

## **Ngo's Contribution In Conservation Of Water By Adopting Zero Liquid Discharge Processes And Rainwater Harvesting – A Case Study Of Vadodara Based Ngo**

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### **Abstract**

*In the year 2015, the members states of United Nations in its agenda 2030 for sustainable development goal (SDG) taken an urgent call for action by all countries – developed and developing in a global partnership for the peace and prosperity for the people and the planet, now and into the future. The SDG 11 and 12 emphasized on sustainable consumption and production patters, and human settlement to have inclusive, resilient and sustainable growth. With the increase of global population, rapid industrialization and urbanization, inadequate reprocessing of waste water and its reuse, traditional flood method of farming, depletion of ground water level are few critical factors causing shortage of usable water for drinking or irrigation or other purposes. 40% of the world population will be facing severe water shortage in the next decade (GiveIndia, 2021; CPCB, 2016). It is estimated that in planet, only 2.5% is fresh water and can be used for drinking purpose. In India the astonishingly beautiful and distinctive lakes act as water reservoir and also play an important role in maintaining ecological balance. Natural water bodies such as lakes & ponds are the sources of drinking water, help control floods, supports bio-diversity and regenerate ground water (Constellation, 2022). Unfortunately, many of these water bodies either dried-up or filled for development or heavily polluted. Over 80% of crude sewage is discharged into water bodies such as lakes/ponds, rivers and oceans in developing countries like India (GiveIndia, 2021). The scientists predicated that India will face a severe water crisis by 2030 if appropriate actions are not taken (GiveIndia, 2021). Non-Governmental Organizations (NGOs) across the world have taken many initiatives to conserve the water. In India, the NGOs implemented water conservation projects such as cleaning and restoring the lakes/ponds and other water bodies, conducting awareness program on water conservation, work in collaboration with communities, local authorities, students, village panchayat for implementing water conservation program. The researcher felt it necessary to study the initiatives taken by the NGOs for water conservation. A study of Vadodara based NGO who is engaged in educational development of underprivileged children at NGO's residential premises was undertaken to understand the water conservation measures taken at the hostel premise of the NGO and the benefits achieved by conservation of water. For the study, NGO and the participants of the NGO are selected using purposive sampling technique. The participant includes functionaries, teachers & children of the NGO who are staying in the hostel premises. The total number of participants were thirty (n=30). The major findings are, 1) the NGO has implemented various water conservation measure to achieve nearly Zero Liquid Discharge (ZLD), 2) bath water, toilet flush, floor wash, kitchen basin water, utensil cleaning water etc. are transported from all the building through pipelines and finally collected at the inlet chamber of sewage treatment plant. The sewage treatment plant (STP) processes the waste water and converts into clean water and sloid waste. The treated water is stored in a pond made of cement concrete with HDPE lining at the bottom to prevent water percolation and act as a source of water for gardening, organic farming and entire playground watering, 3) the solid waste generated from the sewage treatment plant is used in the campus as manures, 4) for rainwater harvesting the Trust has implemented two major system, a) roof top rainwater of the buildings is collected in an underground water storage tank of RCC construction. This water is used for drinking, bathing, toilet flush, cooking etc., b) the rainwater of entire landscape of the campus is collected through water collection chamber located at different areas of the campus and then transported to the rainwater discharge well of 150 feet deep through interconnected underground pipelines to improve the ground water level and reduction of Total Dissolve Solid (TDS) which at present is in the range of 2900-3800, 5) periodically awareness program are conducted for the resident underprivileged children and functionaries/teachers/staffs for conservation of water. Water conservation sticker are put in wash basin/toilets.*

