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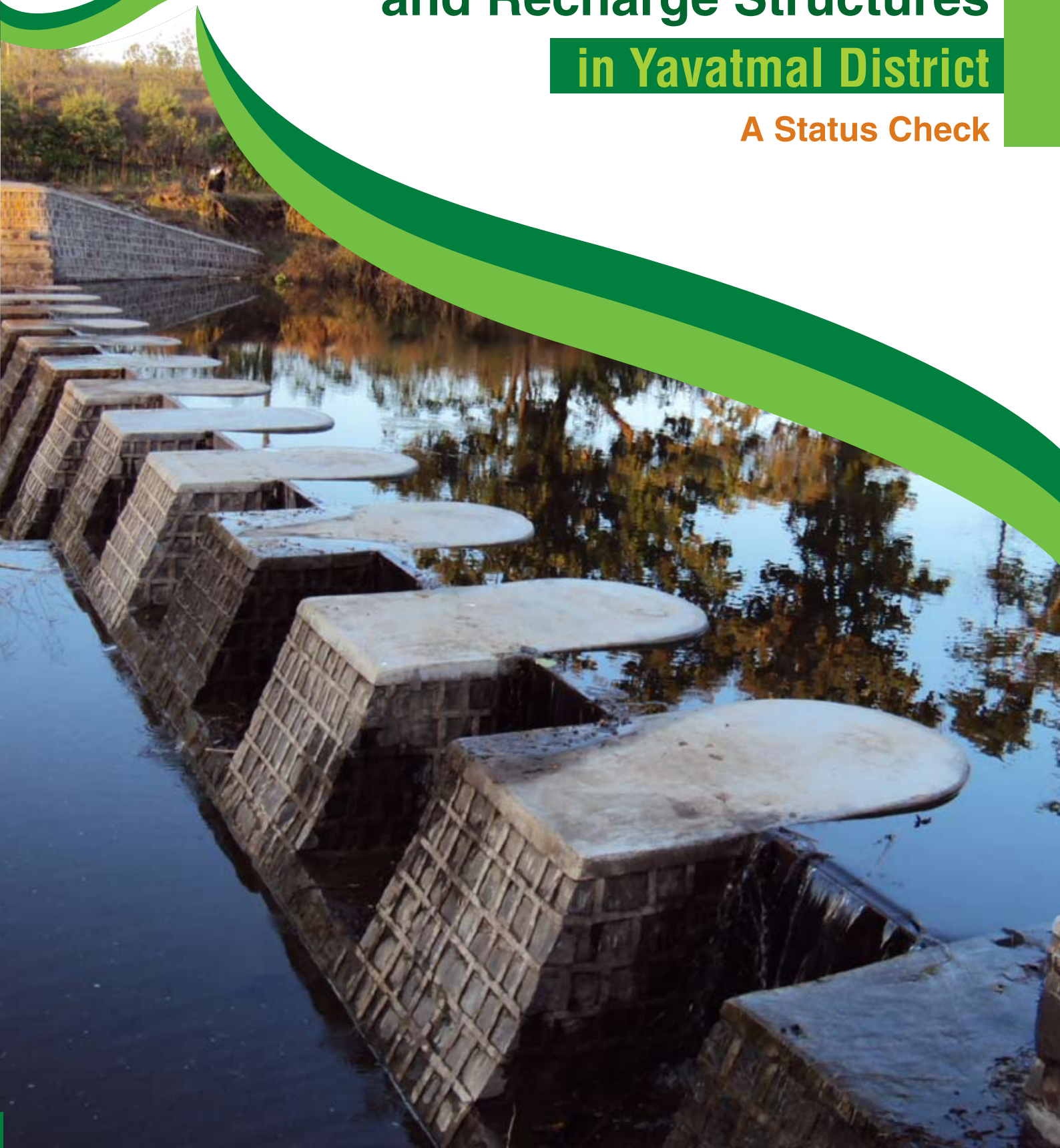
Water Harvesting and Recharge Structures in Yavatmal District

A Status Check



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Institute for Sustainable Communities

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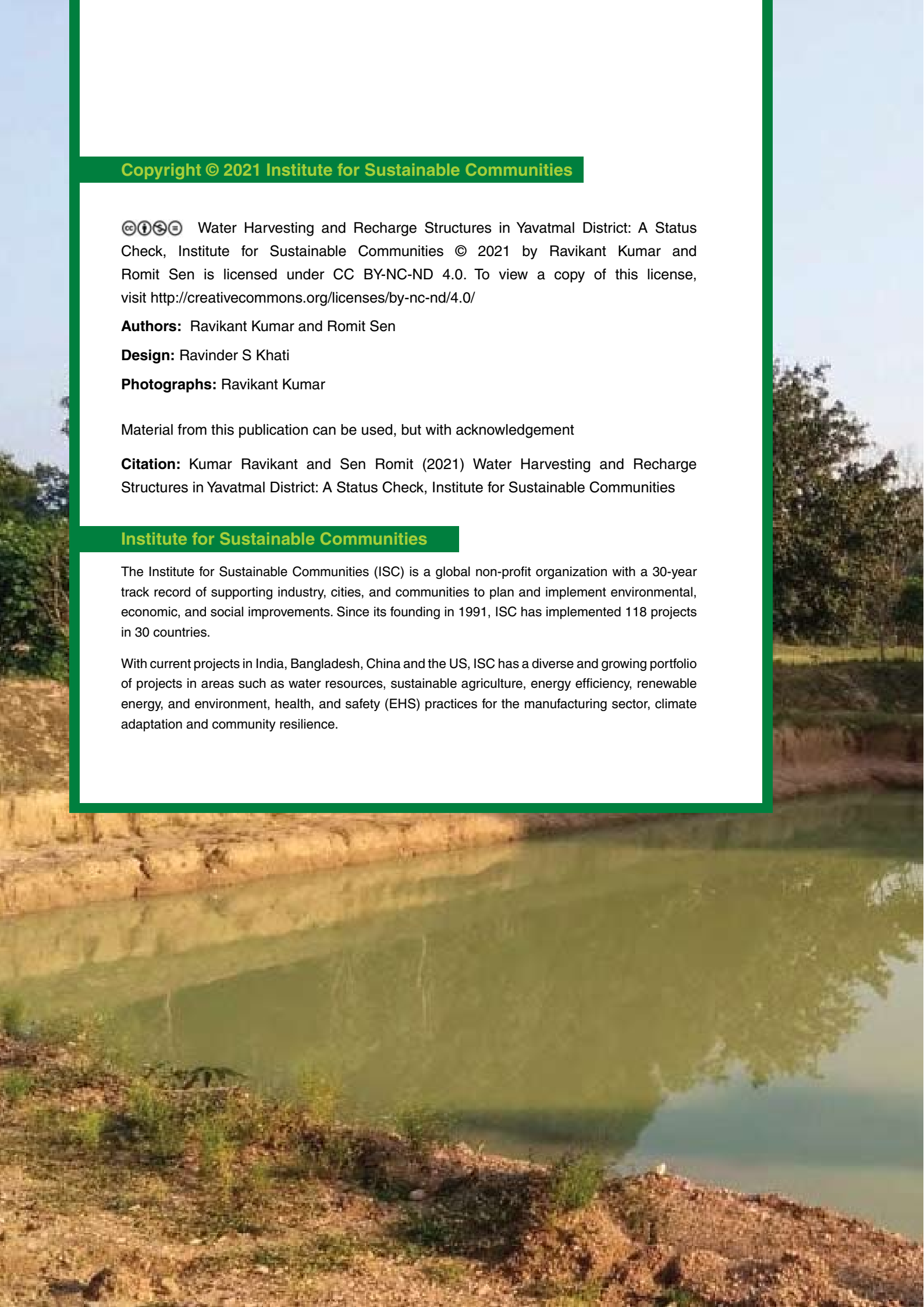
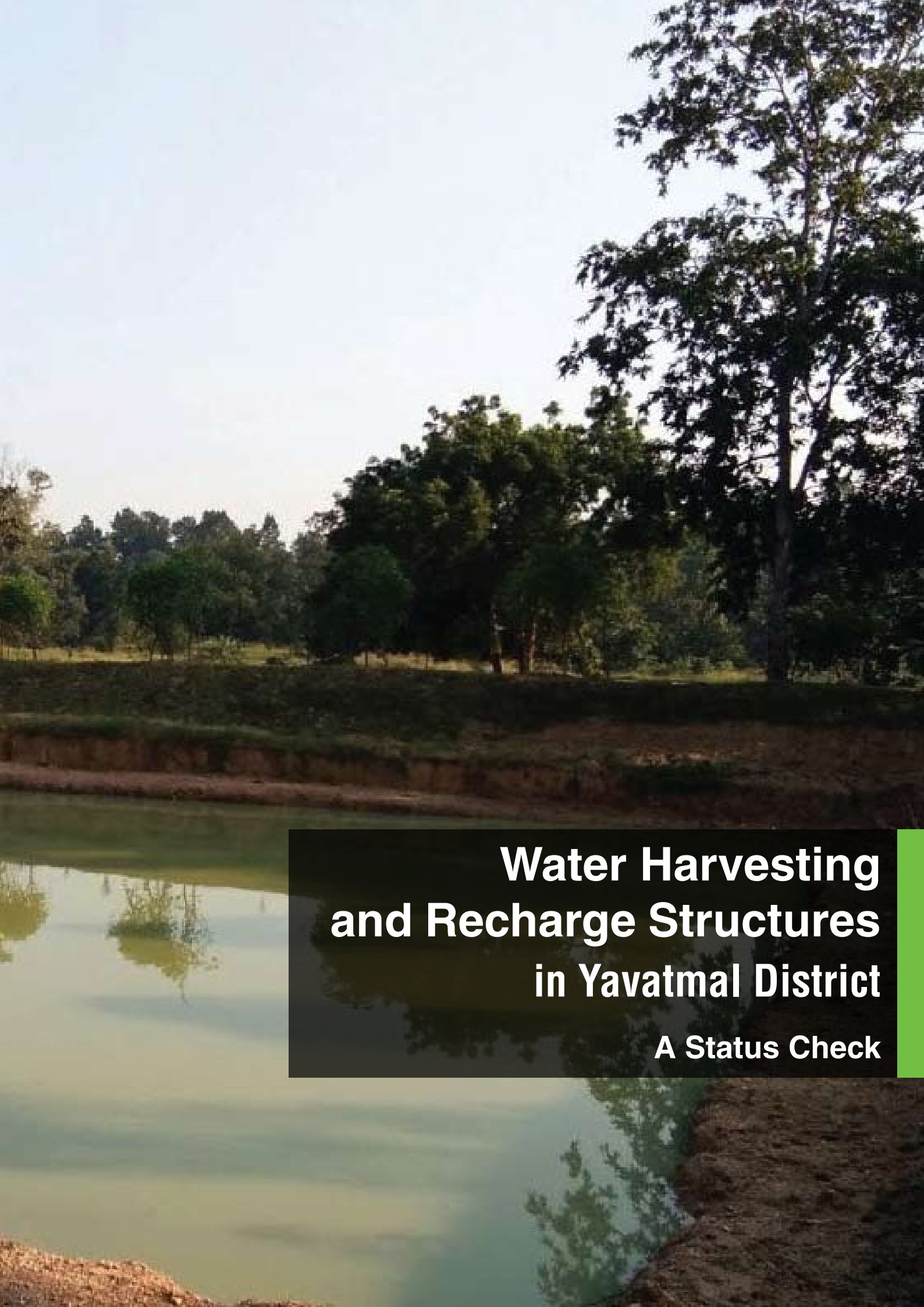
With current projects in India, Bangladesh, China and the US, ISC has a diverse and growing portfolio of projects in areas such as water resources, sustainable agriculture, energy efficiency, renewable energy, and environment, health, and safety (EHS) practices for the manufacturing sector, climate adaptation and community resilience.





