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Rejuvenating the Water Sources of Well by Collection & Filtration of Runoff Water by (Rain Water Harvesting)

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Abstract— A case study on the coastal area of Krawar, karnataka is located at the coastal area where the temperature & humidity will be always in high condition which leads to the scarcity of water during drought (summer) season, as we the final year Civil engineering students of GSIT engineering college, studied the scarcity of water during summer season in our own campus area which is of 11 Acers having a two main sources of water i.e. open well, our college area is covered by the hills & dense forest by which during rainy season the surface runoff water is reaching the sea.

To the collect this huge amount of water from the roof tops of hostel & college buildings also from the nearby non-perennial streams which come from the hilly areas we have studied & surveyed the rainfall intensity & the catchment area.

This project on "rejuvenating the water sources of well by collection & filtration of runoff water by (rain water harvesting)" structure with a study which will be implemented to provide safe drinking water to the community and to identify the best possible technology with respect to the specific region

In this paper, it covers the components that can be taken under the rain water harvesting structure, geographical area, availability of the water quantity, its quality and water demand. It also covered about the design parameters in which the flexibility and community management can promote and accordingly the design was modified. The main conclusion of this paper was the acceptance of the community about the technology, its design considerations and about the promotion of this technology in the water scarcity and pollutant regions. Finally, the study revealed that, it requires awareness (Psychological awareness) about the utilization of direct rain water with a primary filter unit, challenge of social and community acceptance, maintenance and time involvement for effective utilization.

Index Terms— Non-perennial stream, Rain water harvesting, Runoff water, Rejuvenating, Water demand

I. INTRODUCTION

1.1 General

Rainwater harvesting is the process of capturing, conveying, and storing rainwater for future use. The concept of rainwater harvesting can be dated back over 4000 years. Ancient societies have developed various rainwater harvesting technologies and constructions such as agricultural dams, runoff control methods, reservoir or cistern construction in urbanized areas. Water captured by rainwater harvesting systems provides a main source of portable water, supplement source of potable water, and a supplement source of non-portable water (i.e., toilet flushing, irrigation and car washing). The use of rainwater harvesting systems occurs mainly for non-portable water supplies but it has recently become an important alternative water resource to address the water shortage in urban and sub-urban areas among developed countries. Rainwater harvesting systems can be easily implemented at the home, commercial, and community levels. The application of rainwater harvesting in both rural and urban areas of developing countries is well documented

Karwar is situated at the coastal area of Karnataka, as the city is located at the coastal area the temperature & humidity will be always in high condition which leads to the scarcity of water during drought (summer) season, as we the final year Civil engineering students of GSIT engineering college, studied the scarcity of water during summer season in our own campus area which is of **11 Acers** having a two main sources of water i.e. open well, our college area is covered by the hills & dense forest by which during rainy season the surface runoff water is reaching the sea. To the collect this huge amount of water from the roof tops of hostel & college buildings also from the nearby non-perennial streams which come from the hilly areas, so we have studied & surveyed the rainfall intensity & the catchment area.

The collected water is treated, stored in the designed storage pits then the excess water is rejuvenating to the two wells of the campus area. The source of water is turbid and lightly polluted by the surrounding nuisance by land pollution & hence it is necessary to treat this source of water by potassium & chlorination method. This collected & treated water is utilized to fulfillment to scarcity of water in summer season & also for the gardening purpose.

1.2 Need for Rainwater Harvesting

Due to pollution of both groundwater and surface waters, and the overall increased demand for water resources due to population growth, many communities all over the world are approaching the limits of their traditional water resources. Therefore they have to turn to alternative or 'new' resources like rainwater harvesting (RWH).

Rainwater harvesting has regained importance as a valuable alternative or supplementary water resource. Utilization of rainwater is now an option along with more 'conventional' water supply technologies, particularly in rural areas, but increasingly in urban areas as well. RWH has proven to be of great value for arid and semi-arid countries or regions, small coral and volcanic islands, and remote and scattered human settlements.

