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Examining the need and necessity of water management in Greater Noida City, India

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ABSTRACT

Greater Noida, an industrial area is located at the intersection of the western and eastern dedicated freight corridors and is also the gateway to the Delhi-Mumbai Industrial Corridor (DMIC). It lies within the National Capital Region of India's capital Delhi and is adjacent to Noida, one of the largest industrial townships in Asia. Having population of more than 1,00,000 in total as per the census 2011. Greater Noida is a rapidly developing city and moving fast towards becoming the developed city and in the process, obviously, exploitation of natural resources are required to develop an industrial corridor for its infrastructure development. Over exploitation of resources simultaneously creates and increases the scarcity leading to disastrous effects. As over exploitation of ground water leads to lowering the water table and results in effecting the quality of ground water. With more people living in Greater Noida city than ever before and many new construction work is going on, the Greater Noida city draws more water from ground water sources and also the illegal extraction of ground water for construction leads to decrease in water table level. The hardness of water is one of the issues and is a concern for residents of several sectors across Greater Noida for a long time now. The Total Dissolved Solids (TDS) level in water is found to be more than 500 ppm. However, the normal TDS in water should be 500, according to the health department. The TDS levels in water vary across all sectors in Greater Noida. The TDS level in sector alpha is 700 and about 800 in sector omega, as the TDS levels are high, quantity of undesirable minerals like calcium and magnesium are also high. This leads to several issues like corrosion of electric appliances, water pipes and taps. Today the city is facing the biggest problem that is scarcity of drinking water as the level of water is continually depleting. We need well-planned strategies at locations where heavy rainfall occurs, an extra effort could be madein order to save water for future use. Thousands of gallons of water can be saved if we keep our drainage system proper. The groundwater level, according to the CGWB, has surpassed the "critical level" and is now "overexploited", which means the city could face a serious water shortage in the years to come unless its ground water is adequately recharged. The ground water level in the district is falling alarmingly by a meter every year, says a recently released report by the Ministry of Water Resources, a consequence of the city's breakneck pace of urbanization that now threatens to derail it. With more people living in city than ever before and many new construction work is going on, currently, the Greater Noida city draws more water from groundwater. To safeguard its water, authority has planned many ways to conserve water naturally; still the region is in a state of "**water stress**": it uses more than 40 percent of the water available to it.

Key words: *Natural resources, Exploitation, Total dissolved solids, Water stress*

Introduction

Water shortage is one of the major problems of the 21st century which incidentally is also the beginning of the new millennium. Inaccurate predictions are being made regarding the water problems being faced by the mankind during the next 50 years. If the last 50 years are any guide, there is no doubt that the world is going to face a serious problem. Since water is life one cannot do without it and how to deal with this situation is a serious concern. Until the scientists find better and durable solutions, we must do whatever is possible by possible interventions at the grass root level.

The impact is realized soon as depleting water levels and quality deterioration due to over-exploitation and over application for irrigation. The situation is alarming in urban and industrial sectors of the country. Almost all urban areas are depending upon water supply. About 50% of industrial requirements of water are presently being fulfilled by the ground water resources. There is no doubt that country is facing water crisis. As per TERI report of 1997 per capita water availability will drop to 1500 cubic meters in the year 2017, which was around 6000 cubic meters in 1947.

Today we need an integrated watershed development where rivers, canal, lakes, ground water and available rain water in a given area should be tapped to address the local population's water need. Community initiatives to manage water resources in a sustainable manner at local level are most required. In present scenario, when surface water resources are fully contaminated and there is immense pressure on groundwater resources.

Study area

The present study area is Greater Noida, is a nodal industrial city by itself situated in proximity to National Capital New Delhi. It is part of the Delhi Mumbai Industrial Corridor (DMIC) lies at intersection of Western and Eastern freight corridors. Development of this city with its world class infrastructure facility is a mile stone in India journey towards and economic super power. Currently it is accommodating a population of about one lakh (Census, 2011, Table 1). A location map is depicted in Fig.1

Table 1. Demographic details of Greater Noida

Population	Total	Male	Female
City population	102,054	55,540	46,514
Literates	75,431	43,422	32,009
Children (0-6)	14,821	8,152	6,669
Average literacy (%)	86.47 %	91.63 %	80.33 %
Sex ratio	837		
Child sex ratio	818		

Issues identified

The whole area witnesses severe ground water contamination mainly because of its geographical location on the bank of highly polluted Hindon River and also due to the leaching of liquid and solid waste from industries inupstream areaof Greater Noida.

