SUSTAINABLE DEVELOPMENT OF WATER RESOURCES IN URBAN AREAS

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Abstract *Appropriate water resource management is essential for the sustainability of the human race. It is necessary to ensure equitable access to water for all human beings, through protection, conservation, diligent consumption and recycling. In India, the statistics indicate a scenario of deprivation for a vast majority of citizens on the fronts of water supply and sanitation. The resources requirements in bridging the gap are also staggering and beyond the capacity of the state finances calling for private sector involvement. Appropriate water resources management involves conservation of available resources, tapping of alternate sources, equitable distribution, sustainable strategy for service delivery etc. taking recourse to advance tools and technologies. The major initiatives identified towards this end include storm water harvesting, aquifer recharging, macro watershed management, recycling of water with specific reference to rootzone treatment, resource mobilisation and public-private-people's partnerships. The role of HUDCO is also discussed in ensuring sustainability of water supply schemes and conserving the scarce resource for the future generations.*

GLOBAL TRENDS IN WATER SUPPLY AND SANITATION SECTOR

Water, apart from being a basic need, has been the key to the development of the ancient civilisations. Hence, the issue of appropriate water resources management has raised an integral question in the sustainability of the human race. Recognising the need for an integrated approach to the provision of those environmental services and policies that are essential for human life, the 'Global Plan for Action: Strategies for Implementation', urges the governments at the appropriate levels, in partnership with other interested parties, to ensure that clean water is available and accessible to all human settlements through the adoption of improvement of technology, and ensure that environmental protection and conservation plans are designed and implemented to restore polluted water systems and rebuild damaged watersheds.

Emphasising the need for a strong political commitment, the Habitat Agenda Stresses the need to pursue policies for water resources management that are guided by the broader consideration of economic, social and environmental sustainability of human settlements and establishment of strategies and criteria to preserve and restore aquatic ecosystems in a holistic manner, giving due consideration to the carrying capacity of entire drainage basins and the living resources contained therein. It also recommends the promotion of partnerships between the public and private sectors and between institutions at the local so as to improve the allocative efficiency of investments and increase operational efficiency. With regard to the institutional mechanisms, it impresses to implement the institutional and legal

reforms necessary to remove unnecessary overlaps and redundancies in the functions and jurisdictions of multiple sectoral institutions and to ensure effective coordination among those institutions engaged in the delivery and management of services. It advocates for the introduction of economic instruments and regulatory measures to reduce wastage of water and encourage recycling and reuse of wastewater and to develop strategies to reduce the demand for limited water resources by increasing efficiencies in the agriculture and industrial sectors. It also emphasises the need to involve women in decision-making process in regard to management of infrastructure systems at large.

WATER SUPPLY AND SANITATION SCENARIO IN URBAN INDIA

Water, forming the lifeline of any society, plays a critical role in any country's welfare with imminent linkages to most aspects of its economics development. Water supply and sanitation play a major role in ensuring the health of its residents in urban areas. In India, inspite of substantial emphasis on the water supply sector, only about 82% of the urban households had access to safe drinking water as of 1991. Against this overall coverage, estimates also indicate that in 1988-89 about 58% of the urban households had access to drinking water facilities within their premises and about 40% with in a distance of 0.5 Kms. Even the above statistics do not reflect the true conditions as there exists substantial distributional inequity among the states, between the cities and even between the different localities within each settlement. Against the national average target of 135 lpcd of water and 180 lpcd percapita in larger cities, the per-capita availability is low and ranges from 165 lpcd in a few larger towns to about 50 lpcd in most smaller towns. The availability of water in the urban slums was around 27 lpcd.

While the provision of drinking water facilities has been on the agenda, the provision of sewerage and drainage facilities has not received adequate attention. The status of sanitation in urban areas is even worse than the water supply scenario. Sewerage systems were not yet accessible to 54% of the urban population and refuse collection and disposal had yet to reach 28% of the population, as per 1991 census. Toilets were not available for close to 31% of the urban population. Out of more than 3500 urban areas in India only 200 towns have a sewerage system, even these covering only parts of the urban areas served. Moreover the systems are in many cases old and need repairs, upgradation, rehabilitation and replacement.