Rainwater harvesting has been used for ages and examples can be found in all the great civilizations throughout history. The technology can be very simple or complex depending on the specific local circumstances. Traditionally, in Uganda and in Sri Lanka rainwater is collected from trees, using banana leaves or stems as gutters; up to **200 liters** may be collected from a large tree in a single rain storm.

With the increasing availability of corrugated iron roofing in many developing countries, people often place a small container under their eaves to collect rainwater. **120-litre** container of clean water captured from the roof can save a walk of many kilometers to the nearest clean water source. Besides small containers, larger sub-surface and surface tanks are used for collecting larger amounts of rainwater. Many individuals and groups have taken the initiative and developed a wide variety of different RWH systems throughout the world.

1.2 Satellite view of project area

FIG. 1 (a)

1.3 Key plan of project area

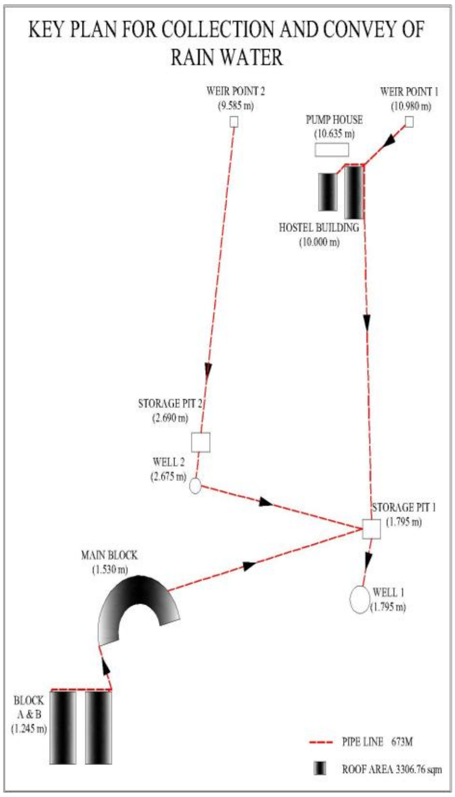

FIG. 1 (b)

1.3 Reasons for Rainwater Harvesting

- Increasing water needs/demands
- Variations in water availability
- Advantage of collection and storage near the place of use
- Quality of water supplies

1.4 Advantages

- Simple construction
- Good Maintenance
- Relatively good water quality
- Low environmental impact
- Convenience at household level
- Not affected by local geology or topography
- Flexibility and adaptability of systems

1.5 Disadvantages

- High investment costs
- Usage and maintenance
- Water quality is vulnerable
- Supply is sensitive to droughts
- Limited supply

II. DATA & CALCULATIONS

2.1 Criteria of the building

- Location of building is at the coastal city of Karwar which is adjacent to the Goa-Karnataka border.
- As the location of the building comes under the coastal city of Karwar there is rapid increase in the temperature as well as increase in the humidity.
- Building is constructed over the first floor,
- As per the case study of civil lecture block the area of the building is found to be **601.5 m^2.**

2.2 Design of storage tank

- Providing 2 tanks for the collection
- Size of the tank A – **(10m x 10m x 3m)**
- Size of the tank B – **(10m x 10m x 3m)**
- Total capacity of storage tank is **- 600 m^3**

The design and calculations are made to utilize the roof and surrounding catchment area for rain water harvesting and implementation on maintenance of building.

Annually we can harvest **90%** of total water, remaining **10%** accommodate for waste, leakage, evaporation etc.

2.3 Runoff quantity

Estimation of Storm water by rational formula

Rational formula: (AIR/360)

Where, A : Area in Hector.

I : Co-efficient of Runoff.

R : Rainfall in (mm/hr.)

