

# Precautionary Water Resource Management for Sustainability by District Metered Area (DMAS) and Remodeling STURE Structure— A Case Study

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**ABSTRACT:** Sustainable management of water resources and access to safe drinking water and sanitation are essential factors for nurturing economic growth and productivity. As per the global goals of sustainable development (17 goals) and management 6<sup>th</sup> goal is Clean Water and Sanitation. And from these goals has 8 targets, 11 indicators and from this one target is to have a clean and sufficient quantity of water for drinking and sanitation purpose. So, sufficient quantity and clean water are supplied to uneven higher and lower elevated areas by use of the District Metered Area (DMA's).DMA's is the solution to create a permanent leakage control system by dividing the network into several sectors. The leakages which allow the mixing of impurities to the water can be prevented. The STURE model is applied to this case study for proper management and attain sustainability.

**KEYWORDS:** District Metered Area, Water distribution network, Sustainable development goals, STURE model

## I. INTRODUCTION

Sustainable Development Goal which is called as Global goal was adopted by more than 170 countries and territories. The 6th goal (SDG 6) Clean water and Sanitation ensure sustainable management and availability of water for all it also confirms the importance of water in the political agenda. SDG 6 perceives that counties economic growth and social development depend on sustainable management of freshwater resources and ecosystems[9]. SDG 6 i.e providing clean water in equal quantity to all is achieved by District Metered Area with the help of Water GEM's software [1]. As water networks worse, they become prone to leakage. Also, new networks frequently include leaks as a result of poor installation practice, incorrect materials and upflow and downflow[2]. Where the distribution network comprises hundreds or thousands of kilometers of pipework, it is not an easy task to locate the bursts and breakages, particularly as many are invisible. This situation progressively worsens until, in extreme cases, it becomes necessary to ration the water for part of the day by closing off the supply. For such a situation permanent leakage control system can be established by dividing the network into the number of zones[3,4]. The traditional way practice to control the leakage is a passive one, leakage is repaired only when it is visible.some of the acoustic instruments improve the situation, allowing the invisible leaks to be located. But these instruments are costly and for the large area, it is time-consuming. So, the permanent solution for leakage control divides the network into District Metered Area (DMA's) system by a limited number of key mains, on which flow meters are installed.

## II. METHODOLOGY

The present study incorporates data collection and consumer survey, a study of the water distribution system, upstream and downstream elevation, generation of the hydraulic model in Water GEMS, District Metered Area marking dividing the network to partial zones residual head, pressure measurement at various location in the study area, analysis of the calibrated model for residual pressure under gravity main. By DMAs permanent pressure control system is established.

The sustainability goal is achieved by this process and the STURE re-model is used to create policy, plan, strategic layout for the sustainability program.

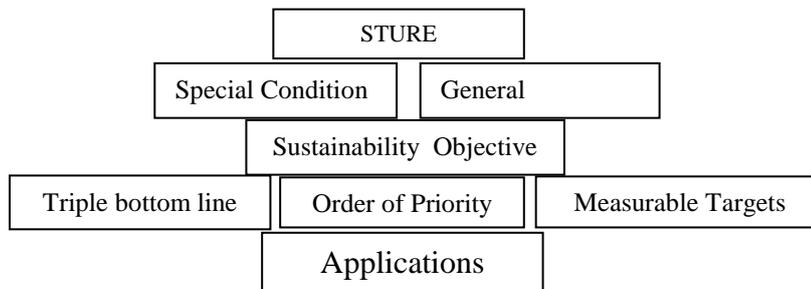
**1.1. BRIEF AREA DETAIL**

A small area of Tekapara, Chattisgarh state. This area is divided into 3 zones, the three zones depending on elevation are taken into consideration. The first part is having RL more than 30- 40 m from elevated service reservoir, the second zone is having RL between 0-5 m and the third zone is having an elevation between 25-40 m.

**1.2. HYDRAULIC MODEL DESIGN WITH DMAS**

Bentley WaterGEMS V8i version was used for the generation of the hydraulic model. The details of various input parameters required for different components of the network like pipes, nodes, tanks, pumps, and reservoirs were collected from field surveys and by Google Earth. After the generation of the model, using pressure gauge, field measurements for residual pressure were taken. The model was calibrated for residual pressure and adjusted values of the roughness coefficient for different pipe material were determined. In the Hydraulic Model HDPE, 6 kg/cm<sup>2</sup> pipes are used of different diameters. The establishment of DMAs will enable the current levels of leakage to be determined and to consequently prioritize the leakage location activities. By monitoring flows in the DMAs it will be possible to identify the presence of new bursts so that leakage can be maintained at the optimum level[7,8].

**Evaluation with STURE model**



The first step of the STURE model is there are two conditions; First condition based on general specification regarding sustainability and second is a special condition considered for environmental protection.