INVESTMENT REQUIREMENTS FOR WATER SUPPLY AND SANITATION

Though the Plan provisions for Water Supply and Sanitation Sector have steadily increased from 0.65% of the total outlay in the Second Five Year Plan (1956-61) to 1.18% in the Seventh Five Year Plan (1985-90), these provisions have been found to be grossly inadequate. As a result, in urban areas against the target of achieving 100% coverage (which was subsequently scaled down to 90%) with safe

drinking water and 75% (which was subsequently scaled down to 50%) with sanitation during the International Drinking Water and Sanitation Decade (1980-90), the coverage achieved in urban areas was only 85% with safe drinking water and 45% with sanitation. The massive investments required being beyond the scope of the Five Year Plans, innovative financing strategies need to be taken up to make Plan funds act as a leverage instrument to increase fund flows from the private sector accompanied by full cost recovery strategies.

The financial resources required to achieve 100 % coverage with safe drinking water and 75 % with sanitation are massive and call for capital and recurring investments of very high order. The Planning Commission has estimated additional investment needs for water supply and sanitation for the period 1997 to 2001, to be about Rs. 51,284 crores. The Rakesh Mohan Committee's India Infrastructure Report had estimated a requirement of Rs. 69,670 crores to address the backlog up to 1995, an additional investment of Rs. 8612 crores during 1996-97 and an additional investment of Rs. 7738 crores during the period 2001-06. Similarly, the requirements for Sanitation has been estimated to be of the order of Rs. 52,860 crores to cover the backlog till 1995 and an amount equivalent to the corresponding investments in water supply from 1996-97 and further from 2001-06.

STRATEGIES FOR WATER RESOURCE MANAGEMENT

The path to water resource management in urban areas involves conservation of available resources, taping of alternate sources, equitable distribution, reduction of wastage and leakages, improving the sustainability through unbundling and appropriate pricing, involvement of private stake and beneficiary participation, Watershed planning, audit and resource-sharing with the use of remote sensing techniques and information technology etc.

RAIN WATER HARVESTING FOR CONSERVATION OF WATER RESOURCES

The fall in ground water table has been affecting many parts of the country, increasing the severity of the drought conditions in many parts of Rajasthan, Gujarat and Madhya Pradesh. The onus of rapid fall in water table has been put on over exploitation of ground water resources by excess withdrawal, estimated to be of the order of 60% in Tamil Nadu and 53% in Rajasthan.

Ground water is a valuable economic commodity and to avoid its depletion, measures to recharge the aquifers should be extensively practiced. There is an increasing need to adopt rain water harvesting methods to adequately recharge the aquifers. In the water starved city of Chennai, people resorted to rain harvesting in a big way during the North-East monsoon in 1993 following acute scarcity preceding the monsoon. The rainwater was collected in ground level sumps, which was subsequently used after filtering and boiling. A number of voluntary organisations took the case for wide adoption and today incorporation of provisions for rain water

harvesting and aquifer recharging is mandatory for approval of building plans by the Chennai Metropolitan Development Authority.

Terrace or Roof-top Collection for Individual Buildings

For ordinary buildings of ground plus one floor, requisite percolation pits filled with broken bricks and sand on top, have been prescribed. Percolation pits 30 cm. in diameter and of 3 m depth are dug all around the plinth of the building at an interval of 3 m. The pits are filled with broken bricks and packed with sand for the top layer of 15 cm. The rain water collected at the open terraces or roof drains is led into the percolation pits for subsequent use. Dwarf walls 7.5 cm high are erected to confine the harvesting area to facilitate recharge. It has also been prescribed for all air-conditioned buildings to have their own waste water reclamation plant and for using the reclaimed waste water for cooling purposes.

Pebble Beds for Apartments and Building Complexes

For larger buildings, pebble beds filled with rounded pebbles are to be constructed all round the buildings and the concrete paving around the building is given necessary slope so that the rainwater from the terraces and other open spaces flow over these pavements and gets collected in the pebble beds around. On the inner periphery adjoining the compound wall, 1 meter wide pit is dug to a depth of 1.5 meters and filled with pebbles of nominal size 5 to 7.5 cm. The rainwater falling on the terraces is allowed to percolate through these pebble beds.

Aquifer Recharging through Ponds or Ditch and Furrow Storage

The collected rainwater may be led to open ponds with pervious layer for recharging the ambient ground water table. Alternatively, the water may led through a ditch or canal to areas of favourable sub-surface soil characteristics, desirably sandy in nature, to allow percolation.

