons.

11 Performance Evaluation Report - Kerala Water Authority, Operation Maintenance Improvement Programme, Dutch Danish Supported Project - 1998

- While well to do people living in low-lying lands misuse the water (for irrigation, car washing), poor people living on hilltops are deprived of water due to the pressure drop caused by pipe breaks and poor design.

- 80% of the target/beneficiary communities own private water sources and hence do not bother to complain even if the schemes fail.

- In tribal areas, almost all schemes implemented by the KWA are defunct because of neglect due to remoteness and absence of political pressure.

Despite ample government funds and a vast network, the KWA could not cater to the needs of a majority of the population, especially in rural areas. As a result, a new policy approach on community based initiatives including local self-governments and NGOs emerged. Experiments were conducted through a spectrum of institutional arrangements ranging from internationally funded organisations to local initiatives. Thus, the government decided to hand over 1,050 single GP KWA schemes to the respective GPs during August 1998. From 1997-98 onwards, separate plan outlays were earmarked for drinking water schemes of the local bodies. However, only 140 schemes were transferred by July 2003 (Economic Review, 2003), with the vast majority of sources still under the KWA.

While bilateral and multilateral institutions (e.g. the World Bank) stopped funding large centralised, supply driven state owned piped water supply schemes for obvious reasons, interestingly, many national and international banking institutions (ADB, JAICA, NABARD, LIC) are funding the KWA to implement large, comprehensive piped water supply schemes. Obviously, the KWA seemed to have convinced these bankers about their resolve to improve its institutional, financial, and technical performance in the years to come. However, until that happens there is no point in reviewing these schemes. Therefore, this review does not discuss such schemes, and instead focuses on the demand driven, decentralised, community managed system.

DEMAND DRIVEN, DECENTRALISED, COMMUNITY MANAGED SYSTEMS

As stated earlier, due to radical change in the water sector, it was accepted that decentralised community managed water management schemes are apt for the rural areas. Thus, after the successful initiatives in the Malabar region of Kerala, a number of institutional delivery models for up-scaling the community driven and managed water supply systems started emerging in Kerala.

One should not get a false notion that all problems of water supply can be solved merely by decentralising the system and making it demand responsive and community managed. In the following sections, we look at the performance merits and demerits of various community managed water supply systems from multiple dimensions.

PERFORMANCE ANALYSIS[12]

Assessing the service performance of the WATSAN sector in Kerala is a challenging task for the following reasons:

- The available information is old, subjective or meagre.

- The peculiar socio-cultural, socio-economic nature of Kerala is not taken into account while compiling and analysing data.

The only available report is 'Performance Assessment and Service Improvement Plan

12
In the absence of any published document on performance evaluation of Demand Responsive, Community Managed Water Supply Systems in Kerala, this section has solely relied on the Performance Assessment and Service Improvement Plan of Community Managed Water Supply Schemes (CMWSS) in Kerala', SEUF, 2006.

of Community Managed Water Supply Schemes (CMWSS) in Kerala', produced by the SEUF in 2006. However this study is seriously limited in its scope and content, because it was purely based on user perceptions and is qualitative in nature. The study also did not analyse the reasons for the good or bad performance of schemes. Under these circumstances, the experience and observations of the authors regarding CMWSS in Kerala will be considered an important input, leading to the following analysis.

Parameters used to assess the performance of CMWSS

The most critical parameters that determine the performance efficiency of water supply schemes, considered in this review are as follows:

1. Regularity of supply
2. Adequacy (quantity) of water supply
3. Water quality
4. Breakdown maintenance
5. Operation maintenance cost

Since the above indicators are greatly influenced by the governance/institutional mechanisms under which the scheme operates, the SEUF study considered sample schemes selected from various governance models as shown in Table 11.

TABLE 11: SAMPLE SELECTION FOR PERFORMANCE STUDY

Programme	BGs (Schemes)	HHs surveyed
Jalanidhi	30	181
Sector reforms	10	60
Swajaldhara	5	30
Jeevadhara	5	30
PRI schemes	11	66
Total	61	367

Regularity of water supply

The important and expected feature of the CMWSS is the regularity in supply. This signifies management efficiency of the user committee which also contributes to the sustainability of the scheme. However, this regularity varies drastically under various institutional mechanisms as can be seen in Table 12, indicating the need for further study that can help in improving the performance.

TABLE.12: REGULARITY OF SUPPLY DURING SUMMER IN VARIOUS CMWSS IN KERALA

Supply in Summer (number of hours)	Schemes (in percentage)				
	Jalanidhi	Sector reforms	Swajaldhara	Support from Dutch Govt. (Chekode)	PRI schemes
< 1 hour	53%	60%	-	40%	-
2-6 hours	37%	30%	40%	40%	73%
6-12 hours	-	-	40%	10%	-
12-24 hours	7%	-	10%	-	-
24 hours	3%	10%	-	-	27%

Source: SEUF Study

One limitation of this parameter is that if the pressure is high, the same total quantity of water can be supplied in less time. So this data does not indicate adequacy of water. However, it is clear that all the CMWSS schemes are functioning regularly.

Adequacy (quantity) of water supply

The user response to whether the quantity of water supplied daily was adequate for drinking and cooking is provided in Table13. The higher rates of inadequacy/not potable reported under Jalanidhi and PRI schemes may be due to the fact that the size of some schemes is very large leading to source depletion and/ or operational problems.

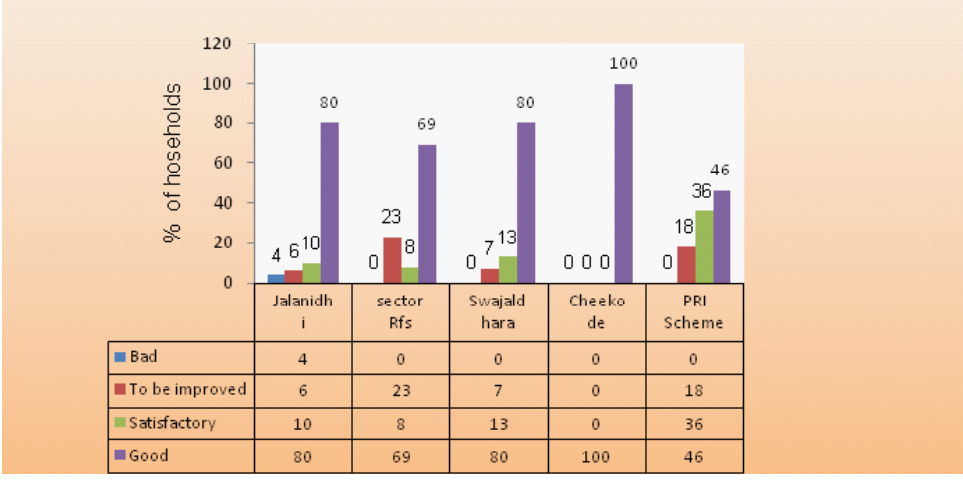
TABLE 13: USER PERCEPTION ABOUT THE ADEQUACY OF SUPPLY IN CMWSS OF KERALA

User perception	Jalanidhi	Sector reforms	Swajaldhara	Jeevadhara	PRI schemes
Adequate	76%	98%	100%	100%	70%
Not adequate	24%	2%	0	0	8%
Available but not used for drinking	0	0	0	0	22%

Source: SEUF Study

Water quality

FIGURE 7: USER PERCEPTION OF WATER QUALITY OF CMWSS IN KERALA



Source: SEUF Study

User perception of water quality purely depends on its colour, smell and taste. While these are very important parameters, they are not adequate to verify whether they satisfy drinking water standards. 80% of households surveyed mentioned that the quality of drinking water supplied was either good or satisfactory. Only very few households reported that the quality of water supplied was bad (Figure 7). More studies need to be carried out to test the chemical and bacterial properties of the water and compare them source wise, as well as to understand the pollution sources.

Maintenance

While the frequency of breakdowns indicates the quality of equipment/components used and the technical capability of the maintenance staff, delays in repairing indicate the managerial inefficiency. Unfortunately, the data on the frequency of breakdowns is not available. There is a general understanding that since most of the schemes are new, the frequency of breakdowns is comparatively less. However, there is some data available on user perceptions regarding delays in repair, summarised in Table14.

TABLE 14: USER PERCEPTIONS ABOUT DELAYS IN REPAIR OF CMWSS IN KERALA

Period taken for rectification	Project Name				
	Jalanidhi	Sector reforms	Swajaldhara	Jeevadhara	PRI schemes
Within a day	7%	5%	0	0	0
Within a week	40%	10%	13%	43%	26%
Within a month	22%	28%	13%	0	21%
Very long/Not known	31%	57%	74%	57%	53%

Source: SEUF study

Table 14 indicates a very confusing picture. We cannot believe that the community will wait indefinitely for repairs. This can mean that either the faults are so minor that they do not affect the functioning of the scheme, or that the community has alternate sources.

How users perceive delays in repairs also depends on the month in which these repairs were delayed, because during the rainy season people do not bother much. Hence Table 14 does not provide a correct picture about maintenance. However, it is very clear that there is tremendous scope and need to improve the repairs and maintenance system of the CMWSS in Kerala.

Operation and maintenance cost

This is the actual cost of operation and maintenance (O&M) of the schemes which includes the operator's salary, electricity charges and small repair costs. The responses are given in Table 15.

TABLE15: MONTHLY O&M COST OF CMWSS OF KERALA

Sr. no.	Schemes	Average O&M cost (Rupees/family/month)
1	Jalanidhi	26
2	Sector reforms	22
3	Swajaldhara	42
4	Jeevadhara	25
5	PRI schemes	32

Source: SEUF study

The community adds a certain percentage of time and money to meet the major repairs and also generate a corpus fund. Hence the water tariff may be slightly higher than the actual O&M Cost.

SECTION 8:
RIGHT TO WATER AS A HUMAN RIGHT

GLOBAL PERSPECTIVE

The world contains sufficient, clean freshwater for everyone's basic personal and domestic needs. Personal and domestic uses of water account for less than 10% (UNDP, 2006) of the total amount of water used for human activities, although essential uses require only a significantly lower percentage.

The 2006 UNDP Human Development Report stresses that issues related to poverty, inequality and unequal power relationships have caused the current water and sanitation crisis. In 2006, over 1.1 billion individuals lacked access to basic supply of water from a clean source that is likely to be safe; of these, the majority are living in rural areas, according to the WHO UNICEF Joint Monitoring Programme. The figure of 1.1 billion does not include the number of people who cannot afford the water, who face prohibitive waiting times for collecting water, who receive water at occasional intervals or have to collect water from dangerous areas.

In rural areas, many people collect water of dubious quality from unprotected wells or surface water sources, often at a great distance from their homes, which deters them from collecting sufficient quantities. This problem is significantly worse during the dry season, when the water table drops, and rivers and shallow wells dry up.

In urban areas low-income groups, in particular those living in informal settlements, often lack access to adequate water supply. Piped supplies seldom cover informal settlements, meaning that people living there access water from a variety of inadequate water supply options, such as wells built close to latrines, water kiosks with water of dubious origin, or water vendors.