**Key words:** Conservation of water, Rainwater harvesting, Non-Governmental Organizations (NGOs)

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## **I. Introduction**

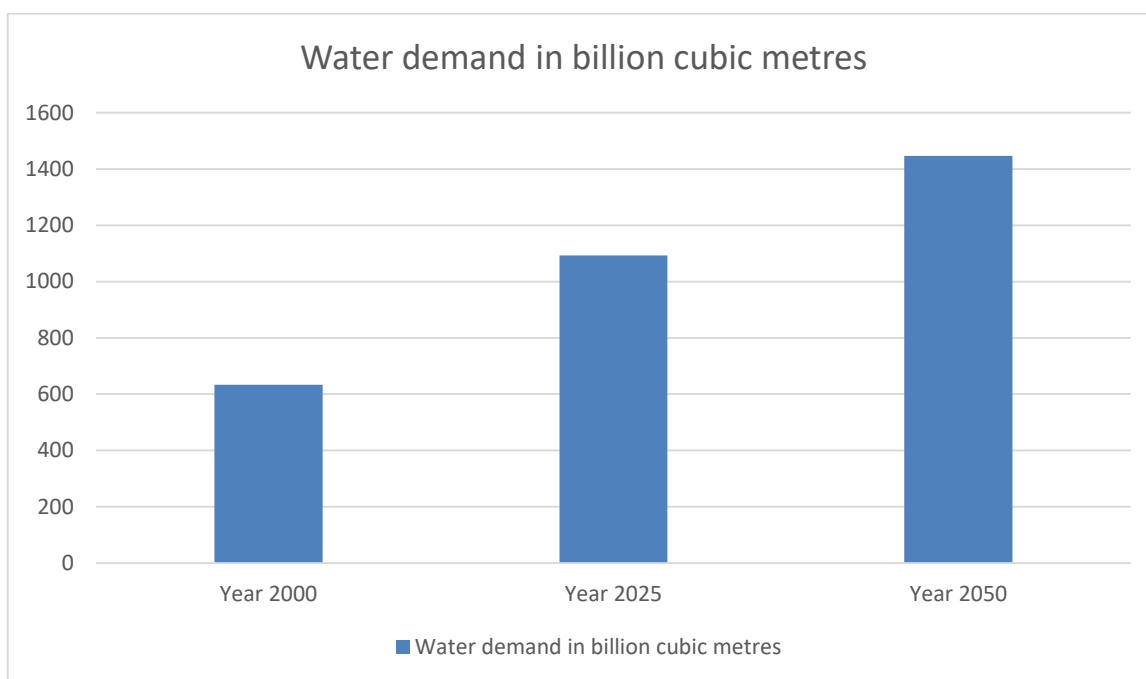
Water conservation is the practice of using water efficiently to reduce unnecessary water usage. According to experts, water conservation is important because fresh water is a limited resource, as well as costly one. Water consumption encompasses the policies, strategies and activities to manage fresh water as a sustainable resource to protect the water environment and to meet the current and future human demand. People are, in general, less aware of the financial costs of inefficient water use and impact on sustainability of our society/environment (Constellation, 2022; Sarangi, Madramootoo & Cox, 2022; Wikipedia, 2022). Only 2.5% of all water on earth is fresh water, of which less than 1% is accessible. Fresh water is essential for drinking water, agriculture, irrigation, industry and power generation. 10% of world's animal species live exclusively in fresh water habitats, many of which are threatened with extinction (Earth easy, 2022). It is a fact that it was never been so important to protect our fresh water environment. This is acknowledged by the United Nation's sustainable development goals. In particular UN's Goal 6 states - 'Ensure availability and sustainable management of water and sanitation for all'. The two important issues with fresh water are, a) quantity (or scarcity) and b) quality. It is estimated that by 2050, nearly half of the world's population will be living in areas where water is scarce and over a quarter of cities globally are already facing water stresses. It is also seen that death due to water quality is more each year compared to that from all forms of violence including wars. Poor water quality is also causing risk of extinction threat to fresh water fish species and 30% of amphibian (Constellation, 2022; Wikipedia, 2022). The key activities of water conservation are, a) beneficial reduction in water loss, b) avoiding any damage to water quality, c) treating waste water by advanced technological process and convert the waste water into usable water, d) improving water management practices that reduce or enhance the beneficial use of water, e) construction of catchment areas to collect rainwater and its appropriate usage (Wikipedia, 2022). Ministry of Jal Shakti, department of water resource, Government of India (GoI) has implemented water conservation projects in association with local community and voluntary organizations. The main agenda of the volunteers was to ensure water availability through the creation and conservation of water resources in the villages, so that the water is available as a basic right. The volunteer liaison with government bodies for renovation of water bodies which are in dire need of repair. In many parts on India, earth is excavated in huge scale to meet the requirement of railway track paying, highway construction, building construction. The water conservation projects utilized these empty spaces as rainwater harvesting pond and human use (CPCB, 2016; Give India, 2021; Moorberg, 2019). It is observed that after 2000, the ground water level has depleted due to power subsidy by the Indian government. Well-off farmers used powerful deep borewell to draw water for their farmland. This resulted fall in ground water level. Poor farmers suffered as the water levels falls below the suction point the bore well installed by the poor farmers. Subsequently interconnected borewell irrespective of owner has resolved the problem. Israel is one of the pioneer countries of the world in water conservation in irrigation, waste water recovery and other water conservation program. One of the biggest modern innovation of drip irrigation was developed by Israel in the year 1960. It is a revolutionary idea of using low pressure slow dripping water through plastic tubing so that appropriate quantity of waters is given to the crop/plants. Similarly, it is estimated that Israel restores around 70 to 80% of the waste water and the processed water is used in irrigation/agriculture (Appropedia, 2014). Water scarcity has reached a new level in India. Farmers are facing a lot of difficulties in cultivating crops with reduced water availability in different regions of India. What is more worrying is that water scarcity is expected to aggravate further in future. Projection made by International Water Management Institute (IWMI) that one third of world's population would face absolute water scarcity by the year 2025. NITI Ayog, the think tank of India, released a report in the year 2018 wherein the scarcity of water is acknowledged and also stated that water stress is going to rise if immediate measures on water conservation is not taken (Naryanmoorthy, 2019; Balasubramanian, 2022). In India, the Central Pollution Control Board (CPCB) enacted in 1974 and amended in 1988 to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country (CPCB, 2016). In order to conserve water in irrigation which accords 80% of fresh water consumption, drip irrigation technology is used in many regions/states of India, thereby elimination traditional flood irrigation method. In India, water consumed in irrigation is two to three times more than that of China, Brazil and the Unites States of America (Naryanmoorthy, 2019). In India, drip irrigation technology in agriculture is implemented in the 1980s and found that it saves 30 to 70% of water for different crops. Efficiency of drip irrigation is 90% whereas it is only 30 to 40% in case of flood method of irrigation (Naryanmoorthy, 2019). A nationwide study by National Mission on Micro Irrigation (NMMI), found that the major benefits of drip irrigation are, a) reduction in water consumption, b) reduction in power consumption by 30%, c) productivity and quality of crop, d) reduction in fertilizer consumption by 28% and d) reduction in cost by 20 to 50%, though initial capital cost is more. The

