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Original Research Paper

ROOF WATER PRESERVATION SYSTEM AND ITS CONSUMPTION IN BHUBANESWAR CITY: EMERGING NEEDS AND CHALLENGES

Science

KEYWORDS: Water Preservation system and Technology (WPSAT), Roof Water Harvesting System (RWHS), Rating systems (RT) Green Building (GB), Water Cycling (WC)

Prof. (Dr.) Ramesh Chandra Rath	Professor-Cum-Dean (R&D), Research Cell, Einstein Academy of Technology and Management, Bhubaneswar, Affiliated to BPUT, Rourkela ,Odisha and Approved by AICTE ,Govt. of India ,New Delhi
Prof. Mrs. Puspita Acharya	Associate Professor –cum –Head of the Department of Basic Science and Humanities, Einstein Academy of Technology and Management (EATM) Bhubaneswar ,Affiliated to BPUT, Raurkela ,Odisha and approved by AICTE Govt. of India New Delhi
Prof. Mrs.Prajnaparamita Nayak	Assistant Professor in Environmental Engineering, Department of Basic Science and Humanities, Einstein Academy of technology and management (EATM) Bhubaneswar ,Affiliated to BPUT, Raurkela ,Odisha and approved by AICTE Govt. of India New Delhi
Prof. Soumyaranjan Swain	Assistant Professor in Chemistry, Department of Basic Science and Humanities, Einstein Academy of technology and management (EATM) Bhubaneswar ,Affiliated to BPUT, Raurkela ,Odisha and approved by AICTE Govt. of India New Delhi

ABSTRACT

Water is essential for the living organism of the world ,without water no one survives ,i.e. human being ,animal or plant .thus, water is like the blood vessel of human body .The Earth's surface is filled with water by 71.7%, but only 3% of this water can be used as potable water. In the present days, with the rapid increase in population water conservation has become a major issue. Green buildings are being created around the world to minimize the use of resources reduce various harmful effects to the ecology and create a clean environment. With the increasing demand for water it has become a necessity to implement water conservation in the design of green buildings. This paper overviews the prioritization of roof water conservation as one of the important aspects of water preservation and its well consumption in order to facilitate green buildings at various high buildings, malls, company offices, government buildings ,apartments as well as private buildings for save water. Various water efficient technologies such as water cooling towers and rain water Again, water harvesting is a modern process of Recent techniques, which is being implemented around the world. Countries such as Taiwan and Jordan have taken major steps towards implementing water efficient technologies into their green building designs. They have introduced water conservation index to evaluate the consumption of water and the water saving efficiency of the green buildings. Different rating systems have been introduced to establish the degree of accomplishment of environmental goals of the green buildings. Hence, it has been concluded that by using these water efficient techniques, the precious water can be saved in an economic way so that our future generations of Bhubaneswar city Won't' face the curse of water scarcity.

1. Introduction:

Water is the life line cell of human life; because without water man cannot live Ground water is one of the most important natural resources, which has a very wide spatial distribution. It serves as a major source of domestic water across the State. As per the water supply and demand status (2015-16) in Urban Local Bodies (ULB), ground water plays an important role. Ground water constitutes about 40% of the total public water supply. Apart from the public supply systems, large numbers of private wells serves as only source of water or many households in these areas. Due to rapid urbanization, the scope of natural ground water recharge is being reduced day by day. Such a situation will eventually lead to water table depression and water quality degradation. Rainwater conservation and ground water recharge practices are essentially required to be adopted for sustainable ground water management in these areas. This techniques first time used in the city of Singapore later many cities like Shanghais , Paris ,Tokyo , Chennai, Pune, Bangalore, Delhi etc. have already adopted such practices to combat water scarcity as well as water quality issues. So we the research have been interested to adopt this technology in the city of Bhubaneswar.

In Connection with, Department of Water Resources (DoWR), Govt. of Odisha, intend to launch a new State Sector Scheme, during FY-2015-16 for rainwater conservation and ground water recharge through adoption of Rooftop Rainwater by Roof water Harvesting Systems (RWHS) from various private and Govt. buildings in all ULB of the State. The Scheme is to be launched on pilot project basis, within the urban local areas of Bhubaneswar city ,such as Baramunda, old town ,Badagada Mancheswara Jharpada, Patia ,khadagiri ,Dumuduma ,Tamado ,jagamara, janla ,Sundarpada even the town of Khordha etc.

Subsequently, towns facing acute shortage of drinking water will also be covered. The Scheme is very eco-friendly and does not require any land acquisition or displacement of people.

Green building refers to a structure which is designed to be environmental friendly and make minimal and efficient use of resources. A green building is eco-friendly and resource efficient during its whole life span starting from its construction to demolition. Green building design mainly emphasizes on making efficient use of resources such as energy, water, etc. while reducing various bad effects on the environment and the occupants during its use. Many innovative technologies such as use of solar panels, green roofs, rain gardens, rain water harvesting, recycling and reuse of grey water, etc. are being used nowadays. "Green building is perhaps best understood as a convergence of two movements: (1) an architectural movement emphasizing environment conscious, integrated, efficient, and innovative design; and (2) an environmental movement arising from the principle of sustainable development" [1].