Percolation Wells

Where hard subsurface strata does not permit percolation, infiltration wells may be dug to penetrate the impervious layer. The rain water collected from the terraces and the surface runoff may be let into these wells through a sandy bed acting as filter.

SHANTIGIRI ASHRAM: A PIONEER IN STORM WATER HARVESTING

A substantial emphasis is being laid towards promotion of local/localised initiatives both by NGOs/CBOs and individuals. An innovative scheme towards enhancing the water availability by ensuring adequate aquifer recharging has been sanctioned by the Housing and Urban Development Corporation (HUDCO) for the

Shantigiri Ashram, Pothencode, near Thiruvananthapuram. The scheme primarily emphasizes, preserving the precious rain water during the lean period. The scheme envisages collecting rain water in a existing rocky pit and providing preliminary treatment before further distribution, in a localised environment. This innovative scheme, envisages harvesting about a million litres of rain water every year.

RAINWATER HARVESTING IN MACRO WATERSHED MANAGEMENT

It is a matter of irony that the examples of Cherrapunji and Kerala are often cited, where though the levels of rainfall are the highest, the shortage of potable water in summer is an often-repeated story. Even in areas of heavy precipitation, a major share of the storm water is lost to the sea by runoff, the ground percolation is minimal on account of the large proportion of paved surfaces, ineffective resource management and water sharing practices often leave much to be desired. Hence the harvesting of storm water runoff at the macro level should start at the watersheds.

Punjab illustrates a successful example of a number of earthen check-dams constructed across the rivulets and streams of the Shivalik foothills, yielding valuable stocks of rainwater for irrigation. The check dams besides conserving the storm water and recharging the acquifers also control flash-floods downstream. The practice of alley cropping, where the food crops are the grown in alleys formed by the hedges of trees or shrubs providing vegetative stabilisation of the soil against erosion.

RECYCLING OF WASTEWATER: AN ADDED DIMENSION TO CONSERVATION

In addition to storm water harvesting, recycling is an important measure of conservation of the water resources. It is estimated that around 80% of the water consumed by a household is let off to the drains or sewers as waste water. Management of the scarce resource would be incomplete without adequate measures in the re-use of this wastewater after primary treatment, for non-potable purpose. There is substantial scope for segregated use of the water for appropriate uses and recycling of the waste water fro further use for gardening, industrial cooling, street cleaning, vehicular washing, fire fighting, irrigation, yard-cleaning, fountains, recreational lakes etc. Though methods are available to improve the quality of recycled water to potable grade, the lack of social acceptance and prohibitive costs may prevent the adoption of these techniques.

A significant initiative towards appropriate utilisation of treated water and use of recycled water for other purpose has been taken up at Bangalore. Two projects are being implemented by the Bangalore Water Supply and Sewerage Board with the financial assistance from HUDCO. This includes establishment of tertiary water treatment plant of 60 mld capacity, which is the first of its kind in India and construction of a 10 mld capacity, which composite sewerage treatment

plant comprising primary, secondary and tertiary treatment components. The recycled water will be used for industrial purpose and for processing boiler feed, air conditioning coolants, sanitary purposes, fire protection, lawn sprinklers, gardening etc. The scheme would help the saving of substantial quantum of treated water for domestic use, which too was being diverted to industrial and other uses. An important aspect of these projects is the involvement of the industrial units which would bear the cost of laying the feeder mains from the treatment plant to the industrial location.

CASE STUDY: NEW JAMMU TOWNSHIP AT SIDHRA MAJEEN RANGOURA

The city of Jammu with a population of 7 lakh at present and acute shortage of water is estimated to grow to 12 lakhs by 2006 with a requirement of 625 gallons of water per day. The new township of Sidhra Majeen Rangura at a distance of 7 km from Jammu over an area of 1000 hectares is to be located on the banks of Tawi River. The township anticipates a capacity of about 20,000 dwelling units with a population of one lakh people. The estimated requirement of water is 40 lakh gallons per day. Of this, 16 gallons would be available from 20 tube wells while the rest is to be tapped from the Tawi River. Stormwater harvesting has been proposed for recharging the aquifers while root zone treatment is being considered as the suitable alternative for water treatment.

