Available in the SSRN eLibrary: http://ssrn.com/link/2019-CTFC.html Engineering Research Network (EngRN)
Mahatma Education Society's Transactions and Journals' Conference Proceedings on CTFC 2019 ISBN 978-93-82626-27-5

SUSTAINABLE WATER HARVESTING TECHNIQUE BY CONDENSATION OF WATER THROUGH ATMOSPHERE IN AN OPTIMIZED APPROACH FOR FUTURE CITIES IN INDIA

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Abstract:
Water is one of the vital needs of humans. Many rural areas lack the water infrastructure to fulfil their basic needs. About 8-10% of the people lack safe drinking water which causes health issues and deaths. Water harvesting structures (WHS) is a vertical conical structure designed to harvest potable water from the atmosphere. In this research work, WHS is constructed by using material such as bamboo, polyester mesh which absorbs the water molecules from humid mist present in atmosphere. This absorbed water passes through the mesh and forms water droplets through condensation and is collected under the action of gravity. Considering the effect of large formation of fog, seasonal rain and dew during majority of the seasons in a year, WHS was constructed keeping Rasayani (Maharashtra) as the study area. Due to the geographical assistance provided by this study area, it was possible to extract water from air at high altitude hence proved to be a sustainable method for the collection of water from atmosphere. Water harvested in this WHS was pure and can be utilized for various domestic purpose like drinking, cooking, etc. This research signifies that by constructing WHS by locally available material, a sustainable low initial cost structure was constructed with less maintenance and zero energy requirement.

Keywords:
Condensation, Sustainable material, Water scarcity
***Submitted on**: 31st October 2018*
***Revised on** : 15th December 2018*
***Accepted on** : 24th December 2018*
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I. INTRODUCTION

Water is a transparent, tasteless, odourless, and almost colourless chemical substance, which is easily found in streams, oceans, lakes, rivers, canals, pond, or puddle and in various forms like ice, liquid, vapour. Water is covering 71% of the Earth's surface, mostly through the sea and ocean. Remaining water is only 3% which is divided in groundwater 3%, ice 68%, surface water 0.3% and other water 0.8%. Surface water is further divided into lakes 87%, rivers 2%, swamps 11%. Rainfall is a major component which is responsible for making the fresh water on the Earth. Water gets transferred in all water reservoirs by the physical processes like evaporation, condensation, precipitation, infiltration, surface and subsurface runoff altogether which is called as the water cycle.

The population is growing inversely proportional to the amount of water currently present on the Earth. Water scarcity is when sufficient quantity of water is not available for community people to fulfill their basic needs like drinking, cooking, etc.around 68% of country is subjected to inaccessible clean water and drought condition problem.

A. Problem statement

India is affected by water scarcity problem from last several years and affects around 600 million peoples all around India. And it is fact that around 2lacs people dies every year due to unavailability of clean drinking water. India is also susceptible drought prone country

around the world as from last five decades, a drought has been take place at least once in every three years.

In the isolated rural areas, people had to walk far away to collect potable water, which was often contaminated with animal and human waste. Women in those areas usually carry a large container of water whose size and weight is almost unmanageable. Some of the natives are even unaware that the bacteria present in the water is very harmful that can make them sick, causing water borne illnesses and can spread among communities. In some cases, it can also cause death, especially in young children as they are viable to various diseases.

To overcome such Water scarcity problem, many policies are adopted by government (such as provision of funds for ground water extraction through bore well and tube well, provision of funds for drip and sprinkler irrigation). But provision of such free utilities, have not had the expected result. And only wells results in uncontrolled exploitation and wastage of resource.

B. Literature Review

The related papers were referred to study water harvesting techniques on different projects and summary of papers has been written as follows:-

Duygunur Koç Aslan et al. (2018) [1] This research paper is about collecting, storing and reusing rainwater in buildings which are designed with biomimetic approaches in terms of rainwater harvesting methods to contribute to the solution of water related problems. Also, they have mentioned about different techniques to water obtain water from the secondary sources like rain, fog, dew, etc. There are different techniques and principles to make the water in this research paper.

Fahad Sultan Al suwaidi et al. (2017) [2] The aim of paper is to increase the accessibility of clean water by making use of fog and clouds at a reasonable cost. This research is based on the material and energy balance calculations necessary to design a fog harvesting collector. They have concluded that there is a need to select the right place and materials to design of a suitable and reliable fog harvesting system.

Fog Harvester (2018) [3] Fog can be an alternative source for production of water with the help of sustainable collection systems. This technique can only be used in high altitude between 400 to 1200 m. and areas where the chances of foggy weather will be more and we can get more amount of water with less hard work. A net of desired shape and size is attached with a setup and left at an area where it can collect the water molecules from the fog and can make water droplets from it. Later, that water droplets get collected in the container attached below.

Gudrun Eriksen Havsteen-Mikkelsen (2016) [4] This thesis is about mutual symbiosis between people and water, which are important for both to survive longer if they bonded with each other. It also says about different water resources, our water cycle and the droughts. Also they have mentioned about the research regarding different structures which can obtain water from different sources.

