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

Watershed Management an Approach of Soil Water Conservation in Dry Zones of West Bengal

Binayak Dutta[1], Ambuj Mahato[2]

[1]Team lead & Sr. Executive,Development Research Communication & Services Center
[2]Technical Officer, Development Research Communication & Services Center

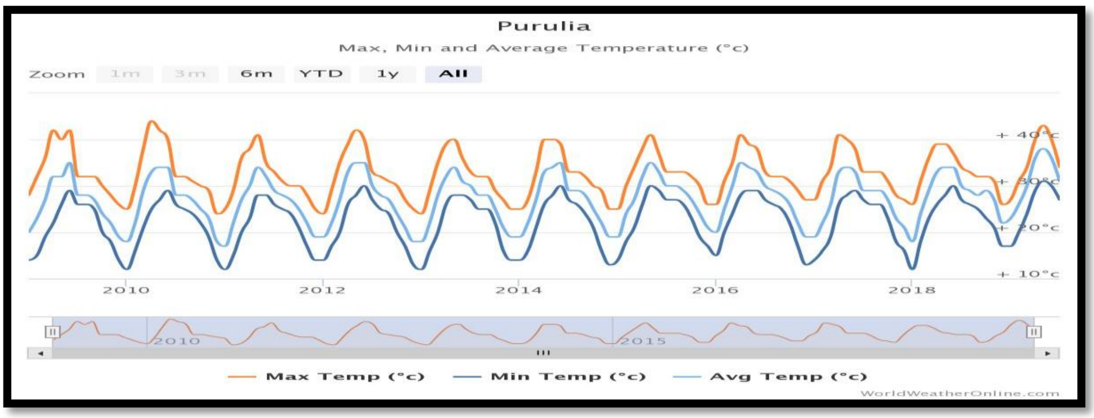
Abstract

Watershed management is **rudimentary concept of integration of water management and livelihood.** In dry and arid zones of West Bengal (Agro climatic zone VII), the districts like Purulia, Bankura, West Midnapore, Birbhum have the issues of severe water crisis, crop failure, and lack of irrigation water, soil erosion. Purulia receives **an annual rainfall of 1200 mm** but most but the condition of the**top soil is degenerative and total top soil is eroded with water and water retention is minimal.** Thus, it can be concluded that rainfall is surely not the issue for the water crisis. Now here is aground breaking initiative of developing the watershed management programme for effective soil water conservation and also for the rejuvenation of six major rivers of South West Bengal.

There are certain structures for example the **30-40 model which** can slows down the speed of the run-off, prevent top soil loss and along with this certain water **harvesting structures and plantation** to secure food fodder and fuel crisis of marginal individuals of these regions. In this paper discussion have been made regarding the formulation of strategies of Watershed development and its field level implementation at Hura Block as this is our **intensive block of the project.** Vigorous **technological use like estimation of run off and development of models** complying with the run off standards are analyzed in the paper. Furthermore, the cropping techniques that have been performed to develop the **watershed and promote soil conservation**has also be critically analyzed in the research paper.

