EMERGING CHALLENGES OF URBAN WATER GOVERNANCE
CASE OF THIRUVANANTHAPURAM CITY, INDIA

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ABSTRACT

Urban water management is a challenging issue, globally. With increasing concentration of population in the urban areas the authorities are finding it difficult to make adequate provision for drinking water supply, sewage system, drainage service and storm water management. There is a need for revisiting the viability of the existing urban water management system and water governance. Integrated Urban Water Management approach stressing on integration and addressing ecological and social dimensions of water management is expected to provide the alternative paradigm. Examination of water management issue in Trivandrum city indicates that overcoming the spatial differentiation in service delivery, providing quality service and taking measures for source sustainability are emerging challenges. In spite of strong commitment to decentralization the water management is fragmented and centralized. The city authority has very little role to play. It is suggested that participatory polycentric governance may be developed considering the city and the hinterlands within the context of Karamana river basin and socio-technical-political space may be created to debate and evolve alternative urban water management practices suitable for the city.

Key Words: Urban water management, governance, integration, polycentric approach, participation, Thiruvananthapuram City.

1.0 Introduction

Urban water governance is emerging as a critical development challenge particularly in the developing countries which are experiencing high rate of urban growth (UNESCO, 2015). Cities in many of these countries are still struggling to ensure universal availability of safe drinking water and to provision for other water related services adequately in the face of fast environmental deterioration of fresh water sources that sustain these cities. In spite of several initiatives, most of the cities in India perform poorly in the matter of availability and reliability of drinking water supply and maintenance of water quality (McKenzie and Ray, 2009, Naster, 2014). The situation is quite alarming when other aspects of urban water services like providing sewer system, drainage services, quick dispersal of storm water, and combating negative impact of cities on water resources within and outside urban centres or environmental wholesomeness are considered (Gopokumar, 2010, Nadhamuni, 2012). The existing technology centred water governance model is not adequate to address all these concerns. The concept of Integrated Urban Water Management (IUWM) is considered as an alternative paradigm (Barga, 2001, Mitchel, 2006). It accords equal priority to technical as well as nontechnical solutions and stresses on sustainability, good governance and empowerment.

Thiruvananthapuram, capital city of Kerala enjoys relatively better services in the matter of drinking water supply and continuity of supply among all State capital cities in India. However, in all other sectors of water services and overall environmental management, performance of the city is far from satisfactory. The present paper proposes to analyse water service sectors and emerging water governance challenges in Thiruvananthapuram city and examine applicability of IUWM framework to overcome these problems. This study differs from earlier attempts to deliberate on urban water management, which concentrated mostly on service delivery of drinking water and sanitation and the focus was often on technology and financial allocation for provisioning of the services. In this paper we argue for a holistic approach and try to discuss all aspects of water regime in the city and surroundings including governance challenge to integrate the services and their effective delivery. How far the provisions of the 74th Constitutional Amendments envisaging implementation of decentralized planning and self-sufficient governance for the Municipalities and Urban Local Bodies to increase their efficiency in execution of basic urban services like water have been utilized is also a point of discussion. This study is expected to facilitate further analysis of political and economic processes and contribute to policy formulation.

1.1 Study area and its environmental settings

Thiruvananthapuram city is located along the south west coast of India (Fig 1). It spreads over an area 250km^2 and houses 7.4 lakh people (2011 census). From the coastal plain the city extend over undulating lateritic midlands. Settlements occupies the ridges and upper slopes, whereas the valleys, given for agriculture, function as water cushioning areas during heavy monsoon showers. Average annual rainfall in Thiruvananthapuram city is around 1700mm. Both the monsoons, active in the city account for 76% of annual rainfall. There is rain in Trivandrum city almost in every month. The river Karamana, its tributary Killi Ar and couple of small streams drain the city. Trivandrum city expanded from 75km^2 in 1966 to 215 km^2 by 2012 and now has 100 Wards. Spatial growth and incorporation of rural areas in the city is well reflected in land use change statistics **(Table 1).**

Fig. 1: Location of Thiruvananthapuram and Karamana River basin

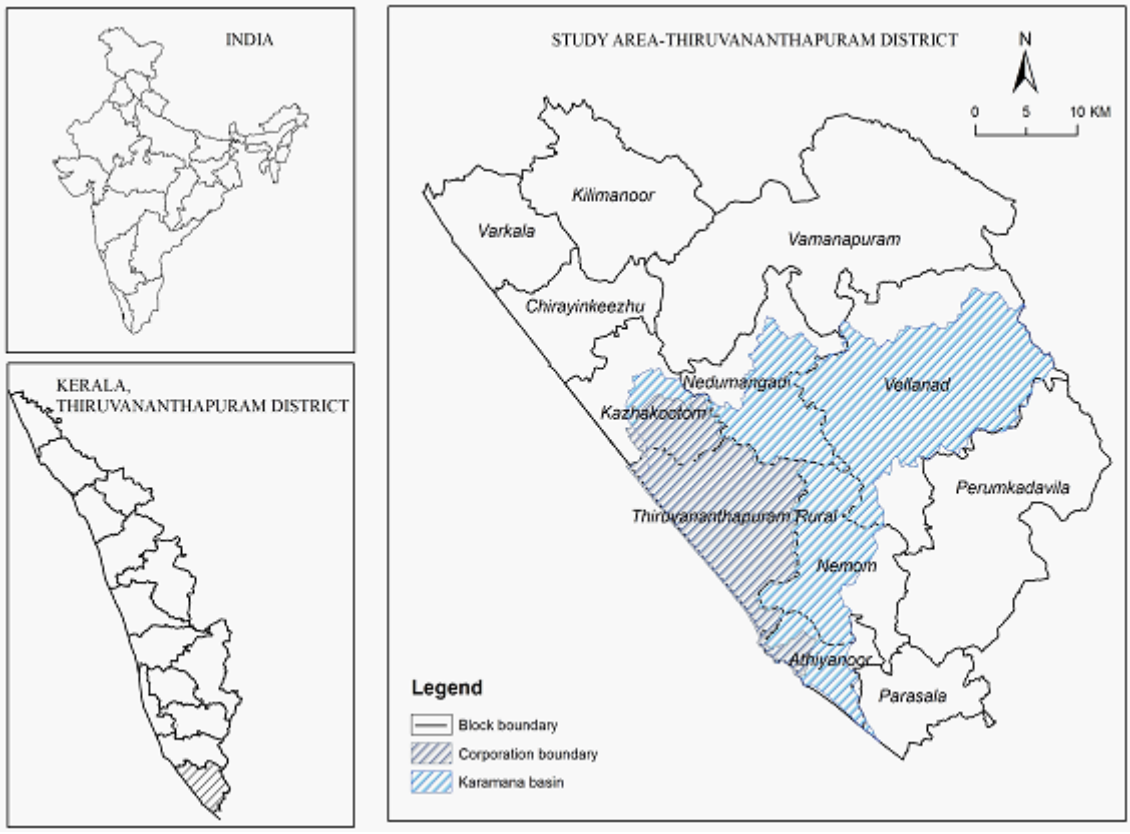


Table 1: Land use in Thiruvananthapuram Municipal Corporation

Category	1966	1990	2012
Total area (in km^2)	74.86	141.74	215.86
Residential	65%	59%	54%
Agriculture (paddy) and fallow paddy land	11%	10%	23%
Public, semi public, parks and open space	6%	9%	13%
Vacant land/ parks and open space	6%	8%	1%
Roads/ streets/ railways	5%	7%	3%
Water bodies	1%	2%	3%
Others	6%	5%	3%

Source: Trivandrum Master Plan, (draft), 2012.

