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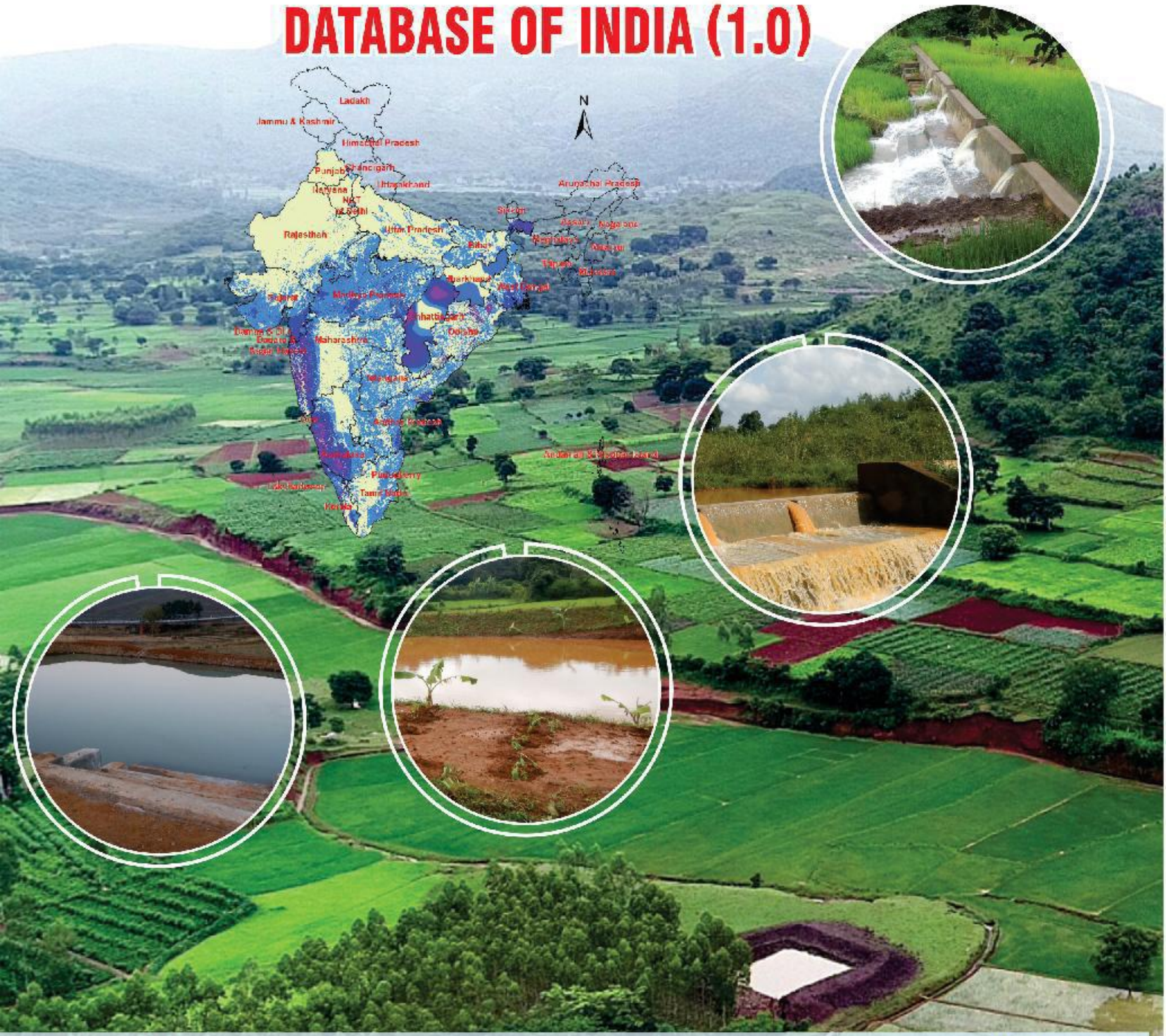
RAINWATER HARVESTING POTENTIAL DATABASE OF INDIA (1.0)



ICAR-INDIAN INSTITUTE OF SOIL AND WATER CONSERVATION (IISWC)
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RAINWATER HARVESTING POTENTIAL DATABASE OF INDIA (1.0)

P.R. Ojasvi, N.G. Patil, S.S. Shrimali, B.S. Naik, Saswat Kumar Kar, K.K. Sharma
S. Manivannan, V. Kasturi Thilagam, D.C. Sahoo, Ch. Jyotiprava Dash, A.K. Singh
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FOREWORD

