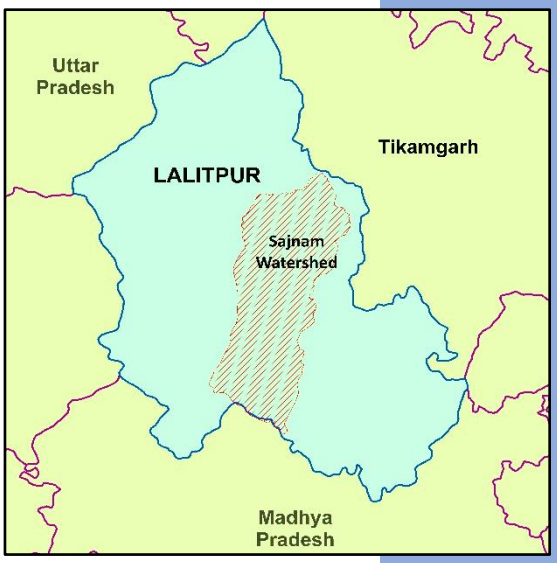
Sajnam Watershed

(Lalitpur, Uttar Pradesh)



Integrated Water Resources Management (IWRM) Plan

2017

National Institute Of Hydrology, Roorkee

Remote Sensing Application Centre-Uttar Pradesh, Lucknow

Madhya Pradesh Council of Science and Technology, Bhopal

Submitted to

District Collector (Lalitpur)

Water Management Planning in Bundelkhand

Water management has always been a prime concern of the district authorities, for which they plan and implement various soil and water conservation measures through different government schemes, funded by both the State and Central Government. The line departments responsible for implementation of such measures include Soil Conservation, Groundwater, Drinking Water, Public Health Engineering, Irrigation, Agriculture, Horticulture, DRDA, etc. Traditionally, structures such as check dam, farm pond, percolation tank, nala bund, contour bund, gabion, etc. are constructed at identified locations using funds available under different government schemes. Keeping in view the needs expressed by the local public representatives, and based on the professional skills of the district officials, a variety of soil and water conservation structures are planned every year depending on the availability of funds.

Integrated Water Resource Management (IWRM) is defined as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". IWRM is considered to be a "Best Management Practice" and is being implemented all over the world. Scientists have found IWRM being useful in Indian context also where a coordinated development of water and land resources is sought as part of complete economic, social and environmental welfare.

Recurring drought conditions, deforestation, inefficient land and water management, unpredictable and extreme weather patterns due to climate change impacts, have together put pressure on available water resources in the Bundelkhand region of India. In 2016, the Ministry of Water Resources, River Development & Ganga Rejuvenation (Government of India) desired that a sound water management plan based on scientific principles be developed for the areas falling under Bundelkhand region. The Ministry assigned the task of developing IWRM Plan for identified watersheds in four districts of Bundelkhand region, namely Jhansi and Lalitpur in UP and Chhatarpur and Tikamgarh in MP. The project aimed at developing IWRM Plans to establish links between water management indicators and socioeconomic objectives leading to users' acceptance and sustainability of the efforts in the region. An integrated action research project thus was required to address the water stress situation on watershed basis, leading to livelihood improvements in the project area.

District Irrigation Plan (DIP) under PMKSY

We realized that the decision makers and planners need a practical approach to transposing the IWRM concept into an operational tool for their water resources management plans. Light IWRM supported by the inputs from a suitable DSS is likely to suite the requirements and expectations of planners and decision makers (such as District Magistrate in Indian context) as well as the end users at the district level. At the district level, IWRM addresses almost the complete supply chain of water management (from rainfall inputs to water consumption by different users to wastewater generation and subsequent handling) and, most importantly, builds on the existing institutions. In Indian context, the inherent cross-sectoral integration requirements of IWRM planning can be best achieved at the district level where the District Magistrate is the single controlling authority for various organizations (e.g. line departments) dealing with the different resources.

Government of India has introduced a scheme on "Pradhan Mantri Krishi Sinchai Yojna (PMKSY)" in 2015 with the vision of extending the coverage of irrigation, accelerating watershed development activities and improving water use efficiency. Under PMKSY, each district is required to prepare a "District Irrigation Plan (DIP)", which provides a comprehensive plan for the future water resources development of the district. The plan includes district water profile, water availability, water requirement/demand, and provides a strategic action plan at Block/Sub-district level for improving groundwater levels through recharge measures, enhancing irrigation coverage, soil and water conservation through structural and non-structural watershed measures, improving the agriculture production and other livelihood activities. The Agriculture Department is the designated nodal agency for this plan, which is envisaged to be implemented with cooperation of various concerned key departments at the district level.

