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Planning a Sustainable Development of Existing Village

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***Abstract*- In the past decade the world has woken up to the environmental deterioration & climate change. The scenario is not different in India. The main reason behind this is increased urbanization. Urbanization is an inevitable phenomenon and it is in fact a sign of a matured economy. India is witnessing tremendous growth in every sector. India has recently launched smart city project. But when the cities in developing world lack long term strategic planning, management skills and struggling with infrastructure provision and high concentration of poverty and slums, thinking of smart cities does not seem to be a realistic goal. Developing countries rather than being obsessed with the dream of smart cities should be focusing more to their villages and try to curb the urbanization growth. But smart village did not make inroads as the cost of developing physical infrastructure in low density rural areas were too high and the village Panchayets have scanty revenues to manage such infrastructure even if they are developed by state or federal funding. So sustainable villages can be another good option. Any society with less resource utilization and sustainable behavioral practices can help in controlling the deterioration of environment, achieving lower carbon footprint and thus could aid to minimize greenhouse emissions and climate change. Villages are more sustainable and resilient than cities.**

The main goal of the project is to develop a sustainable perspective plan for a village in Maharashtra. In the present study, the existing village has been studied in terms of efficient use of resources and energy. The overall consumption of electricity, water and other energy sources has been determined by circulating a questionnaire to all the villagers. Detailed analysis of last 10 years rainfall data and groundwater level survey has been carried out. After detailed analysis of the survey data, a perspective plan will be developed for sustainable development of that village. These findings will assist the government to strategize their efforts towards achieving village sustainability instead of smart cities.

***Index Terms* - Urbanization; Smart villages; sustainable; Perspective Plan**

I. INTRODUCTION

Sustainable development is a process for meeting human development goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depends. Sustainable development is the organizing principle for sustaining finite resources necessary to provide for the needs of future generations of life on the planet. It is a process that envisions a desirable future state for human societies in which living conditions and resource-use continue to meet human needs without undermining the "integrity, stability and beauty" of natural biotic systems.

India is witnessing tremendous growth in every sector. As the sector is growing rapidly, preserving the environment poses a host of challenges. Now there is an imminent need to introduce green concepts and techniques in India, which can aid growth in a sustainable manner. The sustainable development can help address national issues like water efficiency, energy efficiency, and reduction in fossil fuel use for commuting, handling of consumer waste and conserving natural resources. Most importantly, these it can enhance occupant health, productivity and well-being.

From the literature it was observed that India has ranked a low 110 out of 149 nations assessed on Sustainable Development index (SDI) which is topped by Sweden and shows all countries face major challenges in achieving these ambitious goals. It ranks countries based on their performance across the 17 global goals. These goals and targets are a set of ambitious objectives across the three dimensions of sustainable development viz. economic development, social inclusion and environmental sustainability, underpinned by good governance. In India, States like Sikkim, Arunachal Pradesh, Mizoram, Manipur and Meghalaya have set an example that environmental quality can be restored with constant efforts. These states have made countless efforts and achieved the position of most sustainable states from the point of view of environmental protection. Uttarakhand, Assam, Tripura, Meghalaya and Odisha have been doing good in achieving sustainable development. Whereas Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Goa are amongst the moderately sustainable states. But the remaining states are far from sustainable development and are experiencing increase in environmental degradation.

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Several studies have addressed many different factors that affects environment and various measures are suggested to reduce environmental impact. Most of the studies are based on the green building concept. Some studies have addressed on sustainable energy and also on role of environmental education in sustainable development. There is a village named Gowardhan Eco Village which is developed on sustainable village concept. But the studies to convert an existing village into sustainable village are not available. So, the goal of this study is planning for sustainable development of an existing village to minimize the impact on environment and enhance the quality of life.

In order to fulfill the above goal, the following specific objectives have been formulated:

- To review various aspects of sustainable development through literature.
- To find measures for achieving water efficiency, energy efficiency, waste management & outdoor environment
- To develop a sustainable perspective plan of an existing village in Maharashtra.
- Make the model sustainable village plan that could attract resources for the development of other villages in its vicinity.

This paper mainly focuses on rain water harvesting and ground water recharge measures to improve the water efficiency in Nimgavhan.