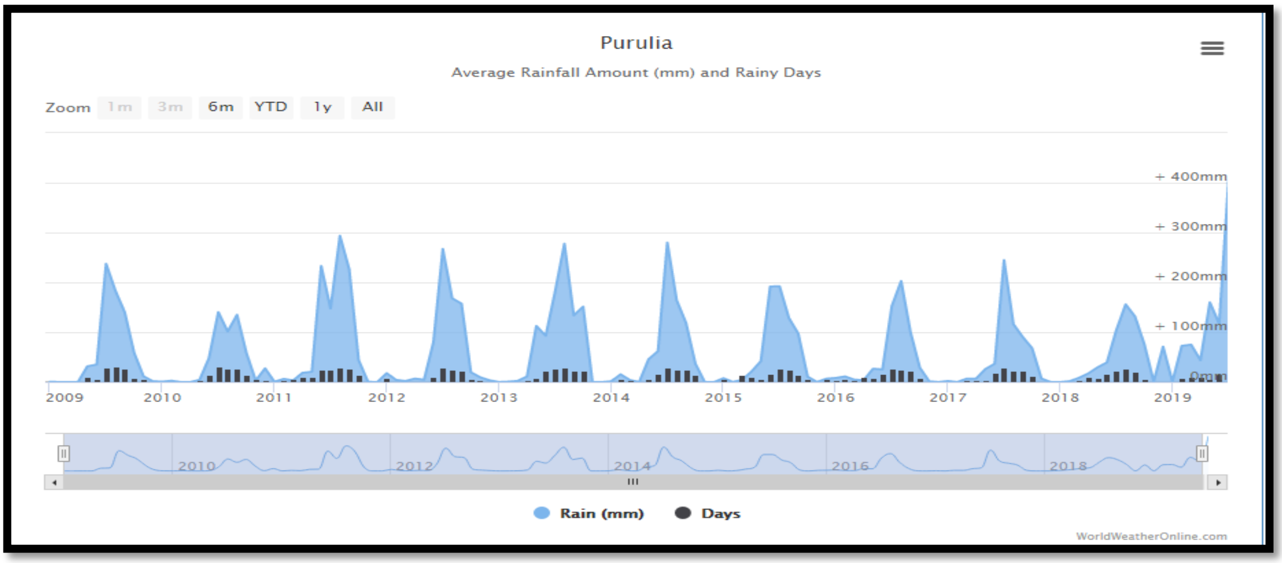
Keywords: Watershed management, soil conservation, estimation of run-off, 30X40 model.

Introduction



According to census 2011, the population of Purulia **2,927,965** and having area of **6,269 sq.km**. **43% of** the total population belongs to poverty level 18.3% of the total population are tribal household (Census report, 2011). The average maximum temperature is near about 36`C and the lowest minimum temperature is 11`C (average). Purulia receives almost 1200 mm rainfall/yearly.

In an average, in spite of that this district faces maximum cases of crop failure, the most fertile topsoil washes with the run off and deposited to the lower lands and transported to districts like Burdwan, Hooghly through rivers (Gunnel et al, 2019). Purulia also have a long agonizing past of severe drought. Water crisis, unproductive land, crop failure influenced the local population to migrate for income. Integrated watershed management approach can be one of the best methods to mitigate water quality and scarcity issues in semi-arid regions of our country (Gupta, Misra &Sahu, 2019)



Watershed approach is one of the crucial techniques that can solve the issues by soil and water conservation and reducing the runoff velocity, vadose zone recharge, enhancing stream flow, flood mitigation and harvesting the rainfall and utilizing the harvested water for **live saving irrigation**, **fishery,** through the proper use of natural resource management watershed approach has an great role in conflict management (Chanya,Prachaak&Keow Ngang, 2014). Another aspect is here to create assets for the marginalized people through their participationand ownership development it can be said that transformation from “wage to wealth” (Bagdi et al., 2015).

Moreover, one of the most important purpose of this project is to rejuvenate 7 major rivers of this areas (aired-semi aired regions of West Bengal) comprises of 6 districts (Purulia, Bankura, Jhargram, Paschim Medinipore, Bribhum and Paschim Bardawan) are-**Damodar, Mayurakhsi, Ajay, Shilai, Shilabati, Kansai/Kangshabati, Dwarakeshwar, Subarnarekha.**

