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MITIGATING THE CLIMATE IMPACTS OF WATER SCARCITY THROUGH 'THE GREEN PROJECT' IN CENTRAL INDIAN REGION, NAGPUR DISTRICT, MAHARASHTRA, INDIA

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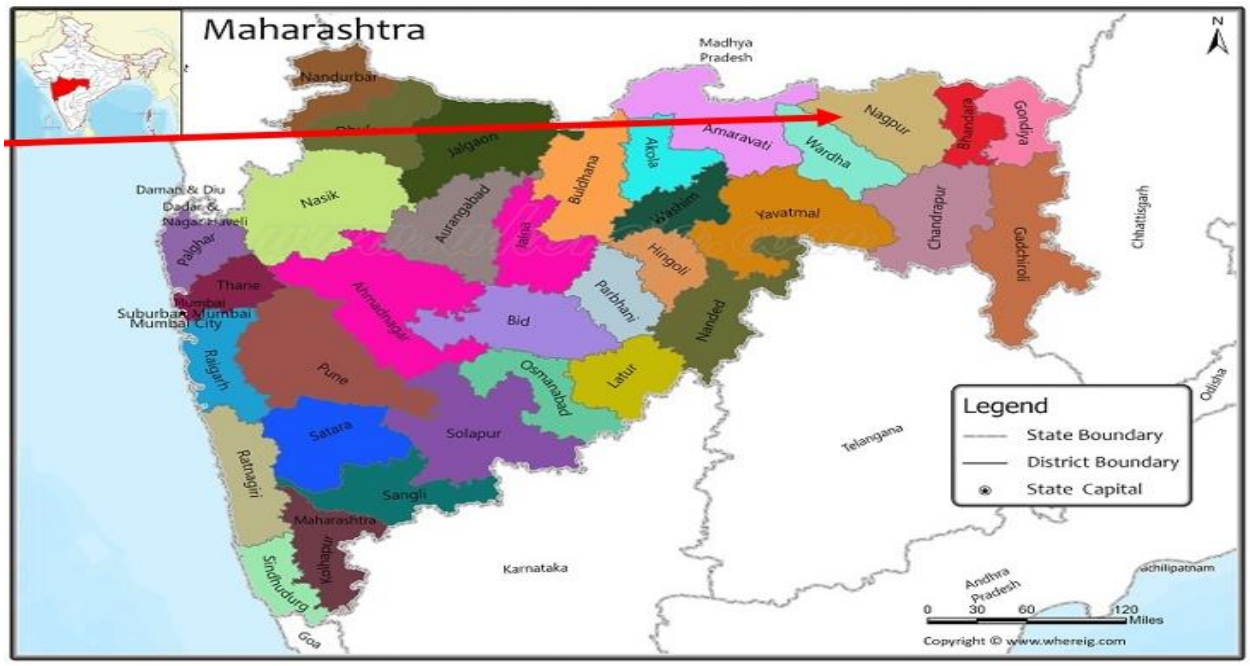
Abstract: "*The Green Project" is an environment-friendly and sustainable method for achieving a clean and green environment. Based on the preliminary qualitative findings, the system will address a set of issues rising due to extreme climate induced conditions like water scarcity, increased temperatures, impact on services and availability of water without contamination and an alternative to the artificial energy. The project perfectly aligns with the mitigation expectations under the SDGs agenda including building a resilient community across service seekers and providers as well as meeting the basic rights.*

Key words: Reuse Structure, Energy, Solar Pump, Green Project, Self-reliant

Introduction

Characterized by extreme cold and heat waves, Nagpur the Winter capital of the State of Maharashtra in the central region of India, is known as the orange city. With an annual assured rainfall of little above 1000 mm, some sub-district regions of Nagpur are facing issues around supply and demand side management due to recent frequent changes in the rainfall pattern, over-extraction of the groundwater in the recent past. All this leading to water scarcity in the key government institutions such as primary health centers, schools, and pre-schools as well as many places impacting the water needs for all purposes for the population both in the tribal and non-tribal belt of the district. Adding to the issues of supply versus demand side management, urbanization and intensive water-fed agriculture is competing the needs of population. And hence, due to uncontrolled utilization of water resources and imaginable depleting water resources, there is a need for water conservation.

