

Legal and Governance Issues in Groundwater Abstraction: Rethinking the Institutional Framework for Sustainable Peri-Urban Water Transfer in Chennai, India

[S. PACKIALAKSHMI¹, N K AMBUJAM²]

Abstract—The increasing urban demand for water and insufficient urban water sources impose its sources expanding towards the peripherals and adjoining villages called peri-urban villages created the marketing mechanism. This is due to inadequate water supply provided by the government authorities. The rapid commercial and industrial establishments, degradation of water resources both surface as well as groundwater in the southern part of city faces severe water shortage. This leads to emerging informal groundwater market from the southern-peri urban villages. The prevailing peri-urban groundwater transfer for urban uses results in depletion due to overdraft and it impacts not only the peri-urban sources but the water rights and livelihoods of the peri-urban poor. This continual extraction causes insecurity and equity issues related to water in the peri-urban villages. This paper describes the existing water management scenario of Chennai Metropolitan Area and the various inequity and insecurity issues in the existing management. Furthermore, it suggests the options to promote the sustainable management measures in to the present pattern of management.

Keywords— Peri-Urban, Groundwater transfer(Water market), Groundwater, Equity of Water, Governance.

I. Introduction

Water is economic and community resource rather than natural resource. It has many dimensions like social, economic, cultural, ethnic and political. Rapid growth of urbanization leads to an increasing dependence on groundwater. This is particularly the case in India where groundwater has become the most important source of freshwater for meeting agricultural, drinking and industrial demands (Naik et al 2008; Meijer 2012). Dramatic increase in use has affected the groundwater resources in the country both in terms of quality and quantity.

S.Packialakshmi, Assistant Professor
Dept. of Civil Engg, Sathyabama University, Chennai
India

N.K Ambujam, Professor
Centre for Water Resources, Anna University, Chennai
India

The presented paper explores the need for an effective legal and institutional mechanism to ensure sustainable management of groundwater resources and to meet the challenges posed by urbanization, population growth, climate change etc. In this context, the present work proposes measures to regulate and manage groundwater. However, in order to ensure the success of any such proposed measures, it is necessary to understand the issues and then addresses the issues and challenges that impact groundwater use and management. However, the existing law, policy and institutional frameworks fail to ensure equity, sustainability and peri-urban water rights.

Providing reliable and adequate water supply involves many challenges to both local and national governments. Currently, some 30 countries are considered to be water stressed, of which 20 are entirely water scarce (Rosegrant et al 2002; Hadipuro and Indiriyandi 2009). According to National Water Policy, adequate drinking water facilities should be provided to the entire population both in rural and in urban areas and drinking water need should be the first charge on any available water. Chennai, one of the major metropolitan in India and the demand for water is increasing in a rapid manner. The water supplied by the local and state authorities cannot be kept pace with the swift increase of demand. Historically, the city's water security was assured by a network of tanks that stored rainwater and recharged the groundwater aquifers that serves as the primary sources of water for the city. This network has long since fallen in to decay. Most of the water bodies, watersheds and drainage courses have been built upon. The remaining turned in to cesspools of garbage, sewage and plastic wastes. Even though the rainfall is good in some years, Chennai faces the scarcity due to improper conservation strategies and huge amount of rainwater go waste as runoff to sea. Severe changes in land use prevent the water that percolate in to the soil and recharges the aquifer. According to Central Ground Water Board, more than 80 percent of city's groundwater resources are already being tapped and contaminated. The people depended packaged and mineral water for drinking purposes.

To meet out the urban need, formal and informal groundwater market is emerged in the peri-urban villages (Butterworth et al 2007). In the northern part of Chennai Metropolitan Area (CMA), groundwater market is prevailing by using the tremendous groundwater potential of Araniyar -

Kosasthalaiyar basin. Whereas in the southern part of CMA, the abundance of tanks and ponds recharges the groundwater which leads to informal ground water market to serve the city’s residential, commercial and industrial establishments. However, the quantification of this informal extraction is not possible; round the clock pumping depletes the ground water table. Groundwater depletion is caused not only by the informal extraction through water sellers; the packaged water industries also added the stress on the peri urban groundwater resources. The people’s dependency on packaged water induces the business of packaged water. The packaged water companies extract the huge quantity water with deep bore wells and submergible pumps. Existing shallow wells in the locality does not yield appreciable water for agricultural as well as the drinking purpose. Generally Chennai and its surrounding having hard rock terrain, the shallow water table depletion causes the wells abandoned. The deep bore wells and high cost pumps only extract the water for marketing purposes. In certain part of the villages, the deep bore wells yield the saline water and it affects the livelihood condition of people. It creates the water security and equity issues in the urban and peri-urban interface. This paper explains the present water management scenario of Chennai Metropolitan Area (CMA) and necessity of importing management and regulatory measures in transferring water from peri- urban village to urban areas.

II. Present Water Supply Scenario of CMA

Current approaches to managing water-related challenges are based more on catastrophic management than strategic planning that are considering long term issues to resources and livelihood impacts. Huge amount of funding are being spent annually on programmes of work that at best are providing impermanent solutions and are causing major harm to the resource base and the livelihood systems of people living in Chennai’s peri-urban areas and the more rural areas that are also being used as sources of water supply (Janakarajan et al 2007). Unavailability of potable water in the metropolitan area and lack of proper water management has left the Chennai Metro Water Board with no alternatives but to look outside the metropolitan for good-quality water resources (Srinivsan 2008). In Chennai, there is no perennial sources, extremely depend the irrigation reservoirs and lakes. The Chennai river basin consists of a group of small rivers such as the Araniyar, Kusathalayar, Cooum and Adayar Rivers. Earlier Cooum and Adayar Rivers supplied fresh water, nowadays they are act as wastewater carriers throughout the city. To meet out the increasing demand for water in the city, groundwater is extracted from northern and southern part of CMA. The distant sources from Veeranam (Cuddalore District) which is located 228 km south of Chennai and Krishna water from Andhra Pradesh over a distance of about 400 km is transferred to Chennai city. But these sources are not reliable. Under this background the government has implemented an option of

Desalination as an alternate and exclusive source of water supply.

III. Critical Assessment of Present Water Supply System

The north east monsoon and surface runoff from the Araniyar and the Koratalaiyar river basin replenish the Poondi, Cholavaram and Redhills reservoirs which are greatly rainfall dependant. The estimated sustainable yield from this basin is 100 Million Cubic Metre (MCM) but the current total extraction is 300 MCM per year, three times the sustainable yield. This over extraction from the A-K basin leads to sea water intrusion in to the aquifer and shortage for local users (Sprenger et al 2014). In this area, groundwater levels are steeply declining makes the water turning to saline. It affects the local people to meet their drinking need and they are forced to dependent on the packaged water. The present water requirement of the city and its urban agglomeration is estimated as 1481 Million Liters per Day (MLD) at 140 lpcd by the year 2011 (Table I).

TABLE I PROJECTED WATER DEMAND FOR CMA

Area	Water Demand in MLD		
	2006	2011	2021
Chennai City	861	924	1012
Industries	100	150	250
Adjacent Urban Agglomeration	249	281	344
Distant Urban Agglomeration	113	126	157
Total	1326	1481	1763

According to the Metro water, the projected demand in the year 2021 will be around 1763 MLD. The fact is recent supply nowhere to meet not only the projected demand but the existing demand also. The extraction in the southern belt is also causes serious threat to groundwater which turns to saline (Lodhia, 2006). By considering the issue, now the government implements a ban on extraction of groundwater in a Coastal Restricted Zone (CRZ).

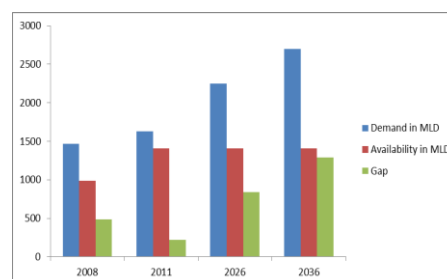


Figure 1. Demand and availability of water in CMA

Chennai Water Supply and Sewerage Board (CMWSSB) have recently passed through a water shortage of unprecedented magnitude. For example, in the year 2003,

against the estimated requirement of CMWSSB for the city alone of around 800 MLD, the supplied water is only 205 MLD by the CMWSSB. Of this, around 150 MLD is supplied to residential purpose and the remaining for industrial and commercial purposes. Figure 1 shows the unabridged gap between supply and demand status of Chennai city and the necessity of improved water management for CMA.

