ASSIMILATED WATER RESERVE MANAGEMENT FOR THIRUPARANKUNDRAM

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ABSTRACT

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. In Indian scenario, water resource have sufficient water to meet the requirements of many users in the country but inadequate management led to water scarcity problem. Thus, water resource management is became more important to utilize the water in efficient manner. The main problem in the local planning area is mainly due to rapid increase in the population and hence present infrastructure of water is not sufficient. Also there is tremendous growth of industrialization and agriculture production activities in the area which has led to increase in demand for water and the need for water supply infrastructure. In this paper, Thirupparankundram is taken as case study and Aqua cycle is a tool used for water resource management that reduces the water demand by 40%.

Keywords : Aqua Cycle Software, Integrated Management, Water Scarcity, Population, Industrialization

I INTRODUCTION

Water-related problems are series threats to humankind. Water use has more than tripled globally since 1950, and one out of every six persons does not have regular access to safe drinking water. Lack of access to a safe water supply and sanitation affects the health of 1.2 billion people annually (WHO and UNICEF, 2000). The latest global environmental outlook of the United Nations Environmental Program (UNEP) reports that about one third of the world's population currently live in countries suffering moderate-to-high water stress, where consumption is more than 10% of renewable freshwater resources. The problems may be attributed to many factors. Inadequate water management is accelerating the depletion of surface water and ground water resources. Water quality has been degraded by domestic and industrial pollution sources as well as non-point sources. In some places, water is withdrawn from the water resources, which become polluted owing to a lack of sanitation infrastructure and services.-

Adequate water infrastructure (like dams, reservoirs and artificial recharge structures) is required to ensure the sustainability of water resources to overcome scarcity problems. Infrastructure like pipe line network is also required to provide water related services, primarily water supply and sanitation, for the population, agriculture and industry, as well as for treatment and disposal of waste water.

Water supply and sanitation in India continue to be inadequate, despite longstanding efforts by the various levels of government and communities. The level of investment in water and sanitation, albeit low by international standards, has increased during the 2000's. Access has also increased significantly. No major cities in India is known to have a continuous water supply and an estimated 72% of Indians still have lack access to improved sanitation facilities.

This research attempts to simulate the water balance, imported water, wastewater discharge and storm water production of different strategies within study area by using Aqua cycle application. Since there is a water shortage within the study area at the present situation, finding alternatives for water sources would be a key factor to scope with this problem. Moreover, future scenarios of population growth and the effect of climate change are also taking into account to fully understand the performance of proposed strategies application.

II. INTEGRATED WATER RESOURCE MANAGEMENT

Integrated water resource management is a complex field, which includes provision of safe water supply and sanitation, sustainable use of water resources, pollution control, climate change adaptation, storm water and wastewater network management and flood prevention.

The main objectives of this study can be presented as following:

- To identify the alternative water sources throughout the water cycle and its quantity that may be available for the possible end use demands, such as rainwater, storm water and treated waste water
- To simulate alternate water management scenarios on the water cycle for existing situation and future population growth and climate change scenario

- To investigate the relationship between the spatial pattern of demand, supply and storage capacity on the reliability of a range of alternative water sources
- To examine the material flows (nutrients) based on the application of water balance model

III. AQUA CYCLE

There is a large number of models available for describing the urban water system. Water Cress (Clark *et al.*, 2002) and Aqua cycle are quasi-distributed daily time step models. The former divides a study area into water system components (nodes) that are interconnected by drainage or supply links, while the latter divides the study area into clusters that comprise residential and industrial areas, roads and open spaces. Water Cress models the quality characteristics of water streams, whereas Aqua cycle focuses more on urban water balance aspects, estimating the volume of water demand and available storm water and wastewater in different spatial scales.

Aqua cycle has been developed with the objective to simulate the urban water cycle as an integrated system and can be a powerful tool in investigating the use of locally generated storm water and wastewater as a substitute for imported (fresh)water in order to improve efficiency in water use (Mitchell *et al.*, 2001). The modelling approach accounts for all stages in the urban water cycle, including the operation of water supply, wastewater production and Storm water runoff systems. The "cycle" starts with water entering as precipitation and imported freshwater in order to meet indoor and outdoor water use requirements. It then passes through the urban water system and exits in the form of evapotranspiration, Storm water and wastewater. Aqua cycle operates on three spatial scales (unit block, cluster, and catchment), in order to enable the modelling of alternative system configurations and the evaluation of alternative recycle and reuse schemes.

The **unit block** can refer to a single household, industrial site, or a public or commercial facility. This scale represents the smallest unit for the management of water supply, disposal and recycle-reuse operations, and is spatially divided into roof, garden and pavement areas.