study also proved that drip method of irrigation is economically viable even for small and marginal farmers who has to invest capital cost. The study also estimated that 80% of crops can be cultivated by drip irrigation method (Naryanmoorthy, 2019). The table 1 below shows the increasing trend in farming area using drip irrigation method (Naryanmoorthy, 2019).

**Table 1**  
*The increasing trend in farming area using drip irrigation method*

Year	Area in ha
1985-86	1500
1991-92	70859
2007	42440000

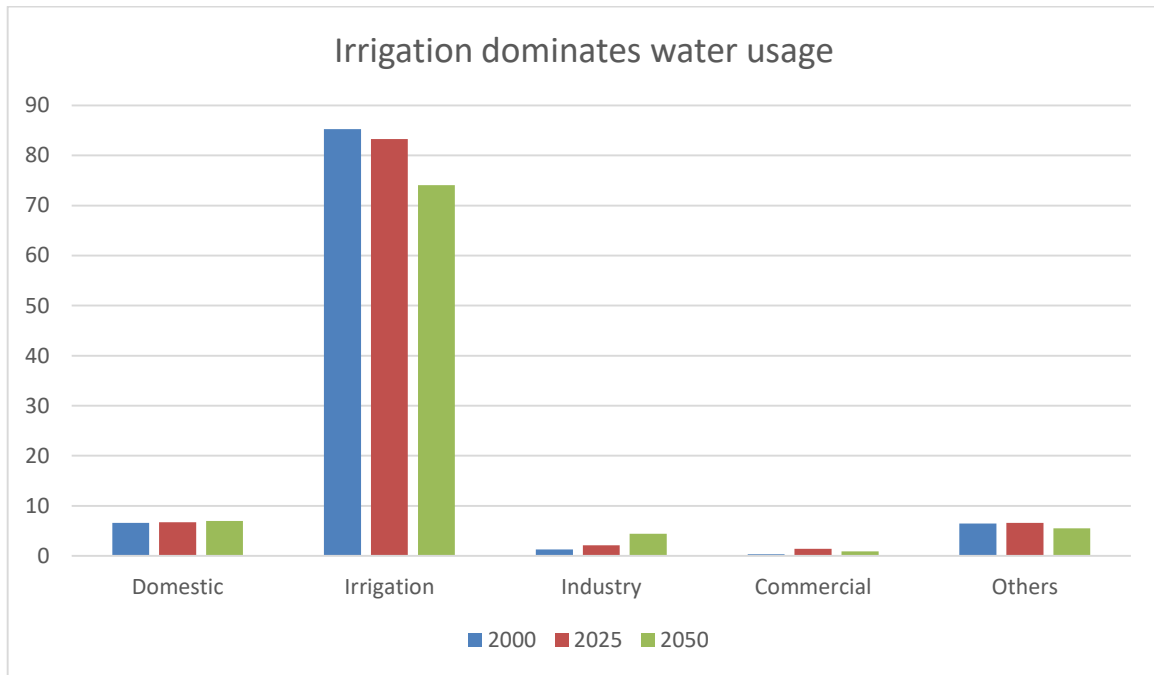
Per capita water demand in urban area is 135 liters against 40 liters in rural area. As per UN, the urban population in India is expected to rise 50% of total population by 2050. This would mean 840 million people in the most water stressed parts of the country compared with 320 million today. Therefore, supply and demand of fresh water is a growing concern in India. The figure 1 to 4 below explains India's water demand, water usage tend, ground water usage and sources of water.