2.4 Calculation of roof area

- Area of college main building **- 584.3 m^2**
- Area of college new building (A) **- 601.26 m^2**
- Area of college new building (B) **- 810.4 m^2**
- Area of Boys Hostel building **- 781.20 m^2**
- Area of Girls Hostel building **- 529.60 m^2**

Total rooftop area 3306.76 m^2 = 0.33 hectar

2.5 Calculation of discharge

2.5.1 Discharge from roof top

- Total area of roof **- 0.33 hector**
- The average Rainfall for the Karwar area- **2.42 mm/hr**
- Runoff co-efficient for roof varies from **- 0.8**
- Discharge = $\frac{0.33 \times 0.8 \times 2.24 \times 60}{360}$ = **0.106 cum /hr.**

2.5.2 Discharge from non-perennial stream

- Discharge **= 0.3 cum/hr.**

(Determined by weir out fall)

- Results:

Total discharge **= 0.4 cum/hr.**

Total discharge / day **= (0.4 x 24) = 9.6cum / day**

Assuming **90 %** of rainwater can be collected after all loses **=8.6 cum / day**

(By considering rainfall duration of **120 hr.** in rainy season)

2.6 Water demand calculations

2.6.1 Water demand for college building

TABLE 2.1

WATER DEMAND FOR COLLEGE BUILDING			
SI NO	YEAR	POPULATION	WATER CONSUMPTION mg/lit
1	2012-2013	72	2520
2	2013-2014	180	6300
3	2014-2015	260	9100
4	2015-2016	270	9450
5	2016-2017	325	11375

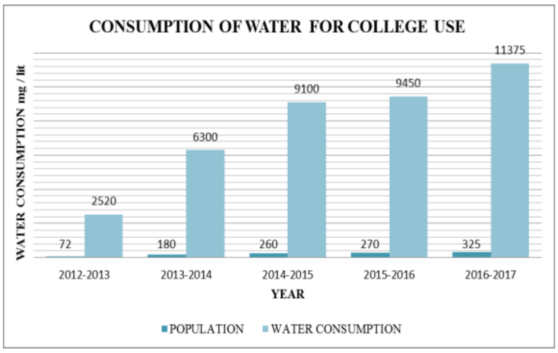

FIG. 2 (a)

2.6.2 WATER DEMAND FOR HOSTEL BUILDING

TABLE 2.2

WATER DEMAND FOR HOSTEL BUILDING			
Sl NO	**YEAR**	**POPULATION**	**WATER CONSUMPTION mg/lit**
1	2012-2013	10	1350
2	2013-2014	40	5400
3	2014-2015	60	8100
4	2015-2016	90	12150
5	2016-2017	100	13500

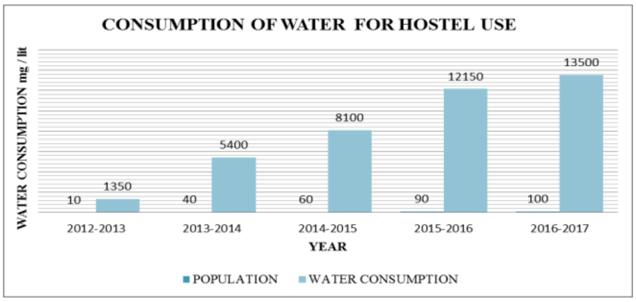

FIG. 2 (b)

Water consumption of college = **11.375 cum / day.**

Consumption of water of hostel = **13.50 cum / day**.

Total consumption / day = **24.875 cum / day.**

2.7 Design of weir

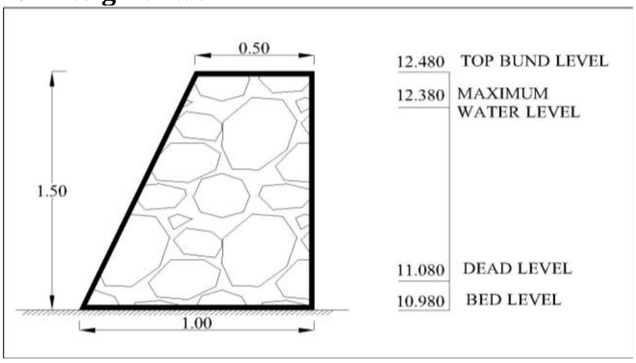

FIG. 2 (c) C/S OF WIER (1)