A **cluster** represents a group of uniform unit blocks that can form a local neighbourhood or suburb. In addition to unit blocks, a cluster includes roads and public open spaces, and is used to represent the spatial scale at which community water servicing operations are managed.

Finally, the **catchment** is made up of a group of clusters.

In Aqua cycle, surfaces are divided into two categories: pervious and impervious. Impervious surfaces (roofs, road and paved areas) are represented as single stores that overflow when full. Pervious areas are divided into areas which produce runoff during a rainfall event and those that do not. Water evaporation from both pervious and impervious surfaces is calculated according to daily evapotranspiration values. The algorithms calculate the total amount of water discharged as storm water runoff from roads, roofs, and paved areas and pervious areas. The amount of water imported into an area is the sum of indoor water use, irrigation, and leakage. The total wastewater discharged from the catchment is the sum of indoor water use, infiltration and inflow from the storm water drainage system.

The Aqua cycle input data requirements are related to physical characteristics of the modelled catchment. A distinction is made between measured and calibrated parameters. Measured parameters are related to physical catchment characteristics and their values are determined through measurement, observation or local experience (e.g. roof and road area), whereas calibrated parameters are estimated by an in build optimisation function and are related to water use, wastewater production and storm water drainage (e.g. trigger-to-irrigate ratios). The Aqua cycle package also models a range of technologies which have the potential to provide alternatives for individual and community scale water management actions. At the unit block scale, options for storm water and wastewater exploitation include the installation of rainwater tanks, on-site wastewater treatment units and subsurface irrigation with grey water.

At the cluster scale, methods include storm water storage, wastewater treatment and storage and aquifer recharge and recovery.

Finally, centralized options applicable at the catchment scale can also be examined, including wastewater reuse and storm water storage in order to meet the needs of a particular or several clusters.

IV METHODOLOGY

1. Literature Review
2. Base Map Preparation
3. Data Collection
4. Problem Identification
5. Analysis
6. Outcome

4.1 Data Collection

The six input files are shown below

- Indoor water usage profile
- Climate data
- Unit block
- Cluster;

- Catchment
- Parameter and Initial values

1	Supply garden irrigation with imported water? 0 or 1
2	Rain tank storage capacity in m3 >= 0
3	Rain tank exposed surface in m2 >= 0
4	Rain tank first flush in Litres >= 0
5	Domestic hot water from rain tank? 0 or 1
6	Domestic kitchen cold water from rain tank? 0 or 1
7	Domestic bathroom cold water from rain tank? 0 or 1
8	Domestic laundry cold water from rain tank? 0 or 1
9	Domestic toilet water from rain tank? 0 or 1
10	Domestic garden irrigation from rain tank? 0 or 1
11	Kitchen greywater for sub-surface irrigation? 0 or 1
12	Bathroom greywater for subsurface irrigation? 0 or 1
13	Laundry greywater for subsurface irrigation? 0 or 1
14	Waste water treatment and storage capacity in m3, >= 0
15	Waste water treatment and storage exposed surface in m2, >= 0
16	Treat kitchen wastewater? 0 or 1
17	Treat bathroom wastewater? 0 or 1
18	Treat laundry wastewater? 0 or 1
19	Treat toilet wastewater? 0 or 1
20	Toilet water from wastewater store? 0 or 1
21	Garden irrigation from wastewater store? 0 or 1
22	Waste water storage overflow to sewer? 0 or 1
23	Waste water storage overflow to storm water? 0 or 1
24	Unit block runoff draining to cluster stormwater store? 0 or 1
25	Supply toilet from a cluster stormwater store? Specify cluster number or 0
26	Supply garden irrigation from a cluster stormwater store? Specify cluster number or 0
27	Unit block wastewater draining to cluster wastewater store? 0 or 1
28	Supply toilet from a cluster wastewater store? Specify cluster number or 0
29	Supply garden irrigation from a cluster wastewater store? Specify cluster number or 0
30	Supply toilet from catchment scale stormwater storage? 0 or 1
31	Supply garden irrigation from catchment scale stormwater storage? 0 or 1
32	Supply toilet from catchment scale wastewater storage? 0 or 1
33	Supply garden irrigation from catchment scale wastewater storage? 0 or 1

0 = no; 1 = yes

Indoor Water Usage Profile

The indoor water usage water profile contains data on domestic waster use with order from occupancy one to seven. It includes Household occupancy, Kitchen water use, Bathroom water use, Toilet water use, Laundry water use.

Climate Data

The climate data file contains historical daily rainfall and potential evaporation data series in unit millimetres per day.

Unit Block

Unit block data input contains details option selected for the unit blocks within each cluster being simulated. Unit block characteristic is homogenous within one cluster, but this characteristic may differ between clusters. Data input sheet for unit block is shown above.