Objective of Research

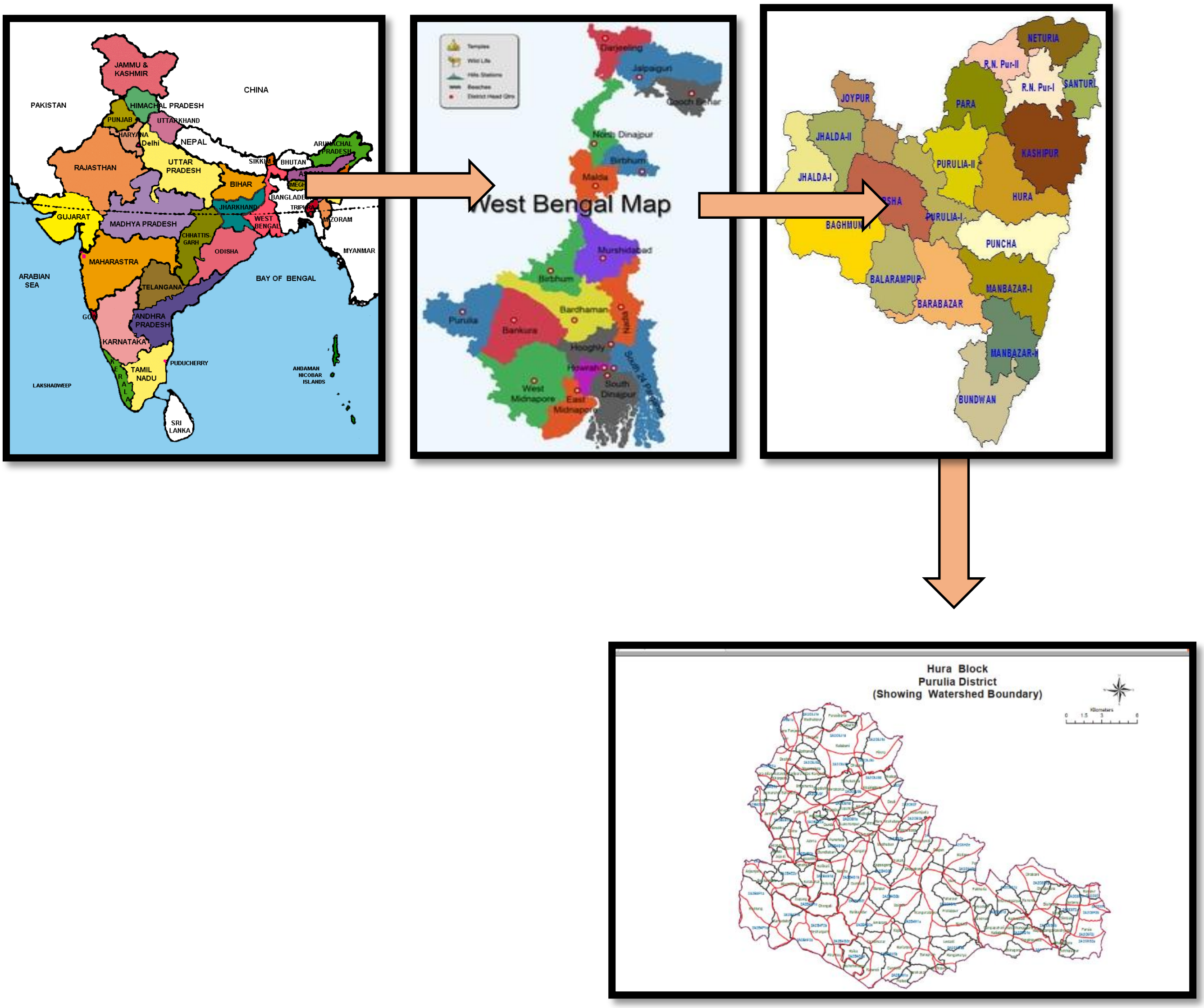
The main objective of the research paper is mentioned below:

- Asset creation through people’s participation, ownership development.
- To harvest the rain water which can percolate deep down to the soil and through this regain the soil moisture,
- To secure second crop by constructing percolation tanks and farm development through creating orchard, fruit, fodder, fuel tress in unproductive fallow lands of upper region.

- Different environmental modeling for activity analysis, crop water budgeting etc.
- Analysis of different water harvesting/ recharging structures in practical scenario.

Materials and Method

Study Area



Location and details of Hura Block (Study area)

Hura Block at a glance:-

Geographical Location of Hura Block Headquarter:	Latitude : 23°18'30"N, Longitude : 86°39'17"
Total Population:	162042 (Male=72867; Female=70708; Child (0 to 6)=18467)
No. of Household:	28368 (General=15543; SC=5604; ST=7221)
No. of Farm Families:	20775
No. of KCC holders:	13253
Percentage of KCC holder out of total Farm families:	63.79%

No. of Rural Hospital:	01
No. of Public Health Centre:	03
No. of Sub-Health Centre:	27
No. of Homeopathic medical dispensary:	04
No. of Ayurvedic medical dispensary:	01
Total No. of Primary School:	189
Total No. of upper Primary School:	11
Total No. of High School:	27
Total No. of SSK:	32
Total No. of MSK:	10
No. of F.P. Shop:	54
No. of Retail Kerosene Oil Shop:	61