The five main components of green buildings include site and design efficiency, reduced energy usage, reduced water consumption,

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environmentally safe construction materials and better air quality. This paper focuses on the Roof water harvesting system and its well conservation for use efficiency in all aspect of green buildings and its importance.

2. Literature Review:

In this Section, we the researchers have taken the above said research title in order meet the water scarcity of inhabitants of Bhubaneswar city and try to findings its solution through a systematic way .Thus, this chapter reviews the literature relevant to the objective of the study, i.e., Rainwater harvesting system and its well consumption by the inhabitants of Bhubaneswar city is an excellent study made by the us, as well as collect the information on development of its components. A brief review on complete analysis & designing of the different component of this system has also been included. A discussion on the purpose of rainwater harvesting i.e. storing harvested water in tank after different available way of filtration and different component & ways of recharging underground aquifer for increasing the water table level and increasing soil moisture condition for good agriculture purpose has also been incorporated. Again, on recharging underground aquifer, underground water can be fetched out by pumping .Rainwater harvesting is an yearlong ancient technique studied by many scientist for different purposes e.g. for storing the harvested water in some storage tank, impact of rainwater harvesting on social and economic aspects and for recharging underground aquifer for increasing soil moisture condition. A few of them has been listed. Rural Rainwater Harvesting: Concept, Techniques, and Social & Economical Impacts by Dr. Osman Mohammed Naggar. This person has really dedicated his work in finding out all the factors which affects the surface runoff and rainwater harvesting impacts on environment. Again a very decant work have being done by Prof.Mrs.Puspita .Acharaya Prof. Mrs.Prajnaparamita Nayak and Prof. Soumyaranjan Swain in their paper entitled, "Roof Water Preservation System and its Consumption in Bhubaneswar City: Emerging Needs and Challenges" In this paper, rainwater is being conserved/harvested by the inhabitants in number of locations of Bhubaneswar city and they used two methods of distribution of harvested rainwater (Rapid depletion method & Rationing method). Finally, the cost for construction of tank was calculated. Apart from it, two books entitled 1. Estimation and costing in civil engineering, by Dutta, B. N. 2. R.C.C. Designs, By: - Punmia B.C., Jain Ashok, & Jain Arun Kumar, was referred. These books have carried out complete costing and estimation of sump and complete structural analysis of underground sump. So these two paper was being referred while doing complete structural analysis and calculating the complete cost of construction of tank. Last but not the least, I would also like to mention Odisha and India Government and its other agencies of various states of our state and country in the field of water resources for creating awareness programme for conserving rainwater using harvesting system. So almost every state hydrology Governments (i.e Orissa and many other states) are coming up with rainwater harvesting system and distributing the information through proper internet channels.

3. Objectives of Research:

For a smooth research work, we have taken the following important objectives of the Scheme which are to augment ground water recharge, improve water table and water quality conditions in the Bhubaneswar city through mass adoption of RRHS by the inhabitants, private buildings as well as in Govt. buildings. Here few of objectives are given i.e.

To provide the adequate knowledge of water conservation and its utility (Consumption) to the habitants of Bhubaneswar City. Provides better facilities of use of water conservation technology in order to use water in different fields such as cultivation on Roof, water pouring to gardens, use in bathing, washing and even use it in the purpose of drinking. Recycling the used water through a water purification process.

4. About Bhubaneswar:

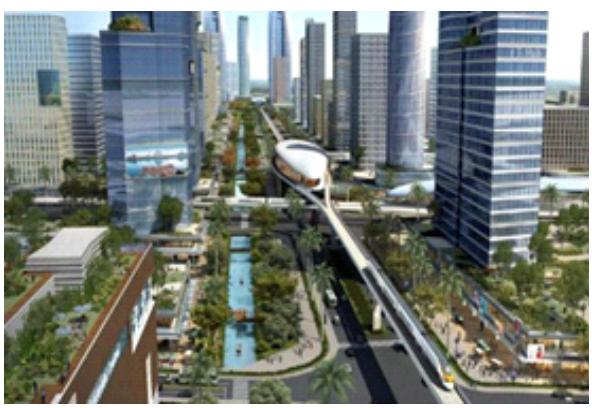
Today, Bhubaneswar is a model of livability evident by the city's stable growth rate in the recent decades. There are 25 Lakhs of people are living in this city and It is one of the few cities that has been able to successfully capitalize upon its assets- be it the tangible and intangible heritage (natural, built and people) or its strategic location- into economic drivers that have shaped the city's growth in the recent decades." It is known as the "Temple City", Bhubaneswar has a unique position by virtue of the ability to seamlessly integrate its rich cultural heritage with a strong regional economic base. Founded during the Kalinga Empire over 3,000 years ago, Bhubaneswar today boasts of a cluster of magnificent temples, constituting a complete record of Odisha temple architecture from its early beginnings to its culmination.

After Post-Independence, the modern city of Bhubaneswar, designed by German architect Otto Konigsberg in 1946, was established to shape the city in serving as an administrative centre for the state. Today, the city is an emerging hub for education, health and information technology.