त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
Trilochan Mohapatra, Ph.D.
SECRETARY & DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001
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Rainfed areas account for 48.7% of the net sown area and 34.1% of the gross cropped area. As the widespread irrigation is not possible in rainfed areas, opportunities do exist for small-scale and supplemental irrigation through use of fresh rainwater. Further, our monsoon climate has wide variation in rainwater availability across the regions. Diverse agro-ecological situations present in the country demand for various strategies to manage the surface and ground water resource. Unregulated exploitation of these precious resources is leading to reduced surface water bodies, declining ground water levels, drying of springs and aquifers. Therefore, scientific management of available water resource is essential, which would assess the rainwater harvesting potential at different spatial scale so that appropriate techniques may be employed to boost development of rainfed areas.

I congratulate the researchers at ICAR-IISWC, Dehradun for their endeavor in releasing state wise rainwater harvesting potential database in the form of bulletin. This database will definitely strengthen various aspects of surface and ground water management efforts by different government and non-government agencies.

Dated the 31st March, 2022
New Delhi

(T. Mohapatra)

MESSAGE

डॉ सुरेश कुमार चौधरी
उपमहानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Dr Suresh Kumar Chaudhari
Deputy Director General
(Natural Resources Management)

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Water resource development and management is a key area which needs focused attention due to increased population and rapid country's water resource. However, with the growing scarcity water, the share of water for farming is decreasing day by day. Therefore constructive efforts are needed to harvest surplus rainwater for its proper utilization and management. Distributed water harvesting provides the opportunities for equitable development as it provides distributed storage and ease of access.

Planning and design of rainwater harvesting system require accurate assessment of runoff potential at different spatial and temporal scale. The present publication will provide a handy ready reckoner for rainwater harvesting resource assessment at macro and micro scale.

I am glad to know that ICAR-IISWC, Dehradun has prepared a geo-spatial database on rainwater harvesting potential of our country. This database is being published in the form of a technical bulletin. I appreciate the efforts put by the team of scientist of ICAR-IISWC, Dehradun who have endeavored to present the data for functional use at field level.

25th March, 2022
New Delhi

(S. K. Chaudhari)

PREFACE

Challenging task of producing 377 M tons of food grain by 2050 to meet food demand of the country's growing population from limited non-renewable natural resources emphasis judicious use of all the resources. Demand for water is increasing, with agriculture being the major consumer and consequently, share of agriculture sector in the total water use may reduce from 78% to 65-68% in 2050 due to competing demands from other sectors. By 2050, about 22% of the total geographic area and 17% of the population will face water scarcity as per the estimate. Water scarcity is the outcome of the ever growing population, which results into higher demand for water in agriculture, industrial and domestic sectors.

Groundwater, which is the major source of irrigation at present, is rapidly declining by about 1 m annually in the rice-wheat areas due to over–exploitation. The percentage of over exploited blocks where ground water extraction exceeded ground water recharge is increasing at rapid rate. Therefore, goals of enhanced food production and agricultural growth will have to be accomplished from declining availability of water, thus necessitating its efficient and optimal utilization.

Rainfed areas account for 49% of India's net cultivated land. In the present scenario, even after the realization of India's full irrigation potential, around 40% of net cultivable area of 142 million ha will still remain rainfed. In the light of the limited scope of increasing production from the irrigated sector, transforming rainfed farming into more sustainable and productive system through efficient use of natural resources provides the only viable alternative to the problem. However, rainfed area offer great potential for agricultural growth. The challenge before the Indian agriculture, therefore, is to transform rainfed farming into more sustainable and productive systems through efficient use of natural resources.

The potential harvestable rainwater in the form of overland runoff in 15 states of the country is 112048 MCM (11.2 M ha-m). Water available for protective irrigation is estimated at 33614 MCM which can support the rainfed area for irrigation to the tune of 22.41 M ha with two supplementary irrigations. A total of about 78434 MCM is available for groundwater recharge. This data has been developed as GIS database so as to facilitate data-driven, location-specific planning of rainwater management.

We appreciate the support and services of all the scientist, technical and administrative staff in bringing out this bulletin which will immensely helps to the administrator, policy makers, and other stakeholders' who are working on water resources particularly rainwater management.