Fig. 1. Struggle for drinking water in the State of Uttar Pradesh

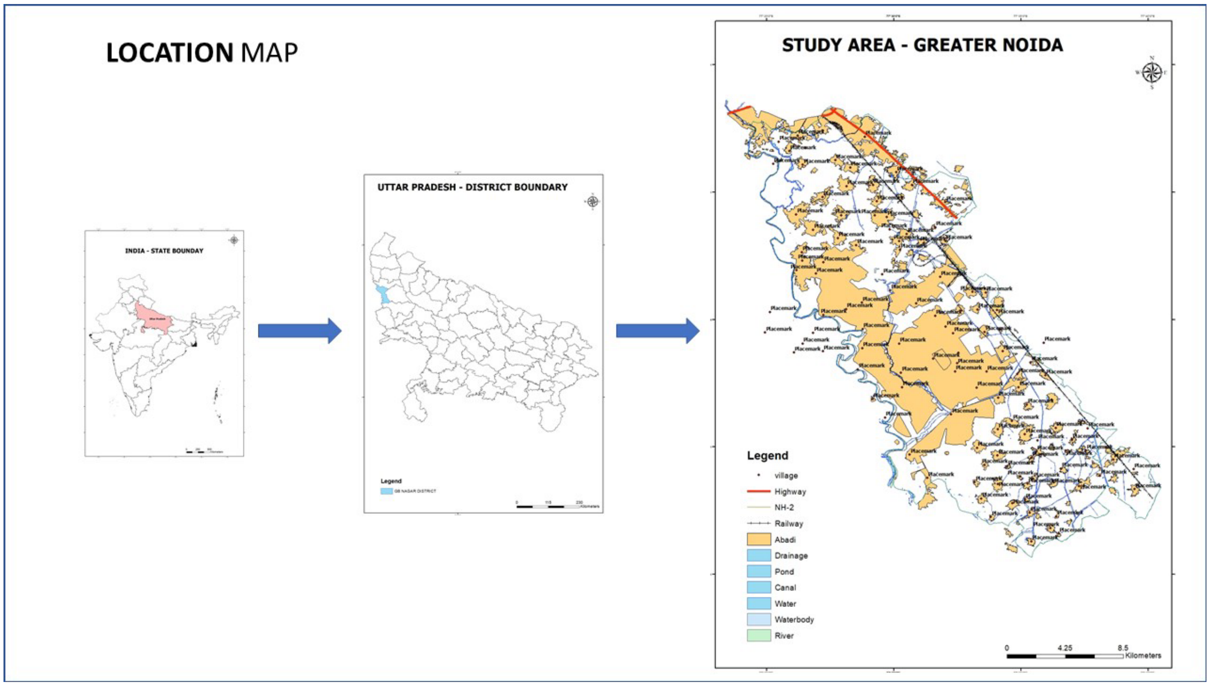

Fig. 2. Location Map

Existing water Resources and needs of Greater Noida

Presently bore wells are used for water supply in rural and urban areas of Greater Noida. The supply is divided into 4 zones. In urban areas 91 bore wells, 28 upper reservoirs and 06 underground reservoirs (Sector-Gamma, Alpha, Delta, Sector-37, Stadium and Balak Inter College) are doing the water supply.

Where the underground reservoirs are functional the bore wells are used to fill underground reservoirs and then from underground reservoirs to upper reservoirs are filled to supply the water in the area. The sector where the underground reservoirs are not there, bore wells fill the upper reservoirs / overhead tanks directly. With the increase in the water demand the new overhead tanks and bore wells are getting constructed in the urban areas of Greater Noida. A total of 29 bore wells are functional and 78 bore wells are under construction.

Sewage treatment plant

- Greater Noida region has been divided into 8 regions in the sewerage master plan.
- 137 mld STP is under construction in the Kasna village area for the phase-1.
- Construction of STP is based on SBR technology, the water BOD is less than 10 in this technology.
- Project is functional at present

Ganga Jal Project

This project envisages 89 km water supply pipe line of which only 81% of the work could complete due to non-availability of land and some disputes. Completion of this project is necessary for the needs of Greater Noida.

Management Approaches and Tools

There is no one-size-fits-all IUWM model; rather, each context will demand a different mix of management approaches. So, what are some of the options for sustainably meeting the water needs of growing cities and reducing their impact on the environment?