The project applied the concepts of "Local" IWRM planning for developing an IWRM Plan for the Sajnam watershed in Lalitpur district of Uttar Pradesh. The Plan considers effective utilization of land, water and other available natural resources, linked to the vulnerabilities and livelihood opportunities in the geographical area. The Plan is designed in such a way that it provides useful inputs to the DIP of the Government, both in terms of water supply and demand management synergized with the land management and livelihood improvement. The IWRM Plan intends to promote the component of water demand management in the district level planning.

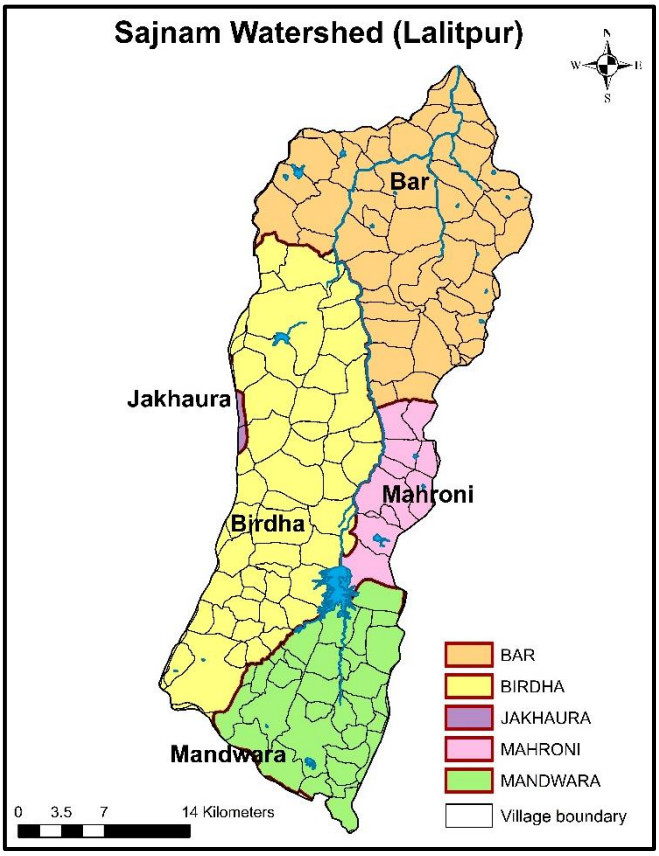
Sajnam River Watershed

Sajnam river watershed is stretched between 78°26'10"E and 78°44'50"E longitudes, and 24°19'00"N and 24°53'50"N latitudes, having a total area of 963.11 km^2. The watershed lies in the Lalitpur district of Uttar Pradesh covering parts of 5 blocks: Bar, Jakhaura, Mahroni, Birdha and Mandwara.

Average annual rainfall of the watershed is about 1070 mm, about 91% of which is received during the south-west monsoon season – June – September (CGWB, 2013). July is the rainiest month, and by end of each November, the area starts becoming dry.

Table 1: Number of towns and villages in the watershed

Block	District	Area covered (ha)	Villages
Bar	Lalitpur	34252	57
Birdha	Lalitpur	36858	56
Mahroni	Lalitpur	7236	12
Mandwara	Lalitpur	17630	31
Jakhaura	Lalitpur	335	3
		96311	159



Integrated Water Resources Management (IWRM) Plan

An IWRM Plan has been developed to address the issues of current water stress situation of Sajnam river watershed through scientific practices of land and water management. The Plan also suggests livelihood options for the villagers to decrease their vulnerability risks. IWRM plan aims at fulfilling the water demands in the entire watershed including domestic, livestock, agricultural and other demands. In addition to current demands, planning has been given to mitigate any future water crisis by recharging water to subsurface aquifers.