1.2 Organisation of the Paper

The discussion will be through five sections besides introduction and conclusion. The section 2 gives a brief account of IUWM and emerging challenges of urban water governance. The 3rd section documents service water sectors in Thiruvananthapuram city and management challenges. The 4th section discusses on fresh water sources, problems of availability and sustainability. Both surface water and ground water have been dealt. The 5th section presents water governance structure and contextualizes it with the decentralization process, for which Kerala is well known globally. The section 6 presents a broad guide line for future challenges and polycentric governance. The concluding section summerises the arguments.

2.0 Integrated Urban Water Management (IUWM) and Challenges of Urban Water Governance

2.1 Integrated Urban Water management (IUWM)

Urban water management witnesses shift in approach and content. The emerging paradigm is more comprehensive, multidimensional and advocates perceptional change in urban water management practices. (Table 2). The International Water Resource Association introduced the concept of Integrated Urban Water Management (IUWM) a couple of decades ago (Braga, 2001). However, it gained serious consideration since 2000 (GWP, 2000) and now there are several initiatives across the world to adopt this new approach (Mitchell, 2006, Bahari, 2012, GWP, 2013, Whitler et al, 2014). Country level experiences indicate that IUWM has brought perceptible positive change in urban water management (Maheepala, 2010; Closas et al, 2012) although there are criticisms about its long term viability and macro scale applicability (Biswas, 2008) and about difficulty in transforming entrenched institutional practices particularly in large cities (GWP, 2013). Nevertheless, IUWM provides a framework that is "flexible, participatory, and iterative process which integrates the elements of urban water cycle with

both the city's urban development and river basin management to maximize economic, social and environmental benefits in an equitable manner"(World Bank, undated). The thrust is to consider all aspects of urban water as components of an integrated physical system, position this physical system within an organizational framework of governance and a broader natural landscape like river basin. On the one hand, IUWM recognises hydrological interconnectedness of all water bodies within and outside the urban area, and on the other, it stresses on designing location specific solutions by encouraging tapping of locally available water sources and innovation. Initiatives may begin with an overarching national policy on integrated water resources management to set the natural landscape scale/ watershed/ river basin level contextualization of the urban area followed by effective legislations at appropriate levels to guide concerned authorities, engage local communities and empower them to solve the problems of water management through collaboration of all stakeholders.

Government of India has shown interest in IUWM as the enabling framework for efficient management of vast challenges and needs of urban India (Brikke, 2015). The Mihir Shah committee constituted by the Government of India to restructure the Central Water Commission (CWC) and Central Ground Water Board (CGWB) recommended unification of these two organisations to form National Water Commission (NWC) which will be responsible for water policy, data and governance in the country. The new paradigm proposed by this committee envisaged fundamental changes in the existing system. It suggests suiting interventions to the contour of nature, partnership, multidisciplinarity, demand management and sustainability as central focus, emphasis on equity in access to water, transparency and national water framework law (Shah, 2016). Arghyam, (a public charitable foundation based in Karnataka) introduced IUWM in Mulbagal town in mid 2008 and the results are quite encouraging (Nadhamuni, 2012). Taking note of this experience Government of Karnataka proposed Integrated Urban Water Management programme for funding by the Asian Development Bank (ADB, 2014). Given the nature of Thiruvananthapuram city- population size, geo-environmental settings and water regime- and the overall commitment of the state of Kerala to decentralized governance the IUWM frame provides good opportunity to address urban water management problems.

2.2 Challenges of Urban Water Governance

The World Water Forum held at The Hague in 2000 accorded high priority to water governance for action (Cooley et al., 2013) and failures in water sectors are often attributed to the failure in governance (UN 2003, Biswas, 2004; Baker, 2010, Pahl-Wostl et.al., 2012). Traditionally, urban water governance refers to technical decision making process following a fragmented departmental demand-supply cycle. Inadequacy of this approach is well documented. The emerging approach of urban water governance considers technical as well as non-technical issues and enlarges its ambit to address water security and source sustainability, reduction of impact on environment controlling human dimension of water environment change, improvement of performance of water services across socio-economic groups, and allocation and reallocation of water among resource rich and resource

poor areas. Case studies across the World indicated that there are three essential roles of urban water governance: first to manage the environmental dynamics, including climate change to provide water for cities at all times; second to ensure justice and fairness in the distribution and access to water in cities; and third to ensure quality in terms of human health and environmental pollution (Olsson and Head, 2015). As there are competing demands and multiplicity in management authorities, the challenge of urban water governance is also to resolve conflicts among techno-scientific, market, policy administration, ecological and socio-political actors. The global pattern manifests that water for urban and industrial uses go up substantially and, as a result, reallocation of water between urban and rural areas is potent to create social tensions and even conflicts (TERI, 2014). There is a need to look beyond the city boundary and take into account the broader territory, establish relationship with the surrounding rural areas, evolve reciprocity with the hinterlands and operate in the frame of co-management with other administrative units surrounding the city.

The risk and uncertainties associated with various changes that the urban centres trigger in hydrological cycle are difficult to comprehend. However, the emerging challenges for water governance due to these changes form part of the urban water governance. The drivers of water use and abuse are location specific, so the insights on water management should arise from local level experiences. A careful analysis of the water governance system, its actors, interests, values and processes in each locality is necessary to bring out required change in the present governance practices. Going beyond the 'instrumental and idealistic' notion of governance and an attempt to depoliticisation (Castro, 2007) as now a days being advocated in some parlance, it is necessary to strike a balance among different aspects of water management activities, ensure convergence between research and practice in water management science and help the society to evolve a proper governance system through democratic means of debate and stakeholder participation in policy making.

3.0 Water Service Sectors and Emerging Management Issues in Thiruvananthapuram City

Water service sectors in Thiruvananthapuram city cover drinking water supply, sewage system, and storm water drainage. There is no separate provision for waste water drainage. So far as drinking water supply is concerned, Thiruvananthapuram city is well placed among all the capital cities in India. Around 80% of households in the city enjoy pipe water connection and the continuity of water supply averages at 18 hrs a day (Jacob, 2012) in contrast to all India figure of <50% of urban dwellers having access to tap water by 2010 (Naster, 2014), and average continuity of water supply limited to 4-5 hours a day (McKenzie and Ray, 2009). However, there are problems of intra-city variations and core-periphery differences in access to drinking water. Even there are some areas facing acute shortage of drinking water. In the matter of sewage system, waste water disposal and storm water drainage, performance of the city is far from satisfactory. We discuss here status of all three service sectors and the emerging management issues in each case.