Storm Water Management

In developing countries, many parts of cities and in particular some low-income built-up areas are experiencing extensive flooding during periods of intense rainfall. There are options for urban storm water management that can reduce negative impacts and increase the availability of water resources locally. These include using retention ponds, permeable areas, infiltration trenches and natural systems to slow down the water runoff. Green areas that take up water can benefit cities with high risk of flooding and provide ecosystem services involving lower costs compared to conventional storm water drainage systems (Bolund and Hunhammar, 1999). Those conventional systems may include cleaning up urban runoff and storm water in order to reduce pollution and increase the availability of water resources locally. The value of natural and constructed wetlands and swamps in urban water retention and purification is increasingly recognized.

Rainwater Harvesting

Roof-water harvesting can be a means of increasing local water supply and groundwater recharge whilst simultaneously alleviating flooding problems in some areas. These measures may be an immediate solution to accompany long-term infrastructure improvements in water supply and drainage. Although roof-water harvesting systems have been implemented in some cities, there has been no comprehensive documentation of design criteria used, costs and benefits, impacts and constraints to large scale adoption. Such an evaluation would allow out-scaling such practices.

Green infrastructure

Incorporating ecological functions into landscape design can also extend beyond storm water management. They include natural or nature-mimicking systems to treat polluted water (Asano, 2005; Brown, 2009). By combining flexible treatment technologies with functional landscapes, they allow various cost-effective approaches to restoring the integrity of urban ecosystems (Brown, 2009).

Payment for ecosystem services (PES)

PES is another tool that has proved useful, particularly in protecting urban water supplies from upstream activities. Here, land owners and users are given incentives (often monetary) to engage in land-use practices that lead to an ecological service. Within the water sector, payment models are designed within the context of watersheds. Conventionally, downstream communities pay upstream water users to refrain from practices that can undermine the integrity of natural resources in general, and river flows and water quality in particular. PES is intended to compensate rural (often poor) water-users to manage a collective ecosystem, even if they are not the immediate beneficiaries of such actions (Isetnepal, 2008). PES, thus, amounts to a tool for joined-up management of natural resources across the urban-rural continuum.

Efficient Water Use

This can involve reducing losses and encouraging more efficient practices on the part of water users. Domestic water supply systems often face major water losses, with leakage percentages of over 50 percent. Efficiency of water use should minimize water losses during treatment, transport, storage andend use. Reducing water loss involves aspects related to design, construction and operation and maintenance of systems, as well as user behavior. Singapore and Phnom Penh achieved significant reductions in unaccounted-for water over the last decade. In Zaragoza, Spain, the municipality instituted a demonstration on water loss management with the installation of water saving devices and with the monitoring of flows and pressures through a supervisory control and data acquisition system, linked to a geographic information system and simulation model (Switch, 2011).

Economic and Financial Instruments

Efforts to promote IUWM must address the ques-

Table 2. Ground water status of Greater Noida

Sl. No.	Blocks	Annual GW recharge (ham)	Net annual gross GW availability (ham)	Existing GW draft for all uses (ham)	Net GW availability for future irrigation development	Stage of GW development (%)	Category of block (2008)	Category of block (2017)
1	Bisrakh	9528.96	9051.96	6756.76	2027.39	74.64	Safe	Over exploited
2	Dadri	20355.50	19337.73	5024.83	14155.37	25.98	Safe	Semi critical
3	Dankaur	17673.36	16789.69	9762.34	6933.23	58.14	Safe	Critical
4	Jewar	15509.17	14733.10	9248.54	5424.44	62.77	Safe	Over exploited
	Total	63066.42	59913.10	30792.48	28592.44	51.40		

tion of capital availability, including appropriate financial tools and cost sharing. Investments by national governments in water resources development have traditionally been overshadowed by those for transport, energy, telecommunications and the military. Functional responsibility for water services has tended to rest on the shoulders of local government (Serageldin, 1994; as cited in Rees, 2006). However, in the global south, local government revenue streams are often inadequate. As a result, they often lack the financial means to maintain investments in line with demographic change and physical development. At the same time, the cost-recovery potential of commercial service providers is constrained by low average incomes among user groups. Water pricing and application of the polluter pays principle can be important components of encouraging more efficient resource use as well as providing funding for IUWM functions. Other financial strategies, including fiscal transfers and cross-subsidies, should be deployed in order to tackle resource depletion and inequality (UNDP, 2006).