1	Catchment size in hectares, >= 0
2	0
3	Catchment scale stormwater storage capacity in m3, >= 0
4	Catchment scale stormwater storage exposed surface area in m2, >= 0
5	Catchment scale stormwater storage first flush in m3, >= 0
6	Catchment scale wastewater storage capacity in m3, >= 0
7	Catchment scale wastewater storage exposed surface area in m3, >= 0
8	Catchment scale wastewater storage overflow to stormwater not sewer? 0 or 1

0 = no; 1 = yes

(a)

1	Cluster scale stormwater storage capacity in m3, >= 0
2	Cluster scale stormwater storage exposed surface in m2, >= 0
3	Cluster scale stormwater storage first flush in m3, >= 0
4	Road runoff to cluster scale stormwater store? 0 or 1
5	Collect stormwater from upstream sluciers? 0 or 1
6	Cluster scale wastewater storage capacity in m3, >= 0
7	Cluster scale wastewater storage exposed surface in m2, >= 0
8	Collect wastewater from upstream clusters? 0 or 1
9	Cluster scale wastewater storage overflow to sewer? 0 or 1
10	Cluster scale wastewater storage overflow to stormwater? 0 or 1
11	Aquifer storage and recovery storage capacity in m3, >= 0
12	Maximum aquifer storage and recovery recharge rate in m3/day, >= 0
13	Maximum aquifer storage and recovery rate in m3/day, >= 0
14	Supply public open space irrigation from imported water? 0 or 1
15	Supply public open space irrigation from a cluster stormwater store? Specify cluster number or 0
16	Supply public open space irrigation from a cluster wastewater store? Specify cluster number or 0
17	Supply public open space irrigation from the catchment stormwater store? 0 or 1
18	Supply public open space irrigation from the catchment wastewater store? 0 or 1
19	Drain stormwater runoff into the cluster stormwater store? 0 or 1

0 = no; 1 = yes

(b)

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(c)

Catchment

Catchment data input contains detail on the water options selected for the catchment within each cluster being simulated. Data inputs for catchment are shown below(a)

Cluster

Cluster data input contains details on the water options selected for each cluster within catchment being simulated. Within catchment, arrangement between clusters may be differ. Data input for cluster are shown below (b)

Parameter and Initial Value

The parameter and initial value input contains details on the measured parameters; calibrated parameters; and initial storage level values for each cluster in the catchment being simulated. Data input for catchment is shown below (c)

4.2 Problem Identification

It is clear that water balance principle is the main key of understanding the urban water cycle. By quantifying the water balance for “what if scenarios” under different proposed strategies will help us to estimate the amount of potential water sources available in study area, and how to deal with uncertainties related to water shortage problem in the future.

In this research, the proposed alternatives strategies have been applied in some part of the world; however the applicability of them depends on the local situation. Community survey and cost and benefit analysis are needed to identify the practicability of the proposed strategies which is beyond the scope of this study

4.3 Analysis

By using the Aqua cycle model, the analysis are taken place by using the above mentioned data.

The options analysed with Aquacycle, each formulated as a unique water management scenario were:

• On-site rainwater use, involving the introduction of a 2 m3 capacity rainwater tank at the unit block scale. The tank collects roof runoff for indoor (kitchen, laundry, bathroom, toilet flushing) and outdoor water uses (garden irrigation). Tank overflows are directed to the stormwater drainage network, and water supply deficits are met through freshwater imports.

• On site wastewater reuse, where household wastewater is treated in an on-site wastewater treatment unit. A 5 m3 storage tank is used for storing treated wastewater, which is further used for toilet flushing and irrigation purposes at the unit-block scale.

• Sub-surface grey water irrigation, where grey water flows from kitchen, bathroom, laundry and toilet uses, are used to meet garden irrigation requirements. Grey water is directly distributed to the garden through a sub-surface drainage field, according to the daily irrigation requirements

V CONCLUSION

Due to the population growth and climate change prediction above, it is clear that there is an urgent need for water source alternatives to provide adequate urban water supply. By taking into consideration water recycled practices through Household rainwater tank (HHRWT), waste water treatment (WWT) and the combination of those strategies, less amount of imported water will be needed. However further research is needed as identified in this study.

Based on the water balance simulation, all proposed strategies (HHRWT, WWT and the combination of them) result to the decrease of imported water needed to be distributed to the study area, as well as amount of wastewater and storm water discharge. Combination of Household rainwater tank and cluster Waste water treatment could be a promising strategy since it contributes significantly to the reducing amount of imported water by 52% on present situation.

By using the method, we can reduce the water demand of this area. If it works efficiently it can be used for nearby areas and the water scarcity is decreases drastically.

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