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Contents

1 STUDY AREA

Yavatmal district lies in the South Western part of the Wardha-Painganga-Wainganga plain. The district lies between 19°26'and 20°42' north latitudes and 77°18'and 79°90' east longitudes. It is surrounded by Amravati and Wardha district in the north, Chandrapur district in the east, State of Telangana and Nanded district in the south and Parbhani and Akola district in the west. The district has an area of 13,52,000 hectares which is 4.41% of the total area of Maharashtra and a population of 20,77,144 which is 2.63% of the state's population.

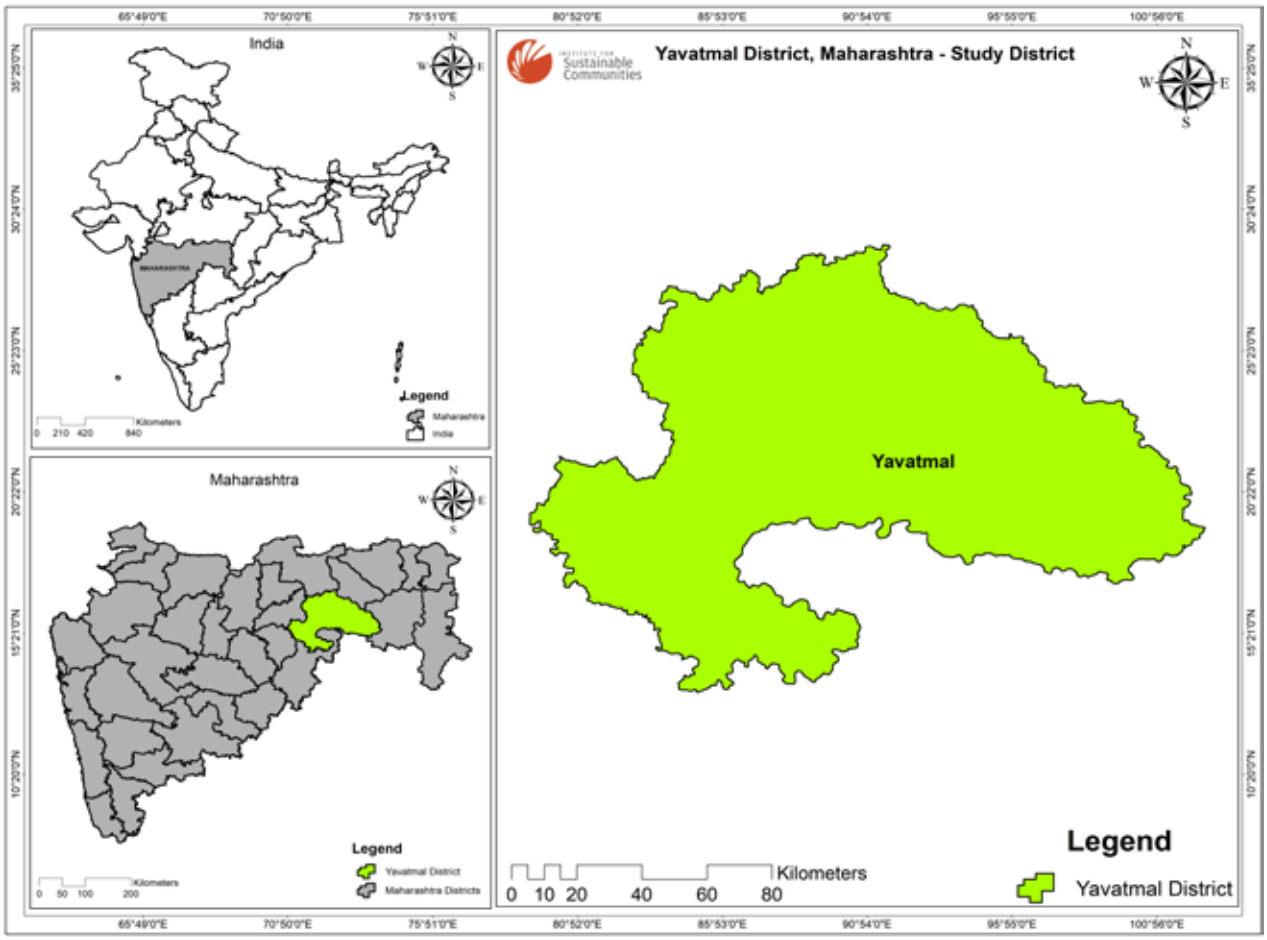

Figure 1: Location Map of Yavatmal District

1.1 Climate

The climate of Yavatmal district is characterized by a hot summer and general dry weather throughout the year, except during the South-West monsoon season, i.e., during June to September. The temperature rises rapidly from February till May, which is the hottest month of the year. The mean daily maximum temperature during May is 41.8°C and the mean daily minimum temperature during December is 15.1°C.

The normal annual rainfall varies from about 880 mm to 1150 mm and it increases from North-West to South-East direction in the district and reaches a maximum at Pandharkawada block (See Figure 2). The average rainfall across the agro climatic zones and in Yavatmal district ranges 775.2 mm from the South-West monsoon (June to September). In addition, the district receives 69.6 mm rainfall from North-East monsoon (October to December). Annual normal rainfall is recorded at 886.4 mm.

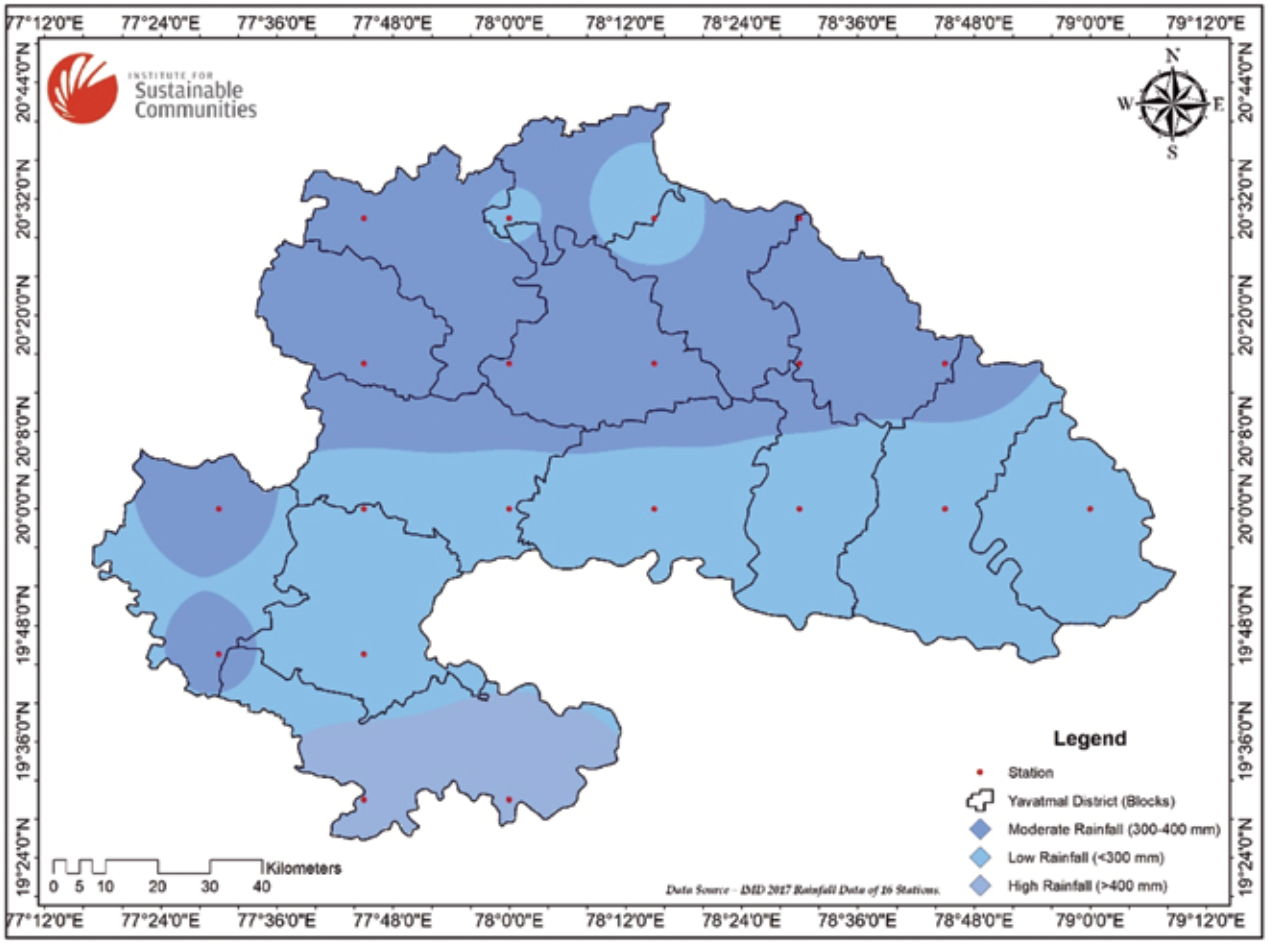

Figure 2: Distribution of rainfall in Yavatmal district

1.2 Geomorphology and Soil

The northern fringe of the district is hilly and forms part of the Satpura range. South of these hill ranges, covering almost entire north central parts, constitutes the alluvial plain. The southern part of the district is characterized by hilly rugged terrain as a part of the Deccan Plateau (See Figure 3).

