Sewage reclamation meets industrial water demands of Chennai

By Kurian Joseph and C. Visvanathan

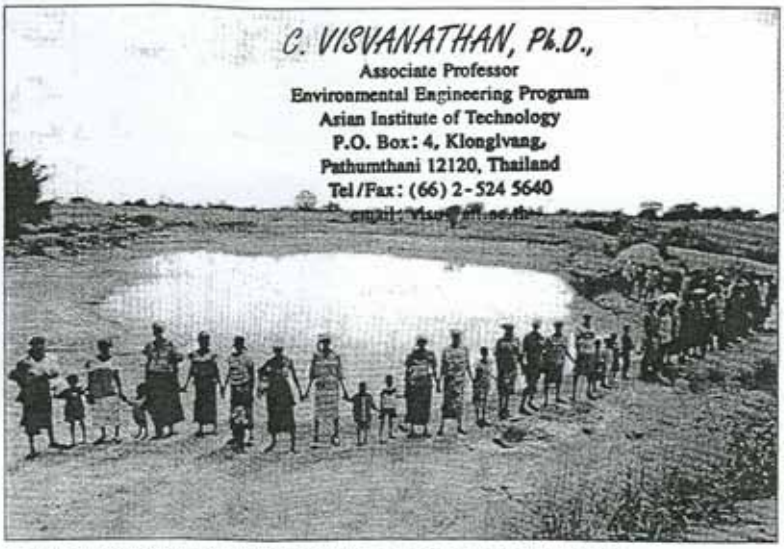
Chennai, formerly known as Madras, is one of the four metropolitan cities of India. It is the fourth largest Indian city and the capital of the State of Tamilnadu, located on the eastern coast of India. Increasing water scarcity for both domestic and industrial use has forced many industries to search for alternatives. Sewage reclamation is a cost-effective alternative that has proved successful.

The metropolitan area of Chennai, India is generally flat, with scanty rainfall, without any major watersheds or rivers, has always been faced with a water shortage problem. Many of the urban environmental problems in Chennai are due to the rapid population growth and consequent intensification in the already built-up parts of the city and spontaneous expansion of the urban area into the rural fringe. In line with the urban growth, the industrial activities have also mushroomed within the metropolitan area leading to water pollution problems and the excessive extraction of groundwater.

'the current water supply is only about 250 million litres per day (mld) as against a demand of about 600 mld'

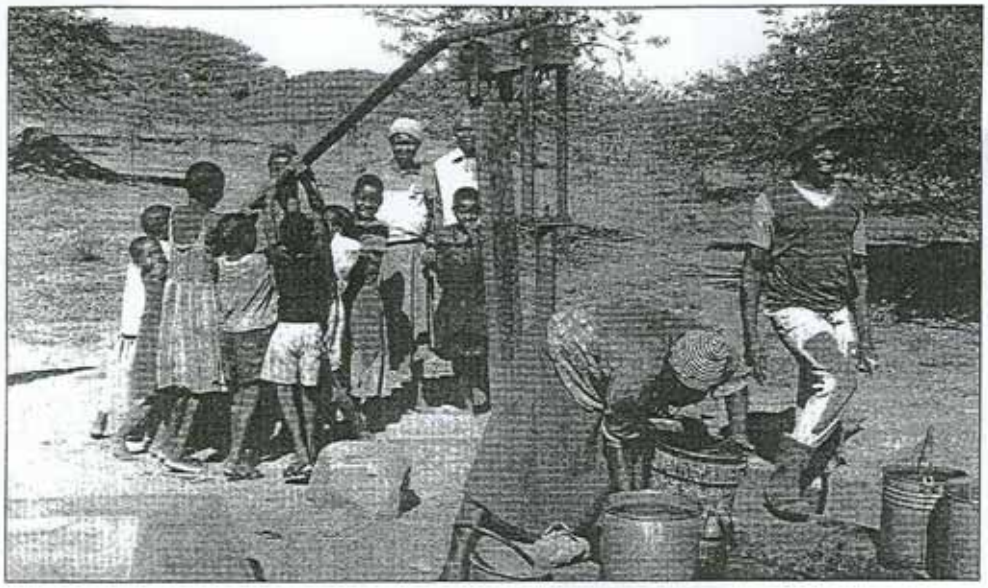
The city is spread over 172 km² with a population of 3.9 million in 1991 that has almost doubled in the past ten years. As a result of the population increase, economic liberalization and industrial growth, the urban life in Chennai is drastically changing and the city civic services, including the water supply system, are being overstrained. Wastewater reclamation is of particular importance to cities like Chennai where the current water supply is only about 250 million litres per day (mld) as against a demand of about 600 mld including 150 mld for industrial activities. The public water supply source of treated surface water from the monsoon-fed reservoirs located nearby, is considered by industries as expensive and unreliable, thus often maintaining groundwater wells as a major alternative source. Today approximately 50 percent of the city's water demand is met by groundwater. Frequent monsoon failure has resulted in acute water shortage and erratic supply for public needs. Due to the local political and social pressures, water supply has often been cut off to the industrial sector, so that the piped water could be diverted for city's public use.