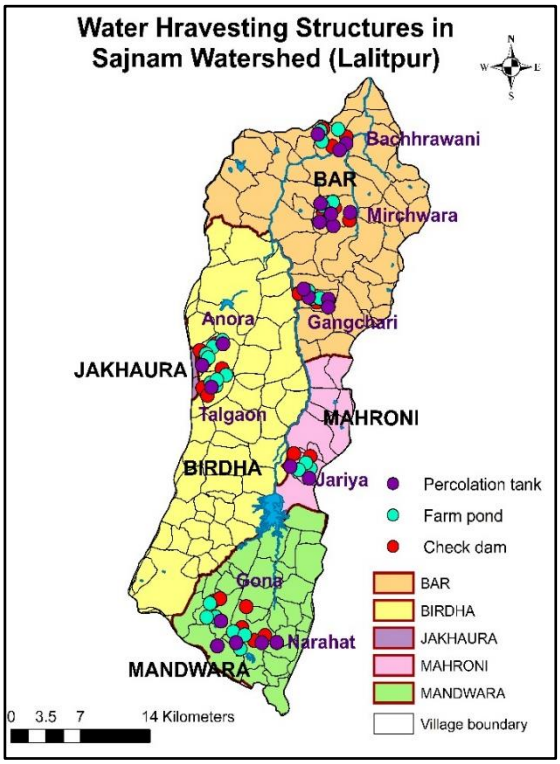
The complete plan has been suggested at block level considering the local level water diversity scenarios; however agricultural and livelihood aspects are similar for all. This is because of the similarity in agricultural or cropping pattern within a watershed area. The major crops are same for each block coming under watershed and hence the suggestions for crop management are same for all.

Development of the IWRM plan started with holding an interaction workshop with the local stakeholders in the watershed. The development issues and water-related problems in the watershed were mapped and possible solutions discussed with the local stakeholders. A vulnerability assessment exercise was conducted to identify the vulnerable areas in the watershed. The sustainability of the area can be understood from Livelihood Vulnerability Index (LVI), which is an index used to assess risk and the level of vulnerability of an area under impacts of natural disasters and other changes.

Components of IWRM Plan

1. **<u>Water Management</u>:**

   It includes incorporation of water harvesting structures based on the topography and land use of the area. For agricultural usage, farm ponds are best suited as a means of collecting rainwater at the site and using it for irrigation. Check dams and percolation dams can be constructed to harvest rainfall excess at suitable location to supplement irrigation. The plan provides suitable locations and component under which it can be constructed. (see Table 3). Apart from



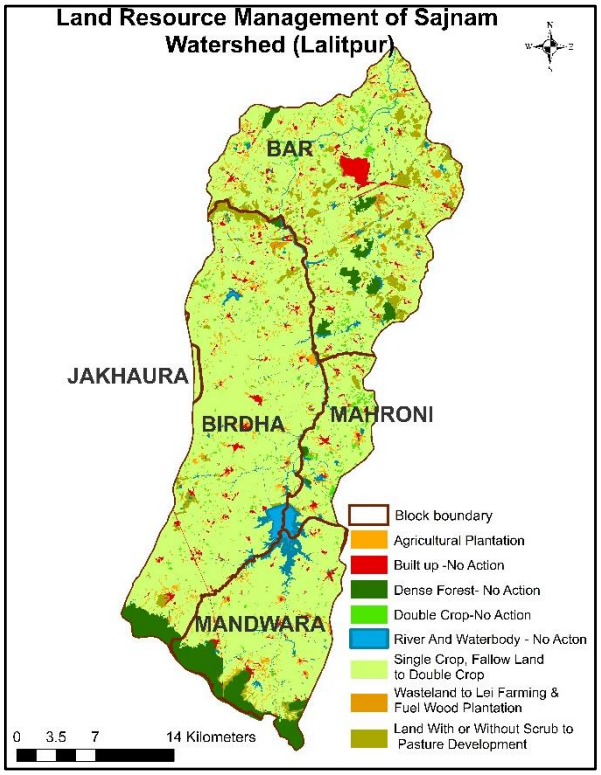
this, for domestic usage like drinking, bathing and cooking, rooftop rainwater harvesting can be an effective solution to store water.

In the Sajnam watershed, groundwater is the primary source of drinking water. Water quality results for water bodies in Sajnam watershed suggest that the area had good water quality for past 5-6 years except for 2013-2014, which experienced a decline in the quality from good to poor (Table 2).

Table 2: Water Quality Index for Patrahi-Lakheri Watershed

Year	WQI	Overall quality
2012-2013	66.55	Good
2013-2014	115.05	Poor
2014-2015	90.83	Good
2015-2016	78.9	Good
2016-2017	67.83	Good

2. **<u>Land Management</u>:** This section provides different ways of improving agricultural production, crop and soil health and efficient irrigation technologies importantly (see table 4 & 5). To make best utilization of available land resource, changes in land use have been suggested in terms of a Land Resource Management map.