Three types of soils are observed in the district, these include, (i) the shallow coarse soil which is reddish brown and brownish in colour, occurring in general at higher elevations along the ridges and alongside the foot hills. (ii) The medium black soil is found along the tributary drainage and also along the intermediate gradient area. (iii) The deep black soil, is found along the lower reaches of Wardha and Painganga riverbeds.

They differ from medium black soil in depth and fertility. In general, all types of soils are observed in this zone. Preferably, medium and heavy in texture, fairly high in clay content, alkaline in reaction, high lime reserve with high base saturation of the exchange complex. The soils are severely eroded and shallow. They are uneven in depth and are uncertain by stony substrata. They are intercepted by gullies having rapid runoff resulting in severe erosion and prone to drought.

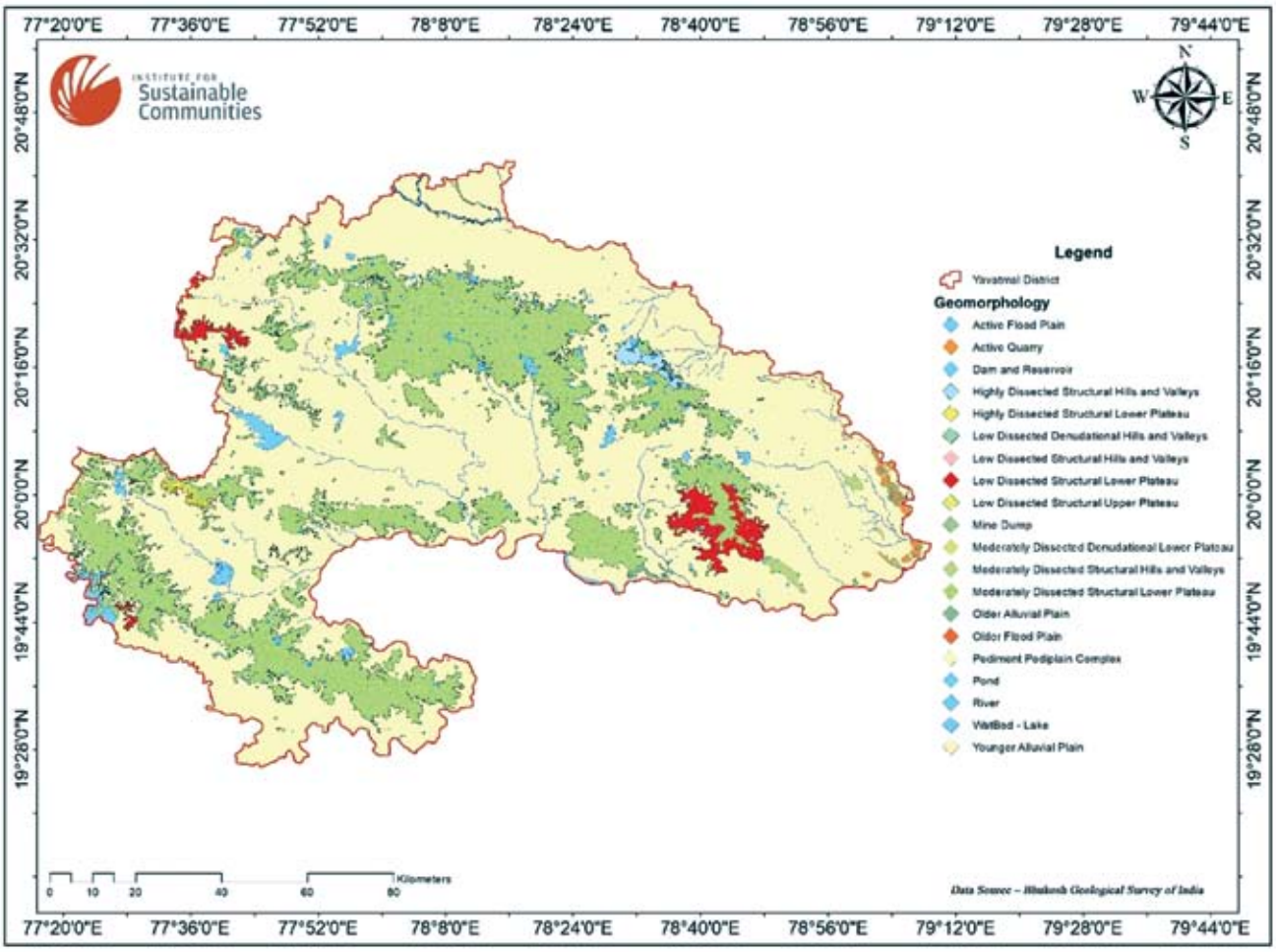

Figure 3: Geo-morphology of Yavatmal district

1.3. Water Resources

Yavatmal district has two main rivers namely, Painganga and Wardha. Both the rivers have various tributaries. Tributaries of Wardha river include Adan, Nirguda, Pus, Kupti, Waghadi, Juni. The Painganga River creates plains along its path on the southern border of the district. Some of these strips stretch up to several miles in breadth. There are eight major dams in the Yavatmal district. Most of these dams are built across the two major rivers - Wardha and Painganga or on their tributaries.

The district has seen the construction of different types of water harvesting, water storage and water recharge structures (KTW - Kolhapuri Type Wear, CNB - Cement Nala Bund, Check Dam, Percolation Tanks, Water Storage Tanks, Farm Ponds, Dohas) across different government programmes and by private agencies and foundations. These structures have majorly been constructed to recharge groundwater and to store water for irrigation and domestic purposes. Data from District Socio-economic Review Report indicates that groundwater is the predominant source when it comes to meeting domestic and agriculture water needs. Data indicate that 78.4% of the districts domestic and agriculture water requirement is met from groundwater sources, and the remaining 21.6% is met by surface water sources.

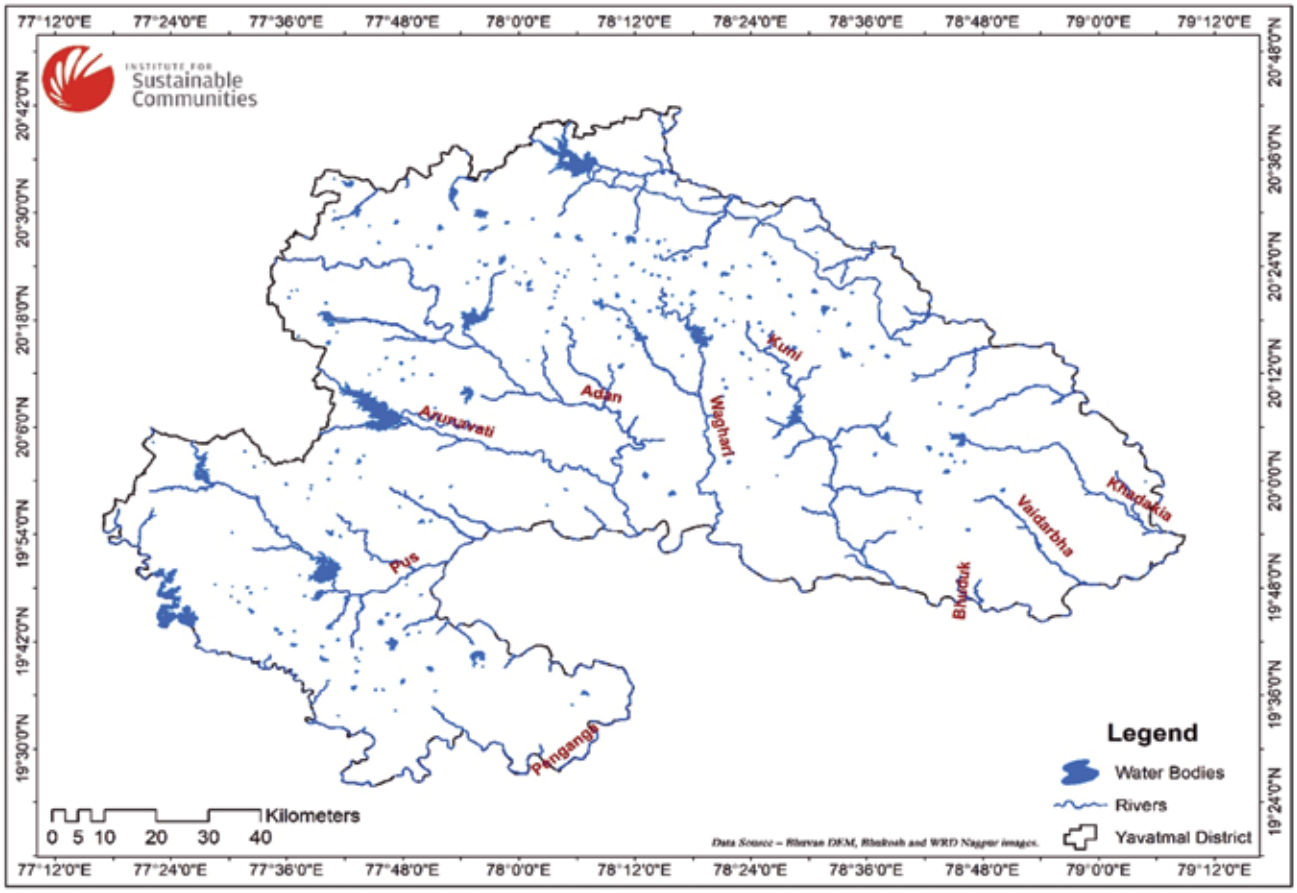

Figure 4: Water Resources of Yavatmal District

1.4 Lithology and Groundwater

Deccan Trap Basalt is the predominant water bearing formation in the district. This is followed by Gondwana formation having Sandstone and Shale sequence. Painganga and Quaternary Alluvium aquifers are spread in limited areas. Archean aquifers are limited and have less significance in the area. During the pre-monsoon (May) month, the depth of water level in the district ranges between 1 meter to 16.60 meters bgl (below ground level) and during the post-monsoon (November) season the water level ranges between 0.90 meters to 15.20 meters bgl (below ground level).