Figure 01: Location Map



Current Challenges

The area faces typical but sometimes common issues in meeting the water requirement for the domestic, institutional, and emergency needs (health care facilities) on account of mainly the following challenges.

- Some of the tribal villages are far flung and outreach is difficult in hilly and forest areas
- Operation and maintenance due to financial constraints and poor management
- Depleted water conditions due to over-exploitation and dried up sources in lean period
- Discontinued supply of electricity and technical glitches
- High capital costs and availability of funds as well as program priorities
- Increased consumption of electricity and demand for appliances like AC and coolers
- Lack of use of WASH facilities leading to health burden and hardships
- Old public buildings whose roofs were not proper for rain water drainage
- High dropout percentage of students in schools due to uncomfortable condition like high room temperature and insufficient water during summer

The Green Project (TGP)

Motivated by the Jal shakti Abhiyan – *Catch the Rain Campaign* of the federal Governments' Jal shakti Department, the district council undertook a series of interventions promoting the

rainwater harvesting concept across areas. The district council led TGP has adopted the model through an approach of disseminating the concept widely through mass media, at official forums, through piloting and demonstrating projects, engaging the public representatives, online platforms like YouTube, Website and offline platforms like workshops, exhibitions and newspapers, model at district council premises, etc. The project also got the attention during exhibition & presentation held at the National Workshop on Water Reliant Village and Clean & Green Village themes under the SDGs conceptualized by Ministry of Panchayati Raj (Local Self Government), Indian Government.

TGP is an auto-technical intervention

- ✓ Rainwater harvesting with focus on rooftop
- ✓ Use of food grade quality white paint
- ✓ Heat reduction
- ✓ Renewable energy
- ✓ Recharging of groundwater

Objective: Self Reliant Facility

A. Rooftop Rainwater Harvesting
Roof Treatment water proofing,
Heat resistant white paint
Drainage System
Filter Equipment
Water Tank

B. Rainwater Management
Recharge shaft & Filter Pit

C. Solar pump System
Flushing old bore well,
Pump & Panel Cost,
Protection Fencing
Net Metering

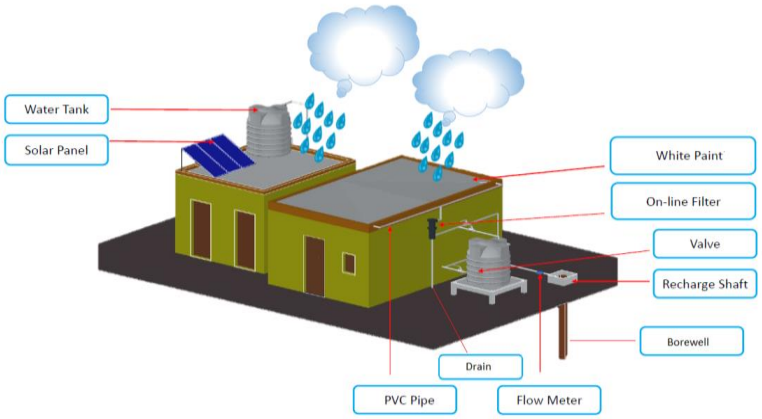


Figure 02: Schematic Representation of the Rooftop Rainwater Harvesting

Methodology

By applying 3C concepts i.e., Catch, Collection & Contamination the following methods were adopted.