Land Statistics:

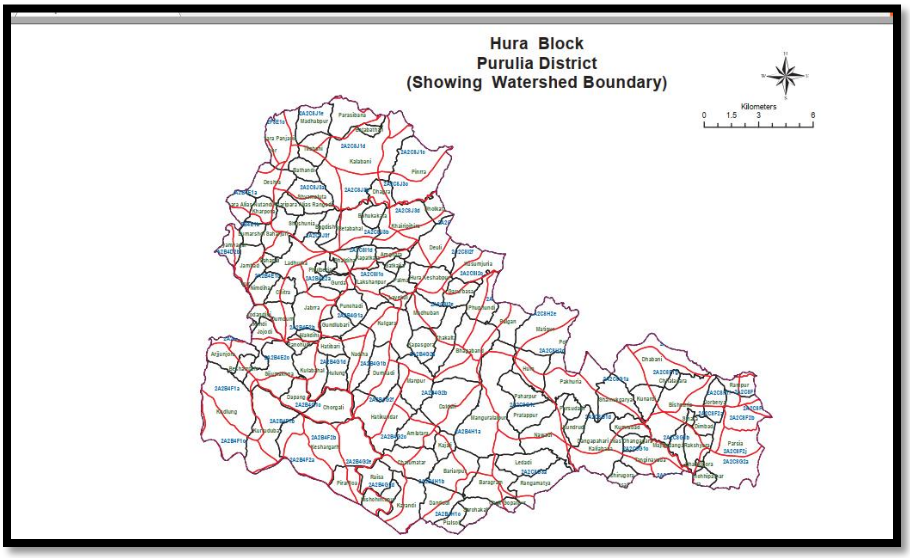
Geographical Area:	38290.20 ha
No. of Gram Panchayat:	10
Total no. of Mouza:	116
Gross Cropped Area:	25882 ha
Net-sown Area:	24944 ha
Forest Area:	3715 ha
Cultivable Waste Land:	1005 ha
Area sown more than once(1-2):	1084 ha

(Source: ADA Report, 2017, Hura Block, Purulia)

Methodology

Boundary delineation First of all we delineate the watershed boundary according to the ridge line (an imaginary rim, water either flows inside of the rim or flows outside of it) and drainage point.

A typical watershed map Hura Block of Purulia,redlined areas are watershed boundary (ridge line) for a specific micro watershed (consists of Mouza's), provided by NRDMS



Patch identification & slope measurement

According to the demarcated ridge lien (watershed boundary) we have to give focus on "**Ridge to valley approach**" (slope wise activity from upland to lowland). Slope of land can be measured through some simple techniques like Water level / Pipe level estimation (**difference between vertical heights divided by horizontal length X 100)** or by using **Dumpy level** for slope measurement. According to the slope we should prepare our activity plan, for an example if the slope is more than **25%** we should plan for **Continuous Contour Trench (CCT)**, If the slope is about **8-25 %** we should go with **Staggered trench**, with the slope of **5-8%** for **30-40 model with plantation** and for less than **5%** slope we proposed the activities like building of **farm pond**, **percolation tank**, **5% model** (5%area of a plot) (Asdak, Supian&Subiyanto,2018),. There are other structures also for preventing runoff rate and soil erosion which might cost formation of gully, so we have to think about gully plugging (**Gabion structure, loose boulder structure**) for retention of topsoil and slowing down the run off rate.

Staggered trench: The Staggered Trench is one of the most important concepts that helps in restoration and rejuvenation of the water in the dry watershed. The process includes the excavation of the trenches which are shorter in length along the line of the counter interspace which is present between them, there are series of trenches built in straight line in vertical intervals. The main aim of the design is to contain the water runoff in particular area so that efficient recharge of the ground water can be achieved. The main aim of the staggered trench is to store the water for proper percolation in the soil.