Table 2: Old and new paradigm of urban water systems

• Human waste is a nuisance. It should be disposed of after treatment	• Human waste is a resource. It should be captured and processed effectively, used to nourish land and crops
• Storm water is a nuisance. Drain it out of the city as rapidly as possible	• Storm water is a resource. It should be harvested for water supply, retain for supporting aquifer recharge, waterways and vegetation
• Demand is a matter of quantity. Amount of water required or produced by different end users is the only parameter relevant to infrastructure choices. Treat all supply side water to potable quality and collect all waste water for treatment	• Demand is multifaceted. Infrastructure choice should match the varying characteristics of water required or produced for different end-users in terms of quantity, quality and level of reliability etc.
• One use (through put). Water flows one way path from supply, to a single use, to treatment and disposal to the environment	• Reuse and reclamation. Water can be used multiple times, by cascading from higher to lower quality needs and reclamation treatment for return to the supply side of infrastructure
• Grey infrastructure. Infrastructure is made of concrete, metal and plastic	• Green infrastructure. It is made of concrete, metal, plastic and also of soils and vegetation
• Bigger/ centralized system is better for collection and treatment plants	• Small/ decentralized is possible, often desirable for collection system and treatment plants
• Limits complexities and employ standard solutions. Small number of technologies by urban water professionals defines water infrastructure	• Allow diverse solutions. Decision makers are multidisciplinary. Allow new management strategies and technologies
• Integration by accident. Water supply, wastewater and storm water may be managed by same agency as a matter of historical happenstance. Physically however, three systems are separated.	• Physical and institutional integration is by design. Linkages must be made between water supply, waste water and storm water, which requires highly coordinated management.
• Collaboration = public relation. Approach other agencies and public when approval of pre-chosen solution is required	• Collaboration = engagement. Enlist other agencies and public in search for effective solutions

Source: Mitchell 2006 (adopted from Pinkham 1999): 591.

3.1 Drinking Water Supply

Pipe water supply project started in Thiruvananthapuram city as Wellington Water Works in the year 1933 covering an area of about 30km^2 and with capacity to serve a population of 1.35 lakh, (projected population for 1961). There were arrangements for water quality checks at various points. The scheme was considered as one of the best in the Country in those days. At present drinking water supply in Thiruvananthapuram city is augmented through Aruvikkara reservoir (storage capacity of 2 million cubic meter) located in the outskirt of the city drawing water from the Karamana river and a new installation at Peppara (storage capacity of 70 million cubic meter) located further upstream on the Karamana river at the foothills. Kerala Water Authority manages drinking water supply in the city. Around 81% households receive pipe water supply at their premises under KWA. Among the rest 19%, wells cater to the need of drinking water supply for 10% households followed by 4% depending on public tap water, 3% households receive water from tankers and rest 2% manage from various sources **(Fig 2)**. However, the supply is not adequate as is evident from frequent shortage reported by the people particularly during summer months. At present the Trivandrum Water Supply Scheme has the capacity of 273 MLD to cater to the need of 9.57 lakh people. The gap between production and supply is estimated at 137 MLD, whereas the water loss due leakage has been estimated to be between 35% to 43%. Cutting across physiographic barriers the problem areas are distributed in various parts of the city **(Fig 3).** Most of these locations along the peripheral areas and suburbs face acute water shortage due to fall in well water level and non availability or infrequent supply of pipe water administered by KWA (The Hindu, 5th April, 2015). Only 58% of slum dwellers have access to tap water (PRIA, 2014). In many places poor people depending entirely on pipe water supply or well water are compelled to purchase water from private vendors. Vizhinjum in the coastal tract off Kovalam coast is one such locality where people have to purchase drinking water.

Fig 2: Sources of Drinking water in Trivandrum Urban area (Data source: Census data, 2011)

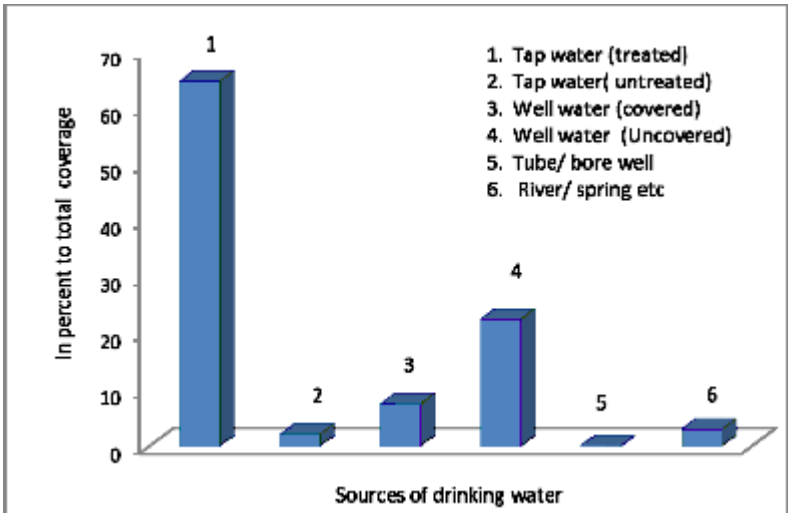
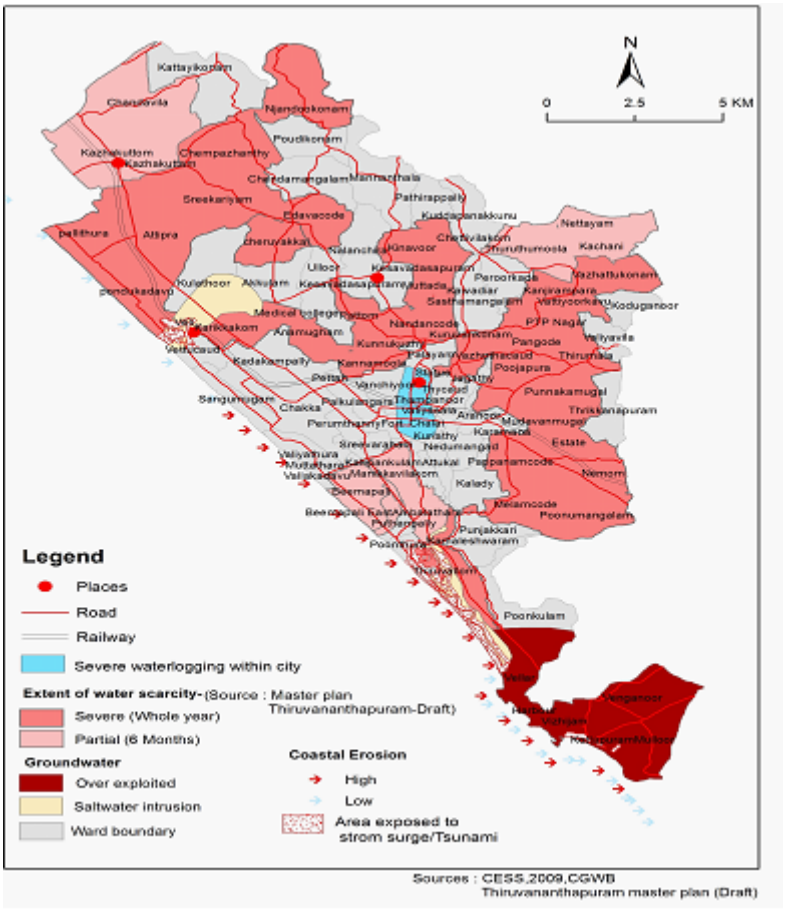