The citizens of Bhubaneswar can take pride in the several distinctions bestowed to the city, including Only Tier-2 city in the country to host the top five Indian IT companies: Infosys, Wipro, Tata Consultancy Services, Tech Mahindra and Mind tree; Ranked 3rd Best Place to "Do Business in India" by World Bank; One of the planned four "Information Technology Investment Regions" in India.

Again, Bhubaneswar has also plays attention of tourist by performing its important role as a regional gateway to the Golden Tourist Triangle of Puri, Konark, and Chilika Lake. Its strategic geographic location along the east coast of India, has positioned Bhubaneswar to serve as the gateway to South-east Asia with easy access to existing and emerging ports, petrochemical and steel hubs at Paradeep, Kalinganagar, Dharma and Gopalpur. Additionally, a number of new ports are being proposed along the Odisha coast, which will further improve connectivity required for exports. (Please see various Proposed Pictures of Smart City of Bhubaneswar.)

[A view of Smart city of Bhubaneswar]



[Scenes of Bhubaneswar Smart city]

5. Back Ground of Water conservation:

Our ancient religious texts and epics give a good insight into the water storage and conservation systems that prevailed in those days of consuming years over the years rising populations, growing industrialization, and expanding agriculture have pushed up the demand for water. Efforts have been made to collect water by building dams and reservoirs and digging wells; some countries have also tried to recycle and desalinate (remove salts) water. Water conservation has become the need of the day. The idea of ground water recharging by harvesting rainwater is gaining importance in many cities .In the forests, water seeps gently into the ground as vegetation breaks the fall. This groundwater in turn feeds wells, lakes, and rivers. Protecting forests means protecting water 'catchments'. In ancient India, people believed that forests were the 'mothers' of rivers and worshipped the sources of these water bodies for fulfilling their needful requirements of water.

Some ancient Indian methods of water conservation:

In connection with, the researchers have focused on various studies of ancient civilization for enhancing the research work like in ancient age, particularly in the Indus Valley Civilization, that flourished along the banks of the river Indus and other parts of western and northern India about 5,000 years ago, had one of the most sophisticated urban water supply and sewage systems in the world. The fact that the people were well acquainted with hygiene can be seen from the covered drains running beneath the streets of the ruins at both Mohenjo-Daro and Harappa. Another very good example is the well-planned city of Dholavira, on Khadir Bet, a low plateau in the Rann in

[Water preservation system of Muketeswar temple, Bhubaneswar in Bamphi]

Gujarat. One of the oldest water harvesting systems is found about 130 km from Pune along Naneghat in the Western Ghats.

A large number of tanks were cut in the rocks to provide drinking water to tradesmen who used to travel along this ancient trade route. Each fort in the area had its own water harvesting and storage system in the form of rock-cut cisterns, ponds, tanks and wells that are still in use today. A large number of forts like Raigad had tanks that supplied water.

- In ancient times, houses in parts of western Rajasthan were built so that each had a rooftop water harvesting system. Rainwater from these rooftops was directed into underground tanks. This system can be seen even today in all the forts, palaces and houses of the region.

- Underground baked earthen pipes and tunnels to maintain the flow of water and to transport it to distant places, are still functional at Burhampur in Madhya Pradesh, Golkunda and Bijapur in Karnataka, and Aurangabad in Maharashtra.

6. Rainwater Harvesting

In urban areas, the construction of houses, footpaths and roads has left little exposed earth for water to soak in. In parts of the rural areas of India, floodwater quickly flows to the rivers, which then dry up soon after the rains stop. If this water can be held back, it can seep into the ground and recharge the groundwater supply

This has become a very popular method of conserving water especially in the urban areas. Rainwater harvesting essentially means collecting rainwater on the roofs of building and storing it underground for later use. Not only does this recharging arrest groundwater depletion, it also raises the declining water table and can help augment water supply. Rainwater harvesting and artificial recharging are becoming very important issues. It is essential to stop the decline in groundwater levels, arrest sea-water ingress, i.e. prevent sea-water from moving landward, and conserve surface water run-off during the rainy season.

Town planners and civic authority in many cities in India are introducing bylaws making rainwater harvesting compulsory in all new structures. No water or sewage connection would be given if a new building did not have provisions for rainwater harvesting. Such rules should also be implemented in all the other cities to ensure a rise in the groundwater level.

Realizing the importance of recharging groundwater, the CGWB (Central Ground Water Board) is taking steps to encourage it through rainwater harvesting in the capital and elsewhere. A number of government buildings have been asked to go in for water harvesting in Delhi and other cities of India.

All you need for a water harvesting system is rain, and a place to collect it! Typically, rain is collected on rooftops and other surfaces, and the water is carried down to where it can be used immediately or stored. You can direct water run-off from this surface to plants, trees or lawns or even to the aquifer.

Some of the benefits of rainwater harvesting are as follows:
Increases water availability.

- Checks the declining water table
- Is environmentally friendly

Improves the quality of groundwater through the dilution of fluoride, nitrate, and salinity Prevents soil erosion and flooding especially in urban areas?

7 Agriculture:

Conservation of water in the agricultural sector is essential since water is necessary for the growth of plants and crops. A depleting waters table and a rise in salinity due to overuse of chemical fertilizers and pesticides has made matters serious. Various methods of water harvesting and recharging have been and are being applied all over the world to tackle the problem. In areas where rainfall is low and water is scarce, the local people have used simple techniques that are suited to their region and reduce the demand for water.

