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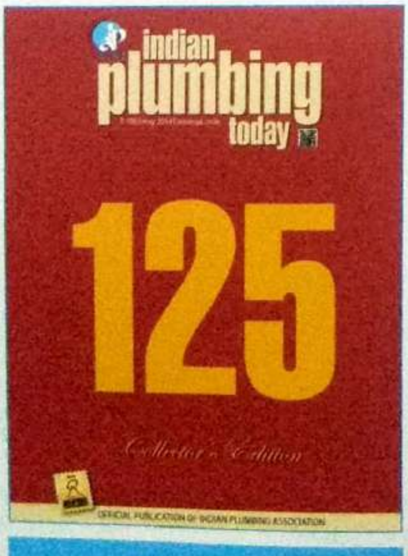
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Urban Water Conservation

PRINCIPLES, PRACTICES & GUIDELINES

Roshni Udyavar Yehuda

Water is everywhere. The Earth is 70 per cent water; we are 60 per cent water by weight and water in our cells account for 70 per cent of their mass. In our cities, it appears as rivers, ponds, lakes, streams, springs, wells and the more familiar faucets that bring water into our homes. The way we treat water in its natural state defines the way it in turn treats us. Cities with contaminated water bodies have the highest incidences of water-borne diseases and poor health.

Although historically, rivers have been the cradles of civilisation with great cities flourishing on riverbanks, flowing water bodies in urban areas have become, with few exceptions, drains for sewageand solid waste – mostly plastics, dumped callously into them. These are then carried to the rivers and ocean affecting marine life.

The relationship of land and water in urban areas is a complex physical, ecological, and social interaction (Cadanasso, et al., 2008). Land-water boundaries are ephemeral. I was surprised- a few years ago -to visit a North Indian state and find most people living atop roofs as the ground floors were flooded with water from the River Ganges. Parts of the city that are, so to say, 'land,' are in fact, part of the river's flood plain (Fig. 1).

It is not just the river itself but its entire basin, catchment and watershed that are affected by urban development. Built forms in cities are constructed piecemeal, adhering to respective land uses but barely consider the surface and subsurface flows or the intake of water into the vadose zone (soil and rock layer with tree roots

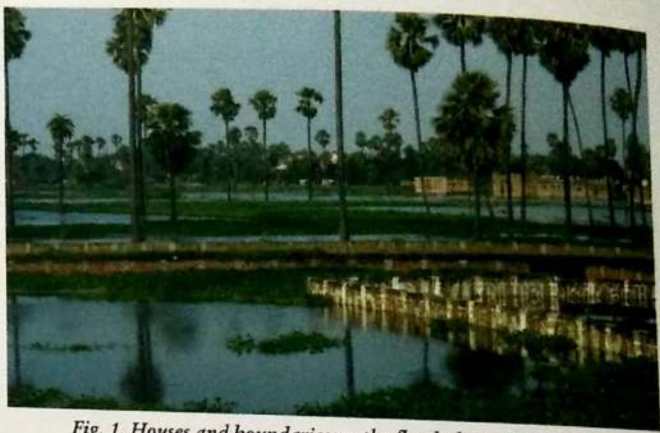


Fig. 1. Houses and boundaries on the flood plain of the Ganges

where water is first absorbed in the earth) that gets affected by concretisation of land. In most urban areas, the vadose zone is gradually concretised.

City water supply usually comes from reservoirs located several hundred kilometers away from the city centre, pumped to overhead reservoirs and then to tanks atop buildings. Thus the physical connection to the river no longer exists allowing it to be polluted and degenerate. Ideally, rivers must be protected by buffer zones along their banks planted with riparian vegetation that performs the dual function of flood control and nitrate pollution reduction from surface overflow.