Fig. 3: Spatial distribution of water related problems in Thiruvananthapuram city



In order to augment water supply KWA has taken up a project at the cost of Rs.311.91 crore with loan assistance from JBIC (Japan Bank for International Cooperation). This project has been formulated to supply 74 mld of water. The projected water demand for 2036, at the rate of 200 lpcd works out to be 410 mld which include domestic use along with a provision for non-domestic and industrial requirement. The ongoing JBIC project can supplement 74 mld still leaving the gap of 185 mld due to growth in population. This gap is proposed to be compensated by a three tier system: (1) augment the system by 76 mld (2) bring down the unaccounted water losses to the range of 15% and (3) Cut-off some boundary areas from the city water supply system (WSS) by providing small WSS exclusively for those areas.

3.1.1 Emerging Management Issues

Our experience suggests that even with augmentation water services are not reaching to all sections and all parts of the society and there are significant losses of water due to leakage. The basic

settlement structure in the city is linear and dispersed. With horizontal expansion of urbanization more and more rural areas along the periphery come under city administration. This type of spatial growth impacts drinking water facilities of the original city, which used to enjoy better services compared to their rural counterparts but now struggling to keep up with population growth and sprawl. Similar trend has been reported from many parts of the world (WHO-UNICEF JMP, 2010). As a result, poor people in the periurban areas mostly rely on informal practices that lie beyond formal support strategies and mechanisms, whether centralized supply policies or market based approaches (Allen et al., 2006, Bahari, 2012). Trivandrum faces similar situations with growing chasm between core-periphery service deliveries.

At present the city water supply depends on surface water sources, which varies with rainfall and is subject to climate change vagaries. It is important to recognize that the conventional surface water based water supply system as existing today in the city has limitations and rather than disregarding all other sources like bore well, well, spring etc., it is necessary to assess their viability and regulate them for quality. State regulations to this effect may be expanded and, where appropriate, may provide operational management and financial assistance, so that all water supply activities within the urban environments may form part of a coordinated effort of urban water management under public utility development.

There have been reforms in water governance sector in Kerala from time to time like formation of KWA, and subsequent start of Jalanidhi, which is now in phase-II of its operation. KWA is mainly looking after the urban sector. However, these reforms have not yielded desired results for various reasons from official apathy to take advantage of 74th constitutional amendments and decentralise the operation with necessary capacity building to fragmented reductionist approach to tackle the water issue. Performance of the schemes under KWA has been questioned (Chakrapani, 2014). Water authority has been taken beyond public scrutiny and social auditing, although KWA would not survive but for public funding. What reform can do is to draw lessons from globally acclaimed experiments like Phnom Penh experience from Combodia (Das et al, 2010) or the experiences of Porto Alegro of Brazil and Kampala in Uganda etc. In all three cases it has been demonstrated that it is public utilities themselves that have been able to bring much needed change through certain reforms. The culture of change, implemented by Phnom Penh Water Service Association, focused first and foremost on employees, particularly on education, motivation and, when necessary, sanctions. It can bring transparency, accountability, operational efficiency through internally driven incentives and also succeeded to engage the consumers and civil society. These lessons may be useful for future restructuring of water governance for Trivandurm city. It is all the more important as Ministry of Urban Development, Government of India is seriously considering private sector participation in water service delivery under public- private partnership (PPP) (MoUD, 2012) to overcome the water problem although global experiences of PPP indicate its limitation to address the problems.

3.2 Sewage Disposal

Sewage disposal is a big challenge although State record 98.3% households in urban sector to posses toilets. Trivandrum city corporation has only 30% geographical area covered under sewerage system. The sewerage network is available in 5 blocks out of 18 sewerage blocks in the city. The covered Blocks under the Thiruvananthapuram sewerage scheme are part of the original corporation area or city core spreading over an area of 74.93 km^2 (Dileep Kumar, 2016). Sewerage networking continues in parts of the city under Asian Development Bank (ADB) programme. On completion, this scheme is expected to cater to 45 % of city area. A Sewage treatment plant of 107 MLD capacities is functioning at Muttathara from November, 2013 onwards, however, only 30 to 40 MLD of sewage is reaching the plant every day through the sewerage network catering 30% of city area.

Due to undulated topography and other infrastructural constraints it will not be possible to bring the entire city area under sewage network scheme. At present 70% area depends on septic tanks and leach pits, which will continue in foreseeable future. More over the existing sewerage network is very old and frequent overflows are common. Sewage overflow from the unsewered areas of the city and adjoining areas into the water body creates water pollution and unhygienic conditions. As the leach pits used by majority of the households are not sealed, there is leakage affecting ground water. The present practice is to collect the septage using vacuum suction into tankers which are then emptied into open spaces and even into water bodies, one of the most dangerous practices. With the present system of sewage disposal both surface and ground water are liable to be polluted. Expansion of network for centralized sewage treatment is hardly feasible as evident after the installation of the new plant. It is necessary to look for alternative approach. Use of water recycled from sewage for agriculture and environmental management as done in many countries may be seriously considered.

3.3 Storm Water Drainage

The river Karamana, and its tributary Killi Ar flow through the city. There are natural drainage channels, manmade drains and lakes serving as storm water drainage. These are Ullor thodu, Pattom thodu, Pazhavangadi thodu, Amayizhanjan thodu, Thekkenekara canal, Kariyil Thodu, Tettiyar thodu, Pangappara thodu, Kaimanam-Azhamkal thodu, Amathara thodu, Koori thodu, Vattakkayal Thodu. Other important drains contributing to storm water drainage to the city canals are Choozhampala thodu, Anathanathodu, Edanada thodu, Arayalloor Ela thodu and Thiruvallom Pallathukadavu thodu. Parvati putnar also facilitate storm drainage. Several small natural channels and canals draining various parts of the city carry water and finally debouch into the main stream/ river to be carried to the sea. Based on location and severity of problems 59 high priority areas were identified within the Thiruvananthapuram Municipal Corporation area and another 53 sites were located in the adjoining panchayat areas (KUDA, 1992).