Land Resources Management: The type of land usage in an area reflects the activities carried out within the region which determine its sustainability. Thus implementing land use changes is necessary to regulate those anthropogenic activities which in long run, might harm the sustainability of the watershed. Under this section, Land resources Management strategies have been proposed (see Table 6) in terms of land use changes feasible for the area under study.

3. **<u>Livelihood Management:</u>** As a part of livelihood management, the aim is to increase both availability and options of livelihood while conserving the natural resources in terms of quantity as well as quality. Through this approach, emphasis has been given on utilizing

the locally available resources to create livelihood opportunities that ensure food security and nutrition, curb hunger and poverty, provide sustainable agricultural practices and helps in combating climate change and related impacts etc. The suggestions for livelihood management were given on the basis of Livelihood vulnerability study (LVI-IPCC approach) conducted for the watershed.

IWRM Inputs for "Strategic Action Plan" component of DIP

The DIP of Lalitpur district includes district water profile, water availability, water requirement/demand, and provides a strategic action plan at Block/Sub-district level for improving groundwater levels through recharge measures, enhancing irrigation coverage, soil and water conservation through structural and non-structural watershed measures, improving the agriculture production and other livelihood activities.

The IWRM Plan for Sajnam watershed, designed in three sections of (1) water management, (2) land management, and (3) livelihood management, provides suggestions on the activities under these three themes. The Plan considers effective utilization of land, water and other available natural resources, linked to the vulnerabilities and livelihood opportunities in the geographical area. The Plan is designed in such a way that it provides useful inputs to the DIP of Lalitpur district, both in terms of water supply and demand management synergized with the land management and livelihood improvement. Identification of the needs and priorities of various water users, as well as the threats that water poses in terms of land degradation, droughts, contamination of water sources, were deliberated with the stakeholders during consultations at various stages.

1. Water Management

Table 3: Suggested sites for water harvesting structures

S. no.	Block	Component	Village	Activity	Total No.	Location	
						Latitude	Longitude
1.	**Bar**	PMKSY Watershed/ Har Khet Ko Pani	Mirchwara	Farm Pond	3	24°47'01.589" N 24°46'48.061" N 24°46'05.231" N	78°38'42.415" E 78°38'06.730" E 78°38'28.459" E
				Check Dam	3	24°46'30.100" N 24°46'43.421" N 24°46'05.125" N	78°38'08.326" E 78°38'50.457" E 78°39'44.003" E
				Percolation Tank	5	24°45'57.166" N 24°46'56.092" N 24°45'46.039" N 24°46'29.880" N 24°46'36.800" N	78°37'57.395" E 78°37'59.040" E 78°38'45.991" E 78°38'37.330" E 78°39'45.620" E