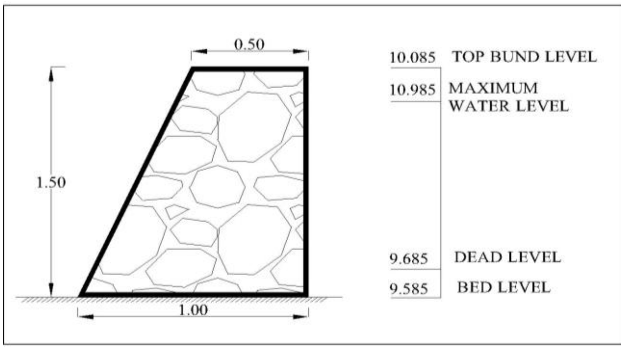

FIG. 2 (d) C/S OF WIER (2)

4.8 Storage tank & filtration unit

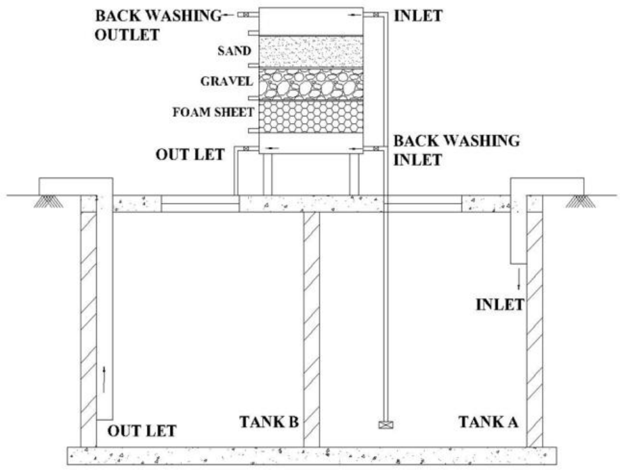

FIG. 2 (e) storage tank & filtration unit

III. AVAILABLE MATERIALS AND COSTS

Selecting the most appropriate storage reservoir

- Locally available materials and skills.
- Cost – of purchasing a new tank.
- Cost – of materials and labour for construction.
- Space availability.
- Locally available experience and options.
- Local traditions for water storage.
- Soil type and ground conditions.
- Type of RWH – whether the system will provide total or partial supply.
-

IV. CONSTRUCTION

Three basic components of a rainwater harvesting system

- **Catchment or roof surface** to collect rainwater
- **Delivery system** to transport the water from the roof to the storage reservoir (gutters and drainpipes)
- **Storage reservoir or tank to store** the water until it is used. The storage reservoir has an extraction

device that- depending on the location of the tank- may be a tap, rope and bucket, or a pump.

V. TESTES ON WATER SAMPLES

5.1 Physical tests

- Total alkalinity test.
- Total acidity test.
- Total suspended solids.
- Total dissolved solids.
- Colour.
- Turbidity.
- Total hardness.
- pH value.
- Electro conductivity test.

Permissible limits for portable water

Table 5.1

SL. NO	PARAMETER ANALYSED	As per BIS 10030-1991 Permissible limits
1.	pH - value	6.5 – 8.5
2.	Colour (Hazen units)	Colourless
3.	Determination of acidity	There is no limit for drinking water
4.	Determination of alkalinity	Less than 200mg/l
5.	Determination of hardness	For 200 - 300 mg/l it is hard water
6.	Electrical Conductivity	150 - 500
7.	Chlorides	Less than 1.7mg/l
8.	Appearance	Clear
9.	Odor	Inoffensive
10.	Turbidity NTU	5.0
11.	Total dissolved solids mg/l	500
12.	Total hardness as CaCO3 mg/l (Methyl Orange)	200
13.	Chlorides as Cl - mg/l	250
14.	Sulphate as SO4-- mg/l	200
15.	Nitrates as NO3- mg/l	45
16.	Nitrates as NO2- mg/l	NIL
17.	Oxidability – 4 hrs. mg/l	2.0
18.	Iron as Fe + + mg/l	0.3
19.	Manganese as Mn + + mg/l	0.1
20.	Manganese as Mg + + mg/l	30.0