Replenishment of groundwater is affected by the city's topography and the



Mark Edwards/Still Pictures

Rainwater harvesting like this in Burkina Faso has not been considered as an option in Chennai



Excessive groundwater pumping has, in many areas resulted in either the intrusion of either salt or pollution

poor management of water source recharging. Concerned water management agencies have not focused on the possibility of rainwater harvesting, and groundwater replenishment. The local monsoon rainfall, where 80 percent of the rain falls within a short period one to two months per year is discharged directly into the sea. The excessive groundwater pumping has already resulted in significant salt-water intrusion, making it unacceptable for many industrial and domestic uses. For the past 15 years, this change in the water supply pattern has forced industries to investigate alternative options of water sources. Although systematic reuse of treated water has not been commonly adopted by the industries, in the recent years there is a significant interest from the government and industrial sector to explore its potential to avoid any future water scarcity problems. Three major industries in the city are already reclaiming about 35 mld water from the city sewage and their experience indicates that reclaimed water is cheaper than the industrial water supply.

'Three major industries in the city are already reclaiming about 35 mld water from the city sewage'

Wastewater reclamation

Wastewater reclamation is the treatment or processing of wastewater to make it reusable for a direct beneficial use or a controlled use that would not have otherwise occurred. As droughts and population increase continue to stress the availability of fresh water supplies, reuse of municipal and industrial wastewater and desalination of brackish waters will play an ever-increasing role in helping to meet water demands. In many of the countries wastewater reuse is already an important element in water resources planning.

Wastewater reclamation has proved valuable in Chennai in various ways, some of which include:

- Water-intensive industries are able to operate continuously, in spite of water shortages, protecting production and employment
- An equal amount of water is made available for domestic supply to the city residents
- It provides a strong motivation for keeping the waste treatment plants in operation all the time and thus controlling the environmental pollution
- It enables municipalities to generate revenue by 'selling' their sewage
- It provides opportunities for 'privatization' in water and wastewater management

The Chennai experience

The two possible and reliable alternative water sources available for the industries in Chennai are:

- Seawater desalination
- Reclamation of the city's sewage

Due to higher capital investment and higher lead-time to start such a project, seawater desalination projects are not favored by the private industrial sectors. Based on the cost comparison, reclamation of city sewage was found to be more economical.

The municipal sewage in Chennai is highly concentrated due to its poor water supply situation, with a BOD of about 500 to 650 mg/l. The total dissolved solids (TDS) is also high (about 1000 to 2000 mg/l) due to dependence on private water supplies from highly brackish bore wells. In recent years there has been considerable development in water and wastewater treatment technologies and the objective of water and wastewater treatment has also been expanded from traditional emphasis on organics and suspended solids removal to the new objectives of removal of dissolved inorganic salts, toxic

chemicals and fine solids. Conventional processes are costly and space consuming and not capable achieving these objectives. In this context, membrane processes such as micro filtration, ultra filtration, reverse osmosis, electro dialysis and membrane reactors are becoming more attractive in the field of wastewater reclamation and reuse. There is a tendency towards the application of membrane processes directly or combined with biological treatment processes for the treatment of wastewater.