			Bachhrawani	Farm Pond	3	24°50’15.228” N 24°50’54.427” N 24°50’54.429” N	78°37’54.270” E 78°38’00.263” E 78°38’57.520” E
				Check Dam	3	24°49’59.728” N 24°50’30.604” N 24°50’54.283” N	78°38’38.031” E 78°39’27.628” E 78°38’03.309” E
				Percolation Tank	3	24°50’37.161” N 24°50’08.926” N 24°49’48.230” N	78°37’45.463” E 78°39’27.759” E 78°39’04.099” E
			Gangchari	Farm Pond	3	24°41’53.324” N 24°41’53.838” N 24°42’16.375” N	78°37’32.770” E 78°38’03.325” E 78°37’20.923” E
				Check Dam	2	24°41’41.204” N 24°42’07.702” N	78°37’50.626” E 78°36’46.399” E
				Percolation Tank	4	24°41’51.208” N 24°41’56.840” N 24°41’26.195” N 24°42’22.410” N	78°38’32.790” E 78°37’21.971” E 78°38’33.133” E 78°37’03.832” E
2.	**Mahroni**	PMKSY Watershed/ Har Khet Ko Pani	Jariya	Farm Pond	3	24°32’50.319” N 24°33’07.417” N 24°32’45.213” N	78°37’38.395” E 78°37’22.290” E 78°36’56.181” E
				Check Dam	2	24°33’43.085” N 24°33’28.365” N	78°36’24.833” E 78°37’37.398” E
				Percolation Tank	2	24°32’18.618” N 24°32’55.093” N	78°37’34.888” E 78°36’26.770” E
3.	**Birdha**	PMKSY Watershed/ Har Khet Ko Pani	Anora	Farm Pond	4	24°39’33.850” N 24°39’12.606” N 24°38’49.306” N 24°38’37.510” N	78°32’15.257” E 78°31’41.592” E 78°31’18.078” E 78°31’25.535” E
				Check Dam	3	24°39’00.372” N 24°39’22.463” N 24°38’27.008” N	78°30’55.082” E 78°31’51.975” E 78°31’14.841” E
				Percolation Tank	2	24°39’22.701” N 24°38’12.663” N	78°32’17.221” E 78°31’03.814” E
			Talgaon	Farm Pond	4	24°37’42.955” N 24°37’08.905” N 24°37’17.626” N 24°37’27.835” N	78°32’30.055” E 78°31’54.934” E 78°31’36.118” E 78°31’57.700” E
				Check Dam	3	24°38’02.918” N 24°36’37.442” N 24°37’00.809” N	78°32’15.539” E 78°31’25.350” E 78°31’06.482” E
				Percolation Tank	1	24°37’03.590” N	78°31’38.600” E
4.	**Mandwara**	PMKSY Watershed/ Har Khet Ko Pani	Narahat	Farm Pond	3	24°24’04.138” N 24°23’10.428” N 24°23’54.629” N	78°33’11.981” E 78°33’37.936” E 78°33’53.612” E
				Check Dam	4	24°24’17.845” N 24°23’37.794” N 24°23’53.790” N 24°25’25.250” N	78°31’43.002” E 78°34’27.908” E 78°35’05.689” E 78°35’37.087” E
				Percolation Tank	4	24°23’30.858” N 24°23’29.484” N 24°23’32.825” N 24°23’18.236” N	78°34’54.969” E 78°33’23.038” E 78°35’48.489”E 78°32’16.070”E
			Gona	Farm Pond	3	24°24’50.209” N 24°25’33.508” N 24°24’48.793” N	78°32’07.997” E 78°31’46.769” E 78°31’36.250” E
				Check Dam	2	24°25’40.293” N 24°25’49.275” N	78°31’58.943” E 78°32’22.533” E
				Percolation Tank	1	24°24’38.008” N	78°32’27.427” E

2. Land Management

The main emphasis of land management is to maintain a judicious combination of crops, water, human and financial resources, to ensure long term sustainability. The planning is done in order to create agri-based livelihood opportunities, increase productivity, maintain soil health etc. The suggestions are aimed at ensuring more production with less crop failure. Suggestions pertaining to the major crops that are grown in the area included System of Crop Intensification, drip irrigation for high value vegetable and fruit crops, Wadi model for fruit and vegetable crops, crop rotations, line sowing, and crop diversification, considering the local soil conditions, nutrition value of crops, crop diversification potential, etc.

Table 4: Suggestion for agricultural management

<table>
<tr><th>Component</th><th colspan="2">Water Efficient Irrigation Technologies</th><th colspan="2">Crop Rotation</th></tr>
<tr><td rowspan="3">Agriculture Technology and Management Agency (ATMA)</td><td>SRI (System of Rice Intensification)</td><td>Rice</td><td colspan="2" rowspan="2">✓Wheat → Green gram → Rice
✓Wheat → Green gram → Maize
✓Soybean → Wheat → Blackgram → Mustard → Soybean
✓Groundnut → Cowpea → Rice</td></tr>
<tr><td>SWI (System of Wheat Intensification)</td><td>Wheat</td></tr>
<tr><td>SCI (System of Crop Intensification)</td><td>Maize, Sorghum, Mustard, Blackgram</td><td colspan="2" rowspan="2">Component: Integrated Nutrient Management (INM)</td></tr>
<tr><td>Per drop more crop (Micro Irrigation)</td><td>Drip Irrigation</td><td>Maize, Vegetable and Fruit crops</td></tr>
<tr><td rowspan="2">AIBP</td><td rowspan="2">Irrigation at critical stages</td><td rowspan="2">Wheat (including crown root initiation and flowering stage), Soybean</td><td colspan="2">Crop Diversification</td></tr>
<tr><td>Kharif</td><td>Rabi</td></tr>
<tr><td>National Horticulture Mission</td><td>Wadi (Agri-Horti based model)</td><td>Fruit (Aonla, Guava, Mango) and vegetable crops</td><td>Cowpea + Groundnut + Sorghum Groundnut + Blackgram</td><td>Gram + Wheat + Pea</td></tr>
<tr><td>National food Security Mission (NFSM)</td><td colspan="4">Line Sowing for all types of crops like Blackgram, Groundnut, Rice, Wheat, Mustard, Maize etc.</td></tr>
</table>