Also, specific strategies are needed to focus public re-sources on leveraging resources from local authorities, consumers and the private sector. Successful microfinance, output-based aid and loan-financed approaches may be adopted as core strategies particularly in the sanitation sector. Conventional public sector financing of water and sanitation services frequently doesn't reach the poor and vulnerable and specific strategies are needed, many of which involve alternate funding sources (Bahri *et al*., 2010).

Action plan for water

From the aforementioned details it should be clear that expansion can be sustained only if it is based upon sustainable utilization of localized water resources. Since the availability of surface water is becoming increasingly difficult expansion beyond that limit sustainable by local resources should take place only once when the additional surface resources are actually made available.

Therefore, spatial planning should be done with a view to efficient resource management of the available localized variety. Planning with water means, incorporating the working of the hydrological and hydro-geological systems and principles of land use planning. Any urban settlement can, within an area of three to four times the urbanized area, if sufficient sites for water storage to meet its requirements within the context of moderate rainfall. It is important for planners to understand:

- The workings of the hydrological cycle
- The interconnectedness of topography, surface soil and runoff
- The interconnectedness of surface water and ground water
- Recharge and soil characteristics for underground flows
- Aquifers hydrogeology
- Mechanics of artificial recharge
- Machines of sustainable groundwater withdrawal

This it would be ensured that any planned development that would not be at the expense of water system but would enhance the localized augmentation of supply and in the process enhance and enrich the local ecology.

In India where the rainfall is concentrated in time the bulk of rain water flows away via riverine system. Indeed so far there has been an exaggerated emphasis on drainage. The realization is now sinking in that rainwater runoff and flood discharge constitute a major resource to beconserved. The usage of monsoon water whose arrival is concentrated mainly in three months needs to be dispersed over the year. Hypothetically, it is estimated that just 1% of the annual precipitation all over India, if stored, is sufficient to take care of its domestic water requirements.

Guidelines for Urban Planning and Development

Urban planning so far has been based on assumption that the colossal need of water of the fast growing population of our cities would be "somehow" served by the groundwater. It has not happened that the water supply scenario for all our metropolis is very grim and we can hope to overcome the problems of water scarcity only by taking all necessary steps towards harvesting rainwater at the city levels, community and individual use.

Necessary acts and byelaws need to be enacted by the states and local self-governments to incorporate rainwater harvesting as mandatory part of building design and city development. The following are some guideline policy recommendations and strategies to get maximum benefits from rainwater harvesting in future.

Techno-Economic aspects

Rainwater harvesting should be adopted as a national program with the objective of increasing ground water storage, and the quantum required for maintain the river ecology. The rainwater harvesting schemes should be based on scientific approach wherein the twin essential elements of source water availability for re-charge and suitable hydrological situations to create sub-surface reservoirs are given prime importance. Multidisciplinary approach including Climatological, hydrological, geological and geophysical aspects need to be adopted for designing rain water harvesting schemes.

Model rainwater harvesting projects in different hydrological setups should be implemented on larger scale so that these could act as “demonstration project” replication in similar environment. The areas with high rate of groundwater development, especially “over exploited” blocks metro and highly urbanized areas should get priority for implementing the rain water harvesting schemes.

Although on a macro scale, major areas suitable for rainwater harvesting have been identified, micro level studies in critical areas need plan for ground water resources management which are also required before implementation of new operational projects. Development of cheaper alternative for rainwater harvesting and conservation methods like laying of sub-surface dykes, various designs of recharge shafts, surface spreading methods and also other combination methods is a major thrust area for scientists and engineers-planners.

Regional aquifer system analysis should also be taken up on a larger scale for further development and management to ground water resources including rainwater harvesting. Central Government, State Governments, institutes and private organizations are required to make joint efforts to achieve it. Techno-economic evaluation of rain water harvesting schemes should be taken up to assess the benefits. A part of the component of the financial assistance from institutional finance agencies, including NABARD, must be set for recharge schemes and extended for the purpose.

A suitable pricing mechanism need to be adopted for water so as to recover the cost of rain water harvesting and management of water resources. It shall also help in promoting conservation of water resources. Rainwater harvesting projects should be taken up in coastal areas to prevent the sea water ingress. Traditional rainwater harvesting techniques, which have severely, eroded should be revived with a mix of modern techniques to private sustainability of water resources.