Land suitability study to safeguard urban hydrology

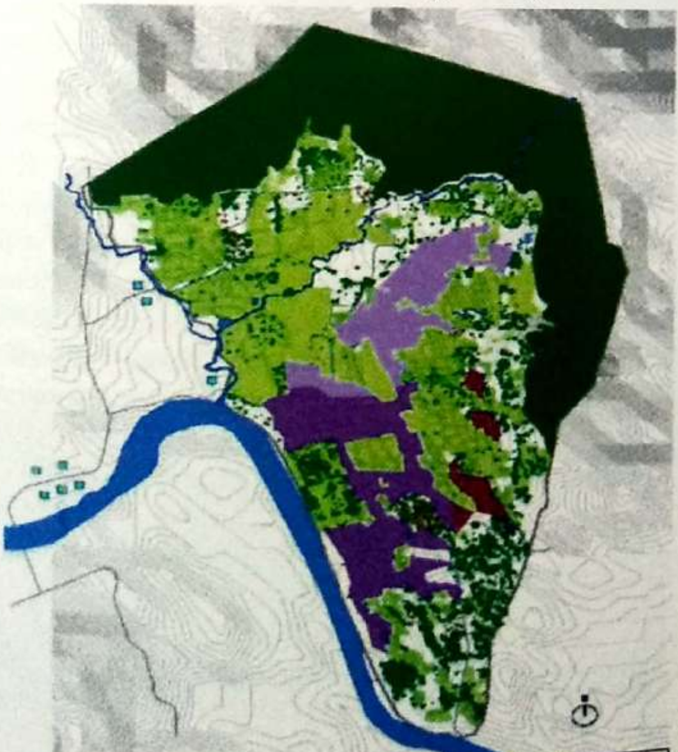
A preliminary topographical and hydro-geological study of any site would help in reducing the impact of built forms on urban water bodies. This involves slope and elevation study and drainage of water on site (Fig. 2). Suitability studies provide a range of values for most suitable, moderately suitable and least suitable for elements on the land such as soil, vegetation, slope and hydrology, thus assisting in the decision-making process.

Hydrologically, those sites that least affect water drainage or water absorption into the land are considered most suitable. Areas which are prone to water collection or which are sources of springs or natural water occurrences are best avoided for construction of built forms. This kind of study becomes even more relevant on sites for industries as water contamination from industrial chemicals often affect aquifers (underground streams of water) which may end up in wells and springs in surrounding areas.

The natural site drainage guides the construction of storm water though ideally run-off from the site should be restricted to not more than 60 per cent.

Measures for water conservation during construction

Construction activities contribute significantly to storm water pollution in cities. Contaminated sediment, debris, and chemicals from construction sites are let off into the city's storm water system unchecked and untreated leading to large scale off-



SUITABILITY	SLOPE	HYDROLOGY	LANDUSE	VEGETATION	SOIL
GH 1	HIGH	HIGH	HIGH	HIGH	HIGH
GE 2	HIGH	HIGH	HIGH	HIGH	MODERATE
ODERATE	HIGH	MODERATE	HIGHE	HIGE	MODERATE

Fig. 2. Land Suitability Analysis for Gorad Village in Wada, Tansa Valley, Maharashtra

Fig. 3. Solid and liquid waste dumped into Dahisar river, Mumbai

load of debris into river beds, creeks and coastlines that destroy aquatic habitats and cause stream bank erosion (Fig.3). Diesel, oil, paints, solvents, cleaners, construction debris, cement, sand and dirt are some of the common pollutants discharged from construction sites. Often these tend to soak into the groundwater at the site as well.

Groundwater pumped out during construction of the foundation contains silt and clay. In addition, wastewater is generated from RMC batching plants, washing of truck mixers and conveyor belts of RMCs. This water must be effectively filtered using an on-site sedimentation pit and, wherever possible, treated to tertiary levels before letting off into storm water drains. Topsoil in these sites should be removed to a depth of 200 mm and stored for later use, for landscaping.

Studies have indicated that, by far, the largest amount of water in building construction is consumed for concrete curing. This water of potable quality can be reduced by using a protective material to prevent evaporative loss and maintain dampness in vertical and horizontal surfaces or by use of resin-based material on concrete surfaces to be cured. Alternatively, wastewater generated on site can be treated and reused for this purpose.

End use water efficiency and conservation

In most cities, water is supplied by Municipalities that provide potable water as per national standards. This water is used for drinking, cooking, bathing, washing, flushing, gardening and car washing. Once flushed or used, water ends up in the drain, mixes with a lot of other polluted water and ends up through sewage channels either in rivers or oceans.

About 40 per cent of all water used indoors is in bathrooms and toilets and more than 10 per cent of that used is in kitchens (The Energy and Resources Institute (TERI), 2007). A conventional flush uses water at the rate of 12-15 litres per flush. Similarly, faucets and showerheads in buildings consume water at the rate of 20 litres per minute. Dual flush systems consume 3 litres and 6 litres per flush. Low-flow faucets along with other water saving devices such as auto- control valves, pressure reducing devices, aerators and pressure inhibitors for constant flow, magic eye solenoid valves and self operating valves can result in 25–50 per cent of water savings. Tap aerators can be effective by facilitating cleaning through increasing the pressure at which the water is delivered even at low-flow rates. Installation of flow regulators can be done in cases in which the aerators cannot be installed. Waterless urinals can be used in public buildings.