Due to a lack of adequate statistics, the number of people without access to water is often underestimated. As many of the informal settlements in urban areas are unrecognized by the local or national governments, the exact number of residents living in these settlements is often unknown, as is the status of water provision.

Tenants may also be missing from the statistics where landlords do not declare them. Water can also be prohibitively expensive, so that even where water is available, people do not have access to a sufficient quantity for health and hygiene practices. As a result, there is considerable inequality in the distribution of water in urban areas, with smaller urban centers particularly badly affected. Statistics for access to water in urban areas therefore tend to be uneven. Further, while people may use safe sources of water for some purposes, such as for drinking, these sources may be prohibitively expensive to use for all other domestic uses, forcing people to use unsafe sources for washing or cooking. This is not reflected in the statistics of access to water supply.

The establishment of an explicit right to water begs questions of definition. The first question is about standards, i.e. what should the per capita share and quality be, and how easy should it be to access?

In 1992, the International Conference on Water and the Environment held in Dublin set out four guiding principles for action to reverse the trends of over-consumption, pollution and rising threats from drought and floods. One of the four principles states that water is an economic commodity with an economic value in all its competing uses. Within this principle, it acknowledged the basic right to have access to clean water at an affordable price. What is then an affordable price?

Another important factor that influences the human rights dimension of water supply is the governance system. There are multiple systems of water supply governance such as the state, donors, private companies, community/user organisations (in which the supplier and the consumer are the community) and combinations of the above with varying levels of success in ensuring right to water. So which governance system is the best?

Last but not the least, there are multiple grey areas while identifying the policy imperatives for ensuring water supply as a human right. Some of the questions that need answers are: Do individuals have a right to water supply? What kind of access is necessary to fulfil this right? What responsibilities do individuals have vis-a-vis this right? What priority does this right carry in relation to other uses of water (e.g., for agricultural use, industry, leisure, the environment)? How is this right promoted and safeguarded?

Answers to the above questions vary widely depending upon the geographical, political, social, cultural and economic contexts of the target population and location, and attempts to define global standards for the above is futile. However, broad guidelines to define and derive contextual standards based on these variables can be developed to assist refinement of policies and programmes. For this purpose, one needs to carry out exhaustive studies at various levels.

Though in India there is no explicit recognition of a right to water in any of the policies or legal instruments, the governments both at the centre and states have been making efforts to provide safe drinking water and sanitation facilities to people. This is very often reflected in the various policies like state water polices or policies of drinking water. There are also various programmes and schemes at national and state levels to provide safe drinking water and sanitation facilities to people. These programmes and schemes are implemented through various modes and under various sets of rules and processes. In short, answers to the above raised questions indicate the compliance of human rights imperatives in the WATSAN sector of a country.

KERALA'S PERSPECTIVE ON RIGHT TO WATER

Very interestingly, the policy framework of the Kerala Water Sector is highly supportive and facilitative for ensuring a right to water. The following quotes from the Kerala Water Policy, 2008 (WRD, 2008) speaks volumes about the intentions of the Kerala government in this regard:

> *"Further, it is important to make sure that the right of every citizen to equitable access to water for his or her basic needs is protected and enforced through appropriate policy, legislative and programme initiatives" (1.1, pg.3)*

> *"Access to water is a human right" (1.2, page3)*

Besides, in the Kerala Water Policy 2008, there is lot of emphasis on equity and social justice as can be seen from the following:

"…considers water as part of the ecosystem for the benefit of all and not as a commodity for the profit of few" (1.1, page 3)

"A policy framework shall be adopted to create an enabling environment for equitable…….management of water resources….." (1.3, page 4)

Keeping these policy provisions in mind, one can surely say that there is a policy environment in Kerala that supports access to water as a human right. However, as we all know policy pronouncements unless converted to legal instruments are not legally enforceable.

SECTION 9:
DOMESTIC WATER SECTOR - CONCLUSIONS AND WAY FORWARD

CONCLUSIONS

Water availability

Studies indicate that there is no appreciable change in the available rain. However, there is definitely a drastic change in the distribution of available water, both in time and space. This is caused due to human interventions such as improper land and water use, overexploitation of natural resources and poor perspective planning.

The peculiar hydro-geological and geo-morphological setting of Kerala is ideal for decentralised, low yielding open dug wells. If properly located and sanitarily protected, these wells meet the domestic water requirements of the people throughout the year. Besides, if well protected and maintained, sources such as ponds and rivers can meet the non-drinking domestic requirements.

In exceptional cases (coastal plains with saline intrusion and hilly tracts), where the population has crossed the carrying capacities, or where the people have started living in water scarce areas, there are real water problems that cannot be solved using conventional measures.

Reasons for supply demand gap

The tendency to highlight depleting water sources as the reason for water scarcity and introduce more schemes as the only solution is dangerous. There is also a tendency to suggest water conservation and artificial recharging as remedies to compensate for depleting water resources. While to a certain extent, this is true, considering the peculiar geo-morphological and hydro-geological conditions of Kerala, there are severe limitations to augmenting water sources through artificial measures.

Since Kerala is already extracting water at a much faster rate than that at which water is provided by nature (in an annual cycle), the major reason for the supply demand gap is the exponential increase in per capita demand (see Figure 5). Can we control this increase in demand?

Coverage

The available statistics on coverage do not yield a clear picture. If the presence of piped water supply is a criterion, then only about 11.5% of the population is covered.

However, as mentioned earlier, a majority of households in Kerala traditionally depend on open wells for their household water supply needs. The NSS data shows that over 85 % of households in Kerala depend on well water for their domestic needs (a reduction in this figure is noticed in the recent NSS data). However, among the people who depend on well as their principal source, nearly 59% are getting sufficient water throughout the year. Besides, among those dependent on wells, around 51% of households were obtaining water at their household premises.

Social justice (inclusion coverage)

There are two interesting observations in the coverage of water supply as far as the social dimension is concerned:

1. A great majority of families deprived of safe and adequate drinking water are those who live in water scarce areas and cannot afford to create their own water source (e.g. digging a well).

2. Most families excluded from the so called demand driven water supply schemes are poor families who cannot afford to pay their share of the cost.

Therefore, the task of identifying families who cannot contribute financially towards the creation of a water source must be prioritised, and special schemes must be planned for them. Alternately, their payment towards public schemes should be reduced or waved.

Water quality and health

Although the bacterial contamination is very high at a few spots in rivers where a large number of pilgrims accumulate or where municipal sewage is discharged in large quantities, by and large the general bacterial quality of Kerala rivers is satisfactory, with Biological Oxygen Demand (BOD) less than 5 mg/l, Dissolved Oxygen (DO) more than 5 mg/l, bacterial load less than 2000 No/100 ml, and faecal coliforms less than 500 No/100 ml. However, there are enough studies that indicate the deteriorating chemical quality of our rivers and lakes.

The levels of chemical contamination in some of the large surface water bodies are extremely high due to industrial effluents and pesticide and chemical residues from large agricultural lands and plantations. It is reported that the chemical content of some rivers (e.g. the Periyar) is so high that the conventional treatment plants cannot purify them.

In addition to the accumulation of chemical pollutants, coastal wetlands also face the problem of saline intrusion, primarily due to over exploitation of fresh water resulting in a decreased inflow of fresh water from rivers. This also results in diminishing aquatic life which further leads to the deterioration of water quality.

As a consequence of the deteriorating water quality there is indirect evidence of deteriorating health in areas with polluted water. Since morbidity occurs due to multiple causes, such as poor environmental and personal hygiene, poor water quality, air pollution and unhealthy food habits and lifestyles, it is difficult to isolate the cause of diseases. For these reasons, it is almost impossible to assess the impact of water pollution on health.

There is no regular arrangement for monitoring the quality of water supplied by schemes. For this reason, it is very difficult to take corrective measures to improve the quality from time to time.

Planning concept

Almost all water supply systems except the Chekode model adopt the top down, linear target oriented, project approach for water supply planning. Strictly based on ‘manuals’, external project facilitators make decisions about the required studies, choice of technology, design norms such as per capita daily supply, etc. and the governance model. Community participation, if at all, is sought only for decisions such as the number of beneficiaries, implementation, O&M procedures and the cost

sharing pattern. Review meetings only assess the actual progress with respect to the stipulated targets.

This is the typical 'waterfall model'[13] which is outdated and no longer used in modern production systems. As opposed to this model, the Chekode model adopts an iterative process based planning, which relies on building on results. Obviously, Chekode has enormous advantages in terms of cost effectiveness, operational efficiency and user satisfaction. The only area where iterations were not carried out in this model was with regard to the maintenance system.

Performance of water supply systems

The performance of the water supply systems is directly dependant on the governance and institutional set up. If one considers regularity, adequacy, water quality, trouble free performance, and cost of operation and maintenance as criteria for performance, then the KWA schemes are the worst and the Dutch assisted Jeevadhara schemes are the best. However, it is proven well beyond doubt that water supply systems can be managed more sustainably and smoothly under decentralised community managed governance systems. One major drawback in all the governance system though is the absence of a regular performance monitoring system.

Governance systems

Following three delivery or governance models exist in the Kerala domestic water sector:

1. Centralised model of the KWA
2. Community managed systems (Jalanidhi, Sector reforms, Dutch Govt. supported Jeevadhara, Swajaldhara, etc.)
3. Decentralised Panchayati Raj systems

If one considers the parameters such as investment cost, maintenance cost, sustainability, quantity and quality, service performance, user satisfaction, WATSAN security, social justice (inclusion, equity), and conflict-resolution, these governance systems can be rated as follows:

1. Jeevadhara
2. Sector Reforms, Swajaldhara
3. Jalanidhi
4. Panchayat
5. KWA

Many attempts to improve the performance of the KWA have failed in the past. While the KWA can still play a vital role in urban water supply and comprehensive piped water supply systems, this model cannot be recommended for rural water supply at all. All the decentralised/community managed governance models can be improved by deriving lessons from the Chekode Model.