**Figure 1**  
*The pace of growth in water demand in India*  
Source: Central water commission, 2009

**Analysis**

- The water demand is increasing year after year due to increase of population and faster rate of urbanization
- The water demand will be more than double by 2050 from present water demand
- If water conservation measures are not taken, there will be absolute scarcity of fresh water and many species will be extinct



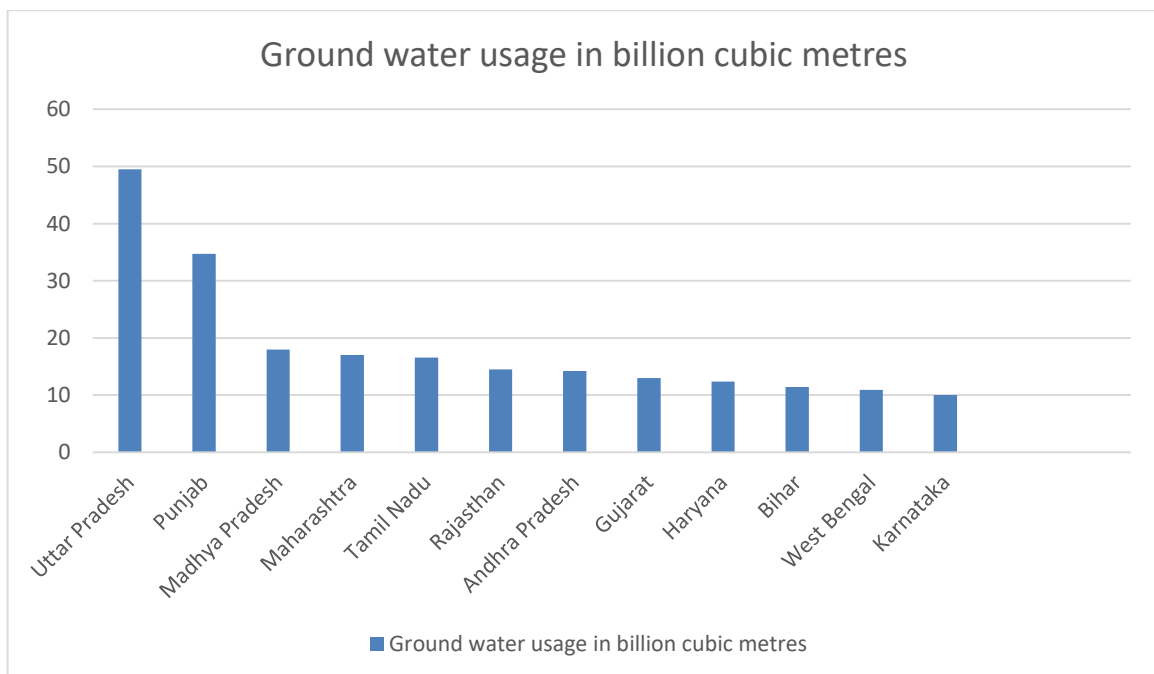
**Figure 2**

*Irrigation dominates water usage*

Source: Central water commission, 2009 in billion cubic meters

**Analysis**

- Irrigation water requirement dominates and it is around 80% of total fresh water requirement
- Implementation of technology in water conservation is the only solution to conserve water
- Government's initiative in water conservation has some impact in water conservation. The data shows that the fresh water consumption in irrigation is in reducing trend