Test results for portable water

Table 5.2

SL.NO	PARAMETER ANALYSED	TEST RESULTS
1.	pH - value	7.5
2.	Colour (Hazen units)	2.0
3.	Determination of acidity mg/l	32
4.	Determination of alkalinity mg/l	36
5.	Determination of hardness mg/l	220
6.	Electrical Conductivity	0.464
7.	Chlorides mg/l	1.7
8.	Appearance	clear
9.	Odour	Inoffensive
10.	Turbidity NTU	1.0
11.	Total dissolved solids mg/l	148.0
12.	Total hardness as CaCO3 mg/l (Methyl Orange)	89.0
13.	Chlorides as Cl - mg/l	28.4
14.	Sulphate as SO4-- mg/l	2.0
15.	Nitrates as NO3- mg/l	NIL
16.	Nitrates as NO2- mg/l	NIL
17.	Oxidability – 4 hrs. mg/l	0.8
18.	Iron as Fe + + mg/l	0.27

19.	Manganese as Mn + + mg/l	NIL
20.	Manganese as Mg + + mg/l	NIL

Chlorine Test Result

Table 5.3

SAMPLE NO	FLASK NO	INITIAL READING (mg/l)	FINAL READING (mg/l)	FR-IR (mg/l)	RESIDUAL CHLORINE (mg/l)
1	1	0	0	0	0
	2	0	0	0	0
	3	0	0.1	0.1	0.17725
	4	0.1	0.3	0.2	0.3545
	5	0.3	0.7	0.4	0.709
2	6	0	0	0	0
	7	0	0.1	0.1	0.17725
	8	0.1	0.2	0.1	0.17725
	9	0.2	0.4	0.2	0.3545
	10	0.4	0.7	0.3	0.53175

Chlorine Test

Table 5.4

Sample no	Flask no	Sample Taken	Concentration Of B P Solution Added	B P Solution Added	Chlorine added 200 ml	(a) 1000ml	(b) R-CL in mg/l
1	1	200	1 mg/l	0.20	0.04	0.20	0
	2	200	1 mg/l	0.40	0.08	0.40	0
	3	200	1 mg/l	0.60	0.12	0.60	0.17725
	4	200	1 mg/l	0.80	0.16	0.80	0.3545
	5	200	1 mg/l	1.00	0.20	1.00	0.53175
2	6	200	1 mg/l	0.20	0.04	0.20	0
	7	200	1 mg/l	0.40	0.08	0.40	0.17725
	8	200	1 mg/l	0.60	0.12	0.60	0.17725
	9	200	1 mg/l	0.80	0.16	0.80	0.3545
	10	200	1 mg/l	1.00	0.20	1.00	0.53175