Whatever the modification strategy initiated in the last two decades, of the many problems characterizing the water crisis, four stand out: i) The issue of a significant and growing section of marginalized people being excluded from provision of water service ii) The continued prevalence of inequity in the distribution of water iii) The problem of water sustainability covering the entire range of water management issues from effective management of water sources to conservation and preservation of water bodies and sources. iv) An uninvolved technocracy with an entrenched mind set (Vibhu Nayar 2006 ; Shah et al 2004). To provide the sustainable solution for existing pattern of management by introducing any water sector reform, these four critical issues need to be addressed.

iv. Peri-Urban Water Transfer for Urban Uses

Most of the agricultural wells in the peri-urban villages act as an important source of the water market, and groundwater is commercially transported through water containers called tankers. About 1200 water tankers were observed per day from the southern peri-urban villages alone and the total estimated quantity is 17.1 MLD. There are 48 packaged water companies in and around the water marketing villages, which are extracting a huge amount of groundwater and discharging the rejected water in the nearby agricultural lands without any appropriate safety measures (Packialakshmi 2011). The study conducted by Srinivasan (2008) showed that between a third and two-thirds of the water supplied to consumers was from non-utility sources.



Figure 2. Movement of peri-urban groundwater towards Chennai city (Sreenivasan 2008)

According to Vaidyanathan (2007) two thirds of Chennai city's domestic demand is met by groundwater. Figure 2 shows the direction of the marketed water movement from the peri-urban interfaces to urban Chennai. The dynamic groundwater market is taking place from the northern, western and southern peri-urban villages and the areas are affected due to scarcity of water in terms of quality and quantity (Packialakshmi et al 2012)

A. Social Equity

The huge gap between demand and supply of water and monsoon dependent surface water resources convey the necessity of groundwater transfer from the peri urban villages. Informal and formal water transfers deplete as well as degrade the surface and groundwater resources. It leads to decline the agricultural activities in the peri urban area (change of attitude) and creates the drinking water scarcity in the village. The situation has forced to people to buy packaged water otherwise people go a long distance to fetch the good quality water or consuming marginal quality water. It leads to health related issues on these areas. Nowadays this transfer is not only for meeting the domestic requirement of urban people and for commercial and industrial establishments also. Thus the way the term of social equity get distorted and the unbalanced situation is created between the livelihood options and resource base with the urban need of water.

B. Economic Efficiency

The opportunity cost of these water transfers are declination of agricultural activities and manmade scarcity of drinking water due to water table depletion and changes in water quality in the peri urban villages. Earlier, groundwater resources considered as unpolluted resource than the surface water because of natural filtration through the process of infiltration and percolation. Now the people's attitudes changed towards the packaged water or mineral water according to the affordability. All the people irrespective of their economic status have spent money for water which incurs the additional expenditure. Medavakkam, one of the village situated in the southern side of Chennai city from where more than 200 loads of water (200x12000 litres) transferred to Chennai city for residential, commercial and industrial purposes (Informal water business). Discussion made with the villagers clearly indicated that water level depletion and the necessity to go for deep bore wells added an additional burden to the people. Thus the transfer of peri-urban water for urban uses aggravated water related stresses and it questioning whether the peri-urban sources are surplus in their locality. According to the CMWSSB Report, more than 1000 Crores are spending for distant sources as well as desalination process. These distant sources may create conflicts issues and in the case of desalination, arguments are going among the environment experts and social activists.

C. *Institutional roles*

The institutional frame work is necessary to improve the effectiveness of water resources management. A key issue is the creation of effective co-ordination mechanisms between different agencies. Flawed coordination and demarcation between the different governmental agencies such as Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), The Pollution Control Board (TNPCB), Agricultural Engineering Department (AED), Public Works Department, Central Ground Water Board, State Ground Water Board, Irrigation Department, Chennai Metropolitan Development Authority, Ministry of Environment and Forestry, Slum Clearance board etc. is the main obstacle for implementing the regulatory measures. Chennai, historically, possessed so many lakes and tanks. At present most of the water bodies are built up and destroyed due flawed demarcation of concerned agencies. Land use change detection study during the period 2004-2008 for Chennai Metropolitan Area stated that area of water bodies has been reduced from 21.94 sq.km to 17.56 sq.km (Packialakshmi et al 2010). It is due to the increase in population, unplanned residential and industrial development towards the peri-urban area. Most of the water bodies are encroached by the slum dwellers and eviction also creates the severe political disturbances. Thus the vacuum between policy formulation and implementations necessitates the revisiting of existing measures to prevent further worsening of existing situation.