Lining of Large Drains and Rainwater Harvesting

The four major drainage channels (nallahs) in Jammu city are proposed to be conserved by strengthening and lining the sides and the edges, with the bottom surface of the drain-bed left untrained to allow percolation. The trained nallahs would have three types of check-dams to retain the conglomerates, which would be removed manually. The infiltration of the water collected in the check-dams would infiltrate into the ground helping the recharge of the aquifers. The large number of retention ponds would also serve in collecting the rainwater.

Recycling by Rootzone Technology

The water drawn from the river upstream, after serving the new Jammu town, is proposed to be returned back downstream, after necessary treatment into the irrigation canal, to be used for farming. In the root zone system, a special variety of reeds called phragmites are planted in seedbeds with soil depth of about 60 cm. The reeds have the capacity to absorb oxygen from the ambient air through their stomatal openings (beneath the leaves) and pass it on to the hollow roots, creating optimal environment for the growth of bacteria and fungi. These micro-organisms break up the complex compounds in the waste water to simpler elements, which could easily be absorbed by plants for their growth. The water available after treatment is rich in nutrients and could readily be utilised for irrigation purposes.

Since the system is devoid of the consumption of either electricity or chemicals, it is best suited for tropical climates.

INITIATIVES TOWARDS SUSTAINABLE WATER SUPPLY AND SANITATION SYSTEMS

Some of the reasons for lack of sustainability in water supply and sanitation systems in India are listed below:

1. Inadequate resources with local bodies
2. Absence of a semblance of reasonable linkage between cost of production and price of consumption
3. Absence of qualified personnel and problem of poor staff strength for maintenance activities
4. Need for regular maintenance of the systems
5. Inability to reduce losses and leakages
6. Inflated project costs due to high administrative and supervision charges of para-statal bodies

Detailed investigations carried out by National Environmental Engineering Research Institute (NEERI) have revealed that about 17 to 44% of the total flow in the distribution system is lost as unaccounted through leakages in main, communication and service pipes and leaking valves. The major portion of leakage (about 82%) occurs in the house service connection, through service pipes and taps. The remaining 18% is due to leakages in pipe lines. Water supply is unmetered in major parts of urban areas and also a significant proportion is supplied, particularly in low-income areas through stand stand posts resulting in unaccountable losses.

At the national level, financial institutions like HUDCO, LIC, ICICI, IDBI, IDFC and IL&FS have begun to rely on market based resources following the macro economic liberalisation. At the State level, specialised state funds such as Tamil Nadu Urban Development Fund and Maharashtra Urban Development Fund have been allocated, while at city level, accessing the capital market through the Municipal Bonds route as in Ahmedabad, Bangalore, Pune and Vijayawada have been implemented. HUDCO and IL&FS are also working with programs such as Indo-USAID Financial Institutions Reform and Expansion (Fire) Project to develop municipal bond market in the country.

HUDCO also emphasises on the provisioning of the following, while agreeing to extend financial assistance:

(i) Principle of full cost recovery to be adopted

(ii) Adequate subsidy to be provided in a transparent manner to meet the basic minimum requirement of the poor

(iii) Efforts must be made for cost reduction by effective savings on manpower, energy consumption, reduction in leakages, improvement in billing and collection, etc.

(iv) Concerned agencies including the local bodies, be given full autonomy for determination of tariffs with the provision for automatic annual increase to cover costs

(v) Tariff fixation should be based on average incremental cost including O&M cost depreciation charges, debt dues etc.

(vi) State level institutions should associate the local bodies and the community at large to instill better sense of participation

(vii) As the chances of success of privatisation are greater in O&M, it could be introduced for new installations initially.

(viii) Compulsory 100 % metering of water supply

(ix) Elimination of Stand Post as far as possible

(x) Operation of Escrow Account

Substantial capacity building programmes are being imparted partly through the Human Settlement Management Institute and All Indian Institute of Local Self Government, Decentralised Training for Urban Development Projects etc. for the local bodies. Such initiatives have resulted in the ULBs adopting the financial viability and user pay approaches in other sectors too.

UNBUNDLING OF WATER SUPPLY AND SANITATION SYSTEMS

There exists a substantial scope for involvement of private sector in water supply and sanitation provision through appropriately unbundling of the operations. The private sector could be involved effectively in the source development from where bulk transfer of treated water could be effectuated through a bulk water purchase agreement by the ULBs. While the distribution has to remain under the control of the public sector, the collection of tariffs/user charges could be effectively delegated to the private sector. The private sector could be allocated a commensurate profit, which would encourage them to maintain appropriate metering and reach of water of the individual households.