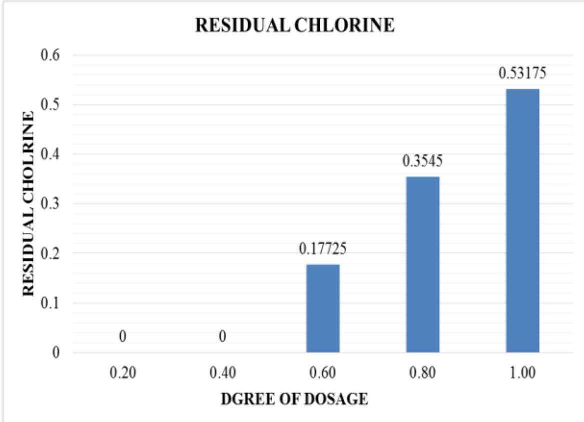

Fig. 5 (a) SAMPLE 1

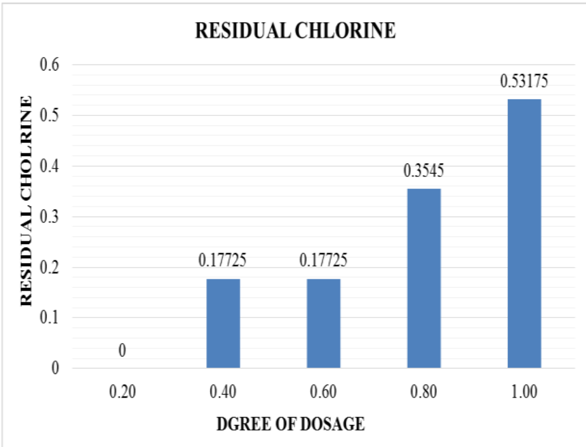

Fig. 5 (b) SAMPLE 2

VI. RECOMMENDATIONS

9.1 Water conservation in GSIT campus

Water is the most precious gift of nature. It is the form of life, almost three fourth of the earth in water. We should conserve and save water as to protect the water environment. Without water nothing can live. It is the source of all life on earth. Water is used for irrigation and plantations and plays a vital role in hydroelectricity.

As to save water in GSIT campus and hostel, we should stop the misuse of water & manage the usage of water properly, take efforts in maintaining the quality of water. Stop the wastage of water in the campus as well as the hostels. Take in the measures to stop water leakages wherever and whenever possible. Promote water harvesting i.e. rain water harvesting for the water shortage issues in the summer seasons.

The following are some measures to conserve water by modifying our everyday habits

9.2 HOSTEL

- The student and faculty should follow these measures in order to save water.
- After brushing the teeth, use a glass of water instead of running water to rinse the mouth.
- While shaving, use water in a bowl to clean the razor or the best option is an electric razor.
- Most of us have a habit of having deep thoughts about life and origin of life while having a shower. This can be reduced by just washing and rinsing the body, so that it saves the time as well as water.

9.3 COLLEGE

- Educational posters regarding water conservation should be put up to increase the awareness.
- Hand sanitizers are must be installed in the washrooms for quick sanitation purposes instead of using water for a hand wash.
- Plants can be replaced which require a lot of water with plants adapted to local climate and rainfall. Also the plants should be watered in early morning / late evenings to decrease the amount of evaporation as well as over spraying.
- Repairing the leakages if any.
- To supplement the ground water supplies during learn seasons.
- To raise the water table by recharging the ground water.
- To avoid flooding of roads as much as possible.

VII. FUTURE SCOPE

Graphene – oxide membrane sieve

[1]Researchers have achieved a major turning point in the quest for efficient desalination by announcing the invention of a graphene-oxide membrane that sieves salt right out of seawater.

At this stage, the technique is still limited to the lab, but it's a demonstration of how we could one day quickly and easily turn one of our most abundant resources, seawater, into one of our most scarce - clean drinking water.

The team, led by Rahul Nair from the University of Manchester in the UK, has shown that the sieve can efficiently filter out salts, and now the next step is to test this against existing desalination membranes.

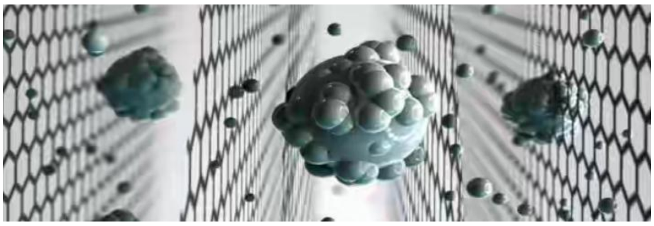

Fig. 7 Graphene – oxide membrane sieve

"Realization of scalable membranes with uniform pore size down to atomic scale is a significant step forward and will open new possibilities for improving the efficiency of desalination technology," says Nair.