Trivandrum corporation has 180 km long streamlets and each of 100 Wards are bestowed with one or more natural water courses / streamlets, which are mostly converted into rainwater drains, concrete/ stone lined. Water accumulates in these drains from individual plots through overland flow. Due to undulating topography and relatively elevated position water drains out quickly in most of the areas, however parts of the CBD suffers from water logging 5 to 6 times in each year and depth of water reaches up to 1.2m in some cases. Genesis of the problem can be deciphered from a detailed investigation in one of the micro watersheds, the Amayizhanjan Thodu following the events of water logging on 21st April and 28th June, 2015 with rainfall of 161mm and 120mm respectively (Shaji and Ravindran, 2017). It is found that more than 78% of 3.94 km^2 watershed area is under built up category or paved, which does not allow percolation. Instantaneous flow has increased and capacity of drainage net has reduced due to encroachment. Frequent water logging in some parts of the city particularly in the CBD area during monsoon months has raised serious question about storm water management in the city.

3.3.1 Management Issues

Storm water drainage in the city is in the form of conveyance, e.g. to drain out the water at a faster rate. This trend prevails for traditional storm water management almost in all urban centres is now found inadequate. Factors contributing to waterlogging are expansion of settlements, growth of surfaced area, reduction of flood cushioning areas due to occupancy of flood plains, encroachment along drainage channels and obstructions, dumping of solid wastes within the water bodies, inadequate and or absence of drains, low level of plinth of houses vis a vis road/ drain level, lack of clear cut outlet to primary / secondary drains, inadequate cross drainage, overtopping of banks, inadequate inlets, poor maintenance level and tides/ sea surge in the coastal areas. Majority of the causes are of anthropogenic origin. In the event of climate change there will be an increase in high intensity rainfall with intervening prolonged dry periods. Probability of water logging will increase. At present there is no clear cut responsibility among the Government departments in the matter of storm water management. It is also not particularly effective at public engagement, at the same time people's interest in storm water management may be difficult to sustain. For a long term solution there must be a balance between infrastructure development, its performance and environmental goals. It is unlikely that cities can build distributed storm water management infrastructure to cope with the eventuality like the rainfall of 161 mm that occurred on 21st April, 2015. The changing storm water management proposes hybrid infrastructure which combines structural measures that facilitate conveyance with distributed measures that promote infiltration (Porse, 2013). Plot level intervention by individuals, business houses and institutions is necessary to increase in-situ infiltration and reduce surface run off. Capacity of the existing ponds/ wetlands may be enhanced to store water. These interventions may not be possible through legislation. It requires awareness among the people and voluntary action at the individual/ family level. Storm water management warrants people centric decentralized approach and appropriate system design of distributed infrastructures.

4.0 Fresh Water Sources of Thiruvananthapuram City: Problems with Availability and Sustainability Challenge

Sustainability of fresh water sources is one of the issues that emergent urban water governance is expected to consider. Thiruvananthapuram city uses both surface and ground water. While the pipe water supply in the city fully depends on Karamana river, many households along the periphery of the city continue to depend on dug wells. Even within the city there are several household still maintaining dug wells as additional source. There are instances of people within the city sinking tube wells in their premises. Thiruvananthapuram City is facing problems in both surface and ground water concerning quantity and quality. We plan to discuss some of these issues here and highlight governance challenges in the matter of source sustainability.

4.1 Reservoir Siltation and Sand Mining in Karamana River

Peppara and Aruvikkara are two reservoirs impounded on this river to cater to the drinking water need of Trivandrum city. The first stage of construction of Aruvikkara reservoir started in 1928 and completed by 1933 and the second stage was completed in the year 1972. The water spread area at the time of impounding was 48 hectares and the maximum storage capacity was 2 million cubic metre (Mm^3). A Survey conducted by Kerala Engineering Research Institute (KERI) in May 2009 brought out that water holding capacity of the reservoir had come down from $2Mm^3$ at the time of final commissioning in 1972 to 1.137 Mm^3 in May, 2009. There is a reduction of 19ha in water spread area and the storage loss of $0.863Mm^3$ during 37 years. The Peppara reservoir with a water spread area of $5.82km^2$ and storage capacity of $70mm^3$ was commissioned in 1982 to augment water supply capacity of Trivandrum city at the level of 24/7. However this reservoir is facing problem of siltation and reduced lean season flow due to various interventions in its catchments. In dry years, water storage in Peppara reservoir is also not sufficient to meet the demand of the city. Water is being diverted from Neyyar river to supplement city water supply.

Sand mining from river bed is another problem that impacts on source sustainability. A recent assessment of sediment deposit conducted under the aegis of Revenue Department, Government of Kerala has indicated that in a 32 km stretch of Karamana river there are sediment deposits of 0.18 million cubic meter within a depth of 2m below summer water level (River Management Cell, 2015). However, all the sediments above summer water level have been removed. The river bed level help maintaining the pizhometric level of water and control water levels in the surrounding wells. Removal of sands from river bed causes not only lowering of river bed level but also reduces water holding capacity. This is an important issue in the matter of source sustainability.

4.2 Water Quality of Karamana River

Analysis of selected parameters indicated that water quality of Karamana is in general not good and it deteriorates as river enters Trivandrum corporation area. Comprehensive monitoring of river water quality by Centre for Water Resource Development and Management (CWRDM) under the

aegis of KSCSTE highlighted that the maximum deteriorated condition is noted in the downstream side of the Trivandrum Corporation towards the coast manifesting effluent load from the urban areas. Nutrient pollution is attributable to domestic use and agricultural runoff along the upstream stretch. Water of Karamana River is not potable at any stretch at any time of the year (Harikumar 2017). Even the monsoon rainfall is not sufficient to flush out the pollution load. Water cannot be used without treatment. During summer months, when river discharge comes down substantially, but other waste inputs continue to be at the same level, the colour of river water records high deterioration. Domestic sewage discharge, increased surface run off from paved urban areas, urban effluents and waste dump in combination contribute to the deteriorating condition of the Karaman River and other surface water bodies draining the city. Impact of urbanization and human action are well evident. Deterioration of river water quality is a serious issue in the matter of source sustainability and it requires public action to ameliorate the situation.

4.3 Ground Water

Ground water is also used in many households. Now there are reports of falling water table and quality deterioration. Water is tapped mostly by dug wells for domestic or irrigation purposes. Trivandrum city area experiences high fluctuation of water table (Rani et al, 2011). According to the CGWB estimates the net groundwater availability of the Thiruvananthapuram block is 23.74 MCM and the current stage of development is 81% (CGWB, 2013). Doubts have been raised about this estimate particularly on account of local geology and aquifer characteristics. Ground reality hardly matches the CGWB estimated resource availability (Soman, 2016). Due to hard rock terrain ground water occurs in patches and there are wide spatial variations. Some parts around the city shows over exploitation with more than 100% development. In these areas ground water extraction is more than recharge resulting in fall in ground water level. Tapping of ground water has increased significantly with increase in population and water use. Number of private tube wells and bore wells has increased tremendously. Majority of the households in the panchayat area and even in the urban area have their own dug wells or bore wells. The ground water, alternative source for drinking water is under stress. While certain pockets are over exploited, the quality of water is an issue warranting serious consideration. Besides, poor quality of ground water is an emerging problem. The coastal aquifers reported high salinity, which is further aggravated due to over exploitation. At present for most of the water quality parameters the ground water in major part of Trivandrum city area is still within the limit, however, bacteriologically contamination is an issue for all the seasons (Harikumar, 2017).