Ho-Gul Park et al. (2016) [5] This research paper says about a workshop conducted make different designs of Warka Tower project which was invented by Arturo Vittori to make people understand about the geometry of the Warka Water tower and understand its water harvesting technique, which is based on collecting water from the air.

R. A. K. Eswari (2018) [6] This research paper is about all the problems that people are facing around the world like water scarcity and water crisis. Also they have mentioned the causes of the impact on the heath and water. It is saying about the research done on an economical, easy to make structure which can become a secondary choice of water resource where potable water from the rivers, wells and tube wells are not available.

Rainmaker by Piet Oosterling (2018) [7] They have invented a technology which consists of an Air to Water unit which uses a turbine that suck surrounding air and let him pass through heat exchanger, where the air is cooled and condensation takes place. A hybrid solution which uses solar power / wind power / electricity can be deployed to the same effect by driving a ventilation system. When the temperature falls down about its dew point, water molecules will form water droplets. They have made three different types of units which can make 5,000, 10,000 or 20,000 litres of drinking water per day.

II. METHODOLOGY

The aim and objective of this research is to make economical and efficient water source (WHS) for rural or urban area.

A. Objectives

- To increase clean water availability for domestic purpose.
- To improve the life of the villagers by creating opportunities for growth and development, as more water available for gardening and other purpose.
- Using atmosphere as a viable source of potable water.
- Eliminate the use of any energy source for producing water.

- Increase groundwater table in area.

B. Meteorological Characteristics of Rasayani

Result from structure is mainly depending upon atmospheric conditions (such as temperature, wind, humidity, precipitation) meteorological condition of the study area which plays a vital role. Various above said parameters are shown graphically below (Source: https://www.meteoblue.com/en/weather/forecast/modelclimate/18.900N73.176E)

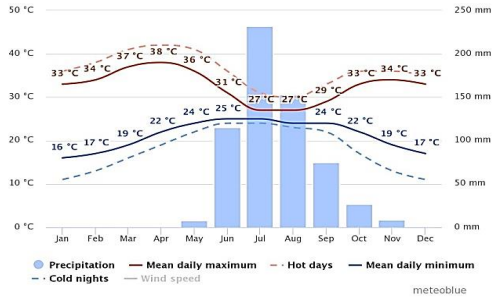

Fig.1 Bar Graph of Temperature & Precipitation

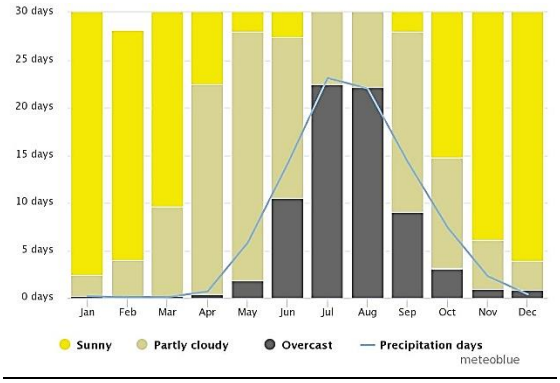

Fig.2 Bar Graph of Climate

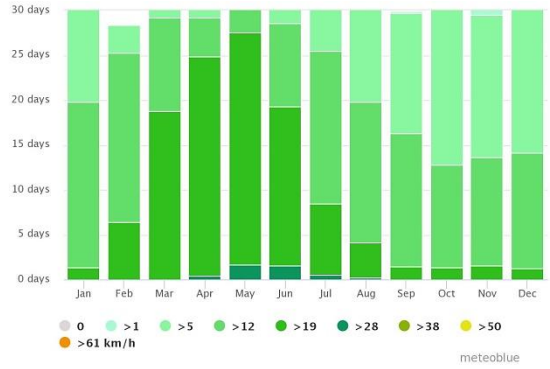

Fig.3 Bar Graph of Wind speed

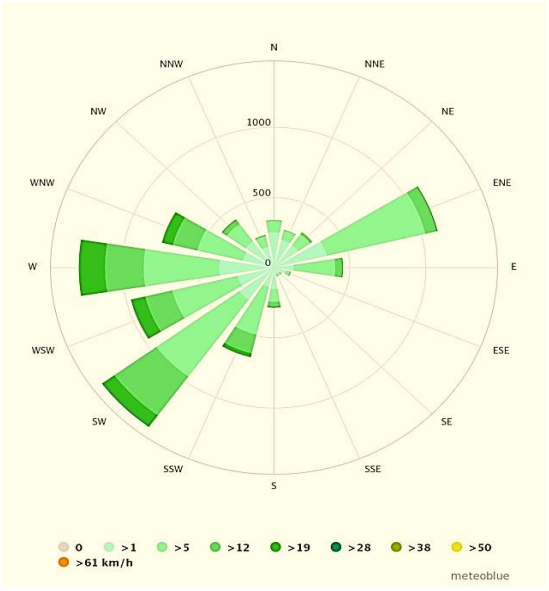

Fig.4 Wind rose diagram

C. Site location

The area for which we are designing the WHS is village Rasayani, Taluka: Panvel, Dist.: Raigad, state: Maharashtra. Latitude and longitude of the location are 18.9004° N, 73.1763° E. This village has a primary and secondary school and Pillai HOC Educational campus Fig.5 shows the study area (i.e. Rasayani village) obtained from Google maps. (Source: https://www.google.co.in/maps/)

Fig.5 Satellite view of study area (Pillai HOC educational campus)

D. Material Description

The materials used are locally available, easy to reuse and are economical.

- Bamboo: - Bamboos are used in the framing of the structure .It is used for the stability purpose.
- Mesh Fabric: - Mesh fabric is most vital component of the tower. It should be made up of polyester fabric which has the tendency to absorb moisture from the atmosphere. The test were conducted on various types of mesh having different properties like the cohesive inter molecular force of attraction between the water

molecules and polymers should be less and It should not react with water.

- Hemp ropes: -Hemp ropes are used to tie bamboos and the mesh fabric together.
- PVC Sheet: - it is sheet which act as an impermeable surface for the water molecules to travel down under the impact of gravity.
- Storage container: - It is used for storing water and distribution purpose

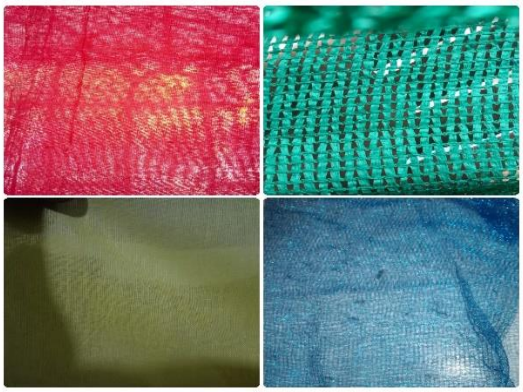

Fig.6 Mesh Fabric

III. PROCEDURE

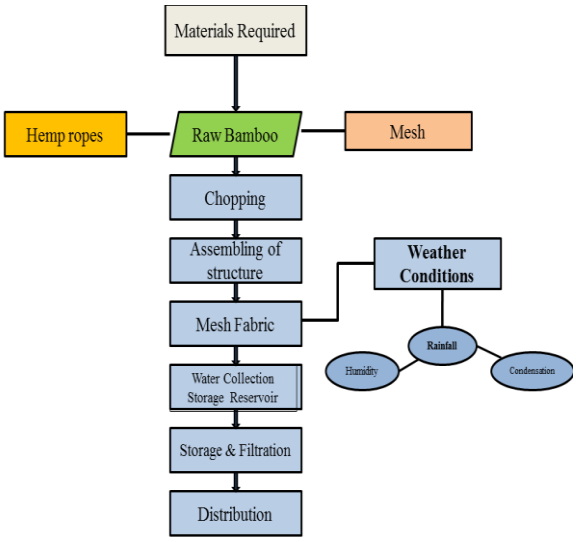

Fig.7 Flow Chart of the process

- Locally available traditional bamboos are being sorted out as per the sizes.
- Bamboos are chopped in different shape and sizes as per required dimensions of the structure.
- The framing of bamboo structure is carried out and assembled with the help of hemp ropes which are tied at different joints.
- The total height of the structure is 12ft, out of which is been divided into two parts. i.e. 5ft and 7ft consisting of varying diameter 6ft at the bottom and 3ft at the top.
- The mesh fabric is been assembled at the inner peripheral circumference of the tower which is connected to the storage reservoir.
- Thus the tower harvests the potable water from the atmosphere. It collects rain, harvests fog and dew.
- It functions only by natural phenomena such us gravity, condensation & evaporation and doesn't require electrical power

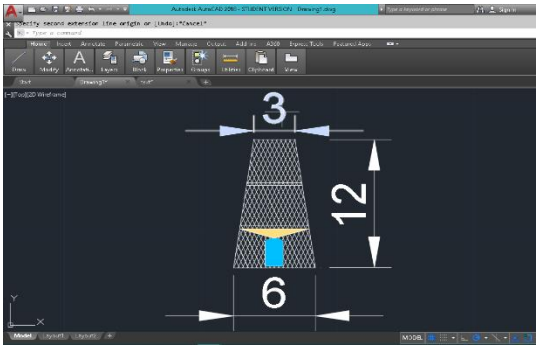

Fig.8 AutoCAD drawing of Structure

Fig.9 Vertical structure

IV. RESULTS AND CONCLUSION

The WHS is vertical structure created by the locally available materials in rural areas. It is designed to

harvest potable water from the atmosphere providing sustainable and affordable water sources to remote communities in the rural villages that are facing water scarcity issues. It is constructed with biodegradable materials with aim to collect an average up to 50 litres of potable water per day which depend on weather conditions. It is designed to be easily built and maintained by local villagers without electrical tools. Beyond providing potable water, the target is to strengthen the local economy through manufacturing the towers locally and provide women and children opportunities to invest their time in care and other productive activities.

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