The groundwater development scenario of the district is favorable for further groundwater development in years to come. Groundwater development scenario varies in the district. While the eastern part of Yavatmal consisting of Wani, Maregeon, Pandharkawada, Ghatanji and Jhari Jamni tahsils are the least developed talukas with less than 15% of development; Ghatanji, Arni, Umarkhed, Kalamb, Ralegaon, Yavatmal, Pusad, Digras and Ner have a stage of groundwater development between 15 to 25%. There is higher groundwater development in Darwah, Babulgaon and Mahagaon talukas where the stage of groundwater development is 25 to 27%. The western part of the district having basaltic aquifers have better groundwater development as compared to the eastern part where the aquifers are Gondwana or trap covered Gondwana/Painganga formations.

However, as the development of groundwater resources proceeds with increasing groundwater withdrawal, the depletion of the water table will accelerate resulting in the drying or deepening of existing wells. There are many pockets in the district where water levels have seen a rapid decline and there are areas that lack adequate natural replenishment. An array of Deccan trap exists, that are frequently weathered leading to formation of murom, rubbles and clayey and black cotton soil. The Basalt rock is of varying composition and their flow beds are known as Deccan trap.

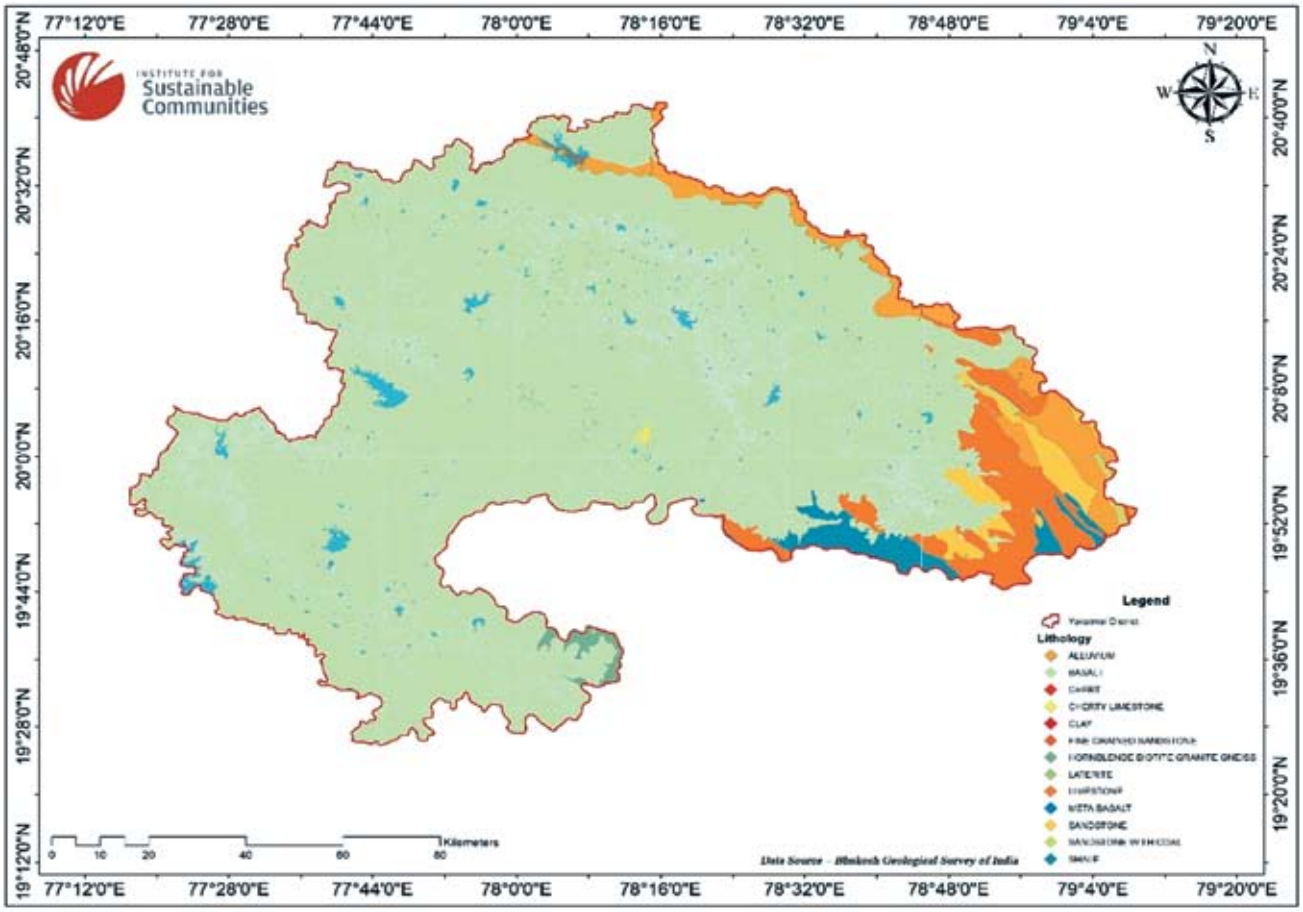

Figure 5: Lithology of Yavatmal District

1.5 Agriculture

Yavatmal district spreads over an area of 13,52,000 hectares. However, the cultivable area is about 8,84,000 hectares. Close to 15,000 hectares area sowing more than once, in a year and thus the gross cropped area increases to 8,99,000 hectares. Yavatmal falls in the agro-ecological zone of western plateau and hills region zone XI categorized as a Moderate Rainfall Zone.

Cotton is the most important crop of the district grown in an area of 4,05,000 hectares. It is largely grown during the Kharif season. Soybean cultivated on 2,87,000 hectares is another important Kharif crop. The other major crops include pigeon pea cultivated on 1,06,000 hectares; sorghum, green pea, black gram grown in 70,000 hectares, 12,000 hectares, and 10,000 hectares respectively. During the Rabi season crops like gram, wheat and safflower are grown.

2 RESEARCH APPROACH

Various water conservation and watershed management programs have been implemented in Yavatmal district over the past several decades. Different types of water harvesting and recharge structures like Farm Ponds, Check Dams, Percolation Tanks, Cement Nala Bund (CNB) have been constructed in the district.

The Institute for Sustainable Communities (ISC) is working in Yavatmal district on interventions relating to catchment security, source strengthening, building institutions to manage water resources, demand management in agriculture to improve water use efficiency and enhancing water literacy amongst rural communities.

In order to assess the current status of the water harvesting and recharge structures and measure their effectiveness based on an analysis of the hydro-geology of the area ISC undertook a status check on various water harvesting and recharge structures in the district. Using various mapping tools, undertaking field visits and interaction with communities, we have made an assessment of the current state of the structures and their effectiveness in recharging and storing water. Water bodies that have an area more than 0.7 acres have been mapped as part of the study on the topographic map at the scale 1:50,000.

The analysis and findings will help prioritize the revival efforts of the various water harvesting and storage structures in Yavatmal. It will help decision makers plan for augmenting water resources in the district.

2.1 Methodology and Data Collection

The mapping exercise involved obtaining satellite images with 30 meters resolution from Bhuvan, which is an Indian web based utility that allows users to explore a set of map based content prepared by Indian Space Research Organization (ISRO). Data on existing water bodies was downloaded from Bhuvan and the location and boundary data were merged with the primarily collected boundary of the structures to map the exact location of the existing structures.

The identification of the water accumulation zone and water recharge zone was done on the basis of borewell data collected from the different government and private agencies. In addition, primary data on the dug wells was collected from the field locations where ISC is working in Yavatmal. Ground truthing validated the mapping results with the status on ground. Figure 6 outlines the methodology used for the study.

Groundwater flow direction was analyzed using ArcGIS 10.3 and Surfer 13 tool. Surfer tool was used to translate the observation wells (dug wells and bore wells) data into clear surface and contour map. To determine the flow direction of groundwater in the study area, a contour map of the catchment was generated using 203 observation wells data of dug wells and bore wells.

In order to understand the position of existing water harvesting and recharge structures, the analysis of groundwater flow system connecting recharge and discharge areas is vital. A water table contour map was generated and subsequently used to identify groundwater recharge and discharge zones. In this event sub-surface topography is a major factor which had to be considered for delineating the recharge and discharge zone. High land areas are an indicator of recharge areas and low land area are an indicator of discharge zones. A water table contour map was also used to locate groundwater recharge and discharge areas.

Surface and sub-surface geologic elements forming a water body have surface expressions that can be discerned by remote sensing techniques. Visual interpretation of Cartosat - 1 (Carto DEM Version - 3 R1) from Bhuvan has been carried out by taking into consideration various image and terrain elements by using a light table.