13
The waterfall model is a top down linear (as opposed to cyclic) model of development with unidirectional flow of controls, inputs and outputs), Larman 2004, Matt Haikin, Feb 2013

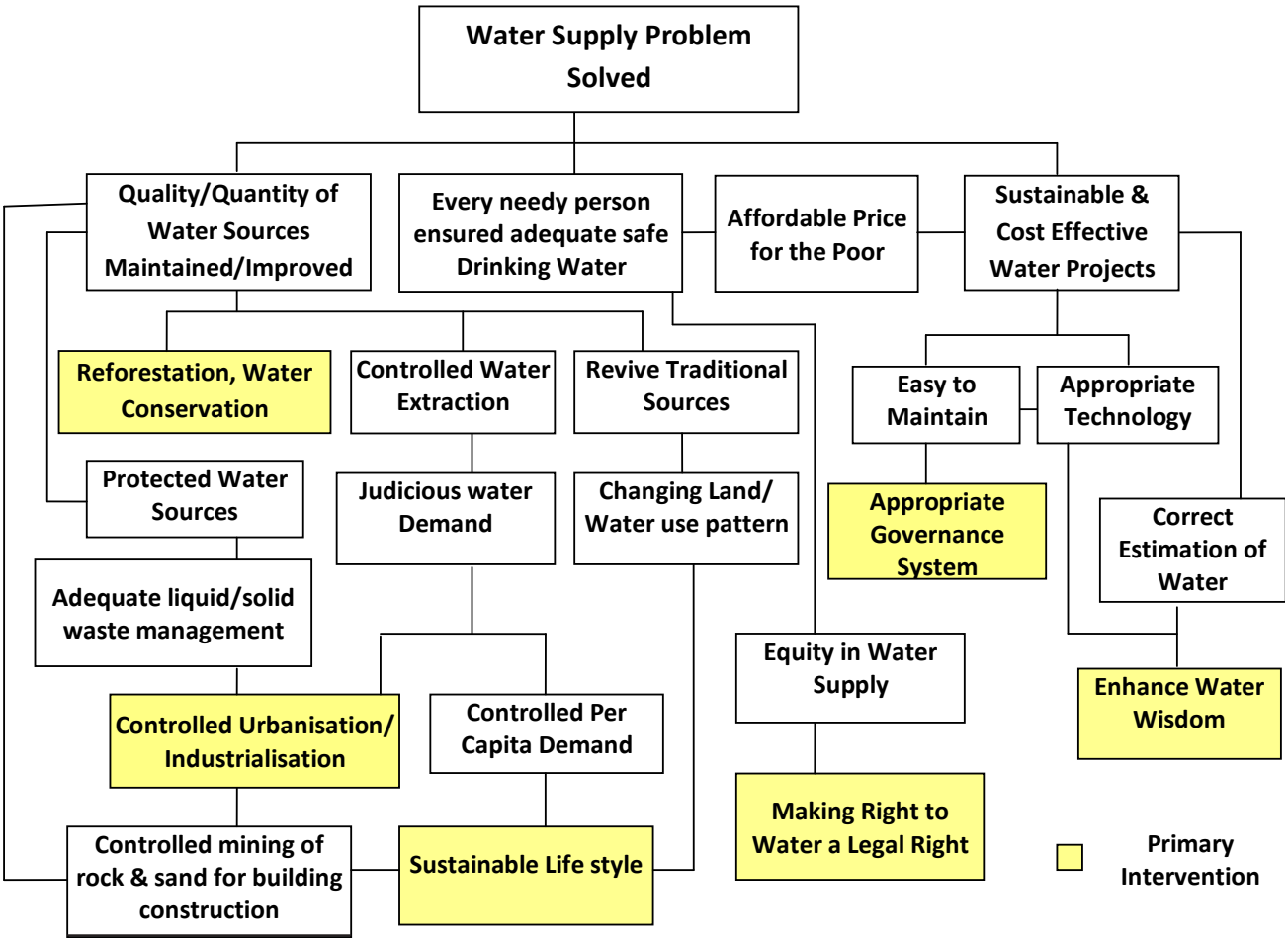
WAY FORWARD

General approach towards a sustainable solution

Following the objective tree (Figure 8) thematically explains the general strategy towards sustainable solutions to water supply problems in Kerala. One can see how complex the situation is, and how one needs to look at the issue much more comprehensively than the conventional sectoral approach. The objective tree illustrates links to many cross cutting issues and sectors, which are missing in all conventional approaches.

There are six areas of intervention that may increase the net water availability, reduce the demand, ensure social justice/equity, sustainability and efficiency of systems so that the water supply problem is addressed in a sustainable and just way.

FIGURE 8: OBJECTIVE TREE



The figure might look dogmatic at the outset. But, if one is looking for a sustainable and just solution for water supply systems, one has to change the basic approach. This is possible in iterative participatory processes in which the community makes informed decisions.

Policy aspects

The provisions of the Kerala Water Policy, 2008 adequately cover all areas to ensure sustainable and socially just water management in the state. What is urgently required is the enactment of a series of legislations that facilitate implementation of the policy. Some suggestions that may help in this regard are as follows:

- Stringent punishment to polluters of water sources
- Recommendations for best practice for mining of river sand, soil and rocks
- Reclaiming encroached lands under water bodies
- Environmental clearance requirements for all water (hydro-electric, irrigation and water supply) projects to be reviewed
- Clearance procedures for industrial water use to be made more stringent
- Enforce severe restrictions on the exploitation of water resources (surface and ground) in critical areas. In this regard, the draft Model Groundwater Act prepared as part of the 12th Five Year Plan preparatory work could be useful (Planning Commission, 2011)
- Subsidies for poor consumers of water supply schemes to be increased
- Provision of encouraging incentives to best performing water supply schemes
- Introduce community managed water quality monitoring systems at the block level. This will not only ensure maintenance of water quality, but also will provide employment to many in the rural area. Alternatively, this can be linked with the science clubs in schools.
- Making right to water a legal right

Introducing the programme to an area

The success and failure of any programme greatly depends on the way it is introduced to the public. The conventional approach of 'launching' a programme in which the politicians and officers 'explain' the programme, the budget, cost sharing pattern, and the duration, and solicit their 'cooperation' should be avoided. Instead, the programme should be announced as a community initiative in which the government would be a facilitator and provider of funds subject to government rules. Of course, the general imperatives of the project, such as iterative planning process, cost sharing, maximum government support per capita, minimum and maximum supply rate, environmental and sustainability conditions, roles of stakeholders in planning, implementing and managing the schemes etc. should be explained.

Planning/ design criteria of water supply schemes

System sustainability, user satisfaction, equity and performance of water supply systems greatly depend on the plan and design. For this reason, one cannot assess the performance of water supply systems without investigating the approaches, tools, and norms used in planning and designing systems. Here, we are laying certain basic principles of water supply planning based on the iterative planning model.

The iterative planning process

As mentioned earlier, one of the major causes for the failure of our schemes is the 'waterfall model' or linear model of planning. Here the system boundaries, quality and quantity of inputs and outputs, time frame and the system design are selected arbitrarily and rigidly, at least during the project tenure. This assumes that the conditions which influenced the choice of the above parameters do not change in time and space. However, in practice, in almost all cases they do change and result in a system failure.

Development is an iterative, evolutionary process which is influenced by much more complex spatio-temporal parameters than is normally recognised by the conventional planning schools. As early as the mid-nineties, this paradoxical situation was recognised mainly by experts in software development. They named the current model 'Waterfall', and introduced many new radical models such as Extreme Programming, Scrum, and Unified Process, which were later followed by IBM's Rational Unified Process (Beck and Fowler, 2000; Larman, 2004; Matuszek, 2008; Wells, 2009a, 2009b, Haikin, 2013).

While there are, of course, distinctions between the above new approaches and methodologies, at their core, they all revolve around the idea of evolving a solution to a problem in small sub-systems in short iterations. Each step of iteration will have small increments of time and space and the output of one iteration becomes the input to the next.

In iterative planning, the system boundary, quality and quantity of inputs and outputs and time frame are taken up in small incremental steps, and at each step the output influences the inputs and design parameters of the next step, until a dynamic equilibrium is obtained. While the basic meteorological, hydrological and physiographic characteristics of the chosen system offer limiting input conditions, the land use and socio-cultural values (which determine the demand) are variable inputs. It is assumed that these can be adjusted through a collective resolve of the community living in the system. The quantity and quality of outputs (targets) and the design norms are flexible. Since the community itself is the major decision maker at every step, there is always user satisfaction and any dissatisfaction at any step is an indication that there is a need to implement more steps.

The strategy, approach and knowledge base to be used for a choice of solutions and processes will depend on the geographical, physical, social, cultural, and environmental characteristics of the area. Hence the first step is to conduct an in-depth study of these aspects. The study should be conducted in the following steps:

Identifying the system boundary

This is the geographical boundary of the area where intervention is needed. This may be a region (e.g. Kuttanad), district, Panchayat or habitation. Depending on the cultural, social, geographical, hydrological and /or hydro-geological homogeneity, the system can be sub-divided into sub-systems. In water resource management, the order of considering these various attributes while dividing the system into sub-systems is as follows:

- Hydrological
- Hydro-geological
- Geographical
- Social/Cultural
- Manageable size

This means that if the system is homogenous in all the above aspects, then the system need not be subdivided. If hydrologically non-homogenous, the system should be divided into homogenous hydrological sub systems. These sub-systems are divided if they are hydro-geologically non-homogenous, and so on. These processes can be completed using available secondary data.

Problem analysis

It is said that more than 80% of the solution is achieved if the problem is studied well. The study should be conducted through a participatory process by resource persons from the community and a team of facilitators consisting of experienced professionals. The following studies may be required:

- For each sub-system, study the change in quantity and quality of surface and ground water resources both in time and space using secondary and if necessary primary data followed by a systems analysis
- Identify various dimensions to the problem (environmental, hydrological, pollution, health, social, political, etc.) and define these dimensions in clear terms and draw up a 'problem tree'
- Quantitatively assess and document the merits and demerits of ongoing government programmes, traditional practices and community-managed initiatives in water management
- Fine tune the system and sub-system boundaries (if necessary)

Ascertaining the safe quantity of available water for extraction

This is the most important and critical step in planning water management schemes. However, unfortunately, this seldom gets its due importance and is even neglected in most cases, and availability of water is taken for granted. In almost all cases, the availability of water is overestimated.

Unless the source is a storage reservoir, the safe available/extractable amount of water should be expressed as rate of flow rather than total volume (monthly, annual). The safe available/extractable amount of water for various sources is worked out as follows:

Stream/Spring = Measured minimum/lean flow – (Demand of planned/ existing schemes in the upstream and downstream + Flow required for ecological balance of coastal/wetland regions + Requirement of future development)

Open Wells = Minimum (peak summer) daily extractable quantity (to be established through pumping tests) – (certain percentage for drought years + certain percentage for future development)

Bore/Tube Wells = Identify aquifer system boundary

Then calculate the annual recharge by determining storage coefficients (through pumping tests), and water table fluctuations, earmark at least 50% for future development, establish the safe yield of the bore wells (which is 50% of the discharge rate that stabilizes the water level at 60% of the water column for continuous pumping of 72 hours and without any deterioration of quality and the water levels of nearby wells)

Choice of technology based on principles of water management

The community uses the 'problem tree', analytical data and comparative studies of government, traditional and community/private initiatives and takes broad decisions on the choice of technology using the following water management principles:

- Redistribute the available water both in time and space (highly decentralised water storage, diversion and extraction systems)

- Do not extract more fresh water than is supplied by nature every year (rainfall, recharge, runoff)
- Do not allow stagnation of (both surface and sub-surface) water, as in the case of neglecting traditional water sources. Maintain the dynamics of all water sources (either by extracting for consumption or allowing the water to flow off). This will allow leaching of salts from the soil every year.
- Allow adequate quantity of water to flow in the rivers even during the summer so as to prevent sea water intrusion and to maintain the ecological balance of the coastal and wetland regions.
- Earmark sufficient reserve for future demands and meeting riparian rights.

The principle of subsidiarity, which prompts the pursuer to solve the problem with minimal institutional involvement, by finding the simplest and smallest possible local solutions and opting for larger, more complex methods only if absolutely necessary can be followed while choosing solutions. This exercise will also prevent use of the proverbial "sledge hammer to kill a fly".