Interventions according to the slope to combat with current situation

Type of land	**Present condition**	**Ideal condition (what should be)**	**Activity planned for soil water conservation**
Upland	dry, top soil loss, vegetation loss, soil erosion, run off velocity very high	Prevent the soil loss, Increasing productivity, plantation, Soil &water conservation, livelihood generation	Contour trench, staggered trench, 30-40 model, semi- circular bund, planation, social forestry, sericulture, fodder cultivation, securing livelihood
Medium upland	Less organic matter in soil, less productive soil, only single crop cultivation, water crisis	Prevent topsoil loss & siltation, increasing productivity, multi crop production	Water harvesting structures, Farm pond, ditches, earthen dam
Lowland	Silt deposition in in water bodies ,Less productive land, High erosion through runoff	Prevent siltation, increasing water table, production of multi crop	Introduction of mixed cropping, sustainable agricultural system, dug well, percolation tank, cultivation of indigenous verities.

Run off estimation

We can easily calculate run of by applying a simple formula

Area of catchment (ha) X **run off coefficient (specific for different regions)** X **75% normal rainfall**
Then we have to consider the **committed** and **non-committed runoff**. We **cannot catch or harvest** the **committed runoff** we only can work with **60% of non-committed rum off known as feasible runoff**. Then we can easily calculate how much water can be hold or stored by which structure.

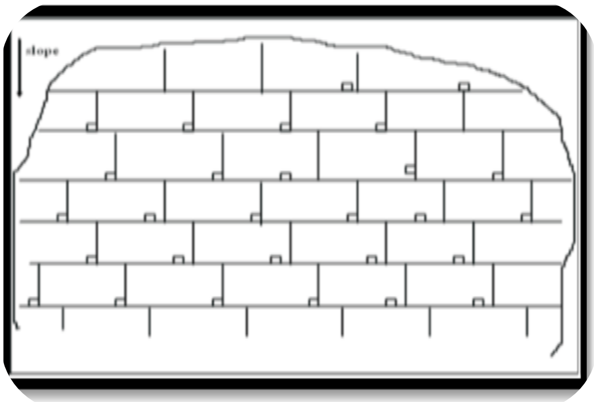
Interventions for upper catchment area

Staggered Trench: This is n water harvesting structure design to harvest rain water in upland areas (8-25% slope). Each trench should be placed 6 feet interval (horizontally) and 12 feet interval (vertically).length of each pit is 6 feet and width 2 feet and of 1ft depth can hold 336 liters of water (1 cft = 28 liter, hence 12 cft= 336 liters of water approximately)

30X40 model and plantation

A typical 30-40 model can capture about 200 cft runoff (1 cft = 28 liter, hence 200 cft = 5600 liter run off), now the question is how we calculate that 200cft for a 30-40 model, there is a simple mathematical calculation for it- 30X40 =1200 sqft, maximum rainfall at one time in Purulia is assumed 2 inch or 50 cm (Watershed Manual, PRADAN).So we can calculate as - 1200 X2/12 =200 cft. This 200 cft water directly absorbed by the plot and the pit (Bagdi&Kurothe, 2014).

30X40 model filled with run off water



30X40 modelgraphic design

typical 30x40 model pit before harvesting water

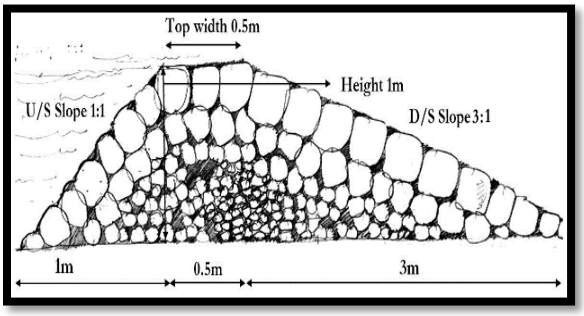
Pit sfter harvesting run off water

Intercropping strategies in a 30X40 model

Along with 30-40 model we are also planning for plantation of food/fodder/fuel trees, for plantation of mango tree we should maintain distance minimum 15 to 20 feet in specific 30-40 model, for better growth and minimize the competition, between this spaces of 15 to 20 feet we should plan for pulses (cow pea, pigeon pea, Roselle) for maximum utilization of space.