II. WORK METHODOLOGY

The study is carried out for converting existing village into sustainable village and for that purpose the village named Nimgavhan in Nashik district of Maharashtra, India have been selected. Geographical area of Nimgavhan is 221.610 Hectares. The agricultural land area is 211.610 Hectares. The main source of income is agriculture & labor work. It has total 189 Households with total population of 939 as per Population Census 2011. It is around 1200 in 2016.

In order to find out the problems in Nimgavhan village, a questionnaire was designed. This questionnaire was divided in five parts: Part –A records the responses related to background of respondent including their family details, source of income etc.; Part-B records the responses related to water supply and consumption; Part C attributed for sources of energy used, electricity supply and load shedding; Part D and part E records the information related to farming and waste management respectively. The questionnaires were distributed among the villagers and 60 responses were recorded. The responses obtained from the villagers will be analyzed.

Rainfall data of last 10 years was collected from Maharashtra Engineering Research Institute (MERI), Water Resources Department, Nashik. The details of last 10 years ground water level (GWL) before and after monsoon was collected from Ground Water Survey and Development Agency, Nashik. Detailed analysis of last 10 years rainfall data and groundwater level survey has been carried out.

III. RESULTS AND DISCUSSION

A. Problems in Nimgavhan village

After detailed questionnaire analysis it was found that only 20 % families live in the village and remaining all the families' lives in their own farms. Agriculture is the main source of income 80 % of the families.

i) Water availability: Water is supplied to this village under 44 Gaon Water Supply Scheme. There is water tank having capacity of 25000 litres which is filled once in week or once in 15 days under this scheme and then water is supplied to only those villagers who lives in village. As per the questionnaire analysis, one family gets only 200-250 litres of water once in 8 to 10 days which is much less than their requirement. The remaining families who lives in their farms have their own sources of water like bore wells and open wells. They have plenty of water till end of December which they use for farming but after that the wells get dried. This water is sufficient only for one crop. Water sources ran dry after December and land remains unproductive due to water shortage. The villagers faces acute water crisis from January to June.

ii) Sewage waste disposal: About 70% of the families do not have WC/toilet facilities. Public toilets are not provided with water. Also they are not maintained and cleaned therefore; people are not willing to use the public toilets. Thus people are using the road sides for excreta disposal and are causing unhygienic conditions. There is no waste water collection system. The waste water from kitchen and bathroom is allowed directly to run on ground. Some of the villagers have constructed soak pits in their farms for sewage waste disposal.

iii) Load shedding: In this village electricity supply is only for 12 hours both in residential and farming area. This is the major problem in this village.

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B. Rainfall data analysis

Last 10 years rainfall data for the village was collected from MERI, Nashik.

The average annual rainfall in the village is 518.3 mm, though this is both erratic and uneven. It was found that from last four years this rainfall is less than the average annual rainfall as shown in the fig.1.

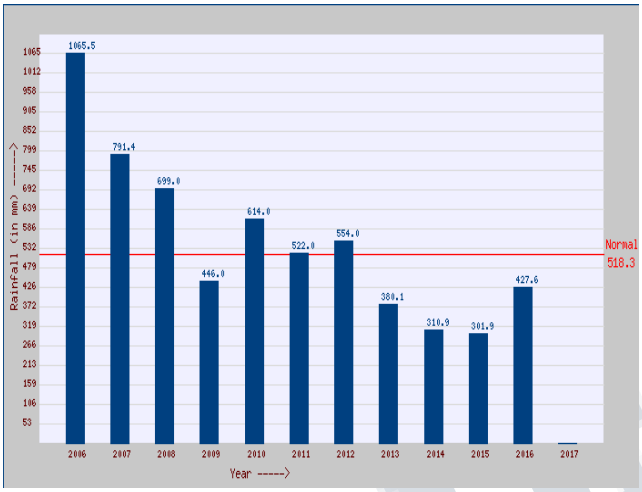

Fig1. Year wise rainfall in mm for Nimgavhan

It is found that the Nimgavhan village has a sufficient rainfall. But due to lack of water conservation means it flows as surface runoff. Thus there is a need to reduce the velocity of that flowing water so that it will percolate in soil and thereby there is increase in GWL.

C. Ground water data analysis

The details of last 10 years ground water level (GWL) before and after monsoon was collected from Ground Water Survey and Development Agency, Nashik as shown in Table 1. It was found that ground water level falls much below in May before monsoon.

It is found that this GWL level data taken from Ground Water Survey and Development Agency, Nashik doesn't matches with actual survey data. Because as per this data GWL falls to 10 to 11m in May whereas from the questionnaire analysis it can be said that the actual GWL in month of May is lower than 30 m, because most of the wells which are deeper than 60 to 90 feet gets dried completely before May. The GWL again rises to 4 to 6m after monsoon.

Table1. Last 10 years average GWL(meters) of observation wells in Nimgavhan (Pre & post monsoon)

Year	Month	GWL(m)	Year	Month	GWL(m)
2007	May	10.21	2012	May	11.1
	Sept	2.46		Sept	4.53
2008	May	10.62	2013	May	10.91
	Sept	2.05		Sept	4.85
2009	May	10.45	2014	May	10.42
	Sept	5.34		Sept	3.67
2010	May	10.98	2015	May	10.98
	Sept	3.86		Sept	6.17
2011	May	10.02	2016	May	10.52
	Sept	3.94		Sept	3.92

From detailed rainfall and ground water analysis, it's clear that there is much shortage of water in summer as all sources of water gets dried. Also water is not supplied regularly by Public water supply scheme. Water is not available to villagers for drinking also. Land remains unproductive in summer as water is not available for irrigation.

So it is necessary to take measures to increase the GWL in a village as water plays a major role in irrigation. Suggested measures for this are roof and non-roof rain water harvesting. It was recommended that the recharge activities should also be undertaken along with measures to increase groundwater abstraction. Construction of recharge pits, artificial recharge of wells are found suitable measures for ground water recharge in this village. Construction of farm ponds is a good option for water storage.

D. Percentage of water conserved through roof rain water harvesting:

Total number of villagers/occupants = 1200

Daily water requirement of a village (litres) = Number of occupants × Daily per capita water requirement

= 1200 × 135 litres/day

= 162000litres/day

Annual water requirement of a village = 162000 × 365

= 59130000 litres = 59130 m3 of water

Total number of houses in village = 189

Average area of each house = 60 m2

For calculation of roof runoff following formula is used:

Roof area (m2) × Average annual rainfall (m) × Runoff coefficient = Roof runoff per year (m3)

Using this formula roof runoff per year for all the houses in the village will be calculated. Runoff coefficient for roof area is taken as o.9 and average annual rainfall is 518.3 mm.

Roof runoff per house per year = 60 × 0.5183 × 0.9

= 27.9882 m3

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Total roof runoff for all houses in a village per year = 27.9882 × 189 = 5289.7698 m3 =5289769.8 litres
Percentage of water saved = 5289.7698/59130 = 8.95 % of annual water requirement if entire water is used.

This rain water collected from the roof of the houses is diverted to a storage tank. The storage tank has to be designed according to the water requirements, rainfall and catchment availability. Here 10 storage tanks of 10000 litres capacity each are provided as 1 combined tank for 3-4 houses.

This water from storage tank can be used during water shortage period. This is the most cost effective way of rainwater harvesting. The main advantage of collecting and using the rainwater during rainy season is not only to save water from conventional sources, but also to save energy incurred on transportation and distribution of water at the doorstep

Excess water could be diverted to the farm ponds which are already constructed by the farmers in their own farms. This also conserves groundwater, as this water is used instead of extracting water from ground.

E. Cost of rainwater harvesting system:

As only 20% families live in village, a separate network will be developed for them to collect rainwater.
Average length of pipe required per house = 10 m
Cost of 75 mm diameter medium pipe = Rs. 150 per meter
Total cost of pipe per house = 10×110=Rs.1100/-
Total cost of pipeline for 40 houses in village = 40 × 1100 = Rs.44000/-
Cost of a 10 water storage tank of 10000 litres capacity each =10×35000 = Rs.350000/-
Additional cost of pipeline to farm ponds = Rs.20000/-

For the households living in farms a direct pipeline will be made to farm ponds.
Assuming this cost to be Rs.165000/- as nearly 1500 m pipeline is required.
Other charges including cost of joints and plumbing charges = Rs.30000/-
Thus, total cost of rainwater harvesting in a village = 44000 + 350000 + 20000 + 165000 + 30000 =Rs.6,09,000/-

F. Water available for ground water recharge

Total agricultural land area = 211.610 Hectares = 2116100 m2
Thus, total water available for ground water recharge = 2116100 × 0.5183 × 0.8 = 877419.704 m3
= 877419704 litres

Recharge pits of 4m diameter and 3m depth are suggested for ground water recharge by considering the soil type in Nimgavhan.
A huge pit of 4m diameter and 3 m depth has to be dug (fig.2).

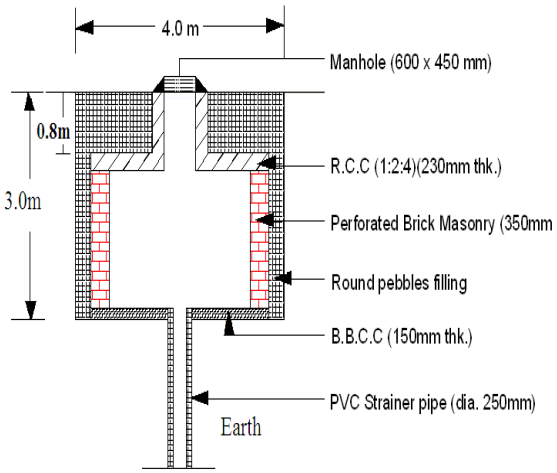

Fig.2
Vertical section of a recharge pit

Considering,
Diameter of RCC slab = 3.4 m
Diameter of recharge pit = 4.0 m
Diameter of bore = 0.25 m
Diameter of perforated brick masonry (0.35 mm thickness) = 3.4 m
RCC required (1:2:4) (230 mm thickness) = 2.09 m3
Perforated brick work required = 6.61 m3
Coarse aggregate required = 23.48 m3
PVC pipe strainer = 9.0 m
Excavation = 58.9 m3

A contour map containing the R.L of several points in the village was studied and 6 points having the least R.L were chosen for construction of the recharge pits. Refer to the fig.3 for the location of the recharge pits.

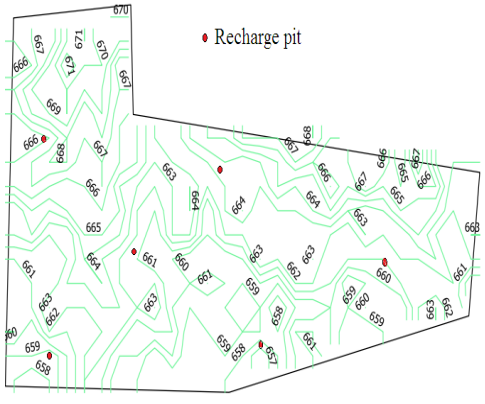

Fig.3 Contour map of Nimgavhan with recharge pit locations

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G. Cost analysis for recharge pits

The total cost for 6 recharge pits according to the requirements is calculated as Rs.295550.4/- as shown in Table 2.

Table2. Rate analysis of recharge pits

Sr. No.	Material	Unit	Total rate including labour	Qty.	Total Cost (Rs.)
1	PVC Pipe Strainer	1 m	410	9	3690
2	RCC	1 m^3	5000	2.09	10450
3	Perforated Brick Work	1 m^3	2000	6.61	13220
4	Coarse Aggregate	1 m^3	450	23.48	10566
5	Excavation	1 m^3	116	58.9	6832.4
6	Boring (250 mm dia.)	1 m	500	9	4500
Total Cost per Recharge pit					49258.4
Total Cost for 6 Recharge pits					295550.4

III. CONCLUSION

The following conclusions are obtained from the present study:

1. The total quantity of water harvested after construction of water harvesting system is found to be 5289.7698 m3 per year which is about 8.95% of the total annual water consumption.
2. The overall construction cost of the water harvesting system is found to be Rs.609000/-
3. Total quantity of water available for ground water recharge is 877419.704 m3.
4. The total cost for construction of 6 recharge pits according to the requirements is found to be Rs.295550.4/-

The use of above suggested measures can provide the very much needed means to improve the water efficiency in Nimgavhan. The future work will be done in other scope like finding measures for achieving energy efficiency, waste management and outdoor environment in Nimgavhan. Finally a detailed perspective plan will be developed for the village.

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