"This is the first clear-cut experiment in this regime. We also demonstrate that there are realistic possibilities to scale up the described approach and mass produce graphene-based membranes with required sieve sizes."

Graphene-oxide membranes have long been considered a promising candidate for filtration and desalination, but although many teams have developed membranes that could sieve large particles out of water, getting rid of salt requires even smaller sieves that scientists have struggled to create.

One big issue is that, when graphene-oxide membranes are immersed in water, they swell up, allowing salt particles to flow through the engorged pores. The Manchester team overcame this by building walls of epoxy resin on either side of the graphene oxide membrane, stopping it from swelling up in water.

This allowed them to precisely control the pore size in the membrane, creating holes tiny enough to filter out all common salts from seawater. The key to this is the fact that when common salts are dissolved in water, they form a 'shell' of water molecules around themselves.

"Water molecules can go through individually, but sodium chloride cannot. It always needs the help of the water molecules," Nair told Paul Rincon from the BBC.

"The size of the shell of water around the salt is larger than the channel size, so it cannot go through." Not only did this leave seawater fresh to drink, it also made the water molecules flow way faster through the membrane barrier, which is perfect for use in desalination.

"When the capillary size is around one nanometer, which is very close to the size of the water molecule, those molecules form a nice interconnected arrangement like a train," Nair explained to Rincon.

"That makes the movement of water faster: if you push harder on one side, the molecules all move on the other side because of the hydrogen bonds between them. You can only get that situation if the channel size is very small."

There are already several major desalination plants around the world using polymer-based membranes to filter out salt, but the process is still largely inefficient and expensive, so finding a way to make it quicker, cheaper, and easier is a huge goal for researchers.

Thanks to climate change, seawater is something we're going to have plenty of in the future - Greenland's coastal ice caps which have already passed the point of no return are predicted to increase sea levels by around 3.8 cm (1.5 inches) by 2100, and if the entire Greenland Ice Sheet melts, future generations will be facing oceans up to 7.3 meters (24 feet) higher. But at the same time, clean drinking water is still incredibly hard to come by in many parts of the world - the UN predicts that by **2025, 14%** of the world's population will encounter water scarcity. And many of those countries won't be able to afford large-scale desalination plants. The researchers are now hoping that the graphene-based sieve might be as effective as large plants on the small scale, so it's easier to roll out.

Graphene oxide is also a lot easier and cheaper to make in the lab than single-layers of graphene, which means the technology will be affordable and easy to produce.

"The selective separation of water molecules from ions by physical restriction of interlayer spacing opens the door to the synthesis of inexpensive membranes for desalination," Ram Devanathan from the Pacific Northwest National Laboratory, who wasn't involved in the research, wrote in an accompanying Nature News and Views article.

"The ultimate goal is to create a filtration device that will produce potable water from seawater or wastewater with minimal energy input." He added that the next step will be to test how durable the membranes are when used over long periods of time, and how often they need to be replaced.

The research has been published in Nature Nanotechnology [1].

CONCLUSION

- It is no denying that sustaining and recharging the groundwater along with judicious use of the limited fresh water resources is the need of the hour.
- If sufficient measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind.
- Efficient management of water resources and education about judicious utilization of water resources along with measures of harnessing, recharging and maintaining the quality of water and water bodies has to be taken up on war footing.
- One of the most logical steps towards this goal would be acknowledging the importance of rainwater harvesting.
- This should not only encompass rooftop rainwater harvesting but also storm water harvesting systems.
- Storm water harvesting is yet to be acknowledged as a better alternative over rooftop water harvesting.
- One of the major hurdles in storm water harvesting is the poor state of storm water drain systems in India.
- A planned approach is hence needed in order to fully utilize the potential of rainwater to adequately meet our water requirements.
- Hence, an equal and positive thrust is needed in developing and encouraging both the types of water harvesting systems.
- We have to catch water in every possible way and every possible place it falls.

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