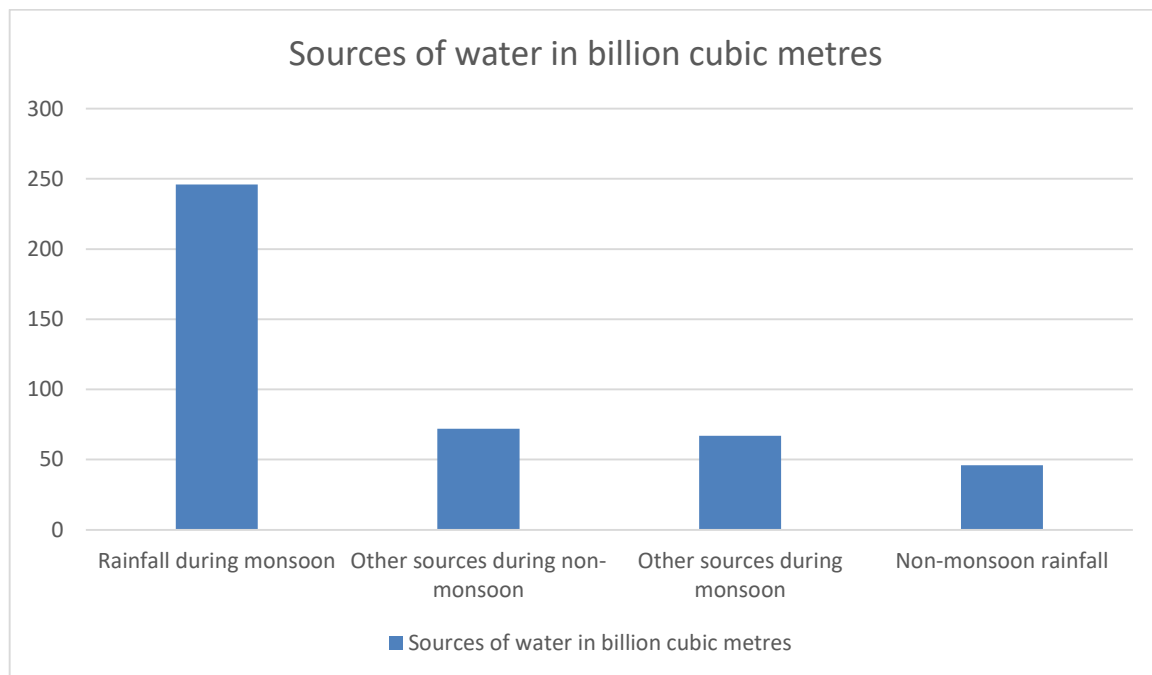
**Figure 3**

*Ground water usage pattern of different major states of India*

Source: Central ground water board, 2009

**Analysis**

- Uttar Pradesh and Punjab consume more ground water
- Rainwater harvesting using modern technology is essential to charge the ground water and reduction in agricultural cost



**Figure 4**

*Sources of water*

Source: Central ground water board, 2009

**Analysis**

- Monsoon water is the largest source of fresh water
- Rainwater harvesting is a necessity to conserve fresh water and ground recharging

**Role of NGOs in water conservation**

Judicious use of water and increased efforts at water conservation are considered vital so that water shortage does not lead to social unrest or conflict. NGOs are playing an important role in popularizing the concept of water conservation by working with stakeholders. To control the fresh water consumption in irrigation/agriculture, human use, waste water recovery etc., NGOs are implementing various water conservation program using modern technology (Sansthan, 2014). International NGOs such as International Union for Conservation of Nature (IUCN), Wetland International (WI), Malaysian Nature Society (MNS) plays important role in conservation of wetlands. The World Wetland Network (WWN), is a fledging global network of 200 wetland NGOs, initiated at the world NGO conference on the eve of Ramsar COP10 meeting in the year 2018 in South Korea (Ibrahim & Aziz, 2012). The government of India has taken various steps for water conservation promoting recharging of underground water, rainwater harvesting, construction of check dams and others. A study of Give India of ten NGOs who are working for water conservation in India found that the NGOs implementing various water conservation program such as revival of contaminated fresh water bodies, reviving rivers, ground water re-charging through rainwater harvesting (Swami, 2022).

**Study of Vadodara based NGO**

The NGOs operating in Vadodara can be classified on the basis of two major factors, which include their operational level or their co-operational level (Dutta & Talegaonkar, 2020). Their main aim is to up-lift the underprivileged section of the society, environment and support emergency services. Various focus areas are education, community development, healthcare, nutritional food for children, sports & cultural activities, women empowerment, environment, relief activities, advocacy, financial support to bright children for higher studies, child labor protection, child abuse and sexual harassment, family planning (Schwabland, 2016; Jgannathan, 2001; Dutta & Talegaonkar, 2020). All such program is designed by the NGO authorities and their remaining tasks are carried out or implemented with the help of volunteers (Dutta & Talegaonkar, 2020). A

study of one Vadodara based NGO who is engaged in educational development of underprivileged children and running a residential educational institute was undertaken to understand a) NGO's infrastructural facilities, b) Measures taken for water conservation and sustainability, c) Benefits of sustainable program, and d) how technology-based water conservation measures help the residential children in their educational development. The NGO's main focus is educational development of the underprivileged children and provide them education, nutritional food, medical assistance, engaging them in sports & cultural activities and skill training for holistic development.

**Objectives of study**

1. To study the fresh water supply and demand
2. To study various measures towards conservation of water
3. To understand the role of government and NGOs to conserve water
4. To study the NGO's initiative towards conservation of water

**Design of the study**

The design of the study is a Case study

**Procedure for selection of the Case**

In the above perspective, one Vadodara based registered NGO was selected using purposive sampling technique for the study. The name, year of establishment and number of beneficiaries (children) of the NGO studied are given in Table 2. The NGO studied satisfy the stringent conditions of transparency, governance and demonstrate impact on beneficiaries and represent most mature Vadodara based NGO in the sector in-terms of size and scale. The study was conducted at the campus of the NGO.

