International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

SUSTAINABLE WATER MANAGEMENT AND WAY FORWARD TO REPLENISH THE WATER RESOURCES IN UKHRUL TOWN, MANIPUR

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ABSTRACT: The land of Shiroy lily, scenic hilly town of Ukhrul has been reeling under the massive water shortage for long though geographically monsoon fed region. Now, Rainfall fluctuation, long dry spell, negligible spring water sources are the order of the day. The causes of this relentless unprecedented water crisis points to the likely Global warming factor attributed by the reckless forest fire around the catchment areas, inconsistent forest cover area. Putting pressure on more water demand by rapid population growth add to the woes, as the town witnesses influx from all four corner villages of the district in the last decades for better livelihood in the headquarter. Moreover, the high elevation landscape means no ground water resources. Time is ripe to think out of the box and devise the roadmap to conserve water resources sustainably with the best eco-friendly manner and locally readily available cost-effective material. One such measure will be to incorporate the concept of forestry and reviving spring water sources mainly to keep the flow of water cycle going. More importantly, Rain water Harvesting is considered arguably the most promising alternative form of collecting fresh water in the hill town.

Keywords: Sustainable, water resources, rainwater harvesting, catchment

INTRODUCTION: Among all the natural resources, water resources is considered among the most essential life supporting substance on earth as water is used in transporting nutrients, Oxygen, waste material and it facilitate in the digestion, absorption of food, regulation of body temperature**(http://www.ctahr.hawaii.edu/new**). interestingly, our human body comprises of about 60 % water content. With 71% of the Earth's surface covered with Water, Earth is aptly referred as 'Blue planet' but abysmally low of about 0.3% is usable by humans and the remaining bulk of 99.7% is in the ocean, soils, icecap and water vapour in the atmosphere.

Distribution of the water on Earth-

Table: 1

Ocean water	97.2
Glaciers and ice	2.15
Ground water	0.61
Fresh water lake	0.009
Inland seas	0.008
Soil moisture	0.005
Atmosphere	0.001
Rivers	0.001

(http://ga.waer.usgs.gov/edu/earthwherewater.html)

Two major water sources:

Surface water comprises the majority water sources in Hill town of UKhrul. It is the water that is available on the surface body like streams, lakes, rivers, ponds and reservoir.

Ground water- Through the porous material water percolated deep into the earth's surface filling the pore and fractures of underground rock known as acquifier.

MATERIAL AND METHOD

Raw Materials

For a detail analysis of water management and conservation, Ukhrul town of Manipur was chosen. The hill town is situated in the north of the Manipur state, 84km from the Imphal city. The terrain of the district is hilly with a varying height of 913m to 3114. The average annual rainfall is 1763.7m (1991).The rainy season in the district is from May to beginning of October. Cervices and slope of Shirui peak are the contributor of majority of Riverand main water resources of the town. Different building structure of Government institution like school, offices and religious institution building Churches are the pick for rain water storage . Spring water sources , forest cover area percentage then and now and are the other dimentions included for necessary survey and water harvesting potential and negative impact factor.

Figure 1: Ukhrul Hr sec school

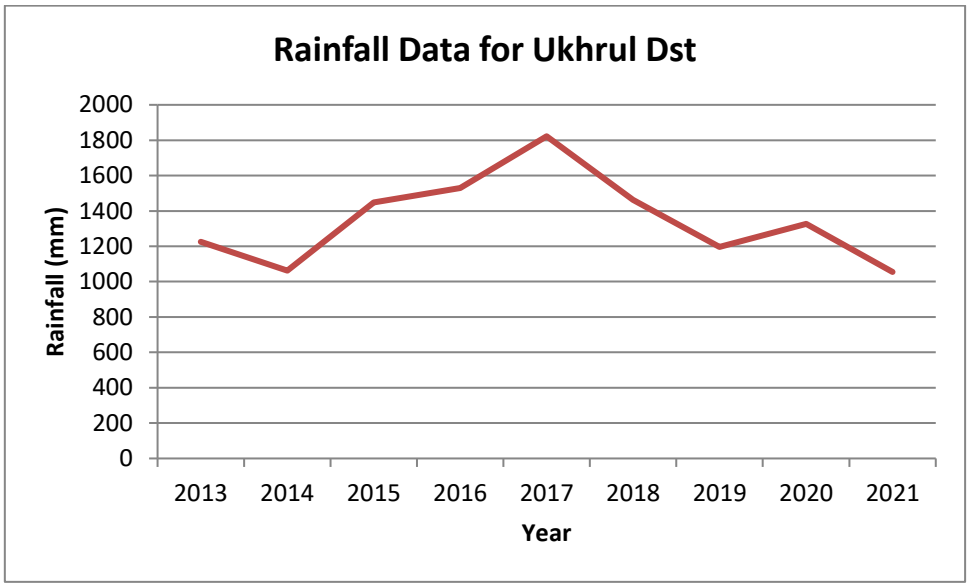
Figure 2: Spring water Harvesting Chekra, Awontang,Ukhrul town ($21\times 13\times 4ft$)

Figure 3: Ukhrul Hr.sec.School ($250\times 32ftapprox$)

Ngayira, Awungtang ($29\times 25\times 20ft$)approx

Figure 5:**Phungyo Baptist Church, ($100\times 60ft$)*approx***

Table 2



Forest cover area has not been consistent in the hill town .The dwindling forest trees of Ukhrul especially around the catchment areas has been the main cause of concerns for the lack of water scarcity in the Ukhrul town. Primary Forest loss in Ukhrul, Manipur from 2002 to 2020,Ukhrul lost 5.68 kha of humid primary forest, making up 15% of its total tree cover loss in the same time period. Total area of humid primary forest in Ukhrul decreased by 5.7% in this time period . Between 20th of August 2018 and 16th of August 2021 Ukhrul experienced a total of 619 visible infrared imaging radiometer suite (VIIRS) Alerts fire alerts. In Ukhrul, and 8.5kha of land has burned so far in 2021. This total is high compared to the total for previous years going back to 2001. The most fires recorded in a year were 2014, with 35kha.(https://www.globalforestwatch.org)

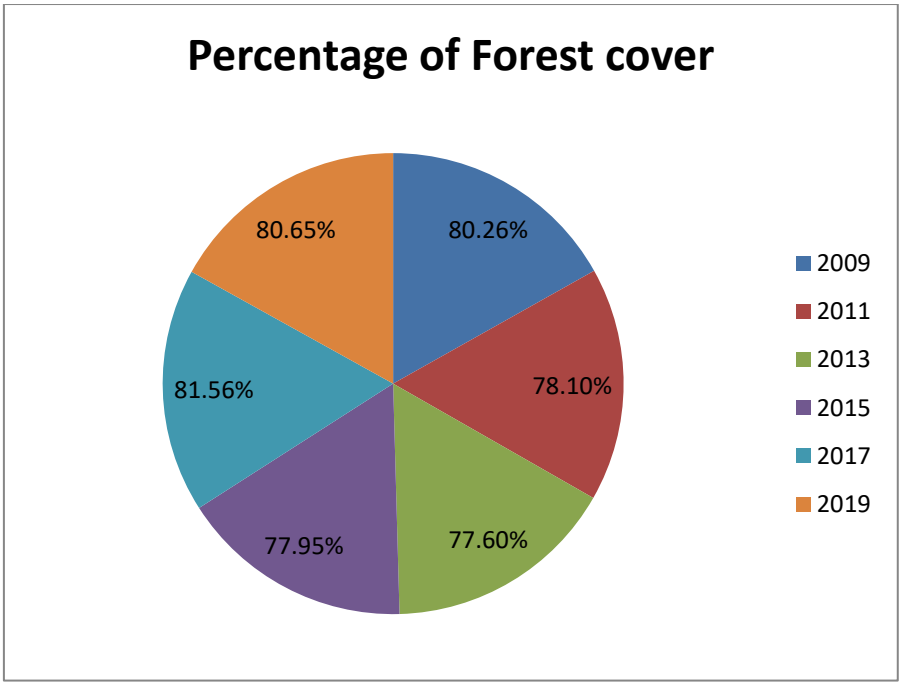


Figure 7: Percentage of Forest covers in Ukhrul district, Manipur. Source: Forest survey of India, 2019

Disappearing of **springs** in mountainous region like Ukhrul , Changing climatic scenario especially the erratic rainfall pattern, seismic activity and ecological degradation associated with land use change for infrastructural development is posing huge pressure on mountain acquifer systems a marked decline in winter rain. There is an urgent need to revive the spring water in mountainous region like Ukhrul. All springs which will flow to the catchment area or river head are vanishing due to many factors. In the name of development, many trees are being cut. Deforestation is also practiced for livelihood purposes as well. Springs take the role of maintaining the environment flow (e-flow) of the rivers during lean seasons. As the springs have vanished, there is no e- flow in the rivers. Rivers becoming dry in the hill district is the proof that there is no e-flow during lean season. Environment flow has been described as the quantity; quality and timing of water flows required for sustaining the freshwater ecosystem and human livelihoods and others depend on these ecosystems. (Reference: JAL JEEVAN MISSION,2020)

Table 3:

STATE	NUMBER OF VILLAGES WITH SPRING	TOTAL NUMBER OF VILLAGES	PERCENTAGE OF VILLAGES WHICH REPORT HAVING SPRINGS	SPRING CHANNEL BASED SURFACE FLOW IRRIGATION SCHEME	TOTAL NUMBER OF SURFACES FLOW IRRIGATION SCHEME	PERCENTAGE OF SPRING CHANNEL BASED SURFACE FLOW IRRIGATION SYSTEM
MANIPUR	1405	2581	54.4	0	516	0.0

Sources: Report of working group 1, NITI Aayog

METHODS

Rain water Harvesting potential

We estimated the rainwater harvesting potential of the site surveyed/ studied using the formula described by (Reference: Sanjith S et,al. 2021) in equation 1

Rainwater Harvesting collects and stored water for reuse-on-site, rather than allowing it to run off.

RTRWH Collection formula

$$Q = CIA \quad (1)$$

Q Denotes total discharge from roof, C represents coefficient of runoff, I denoted by intensity of rainfall(mm) and A represents total rooftop catchment area.

All rainwater falling over an area cannot be effectively Harvested, Some will be lost from the catchment by evaporation and retention on the surface itself. Here, coefficient run off is important.

We used the runoff co-efficient values as described by (Pacey et al., 1989)

Table 4:

Sr.no	Type of catchment	Coefficients
Roof catchment		
1	Tiles	0.8-0.9
2	Corrugated metal sheet	0.7-0.9

One Government school of the town named as Ukhrul Hr. sec. School hostel is used to assess the calculation of water consumption in the school hostel with the building structure of L=120 ft and B=32 ft of 10 consumers and water coefficient run off corrugated metal.

RESULTS

R.W.H.P= Avg rainfall(mm)×area of catchment×runoff coefficient (calculating Ukhrul hr,sec school hostel) fig:

=1,763mm×120ft×32ft×0.9

=1.763m×36.576m×9.7536m×0.9 ×1000L

= 566,051.53370 L ——————————— (2)

WATER TANK VOLUME=20fT×10ft×8ft (l× $b \times h$)

=20× 10×8×28.317L

=45,307L

Table 5: Ukhrul water consumption status and volume received

Water consumption status in ukhrul town per day	Volume of water received
Total population×55(55 lpcd) =45000×55 =24,75,000L	Lean season=6,00,000 litres per day Monsoon =23,00,000 litres per day

(SOURCES: PHED,UKHRUL)

FOR 10 WATER CONSUMERS OF THE SEC.SCHOOL HOSTEL ANNUALLY WATER REQUIREMENT=10×55×365L (based on table 2)

=17050L

Water consumption per month constantly throughout the year for 10 consumer hosteller in the Ukhrul town=55× 30 ×10

=16500L

Table 6

MONTH	WATER HARVESTING POTENTIAL	WATER CONSUMPTION	WATER DEFICIT/EXCESS
JANUARY	10mm×120ft×32ft×0.9 =0.032ft×120ft×32ft×0.9 =110.592× 28.317L =3,131.63L	= 10×55(@55LPCD) =550×31 =17050L	Water deficit =1,7050-3,131 =13,919L
FEBRUARY	4.8×120×32×0.9 =0.015×120×32×0.9×28.317L =1,467.9L		Water deficit =17051-1,467. =15583.1 L
MARCH	39×120×32×0.9 =0.127×120×32×0.9× 28.317L =12,428.67L		Water deficit 17,051-12,428L =4,623L
APRIL	62.6mm×120ft×32ft×0.9 =0.205×120×32×0.9×28.317L =20,062.02L		Excess = 20,062.02-17,051L =3,011.02L

MONTH	RAIN WATER HARVESTING POTENTIAL	WATER CONSUMPTION	WATER DEFICIT/EXCESS
MAY	186.3×120×32×0.9 =0.6112×120×32×0.9×28.317 =59,814.203L		Excess = 59,814.2032-17,0512 =42,763.2032L
JUNE	159.3×120× 32 × 0.9 × 28.317 =0.52× 120 × 32 × 0.9 × 28.317 =50,889.047L		Excess = 50,889.047-17,051L =33,838.047L
JULY	269.1× $120ft \times 32ft \times 0.9$ =0.88× 3,456 × $28.317L$ =86,119.9L		Excess=86,119.9-17,051L =69,O68,9L
AUGUST	199.6× 120 × 32 × 0.9 × 28.317 =0.654× 120 × 32 × 0.9 × 28.317 =64,002.763L		Excess = 64,002.763-17,0512 = 46,951.763L
SEPTEMBER	58.9× 120 × 32 × 0.9=0.1932× 120 × 32 × 0.9 × 28.317 =18,907.23L		Excess = 18,907,23-17,051 =1,853.23L

TOTAL EXCESS=1,97,482.1632L

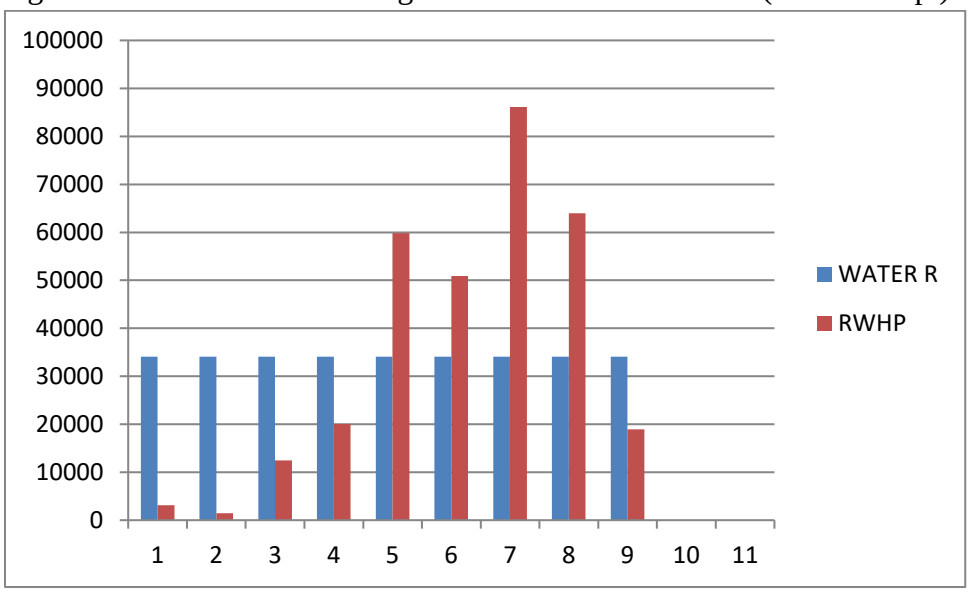
TOTAL DEFICIT=34,125 L

STILL EXCESS OF = 1,63,357.1632L

Altogether more water consumers of 10 can fetch the available water =55× 10 × 271

(Calculation till Sept 2021)=149

Figure 7: Rainwater Harvesting w.r.t ukhrul Hr.sec school.(2021 till sept)



Another water sources need to tapped in, Spring water sources, will sustain the remaining consumers for instances:

Chekra,Awontnag spring water pond : Figure()

Volume of water content=l× $b \times h$

=21× 13 × 4

=1,092×21.317L

=23,278.164L

The locality spring water pond sustain around 200 consumers.

Ngariya, Awungtang water sources Figure()

Volume of water content=L× $b \times h$

=29× 23 × 20

=13,340×21.317L

=284,368.78L

DISCUSSION:

In line with the Ukhrul Hr. sec hostel water harvesting potential calculation if all the big building both Govt. and private institution like School, colleges, Churches put together and made use of it (Approx 15 church, 25 school, 4colleges, other Govt. Institution like secretariat, bank etc, will reap the dividends

since every household couldn't effort to install a water tank though some Govt. project already in place to stock a water reservoir and tap rain water harvesting.

Table 7

Number of building(approx)	Water harvesting potential (equation 2)	Water consumer to be benefited despite lean season
45	45× 120 × 32 × 0.9 × 28.317 × 4.8=21,138,527.232L	13,500× 55 × 28=20,790,000L

TABLE NO. Taking the lean season month of February and rainfall data of the District

The lion share lost of rainwater is due to run off, If install successfully it will be a viable alternative to conventional water supply considering the fact that any land anywhere can be used to harvest rain water(Ngachan,2016). Zabo system of indigenous water conservation practiced in Mizoram and Nagaland where rain water is collected in catchment and stored in ponds along mountain slopes can be suitably implement in the region. Sukanta sarkar(2017)

Incorporation of forestry to enhance Hydrological cycle is another dimention needs to be zeroed in **Trees** play an important role in maintaining water cycle. It add water to the atmosphere through the process of transpiration (in which plants release water from their leaves during photosynthesis

This moisture contributes to the formation of rain clouds, which release the water back to the forest. When forests are cut down less moisture goes into the atmosphere and rainfall declines. Forests are a vital constituent of the global water cycle, as they have evaporation rate due to a high leaf area index, natural forests maintain high evaporation fluxes (transpiration and interception).

Evaporation and transpiration cause elevated moisture content. The forest canopy recycles water more efficiently though evapotranspiration than sparsely vegetated surfaces such as crop fields. Evapotranspiration is the combination of evaporation and transpiration from vegetation to the atmosphere Ekhuemelo et al. (2016).

Deforestation weakens the local hydrological cycle, reducing evapotranspiration due to loss of vegetation. This results in reduced moisture circulation and decreased rainfall. Healthy forest around the catchment area is inevitable for sustain water quality, water flows, and watershed health and condition due to leafy canopy that intercepts rainfall, slowing its fall to the ground and the forest floor. A forest buffer strip planted along the catchment area of stream can filter out pollutants before they enter waterways.

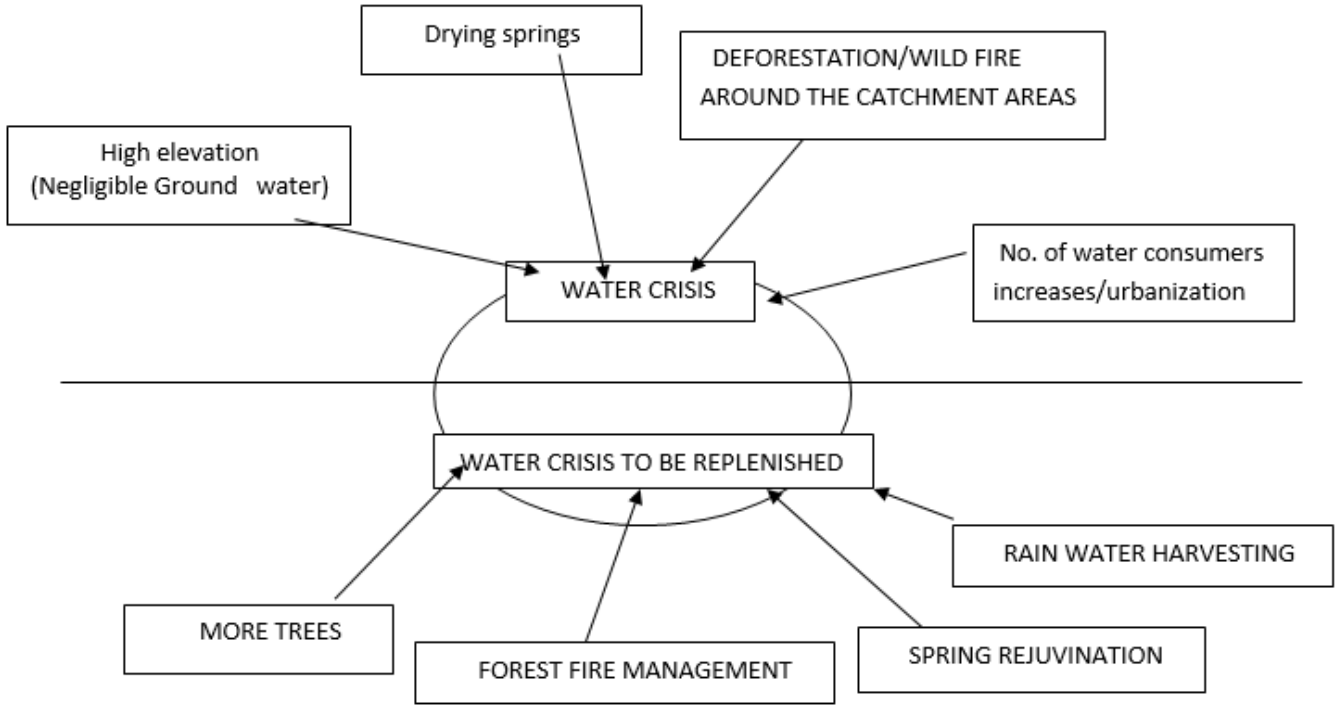
Forest fire management and a forestation programs need to be zeroed in seeing the trend of rapid degradation of environment especially Shirui range consequently disturbing the flow of water cycle which in turn affecting the water supply in the hill town of Ukhrul. The first and the most important step is to implement the Forest fire prevention and management cycle (FFPM).

Springs rejuvenation: Spring water sustain the major bulk in hill town especially Ukhrul some example shown in the fig. Awungtang, Pettigrew spring water source. It maintain e- flow in mountain rivers. But, lately spring water are facing the threat of drying up due to certain factor like more water demand pressure, unplanned work development activities around the spring region, erratic trends in precipitation.

Some measures to heal the spring water sources includes:
1) Survey to assess the hydrogeological mapping to identify spring types and making observation to determine their connectivity with surface water and deep groundwater acquifers.
2) To monitor the impact assessment
3) Community participation are important key to preserve the threatened spring water sources by disseminating the knowledge of spring water potential.
4) Installing Data monitoring system.
Sources:(National hydrology project).

PROPOSED BLUEPRINT OF WATER CRISIS MANAGEMENT AND RESTORATION IN UKHRUL TOWN

Figure 8



CONCLUSIONS:
Planting more trees in the catchment areas of Shirui hill range, strengthening forest fire management, encouraging the sustainable use of water collection through rain water harvesting and rejuvenating the spring water sources can thoroughly mitigate the water crisis to the larger extent in Ukhrul if implemented successfully. Both government and responsible citizen needs to joint hand with seriousness to address the water crisis instantly. '**Save water save life'** could be the most apt slogan reverberating the whole citizen of Ukhrul district amidst the water crisis.

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