- **Rooftop rainwater harvesting:** Though the average rainfall of Nagpur district is about 1000 mm per year. The rainfall occurs in just 3 months. The falling rainwater generally gets run-off and is wasted. So, by applying catch and collection concept of rainwater harvesting is implemented in which the rainwater falling on roof of public buildings are tapped by providing a parapet wall on roof slope (as the building roof was not proper for rainwater drainage) and directing it through pipes to direct storage and ground water recharge through filters.
- **White Paint:** The rooftop of the buildings is made waterproof. A food grade white paint is applied over it. This result in strengthening of building structure, smooth flow of water and reducing the temperature of building by reflecting sun rays & to avoid chemical contamination.
- **Filter:** Filtration is a part of every rainwater harvesting system. Rainwater harvesting filter design includes a chamber which is filled with filtering substances such as fiber, coarse sand, and gravel layers. These substances remove debris and dirt from water & stop them from entering the storage tank or recharge structure. These substances are to be cleaned & replace periodically. Thus, increase in the cost of maintenance**.** To avoid this new type of on-line self-cleaning filters are used now-a-days.

- **Storage Tank:** the storage tank is installed either at the ground level or on the top of the premise to store the water and use it during the lean period as and when required.
- **Recharge Shaft:** Recharge shaft has been prepared with lots of attention and detail. Due to that design, along with increase in ground water level, the quality of ground water improves by preventing bacterial and chemical contamination which may occur due to fertilizers and pesticides use for agriculture.
- **Solar Pump & Net Metering:** Instead of using conventional electric pumps, solar pumps are installed which run on sunlight which is practically free of cost. After full filling the water needs of the building the extra solar energy is fed to grid. Net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. For example, if building has a PV system on their roof, it may generate more electricity than the home uses during daylight hours. The efficiency of solar panels is increased due to application of white paint reflection.

Reuse Structure

Rooftop Rain Water Harvesting

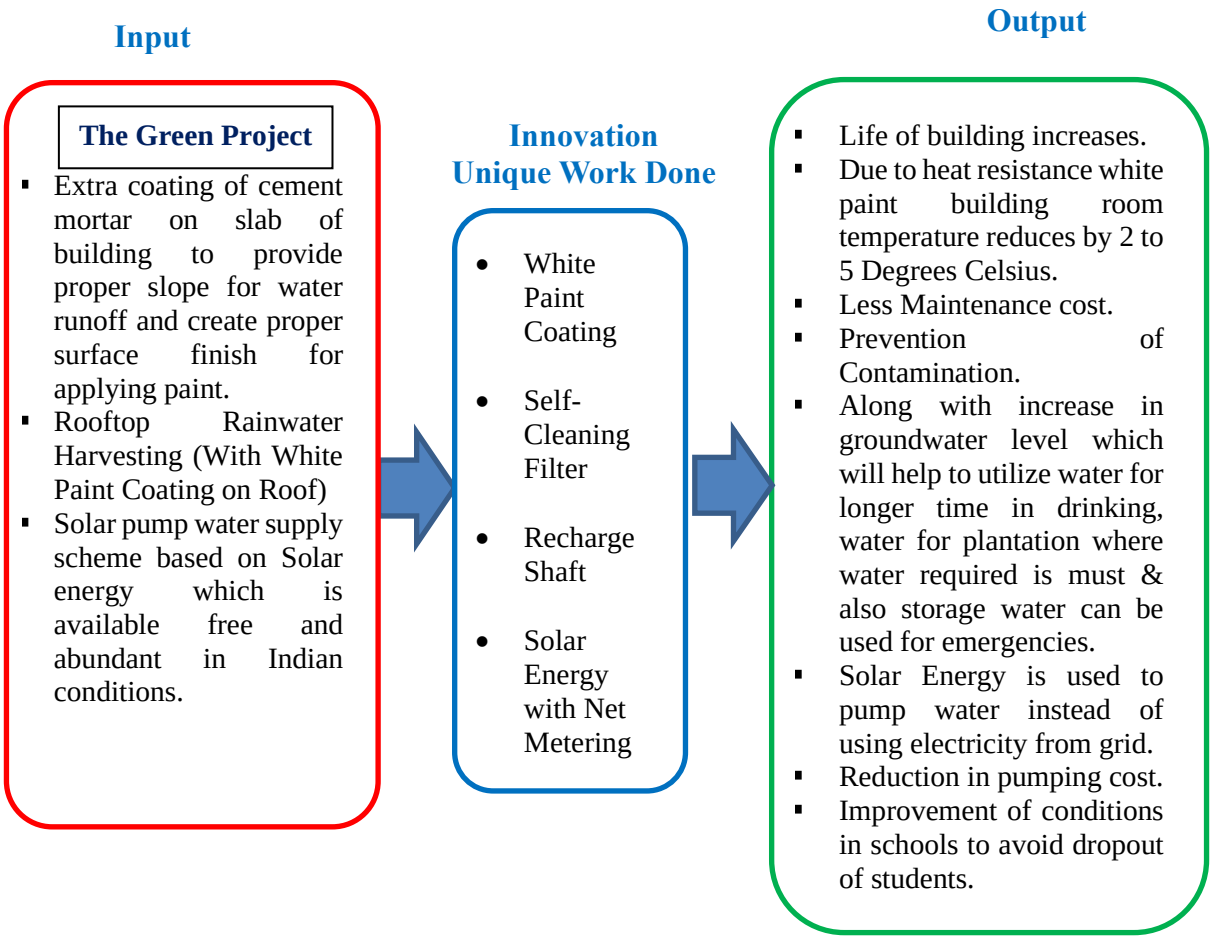
- After a long period, existing borewells get chocked due to mud, sand and tree roots. Due to this, these water bodies are not usable for drinking purpose. Such water bodies need cleaning through re-drilling/flushing process.
- The existing borewells which cannot be used after flushing due to deep water level, have been used as recharge shafts to enhance ground water level. Because of which there was no need to dig new borewell/recharge shafts. Thus, saving a lot of governments funds.
- The government, semi-government and private buildings in the district were studied and it was found that the rain water falling on roofs of the buildings flows out and get wasted. Measures should be taken to recharge and reuse such runoff water. So, the existing borewells which cannot be used due to very deep-water level were used as a recharge shaft into which the roof water was catched and delivered into such borewells.

Scope and Scale of TGP

TGP has been fund successfully addressing the core issue of water scarcity, reducing energy consumption (because of reduced requirements of use of pumps and air coolers and air-conditioners) and making the premises and smaller communities self-reliant with water for necessary needs. The model is demonstrated at schools, pre-schools, health care facilities, religious places like temples, government buildings, etc. This is an easily adaptable model in the areas of water scarce remote areas primarily. The 'Green Project' is a useful idea for tackling the impacts of climate change in terms of addressing water scarcity, ensure access and equitable distribution.

1. **Rooftop Rainwater Harvesting & Recharge Potential in Health Care Facility**
   Naghardhan, District Nagpur (Year – 2021)

- Water Usage: domestic purpose, cleaning, sanitation etc.
- Daily OPD = 150 Patient
- Total No. of Staff = 15
- Water Source – Borewell
- Total Demand of Daily water = 5000 Liters
- Annual Demand = 18,00,000 Liters
- **Lean Period = April to June = 90 Days**
- Available water = 3000 Liters/Day
- **Short Fall = 1,80,000 Liters**
- Average Annual Rainfall: 1012 mm
- Roof area: 236 Square Meter
- **Recharged Water =~ 1,82,706 Liters**



2. Rooftop Rainwater Harvesting and Recharge potential in Ganesh Temple

Adasa Ganesh Temple District. Nagpur (Year - 2020)

- Water Usage: Drinking purpose, Sanitation, Gardening
- Daily Pilgrims = ~ 1800
- Water Source – Borewell
- Total Demand of Daily water = 9,000 Liters
- Average Annual Demand = 32,40,000 Liters

➢ **Lean Period = April to June = 90 Days**

- Daily Pilgrims = ~ 1000
- Average Water Demand = 5000 Liters/Day
- Available Water = 3500 Liters/day
- **Total short Fall = 1,35,000 Liters**
- Average Annual Rainfall: 925 mm
- Roof area: 226 Square Meter
- **Recharged Water = ~1,77,693 Liters**

Plate: Primary Health Center, Village Nagardhan, Block Ramtake

Apart from this, the energy saving and water saving calculations are presented below.

A. Air Cooler Power Consumption Calculation: (Nos. of Air Coolers 6)
Power Consumption Calculator:
Rated Power of Your Appliance (Watt) = 1200 W
Daily Operational Hours (Hours) = 12 Hours
Electricity Tariff (USD) = 0.11/kWh

Due to heat resistant white paint 50 % reduction in needs of Air coolers: -
Consider Summer Season 4 Months Units Consumed (kWh) = 720
Consider Summer Season 4 Months Electricity Bill (USD) = 78.85
Final Saving unit Cost (USD): - 78.85 (Approx.)

Table 01: Reduction in Air Cooler Power Consumption

Unit Consumed	Electricity Bill
Daily Units Consumed by The Appliance (kWh) = 12	Daily Electricity Bill Because of This Appliance (USD) = 1.31
Monthly Units Consumed by The Appliance (kWh) = 3610	Monthly Electricity Bill Because of This Appliance (USD) = 39.43
Consider 6 Months Units Consumed by The Appliance (kWh) = 1440	Consider 6 Months Electricity Bill Because of This Appliance (USD) = 157.71
Due to heat resistant white paint 50 % reduction in needs of Air coolers and hence 4 Months Electricity Bill Because of this appliance is reduced by 50% which is 78.85 USD.	

B. Air Coolers Water Consumption Calculation: (Nos. of Air Coolers 6) Water Consumption:
No. of Air Coolers = 6
Water required per Air cooler = 30 Liters/Day
Summer Season 4 Months Water Consumed = 21,600 Liters
Due to heat resistant white paint 50 % reduction in uses water for air coolers: -
No. of air cooler required = 3
Summer Season 4 Months Water Consumed = 7200 Liters
Total Water Saving: - 7200 Liters

C. Reduction in Energy consumption by project (in kWh) in Primary Health Centre

- Requirement of Air conditioners - 2 Nos. Capacity 2 Ton each
- Power Consumption Calculator: Rated Power of Appliance (Watt) = 4000 W
- Daily Operational Hours (Hours) = 12 Hours
- Electricity Tariff (INR) = 0.11/ kWh

Table 02: Reduction in Air Conditioners Power Consumption

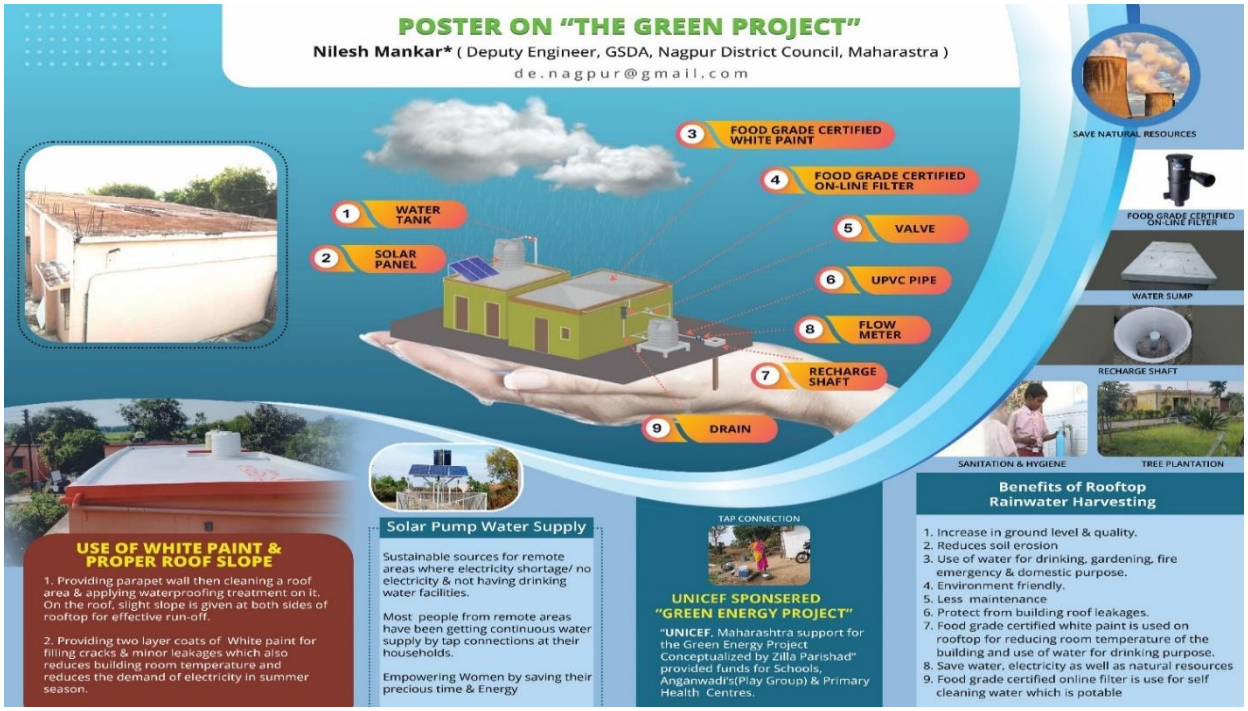
Unit Consumed	Electricity Bill
Daily Units Consumed by The Appliance (kWh) = 48	Daily Electricity Bill Because of This Appliance (USD) = 5.26
Monthly Units Consumed by The Appliance (kWh) = 1440	Monthly Electricity Bill Because of This Appliance (USD) = 157.71
Consider 6 Months Units Consumed by The Appliance (kWh) = 8640	Consider 6 Months Electricity Bill Because of This Appliance (USD) = 946.25
Due to heat resistant white paint 50 % reduction in needs of Air Conditioning and hence 6 Months Electricity Bill Because of this appliance is reduced by 50% which is 473.13 USD.	

D. Rooftop Rainwater Harvesting and recharge potential in Health Care Facility

- Name of Facility: Naghardhan, Block - Ramtek, District Nagpur
- Functional Status: Operational
- Water Usage: domestic purpose, cleaning, sanitation, gardening & fire emergency

- Calculation of Quantity of water harvested through Rooftop Rainwater harvesting
  - Average Annual Rainfall: 1012 mm
  - Roof area: 236 Square Meter
  - Coefficient of friction: 85% & Filter Efficiency: 90%
  - Rainwater harvested and recharged: 236 x 0.85 x 0.90 x 1012
  - Total quantity: 182,706 Liters
- No. of trees planted in surrounding – more than 100 Plants

Figure 03: Schematic Representation of the overall "The Green Project"



Key Finding

Support from UNICEF, Maharashtra, India

- Detailed study underway, final report awaited
- Demonstration of whole concept at 7 sites through partner agency SACRED
- Net Metering introduced for using generated electricity
- Documentation in the form of Audio-Visual underway
- Disseminating this concept for school students and college youths
- A policy paper to be prepared
- Support for National & International cross learning

USD Rate considered is 1 $ = INR 83, Rooftop surface friction coefficient is 0.85, Filter Efficiency = 0.90

- Quantity of water harvested per square meter = 0.81 cubic meter per square meter = 810 litres
- Cost of harvesting system in US dollars per square meter = 41 $/Sq Mt = @ INR 3,415 / Sq Mt
- Cost of water harvested in US dollars per cubic meter = 51 $/M3 = @ INR 4,195 /Sq Mt
- Average cost of water harvested and recharged in US dollars per Sq MT per M3 = 46 $/Sq Mt/M3

Water Availability: As an example, there are more than 60,000 schools and 100,000 Anganwadi centres in the State with an average available rooftop of 50 square meter to 150 square meter. Considering the average annual rainfall for Maharashtra on a lesser side of 1,000 mm per year, there is a huge potential of rainwater harvesting ranging from 80 million cubic meter to 240 million cubic meter. This is huge and equivalent to 8,000 football grounds flooded with a 1-meter height water column. This water will be enough for 800,000 families for a period of one year at 55 litres per capita per day.

Table 03: Total Water Harvested Through RWH Installation According to Roof Top Area and Average Annual Rainfall Pattern

#	Site Name and Location	Institution Type	Roof Area (Square meter)	Average Annual Rainfall (mm)	Total harvest (m^3/ year)
1	Zilla Parishad schools (3 Buildings) and Anganwadi, Bahadura, Block Nagpur	Educational Institution	184	1007	142
2	Gram panchayat, Bazargaon	Local Government Building	105	1007	80
3	Gram panchayat, Vedahari, Block Nagpur	Local Government Building	297	1007	129
4	Gram Panchayat, Kharbi, Block Nagpur	Local Government Building	98	1007	76
5	Gondkhairi, Dist. Nagpur	Primary Health Centre	315	1007	243
6	Salai Godhani, Block Nagpur	Primary Health Centre	280	1007	216
7	Dhanla, Block Mouda	Primary Health Centre	135	1079	111
8	Jalalkheda, Block Narkheda	Primary Health Centre	300	825	189
9	Satak, Block Parseoni	Primary Health Centre	324	949	235
10	Ghorad, Block Kalmeshwar	Primary Health Centre	92	925	65
11	Naghardhan, Block Ramtek	Primary Health Centre	236	1012	183
12	Bhandarbodi, Block Ramtek	Primary Health Centre	154	1012	119
13	Adasa Mandir, Adasa, Block Kalmeshwar	Religious Place	226	925	150

Table 04: Location wise details of Green Project Intervention in Nagpur

#	Location	Location
1	Nand Block : Bhivapur	Installation of Solar Dual Pump/rain water harvesting & recharge & distribution at Primary Health Center at Village Nand Ta : Bhivapur
2	Mohgaon Dhole Block : Katol.	Installation of Solar Dual Pump at school & Anganwadi Building at Mohgaon Dhole Ta : Katol.
3	Pilkapur Block : Nagpur	Roof top rainwater harvesting on School Building at Village Pilkapur Ta : Nagpur
4	Bhansoli Block: Hingana	Roof top rainwater harvesting on School Building at Village Bhansoli Ta: Hingana
5	Kondhasawali Block : Katol	Rain water harvesting & recharge Shaft and distribution at School & Anganwadi at Kondhasawali Ta : Katol
6	Kandri Block : Parashivani	Roof top rainwater harvesting on School Building at Village Kandri Ta : Parashivani
7	Gahuhiwara Block : Parashivani	Roof top rainwater harvesting on School Building at Village Gahuhiwara Ta : Parashivani

Table 05: Location wise details of Green Project Intervention Investment Analysis

#	Location	Cost, INR	Cost, USD	Roof Area, SqMt	Water Harvested M3	Water Harvested (Litres)	Cost / SqMT, USD	Cost/ M3, USD
1	Nand Ta : Bhivapur	644923	7770	91	74	74070	85	105
2	Mohgaon Dhole Ta : Katol.	242102	2917	108	88	87908	27	33
3	Pilkapur Ta : Nagpur	88424	1065	48	39	39070	22	27
4	Bhansoli Ta: Hingana	99583	1200	54	44	43954	22	27
5	Kondhasawali Ta : Katol	162191	1954	54	44	43954	36	44
6	Kandri Ta : Parashivani	142341	1715	52	42	42326	33	41
7	Gahuhiwara Ta : Parashivani	180895	2179	50	41	40698	44	54
Total INR		**1560459**	**18801**	**457**	**372**	**371980**	**41**	**51**

Results and Discussion

The initiative and implementation of the “The Green Project,” undertaken by Nagpur District Council and UNICEF, is an environment-friendly and sustainable method for achieving a clean and green environment. Based on the preliminary qualitative findings, the system will improve the groundwater levels, reduces runoff, lowers building temperatures, ultimately resulting in less energy consumption and water saving and recharge. On the other hand, a combined system of rainwater harvesting, and solar pump will bring a sustainable future by conserving energy and improving energy efficiency. It will be lowering system costs and simultaneously air pollution through the reduction of greenhouse gases. “The Green Project’ is a win-win approach.

The ‘Green Project’ is a useful approach for tackling the impacts of climate change and its mitigation in terms of addressing water scarcity, ensure access and equitable distribution during the lean period. The potential population that can be benefited from this is primarily the deprived population accessing the government institutions such as Primary Health care Centres, Pre-schools, Schools as well as tribal population in remote areas but also for population in peri-urban and urban areas. Taking the note of this UNICEF, Maharashtra field office had undertaken few pilots in few more sites considering the possible improvements. The proposed interventions from UNICEF have further improvised the design aspects, bring in the element of community and or stakeholder engagement as well as documenting the efforts from environmental and climate change perspective.

There is a great scope for scaling up and replicating this approach to ensure the environmental sustainability of the existing systems at an institutional level, mitigating the climate risks and helping the unreached or deprived population with green technologies. Following are some of the recommendations based on the existing opportunities.

a. Strengthen the existing water supply systems and increase the investment for long term results for climate resilient water supply systems which are sustainable in nature. This will be useful for the population in remote areas. The investment here could be in the range of INR 3 to 6 lakhs.

b. Explore the possibilities of converting the existing health care facilities into green and clean facilities and converge with WASH related activities for better environment, access to functional facilities for the patients (service seekers) and staff (service providers). The investment here could be in the range of INR 4 to 6 lakhs.

c. Ensure that 100 percent educational facilities like the schools and Pre-schools are equipped with The Green Concept package so that the loop is completed offering a greater learning environment in the schools. The investment here could be in the range of INR 1 to 3 lakhs.

d. This entire approach could be further unpacked for household level design and propagated for adoption as part of the LiFE (Lifestyle for Environment) agenda of the Government to mitigate the climate impact on large scale.

e. Generate evidence from the interventions through data collection, case studies so that the approach is proven as a scientific approach. There is a further need to unpack the intervention potential, spread the findings to the larger community and attract investments from various sources and stakeholders.

f. The approach is in alignment with the Green Buildings Standard and Certification Systems by efficiently utilising available natural resources like water.

g. The approach recognises the vision of the India Cooling Action Plan which aims to reduce cooling demand with the help of technology advancement and energy efficiency.

The analysis of energy saving, carbon footprints, water availability, etc. in qualitative and quantitative terms reflects a win-win situation. If a large-scale investment is done on this approach it is going to be of immense support to the environmental sustainability and mitigating the impact of the climate change. Another key area that will be identified is the development of communications materials for more dissemination and scale up.

Conclusion

1. Useful idea for tackling the impacts of climate change
2. Addresses water scarcity
3. Ensure access and equitable distribution during the lean period
4. Reaches to the deprived population in the institutions
5. Health care Centers, Pre-schools, Schools as well as tribal population
6. Useful technology for peri-urban and urban areas
7. Element of community and or stakeholder engagement is must
8. Further data collection and analysis is required
9. Analysis of energy saving, carbon footprints, water availability, etc.
10. Qualitative and quantitative aspects need to be looked at
11. Cost benefit analysis
12. Development of a working policy paper for Green Concept as a mission

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4. Dr. Prabhat Jain, Former Regional Director, Central groundwater board, Ministry of Jal Shakti, Government of India
5. Elected members of District Council
6. UNICEF, Maharashtra

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