This brief discussion brings out that the city is facing problems due to fall in quality of surface water, which affects quantity of availability also, reduction in storage capacity, fluctuation of resource availability due to vagaries in climate, and over exploitation and pollution of ground water. Therefore the challenges of water governance so far as source sustainability in Trivandrum city is concerned will be to address both surface water and ground water sectors. Revenue department, Water Resources Department particularly, Irrigation department, and Ground water department are involved to administer

these two sectors of surface and ground water. Governance challenge here is more of coordination among the departments and also to enhance in-situ water harvesting within the city limit.

5.0 Present Water Governance System in Thiruvananthapuram City

The discussion in Section 3 has brought out the emerging challenges of water governance in all three water service sectors and section 4 deliberated on problems of fresh water that impact sustainability of water resources in Thiruvananthapuram city. In this section we intend to deliberate present water governance system in Thiruvananthapuram city, and decentralized planning and urban water management.

5.1 Water Governance in Thiruvananthapuram City

Water governance in Thiruvananthapuram city falls under the purview of more than one Government departments and the City Corporation has hardly any role (Table 3). In fact, urban self-governments in Kerala play no role or a very marginal role in providing basic water services of drinking water, sewage water and storm water drainage to the city dwellers, although there are evidences in other States in India where local urban governments manage all these basic services (Jacob, 2011). Thiruvananthapuram Corporation with 100 wards is administered through six zones for operational purposes. There are eight standing committees, namely, Finance, Development, Welfare, Health, Public Works, Town Planning, Tax appeal and Education & sports. However, there is no standing committee looking after water. The corporation's activity in relation to water is limited to supply of water through tankers in some of the stressed areas during emergency situations.

Kerala Water Authority, an autonomous body established by Government of Kerala in 1984 for the development and regulation of water supply, waste water collection and disposal manages drinking water supply and sewage treatment in the city. The two dams on Karamana River, principal source for harnessing water for the City are under the administrative control of Water Resources Department. The upper catchment area of the Karamana River comes under the administration of the forest department. Any activity within the forest department is subject to the control of the Ministry of Environment, Forest and Climate Change, Government of India. Even desiltation of the reservoir falling within the forest boundary needs clearance from Government of India. The portion of the Karamana River downstream of Peppara reservoir till its confluence is under the jurisdiction of Revenue Department, Government of Kerala and most lands are privately owned. The drainage channels within the city are partly controlled by City Corporation, although some of the construction activities are undertaken by minor irrigation department. There is no specific agency to manage storm water drainage separately. To initiate the programme of drainage rejuvenation following 2015 water logging of the city Government of Kerala pressed seven organizations into the service and the provision of disaster management law was invoked. The Central Ground Water Board, Government of India and the State Ground Water Board, Government of Kerala are entrusted with the job of exploring ground water.

The coastal zone (tide affected areas) is under the purview of Coastal Regulations, promulgated by Government of India from time to time. What emerges from this brief discussion is that urban water governance is fragmented and urban self government virtually plays no role.

Table 3: Actors in relation to Urban Water Governance of Trivandrum city

Administrative level	Department/ Organisation	Responsibilities/ actions
Government of India	Ministry for Water Resources	National Water Policy, 1987, 2002 and 2012
	Ministry of Urban Development	National Urban Policy
Government of Kerala	Department of Water Resources	Looking after the dams and reservoirs
	Department of Local Self Government (Urban)	Policy formulation for local self government activities
	Trivandrum Development Authority (TRIDA)	Supervision of development work in TRIDA area
	Town and Country Planning Department	Preparation of perspective plans for urban development
	KSUDP	Working out plans for urban development
	KWA	Drinking water, sewage and waste water disposal of urban centres
	Trivandrum Corporation	
	Trivandrum District administration	Emergency management of storm water

To communicate clearly about the important aspects of urban water governance and their interrelationships a three layer model of governance consisting of Content, Institutional and Relational aspects has been proposed (Hofstra, 2014, OECD, 2014). It serves as a checklist and can be used to assess the prevailing condition. We use this checklist in the context of Thiruvananthapuram (Table 4) and it is found that the city lacks in almost all fronts and urban water governance is yet to be conceived properly.

Table 4: Three layer model of governance and Position of Trivandrum

Layers	Questions	Trivandrum city
Content	*Do we have sufficient and relevant information? *Do we have the necessary knowledge and skills? * Is there a clear policy and planning for the water management?	*Partly *Yes *Partly
Institutional	*Are the roles and responsibilities clear? *Do we have the necessary tools? *Is functioning of the financing system ensured?	*partly *No *No
Relational	*Is the water policy well connected with other policy fields? *Are all stake holders involved in decision making in water management? *Is there transparency in water management? * Is there enough trust to work together?	* No *No *No *No

5.2 Decentralization and Urban Water Management

The 73rd and 74th Constitutional Amendment set the motion for decentralized government in the country. While 73rd amendment was for strengthening Panchayati Raj Institutions, the 74th amendment aimed to strengthen municipal level governance. The 11th and 12th schedules of 73rd and 74th constitutional amendments included water supply as one of the transferable responsibilities to LSGs. The Ministry of Urban Development (MoUD) initiated a series of institutional and financial reforms under this Act in an attempt to increase the efficiency of urban local bodies for service delivery. This Act also provided a basis for state governments to delegate responsibility to urban bodies for providing a host of services including water supply. The Kerala Municipality Act 1994 envisaged various reform activities covering transfer of certain institutions and also giving responsibility to prepare plans and implement those plans. Providing urban basic services, including water supply, sanitation, storm water drainage and urban roads (excluding those provided/maintained by the State Public Works Department) is one of those. Urban Local Body was expected to manage the "water regime" and provide water services. To facilitate this devolution the Kerala Water Authority (KWA) act was amended permitting any local governments to take over from KWA an existing water supply scheme or to establish a new stand-alone water supply project (Government of Kerala, 2009). However, so far no LSG has taken over any of the existing schemes from KWA, which continues to hold the responsibility for pipe water supply and sewage treatment. There are enormous challenges for implementing decentralization in water service delivery (Naster, 2014).