Two software were used to conduct the classification of the downloaded satellite images. The ArcGIS 10.3 software was used to process the data which helped in digitizing the images, generating the boundary of the existing water bodies, calculating the area of the existing water bodies, and exporting the water resources maps. The Google Earth Pro was used to verify the digitized boundaries of the existing water bodies. Microsoft Excel was used to prepare the dataset and for calculations.

Significant hydro-geomorphic units have been demarcated based on tone, texture, shape, size, pattern and association. Delineation of all linear features have been carried out and with available information, classification of these linear features has been attempted. Delineation of hydro-geomorphological significant landforms like alluvial fans, alluvial plains, braided channels, abandoned channels, paleochannels, flood plain has been carried out in the area covered by unconsolidated sediments. Interpreted maps have been modified by taking into consideration the on-ground observations.

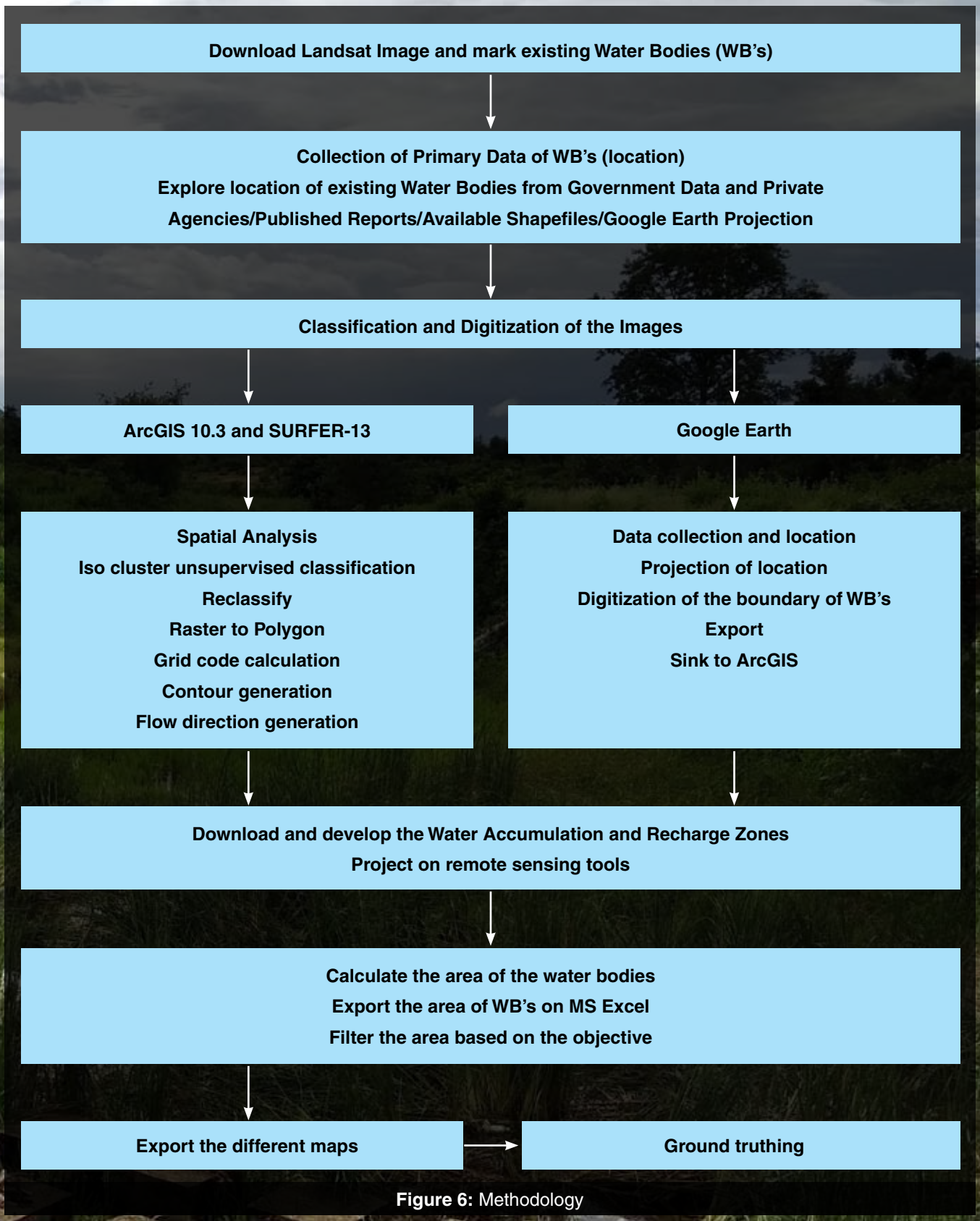

Figure 6: Methodology

3 FINDINGS

The main aspect of the research was to ascertain whether the water harvesting and storage structures in Yavatmal district have been constructed in appropriate locations in order to be effective for groundwater recharge or surface storage. A total of 686 structures comprising check dams, percolation tanks, ponds, water storage tanks, and reservoirs were mapped across the district (See table below) with an indication of their location across recharge and discharge areas.

Table: Water harvesting and storage structures in Yavatmal

Structure	Area	Number of structures
Check dam	0.7-2 acres	204
Percolation Tank	0.7-3 acres	211
Ponds/Farm Ponds	0.7-9 acres	175
Water Storage Tank	10-30 acres	52
Reservoir	30-100+ acres	44
	Total	686

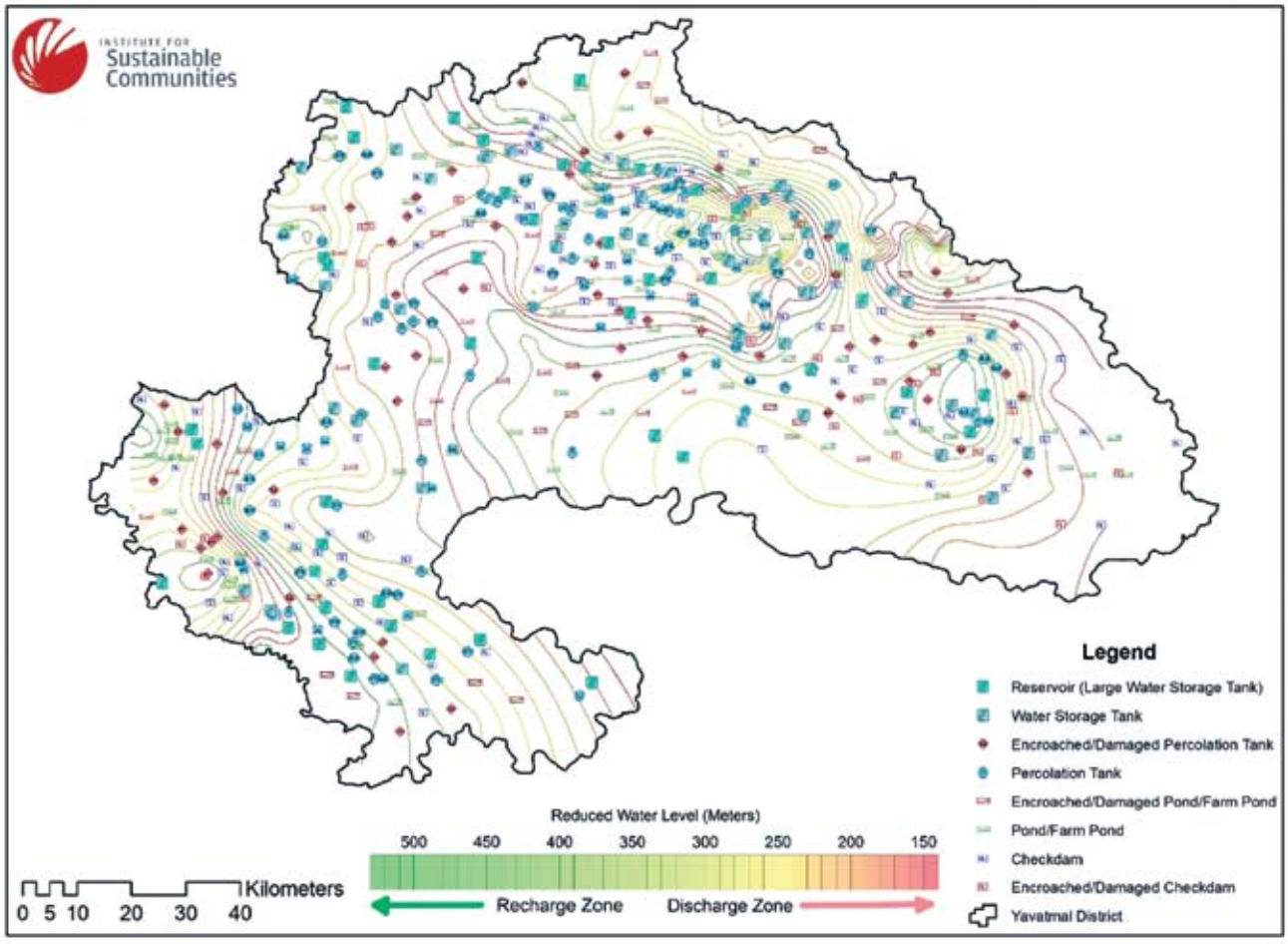

Figure 7: Water harvesting and storage structures in Yavatmal

There are some structures across each of the types that have been damaged or encroached. These have been indicated in the maps. Section below outlines the findings for each of the type of structures.

3.1 Check Dams

A total of 204 check dams lying within an area range of 0.7-2 acres, were mapped in the district. Out of these 117 check dams (corresponding to 57.4 %) lie in the recharge zone and 87 (corresponding to 42.6%) lie in the discharge zone.

Structure	Number of structures	In Recharge Zone	In Discharge Zone
Check dam	204	117 (57.4%)	87 (42.6%)

Given the main purpose of constructing check dams is for enhancing groundwater recharge, on would argue that a higher number of check dams should have been constructed in the recharge zones in Yavatmal.

Around 73 check dams were found to be damaged or encroached. Of the 73 check dams, that are either encroached or damaged, 28 lie in recharge zones which should be prioritized for revival. Given the scenario of growing groundwater extraction in the district, efforts to revive and protect the damaged / encroached check dams need to begin immediately.