Table 5: Major crop systems: problems and solutions

Crop System	Problems	Solutions
Rice – Wheat	• Soil nutrients' deficiency • Soil health deterioration • Groundwater level depletion • Increase in crop diseases and pests • Less use of fertilizers	• Taking Green gram (summer crop) between wheat (Rabi) and Rice (Kharif), i.e. Wheat → Green gram → Rice • Efficient usage of fertilizers • Carbonic manure, bio-fertilizers, green manure usage to maintain soil fertility and productivity for long • Coordinated management • Adopting direct seeding of rice technology
Maize – Wheat	• Nutrient deficiency • Weeding problem • Inefficient fertilizer usage • Water logging causes maize crop destruction	• On time sowing • FIRB (Furrow Irrigated Raised Bed) method of sowing to manage efficient water exit • Efficient carbonic and non-carbonic fertilizer usage • Both maize and wheat decrease soil fertility, so usage of green manure and pulse intercropping to improve soil health • To manage adequate water exit, construction of drains in maize crop field
(Source: Labhdayak Fasal Pranaliya: Samasyaye evam Samadhan (2013) Indian Agricultural Research Institute, New Delhi 110012. ICN: H-130/2013)		

Table 6: Land use change suggestions for LRM

Current Land Use	Blocks	Suggested change
Land with or without scrub	Bar	Pasture development
Single Crop, Fallow Land	All blocks	Double Crop
Wasteland	Bar and Birdha	Lei Farming and Fuel wood plantation
Built up	All blocks	No action
Dense forest	All blocks	No action
Double Crop	All blocks	No action
River and Water bodies	All blocks	No action
-	All blocks	Agricultural Plantation

3. Livelihood Management

As a part of livelihood linked natural resource management, the aim is to increase both availability and options of livelihood while conserving the natural resources in terms of quantity as well as quality. Through this approach, emphasis is given on utilizing the locally available resources to create livelihood opportunities that ensure food security and nutrition,

curb poverty, provide sustainable agricultural practices and help in combating climate variability and related impacts, etc.

Using LVI-IPCC approach, vulnerability value of each block falling in the watershed area was calculated. Among the five Blocks, Bar has been found to be the most vulnerable and Mahroni as the least vulnerable Block (Bar > Mandwara > Birdha > Jakhaura > Mahroni). Suggestions to reduce the vulnerability values in future are given as:

1. Raising awareness on climate change – causes, impacts and mitigation of extreme events
2. Building health and education infrastructures
3. Promoting off farm and non-farm occupations (e.g. livestock and poultry rearing, pisciculture, beekeeping, handicrafts)
4. Increasing community networks and social interaction amongst the villagers
5. Facilitate micro-financing support
6. Practicing fishery in suitable water bodies as a livelihood option.

The conventional livelihood practice in this watershed has been agriculture, which as a result of climate variability and other crop failure consequences, has resulted in diminishing employment and financial gains. A focus shift on non-agricultural, employment generating opportunities will help prevent people from migration, which is one of the biggest social challenges these watersheds are currently facing. Off farm activities like poultry, fishing, handicrafts, are being promoted to engage people in a variety of livelihood activities. The following livelihood activities related to handicraft, bee keeping, etc. are suggested for villages falling under Sajnam river watershed (see Table 7).

Under capacity building, one-day workshops will be organized in the selected villages on organic farming and village livelihood generation.

Table 7: List of activities proposed in the selected villages of Sajnam Watershed

Block	Village	Activities
Mahroni	Jariya	Pisciculture, Organic farming/Vermicomposting, Bee Keeping, *Agriculture/Horticulture demonstration, Edible mushroom cultivation, Jute items making/ bamboo craft, Roof water harvesting model.

