RESIDENTIAL TYPOLOGY AND WATER MANAGEMENT OPTIONS FOR URBAN AREA

Biswas R.
Department of Physical Planning, School of Planning and Architecture, New Delhi (INDIA)

Received January 16, 2016 Accepted May 18, 2016

ABSTRACT
Water scarcity is matter of concern in almost all urban areas in India. The gap between supply and demand is increasing constantly. This gap is not only due to actual physical shortage of water but also due to the mismanagement of the scarce water resources in these urban settlements. The predominant use of water in urban area is domestic use. There are many sustainable water management approaches for residential development in urban area. But hardly these approaches are applied in these residential areas in India. There are different types of housing options in these residential developments which are proposed by the development plan or master plan of these urban areas. The water management approaches for these different types of housing typology cannot be uniform. Different types of housing developments have different responses for the applicability of different water management approaches. The applicability of few selected water management approaches are first established based on the literature study, primary survey analysis and the personal interaction with the selected household in different residential developments in Dwarka. The space requirements and water saving due to the application of these water management approaches are estimated for selected residential case study to understand the suitability of these water management approaches. Finally, this paper suggests the type of housing which is more suitable for efficient water management in urban residential development.

Key Words: Housing typology, Sustainable water management, Grey water recycling, Water scarcity, Urban residential development

INTRODUCTION
Water scarcity is matter of concern in almost all urban areas in India. It has been observed that the water management in Delhi is basically city level centralised supply system. Supply has been increased to meet the demand even then demand supply gap exist. Demand management approaches of urban water management are not tried in city level water supply and water resource management. The different residential developments have potential for application of demand management techniques to reduce demand of water to manage residential water with the existing water resources available instead of going for increasing supply and increasing the water footprint of city. To find out the applicability of such alternative approaches Dwarka a sub-city of Delhi has been considered as case study area and different residential typologies are selected to evaluate existing water management strategies and the applicability of demand management approaches for such development.

Dwarka sub-city
The Dwarka sub-city is a part of the urban extension of Delhi in the Planning Zone K (Nazafgarh District) with a total area of 5648 hectares. Dwarka is planned for a population of around 1.1 million. Dwarka has a semi arid climate with about 80% of the annual rainfall received during the South-West monsoon period between July and September (27 rainy days). The average rainfall is around 611mm. The future daily requirements for the population of 1.1 million, based on Master Plan for Delhi 2021 (MPD 2021) would be 248 MLD (54 MGD) where 83 MLD (18 MGD) for potable purposes and 165 MLD (36 MGD) for other domestic purposes. Dwarka is getting around 50% of its water demand from Delhi Jal Board and from bore wells. The residents manage the rest of their demand by procuring water from government or private tankers or extracting groundwater or purchasing package water. Almost all group housing societies and plotted
Housings have their own private bore wells, leading to the over-exploitation of groundwater and the amount of underground freshwater are decreasing at a rate of one meter per annum. The Central Groundwater Authority made it mandatory for buildings (for plot area 100 m$^2$ or more) in Delhi to make provision for rainwater harvesting. The byelaw is applicable for Dwarka also however the implementation of the same is not being monitored by the government concerned agencies and the implementation is low. The Delhi Government has also modified the building byelaws (GOI notification 28 July 2001) to promote reuse of wastewater in buildings where daily wastewater generation is 10,000 litres or more. DDA initiated use of dual water supply systems in Dwarka in 2002-03 to promote the reuse of rainwater and recycled wastewater. The Master Plan for Delhi 2021 has also emphasized the recycling of treated wastewater through dual supply systems, however, these concepts have not been implemented in Dwarka until today. Besides these two measures there were no initiatives for promotions of water saving devices, universal metering or any other demand management approaches.

**METHODOLOGY**

The case study residential developments were chosen from the planned development of Dwarka. Primary house hold questionnaire survey has been done in 2008 by the author. Additional information is drawn from the discussion with members of Residential Welfare Associations, Secretaries of Cooperative Group Housing Societies, planners and engineers of Delhi Development Authority (DDA). The case study residential typologies selected were (1) Cooperative Group Housing Societies developments (CGHS) Fig. 1 to Fig. 3 (2) residential development and (3) DDA Group Housing (DDAGH) (Fig. 4). The details of the sample survey are given in Table 1. The total sample size is 145, CGHS Plot size surveyed between 4000 to 8500 m$^2$, DDA GH Plot size between 10,000 to 40000 m$^2$ and Plotted development plot sizes between 100 to 210 m$^2$.
Table 1: Sample size of residential units surveyed

<table>
<thead>
<tr>
<th>Types of development</th>
<th>CGHS</th>
<th>DDAGH</th>
<th>Plotted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated total DU’s</td>
<td>6200</td>
<td>1936</td>
<td>2004</td>
<td>10140</td>
</tr>
<tr>
<td>Sample DU’s</td>
<td>55</td>
<td>14</td>
<td>76</td>
<td>145</td>
</tr>
<tr>
<td>%</td>
<td>0.80%</td>
<td>0.70%</td>
<td>3%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Note: DU = dwelling units

**RESULTS AND DISCUSSION**

**Survey analysis and findings from primary survey**

The major findings of primary survey analysis which can be used to decide the residential water management options and policy considered for the case study area are discussed below. It was found that the CGHS and DDAGH have less percentage of roof area (29% and 30%) but higher percentage of unpaved area (49% and 43%), so natural recharge in such development is expected to be high on the other hand, the plotted housing has higher percentage (73%) of roof area but less (9%) unpaved area, almost nil natural recharge possible.