Gully plugging techniques

Removal of top soil by the action of run off creates gully, it continues to carry the productive soil with water gives formation of depression over a specific land. To protect this land and utilize the runoff (which spills away and rises flood like situation) we are adopting gully plugging techniques like loose boulder structure (LBS) in upland and mid upland. (If we consider the height of the structure is 1mt then the upstream slope should be 1mt and the downstream slope should be 3mt at least an0d the top width must be 0.5m)



Interventions for lowland

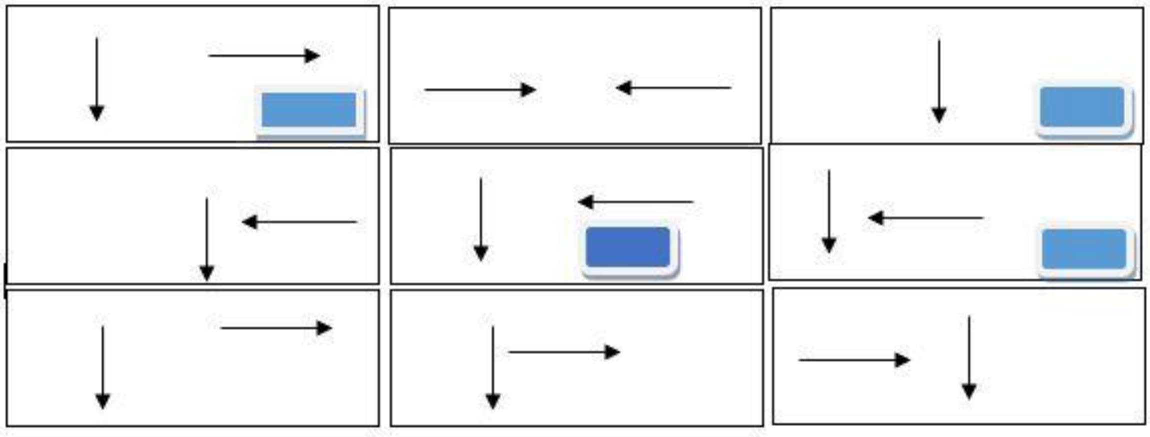
For low land we planned for irrigation wells to supply water for lower land mainly paddy.

Vadose zone recharge

By using some simple methodology, we can estimate how much vadose zone (unsaturated zone resides just beneath of the soil layer) recharge has been done by our activity. First we have to measure the water depth at least for 3 wells situated at different locations like upland, mid-upland and low land in a particular micro watershed and should take the average water depth and have to multiply it with the watershed area then we can easily calculate how much vadose zone can be recharged with runoff, after all these activities we will again estimate the well water depth and if the water level increases then we can calculate how much the level has been increased(Watershed Manual,SPS)

Low land water harvesting structures:

A typical low land water harvesting structure, if it can design properly (through 'Ridge to Valley' approach) it could be perennial and could be a source of water for cultivation of any second or third crop even in any less productive land (Wang et al., 2016). A storage tank of 50 ft x 50 ft x 10 ft =25000 cft. can harvest up to 700000liters of water, considering evaporation, seepage loss still more than 500000 liters (Reddy, Saharawat, and George, 2017). This much water is can ensure a second crop certainly. To harvest water it should be planned in saturation mode. It can be in various size and shape from 5% model (5% area of an cultivated land) to as large as 200 ft X 200 ft or more (Warner, 2016).