(Authors)

ACKNOWLEDGEMENTS

The development of this database and present bulletin is culmination of the geo-spatial analytical study carried out for assessing the rainwater harvesting potential (RWH) across 15 states of India under Consortia Research Platform – Water project funded by ICAR, New Delhi. We express our deep sense of gratitude to Dr A.K. Sikka erstwhile Deputy Director General (NRM), ICAR for his keen interest and guidance for the initiation of CRP-Water project and identifying key issues in the rainwater management sector of our country. Dr S.K. Ambast erstwhile Director, IIWM had provided all-round support for the execution of the project and his suggestions are thankfully acknowledged. We would also like to acknowledge the support of all the Directors of partner Institutions and their scientists for their constant support and academic contribution during the period of this study. Help rendered by the staff of ICAR-IISWC while preparation of this document is also acknowledged.

(Authors)

1.0 INTRODUCTION

Out of 4000 BCM of rainfall in our country, the estimated available river flow water is 1869 BCM, and a typical water balance would reveal that our drainage systems carry approximately 40% of the received rainfall. Remaining 60% is attributed to evapotranspiration and natural ground water recharge, latter component being very meagre. The concept and perspective of looking into salvaging the apparently lost ~60% of the total water resources as runoff-soil storage and majorly to evaporation (in the absence of any productive vegetative growth) is the core objective of rainwater harvesting technology. Hence, to tap the difference between the precipitation received and the present utilization, measures are to be taken to maximize the use of precipitation. This can be achieved through well planned water conservation schemes for managing unused rainwater with focus on water storage (*ex-situ* and *in-situ*) for deferred use and enhanced groundwater recharge while controlling runoff, siltation of water bodies and evaporation.

In this context, the water harvesting has been duly emphasized in the National Water Policy as well as in the National Agriculture Policy of Government of India. Therefore, rainwater harvesting and its management has become imperative in both rural as well as urban areas. It has been demonstrated in various programmes of IISWC, Dehradun that participatory water resource development increases crop yields, groundwater recharge, employment generation and improvement of socio-economic conditions of the local people.

However, large-scale adoption of water harvesting initiatives suffer from lack of hydrological data and insufficient attention during the planning stages to important social and economic considerations. Transfer of water harvesting technologies calls for stronger partnership among researchers, farmers and other development agencies through location-specific, data-driven development programmes. Therefore, this geo-database is developed based on the sound hydrological methodology and provide factual information on the harvestable water in different agro-ecological regions of the country.

2.0 METHODOLOGY

The part of rainfall that appears as overland flow on landscape is typically estimated as instantaneous rainfall excess and depends on the soil, vegetation or land cover, slope and rainfall intensity. A well-tested rainfall event-based model to compute the rainfall excess under the influence of soil and land cover conditions is the Curve Number Method (USDA-SCS,1985).The method uses an integration of land use and soil data to determine CN values of each grid cell.

The data on hydrologic soil group (HSG) was developed by ICAR-NBSS & LUP, Nagpur. The global land use/land cover data (Chen *et. al.*, 2014) was further verified for accuracy from local available resources and corrected wherever large discrepancies were found. The gridded rainfall data of India (IMD, 2005) was analysed and different time series of input rainfall were used in the model. Finally, the runoff grid data was developed by summing the model output on an annual time scale in each grid cell. Therefore, the data that is presented here is for average annual rainfall condition. The harvestable runoff potential was taken as 60% of the total rainfall excess so computed.

This value is adopted for brevity and uniformity and keeping in view the overall water balance of the country. The process is depicted in Fig. 2.1.

Main Features of the Database

1. High resolution (30 m) GIS database based on the following available country-wide data for India
   - (i) Gridded daily rainfall data (1951-2007) (IMD, Pune (Rajeevan *et. al.*, 2005)
   - (ii) Landuse / landcover data (Global land cover (Chen *et. al.*, 2014)
   - (iii) Aster DEM data for India (U.S./Japan ASTER Science Team (NASA, 2019)
   - (iv) Hydrologic soil group data (ICAR- NBSS & LUP)
   - (v) Analyzed design rainfall data (ICAR-IISWC)

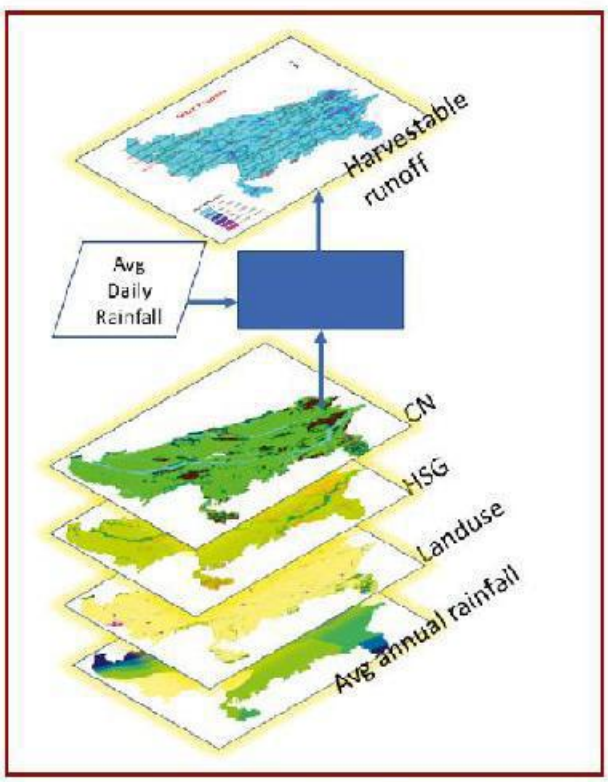


Fig. 2.1: Spatial and non-spatial data for the implementation of CN method

2. Database is updatable with any change in above mentioned input data.
3. The existing water bodies and urban/built-up areas are excluded so as to provide factual harvestable rainwater potential for agricultural use and ground water recharge.
4. Specific use of database is for planning and designing of location-specific water harvesting structures with no need for entangling to cumbersome hydrologic estimation methods.
5. This is also an endeavour to account for and include harvestable rainwater resources in the mainstream policy as this will be imperative under the climate change scenario.

3.0 COUNTRY WATER RESOURCES AND AGRICULTURAL AT A GLANCE

Photo 3.1: Check dam at Raipalli-2 micro watershed in Bidar District of Karnataka

Photo 3.2: Farm Pond at Navagam Vanta, Khambhat, Gujarat

Photo 3.3: Farm Pond in Koraput District of Odisha

Photo 3.4: Check dam in Maharashtra state

Photo 3.5: Oorani System for Rainwater harvesting for Drinking purpose in Tamil Nadu

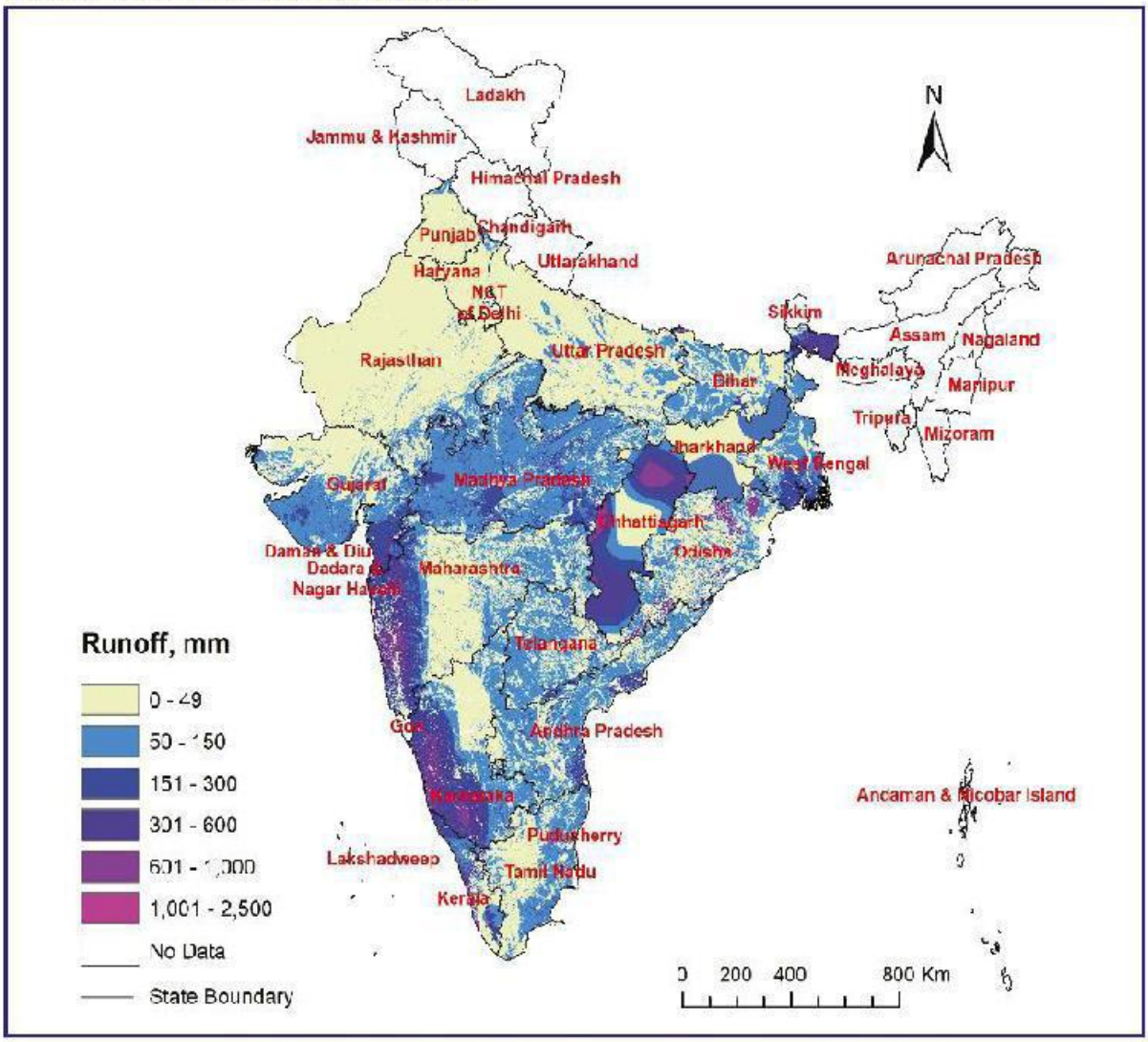
Photo 3.6: Lift irrigation system in Dahod, Gujarat