**Water supply status**

The water supply is insufficient for all types of residential developments. The CGHS is bulked metered and resident don’t know even how much they pay to government, therefore don’t even serious about the water conservation. DDAGH is 100% individually metered but plotted housing is only 39% metered, grossly low and not ensures water conservation. Metered water supply and water billed based on the actual water use is essential to ensure water conservation and reduction of wastage and efficient use of water. Residents of DDAGH and plotted development pay average water fixed bill irrespective of quantity used. Therefore, people are not interested for judicious water use.

**Rainwater harvesting and water recycling**

Though, it is mandatory, the status of the implementation of Rainwater Harvesting (RWH) systems in the case study residential development is not satisfactory. In the study area 78% of CGHS have RWH where as 21%
DDAGH and only 5% plotted residential development have RWH. There is no storage of rainwater in the harvesting systems only recharge is considered so there is no direct visible benefit and people are least interested for RWH. Maintenance of the RWH system is also not done. Though mandatory, water recycling has not been done within the selected case study samples. People are ignorant about the byelaw and also do not know the benefit and technology of waste water recycling systems.

**Use of water saving devices**

The uses of water saving devices in selected residential developments are negligible. There are higher percentages of use of water saving cisterns (26%) in plotted developments and use of all other water saving devices is negligible. There is scope of introducing water saving measures in all types of developments.

**Table 2**: Estimated water saving due to water demand management options in different types of residential development in Dwarka

<table>
<thead>
<tr>
<th>Management options</th>
<th>Water demand reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group housing</td>
</tr>
<tr>
<td></td>
<td>CGHS 8500 m²</td>
</tr>
<tr>
<td>Rainwater harvesting (%)</td>
<td>06</td>
</tr>
<tr>
<td>Grey water reuse (%)</td>
<td>36</td>
</tr>
<tr>
<td>Water saving devices (%)</td>
<td>39</td>
</tr>
</tbody>
</table>

Source: Estimated by author, 2009

**Space requirement for water management options for different types of residential development**

Now the space requirements of water storage for rainwater harvesting, greywater recycling system and storage are estimated for the same typology of residential development in Dwarka. The comparison of estimated space requirement due to the water harvesting, greywater recycling and reuse in the selected four types of residential development is given in Table 3. It is observed that the rainwater harvesting tank is the major component of rainwater harvesting system. It has been seen that the percentage of area requirement within the plot area for rainwater harvesting tank for selected residential development is between highest four percent for 100 m² plot to even less than one percent in the case of group housing development. Fig. 5 to Fig. 7 clearly shows that the rainwater harvesting tank can be accommodated within the plot of all selected residential development. The components of conventional greywater recycling system take larger percentage of area within the plot. For group housing developments the area requirement for greywater recycling system is around four percent of the plot area but for plotted development the percentage is high between 12 to 24%. So it is difficult to accommodate greywater recycling system in the smaller plots. In the case of plotted development of plot size 100 m² the greywater recycling system cannot be accommodated within the available spaces. However setback area can be used for the same which is not allowed under existing building byelaw. Therefore, it is seen that group housing residential development are more suitable for greywater recycling due to the availability of large percentage of open area.
Table 3: Space requirement for different water management options in residential development of Dwarka

<table>
<thead>
<tr>
<th>Management options</th>
<th>Group housing development</th>
<th>Plotted development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CGHS (m²)</td>
<td>DDAGH (m²)</td>
</tr>
<tr>
<td>Water harvesting tank (% to total available area)</td>
<td>27.5 (&lt;1%)</td>
<td>60 (&lt;1%)</td>
</tr>
<tr>
<td>Greywater system</td>
<td>227.5 (4%)</td>
<td>448 (4%)</td>
</tr>
<tr>
<td>Total area requirement</td>
<td>255 (4%)</td>
<td>506 (4%)</td>
</tr>
</tbody>
</table>

Fig. 5: Components of rainwater harvesting and greywater recycling in CGGH plot

Fig. 6: Components of rainwater harvesting and greywater recycling in DDAGH plot
CONCLUSION

Dwarka is facing water scarcity. The concerned authority is not able to provide required quantity of water but not coming up with proper strategies or policies to reduced demand and to make additional water available through rainwater harvesting and greywater recycling. Based on the survey findings, it is clear that the group housing developments have more unpaved areas and ensure natural recharge. It is evident from the survey analysis that the water management measures like rainwater harvesting, greywater recycling, use of water saving devices, metering can be given priority and their applicability can be found out based on the space availability in the residential typology. If these techniques are implemented there will be substantial water saving. The authors discussion with members of RWAs, planners and engineers of the implementing agencies revealed that they have an impression that storage for rainwater harvesting and implementation of greywater recycling is not possible in the plotted development due to space constrain but which is not true for higher plot sizes. For lower plot size only rainwater harvesting system with storage can be accommodated within available area but conventional greywater recycling system is difficult to accommodate. To accommodate conventional greywater system use of setback areas are to be permitted which require the change of existing building byelaws. The group housing developments are more suitable for implementation of selected water management measures in terms of space availability. As estimated for all types of residential development the water saving from greywater recycling and implementation of water saving devices ensure highest reduction. But government policy has never given any importance to use of water saving devices and greywater recycling for water management in urban residential development in
Dwarka. Both the rainwater harvesting and greywater recycling systems can be easily accommodated in CGHS and DDAGH development. The percentage space required for both the systems against available space is least for both CGHS and DDAGH, but is highest for plot size of 100 sq. m. So the applications of selected water management techniques are easy possible in group housing (CGHS and DDAGH) development in Dwarka.

REFERENCES