**Table 2**

*Name, year of establishment and number of beneficiaries(children) of the NGO*

Name of the NGO	Year of establishment	Number of beneficiaries	Remark
Srotoshwini Trust (STTR)	2010	123	Boarding facility, activity center and coaching beyond school hours. Beneficiaries are underprivileged children. The children are attached with Private / Govt. schools

**Sources of data**

The sources of data were the functionaries, resident teachers, kitchen / campus staffs and students of the NGO, and the documents of the NGOs

**Nature of data**

The nature of data - qualitative

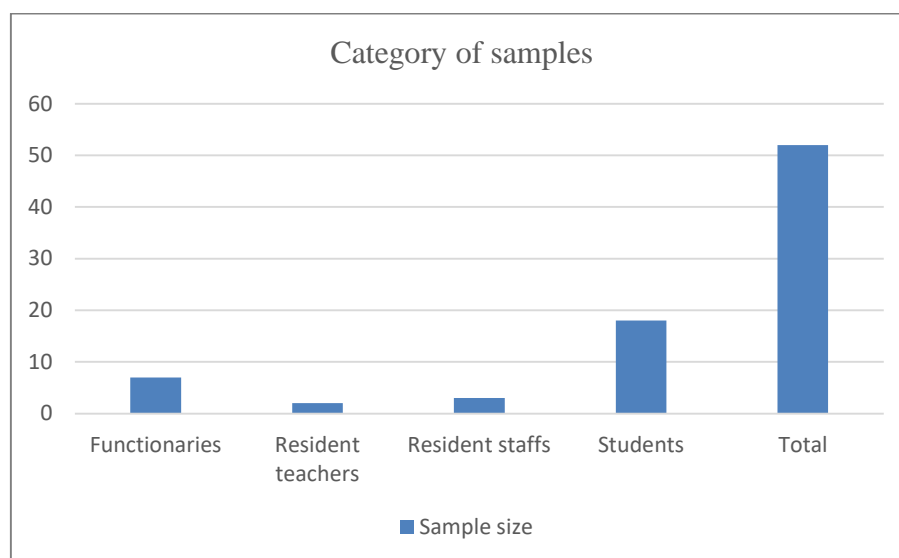
**Sample**

The participants of the NGO are selected using purposive sampling technique were functionaries, resident teachers, kitchen/campus staffs & student. Total participants were fifty-two ( $n = 30$ ). The category wise sample size is given in Table 3 and Figure 5 below.

**Table 3**

*Category wise Sample size*

I.no.	Description	Sample size
	Functionaries	7
	Resident teachers	2
	Resident staffs	3
	Resident Students	18
	Total (n):	30



**Figure 5**  
*Category wise sample size*

**Tools**

The tools for the study were un-structured interviews, and Focus Group Discussion (FGD).

**Data collection**

Two-way data collection was made: a) Primary data collection by un-structured interview, and FGD, b) Secondary data collection from annual reports, brochures, web site.

**Data Analysis**

The data collected in the study were analyzed using the technique of content analysis.

**Findings of the study**

The findings of the study are presented in the following categories.

- Background of the NGO and its ecofriendly infrastructure facilities
- Water conservation measures

**Background of the NGO**

Srotoshwini Trust is originally a cultural organization formed by likeminded empowered women of Vadodara city, Gujarat state of India. The organization was registered as an NGO in the year 2010 as per India’s society act. In the year 2013, they started a mobile school, “Pathshala” in a construction site and then expanded educational activities of underprivileged children in the streets and in slums of Vadodara city. In the year 2015, they launched Underprivileged Women Empowerment initiative by engaging the underprivileged women in livelihood generation activities. In the year 2019, the Trust established Pathshala hostel campus in Lasundra village, near Vadodara city of Gujarat state, India, wherein 103 children (both girls and boys), herein the beneficiaries, are staying. Trust takes care of their staying, food, medical, education and livelihood training. The children are enrolled in school which follows Gujarat Board state syllabus and National Institute of Open Schooling (NIOS) education system. The functionaries have taken many initiatives to make the hostel campus ecofriendly with water conservation measure such as waste water recovery through sewage treatment plant and rainwater harvesting system, renewable energy such as solar power, solar water heater, solar cooker, energy efficient electrical systems etc. The details of eco-friendly installations, capacity/configuration, end use, beneficiaries are mentioned in the Table 4 below.