Despite all initiatives since 1992 Act and the introduction of People's Plan Campaign in 1996 (Thomas Isaac and Franke,2000) facilitating substantial decentralization and providing greater functional autonomy to municipal and local self governments, (Heller and Harilal, 2007), the centralized administration continues its hegemony in management of urban services. Continuation of central control through regulation and funding by the federal and state governments, inadequate capacity to perform decentralized functions effectively by local self government and non inclusion of the stake holders in decision making are some of the issues that hindered effective decentralized governance and required institutional changes (Naster 2014). The City Corporations and Municipalities operate within a policy framework designed at the state level and executed locally by the district collector. There is a tendency of recentralistaion of all urban services through various authorities and government departments, besides bureaucratic and technocratic apathy to devolve authority to the LSG institutions. Trivandrum Corporation is neither technically equipped nor hold the authority to manage the water regime. Redesigning of urban governance is considered a key element in effecting decentralization and improving basic services (Jacob, 2011). The elected urban local self governments are mere implementing agency with little scope for creativity. In this context the observation, "The Municipal governance in Kerala is seen by some state level elite as nothing more than a costly exercise in keeping the local government democratic" (Gopokumar, 2012) seems appropriate.

6.0 Coping with Future Governance Challenges

To cope with future water governance challenges we propose some structural/ institutional changes, which require legislative as well as technical interventions and people's participation at various levels, which are discussed below.

6.1 Polycentric Governance

Intra city variations, especially core-periphery differences in access to water services, growth of urban sprawl without commensurate increase of urban service facilities, encroachment and diversion of natural water bodies for other purposes, effluent discharge from urban settlement and other wastes, and allocation and reallocation of water between the city and the surrounding rural areas are the emergent issues of serious concern. The water resource base is shrinking, at the same time demand for water is increasing. The City authorities need to pay simultaneous attention to improve the existing water availability and to address the issue of sewage, respond to environmental problems like storm water management, quality deterioration of surface and ground water etc. The existing urban water governance has limitations to address these issues and a new governance system is necessary to cope up with future challenges. Lack of interdepartmental coordination has emerged as a serious impediment to integrate all three water service sectors.

In the macro scale, country level analysis, it was suggested that performance improvement requires polycentric structures, which creates possibilities to respond at different spatial scale as well as dealing with heterogeneity in impacts and capacities among different places and sub basins

(Pahl-Wostl, 2012). This is perhaps significant for Trivandrum city, however, the challenge will be how to evolve polycentric water governance structure both at the level of Karamana river basin and at the city level as the activities, priorities, actors and aspirations are different at these two levels. To initiate the process it is imperative to evaluate the nature of distribution of power among the State Government, District administration, Corporation and the surrounding panchayats in management of hydrological regime. Proper assessment of the interplay among different governance modes – line departments and bureaucratic hierarchies is also necessary. Differing power structures between the urban and rural areas within the basin and among various socio-economic groups within the urban and rural areas are important contending factors.

The most promising level of intervention is perhaps at the bottom, building local governance capacity and civil society through formal and informal process, and the lessons from the Jalanidhi experiment may be internalized in such an attempt. Participatory processes have great potential to integrate governance within and across scales, however, the power positions of actors at various scales influence the success of participation and therefore the scale perspective is an important issue in multi-level aspects of water management and governance in view of democratic legitimacy, efficiency and equity (Moss and Newig, 2010). Often the impediments of a bottom up approach are competing relations between formal and informal institutions, short sightedness at the local level and lack of technical support necessary to sustain the structures developed through informal process. There are several barriers including lack of involvement of all stakeholders, particularly from economically weaker groups, in the process of decision making.

To address these issues it is suggested to have multiple level interactions between governments and all other stake holders/ actors, all of whom must be drawn into continuous dialogue and negotiations, which may turn into conflicts and uncertainties. However all these as part of democratic water governance may progressively lead to concentrative process in order to reach some kind of agreement to move on to implementation and evolve an iterative multi-level governance processes that continually progress through social learning and create a broader conceptual space for wide ranging debate over urban water governance (Mirinda et al, 2011, Gupta and Pahl-Wost, 2013, Bakker, 2010). To facilitate this process and to evolve poly centric governance for water management in Thiruvananthapuram city a three tier activity level has been envisaged as elucidated here:

- Landscape level or macro level perspectives at river basin scale: The forces operative at this level are mostly ex-situ and beyond direct control of the city authority, however they need to be factored for urban water governance. This level consists of larger hydrological regime, climate change related aspects, demographic pressure, rural-urban water resource sharing, sustainability of resources, environmental dimensions and political economic issues linked to the national/ regional development domain. Governance at this level refers to the integration between river basin and the urban area.

- City region or regime level: This level concerns about the existing situation within the city. The institutional arrangements, prevailing technology, local users, customs, markets, local politics, rules and regulations as effective at the city level are part of this stratum. Governance at this level is essentially interdepartmental coordination, integration of service sector- drinking water, waste water, sewage and storm water drainage as part of an integrated water system, and integration of urban planning and water bodies through zonation of urban land scape.

- Local level or niche level: This level refers to the resident levels, which are building blocks. They act in micro scale and facilitate innovation. People are directly involved in action. The units are small and decisions are in the form of commonly agreed principles. Governance at this level is to ascertain direct involvement of local people, accord them ownership, honour local value system, internalize views of water user's group, which are mostly heterogeneous, nurture innovation and facilitate up-scaling of good practices.

Institutional repositioning is necessary both at the Karamana river basin level and at the City level to initiate the process to reorient governance system as proposed here. Water regime in Trivandrum city cannot be managed by the corporation alone in the present condition even if it is given all the required support-administrative, financial and technical, as provenance of the surface water courses and recharging area for ground water extend well beyond the jurisdiction of the Corporation. In view of this reality it is important to plan for the transition from KWA and or Corporation centric management to decentralized management and create necessary socio-political space for a wider debate involving all the stake holders and society at large.

6.2 Bringing Water Back to Urban life

An important way to evolve more integrated as well as democratic/participatory system of governance is to bring back water resources and water related infrastructure to the public sphere. One major reason for the crisis in the water sector is lack of social visibility of water resources and infrastructure in the urban areas. They are now dumped in the back yard of urban life, far removed from public gaze or intervention. Rivers and water bodies have turned into dumping grounds for urban waste of all sorts. They have also become sites of illegal activities such as brewing of illicit liquor, sand mining etc. As abodes of illegal gangs and waste dump river banks are not approachable, and usually do not attract people or even the media. In many locales, even the law enforcing authorities hesitate to visit these places. Obviously this was not the case in the past. Rivers and other water bodies occupied a pride of place in social life and public activities. As such they were remarkably visible. Water continues to be critical for daily life even today; but its sources have generally become too remote and obscure from everyday social life.

To accomplish this task of bringing water bodies back to the centre stage of public life it is necessary that people belonging to the Corporation Wards should engage in healthier competition to

take care of water bodies in the respective Wards. Students and institutions should be encouraged to participate in the integrated water management programme. There could be 'Know Your River/ Water Resources' campaigns to cultivate public interest in the rivers/ streams/water bodies. Research Institutions and the media may be encouraged to undertake periodic survey of the water bodies. The Water bodies should become public spaces like public parks that the locals proudly present to the visitors as examples of ideal river management and waste mitigation programme, and cleanliness.