Following general and special conditions are considered at the planning phase for a specific case study.

**General conditions For Case Study** – STPES Model maturity roadmap based on Increasing awareness, Developing Strategies, Increasing visibility, Improving performance, Sustaining the performance. Government Environmental policies, Indian Government Environmental legislation provisions are taken into consideration.

**Specific conditions For Case Study** –

1. Environmental Friendly material has to be used when actual development started. We are considering plastic piping systems should a variety of attributes that make them a sustainable and environmentally-responsible decision. Life Cycle Assessment studies for high-density polyethylene pipe estimate that the entire energy consumption is about 95 MJ per kg of pipe (approximately 26 kWh per kg of pipe). A low carbon footprint, lightweight also plastic piping have fuel-efficient shipping, hazardless installation, long service life, and recyclability are among the many features and benefits that make a plastic piping system the preferential choice.

2. Soil Erosion Control techniques consider for excavation of pipeline. Excavation process involves disturbance to the existing soil conditions, in lesser level removal of existing trees and the overall change in the microclimate and drainage pattern. Steps to minimize precarious effects should be put into effect as described below.

- i. Excavation work and erosion handle applications shall be programmed and sequenced during dry weather periods when the potential for erosion is the most moderate.
- ii. Try to protect existing vegetation. We prepared the landscape plan for the case study that indicates trees, which have been preserved.

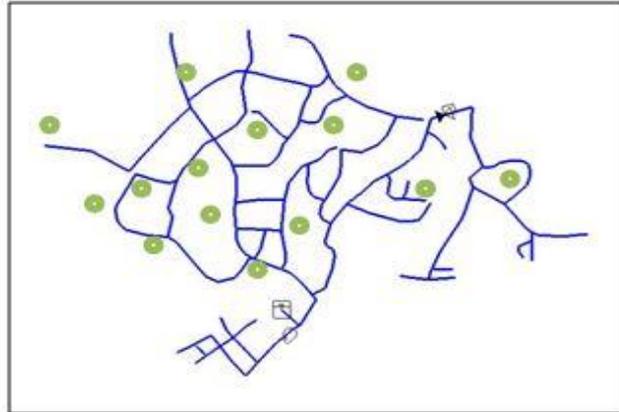


Fig. no 1 Green Spot in the image indicates trees that have been preserved.

3. Retain natural topography of the site.
4. Basic facilities will be provided for plumber and excavation workers as per below-  
First Aid, Ambulance Services, Temporary washroom, Restroom, Safety, and Welfare program, Transport service.
5. Water-efficient plumbing fixtures. We are focusing on a zero leakage water distribution system.
6. A solar-powered automated water pumping system for eco-friendly water distribution.

$$\begin{aligned}
 \text{Population} &= 3690, 70 \text{ lpcd} , \\
 &= 3690 \times 70 \times 1.2 \\
 &= 258300 \times 1.2 \\
 &= 309960 / 10^6 \text{ Water Demand} \\
 &= 0.309960 \text{ MLD} \\
 &= \frac{0.30996 \times 10^6}{24 \times 3600} \\
 &= 3.5875 \text{ Lps.}
 \end{aligned}$$

$$\text{Capacity of tank} = \frac{309960}{2} = 154980 \text{ that means approximately } 150000 \text{ liters}$$

$$\begin{aligned}
 \text{Rate of Pumping} &= 0.30996 \times 12 \text{ hr} \times 10^6 \\
 &= 25830 \text{ L/hr}
 \end{aligned}$$

$$\begin{aligned}
 \text{Pump efficiency} &= 65 \% \\
 \text{BHP required} &= 6 \text{ BHP}
 \end{aligned}$$

Generally, 746 Watts powers required for safe working of 1 HP pump. 3 A solar panel generates approximately 760

Watts power. So, 1 HP – 746 W - 3 panel  
For 6 HP we required 746×6= 4476 W  
To Generate 4476W we required 3×6=18 Solar Panels.

The second step of the STURE model is about the development of the Sustainability program. The sustainability program is the outcome of an optimization of the specific and general conditions. In consists of three-part: Sustainability Objectives, Priority of sustainability objectives, Sustainability target. We fixed our sustainability objectives for a project on the concept of triple-bottom-line

- Environmental - Try to protect existing vegetation. Soil Erosion Control techniques consider.
- Economical - Installation and maintenance of solar-powered automated water pumping systems are 50% more economical as compared to the working life span.
- Social - Social and cultural values are to be considered in the planning, construction, and maintenance phase also occupational health, safety good working conditions objectives are made in the specific condition of the project.

STURE Third step is correlated with the second step so our objectives developed in the sustainability program with consideration of triple bottom line, an order of priority and set targets. We apply our developed program of sustainability in brief documented context on the district metering area. Some of the objectives are as below.