Structure	Damaged/ Encroached	In Recharge Zone	In Discharge Zone
Check dam	73	28	45

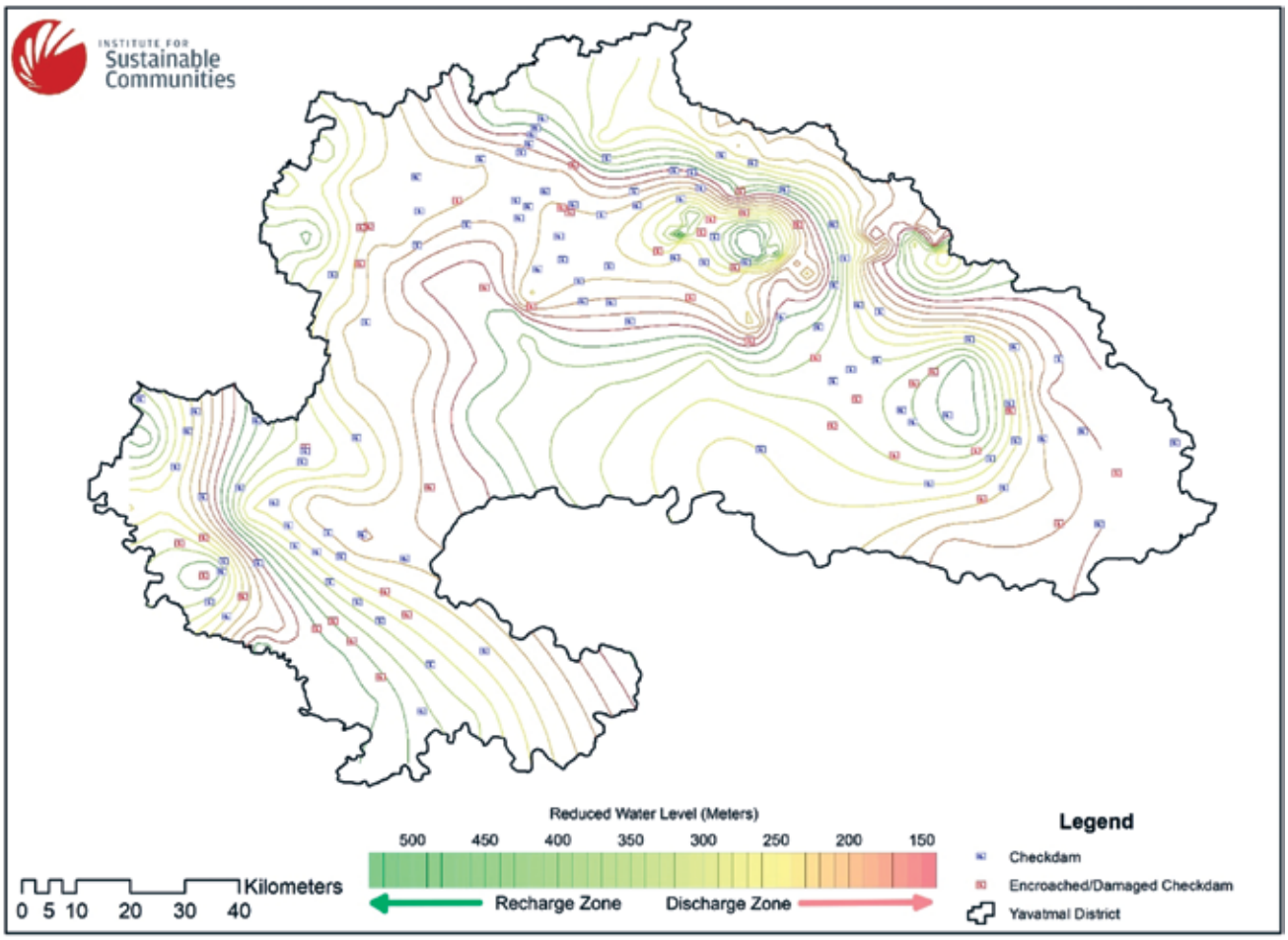

Figure 8: Status of check dams in Yavatmal

3.2 Percolation Tanks

A total of 211 percolation tanks lying within an area range of 0.7-3 acres, were mapped in the district. Out of these 159 percolation tanks (corresponding to 75.4 %) lie in the recharge zone and 52 (corresponding to 24.6%) lie in the discharge zone.

Structure	Number of structures	In Recharge Zone	In Discharge Zone
Percolation Tank	211	159 (75.4%)	52 (24.6%)

While a significant percentage of percolation tanks have been constructed in the recharge areas to be able to contribute to groundwater recharge, the high percentage of encroached percolation tanks is a matter of concern and calls for urgent action for their revival.

Around 68 percolation tanks were found to be damaged or encroached. Of the 68 percolation tanks, that are either encroached or damaged, 47 lie in recharge zones which should be prioritized for revival. Rejuvenation of percolation tanks will help in recharging aquifers in the region.

Structure	Damaged/ Encroached	In Recharge Zone	In Discharge Zone
Percolation Tank	68	47	21

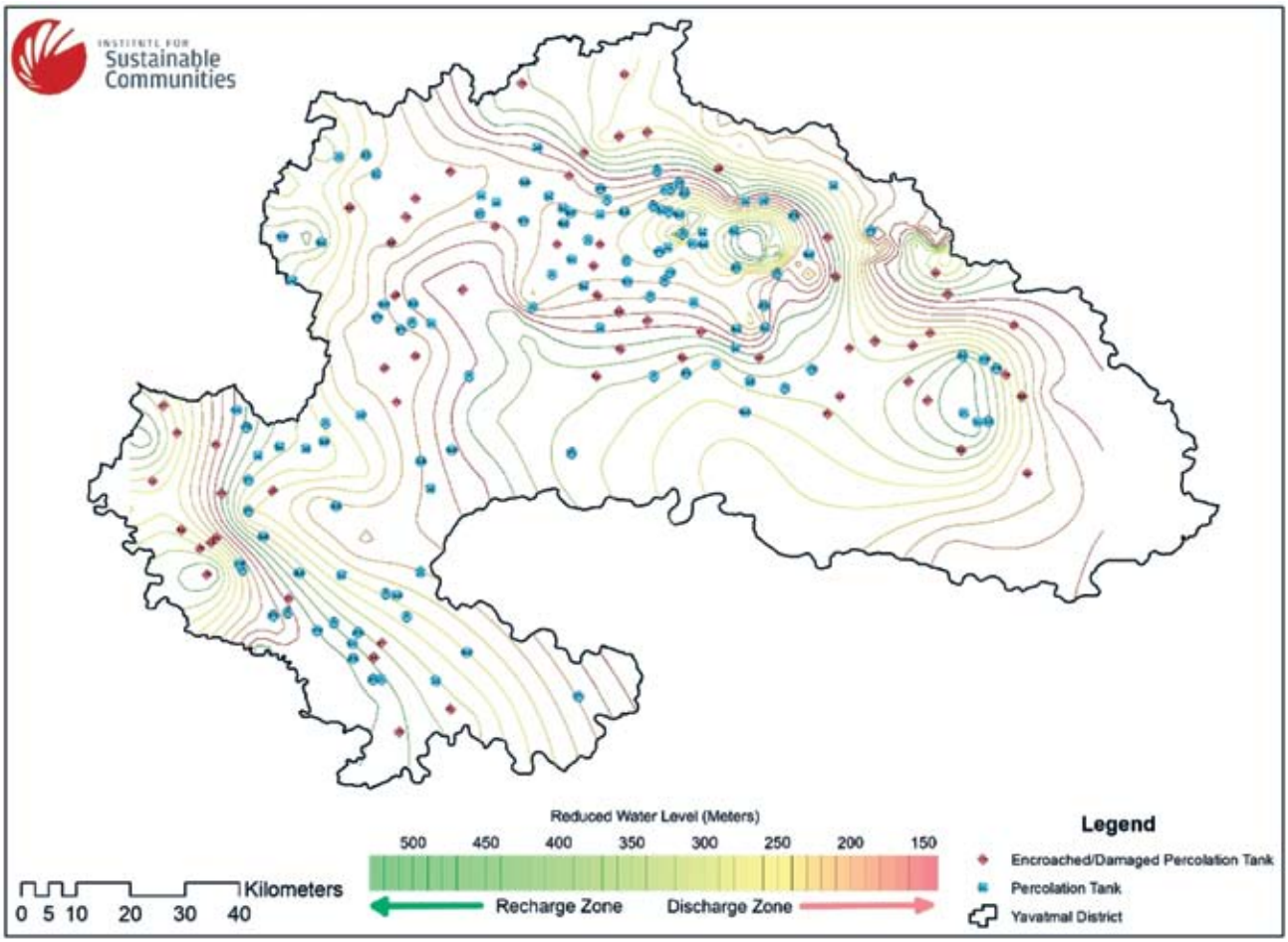

Figure 9: Status of percolation tanks in Yavatmal

3.3 Ponds/ Farm Ponds

A total of 175 ponds/farm ponds lying within an area range of 0.7-9 acres were mapped in the district. Out of these 68 check dams (corresponding to 38.9 %) lie in the recharge zone and 107 (corresponding to 61.1%) lie in the discharge zone.

Structure	Number of structures	In Recharge Zone	In Discharge Zone
Ponds/Farm Ponds	175	68 (38.9%)	107 (61.1%)

While a significant percentage of ponds/farm ponds constructed in the discharge zone will meet the objective of increasing surface water availability for the communities. One would need to have a better understanding on the construction of ponds in the recharge areas. Ponds may contribute to recharge, but one would lay emphasis in building ponds in areas of higher discharge.

Around 57 ponds/farm ponds were found to be damaged or encroached. Of the 57 ponds, 11 lie in recharge zones and 46 lie in discharge zones which should be prioritized for revival. Rejuvenation of ponds will help meeting the water requirements of the communities.