Planning and Management aspects

Clear delineation of rights of individual, community, state and centre over ground water in an area need to be defined by the planners and legal experts if maximum benefits are to be reaped though rainwater harvesting. Role of central state and local bodies is also to be defined clearly in construction and maintenance of rainwater harvesting structures.

People participation and social acceptance is essential for success of rainwater harvesting projects. There is no alternative to mass awareness for popularizing water resources management practices; otherwise all such programs may not be successful without people participation. All the rain water harvesting techniques should reach to the panchayat/ municipality level since these local bodies will be more effective in the management of ground water resources of their area. The participatory association of scientists, engineers and beneficiaries would definitely go a long way in proper and overall development and management of ground water resources.

Roof-top rainwater harvesting offers a good scope for recharging the ground water reservoir in urban areas. Creating such facilities with the construction of buildings be made mandatory and included in the building byelaws in urban areas. It should be responsibility of the urban municipal bodies to harvest the storm runoff from the existing drainage system, which can be effected investing little amount of funds.

Funds for rainwater harvesting are being released under various schemes such as water management, rural development etc. CGWB can be designated as nodal agency for technical vetting of schemes. It shall ensure technical viability of artificial recharge schemes including gainful utilization of funds.

Till recently, rainwater harvesting has been government’s efforts. Off late some NGOs and VOs are also coming forward and have done commendable work. A mechanism should be evolved so that continuous process of interaction among Central/ State Government agencies, local bodies, NGOs and VOs who in turn will ensure optimum utilization of funds for deriving maximum benefits from rain water harvesting schemes. This mechanism will also generate additional employment opportunities for local populace. Co-ordination between various central and state government agencies institutions and community in funding and implementing rainwater harvesting schemes in the core issue, if maximum benefits arise are to be obtained from such schemes. Projects/schemes are evaluated and success stories be disseminated through electronic and print media (TV, radio, internet, newspaper etc.) so that the same may be replicated.

Community Participation

From the experience of pani panchayat working in purandhar tehsil of Maharashtra State, model is a gogives learn various lessons, which can be directly implemented in other areas well as. The following recommendations shall be useful at the community level.

1. There should be a committee in each ward, which should take care of the water management of local area and maintain the local water harvesting structures.
2. For any proposal only group scheme should be taken, which fosters a community spirits.
3. Water should be shared on the basis of the number of family members and not size of landholding. In this way we can incorporate the principle of equity.
4. Water right should not accompany land rights, if the land is sold, the water rights revert to the group.
5. Beneficiaries must share, in cash, a total of 20 percent of the capital cost of any water harvesting project in the area according their water share, before the commencement of the project. People's participation is thus ensured. The balance 80 percent should be given by the government and other agencies as an interest free loan to be paid in five years. Project beneficiaries should administer, manage and operate the scheme. This recognizes the leadership capability and skills of the community people.
6. Uses other than residential should not be permitted in the area, which consume more water.
7. Landless people and poor and slum resident should also get a share of the water so that they can share the labor in the project. This helps them to get employment in the area itself and checks unemployment.

Designs of rainwater harvesting structures

Rapid urban expansions and rampant construction activities in the recent past have negative impact on water systems. These urban growth and construction have limited hydrological considerations in planning and later restrictions on water resource development made on strictly on engineering basis. In order to compensate the imbalance between the withdrawal and recharge rates rain water harvesting is a pre requisite in developmental activities. The rainwater harvesting proposed for the Greater Noida region to be incorporated in all planning activities are given below.

- House hold levels
- Cluster levels
- Neighborhood levels
- Sector levels
- City level

House hold levels: Rainwater harvesting structure in a house hold level depends on type of house, rainfall availability and water requirement. The collection tank size and material will be based on many such factors. An analysis of the daily rainfall will give an idea on average longest spell of non-rainy days in a year. This along with the requirement of water will determine the size of the tank. A dynamic daily storage and usage model will give an idea on how many days tanks will overflow and same can be directed to a recharge pit to recharge ground water.

Cluster levels: This is majorly housing societies. Here roof will be common and harvested water can be used for common purposes like washing gardening etc. The excess water can be sent either to storm water drainage or to underground pits. These waters can also be used for recharging the existing bore wells in the compound itself after a level of filtering.