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In India's arid and semi-arid areas, the 'tank' system is traditionally the backbone of agricultural production. Tanks are constructed either by bonding or by excavating the ground and collecting rainwater.

Rajasthan, located in the Great Indian Desert, receives hardly any rainfall, but people have adapted to the harsh conditions by collecting whatever rain falls. Large bunds to create reservoirs known as khadin, dams called johads, tanks, and other methods were applied to check water flow and accumulate run-off. At the end of the monsoon season, water from these structures was used to cultivate crops. Similar systems were developed in other parts of the country. These are known by various local names ¾ jal talais in Uttar Pradesh, the haveli system in Madhya Pradesh, Ahar in Bihar, and so on.

8. Roof Water Harvesting System:

In response of the highly requirements of water demand apart from the people of different countries/ states /cities the researcher have focused on how to collect the roof water through a systematic system of Roof water harvesting and its well consumption .thus, we have focused on various areas of water scarcity of the temple city of Bhubaneswar and collected the following inhabitant of different section and profession. I.e. Industrialist, Companies, engineering Colleges, Govt. offices, Apartments, shopping malls, residents etc. here some of schematic views of water harvesting system model are given

[Models of RWHS, figure: 01 for Apartment in Bhubaneswar city]

[Figure: 02 for Model of RWHS of Workshop]

9. Reducing water demand:

Simple techniques can be used to reduce the demand for water. The underlying principle is that only part of the rainfall or irrigation water is taken up by plants, the rest percolates into the deep groundwater, or is lost by evaporation from the surface. Therefore, by improving the efficiency of water use, and by reducing its loss due to evaporation, we can reduce water demand.

10. Methods of Roof Water Harvesting:

There are numerous methods to reduce such losses and to improve soil moisture. Some of them are listed below.

- Mulching, i.e., the application of organic or inorganic material such as plant debris, compost, etc., slows down the surface run-off, improves the soil moisture, reduces evaporation losses and improves soil fertility.
- Soil covered by crops, slows down run-off and minimizes evaporation losses. Hence, fields should not be left bare for long periods of time.
- Ploughing helps to move the soil around As a consequence it retains more water thereby reducing evaporation.
- Shelter belts of trees and bushes along the edge of agricultural fields slow down the wind speed and reduce evaporation and erosion.
- Planting of trees, grass, and bushes breaks the force of rain and helps rain all urban areas (ULB) of the State water penetrate the soil.
- Fog and dew contain substantial amounts of water that can be used directly by adapted plant species. Artificial surfaces such as netting-surfaced traps or polyethylene sheets can be exposed to fog and dew. The resulting water can be used for crops
- Contour farming is adopted in hilly areas and in lowland areas for paddy fields. Farmers recognize the efficiency of contour-based systems for conserving soil and water.
- Salt-resistant varieties of crops have also been developed recently. Because these grow in saline areas, overall agricultural productivity is increased without making additional demands on freshwater sources. Thus, this is a good water conservation strategy.
- Transfer of water from surplus areas to deficit areas by inter-linking water systems through canals, etc.
- Desalination technologies such as distillation, electro-dialysis and reverse osmosis are available.
- Use of efficient watering systems such as drip irrigation and sprinklers will reduce the water consumption by plants.

11. Water conservation:

The most important step in the direction of finding solutions to issues of water and environmental conservation is to change people's attitudes and habits¾this includes each one of us. Conserve water because it is the right thing to do. We can follow some of the simple things that have been listed below and contribute to water conservation.

[Figure : 03 [A schematic view of an open area of Water harvesting system (consumption)]

- Try to do one thing each day that will result in saving water. Don't worry if the savings are minimal¾every drop counts! You can make a difference.

- Remember to use only the amount you actually need. Form a group of water-conscious people and encourage your friends and neighbors to be part of this group. Promote water conservation in community newsletters and on bulletin boards.

- Encourage your friends, neighbors and co-workers to also contribute.

- Encourage your family to keep looking for new ways to conserve water in and around your home. Make sure that your home is leak-free. Many homes have leaking pipes that go unnoticed Do not leave the tap running while you are brushing your teeth or soaping your face.

- See that there are no leaks in the toilet tank. You can check this by adding colour to the tank. If there is a leak, colour will appear in the toilet bowl within 30 minutes. (Flush as soon as the test is done, since food colouring may stain the tank.)

- Avoid flushing the toilet unnecessarily. Put a brick or any other device that occupies space to cut down on the amount of water needed for each flush.

- When washing the car, use water from a bucket and not a hosepipe.

- Do not throw away water that has been used for washing vegetables, rice or dals¾use it to water plants or to clean the floors, etc.

- You can store water in a variety of ways. A simple method is to place a drum on a raised platform directly under the rainwater collection source. You can also collect water in a bucket during the rainy season.

12. Salient Features of Scheme:

(a) Building owners shall choose any one out of the nine RRHS Models specified below, based on the water requirements and space for execution of different components. Initially building owners shall construct the RRHS at their own cost.