Developing technology selection matrix

The physiographic, hydro-geologic and socio-economic conditions of Kerala differ vastly from its neighbouring states, hence the water conservation and management models developed in other states cannot be directly applied to Kerala. The complexity of these problems is so vast that simple prescriptions are neither possible nor desirable.

A decision system that incorporates as many variables as is critical in defining the situation and choosing a logical path in order to select the most appropriate solution. Perhaps this is a better tool than standard sets of designs and user manuals or prescriptions. A Technology Selection Matrix (TSM) that offers solutions for different problems under different conditions could be a sound approach. The user of such a matrix should, however, be fully aware of the limitations of this tool and should modify the solutions depending upon changes in the situation both in time and space.

TABLE 16: TYPICAL TECHNOLOGY SELECTION MATRIX FOR WATER SUPPLY PROBLEMS

Scope (in the order of preference)	**Solutions for various problem categories**							
	For households facing water problem for less than 3 months				**For households facing water problem for more than 3 months**			
	Scattered	**Dense <15**	**Dense (15-50)**	**Dense >50**	**Scattered**	**Dense <15**	**Dense (15-50)**	**Dense >50**
1.Manual drawing systems (Source<100 m)								
Scope of improving existing draw wells	IWR	PWR			IWR	PWR		
New open draw well						Yes		
Developing springs						Yes		
Rehabilitation of existing hand pumps		Yes				Yes		
New Hand Pumps						Yes		
2.Gravity pipe supply (Source>100 m), and community will be able to share capital cost								
Spring yielding>160 lpd/family and a gravity main length<25 m/family		GS	GS	GS	GS	GS	GS	GS

Scope (in the order of preference)	Solutions for various problem categories							
	For households facing water problem for less than 3 months				For households facing water problem for more than 3 months			
	Scattered	Dense <15	Dense (15-50)	Dense >50	Scattered	Dense <15	Dense (15-50)	Dense >50
Stream water needing treatment yielding>160 lpd/ family and a gravity main length<25m/family		GST	GST	GST	GST	GST	GST	GST
Ponds/quarries needing water treatment with mean annual storage of 30000 l/family and a gravity main length<20 m/ family		GST	GST	GST	GST	GST	GST	GST
3.Pumping schemes (Source>100 m), and community will be able to share capital cost								
Spring yielding>160 lpd/ family and a pumping main length<25 m/family			PS	PS			PS	PS
Existing bore wells yielding>40 lpd/family and pumping main length<25 m/ family			PS	PS			PS	PS
Existing open wells yielding 15000 – 20000 lpd and a pumping main length<15m/ family			PS				PS	
Existing ponds needing water treatment with mean annual storage of 30000 l/family and a pumping main length<15 m/ family			PST				PST	PST
Stream water needing treatment yielding>160 lpd/ family and a pumping main length<25m/family			PST	PST			PST	PST
New bore wells yielding>50 lpd/family and pumping main length<10m/family			PS	PS			PS	PS
New open wells yielding 15000 – 20000 lpd and a pumping main length<15m/ family			PS				PS	
4.None of the above	RWH	RWH	RWH	RWH	RWH	RWH	SPS	SPS

IWR : Individual Well Rehabilitation to improve the quality and yield of the well

PWR : Public Well Rehabilitation to improve the quality and yield of the well

GS : Gravity Schemes based on springs with individual house connections

GST : Gravity Schemes with slow sand filtration and chlorination with house connections

PS : Pumping Schemes with house connections

PST : Pumping Schemes with slow sand filtration and chlorination with house connections

SPS : Special Pumping Schemes from distant sources, sometimes requiring treatment

Initiate iterative learning process

It is one thing to suggest solutions but quite another to be sure about their appropriateness and sustainability, which can be ascertained only by testing them on the ground. We know that development has always been a conscious, iterative and evolutionary process. An iterative process that continually refines the designs based on experience until a near perfect/appropriate solution is found, is a better approach than a lengthy planning process (using manuals and handbooks) followed by a lengthy implementation process. Since the community itself spearheads such processes, they will not only own the responsibility but also sharpen their analytical skills during the implementation.

During the above studies (particularly the analytical part), care should be taken to ensure active participation of as many stakeholders as possible. An efficient moderation technique using scientific tools such as Participatory Rural Appraisal (PRA), Objective Planning Tools, etc. can filter prejudices and vested interests during such participatory exercises.

Standards

While prescribing standards, it is better to prescribe lower and upper limits of per capita supply, level of service and ease of access (which changes in time and space) rather than one single national standard. While the lower limit is the minimum quantity, quality and the service level, the upper limit is the net available/extractable quantity of water divided by the population within a natural system boundary (watershed). Of course, while computing net available water, one must not forget to earmark adequate quantity of water for future generation of all living things and water necessary to maintain the eco-environmental balance. Another important point to be considered in locations where the upper limit of extraction has been reached is to progressively introduce control over per capita use.

Identifying local resource persons

One should not take the knowledge of the community for granted. This is particularly true in the case of rural Kerala. A vocal and somewhat literate person can easily misguide the community and the facilitators and give an impression that he/she is an expert. While his/her enthusiasm is a social capital, his/her inexperience might be detrimental. The decisions of the community should be vetted on sound logical and technical bases. Local resource persons with hands-on experience and deep insights into the technical, environmental, socio-cultural and socio-economic aspects of the problem should lead discussions. If such know-how is not readily available amongst the community, one might need to arrange for external help and impart this knowledge to them.

The selected persons should be offered thorough training in conflict resolutions, communication skills and facilitating processes of iterative planning and making informed choice at every stage of project development. In Chekode, school children were trained to map the area, collect data and conduct surveys. School children also assessed the yield of wells and communicated concepts of safe and sustainable yield to the villagers.

Community organisation

Various community organisation models have been tried. The Chekode Model of evolving community management systems with active participation of the Panchayat seems to be better than other models. A trained group of motivated local persons will spearhead this process. Local units of Kudumbashree can play a vital role. Several brainstorming sessions will sharpen the analytical skills of the community so that they are equipped to make informed choices. Once the technology and designs are ready, the beneficiaries are formally organised and registered.

Governance model

In all proven governance models, the role of a professional facilitating agency (PFA) (like SO, CSO) is very crucial. This review also recognises the need for such an agency. It is an agent of change that brings in a radical transformation in the planning tools, community organisation and capacity building. It is expected to have an organisational vision. However, one must be very careful while selecting such institutions. They should have facilitated attitudinal changes in the past in the

community and politicians about the virtues of environmental concern, equity and social justice. They should also have independent and practical view points on how to go about achieving this. Yet another positive indication is their ability to motivate communities to organise into self-help groups to implement projects with minimum external financial support. Kudumbashree is one such agency. For iterative planning, the facilitating team should be creative, and experienced in handling situational changes that occur in time and space without compromising on the objective.

Whether community action should precede institution building or vice-versa to pursue sustainable solutions to any natural management issue is a “chicken or egg” question. However, what is most effective is initiating a series of community actions facilitated by experienced professional groups. Since these initiatives need creativity and flexibility, it would be better if autonomous citizens/civil society forums implement them under the public relations dispensation. These forums should network and share experiences. Their success should lie in initiating concrete action on the ground with limited external funding for creating physical assets. Most of the inputs (including intellectual and financial) should be generated locally.

After the success of the first iterative step, the programme can be anchored in a decentralised governance system. A Neighbourhood Group (NHG) of Kudumbashree is an ideal planning unit. These planning units are recognised by the *Gram Sabha* (ward) and anchored in the Panchayat planning process. Subsidiarity principle has to be followed and decisions should be made at the lowest level possible especially concerning issues like technology choice, standards, location, implementation, sustainability, O&M and management while retaining an umbrella role for the GPs for effective implementation.

Women should be included in all aspects of decision making with respect to drinking water security planning, implementation, operation, maintenance and management.

Water quality

Bacteriological contamination

Existing drinking water sources and freshwater resources in general should be protected by the implementation of the Total Sanitation Campaign to make villages open-defecation free and maintain a clean environment; by safely disposing of solid and liquid wastes; by ensuring the control and treatment of industrial effluents; and by raising awareness about the impacts of the use of high concentration of fertilisers and pesticides on water.

Chemical contamination

To address salinity problem in drinking water, various technological options like tapping of alternate safe surface water sources, roof-top rainwater harvesting and in situ dilution through artificial ground-water recharge etc., could be adopted. High-tech options should only be considered as a last resort. In fact, there is tremendous scope for action research in deriving low cost solutions to simple chemical contamination.

Sustainability Plans

Sustainability plans should be prepared especially for over-exploited, critical and semi-critical blocks for taking up scientifically located recharge measures and water harvesting structures on a watershed or aquifer basis. This may include reforesting the denuded forests and soil/water conservation in upper catchments to increase the base flow and prevent erosion, artificial recharging and water conservation measures.

Sustainable model of operation and maintenance and service delivery

Since this model does not consider large comprehensive piped water supply projects as a desirable option, only decentralised community managed schemes are considered. An O&M Plan should be developed right at the planning process. The community and the Village Water and Sanitation Committee (VWSC) should be engaged in developing the O&M Plan. A simple and practical O&M manual should be handed over along with the formal transfer of the scheme to the Managing Committee/ VWSC. While working out the operational cost to be shared by the user on a monthly basis, a provision should be made for an emergency fund to be used to meet price escalation, unforeseen expenditures such as replacement of equipment, source revitalisation, artificial recharging, etc.

From the experience of community managed water supply systems, the best models for O&M management are those implemented under the sector reforms model, which also pays attention to local employment generation.

Safe water to disadvantaged sections

Exclusion of remote habitations and those with concentrations of Scheduled Caste, Scheduled Tribe and minorities should be prevented by the appropriate use of MIS and GIS maps in the planning process. By making water supply a legal right of the citizen, the government can no more deny such community access to safe and adequate drinking water by arguing on economic grounds. Besides, the active participation of the user community in planning, technology choice and scheme design can make the schemes better suited for the socio-economical and socio-cultural aspects of the community. This will also prompt the community to own and maintain the schemes.

Information, education, communication

Participation of Women Groups such as Kudumbashree and children's forums have tremendously helped in awareness generation and building the capacity of the community to take informed decisions in Punarjani, an environmental regeneration project of Alappuzha. This is a good model for the IEC campaign for Kerala.

The following measures should be implemented for schools and Anganwadis strengthen institutions, teach the use of water testing kits (WTKs), mobilise the community through rallies and door-to-door IPC by school children, introduce a chapter on sanitation, water and hygiene in the school syllabus, and introduce a school cabinet in each school in coordination with the education department.

Capacity building

The common thread running through all the component activities of the programme is a strategy of introducing change in how the water supply systems and related services are planned, implemented and sustainably managed. Yet another important objective of capacity building is to invoke the creative wisdom of the community and stakeholders. These steps will be implemented by the PFA.

Cost sharing strategy

There are advantages and disadvantages to the general policy that the user must share the cost of service facilities. On one hand, while providing all service facilities to every citizen free of cost will benefit the socially and economically vulnerable communities, the opportunity to generate funds required to meet the capital and maintenance costs of such facilities, the demand for which is steadily growing, will be lost. On the other hand, if one chooses to levy a price for water, then the poor who cannot afford that price may be left out, and the rich can buy any amount of water

depending on their financial status. This creates gross social iniquity. So the solution lies in deriving a variable cost sharing pattern depending upon the social/economic status of the user.