**Table 4**  
*Eco-friendly installations, capacity/configuration, end use, beneficiaries*

Sl. No.	Eco-friendly system installed	Capacity / configuration	End use
1.	Sewage treatment plant – Treating toilet water, floor wash, kitchen water, bath water etc.	10,000 Liters Per day (LPD)	Treated water is used for gardening
2.	Rainwater harvesting	Rainwater during rainy season	Rainwater from roof is collected in an

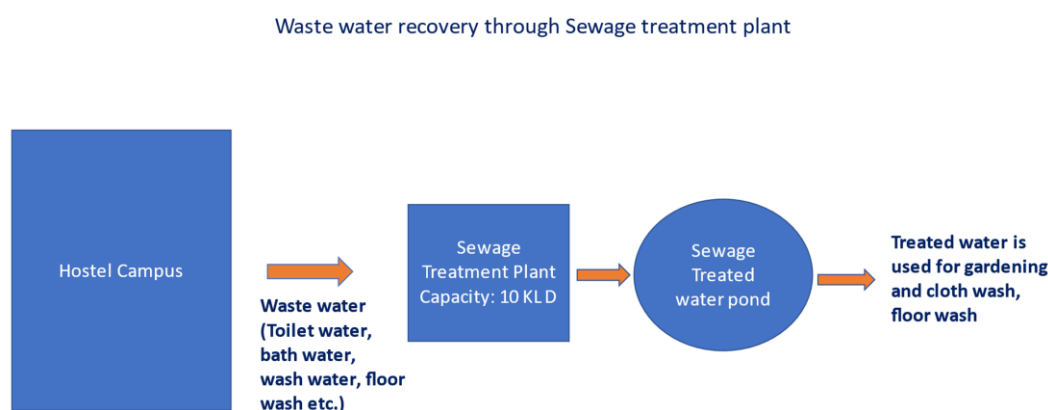
			underground water tank of 70,000 Liters and used for drinking / bathing / cooking etc.
3.	Rainwater harvesting to re-charge the ground	Rainwater during rainy season	Rainwater of the open field is collected at various points and through interconnecting underground piping discharged in to discharge well
4.	Parabolic solar reflectors	Cooking capacity for 200 persons	Cooking of food
5.	Roof-top Solar PV cells	40 KW	Entire campus electric load
6.	Solar water heater	3500 LPD	For bathing etc.
7.	LED lights	5 KW	Building, internal roads and boundary illumination

**Water conservation measures**

The existing source of water is, a) a well adjacent to the pond of the village located outside the boundary wall of the hostel campus. The water gets dry in summer and there is a restriction imposed by the village sarpanch for drawing water to meet the demand of the hostel, b) deep bore well located inside the hostel campus. The TDS of the bore well water is in the range of 2900 to 3800, which is very high and hence cannot be used for drinking and other purposed directly. A RO plant is installed to reduce the TDS to below 1800 level.

Due to scarcity of well water and sustainability, the NGO had designed the water system of the hostel in such a way that waste water can be recovered to the maximum extent. Presently two ways the NGO is conserving water and successfully reduced the daily fresh water demand of the hostel campus. The two major water conservation initiatives are presented next.

**Waste water recovery through sewage treatment plant**



**Figure 6**  
*Waste water recovery scheme*

**Reduction in fresh water demand through waste water treatment**

The recovery of waste water through waste water management is given in Table 5 below.

**Table 5**  
*Recovery of waste water*

l. no.	Description	Consumption in Kilo litres	Remarks
.	Daily fresh water requirement (for drinking, bathing, toilets, utensil wash, floor wash, cloth wash etc.) per day @ 130 litres per day per resident, for 120 persons,	15.6	All the waste water such as toilet flush, floor & cloth/utensil wash, bath water etc. are collected in a RCC tank and then treated in sewage treatment plant. The processed water is stored in a water reservoir and used for gardening



.	Loss of water due to evaporation, leakage into ground	2.8	
.	Recovery of water	12.8	82% waste water recovery