D. *Governance Issues*

Groundwater governance has been defined as: the process by which groundwater resources are managed through the application of accountability, involvement, information availability, transparency, and rule of law. It is the practice of coordinating administrative actions and decision making between and among different levels – one of which may be global (www.groundwater-governance.org).The emerging groundwater market requires the support of governments to provide the legal, social, and economic environment, in which trade and competition can flourish, and mechanisms will also be needed to ensure that trading does not impose external costs on other water users including the environment. The governance in the peri-urban interface tends to be severely uneven, with a multitude of sectors, and no single organization providing guidance and leadership. The Chennai Metropolitan Area Ground Water (Regulation) Act, 1987, and the Tamil Nadu Groundwater (Development and Management) Act, 2003 for the whole state of Tamil Nadu have given the direction to regulate, control, and conserve the groundwater. Most of the peri-urban water marketing villages are listed under these notified villages. But the governing authorities find it difficult to control or regulate the prevailing informal mechanism, since water rights in India is attached with land

ownership and it aids in minimizing the risk of water accessibility which serves to bridge the supply–demand gap (Mukherji and Shah 2005). Hence, the prevailing informal water market can be institutionalized through effective regulatory and legal mechanisms or by appointing apex body to regulate the entire process; in this way, traditional users can protect their resource base, and enhance the environmental sustainability.

To provide an enabling environment, such as a formal and controlling mechanism, an attitudinal change of all levels of authorities and stakeholders, and political will without considering any self-benefit, is essential. The awareness programs, media influences, participation of stakeholders at all stages to protect the resources, and better data base management for micro level studies, may provide an enabling environment for both the policy makers as well as the users. The reappraisal of a hydro geological survey, micro macro level basin studies, vast data base management, and formulating an effective monitoring body are indispensable to monitor as well as manage the groundwater resources successfully.

V. **Conclusion**

The existing approaches of water management in the CMA are obviously deviated to promote the water security and equity. Transfer of water from the surplus to scarce region is not the problem. But the transfer should not create any societal, economic and environmental impacts on the region. The peri urban villages are under stress as they are in the proximity to the city. The land and water resources are highly utilized for urban uses. Intensive use of groundwater can continue to play a major role in the development of urban areas, but new technologies and judiciously planned management and protection strategies are required to increase water supply, reduce demand, and make more efficient use of the available resource. The knowledge gap between the affected people, selling entrepreneurs and regulating bodies can be mitigated by providing secured platform such as conducting stakeholders' meeting involving all influencing groups in the entire water marketing processes. By considering the above facts related to water supply-demand management, alternative strategies like water marketing by private entrepreneurs should be researched for effective monitoring and regulative purposes.

Revitalization of traditional water bodies and monitoring authority with empowered stakeholders and local community play a major role in the water management system. It will reduce cost of augmentation of distant and temporary sources. Reappraisal of hydro geological surveys and intensive data base management of water resources for both surface water and groundwater is mandatory to frame the effective legal framework. Out of this, some of the saline points those

are important to provide effective and sustainable water management system.

1. Creating a data base on water resource availability and quality, watershed planning based on local water resources including rejuvenation of traditional harvesting systems. This would include aquifer recharging and ecosystem restoration
2. Identifying inter-sectoral demands and use and promoting community involvement in managing services
3. Identifying management measures including augmentation of local sources within the Chennai basin. The measures include i) maximizing rainwater harvesting from public areas and in built up areas ii) increasing storage capacity of surface tanks iii) recharge of known and new aquifers iv) recycling of black and grey water v) reduction of loss through evaporation vi) cutting down transmission losses and other avoidable losses at the consumers' end vi) metering of all apartments and vii) restructuring of tariff.
4. Provision of integrated sewerage systems for the urban as well as peri-urban local bodies that are contiguous to each other should be planned so that the sewage generated from more than one local body can be treated in a single sewerage treatment plant.
5. Greater consideration should be given to reuse of waste water and reduce the fresh water demand
6. Formulating a policy framework, enacting enabling legislation and establishing a regulatory mechanism for promoting the ensured supply and equity of water.

Acknowledgment

This research was funded and supported by Wageningen University, Netherlands, under the Crossing Boundaries (CB) Project. The authors sincerely thanks the South Asian Integrated Water Resources Management Consortium (saci WATERS), Hyderabad, coordinator of the CB project for providing the necessary support and fellowship to complete the present work.