Pressure reducing devices can be used to control pressure in the water line, which will affect the discharge rate and maintain uniform flow at different levels. A pressure reduction device can be installed when the pressure in the line exceeds 50-60 psi. It is observed that a reduction of pressure from 80 to 65 and 50 psi can result in a reduction of water flow of 10 per cent and 25 per cent, respectively (The Energy and Resources Institute (TERI), 2007).

Manual controls in buildings for pumping water from underground to overhead tank, often lead to wastage from unchecked overflow. This can be controlled using an automatic or manual level controller and pump operation for storage tank.

Landscape water use

It is extremely wasteful to use potable water for irrigating lawns and gardens in building compounds. Watering is usually done through pipes, and plants are generally over-watered during mid-day, when maximum evaporation loss occurs.

Fig. 4. Drip irrigation could effectively reduce water use in gardens

Fig.5. Roof top harvested rainwater is used for ground water recharge at a residential apartment building in Worli, Mumbai

It is suggested to have grey water from kitchen, bath and sinks filtered at primary level using sedimentation tank, grease filter and plant filter or aerobic method, to be used for irrigating landscapes. The irrigation techniques that can be used are drip irrigation for shrubs & saplings, and sprinklers for lawn (Fig. 4).

Rainwater harvesting

Rainwater harvesting is the act of collecting, storing and using rainwater falling on site. This can be done by storing the rainwater that falls on rooftop after filtration in a storage tank (with capacity of one or two days storage) and use it for non-potable purposes such as flushing during the monsoon season. Alternatively, water collected from rooftop and other surfaces such as parking and landscaping can be collected and charged into the ground after filtration (Fig. 5). A number of ground water charging techniques can be used such as percolation pits and trenches, continuous contour trenches, check-dams, etc.

The charged water could be used for non-potable uses such as car washing and flushing in seasons other than monsoon.

Grey and Black water recycling

On-site treatment of grey water (waste water from bath, kitchen and wash) for reuse in landscape irrigation requires minimal inputs in terms of infrastructure and energy, and can be achieved in a small space (Fig. 6). Black water (waste water from toilets) treatment is costly, requires maintenance, space and energy to function efficiently. There is also the issue of quality control when considering reuse.

Therefore, installation of dual pipe plumbing, separate for recycled water and potable water from municipal supply is suggested. Although it implies space and initial capital investment or retrofitting, it has the potential of saving more than one-third of fresh water demand as also extending the life of existing sewerage systems.

Where space and capital investment on black water treatment is possible, with regular maintenance, dual plumbing lines need not be provided, as a larger volume will be available for treatment making it more feasible. Several wastewater treatments can be adopted depending upon space availability, cost and maintenance. These include aerobic systems, anaerobic systems, soil biotechnology, membrane bioreactor, DEWATS, root zone systems or constructed wetlands, electrolytic and other packaged treatment systems. It is important for the output water to adhere to CPCB norms.

Water Metering

Installing separate water meters for flushing, domestic, gardening at the distribution level of building will help in quantifying water usage for various uses. Water meters for individual households will be useful in tracking excess use and further measures to control the same.

Endnote

The question of whether water being a valued resource, should be priced highly, such as in Israel where exponential metering is used and fines are imposed on those consuming excessive water, or water being an essential resource, should be available to all, is a question open to debate. Currently, municipalities such as MCGM use a system of cross subsidy where slum-dwellers are charged at ₹ 3 per thousand liters (kl), residential consumers are charged at ₹ 4 per kl, hospitals at ₹ 16 per kl, shopping malls at ₹ 40 per kl and star hotels at ₹ 60 per kl (MCGM 2013). There is still a shortage of 1000 million liters daily for which new reservoir projects are being undertaken in the Upper Vaitarna river more than 100 km from the city of Mumbai. One may contest the low price being paid by residential consumers and slum dwellers, which constitute 88 per cent of total water connections. On the other hand, migration from rural to urban areas is primarily due to lack of adequate water to irrigate farmlands and sustain an agricultural livelihood.

Fig 6. A reed bed water treatment system treating 7000 litres ofgrey water at Victoria Memorial School, Tardeo, Mumbai

Protecting and safeguarding our rivers–rural or urban–should be our priority. Identifying watersheds such as those in the Himalayas and the Western Ghats, which are key to the surface and ground water, is an important and immediate necessity. These areas should not be compromised for development and creation of new townships for they sustain the ones that already exist. In cities, pricing water at higher rates could lead to efficient practices.

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