Structure	Damaged/ Encroached	In Recharge Zone	In Discharge Zone
Ponds/Farm Ponds	57	11	46

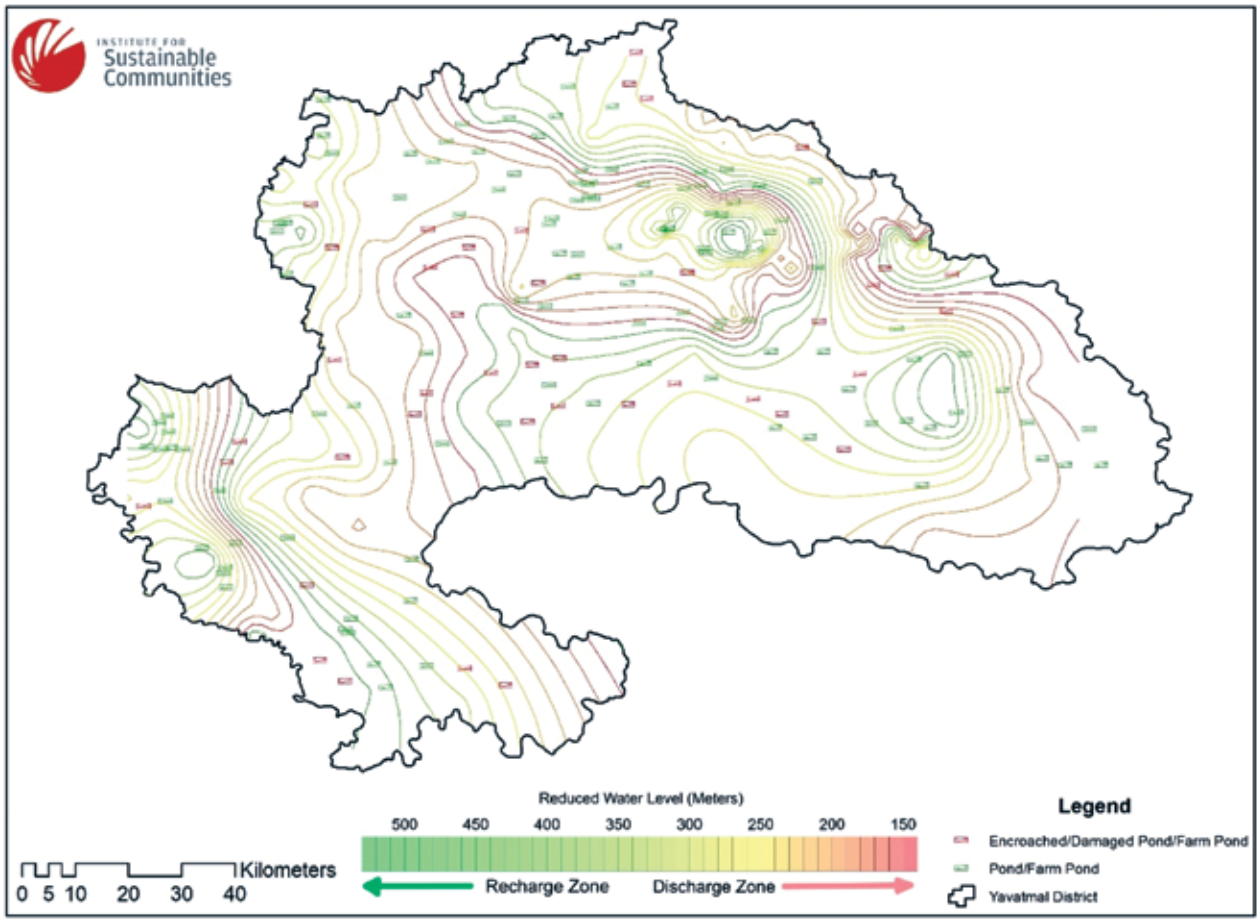

Figure 10: Status of ponds/Farm Ponds in Yavatmal

3.4 Water Storage Tanks

A total of 52 water storage tanks lying within an area range of 10-30 acres were mapped in the district. Out of these 12 water storage tanks (corresponding to 23.1%) lie in the recharge zone and 38 (corresponding to 73.1 %) lie in the discharge zone. Only 2 water storage structures were found to be encroached. A high percentage of water storage tanks in discharge areas meets the purpose of surface storage which is the main aim for the construction of these tanks.

3.5 Reservoirs

A total of 44 reservoirs lying between 30-100+ acres were mapped in Yavatmal. These reservoirs store water, mainly across dams to meet the water demand for irrigation and domestic uses. It is satisfying to observe that 34 out of the total of 44 reservoirs, corresponding to 77.3% of the structures have been suitable constructed in discharge zones while none of them show any encroachment or damaged.