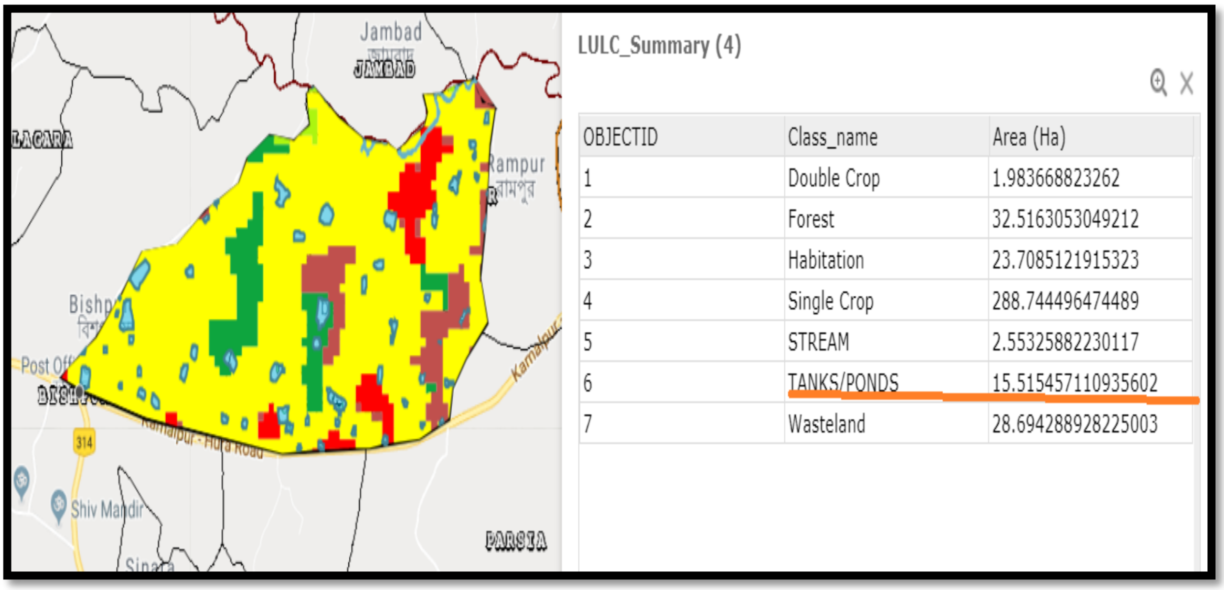


Result and discussion

Analysis: How much water can be harvested from all interventions in one particular micro watershed:

It is already mentioned that Hura block is considered in this paper, we have 56 micro watershed in this block. Here is the analysis of one particular micro watershed consist of population of 375 people of 3 mouza's (Rampur, Jorberia&Bishpuria)

Total population	SC population	ST population	OBC	Minority	General
385	53	57	143	47	85



OBJECTID	Class_name	Area (Ha)
1	Double Crop	1.983668823262
2	Forest	32.5163053049212
3	Habitation	23.7085121915323
4	Single Crop	288.744496474489
5	STREAM	2.55325882230117
6	TANKS/PONDS	15.515457110935602
7	Wasteland	28.694288928225003

Source of water body (available water for this micro watershed)

According to the WBADMIP LULC map we found 15.51 Ha's of water bodies in this micro watershed, if we consider the average depth 2 meters (approximately 6.5ft.), so the available water for this micro watershed is 31.02 Ha-mt.

Water harvested through 30X40 model

Total no of 30X40 model (no)	Total area of 30X40 model (Ha)	Water depth/30X40 model (mt)	Water harvested (Ha-mt)
11	**7.7**	**0.6**	**4.62**

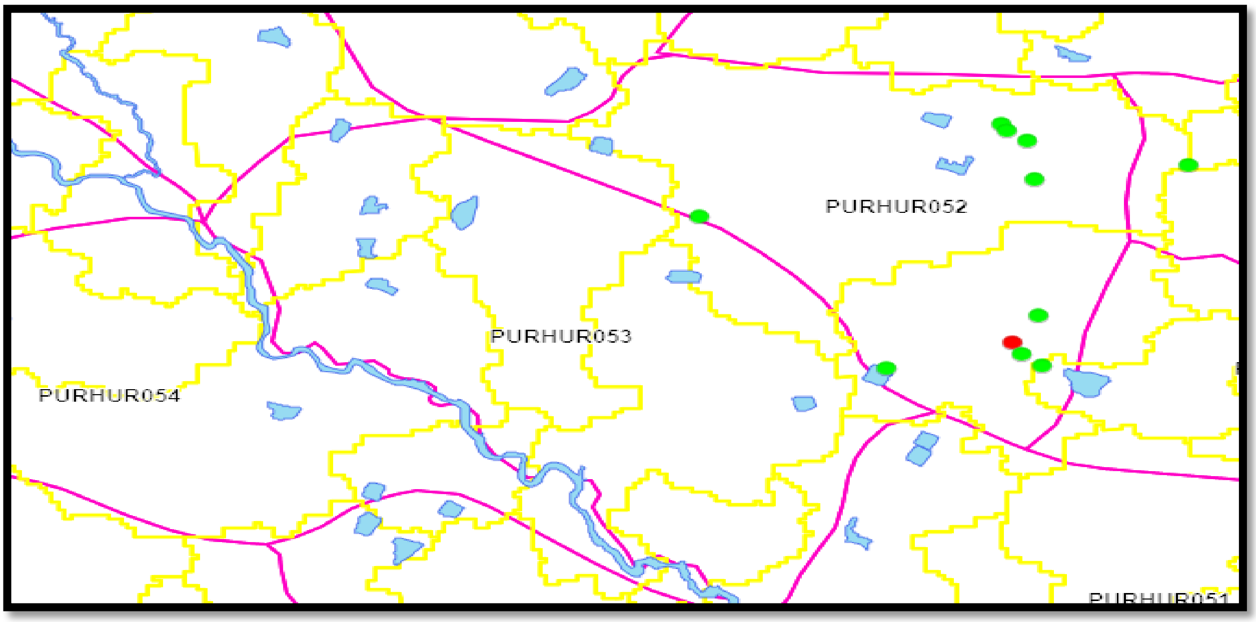
Water harvested through Happa (Ponds)