(b) The actual cost of a Rooftop Rainwater Harvesting System (RRHS) may vary from building to building depending on the water requirements, type and size of roof, Model of RRHS adopted etc. The typical cost estimate for a building having roof area less than 200 Sqm with different Models of RRHS, which includes cost of following four major components of RRHS.

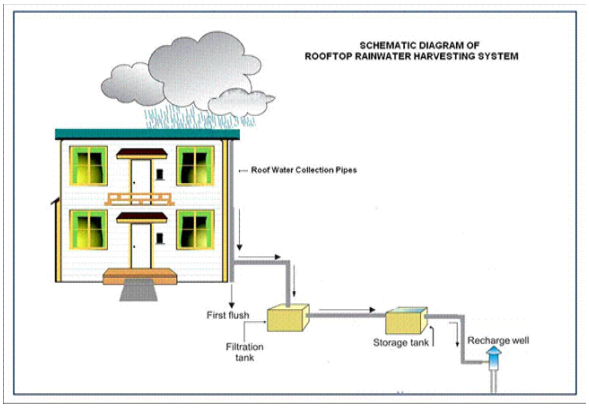

figure :-4[Schematic diagram of Roof water parameter harvesting system]

1. Rainwater Collection Unit - PVC (110-150 mm) pipeline with fittings for rooftop rainwater collection and conveyance to different units.

2. Filter Unit - Masonry tank with a bed of filter materials.

3. Storage Unit - RCC underground rainwater tank of 5,000 - 10,000 liters capacity

4. Recharge Unit - Dug well / Bore well / Tube well with depth range of 10-50 m.

© In case any or all of the four components such as dug well or bore well or tube well,

Water storage tank or sump and roof water drain pipes exist in the building premises, the same can be suitably modified to be incorporated into the RRHS.

(d) The RRHS should have a suitable recharge unit (well), which is compulsory under the Scheme for claim of subsidy. The modular PVC / HDPE Filter Unit or Storage Unit available in the market can also be used in place of such units made of RCC or Ferro-cement or masonry.

(e) The typical cost estimates of four major components of RRHS have been indicated below .The cost of RRHS shall be evaluated considering the actual investment made by the owner for the different components as described above. The cost of existing components, if any, can be considered for such evaluation under the Scheme. After successful testing of the RRHS by the authorized officer, a Certificate of Fitness shall be issued by GWS&I

(f) The State Government shall release 50% of the cost investment actually made (limited to the cost of adopted model) by the building owner or Rs. 45000/- whichever is less, as subsidy through GWS&I.

(g) Any person, owning a building having a roof area less than 200 Sqm and not having more than three floors will be eligible to apply under the Scheme. The building owner at the time of submitting application shall have to attach the proof of his ownership (copy of holding tax / land revenue receipt / ROR etc).

(h) Non-residential and residential Govt. buildings (in urban / rural areas) shall also be covered under the Scheme in a phased manner. The total cost of the installation of RRHS in these buildings shall be met from the budgetary allocation under the Scheme.

13. Process of water Conservation: Process of water conservation is a Simple and scientific system adopted by many development countries i.e. Singapore, USA, Japan, china, UK, Australia etc. for providing sufficient water at the time of water scarcity in the urban people when they needed it for cultivation ,roof gardening, agriculture , even the purpose of domestic consumption

14. Research Methodology:

14.1 Method of Study:

In this section, we the researcher have trying to our level best in order to know the authenticity of research work. Henceforth, we have followed the research methodology as the previous researchers have followed the method of research work. Here, we have followed both the method of data collection such as primarily method as well as the secondary method of data collection (Empirical study).

In primary method, we the researcher have gone to the field for collection of the response of inhabitant of the temple city of Bhubaneswar (Odisha) from various category of citizens like industrialist, Businessmen, educationist, Corporate people, doctors, residents, Apartments ,shopping malls etc. regarding their water requirement and consumption in their day-to-day of life.

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15. Problem Formulation:

Initially, we the researchers were faced many problems for collecting the data/information from the respondents of Bhubaneswar city regarding the taken project, because they were not initially interested for the taken research project by the researchers. But gradually, when they know about its benefit, they were come forward and asked us regarding the project functionality and its utility in their day to day life.

16. Constraints:

The taken research work has emphasized on number of constraints because without these the taken project may not success .Henceforth, we have taken the following constraints. i.e

- Surveying for Pilot Project
- Weather report and report of rainfall
- Blue print / layout/design etc.
- Budget for the project
- Manpower
- Office Space
- Needful Machines and thing
- Advertisement
- Government Support
- Subsidy
- Bank loan assistance etc.

By utilizing the above said constraints, the personnel's of Roof Water Harvesting System Project has successfully executed to construct the said project. By which the habitants of Bhubaneswar city are highly benefitted. (See the data table: 1)

Data Table: One

[Respondents of Bhubaneswar City: Table: 01]

Category of Respondent	No. of Respondent	Sample Size	Response			%of Response
			+Ve	-Ve	Neutral	
Industrialist	50	100	+Ve			50%
Apartment owner	150	200	+Ve			75%
Builder	100	150	+Ve			67.66%
Private Resident	200	350	+Ve			57.14%
Govt. offices	30	50	+Ve			60%
Companies	50	100	+Ve			50%
Colleges	50	70	+Ve			71.42%
Total	630	1020				

In this section, we have adopted the research methodology as followed by our time before .here we have taken two hypotheses like observational hypothesis (Ho) and expected hypothesis (He). In anticipation of the said hypothesis, we have taken two variables such as variable one and variable two. In variable one the researcher have focused on Roof water Preservation System which has a positive impact on the water users of Bhubaneswar city (Ho) and the second variable is that Roof water preservation system not only meet the water requirements of inhabitants of Bhubaneswar city but also it facilitates the green building, agriculture, plant etc .regarding the water scarcity in future.