Birdha	Talgaon	Organic farming / Vermicomposting, Bee Keeping, *Agriculture/Horticulture demonstration, Pisciculture, Jute items making/ bamboo craft, Roof water harvesting model.
Birdha	Anora	Organic farming / Vermicomposting, Bee Keeping, *Agriculture/Horticulture demonstration, Jute items making/ bamboo craft, Roof water harvesting model.
Mandwara	Gona	Pisciculture, Organic farming /Vermicomposting, Bee Keeping, demonstration, Edible mushroom cultivation, Jute items making/ bamboo craft, terracotta, *Agriculture/Horticulture, Roof water harvesting model.
Mandwara	Narahat	Organic farming/Vermicomposting , Bee Keeping, *Agriculture/Horticulture, Jute items making/ bamboo craft, Edible mushroom cultivation, Roof water harvesting model.
Bar	Gangchari	Organic farming/Vermicomposting , Jute items making/ bamboo craft, Edible mushroom cultivation, *Agriculture/Horticulture demonstration, Roof water harvesting model.
Bar	Mirchwara	Organic farming/Vermicomposting , Jute items making/ bamboo craft, Edible mushroom cultivation, Bee Keeping, *Agriculture/Horticulture demonstration, Roof water harvesting model.
Bar	Bachhrawani	Organic farming/Vermicomposting , Bee Keeping, *Agriculture/Horticulture demonstration, Edible mushroom cultivation, Jute items making/ bamboo craft,Roof water harvesting model.

*

- Agroforestry
- Crop rotation, inter-cropping, crop diversification
- Soil testing based decision on fertilizer application
- Water quality testing
- Line sowing
- Crop intensification techniques (SRI, SWI, etc.)
- Establishment of seed bank
- Singhara cultivation
- Use of net-shade and poly houses for high value crop cultivation

Summary

IWRM planning is shown to be a practical tool in district level planning for implementation of water management activities. The IWRM Plan of Sajnam river watershed, designed in three sections of (1) water management, (2) land management, and (3) livelihood management, provides suggestions on the activities under these three themes. The IWRM Plan, developed through a participatory approach, is better positioned to provide useful inputs to the District Irrigation Plan (DIP) as articulated by the stakeholders during consultations. Identification of the needs and priorities of various water users, as well as the threats that are posed in terms of land degradation, droughts, contamination of water sources, were deliberated with the stakeholders during these consultations.

The IWRM Plan considers effective utilization of land, water and other available natural resources, linked to the vulnerabilities and livelihood opportunities in the geographical area. The Plan is designed in such a way that it provides useful inputs to the DIP of Lalitpur district, both in terms of water supply and demand management synergized with the land management and livelihood improvement. The IWRM Plan suggests interventions to promote the component of water demand management in the district level planning. A unique feature of the IWRM plan presented here is that mostly secondary data as available at the district level was used in developing the plan.

Annexure I

Stakeholder Workshop for Sajnam watershed IWRM Planning

Venue	Conference Hall, Collector office, Lalitpur
Date and Time	21/12/2016 3:00 PM – 5: 00 PM
Attenders	• Chairperson: Sri. P.K. Lakshakar (CDO, Jhansi) • Officers from different departments: Irrigation and Water Resources, Minor Irrigation, Soil Conservation, Agriculture, Horticulture, Krishi Vigyan Kendra, IWMP, WUA members • Farmers, local residents and people from different line departments • NIH team from Roorkee and Bhopal • UPRSAC team from Lucknow • MPCST team from Bhopal

During the conference, Dr V. C. Goyal, Principal Investigator of the project, informed the gathering about project objectives and deliverables. The progress of project including overview of project, generation of GIS data base, Water balance study for Sajnam dam catchment, selection of Villages for livelihood, interventions for rural development and proposed web portal for IWRM were presented by scientists of participating agencies such as NIH Roorkee, NIH RC Bhopal, MPCST Bhopal, and UPRSAC Lucknow. Overwhelming response from officers and different sections of stakeholders was received and it was learnt that low and erratic nature of rainfall, recurring droughts, hard rocks, shallow soil etc. are the main cause of less availability of water in the region. The groundwater availability in the region is possible only by tapping lineaments in the watershed. Groundwater recharge, watershed management,

interlinking of rivers, emergency plan etc., could be the key to successful and sufficient water availability at village level during drought years. In the presidential address, Sri P. K. Lakshakar, CDO Lalitpur informed regarding problems of water shortage in villages of Lalitpur, works of irrigation under PMKSY etc. He emphasized that Lalitpur has maximum number of dams but still there is problem of water in summers. Changes in the regular practice of irrigation needs improvement as it is a major water user in India. The workshop ended with vote of thanks by Sri R. K. Jaiswal, NIH Bhopal.

Given are some pictures from the workshop.