Total no ofHappas(no)	Total area of Happas (Ha)	Water depth/Happa (mt)	Water harvested (Ha-mt)
17	**8.5**	**3.5**	**29.75**

Total water harvested through 30X40 model &Happas= (4.62+29.75) Ha-mt = 34.37 Hamt

Water req (deficit water) (Ha-mt)	Total water harvested through 30X40 models and Happas (Ha-mt)	Activity(%) to conserve water

41.16	**34.37**	**83.50**



(Activity monitoring through**ArcGIS, Usharmukti website**, 2018-19)

Conclusion

It is planned **5027 number** of plans in Hura Block which will directly benefit to more than **7000 through** Annual Action Plans (AAP) and Supplementary Annual Action Plans (SAAP) every year. Through all this activities.**3854 Ha** of land area planned for increasing rate of water harvesting, In this block rain water harvesting structures would be developed in which **4635000m3** Surface Water can be stored, by which at least**463.5 Ha** land can be turned into at least double cropping land from rain-fed single cropping land.833.68 Ha land can be changed into greenery, through social forestry/orchard plantation/sericulture, which can be created the scope of livelihood in long run.

References

1. ADA Report
2. Chay Asdak a, SudradjatSupian b, Subiyanto c. Watershed management strategies forflood mitigation: A case study of Jakarta's flooding, 21 ed.: Weather and Climate Extremes; 2018.
3. G.L.Bagdi, R.S.Kurothe. People's participation in watershed management programmes: Evaluation study of Vidarbha region of Maharashtra in India, Volume 2, issue 3: International Soil and Water Conservation Research; 2014
4. India Meteorological Department (IMD)
5. NRDMS
6. Reddy, V.R., Saharawat, Y.S. and George, B., 2017. Watershed management in South Asia: A synoptic review. Journal of hydrology, 551, pp.4-13.
7. Ruchi Gupta 1 · Anil Kumar Misra 2 · Vaishali Sahu 1. Identifcation of watershed preference management areas under water quality and scarcity constraints: case of Jhajjar district watershed, India. Applied Water Science: 2019.

8. Salimi, J., Maknoon, R. and Meijerink, S., 2019. Designing Institutions for Watershed Management: A Case Study of the Urmia Lake Restoration National Committee.
9. usharmukti.nregawb.in
10. Wang, G., Mang, S., Cai, H., Liu, S., Zhang, Z., Wang, L. and Innes, J.L., 2016. Integrated watershed management: evolution, development and emerging trends. Journal of Forestry Research, 27(5), pp.967-994.
11. Warner, J., 2016. Participating in watershed management: policy and practice in the Trahunco Watershed, Argentinean Patagonia. In Multi-stakeholder platforms for integrated water management (pp. 141-152). Routledge.
12. Watershed Manual SPS
13. Watershed Manual, PRADAN (Professional Assistance for Development Action)
14. West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP)