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ATMOSPHERIC WATER HARVESTING

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ABSTRACT

In many regions of the world, the climatic conditions are suitable for generating drinkable water; however, they have one or more types of water scarcity. Water supply in urban areas is always shortage against total water demand. This scenario requires an alternative source to bridge the gate between demand and supply. Atmospheric condition has been studied like humidity, annual precipitation and different temperatures. The studied method is for water scarcity regions. It is a new technique to harvest water from atmosphere by rain water harvesting and atmospheric water generator which run via wind energy and solar energy. The water generator works on the principle of Dehumidification.

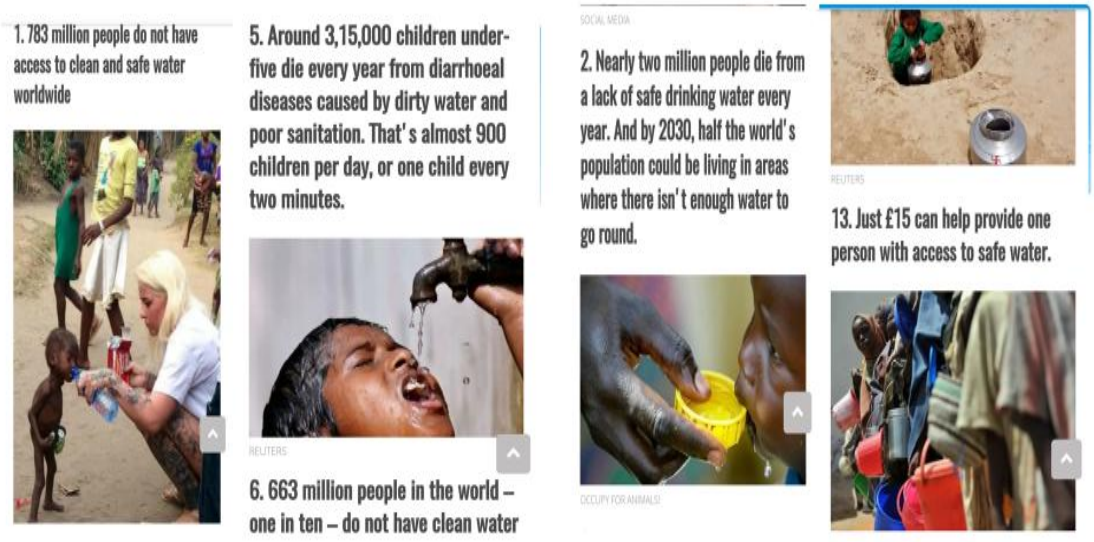
KEYWORDS: *Coefficient runoff, Dehumidification, Humidity ratio, Population forecast, Relative humidity, Water demand.*

INTRODUCTION

Water that covers about 70%of earth's surface and essential substance for the nature and the ecosystem of the world's and about 97.5% of all water on the earth is salt water.

Water leaving only 2.5% as fresh water which can be found in various forms such as glaciers, ground water surface water as well as atmosphere water. So it's evident that fresh water though is a limited resource.

Report revealed that 768 million people would wide lack Acer to safe water which is often termed as physical water scarcity. Whereas 1.8 billion people are predicted to live in regions with absolute water scarcity by 2025. This is due to unplanned management of water resources, insufficient planning and insufficient political will. Water scarcity is therefore thought to be a serious problem throughout the world and to overcome this problem is one of the biggest challenges of the 21st century.



STUDIES CARRIED OUT IN INDIA:

Today, only 25%of the entire world's water is fresh which is fit for human consumption, agriculture and industry. In several parts of world, however water is being used at a much faster rate than can be refilled by rainfall. In 2025, the per capita water availability in India will be reduced to 1500m^^{3} from 5000 in 1950. The United Nations warns that this shortage of fresh water could be the most serious obstacle to producing enough food for growing world population, reducing poverty and protecting the environment. Hence, the water scarcity is going to the critical problem if it is not treated now in its present stage. Contrasting figures of water scarcity in world between two timeline (1999 and 2025). Some of the major city where rain water harvesting has already implemented is Delhi (centre of science and environment (CSE) designs sixteen model projects in Delhi to set up rainfall harvesting structures in different colonies and institutions), Bangalore (rain water harvesting escorts Mahle Foetze designed by S.Vishvanath, rainwater club), Indore (Indore municipal corporation IMC has announced a rebate of 6% on property tax for those who have implemented the rain water harvesting work in their house/bungalow/building.

In the present scenario of water scarcity, **water conservation** plays a vital role and this water conservation can be done by two methods which are enlisted below:

1. **ATMOSPHERIC WATER HARVESTING**
2. **RAIN WATER HARVESTING**

So, our **aim of the project** is to reduce water scarcity by harvesting atmospheric water via rain water harvesting and air moisture harvesting by atmospheric water generator. This atmospheric water generator will run by wind or solar energy that works on the principle of **Dehumidification.**

In our project we will take water scarcity area i.e., **"Chikkabanavara, Bangalore",** area into consideration and hoping that requirements were to ensure that the final project would effectively fulfill its intended purposes i.e.

1. Increase in availability of water.
2. To meet increasing water demand.
3. Avoiding flooding on roads.
4. Utilization of atmospheric water effectively.

METHEDOLOGY

1. Remote sensing device are used to describe the area like topography.

2.To harvest the atmospheric water firstly survey has to be done to find out the water scarcity areas and parameters like catchment area, no. of houses, road area, population, water demand, rain fall statistics and relative humidity is to be ascertained.

3. The sources of water available in that area and quantity of water available for the population in that area has to be ascertained

4. Surface run off from roads has to be harvested and should be transferred to treatment locations.

5. In design of rain water harvesting system, collecting rain water from roofs slabs and sloping roofs by the help of channeling system in hygienic manner.

6. Annual rain fall statics' has to be studied and also case study on relative humidity of that area there fixing of atmospheric air water generator has to be done.

7. By the help of meteorological department amount of water which can be obtained in $1m^3$ of air at different relative humidity for different temperature conditions are necessary.

8. Ratio of daily water demand and quantity of water being harvested annually has to be calculated.

9. The water harvested has to be sent for treatment like PH, turbidity, disinfection and screening.

10. The so harvested water should meet WHO standards.

DESCRIPTION OF STUDY AREA

"Chikkabanavara" is located in **Bangalore** north taluk of Bangalore urban district **Karnataka** between the latitude **13.0796 degree north** and **77.5047 degree east** is just on the outskirts of Bangalore.

Description	Quantities
Total area	83100 km^2
No of houses	890
Pitched roof	89
Flat roofs	801
Length of road 1.metalled roads 2. un metalled roads	4.03Km 2.23 km 1.8Km
No of bore wells	43
No of municipal water connections	1258

IS WATER DEMAND STANDARDS

S no	USE	DEMAND (lpcd)
1	Domestic use	200
2	Industrial use	50
3	Commercial use	20
4	Civic or public use	10
5	Waste total	55 335 lpcd

DESIGN POPULATION

Design population for year 2021

Population in Chikkabanvara village in 2001 =5209

Population in Chikkabanavra village in 2011 =14409

Therefore,

Design population by 2021= P +nI

Where p = present population = 14409

n = no of decades = 1

I = increase in population = 14409 – 5209

= 9200

Then, **Design population by 2021 = 23609**

Hence,

Demand =355*23609=79, 09,015 lpcd.

Therefore the water demand for the chikkabanavara area =79, 09,015 lpcd

Calculation of Availability of water

No of bore wells =43

Horse power of motor=2, 2.5, 1, 1….

Diameter of pipe =50.8, 25.4 mm

Velocity of water in 6 inch pipe = 2 to 3 m/s

(Assume =2.7)

Velocity in 50.8 mm pipe =0.9m/s

Therefore

Q= A*V

Q= (3.14*(dia) ^2)/4 x velocity

Q= 1.8 *10^-3 cum/sec

Q=1.8 lit/sec

Working hour 3hrs/day

Q=1.8*10800

Q=194400 l/sec

Discharge from bore wells per day

Q=19440*43

Q=835920 l

Therefore, water withdraw in each day from bore wells = 835920 liters.

Also, water supply by BWSSB

No of water connections =1258

Working hours =3 to 4h/day

Water supplied/day= 2000l/day

For 1258 connections

Amount of water given=2000*1258=2516000 l/day

Therefore, water given by BWSSB = 2516000 liters/ day

Hence, Total water available = 835920 +2516000

=3351920 l/day

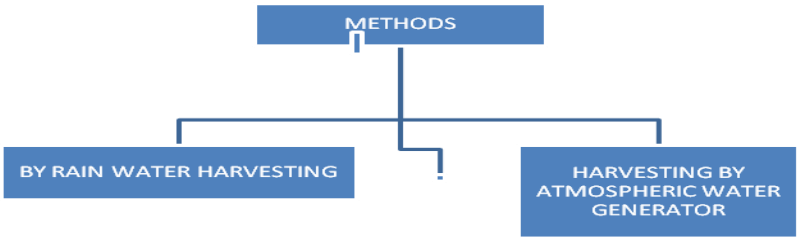
Therefore, 33lakh 51 thousand 920 litres Water is available in study area

But water demand = **7909015 lpcd.**

Since, water supply is much lesser than the water demand for the population present in the study, we can conclude that water scarcity is a serious issue this area.I.e. the area is having 43%of water scarcity.

According to IS 1172-1983water demand per person per day is 335lpcd, but with the available water in this area a single person can get only 108 lpcd. Which means 227 lpcd of water demand is not supplied.

METHODS OF HARVESTING ATMOSPHERIC WATER



Rain Water Harvesting

It is a process of collection of rain water rather than allowing it to runoff.

METHODS OF RAIN WATER HARVESTING:

1. ROOF TOP RAIN WATER HARVESTING : It is a system of catching rain water from roof top oh houses either flat or pitched roof.

2. SURFACE RUNOFF HARVESTING: In this type of harvesting we catch the rain water from roads.

Calculations of roof top rain water harvesting

Type of catchment	Coefficients
Roof catchments -tiles - Corrugated metal sheets	0.8 - 0.9 0.7 – 0.9
Ground surface coverings -concrete -brick pavement	0.6-0.8 0.5-0.6
Untreated ground catchments -soil on slopes less than 10% -rocky natural catchments	0.0-0.3 0.2-0.5
Untreated ground catchments -soil on slopes less than 10% -rocky natural catchments	1.0-0.3 0.2-0.5

Calculation of rain water from roof top area

No off roofs=890

Assuming roof catchment area=60m^2

Runoff coefficient from RCC and pitched Roof, c=0.8.

Filter efficiency, (F) =80%

Annual rain water yield,

Q=A*R*C*F

Q =60*970*0.8*0.8

Q= 37248Litres

Therefore, we can yield 62080litres/annum from per house.

Since, there are some losses while calculating which are enlisted below,

- Absorption loss
- Adsorption loss
- Evaporation loss etc;

Assuming 40% of all losses ;

Therefore, Annual rain water yield=

Q'=Q-40%Q

Where Q'=annual rainwater Yield with losses

Q=annual rain water Yield without losses

Q'=62080-40/100*62080

Q'=37248Litres

Calculation from surface covering

1. From bitumen road

Catchment area of metaled road=15610m^2

Intensity of rainfall=970mm

Runoff coefficient=0.82

Q=A*I*C

Q=15610*970*0.82

Q=12416194Litres

Assuming losses=70%

Q=37, 24,858.2Litres

2. From unmetaled Road

Runoff coefficient=0.2

Losses=80%

Area = 12600

Q=C*I*A

Q=0.2*970*12600

Q=2444400Litres

Including losses, **Q=4, 88,880Litres**

3. Open Area

Area=1490m^2

Runoff coefficient=0.2

Losses=90%

Intensity=970mm

Q=A*R*I

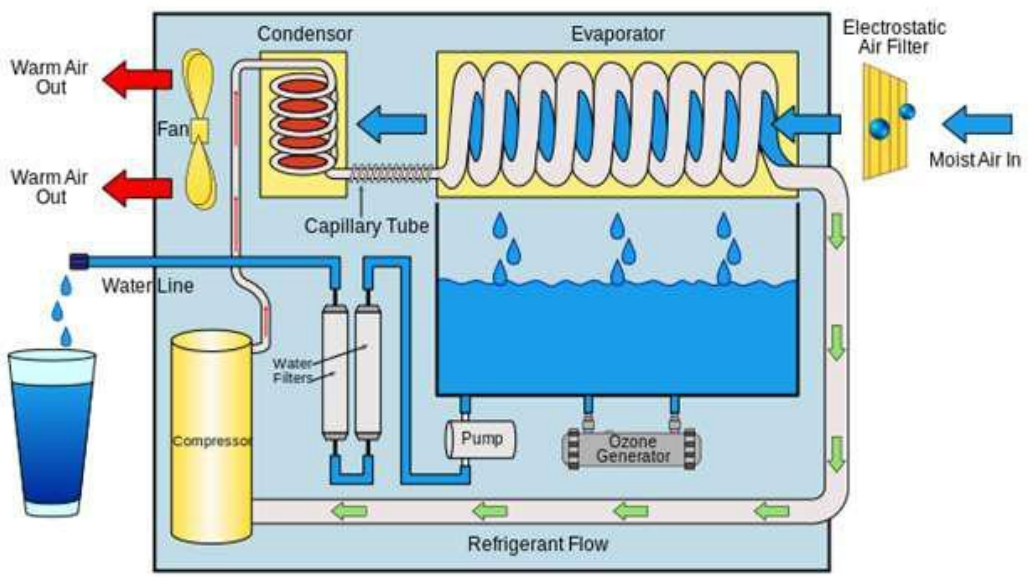
Q=289060Litres

Q=289060-90/100*289060

Q=28906Litres

Harvesting by Water Generator

- This harvesting is wholly depends upon **DEHUMIDIFICSTION technique.**



Water (in liters) present in 1m^3 of air

- It's given by = humidity ratio x 1000

Where, humidity ratio = 0.622 x Pw/(Pa – Pw)

Pw = (RH/100) x Ps

Pw = Partial pressure

RH = relative humidity

Pw = pressure of atmosphere

Definitions

- **Saturation pressure:** is the pressure of the vapour which is in the equilibrium with the liquid(as steam with water) i.e. the maximum pressure possible by water vapour at given temperature. The saturation water pressure of water at atmospheric temperatures is obtained from the commercially available steel table.
- **Relative humidity (RH):** The ratio of partial pressure of water (Pw) to the saturation pressure (Ps)

That is,

RH = (Pw /Ps)*100

- **Partial pressure of water:** it is the pressure of the water vapour present in the mixture of air and water vapour.
- **Humidity ratio:** it gives the amount of water present in 1m^3 of air.

CALCULATIONS

For atmospheric temperature 30 degree, RH = 65.2%

Ps = 0.0423965 (from steam table)

Pw = RH/100 x Ps = 0.02764252

Humidity ratio = 0.0174472387

Therefore,

Amount of water present in 1m^3 of air = humidity ratio * 1000

= **17.44 liters**

By taking the references of journal paper **"development of water generation system from air; Sahil Doshi (March 2016)"**

Extraction efficiency = 40 %

Therefore water extracted = 6.97 =**7 liters**

Temp (degree)	Saturation pressure	Relative humidity (%)	Partial pressure (bar)	Humidity ratio (in 1m^3 of air)	Amount of water (liters)
25	0.03167	65	0.0205855	0.0128988	12.8988001
29	0.04005	65	0.0260325	0.0164018	16.401
30	0.04241	65	0.027566	0.01739540	**17.3954**
32	0.04755	65	0.0309075	0.01957	19.5702
35	0.05624	65	0.036556	0.023280	23.280
40	0.07376	65	0.047944	0.03089	30.8929
45	0.09585	65	0.0623025	0.0407510	**40.75109**

RESULTS

- **Water demand = 79,09,015 lpcd acc to population by 2021**
- **Availability of water:**

1. From bore holes = 8,35,920 liters
2. From water connections = 33,51920Liters

Total = **41, 87,840 liters**

Therefore, only 52 % is available

Water given = **177.38 lpcd but demand is 335 lpcd**.

- **Water yield by rain water harvesting = 1,02,368 l/day**
- **By atmospheric water generator of 100 units = 700 l/day**

CONCLUSIONS

- The application of this technology may results in solutions for water supply problems in many situations.
- It could create the additional potable water without depleting existing resources.
- Thus it helps us to tackle the problems of availability of pure drinking water in remote locations, mining sites, and instances where scaling is an issue.

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