This is easier said than done. Firstly, it is very difficult to define economic criteria, and secondly it is also equally difficult to define a pattern of sharing of capital and O&M cost. However a set of tentative suggestions that can be debated areas follows:

Category	Capital Cost (%)	O&M Cost (%)
All APL Families	15	100
All BPL Families	5	50*
ST Families	0	0*

* The subsidised amount of 50% O&M cost for BPL families and 100% O&M cost for ST families shall be paid by the government to the O&M committee through the respective local government

The following conditions shall apply while allocating water:

- Everyone shall get the same amount of water irrespective of his/her willingness/ ability to pay
- The O&M cost shall be shared equitably by all
- There shall be an upper limit of water which cannot be exceeded at any cost

One most important point to be kept in mind to reduce the user share is to choose a cost-effective technology and design, in which the user community can play a decisive role.

SECTION 10:
SANITATION - AN ASSESSMENT

UNDERSTANDING THE CONCEPT OF SANITATION

The World Health Organisation (WHO) states that:

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal".

COHRE, Water Aid, SDC and UN-HABITAT (2008), define sanitation as,

"Sanitation is access to, and use of, excreta and wastewater facilities and services that ensure privacy and dignity, ensuring a clean and healthy living environment for all"

Arno Rosemarin in the Swedish magazine, Sanitation Now (2008) observed that

"Sanitation is firstly about human behaviour; and to be successful, systems need to prioritise such things as affordability, comfort, dignity, privacy, odour control, ease of cleaning and user acceptance by men, women, elderly and children. To be sustainable, sanitation systems must build in all these aspects."

Environmental sanitation

WHO defines 'Environmental Sanitation' as,

"the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival." Environmental sanitation/hygiene includes all the activities aimed at improving or maintaining the standard of basic environmental conditions affecting the well-being of people. These conditions include (1) clean and safe water supply, (2) clean and safe ambient air, (3) efficient and safe animal, human, and industrial waste disposal, (4) protection of food from biological and chemical contaminants, and (5) adequate housing in clean and safe surroundings, also called environmental hygiene."

Sustainable sanitation

When one talks about sanitation, only provision of toilets, wastewater treatment and provision of hygiene facilities is not enough. To achieve sanitation in a sustainable manner, the schemes or approaches should be socially acceptable and economically viable (Conradin, n.d.). One example of approaching towards sustainable sanitation is to consider the value of the waste (human excreta and wastewater) as something very resourceful that can be reused and recycled.

The concept of sustainable sanitation[14] recognises that any improvement in sanitation has to consider the entire sanitation chain. It then discusses the various dimensions of sustainability and their implications for the different components of the sanitation chain[15]. Finally, it argues that sustainability is more a general direction for improving sanitation services than a final goal to be achieved, and decisions made in the relevant sectors will always have to consider the local circumstances and resources available to move ahead.

Ecological sanitation

Ecological sanitation (ecosan) works on the principle that human excrement is not a waste product but contains the nutrients required to fertilise land, and that it should be used for this purpose. The ecological sanitation cycle begins with containment, the stage at which excreta is held in the sanitation installation. The waste is then sanitised through one or several processes which cause pathogens to die. The resultant safe soil conditioner (from faeces) and fertiliser (from urine) is then recycled and used to assist crop production.

The underlying principle of ecological sanitation is to return the valuable nutrients from waste back to the environment and avoid the pollution often caused by conventional sewerage (Esrey et.al, 2001)

SANITATION: A HUMAN RIGHTS IMPERATIVE

"Everyone has the right to an adequate standard of living for themselves and their families, including adequate food, clothing, housing, water and sanitation",

The Habitat Agenda, adopted by consensus of 171 states at the Second United Nations Conference on Human Settlements (Habitat II), 1996

"Clean water and sanitation are not only about hygiene and disease, they're about dignity, too. … Everyone, and that means ALL the people in the world, has the right to a healthy life and a life with dignity. In other words: everyone has the right to sanitation"- Prince Willem Alexander of the Netherlands, Chair of the UN Secretary General Advisory Board on Water and Sanitation (UNSGAB)

The recognition of sanitation as a human right alongside water is central to this effort, clarifying the role of member states in ensuring access to adequate sanitation, establishing standards that can be monitored and to which the states can be held to account, and lending priority to providing facilities to those without access, particularly the vulnerable and marginalised, in a non-discriminatory manner.

UNDERSTANDING SANITATION PROBLEMS OF KERALA

The people of Kerala always had adequate awareness about personal hygiene and sanitation. They took a bath twice a day, and kept their homesteads very clean. The plentiful availability of water was helpful in this regard. Although open defecation was prevalent amongst economically and socially backward communities, their personal hygiene habits were of a high standard. Due to lower population density, a lower rate of waste generation, and the degradable nature of most waste, the management of solid waste was a simpler task.

However, over the last few decades, the following developments took place (Refer to Figure 9).

- The high density of population and emergence of nuclear families resulted in an

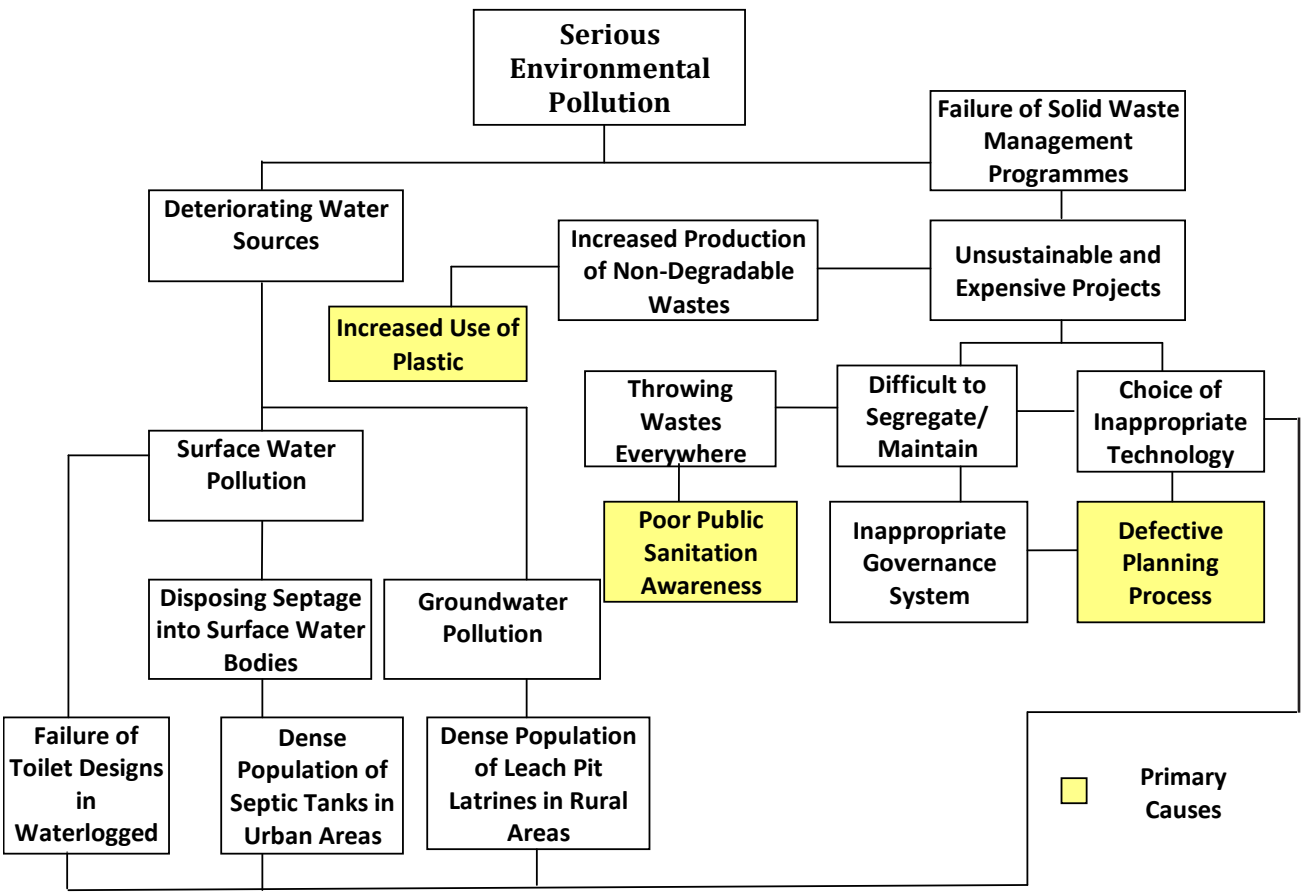
14
ICLEI European Secretariat, 3rdJuly 2012, available at http://www.accessanitation.org/fileadmin/accessanitation/Documents/ACCESSanitation_Concept_of_sustainable_sanitation.pdf

15
Sanitation is much more than toilets. It is rather a series of linked steps ranging from the provision of resources to operate a sanitation system, to disposal or reuse of the end-products. These links form what is known as the sanitation chain and each of the elements within this chain needs to be considered if the system is to be sustainable.

increasing number of toilets, leading to a very high density of leach pit latrines in rural areas. This led to the pollution of ground water.

- Similar developments and uncontrolled growth in the urban areas resulted in a high rate of growth of septic tank toilets. Untreated septage from these toilets is removed and disposed into water bodies, contaminating surface water sources.
- Failure of leach pit type toilets in waterlogged rural areas and the continuation of direct defecation in surface water bodies also led to further pollution of surface water bodies.
- These developments resulted in heavy contamination of water resources.
- On the solid waste management front, the adoption of a modern lifestyle resulted in the increasing use of plastic packaging materials leading to the accumulation of non-degradable wastes.
- Segregation and management of waste became a herculean task because waste was thrown and dumped in public places everywhere due to a lack of awareness.
- A defective planning process led to the choice of inappropriate technology and governance systems resulting in unsustainable and inefficient waste management systems.

FIGURE 9: KERALA SANITATION PROBLEM TREE



The above analysis reveals that the sanitation problems of Kerala are much more complex and multidimensional in nature than is normally recognised.

Coverage of sanitary toilets in Kerala

The availability of sanitary toilets has improved in most parts of the state except backward regions like coastal areas, hilly regions, tribal areas and urban slums.

TABLE 17: HOUSEHOLD SANITARY LATRINES: ACCESS TO SANITATION FACILITIES (1991-2005)

Timeline	1991 (1)	1995(2)	2001(3)	2005(4)
Rural households with toilet (%)	44	73.4	81.3	94.9
Urban households with toilet (%)	73	90.0	92.0	98.3

Source - (1) Census of India, 1991, (2) NSSO, 1995, (3) Census of India, 2001, (4) NFHS 3rd round, 2005

TABLE 18: COVERAGE OF TOILETS IN KERALA, 2011 CENSUS

Total HHs	7,716,370
HHs in Urban Areas (UA)	3,620,696
No. of HHs having toilets within the premises in UA	3,527,650
No. of HHs not having toilet within the premises in UA	93,046
No. of HHs practising open defecation in UA	60,621
% of open defecation	.017%
HHs in Rural Areas (RA)	4,095,674
No. of HHs having toilets within the premises in RA	3,818,327
No. of HHs not having toilet within the premises in RA	277,347
No. of HH practising open defecation in RA	229,103
% of open defecation	5.60%

Source: Census 2011

This indicates a very high percentage of coverage. Uncovered households, which constitute a very small percentage, are in tribal belts, slums where BPL families reside, or coastal waterlogged areas.

The Suchitwa Mission carried out an assessment of the sanitation coverage among BPL families in different districts achieved by the Total Sanitation Campaign. The results are presented in Table 19.

TABLE19: DISTRICT SANITATION COVERAGE OF BPL FAMILIES

No.	District	Rural Population	% of Total Rural Population	Urban Population	% of Total Urban Population	Total Population	% of Total Population
1	Trivandrum	1,601,803	74.76	958,617	87.81	2,560,420	79.16
2	Kollam	135,397	63.01	453,781	97.38	1,789,178	69.21
3	Pathanamth	813,091	73.24	107,700	87.00	920,791	74.62
4	Alappuzha	1,182,805	79.00	528,255	85.00	1,711,060	81.13
5	Kottayam	964,558	57.09	292,663	97.62	1,257,221	64.35
6	Idukky	632,423	59.12	55,262	95.95	687,685	60.90
7	Ernakulam	1,593,378	97.83	1,393,990	94.38	2,987,368	96.19
8	Thrissur	1,832,646	85.85	828,354	98.68	2,661,000	89.47
9	Palakkad	1,468,977	64.97	340,964	95.62	1,809,941	69.15
10	Malapuram	1,790,729	54.77	353,860	99.35	2,144,589	59.15
11	Kozhikode	693,578	39.01	830,762	75.44	1,524,340	52.94
12	Wyanad	669,798	89.19	14,835	50.01	684,633	87.7
13	Kannur	829,761	69.37	708,332	58.40	1,538,093	63.85
14	Kasargod	751,235	77.42	143,298	61.32	894,533	74.29
	Total	16,160,179	68.55	7,010,673	84.08	23,170,852	72.77

Source: Economic Review 2010

Generation of solid waste

The quantity of garbage generated in the state is about 12,731 tonnes/ day. This includes waste generated in all municipal corporations, municipalities and GP areas. As per the Audit Report (LSGIs) for the year ended 31st March 2010, all Urban Local Bodies (ULBs) are required to furnish the details of the quantity and composition of solid waste generated to the concerned district collectors on an annual basis (CAG, 2010).

TABLE 20: WASTE GENERATED IN ULBS

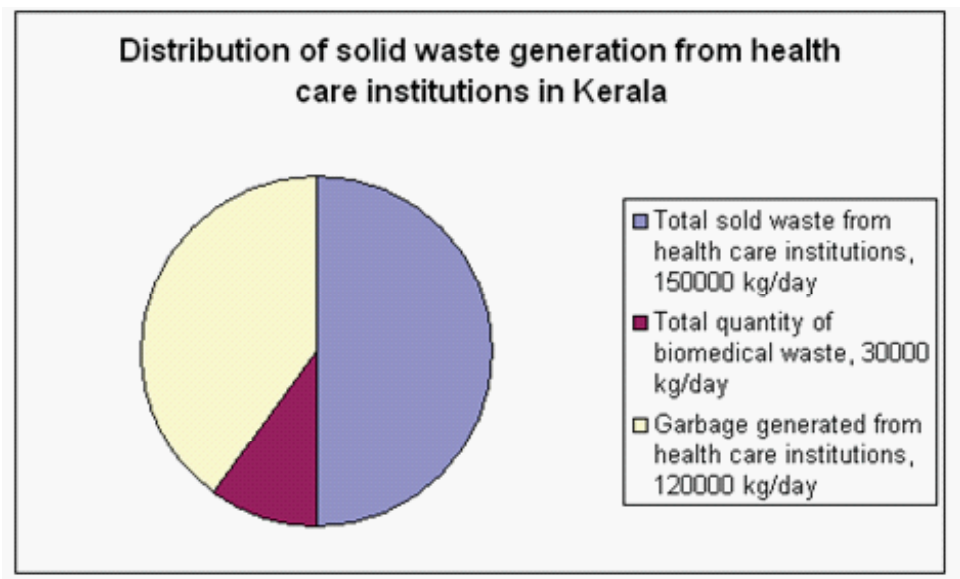
Name of the ULB	Population 2001	Waste generated (SEUF report)	Quantity of waste reported by ULBs (in MT)				
			2005-06	2006-07	2007-08	2008-9	2009-10
Adoor	28,952	8.68	6.66	6.68	6.70	6.71	6.73
Alapuzha	177,029	53.11	45-50	45-55	50.00	55.00	60.00
Angamaly	33,409	10.02	8.00	8.00	8.00	8.50	9.00
Attingal	33,831	10.15	16.50	16.50	18.00	18.00	19.00
Chavakad	38,138	11.44	8.00	8.25	8.50	8.60	9.00
Cherthala	45,102	13.53	9.00	9.50	10.00	10.50	11.00
Kanjangad	65,503	19.65	20.00	20.00	20.00	20.00	20.00
Kasrgod	52,683	15.80	12.00	13.00	13.00	15.00	15.00
Kozhikodu	440,000	176.00	300.00	300.00	300.00	300.00	300.00
Malapuram	58,491	17.55	10.00	10.00	15.00	15.00	15.00
Payyannur	68,711	20.61	4.50	4.70	5.00	5.50	6.00
Perinthalmanna	44,612	13.38	15.00	15.00	17.00	17.00	17.00
Perumbavur	26,547	7.96	7.00	8.00	8.50	9.00	9.50
Thaliparampu	67,507	20.25	8.00	8.00	8.00	8.00	8.00
Thirur	53,654	16.10	10.00	10.00	12.00	15.00	15.00
Thrissur	317,526	127.01	45.00	50.00	50-55	50-55	45-50

Source: Adapted from the Audit Report (LSGIs) for the year ended 31st March 2010, CAG, 2010

All the ULBs failed to maintain any records of the quantity and composition of generated wastes. As there was no reliable data on the quantity of waste generated in the ULBs, the auditors adopted the study report (2006) of the SEUF on solid waste management under Water and Sanitation Project (WSP). As per the report, the per capita waste generation per day was 300 grams in municipalities and 400 grams in municipal corporations. The mismatch between the figures furnished by the ULBs and those based on the study report of the SEUF is shown in Table 20 (CAG, 2010).

Biomedical waste generation

FIGURE 10: BIOMEDICAL WASTE GENERATED IN KERALA



Source: ENVIS Centre, Kerala State Council for Science, Technology and Environment, MoEF, GoI, http://www.kerenvis.nic.in/Database/Soil_836.aspx

It is roughly estimated that about 1.3 to 2.0 kg/bed/day of solid waste is generated from health care institutions, of which 15 to 20% is biomedical waste. Thus, about 1.5 lakh tonnes/day of solid waste is generated from hospitals and other health care centres in the state. (Kerala ENVIS 2013c).

Hazardous waste

FIGURE 11: DISTRIBUTION OF HAZARDOUS WASTE HANDLING UNITS IN KERALA

Source: ENVIS Centre, Kerala State Council for Science, Technology and Environment, MoEF, GoI, http://www.kerenvis.nic.in/Database/Soil_836.aspx

The quality and quantity of industrial hazardous waste is based on the type of its source. In Kerala the solid wastes from the industries and the sludge from the Effluent Treatment Plant (ETP) are not properly disposed. Further waste generated from conventional industries like coir and cashew cause severe disposal problems. According to the pollution potential, hazardous waste handling units are classified into three categories (See Figure 10), namely red category (highly polluting), orange category (medium polluting) and green category (less polluting). (Kerala ENVIS 2013c).

SANITATION PROGRAMMES OF KERALA

Kerala sanitation policy

An integrated action plan, the Malinya Mukta Keralam Action Plan, was drawn up for a comprehensive intervention in the sanitation situation in Kerala. The Action Plan, which was released by the President of India on 1st November 2007, put forward an overall strategy for organisational reform and specific action plans with a recommended time-frame and expected outputs. The Kerala government announced a general framework for a very ambitious sanitation policy on 1st November, 2007 which is described below.

Vision

The policy aims to make Kerala waste free, with an unpolluted environment, public hygiene and cleanliness. It is expected that the quality of life in the state will improve due to better health and overall well-being, economic gains, better aesthetic surroundings and a healthier environment.

Mission

- Sanitation for all
- Facilitate an attitudinal change among the people of Kerala towards waste management and maintaining a healthy environment
- Enable achievement of an overall hygienic environment
- Facilitate implementation of comprehensive scientific waste management systems
- Promote employment of appropriate technology
- Facilitate active community participation
- Achieve waste reduction at source

Targets

- Total coverage of household sanitary latrines in nine months
- Total coverage of sanitary latrines in public institutions, schools, hospitals etc. in one year
- Systematising household and institutional waste treatment systems within three years
- Popularising the segregation of household and institutional waste within one year
- Developing decentralised common waste treatment facilities within three years
- Developing common sanitary land-fill sites for inert waste during the 11th plan period
- Making colonies clean and neat within two years
- Making public places litter-free within three years
- Preparing a perspective plan for liquid waste management within two years
- Extending sewerage facilities and tripling their coverage within five years

Performance of sanitation systems

There are glaring differences between the factors that support the performance of water supply and sanitation systems. Some of them are as follows:

- While the absence or inadequacy of water supply affects the life of people directly and immediately, issues pertaining to sanitation and hygiene take a long time to be felt by the public and more often than not only when the problem becomes intolerable.
- While the success or failure of environmental sanitation depends upon a behavioural change in the public, the performance of water supply systems depends upon the chosen technology, the operational or managerial efficiency and revenue generation in addition to people's participation and their attitude.

Therefore, the parameters for assessing the status of environmental sanitation are quite different and mostly attitudinal and socio-cultural in nature.

Here again, the data available to assess the performance of solid and liquid waste management systems (both urban and rural) is extremely limited. While there are statistics on the coverage of environmental sanitation and waste management, there is not much data available on whether these projects are functioning well, and related problems. Under these circumstances, similar to the situation regarding water supply, the authors are constrained to come to certain tentative conclusions.

Solid waste management systems

Solid waste management is the most burning issue in terms of its administrative, ecological and public health implications. It is a major problem in municipal corporations of Trivandrum, Ernakulam, Kozhikode and Thrissur. It has become a major threat to public health in urban areas and urban townships in rural areas as well. The accumulation of plastic waste and the issue of thin plastic carry bags which are still in use even after repeated legal measures further complicate the scenario. The pollution of water bodies and the environment due to the misuse of pesticides poses serious health hazards. Health problems due to occupational pollutants, such as asthma, allergies, and chronic obstructive pulmonary diseases especially in the context of rising urbanisation and increasing vehicular traffic are other related issues that need to be addressed.

Kerala is a developed state. As a result, the huge consumption of resources results in the generation of large quantity of waste. Several initiatives at the national and state levels have abated the problems arising due to waste generation, in particular, pollution. Solid waste generation is mainly due to industrial and domestic activities. The waste generated due to industrial activities is of hazardous as well as non-hazardous nature. Biomedical waste is generated from health care institutions. The responsibility of collecting, treating and safely disposing off all types of solid waste lies with the institution or industry which generates the waste. Even though there are 58 urban municipalities in Kerala, most of the GPs depict the characters of urban areas particularly in respect of Municipal Solid Waste (MSW) generation.

Collection of solid waste in ULBs[16]

According to the Municipal Solid Waste (Management and Handling) Rules, 2008 all municipal solid waste generated should be collected by the local authorities and that no waste shall remain uncollected posing risks to public health and the environment. However, none of the ULBs except Kozhikode Municipal Corporation have maintained records showing the quantum of waste collected. The quantity of waste reported to have been collected by Attingal and Perinthalmanna Municipalities were 38% and 12% more respectively than the actual quantity of waste generated. In the remaining ULBs, the reported collection of waste was in the range of 18% to 85%. In six of these ULBs, the percentage of collection was below 50. The uncollected waste is hazardous for public health and the environment. (CAG, 2010).

A comparison of the quantum of waste collection (based on approximation) as reported by the ULBs with the quantum based on average per capita norms is presented in Table 21.

16 Most of the information in this section is adapted from the Audit Report (LSGIs) of Kerala for the year ended 31st March 2010, prepared by CAG, India.

TABLE 21: WASTE GENERATED IN ULBs

Name of the ULB	Total No. of wards	Waste generated	Waste collected and transported per day(in MT)	Percentage of waste collected
Adoor	25	8.68	3.3	38
Alapuzha	50	53.11	45.0	85
Angamaly	27	10.02	8.0	80
Chavakad	29	11.44	6.5	57
Cherthala	32	13.53	8.5	63
Kanjangad	40	19.65	7.0	36
Kasrgod	35	15.65	8.0	51
Kozhikodu	55	176.00	50.0	28
Malapuram	37	17.55	10.0	57
Payyannur	41	20.61	4.5	22
Perinthalmanna	31	13.38	15.5	112
Perumbavur	24	7.96	5.0	63
Thaliparampu	41	20.25	3.6	18
Thirur	35	16.10	13.0	81
Thrissur	52	127.01	42.5	33

Source: Adapted from the CAG Audit Report (LSGIs) of Kerala, 2010

Segregation and storage of waste

As per the implementation schedule (Schedule II), each ULB should collect municipal solid waste through any of the methods like community bin collection (central bin), house-to-house collection, collection at regular pre-informed timings and scheduling by ringing a bell. Further organic and inorganic waste should be collected separately for facilitating effective processing and disposal of waste.

The ULBs are also required to provide covered community bins of different colours -green for biodegradable, white for non-biodegradable and black for other waste. In Kerala, none of the ULBs provided community bins of different colours. Nine ULBs have introduced the system of house-to-house collection of waste partially with the help of Kudumbasree units. The service-level bench-mark prescribed by the Ministry of Urban Development, GoI was to be 100% coverage of Solid Waste Management (SWM) services by the ULBs. However, in the selected ULBs, the percentage of collection of waste from house-holds varied from zero to 34%, except in Kochi where it was 100%. In five ULBs, the percentage of collection of waste from shops was nil. The details are given in Table 22.

TABLE 22: NUMBER OF HOUSES AND SHOPS FROM WHICH WASTE WAS COLLECTED BY KUDUMBASREE UNITS

Name of the ULB	Total no. of houses	No. of houses from which waste was collected	% of collection	Total no. of shops	No. of shops from which waste was collected	% of collection	Whether segregated or not segregated
Alapuzha	52892	12000-150000	25	5909	0	0	No
Attingal	11188	3800	34	1660	1660	100	Yes
Chavakad	7233	750	10	1250	0	0	No
Kozhikodu	76030	76030	100	16855	16855	100	Yes
Malapuram	16000	2000	13	2106	0	0	No
Payyannur	17393	200	1.14	2507	0	0	Yes
Perinthalmanna	16880	0	0	2068	2068	100	Yes
Thrissur	93843	15165	16	11055	3373	31	No
Thirur	10171	350	3	2982	0	0	No

Source: Adapted from the CAG Audit Report (LSGIs) of Kerala, 2010

Transportation of wastes

According to MSW Rules, municipal solid waste is to be transported using covered vehicles in order to avoid scattering and exposure to the environment. The vehicle shall be so designed to avoid multiple handling of waste prior to its final disposal. Out of 136 vehicles used by the 16 ULBs, only 39 vehicles were covered and 28 were designed to avoid multiple handling.

Processing of waste

The implementation schedule (Schedule IV) of the MSW Rules stipulates that the biodegradable waste shall be processed by composting, vermi-composting, aerobic digestion or any other appropriate biological processing so as to minimise the burden on the landfill. The mixed waste containing recoverable resources should follow the route of recycling and the end products of processing should comply with the standards specified in the schedule. Among the 16 ULBs the Payyannur Municipality had established a small vermi-compost plant with a capacity to process a limited quantity of biodegradable waste.

TABLE 23: QUANTITY OF WASTE PROCESSED

Name of the ULB	Period of processing	Waste brought to site in MT	Manure produced in MT	Quantity processed as per norm in MT	% of processing	O&M charges paid to service provider (in lakh rupees)
Thrissur	April 2008 to March 2009	15792.00	87.63	350.52	2	39.48
Kozhikode	November 2006 to June 2008	39900.00	1736.00	6944.00	17	146.46
	January 2009 to December 2009	14647.37	1088.00	4352.00	30	Nil*
Thirur	April 2009 to March 2010	3978.00	30.96	123.84	3	2.20
Malapuram	August 2005 to March 2010	15960.00	756.00	3024.00	19	68.41

* The Corporation received royalty of Rs.4.80 lakhs per annum

Source: Adapted from the CAG Audit Report (LSGIs) of Kerala, 2010

The Kozhikode and Thrissur Corporations had established processing plants many years ago. The Kasaragod, Angamali, Perumbavur and Cherthala Municipalities have not established processing plants. From the table it is seen that 70 to 98% of the waste collected by the municipalities was dumped in dump yards as crude waste. This led to an increase in the pressure on scarce land resources available with the ULBs apart from associated environmental problems.

Important observations from the audit report:

- Though Taliparamba, Alappuzha, Chavakkad, Kanhangad and Adoor began working on this issue between 2005 and 2008, the processing plants had not been commissioned even as of April 2010. Incomplete projects indicated that Suchitwa Mission, which provided financial assistance to the ULBs, had not monitored the projects properly.

- Among six ULBs which began waste processing, Attingal and Perinthalmanna did not maintain any records of the quantities of waste received in the processing plant, waste processed, and manure produced and sold. The only data available in the other four ULBs was the quantity of waste brought to the site and the manure produced. As per the norm adopted by Suchitwa Mission, the quantity of organic manure obtainable was 25% by weight of the quantity of waste processed. Based on this norm, the quantity of waste processed (ranging from 2% to 30%) by the four ULBs was low. The details are given in Table 23.

Liquid waste management

The coverage of sewerage facilities, even in the city corporations, is extremely low. It is of the order of 30% in Thiruvananthapuram and 5% in Kochi corporation areas, probably one of the lowest in the country. Even in this system, the provision for treating black liquor is almost absent. The remaining municipal and rural areas do not even have such a facility. The septic tanks have volume constraints due to scarce land available, and the leach pits overflow because of the high water table, especially during the rainy season which extends up to about 150 days in a year. Therefore, there is a requirement for the clearance and removal of septage, for which facilities are not available anywhere in the state. The dangerous practice followed now is that the septage is collected using vacuum suction into tankers which are then emptied into open spaces and even water bodies.

Shortcomings of the current planning process

The current process of planning sanitation programmes in Kerala has the following serious shortcomings:

- It is a top down, target oriented, linear, project approach in which standardised designs and governance models borrowed from elsewhere are imposed without any effort to adapt to local situations (e.g. two pit leaching type toilets).

- Despite the boastful terminology of the state policy regarding community participation, the involvement of the people in planning, implementation and management of public systems is only notional. In fact, these responsibilities are squarely vested with the three-tier Panchayat governance systems, both rural and urban.

- Social acceptability is taken for granted, and if there is resistance from the people, it is assumed that an 'awareness campaign' will effect attitudinal changes in the community.

- All solutions are 'curative' in nature. Preventive measures are not even considered. It is important to remember that improvement in sanitation requires a value and attitudinal change which cannot be achieved through 'projects'.

SECTION 11:
CONCLUSIONS AND WAY FORWARD

CONCLUSION

While the personal and household hygiene of Kerala is better than elsewhere in the country, with the state's 100% coverage and usage of sanitary latrines and the reasonably good water and food handling habits of its people, it faces serious problems of environmental hygiene and related public issues.

The primary causes of sanitation problems in Kerala can broadly be classified into the following:

- Conventional, top-down, project approach in planning has led to the choice of inappropriate technology and governance systems. This has led to a failure of individual as well as public sanitation systems.

- The behavioural patterns of the people towards waste handling are not supportive of introducing efficient/sustainable systems for the management of solid and liquid wastes.

- The increased usage of plastic carry bags has resulted in increased production and accumulation of non-degradable wastes.

This also reveals that the problem is much more complex and a project approach cannot lead to a sustainable solution.

THE WAY FORWARD

An approach that incorporates and integrates multiple sectors in three major areas is required:

- Adopt an iterative planning process leading to

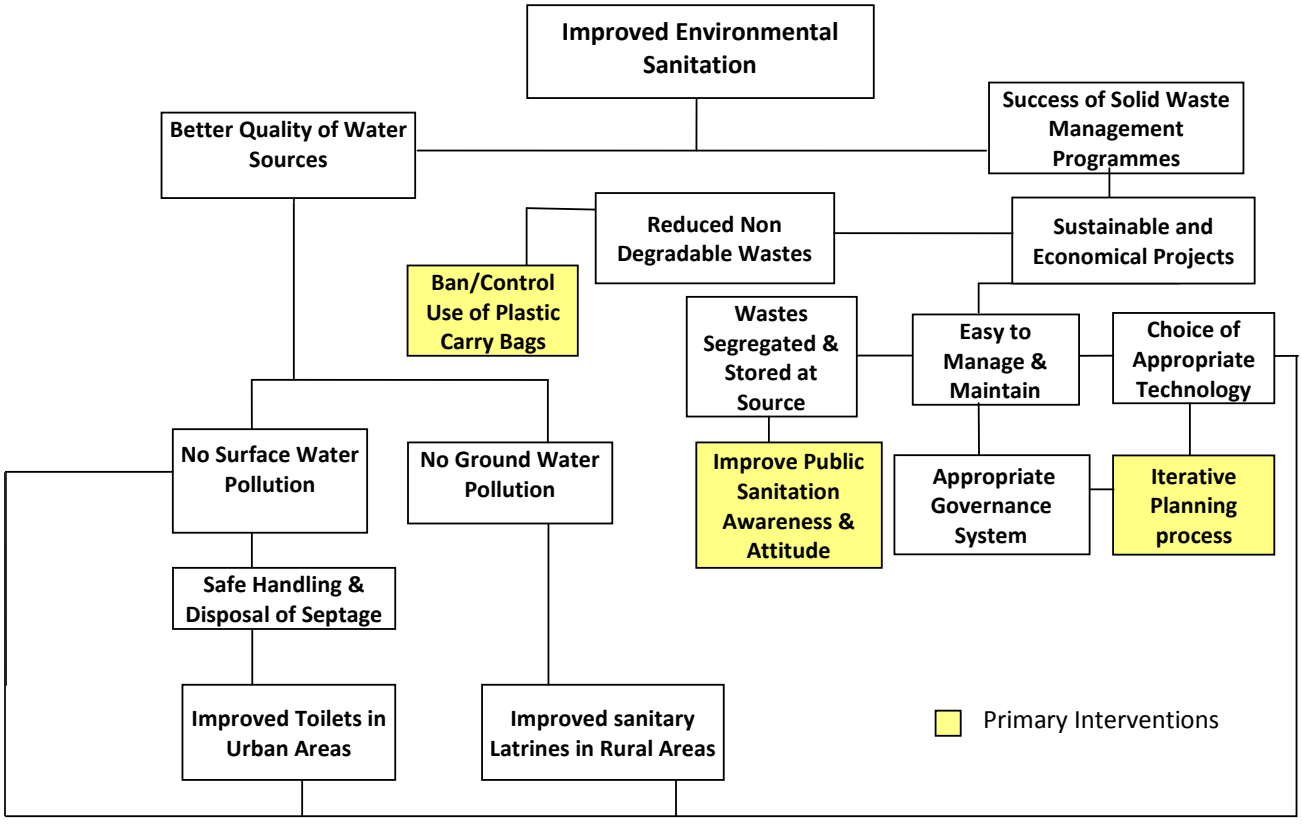
- The choice of appropriate technologies in toilet designs, sewage disposal systems and waste management systems

- The choice of appropriate governance systems in waste management

- Inculcate better waste handling habits. This calls for a reform in the education system.

- Control and/or ban the use of plastics through legislative and regulatory measures.

FIGURE 12: TREE DIAGRAM FOR IMPROVED SANITATION



An iterative planning process

Through this method, planning and implementation should be taken up in a series of iterative steps of spatial and temporal increments. These should be small loops of 'doing-learning-doing' until a reasonably satisfactory and sustainable solution is found to the problem. The spatial system boundary of the first iteration should be a ward or Gram Sabha, for a period of one year. This implies that a series of experimental interventions should be made in a ward in the areas of technology choice, governance models (planning, implementing and maintenance of systems), and strategies in bringing about positive attitudinal changes in waste handling and environmental protection.

Based on periodical (monthly, quarterly) observations and participatory evaluations, the designs, governance and education models should be improved until sustainable solutions are found. The time frame can be expanded if necessary. The entire process should be carried out by the community with the support of trained and professional facilitators. Subsequently, this approach should be extended to the whole Panchayat, block, district and state.

A series of situations and the respective solutions (technology, institutional choice), depending upon spatial variations of social, economic, cultural, and geographical conditions can be defined, which can be used to develop guidelines for planning at the district and state levels. Such planning tools are far more superior to the conventional users' manuals, most of which present standard designs and methodologies.

Choice of appropriate technology

Comprehensive research should be initiated in order to develop efficient, sustainable, user-friendly and cost-effective technologies for the following situations:

- *Toilets for waterlogged areas*: Various models of ecosan designs currently available should be tried and their socio-cultural, economic and environmental impacts monitored for at least one year. A comparative study should be carried out to choose the most appropriate design under different situations.
- *Improved designs of leach pit toilets*: The design of leaching-type toilets should be improved to prevent/reduce ground water contamination in rural areas.
- *Toilets for urban areas* including *septage handling*: The design of toilets should be improved to separately handle excreta, urine and water so that the entire septage is disposed off safely.
- *Improved liquid waste management for urban/semi-urban areas*: Low cost, environmentally sound and socially acceptable sewage handling and treatment systems should be designed and implemented.
- *Improved solid waste management for urban/semi-urban areas*: Low cost, environmentally sound and socially acceptable solid waste handling and treatment systems should be designed and implemented.

Choice of appropriate governance/ delivery systems

One of the major reasons for the failure of the public sanitation programmes is the choice of an inappropriate governance system. A few experiments of community managed environmental protection initiatives in which environmental sanitation is an important component have thrown ample light on more appropriate governance systems for environmental management in rural and urban areas. (See box 4).

Some important lessons that can be learned and used in developing governance models for environmental protection and sanitation are as follows:

1. Continuous support of competent institutions/trained professionals as facilitators is essential in planning, implementing and managing environmental sanitation systems. These professionals should be competent in iterative planning, capacity building and technical aspects of environmental sanitation.
2. The institutional set-up of Kudumbashree, the state-sponsored women's empowerment programme operating under the Panchayati Raj system of governance, is ideal for spearheading governance systems of solid waste management in rural and urban areas because:

a. Where many alternative community/Panchayat models have failed, Kudumbashree units have managed to sustain not only the process of waste collection and management but also to inculcate attitudinal changes in the community.

b. Kudumbashree is an officially recognised institutional entity which leads development programmes at various levels of the Panchayat governance system.

c. This programme provides an opportunity for income generation for poor women.

d. The functionaries are already trained and motivated in addressing issues of public interest.

e. They are available at every nook and corner of the state.

6. Involvement of children's forums (*Bala Sabhas*) in creating awareness about the imperatives of environmental sanitation and monitoring systems (water quality and environmental indicators) has been implemented successfully. One needs to undertake a pilot study about the involvement of *Bala Sabhas* and the science/ environmental clubs of schools, as well as educational curriculum reforms.

7. Special training should be provided to functionaries of Kudumbashree in iterative planning, implementation and management of decentralised sanitation programmes.

8. Special training should be provided to functionaries of the *Bala Sabhas* in awareness generation, monitoring of water quality, and other environmental indicators.

9. Funds can be earmarked from national and state programmes for supporting programme facilitation, hardware costs, and emoluments for the functionaries at the Panchayat and municipality levels.

BOX 4: SOLID WASTE MANAGEMENT IN KERALA
– AN EMERGING INSURMOUNTABLE PROBLEM?

There is hardly any informed person in Kerala who does not have an opinion about waste being generated in the process of urbanisation, but nobody knows how exactly to manage it. There is a serious crisis in urban waste management that has manifested itself in the form of deadlocked garbage disposal plans in some municipalities and Corporations in the State. It highlights the gap between accepted standards in solid waste management and their achievement.

Caught in the struggle are the civic bodies, the people and the government. The impasse in garbage disposal and treatment is acutely felt in the Corporations of Thiruvananthapuram, Kochi, Kozhikode, Thrissur and Kollam, and the municipalities of Kannur and Thalassery.

With an urban population share of nearly 48%, Kerala comes close to the global rate. The hotspots of garbage management crisis in the State are a reflection of the collective failure to devise an appropriate strategy and technology.

The crisis has turned local panchayats against municipalities and Corporations on the one hand and the civic bodies against the government on the other.

Transportation of waste to the landfills triggers protests by local residents, who raise the issue of their right to live in a clean environment. The waste disposal systems of the civic bodies are naturally left in a mess, with mounds of rotting garbage in parts of towns and cities.

The no-holds-barred battle between the Vilappil Panchayat and the Thiruvananthapuram Corporation over a solid waste treatment plant set up there continues with no solution in sight. Even a decade after the plant started functioning, the Corporation is unable to put in place a leachate treatment plant. In spite of favourable High Court pronouncements, the district administration had to abandon two attempts to bring the plant-related equipment and clay to the Vilappil plant in the face of local protests.

Source: The Hindu, August 12th, 2012

Ensuring attitudinal and behavioural changes in the public

Conventional methods of 'awareness campaigns' will not be effective in achieving this herculean goal. The following strategies have a better chance of success:

- Launch model initiatives of cleaning in which all sections of the community will participate, followed by small pilot group activities consisting of segregation at source, collection, and disposal of wastes. The involvement of Bala Sabhas and Kudumbashree will add to the success of such initiatives.
- Involve school children in monitoring water quality and environmental degeneration. They can influence their fellow students and their parents.
- Design, produce and screen short films/advertisement clips that highlight the damage caused by environmental degeneration and unhealthy lifestyles, and the virtues of the sound practices of keeping the environment clean and maintaining a healthy lifestyle. Commercial TV channels should be used to screen these films.

Control/ ban the use of plastic packaging material

The existing law prohibiting the use of plastic packaging materials and carry bags should be amended to include more poor grades of plastics including bottles. Implementation of this law must be ensured through the Panchayat level governance system with incentives to those who report misuse, and stringent penal action against those responsible for violation. This can only be successful through active public participation, including that of shop owners.

School sanitation

Schhol Sanitation and Hygiene (SSH) is an important component to ensure universal sanitation coverage in rural areas of the country. School teachers, ASHA and anganwadi workers should be trained to deal with the sanitation crisis. Education departments in states and the centre should include the functionality and usage of toilets and hygiene practices including handwashing with soap in all inspection reports and reviews of programmes. Moreover, sanitation must be made a part of school curricula. Efforts should be made to ensure that there are functional toilets in schools and anganwadis located in private premises. Coverage should be extended to schools and anganwadis housed in private buildings, in particular government-aided schools.

Community toilets

The present concept of community toilets is limited to provisions for the landless and migrant population apart from provisions at public places like bus stands and market places in rural areas. Tie-ups with a concerned authority like the National Highway Authority of India (NHAI) in order to provide public toilets along highways will certainly help.

Government orders should be brought out to ensure appropriate sanitation facilities at petrol pumps, and in restaurants and dhabas. The issue regarding operation and maintenance of such facilities should also be suitably addressed and a one-time option of funding by the government should be included in the TSC.

Data Management and Monitoring

The latest concepts for effective monitoring and reconciliation of data received through various sources for consolidated reporting on sanitation status should be introduced by the nodal ministry. A dedicated monitoring directorate should be created for continuous and effective monitoring coupled with sufficient funds.

A fresh assessment of the status of coverage should be carried out with major emphasis on the status of coverage of SC, ST and other deprived groups. The rural sanitation coverage reported by census 2011 should become the basis for revised project objectives to be identified for 100% access to sanitation facilities by all rural households.

The online monitoring system maintained by the ministry should be upgraded to evidence based on real-time monitoring in convergence with identifications like BPL card number / UIDAI in addition to visual evidences.

Impact assessment of sanitation on incidence of water-borne and other related diseases should be undertaken through ASHA workers and independent studies.

States should mandatorily conduct independent studies on TSC implementation and impact every two years to assess the outcomes and plan the way forward. An independent regulator to check programme implementation and actual progress at the state and district level should be included in the plan. The system of independent assessment of sanitation status should be more specific and periodic in nature with fixed intervals to create a reliable database. This shall also help to implement mid-course corrections in programme implementation through policy interventions.

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