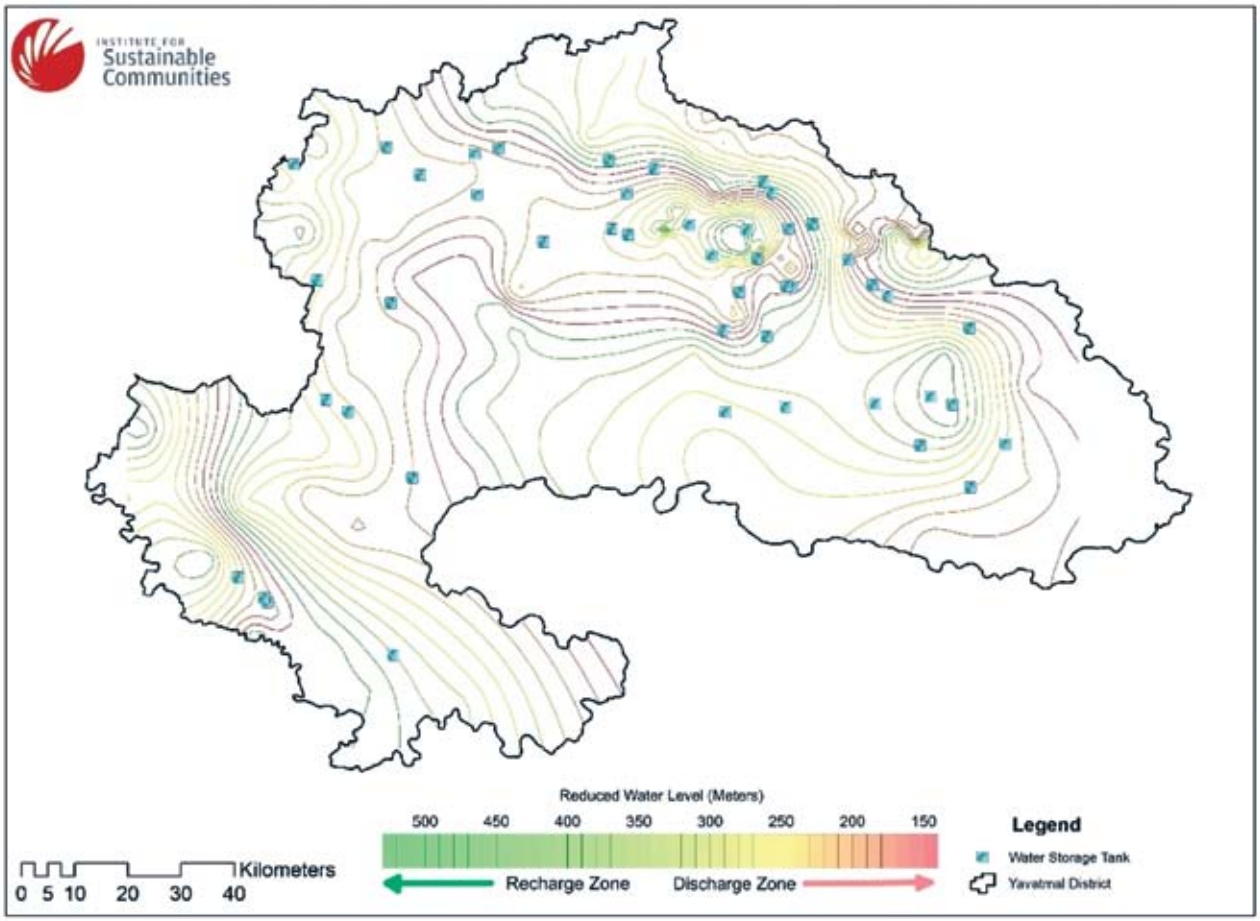

Figure 11: Status of water storage tanks in Yavatmal

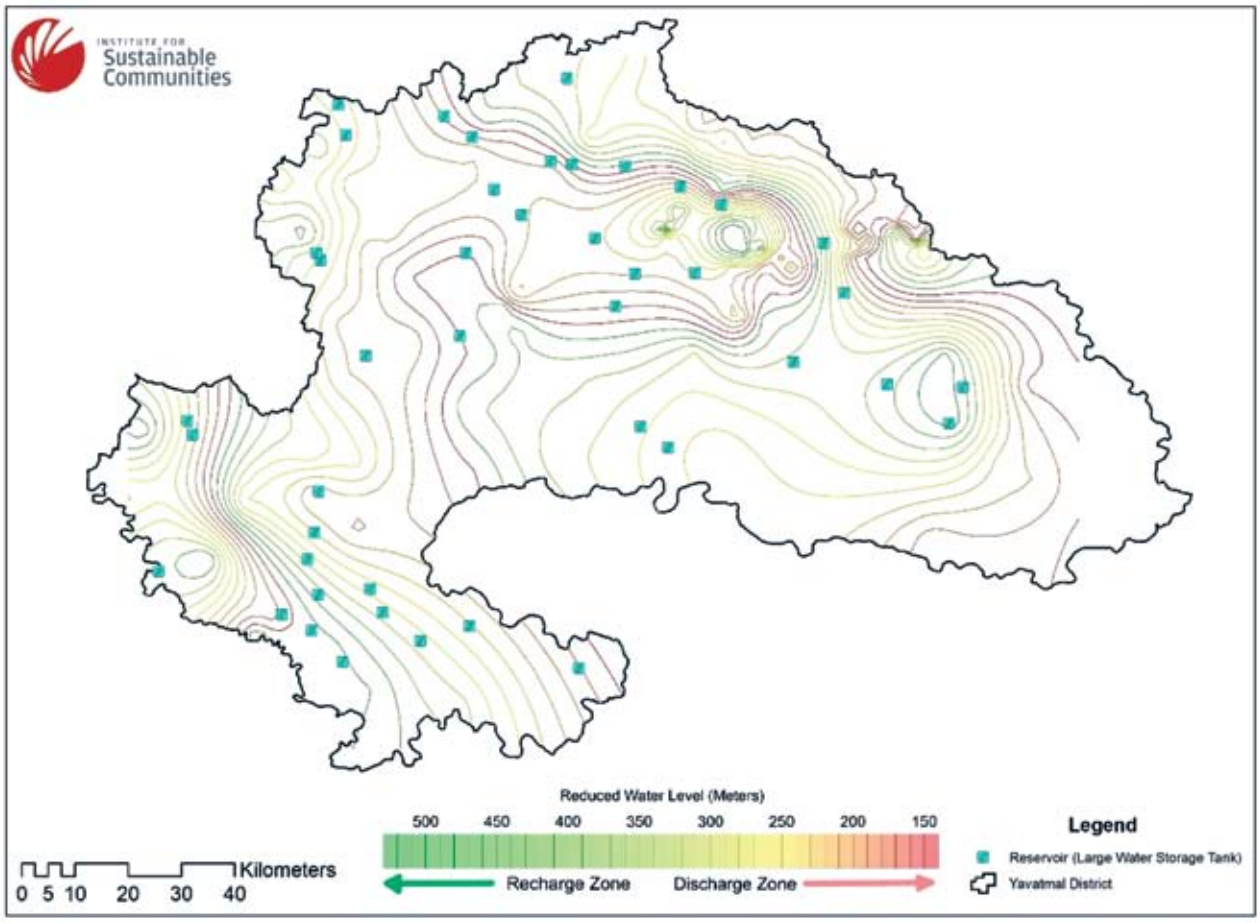

Figure 12: Status of water reservoirs in Yavatmal

4 SYNTHESIS

Yavatmal is a major agricultural district of Maharashtra. Meeting the water needs and future demands will be critical in the times to come. In 2018, data from the Central Ground Water Board, Nagpur indicated that Yavatmal is one of the districts in Maharashtra where the rate of groundwater decline has been around 4 metres. Given this scenario it is important that water conservation and recharge measures in the district are undertaken based on the aquifer characteristics.

Findings of the current research by ISC indicate that more than 40% of the check dams have been constructed in discharge areas. Given the main role of constructing check dams is to enhance groundwater recharge one would argue for having these check dams constructed in recharge areas.

It is important to note that more than 35% of the check dams and 32% of the percolation tanks are either damaged or have been encroached. Communities have pointed towards the poor operation and maintenance of the structures as a major reason for the current state.

It is therefore recommended that a comprehensive plan for repair, renovation and reconstruction of the water harvesting and recharge structures are carried out in the district to ensure long term availability and sustainability of water resources.

This should include a plan to ensure their maintenance involving the engagement of the Gram Panchayat and the village communities. A list of damaged and encroached check dams, percolation tanks and ponds/ farm ponds have been indicated in Annexure 1. Emphasis should be given to repair/renovate the check dams and percolation tanks lying in the recharge areas and the ponds in the discharge areas for ensuring long term water security for Yavatmal district. Community participation and creating mechanism for effective operation and maintenance will be key for the proper up-keep of the structure in the times to come.

5 REFERENCES

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Annexure 1

Details of damaged/encroached water harvesting and storage structures

Block	Location of Encroached/ Damaged Percolation Tank in Recharge Zone	Location of Encroached/ Damaged Ponds/Farm Ponds in Discharge Zone	Location of Encroached/ Damaged Check dams in Recharge Zone
Yavatmal	8 nos.	2 nos.	8 nos.
	20.14N, 78.14E	20.25N, 78.05E	20.22N, 78.29E
	20.16N, 78.18E	20.28N, 78.25E	20.29N, 78.24E
	20.18N, 78.29E		20.31N, 78.23E
	20.20N, 78.20E		20.33N, 78.17E
	20.29N, 78.11E		20.38N, 78.07E
	20.31N, 78.09E		20.39N, 78.05E
	20.33N, 78.06E		20.45N, 78.08E
	20.43N, 78.09E		20.40N, 78.16E
	20.47N, 78.10E		20.28N, 78.14E
Wani	1 no.	1 no.	3 nos.
	19.96N, 78.85E	20.01N, 78.97E	19.99N, 79.08E
			19.95N, 78.98E
			20.03N, 78.89E
Umarkhed	2 nos.	4 nos.	7 nos.
	19.58N, 77.79E	19.57N, 77.99E	19.60N, 77.79E
	19.75N, 77.57E	19.61N, 77.91E	19.66N, 77.71E
		19.57N, 77.71E	19.68N, 77.64E
		19.61N, 77.67E	19.67N, 77.57E
			19.74N, 77.54E
			19.73N, 77.56E
			19.70N, 77.58E
Ralegaon	7 nos.	7 nos.	4 nos.
	20.16N, 78.58E	20.35N, 78.45E	20.37N, 78.47E
	20.17N, 78.62E	20.26N, 78.74E	20.22N, 78.58E
	20.18N, 78.66E	20.17N, 78.70E	20.30N, 78.64E
	20.26N, 78.64E	20.20N, 78.54E	20.27N, 78.65E
	20.31N, 78.55E	20.25N, 78.57E	
	20.33N, 78.50E	20.28N, 78.62E	
	20.30N, 78.63E	20.26N, 78.74E	

Pusad	11 nos.	3 nos.	5 nos.
	19.79N, 77.48E	19.87N, 77.36E	19.80N, 77.57E
	19.82N, 77.47E	19.95N, 77.51E	19.82N, 77.51E
	19.85N, 77.49E	19.99N, 77.55E	19.85N, 77.50E
	19.85N, 77.42E		19.83N, 77.43E
	19.83N, 77.48E		19.93N, 77.43E
	19.86N, 77.48E		
	19.94N, 77.41E		
	19.94N, 77.39E		
	20.06N, 77.39E		
	20.06N, 77.40E		
	20.01N, 77.42E		
Pandharkawada	4 nos.	4 nos.	6 nos.
	20.04N, 78.50E	19.97N, 78.56E	19.99N, 78.56E
	20.07N, 78.52E	20.03N, 78.46E	20.02N, 78.51E
	20.10N, 78.63E	20.09N, 78.58E	20.07N, 78.55E
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			20.20N, 78.44E
			20.10N, 78.62E
Ner	5 nos.	3 nos.	4 nos.
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	20.45N, 77.88E	20.39N, 77.88E	20.33N, 78.04E
	20.36N, 77.95E	20.49N, 77.82E	20.39N, 78.00E
	20.33N, 77.98E		20.43N, 77.86E
	20.21N, 77.87E		
Maregaon	5 nos.	1 no.	6 nos.
	20.20N, 78.78E	19.98N, 78.75E	19.90N, 78.76E
	20.13N, 78.70E		19.98N, 78.74E
	20.23N, 78.78E		20.05N, 78.80E
	20.15N, 78.72E		19.97N, 78.61E
	20.15N, 78.73E		20.08N, 78.66E
			20.11N, 78.68E

Mahagaon	3 nos.	5 nos.	7 nos.
	19.73N, 77.62E	19.74N, 77.65E	19.71N, 77.80E
	19.66N, 77.76E	19.74N, 77.58E	19.91N, 77.87E
	19.64N, 77.75E	19.80N, 77.64E	19.95N, 77.83E
		19.96N, 77.71E	19.96N, 77.65E
		19.86N, 77.78E	19.99N, 77.66E
			19.95N, 77.67E
			19.76N, 77.78E
Kalamb	3 nos.	7 nos.	8 nos.
	20.45N, 78.29E	20.48N, 78.48E	20.36N, 78.32E
	20.32N, 78.32E	20.29N, 78.34E	20.40N, 78.36E
	20.27N, 78.39E	20.31N, 78.26E	20.41N, 78.31E
		20.33N, 78.27E	20.32N, 78.30E
		20.49N, 78.45E	20.30N, 78.29E
		20.51N, 78.28E	20.27N, 78.43E
		20.47N, 78.21E	20.32N, 78.49E
			20.36N, 78.26E
Ghatanji	5 nos.	4 nos.	4 nos.
	20.11N, 78.13E	20.04E, 78.07E	20.17N, 78.37E
	20.14N, 78.26E	20.05N, 78.19E	20.11N, 78.42E
	20.15N, 78.41E	20.08N, 78.27E	20.07N, 78.38E
	20.05N, 78.40E	20.05N, 78.41E	20.10N, 78.34E
	20.13N, 78.35E		
Digras	4 nos.	7 nos.	2 nos.
	20.17N, 77.81E	20.11N, 77.69E	20.18N, 77.73E
	20.13N, 77.68E	20.06N, 77.85E	20.02N, 77.65E
	20.22N, 77.75E	20.10N, 77.96E	
	20.12N, 77.94E	20.12N, 78.05E	
		20.14N, 78.09E	
		20.01N, 78.02E	
		19.99N, 77.91E	

Darwha	4	4	3
	20.22N, 77.74E	20.38N, 77.66E	20.30N, 77.72E
	20.32N, 77.78E	20.32N, 77.70E	20.35N, 77.73E
	20.37N, 77.80E	20.27N, 77.86E	20.36N, 77.75E
	20.38N, 77.71E	20.22N, 77.78E	
Babulgaon	5	5	6
	20.51N, 78.20E	20.56N, 78.19E	20.51N, 78.07E
	20.50N, 78.16E	20.58N, 78.17E	20.54N, 78.01E
	20.48N, 78.09E	20.64N, 78.21E	20.53N, 78.16E
	20.59N, 78.00E	20.65N, 78.13E	20.55N, 78.21E
	20.63N, 78.16E	20.67N, 78.20E	20.65N, 78.20E
			20.60N, 78.19E

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