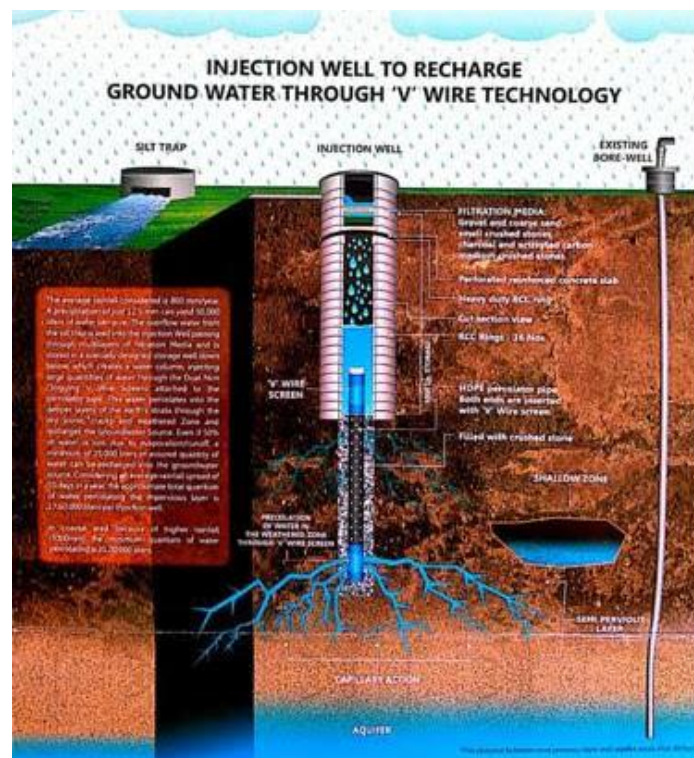
**Rainwater harvesting**

The rainwater is conserved in the following way.

- The rainwater of roof of the main building is collected through downcomer pipe and connected to the RCC underground water tank from where the water is pumped to overhead tank for use in the hostel
- All the rainwater falling on the open field of the hostel is collected through chambers located at different part of the ground and underground interconnected pipes and fed into the discharge well. The discharge well is having a pipe of 150 feet deep, is discharging the water collected in the discharge well into the ground at level 150 feet. The figure 6 and 7 below shows the flooding of open space during monsoon (before rainwater harvesting system) and the scheme of rainwater harvesting respectively.



Rainwater accumulation during monsoon session at Hostel campus



Discharge well of rainwater harvesting system

### **Benefits of water conservation**

During interaction with the President of the NGO, she said, "Our main vision is to serve the society and help the beneficiaries in-terms of education, medical, hygiene, nutritious food, vocational training for livelihood generation etc. Being a responsible citizen of the nation and to support the sustainable development goal of the world, at the conceptual state of construction of the Pathshala hostel, we decided to make it an eco-friendly". The eco-friendly infrastructure facilities not only reduced the operational cost of the Trust, it is helping the teachers/staff/students and visitors the direct benefits of water conservation, use of renewable energy, conservation of power and mainly contribution towards United Nations sustainability development goal (SDG). It is helping the students/teachers and all others who are directly or indirectly connected with the hostel to understand how one can contribute to the society. "Awareness of our children have increased about sustainability, they are understanding the technology better", the education coordinator proudly said during the interaction.

- The NGO's functionaries, teachers, staff, students and associated society population are now aware of how each one can contribute the environment by adopting conservation of water measures, renewable energy sources
- The students of Pathshala hostel are updated with the latest technology of rainwater harvesting and waste water management. The process and equipment knowledge are given to the students through skill development sessions specially designed for the underprivileged children

During the interaction with the children, Manisha, 13 years old girl and studying in class VIII said "we realised how important it is to save even a single drop of water. We have seen in our village; people are using flood water method in irrigation". Tejal, 14 years of age and studying in class VIII said, "we have seen how ground water can be re-charged through rainwater harvesting method. I have drawn a sketch of rainwater harvesting scheme implemented in the hostel during our skill development class". Ajay, 19 years of age and studying diploma engineering said, "we learnt how waste water including toilet water can be reused and water can be conserved. In our village, toilet water is always treated as dirty water and should not be used in any form".

- The NGOs mainly depends on CSR funds, individuals etc. for their projects and running expenses. They have observed that the donors appreciate NGO's proactive initiatives towards protection of environment and usage of renewable energy and prefer to donate to the NGOs from their CSR funds as per CSR Act 2013
- Installation of such systems have increased the awareness among the people including villagers to use sewage treatment system, rainwater harvesting, renewable energy source etc.
- The total dissolve solid (TDS) level of ground water has been reduced from 2900-3800 range to 2500-2900 range in one monsoon season. It is estimated that in 3-4 years' time, the TDS level will be below 1000 and can be used for drinking

The capital cost and cost saving/benefits are mentioned below.

### **Capital cost and yearly cost saving due to sewage treatment plant**

The plant was commissioned in the year 2019 when the hostel started operating.

The capital cost of sewage treatment plant is Rs 6.3 lacs

Yearly cost saving due to 82% recovery of waste water is Rs 17,280/-.

### **Capital cost and benefits due to rainwater harvesting**

The system was commissioned in the year 2019 when the hostel started operating.

The capital cost of sewage treatment plant is Rs 2.55 lacs

Benefit: Reduction in TDS of bore well water

### **Water conservation measures in the campus**



**Sewage Treatment Plant & treated water pond**



**Rainwater discharge well**



**Children of hostel campus made a project on 'Harvesting with drip irrigation and rain water harvesting'**

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