The path to privatisation of services in India cannot be expected to be smooth and various steps of different levels of private involvement in water supply and sanitation needs to be followed depending on how prepared the institutions involved are, for full privatisation. The various options available and used for involving the private sector in urban infrastructure development in the increasing order of private stake in the project are:

1. Service Contracts – limited benefits
2. Management Contracts
3. Leases – a way to pass on commercial risk
4. Concessions – the first step to private participation
5. BOT, BOO etc – direct private involvement
6. Disinvestiture – the route to full fledged private participation

Many cities and water boards are entering into service and management contracts for improving the quality of services and reduction of costs. These experiences range from service contracts for labour and services (in almost all cities in India) to management contracts for operation and maintenance of water and sewerage treatment plants (Chennai, Navi Mumbai). Another emerging innovation is development of BOT type projects for urban water supply and sewerage. These innovations include attracting capital, bringing in appropriate technology and improve the operational efficiency of urban services. The successful examples include Tiruppur, Pune, Hyderabad, Bangalore, Goa, Kolhapur, Dewas, Cochin, etc.

PARTICIPATION OF COMMUNITY GROUPS

It is being increasingly realised that the user participation, either as provider or for performance assessment can be critical to the effectiveness and at times efficiency of the smaller community level infrastructure services. In many of these, the provisions and operations at the local level can be better handled by the user or community groups. Some of the important initiatives taken in this context are given below:

(i) Specific arrangement for involving user and community groups may be achieved by unbunding of the services in an effective manner. For example, depending on the technical considerations of scale economics, local distribution networks for water may be provided by the community groups and they may be supplied with bulk water by a water utility company. In such cases the entire provision and operation can be transferred to the SPVs formed of the user and community groups.

(ii) The City and Industrial Development Corporation (CIDCO), a public sector institution at Navi Mumbai has privatisated the maintenance of sewerage pumps and water pumps, meter reading and billing, maintenance of park and gardens, collection of service charges and so on. CIDCO has given the responsibility of collection of its service charges to the Senior Citizens Club (an association of retired persons) to whom it pays 1% as commissions, reducing its A&M expenses to one third.

For greater all round participation of all stakeholders in water supply and sanitation systems development, especially the community groups, a model based on Public – Private – Peoples – Partnerships (PPPP) has to be put in place.

THE ROAD AHEAD

India is projected to overtake China and become the most populous country in the world in the coming forty years, in spite of substantial emphasis on population control. On the other hand, estimates predict a rapid dwindling of water resources in the country. A report of the United Nations Children's Fund (UNICEF)

indicates that by the year 2017, the per capita availability of water will decline to 1,600 cubic meters, a level determined by the UN – 'significantly water-stressed' and holding out the threat of water borne diseases. This emphasizes the need of the hour for initiating sustainable measures towards ensuring large scale appreciation and adaptation of integrated water management practices, encompassing development of resources including conservation of storm water as well as recharging of aquifers, use of information technology and remote sensing techniques, appropriate treatment and recycling of waste water, conveyance and distribution, unbunding of services and community participation.

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To disseminate information and promote hydrological research in the country, INCOH brings out the bi-annual Journal '*Jalvigyan Sameeksha*' (Hydrology Review Journal). The papers published in the Journal are by invitation only. The Journal is widely circulated to all organisations and agencies dealing with water sector.

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In pursuance of its objectives to prepare and periodically update research trends in different branches of hydrology, state of art reports, authored by experts identified by INCOH from various institutes and organisations in India, are published regularly. These reports are circulated free of cost to state and central government agencies including academic and research organisations.

IHP-VI activities

India is actively participating in the IHP-VI activities and has chalked out a detailed program in accordance with IHP-VI themes towards preparation of reports, taking up research studies, organisation of seminars/symposia at national and regional level, promotion of hydrological education in the country, establishing nodal point for implementation of G-WADI program of IHP, UNESCO, for arid and semi-arid regions of South and Central Asia, and HELP basin program for India. It is envisaged to participate in all the relevant and feasible programs identified under the various focal areas of IHP-VI as given below.

India's participation in IHP-VI programs

Focal Area	Integrated assessment of water resources in the context of global land based activities and climate change
Focal Area	Extreme events in land and water resources
Focal Area	Dry lands
Focal Area	Public awareness raising on water interactions
Focal Area	Continuing education and training for selected target groups

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