6.3 Tax on Waste / Effluent Tax

It is also possible to have a system of incentives to promote best practices and disincentives to check activities that adversely affect water resources. Producing waste is not a crime; but not owning up is. An important idea that we intend to put forward in this connection is a local tax on waste generation. All big economic units should be encouraged to submit waste tax return every year to the local government. The returns should give a clear estimate on the generation of waste by the unit. It should also say how the waste is treated or disposed. Such a system of waste accounting will not only help mobilize resources; but in addition it would also act as a major disincentive for those who hide and take free ride on its disposal. Indonesia introduced a programme of voluntary disclosure of waste generation and environmental performance of the industrial units as part of river cleaning programme, which has been partly effective (Afsah et al., 1996).

Effluent tax, one of the economic instruments for environmental protection has been widely discussed in terms of impact and frequency of application (EEA 1996). The idea germinated in mid 1960s when there was proposal to study a tax-like system in which all polluters would be subject to effluent charges in proportion to their contribution to pollution (Boyd, 2003). From the environmental point of view, pricing pollution is useful to assess full social cost of polluting activities, besides, it can achieve something that is not possible through presently followed command-control system and technology centred practices. Case studies on effluent tax in Germany indicated that a policy mix consisting of regulatory and economic instruments can be very powerful in implementing and enforcing policies to address direct effluent emissions in water bodies and in this context, setting up of right incentive structure, which is often hampered by interest groups assumes significance (Mollur-Gulland et al, 2011). So far, eco-taxes have not been introduced in India, but there are deliberations to introduce environment taxes from time to time and the state of Karnataka introduced forest development tax and Sikkim collects ecology and environment tax (Verma, 2016). The Kerala State Environment Policy-2009 proposed introduction of polluters pay principle to create a separate corpus fund for meeting expenses exclusively to protect environment and tackle environmental hazards (Govt. of Kerala, 2009). The Working Group on Environment constituted by State Planning Board, Government of Kerala also suggested introduction of polluters' pay principle and collect eco-taxes. These proposals are yet to be implemented.

Implementation of effluent tax is fraught with various challenges. The first and foremost is about measurement of effluents. While measurement is somewhat possible for point sources, in case of

non-point sources, it appears not so realistic. Thiruvananthapuram city is primarily an administrative town with concentration of tertiary sector activities dominated by residential land use. Around 2 lakh households in the city produce waste water and therefore the sources are largely nonpoint. In such a situation the suggestion to impose tax on input resulting in pollution may be useful. Such practice is already in place in some of the European countries like Germany, where tax for waste water (waste water user fee) is collected at the same rate levied for water. Non-point source pollution and its pricing is a major issue throughout the World and has drawn considerable attention among the concerned academicians and policy makers. Besides, there are challenges of governance in introduction of effluent tax- institutional mechanism, execution, operation and utilization.

In India, there is paucity of serious studies on this issue. However, available studies on Forest Development Tax introduced in Karnataka and Ecology and Environment Tax introduced in Sikkim highlighted certain drawbacks related to project selection, transparency, technical expertise and monitoring mechanism while executing environmental safe guard projects for which these taxes were primarily introduced (Verma, 2016). All these issues will crop up in case of Trivandrum. Nevertheless the idea is significant and warrants serious considerations. With little effort effluent tax can be introduced in the urban areas at the household level. KWA manages water supply and sewage disposal in Trivandrum. As both the sectors are under single department it may not be difficult to administer this tax. However, the major impediment may be people's willingness to pay such tax. Massive awareness campaign at the Ward level may be required to take people into confidence and apprise them about the necessity to introduce waste water tax to serve the city better and proper provisioning for sewage management. A proper study can be initiated in Kerala to introduce this concept. The effluent tax generated at the local level as proposed in our study can be used for waste treatment and also to meet administrative costs for waste management as is being practiced in many of the developed countries.

7.0 Conclusion

Problem of water management in urban areas is a growing concern across the world and it is being stressed that the problems emanate not so much from resource scarcity but due to governance failure. Integrated Urban Water Management approach is being advocated as an alternative paradigm. This study covering the water management issues in Trivandrum city argues that there is need to reconsider the existing water management practices and posit urban water issue in the larger context of water regime management covering surface as well as ground water. The city is facing serious challenges. Due to growth of city there is already core-periphery differentiation in urban services. In spite of various augmentation plans there are limitations and unsuitability of networked supply of drinking water to reach all parts of the city. Technological approaches in water service delivery may not yield desired results. The poorer sections are often deprived which is partly geographical due to location and partly infrastructural. Non networked water supply alternatives, on which many people, both poor and non-poor, depend may be properly regulated; quality checked and developed to supplement the

pipe water supply. In many of the scarcity areas local ground water sources could be developed as alternative. Source sustainability is an emerging challenge as quality and quantity of surface and ground water are deteriorating alarmingly. The water management of Trivandrum city cannot be considered in isolation. The Karamana basin and the underground water regime cutting across administrative boundary may be considered. This will certainly call for interacting with the surrounding panchayats within the basin. Even within the city the fragmented departmental approach in handling different component of water is one of the impediments and the responsibilities are sometimes not well defined, particularly in storm water management. Instead of draining out storm water there may be provision to recharge ground water and store as part of rain water harvesting. This will also contribute to source sustainability. Use of various water harvesting techniques could be a viable innovative option and for which there is a need for suitable and facilitating institutional set up.

The real challenge in water governance is integration, rural urban or upstream downstream and inter-agency partnership and people's participation. Urban water is part of a total water regime and it cannot be governed in isolation and fragmented manner. Although the 74th Constitutional amendment and Kerala Government municipal Act created provisions for decentralization of water service delivery, in reality it has not been effective. There are bureaucratic-technocratic apathy and tendency to recentralize. Trivandrum Corporation has virtually no role in water management, be it drinking water, sewage or storm water. The Corporation is also not technically, financially and administratively equipped to perform any role. To face the emerging situation it is necessary to initiate reform of the existing public institutions, capacity building and restructuring of the institutions involving all stake holders across the society for managing all aspects of water through polycentric/ multilevel governance. This is important as there is a tendency already underway to involve private bodies to solve water shortage problem to overcome governance failure. The pressure will continue to grow with involvement of international funding agencies.

The experience of PPP is not without question. Water is a heritage resource and all citizens are bestowed with the right to water, therefore management of water should be through public institutions and through public utility services. There is a need for coordinated efforts of local people, civil society and political action which can create an arena to promote alternative visions of development in the water sector that are different from the existing practices. An important element of the new system of water governance would be to bring the water bodies to the centre stage of social and public life, so that their visibility is enhanced. It is also argued to have an appropriate system of incentives and disincentives to manage externalities related to water use. Focusing on bottom-up approaches it is necessary to explore the possibility of building continuous pressure and create socio-political space for such experiments. Adopting IUWM framework may open the opportunities to innovate new alternative however, the key elements are decentralisation, co-operation and participation. For which Kerala has successful niche experiments that may be up-scaled and improved through social learning and create a broader conceptual space to address the challenges of urban water governance.

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