Neighborhood levels: These are generally community levels such as schools. Here water harvesting can be done to underground reservoirs and can be provided to the users after necessary purification. Here also provision is necessary to pass the excess water overflowing the tanks to recharge pits or abandoned wells in the vicinity.

Sector levels: Sector Level is very important from the geological point of view. Generally, the lithology soil condition and groundwater level vary at this level. Hence on the basis on proper survey and information of the hydrogeological features we can specifically recommended the type and method or rainwater harvesting and recharge techniques. At the sector there are various land uses, on the basis of which we can further categorize the various rules and regulations related to rain water harvesting. Like for commercial use the measures and bye-laws will be different that the residential use. In the same way institutional and public buildings may have the common provisions. Roads, parks and other public open spaces can be used for rainwater harvesting. Atthis level government and public participation is must. The following general methods can also be adopted using the site condition. Small check dams are suitable for areas in the ridges. Structures like recharge shafts, recharge trenches are suitable for areas in the ridges. Structures Open Ground: Remove the top soil of a depth of 30cm to 60cm and place with river sand to allow for slow percolation of the rain water into the soil.

City level: The runoff water generated in monsoons within an area can be well utilized for ground water recharging by diverting it into suitably designed recharge structures in public parks, play grounds, stadiums, airports, stations, temple tanks etc. Storm water drains should be designed in such a way that two separate segments are made so as to accommodate water coming from house and water coming from the rocks. The segment on the side of the road should be covered with perforated slabs and should have percolation pits of depth 20 to 50 ft. depending on the soil condition at regular intervals.

Huge quantities of sewage waters generated from the domestic segment can be separated and reclaimed through soil aquifer treatment (SAT). This treated water can be used for recharging dry rivers for irrigation purpose.

Some issues for decision making and implementation

Countrywide demonstration projects in selected areas to provide useful information and ideas for rainwater harvesting and wastewater utilization. The scope of incorporating water harvesting in a micro-watershed basis and equitable use of this water in a way that it increases production and employment per unit of water needs to be the basis of regional planning. The need for correcting the current use of surface water by forming a grid of small watershed of individual wards and of major and minor industrial, institutional and other water uses. The potential of replacing land use planning with a combined land use water use planning is critical for developments.

The need for adopting participatory planning in city planning process to involve the community at household level with regard to planning for basic needs and services, like water supply and solid waste management.

Policy dimension

A policy for promoting urban water harvesting should include a mix of incentives and penalties. The experience of Chennai that to promote widespread, adoption of rain water harvesting in urban areas, a number of measures need to be undertaken which will be the case with Greater Noida as well. Most of these suggestions are not available with Greater Noida and is desired to be implemented here as well.

1. Town planning requirements must provide a checklist of essentials in which the provision of rain water is a prerequisite for sanction of all new colonies/layout.All building plans must provide for rainwater harvesting structures before applications are accepted. Provision of rainwater harvesting systems in plans should be followed up by enforcement, for example, at the time of grant of water/ sewer connections/ assessment of property tax etc.

2. Town planners/local authorities/municipal bodies must immediately provide for surface water percolation along roads/pavements and other open spaces.

3. No building/layout should be permitted to allow rainwater to flow into sewage drains or septic tank systems.Builders/planners should be given clear technical guidelines on cautions to be observed in providing storm water in a way that there is no contamination with septic tanks. Suitable punishments such as fines/disconnection of water supply should be provided for violation of such stipulations.

4. Misuse of water ways through discharge of sewage should be rigorously followed up with the provision of interceptor sewers along waterways. This should be avoided.

5. Rainwater harvesting systems must be promoted as a means of both provisions of water and prevention of flooding of low-lying urban areas.

A comprehensive approach is therefore necessary. The above policy initiatives can be further strengthened through legislation, legally compelling. Owners need to be compulsorilybuilding rainwater harvesting structures in all buildings. In additions, there is also the need to legally regulate groundwater use. No amount of rainwater harvesting will be of help in situation where there is no control on the amount of groundwater extracted.

Conclusion

To sum up it may be said that the last few decades of the 20th century have focused our attention to the problems of water shortage which we are likely to face in the next few decades. Luckily the science and technology has made it possible for the human being to find solutions to the problems provided the people take advantage of it. It must be our endeavor to protect our flora and fauna and conserve water to meet our needs. With the technologies available and legal policies, it should not be different to sustain our life by incorporating all the technologies to harvest rainwater.

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