Objectives

1. Improvement in the water distribution sector
2. Low leakage and reduce water wastage.
3. Reduction of hazardous impact while improving values.
4. The sustainable approach in designing and planning phase.
5. Protecting the existing landscape.
6. Use of renewable energy for the water distribution system.

II. RESULTS

3.1 After running the hydraulic model of water network without the use of DMAs the results are shown in the fig. no. 1 the color-coding represents the pressure in that specific area. The red color pipes indicate low pressure and green color represent high pressure in the pipeline and blue color pipes having normal pressure. The detail of pipe pressure is shown in table 1. The result obtains by STURE model planning and running the hydraulic model by Using DMAs the result are figuratively shown in fig. no. 3. In Water GEMS, the DMAs model with PRVs and solar Pumps help to maintain the pressure.

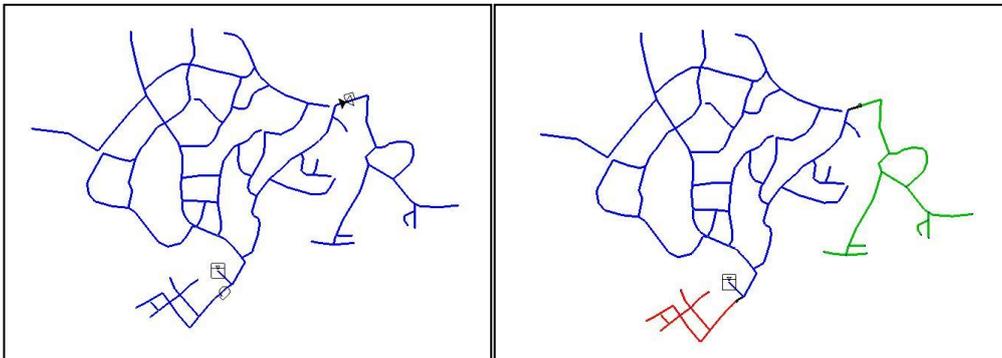


Fig. no 2 without DMAs

Fig. no 3 with DMAs

Lower Elevated Area (Green Part From Fig. 3)				
Label	Elevation (m)	Demand (l/s)	Pressure (m H2O) without PRVs	Pressure (m H2O) with PRVs by DMA Structure
J-1	283.987	0.03	58	19
J-2	283.859	0.03	58	19
J-3	283.627	0.03	58	19
J-4	283.557	0.05	58	19
J-5	283.496	0.06	59	20
J-6	283.103	0.04	59	20
J-7	283.000	0.12	59	20
J-8	283.199	0.03	59	20
J-9	283.000	0.03	59	20
J-10	282.456	0.08	59	20
J-11	281.887	0.15	60	21
J-12	281.439	0.04	60	21
J-13	281.311	0.04	61	22

Higher Elevated Area (Read Part from fig. 3)				
Label	Elevation (m)	Demand (l/s)	Pressure (m H2O) without Pump	Pressure (m H2O) with Pump by DMA Structure
J-1	369.918	0.02	-27	12
J-2	369.889	0.02	-27	12
J-3	369.823	0.02	-27	12
J-4	369.784	0.02	-26	12
J-5	369.610	0.03	-26	12
J-6	369.437	0.02	-25	12
J-7	369.373	0.03	-24	13
J-8	369.304	0.04	-24	15
J-9	349.257	0.15	-24	15
J-10	349.051	0.12	-20	15
J-11	329.394	0.13	-18	18

Color coding	Pressure range (m H2O)	
	-27 to -18	Negative or low pressure
	58 to 61	High or breakage pressure
	12 to 20	Feasible pressure

**STURE Table**

Project Name	STURE conditions		Sustainability program	Objectives	Triple bottom line	Order of priority	Measurable targets	Applications
	Specific conditions	General conditions						
<b>Tekapara, Chattisgarh state.</b>	Considered	Considered	Developed in the planning phase. Also, Monitoring Phase is included	Considered	Yes, Objectives are based on the triple bottom line	Point fulfill with General Condition	Point fulfill with consideration of specific conditions	Brief document of sustainability

STURE optimizes the desired concern of sustainabilities and formulates data to create fundamental polices for positive future impact on the environment.[10]

**III. CONCLUSION**

It is possible to reduce leakages in the network where traditional acoustic technology is not able to apply. Invisible leakages are identified in a low-pressure area. Maximum Leakages can be prevented by zoning the network. In this way, it is possible to regularly check the leakage level in each DMA so that the leakage location activity is always directed to the worst parts of the network. Remodeled system of STURE help to prioritize motives and to collect information on how to organize the procedures or alternatives to boost the mainstream Hydraulic Model Design work towards sustainabilities. STRUE optimizes the desired concern of sustainabilities and formulates data to create fundamental polices for positive future impact on the environment.

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