The Orange County Water District, sewage reclamation project (Water Factory 21) in Southern California, USA is the first reported large-scale reclamation project. Even in this project the treated effluent is mainly used for groundwater recharging as a saltwater barrier system. Following this example, the city of Chennai has taken the lead in this direction by having large capacity sewage reclamation plants in Asia. Here industries such as Madras Refineries Limited (MRL), Madras Fertilizers Limited (MFL) and GMR Vasavi Power Corporation Limited (GMR) have set up their own sewage reclamation plants. Such plants have ensured sustainable water supply for these industries and made available an equal quantity of water for domestic use in the water-starved city.

Manali Industrial Estate is the second biggest petrochemical complex in India, and the fifth in Asia, where both MRL and MFL plants are located. Considering the water scarcity problem, these two industries responded by developing a sewage reclamation strategy in early the 1990's. The wastewater reclamation plant at MRL, in operation since 1991, is of 12 mld capacity and that of MFL commissioned in 1992 reclaims 16 mld sewage. Both these industries receive secondary treated sewage from Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) for further treatment and reuse at their premises. Both these plants were originally designed to obtain the treated effluent from the municipal sewage treatment plant located at Kodungaiyur. However, due to the characteristic of the city sewage and the operational problems, often the BOD of the secondary treated effluent could be as high as 120 to 200 mg/l. This inconsistency in the treated sewage from CMWSSB created significant operational problems at the reclamation units, which was overcome by adopting another level of extensive secondary treatment at the industry premises.

Based on the experience of the MRL and MFL reclamation plants, GMR designed its reclamation units, by directly purchasing 7.5 mld of raw sewage from CMWSSB, and carries out the primary, secondary and tertiary treatment within its premises. The GMR reclamation plant is under operation for the past two years, without any major operational hurdles.

The treatment scheme followed by these industries in Chennai includes biological treatment to remove the residual BOD in the incoming sewage; chemically aided settling; pressure sand filtration; ammonia stripping; carbonation; breakpoint chlorination; multimedia filtration; dechlorination; catridge filtration and pressurized by high pressure pumps (15 to 18 kg/cm^2) and the delivery to three train Reverse Osmosis (RO) units for desalination before reuse. Reverse Osmosis (RO) is a pressure-driven membrane filtration process and the permeate from the RO is used for reuse as cooling water makeup. In the early 1980's many water treatment experts considered RO as an expensive alternative. They did not have the practical know-how to

Waste water can be treated in a number of ways. This is one example from Malaysia

Mark Edwa... ll Pictures

about the authors

Kurian Joseph is a Senior Lecturer at the Centre for Environmental Studies, Anna University, India. He can be contacted via email at: kuttiani@vsnl.com

C. Visvanathan is an Associated Professor at the Urban Environmental Engineering and Management Program of Asian Institute of Technology, Bangkok, Thailand. He can be contacted at: P. O. Box 4, Klong Luang, 12120 Pathumthnai, Thailand. Or via email at: visu@ait.ac.th

handle many of the operational problems associated with sewage effluent containing organic foulants, which led to the biofouling on the membrane surface. But today, with the wider application of membrane technology in many industrial applications, the membranes are available at 25 to 30 percent of its 1980's cost.

The capital costs of each of the wastewater reclamation plants were about Rs.250 million and the operating cost, including the cost of about Rs.5 per 1000 litres for supply of sewage by CMWSSB, is reported to be about Rs.35 per 1000 litres as compared to Rs.60 per 1000 litres for freshwater supply to the industries.

Chennai as a leader

Continued population growth, contamination of surface and groundwater, uneven distribution and exploitation of water resources and periodic droughts are forcing water agencies and industries to search for innovative sources of water supply. Use of highly treated wastewater effluents, now discharged into the environment from municipal wastewater treatment plants, is gaining more attention in industrial and domestic water supply sectors. Three major industries in Chennai are already reclaiming about 35 mld of water from the city sewage and their experience indicated that reclaimed water is a cheap and sustainable source of industrial water supply and it is expected that many will follow suit. These industries have taken the initial step of venturing into this new field sewage reclamation, and adopting membrane technology to and proved that both technically and economically, such alternatives are very attractive. It is interesting to note that these industries have accumulated high technical skills to adopt such large-scale reclamation projects. CMWSSB, the agency responsible for the city water supply, have plans to set up similar large-scale plants in the near future to meet major part of the city's non-portable water application. Thus, today Chennai could be considered as the Mecca of water reclamation, where many of the Asian urban cities could learn how develop a more viable alternative.