References

- [1]. Hadipuro, W. and Indriyandi, N. Y. "Typical urban water supply provision in developing countries: a case study of Semarang City, Indonesia", Water Policy, Vol.11, pp. 55-66, 2009. Janakarajan S, Butterworth J, Moriarty P, Batchelor C Strengthened city, marginalised peri-urban villages: stakeholder dialogues for inclusive urbanisation in Chennai, India. Delft, the Netherlands, pp 51-75, 2007.
- [2]. John Butterworth, Raphale Ductor, Nicolas Fayasee and S. Janakarajan, "Peri-Urban Water Conflicts, Supporting Dialogue and negotiation", Technical Paper series 50, IRC International Water and Sanitation Centre, Delft, The Netherlands. 2007.

- [3]. Lodhia S. Management Of Groundwater Resources Through Community Participation Approach In The Coastal Saline Region Of Gujarat, Working Paper 12.Centre For Development Alternatives, Ahamadabad, India 2006.
- [4]. Mejer P Access to Groundwater Case study on extraction of groundwater in the A-K basin in the north of Chennai, India, Master Thesis, Law and Governance Group, International Development Studies, Irrigation and Water Engineering Group, 2012.
- [5]. Mukherji A, Shah T Groundwater socio-ecology and governance: a review of institutions and policies in selected countries Hydrogeol J 13:328-345, 2005.
- [6]. Naik P.K, Jivesh A. Tambe, Biranchi N. Dehury, Arun N. Tiwari Impact of Urbanization on the groundwater regime in a fast growing city in central India, nvironmental Monitoring and Assessment, Volume 146, Issue 1-3, pp 339-373, 2013.
- [7]. Packialakshmi S Ambujam N. K Prakash Nelliyyat P Groundwater market and its implications on water resources and agriculture in the southern peri-urban interface, Chennai, India, J. of Env. Dev and Sustainability, 13 (2), 423-438, 2011.
- [8]. Packialakshmi S, Ambujam N K A hydrochemical and geological investigation on the Mambakkam mini watershed, Kancheepuram District, Tamil Nadu, J. of Env. Monitoring Assessment, May;184(5), 2012.
- [9]. Packialakshmi S, Ambujam N K, Mahalingam Emerging land use changes and their effects on groundwater; A study of the Mambakkam mini watershed, southern suburban area of Chennai, India, J.Env. Research and development, Vol 5 ,No. 2, 2010.
- [10]. Rosegrant, M. W., Cai, X. and Cline, S. A. "Averting an Impending Crisis", Global Water Outlook to 2025, Food Policy Report, International Water Management Institute (IWMI), Colombo, Sri Lanka, 2002.
- [11]. Shah T, Giordano M, Wang J Water institutions in a dynamic economy: what is China doing differently from India? Econ Political Weekly 39(31):3452-3461, 2004.
- [12]. Sprenger, C. Parimala Renganayaki, S Schneider M. and Elango L Hydrochemistry and stable isotopes during salinity ingress and refreshment in surface- and groundwater from the Arani-Koratallai (A-K) basin north of Chennai (India), Environmental Earth Sciences, 2008.
- [13]. Srinivasan, V. "An Integrated Framework for Analysis of water Supply Strategies in a developing City, Chennai, India", Published Ph.D Thesis, Stanford University, Australia, 2008.
- [14]. Vaidyanathan A India's Water Resources- Contemporary Issues on Irrigation, Oxford University Press, pp. 15-22, 2010.
- [15]. Vibhu Nayar, "Democratization of Water Management: Establishing a Paradigm Shift in Water Sector", The Tamil Nadu Experiment with Governance Reform. http://www.undp.org/water/about_us.html 2006.
- [16]. www.groundwatergovernance.org



Dr.S.Packialakshmi was born on 7th March 1978. She completed her Bachelor Degree in Civil Engineering from Bharathiyar University, Coimbatore and her post-graduation and doctoral research at college of engineering, Guindy. She obtained SAWA fellowship from Netherlands. Her research interest includes water resources development, management, and rural land and water issues.



Dr.N.K Ambujam Prof. N K Ambujam, Director, Center for Water Resources, Anna University at Chennai, India. Her research interest includes agriculture, irrigation water management and waste water reuse