18. Result Analysis:

After got the requisite information or data from the field ,we have caparisoned about the availed information i.e report of rain fall ,areas of Scarcity water, Weather Report from the Indian Metrological department (IMD) requirements of water for inhabitants of Bhubaneswar in daily ,monthly etc. through a direct survey method from the various respondents of Bhubaneswar like 50(100) number of industrialist, 150(200) number of Apartment owner, 100(150) number of builder, 50(100) Number of Companies, 40(60) number of Construction Companies, 30(50) Government offices, 200(350) Private Residents 50(70) Engineering Colleges, and 20 (40) corporate offices are responses positively and strongly interested for the implementation of project in Bhubaneswar. Here, the data's of Response Model are given in the data table. As per the data availed from the field and represented in the respondent table, all respondents are likely to respond positively regarding the project .therefore we the researcher have correlated number of response model and correlated in between their response. Finally, we observe that the availed result is highly significant. Hence forth, we accept the taken hypothesis in both the level of alpha 0.1 and 0.5 levels due to its highly positive.

18.1Semiotic Models of Respondents in Histogram:

For more clarity of research work, we the researcher have adopted semiotic model of different graph regarding the no of respondents of Bhubaneswar city who are positively respond in favour of project. Where the enumerator asked an appendix of questionnaire to the inhabitants of various categories

[Reports of Rainfall in Bhubaneswar City: [01st November to 08th November 2016].

[Cumulative Rainfall Records in the Cities of Odisha: Table -02]

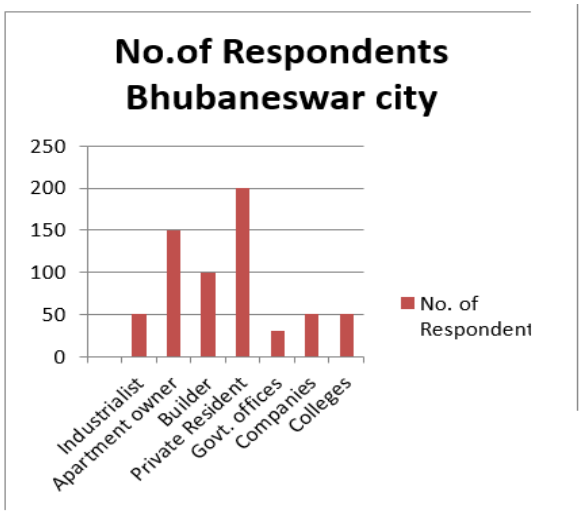
State/Union Territory	Locations	Normal monthly rainfall [mm]	Cumulative rainfall [mm] (01 Nov 2016 till Date)	Rainfall on 08th Nov 2016 [mm]
Orissa	Balasore	NA	77.2	0
Orissa	Bhubaneswar	NA	24.2	0
Orissa	Jharsuguda	NA	0	0
Orissa	Puri	NA	82.7	0
Orissa	Sambalpur	NA	0	0
Orissa	Cuttacksa	NA	5.2	0
Orissa	Keonjhar	NA	3	0
Orissa	Balangir	NA	0	#N/A
Orissa	Malkangiri	NA	0	#N/A
Orissa	Sundargarh	NA	0	#N/A
Orissa	Phulbani	NA	1.2	0
Orissa	Angul	NA	7.6	0
Orissa	Baripada	NA	0	#N/A
Orissa	Bhawanipatna	NA	0	0
Orissa	Koraput	NA	3	0
Orissa	Chandbali	NA	90	0
Orissa	Gopalpur	NA	40.1	0
Orissa	Paradeep	NA	111.7	0
Orissa	Hirakuda	NA	0	#N/A
Orissa	Titilagarh	NA	0	0
Orissa	Sonepur	NA	0	#N/A
Orissa	Talcher	NA	0	#N/A
Orissa	Daringibadi	NA	0	#N/A
Orissa	Dhenkanal	NA	6	0

Weather Report of Bhubaneswar City as On 13th November 2016

30 °CSunny.
Visibility: 2 km
Pressure: 1016 mbar
Humidity: 56%
Dew Point: 20 °C
Feels Like: 31 °C
Forecast: 19 / 31 °C

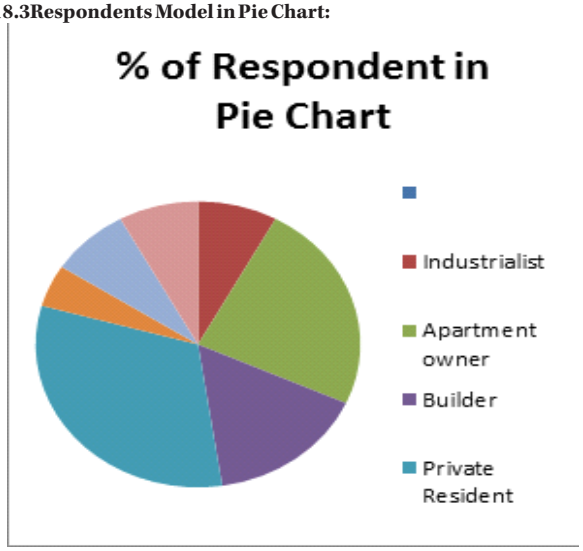
Wind: 7 km/h from NortheastLocation: Bhubaneswar
Current Time: 13 Nov 2016, 13:15:57
Latest Report: 13 Nov 2016, 11:30

[Weather report view on 13th Nov 2016 on Bhubaneswar.]

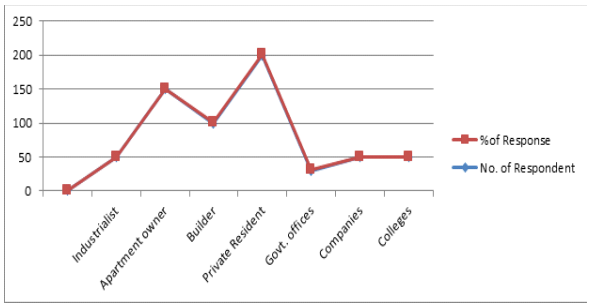


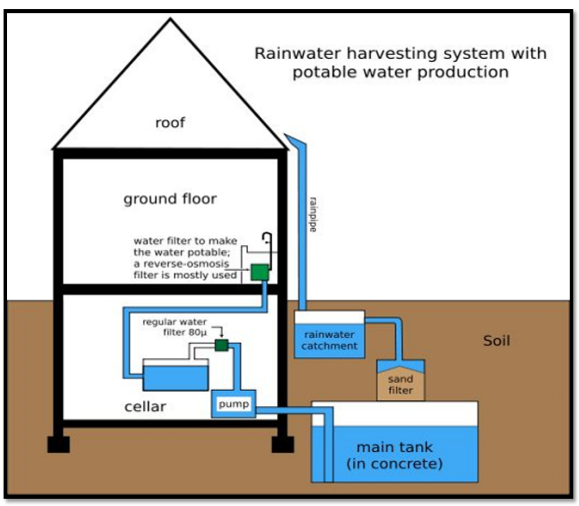
18.2Semiotic Models of Respondents in Pie Chart: [Graph Table: 01]
This model of Pie chart refers about the inhabitant's of Bhubaneswar city who responses positively regarding the Roof Water Preservation System and its consumption .Here, the percentage of their response are given in pie chart.

18.3Respondents Model in Pie Chart:



[Respondents Model in Pictorial Chart: [Figure: 03]





[A Model of Rain Water Harvesting System with potable water Production]

19. Water Efficient Technologies:
Water efficiency refers to the decrease in the usage of water as well as decrease in the wastage of water. Wastage of water or its extra usage leads to drawing out of more water from the fresh water resources, resulting in their depletion. Thus, water efficient technologies have been developed to conserve potable as well as non-potable water and to ultimately save the already limited fresh water resources. Water efficient technologies in buildings mainly include water saving fittings and fixtures. They also include rain water harvesting and recycling and reuse of grey water. A study of household water consumption in different areas revealed that almost 50% of the total water is used in baths and toilet flushes.[4] Thus, instead of using luxurious but water wasting fittings and fixtures, water saving ones

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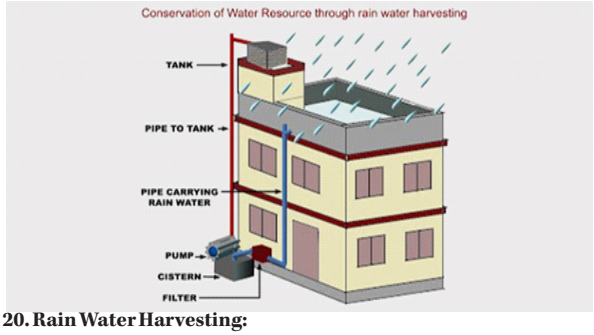
can be used. These include used of low flow shower heads and low flushing toilets instead of bathtubs and normal flushes, which use more water respectively. Other such fittings and fixtures such as two-sectioned water closets, bidets, composting toilet systems, dry urinals, auto sensor water taps etc. But the major water saving is done by rain water harvesting and grey water recycling and reuse



20. Rain Water Harvesting:

It is the collection and distribution of rainwater for using in daily life, rather than allowing it to run off. Rainwater is generally accumulated from roof tops. Then it is deposited in a reservoir with percolation. It is used for gardening, cultivation and domestic uses. The harvested water can also be used as ground water recharge. Water shortage is caused by climate change, lack of planning of water uses, rapidly increasing water pollution and increasing population. According to studies, if more supplies of freshwater aren't found by 2020 Sudan, Venezuela, Ethiopia, Tunisia and Cuba will face sever water scarcity. By 2035 Himalayan glaciers will disappear leaving India, Myanmar and Bangladesh in the state water shortage. So, under such dire conditions some serious steps towards conservation of water must be taken. Rain is a natural source of water. So, if it can be collected and treated, it can be used as potable water. It is a cheap and simple

Technology, so it can be easily installed in normal households and a lot of water can be saved.

21. Stages in Rainwater Harvesting:

A basic system for the harvesting of rainwater consists of three stages:

21.1 Collection Stage

It is the first step of Rainwater harvesting. At first while it's raining in a catchment area, rainwater is collected in a container on roofs, pavement or the soil surface. Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank.

21.2Distribution Stage:

Pipelines are the backbone of the distribution system in RWH. They carry rainwater from the catchment or rooftop area to the harvesting system. They can be semi-circular or rectangular and are made using galvanized iron sheet (20 to 22 gauge), PVC, Bamboo. Table 1 shows diameter of pipe required for drainage of rainwater according to rainfall intensity and area of the roof [5]

21.3 Storage Stage:

After collection and distribution, next comes the most important step, the storage system. For simple RWH storage tank is used. The capacity of the storage tank is based upon several design criteria:

a)Rainfall
b)The length of dry season
c)Estimated need

The increasing requirement of water is resulting in lowering of ground water table. The rainwater recharges the ground water. This water is available in lakes, rivers, ponds, aquifers, etc. but these are fickle sources. Treated rainwater can solve the demand of household water needs. Generally the water sources are located far from community. If rainwater can be collected and used, it will reduce the cost of distribution.

24. Grey Water Recycling and Reuse:

Grey water refers to the domestic waste water which is drained out excluding the waste water from kitchen sink and the water closet as they have high concentration of organic matters. [8] In order to conserve water this water cannot be just drained out but should be recycled and reused. The benefit of using recycled grey water is that it is a large source with low concentration of organic matter. [6] The bathroom grey water consists of waste water from showers, bathtubs and washes basins. It has a very low concentration of organic matter. The other sources of grey water are from washing of clothes, car washing, etc. Again it has some advantages which has compared in the given table.

A schematic Comparison in between Extensive Roof and Intensive Roof:

Comparison of Extensive and Intensive Roofing Systems

	Extensive Green Roof	Intensive Green Roof
Brief Description	▪ Thin soil, little or no irrigation, stressful conditions for plants	▪ Deep soil, irrigation system, more favorable conditions for plants
Advantages	▪ Lightweight ▪ Suitable for large areas ▪ Suitable for roofs with 0-30° slope ▪ Low maintenance ▪ Often no need for irrigation and drainage systems ▪ Relatively little technical expertise needed ▪ Often suitable for retrofit projects ▪ Can leave vegetation to develop spontaneously ▪ Relatively inexpensive ▪ Looks more natural ▪ Easier for planning authority to demand green roofs be a condition of planning approvals	▪ Greater diversity of plants and habitats ▪ Good insulation properties ▪ Can simulate a wildlife garden on the ground ▪ Can be made very attractive ▪ Often visually accessible ▪ Diverse utilization of roof (i.e. , for recreation, growing food, as open space."
Disadvantages	▪ More limited choice of plants ▪ Usually no access for recreation or other uses ▪ Unattractive to some, especially in winter	▪ Greater weight loading on roof ▪ Need for irrigation and drainage systems, hence, greater need for energy, water, materials, etc. ▪ Higher cost ▪ More complex systems and expertise required

25. Research Findings and Suggestions:

In this proposed research work, we have initially faced number of problem, but gradually all things are managed by us. This is excellent project work taken by us. After the research work over from the said research we observed that it is a tremendous impact of positive essence for solves the water scarcity problem with available low cost of economic.

Here few of recommendation are given for fulfilling the future needs of research work I.

- It is fulfilled the future water scarcity or demands of habitants of the city of Bhubaneswar and other places.
- The cost of project is acceptable for any category of citizen in accordance to their economic condition.
- It can be applied at any places of state and country or abroad where rainfall is minimum to moderate but not applicable in no rain area.
- The cost of the Roof Water Harvesting System (RWHS) is very low budget and it can be initiated by all levels of citizen as per their needful of water. It may be small or large.
- To construct this project The Central Government and state Government has given financial facilities and subsidy facilities to the citizen who are intends to implement
- Finally it has a long impact for solving the water scarcity in every aspects of human life like Agriculture, drinking, washing, watering plants, and even use of water in domestic and production process of companies.

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Conclusion:

The main objectives of this research paper are to highlighting the rising need for water conservation and its consumption in today's requirements of people of the present world .again the researchers have given importance as a part of water preservation and its consumption of the inhabitants of Bhubaneswar city regarding use of water in green building designing and construction. The necessity for water conservation has become so much significant that recently LEED rating system has doubled the points under the water efficiency category to ten from the previous quantity of five. Several countries around the world have already started devising green building designs in all their construction works with special emphasis on water conservation and are encouraging their citizens to use water efficient technologies. Numerous rating systems to evaluate the efficient use of water in buildings have been brought into practice. Protection of the remaining fresh water resources around the world has become a matter of global significance and measures are being taken to preserve them so as to avoid facing the problem of water scarcity in the future.

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