3.1 Country Profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	328.73		DES (2019)
1.2	District		No	742		LGD (2022)
1.3	Gram panchayat		No	255275		
1.4	Villages		No	662294		
1.5	Total population		M	1210.9		
1.5.1	Male	Female	M	623.3	587.6	
1.6	Livestock population		M	535.79		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	72.81 (21.91% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	27.34		
2.3	Barren & unculturable land		Mha	17.17		
2.4	Permanent pastures & grazing lands		Mha	10.38		
2.5	Culturable wasteland		Mha	12.22		
2.6	Land under misc. tree crops		Mha	3.15		
2.7	Fallow land other than current		Mha	11.63		
2.8	Current fallow		Mha	14.53		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Crore	3587966		DES (2020)
3.2	Total operational holdings		'000'	146454		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)	Large (10.0 ha and >)	
	100251	25309	13993	5561	838	
3.3	Net sown area (NSA)		Mha	139.35		DES (2019)
3.4	Gross cropped area		Mha	197.32		
3.5	Cropping intensity		%	141.60		
3.6	Rainfed area		Mha	67.80 (48.7% of NSA)		
3.7	Horticultural crops		Mha	26.22		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	71.55		DES (2019)
4.2	Gross irrigated area		Mha	102.57		
4.2.1	Canal	Tanks	Tube-wells	Other wells	Other sources	
	16.43	1.67	34.71	11.04	7.71	
4.3	Intensity of irrigation		%	143.48		
4.4	Annual extractable groundwater		BCM	392.70		CGWB, 2019-20
4.4.1	Irrigation use (BCM)			Industry use (BCM)	Domestic use (BCM)	
	221.4			2.38	24.87	
4.5	Stage of groundwater extraction		%	63.33		CGWB (2020)
4.6	Area under micro-irrigation		Mha	12.53 (17.5% of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	6881		CGWB (2020)
4.7.1	Safe 4310 (63%)	Semi-critical 972 (14%)	Critical 313 (5%)	Over-exploited 1189 (17%)	Saline 100 (1%)	
4.8	Annual rainfall (Range)		mm	1177 (308-3510)		DES (2020)
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[a] (Mha)			Treated area (Mha)	To be treated area (Mha)	
	210.27			11.84	109.42	

[a] Area to be treated with watersheds

3.2 Rainwater Harvesting Potential



Map 3.1: Rainwater harvesting potential of India (15 states)

Table 3.1: Total harvestable runoff, available for irrigation and ground water recharge for 15 states of India

S. N.	Particular	Unit	Data
1	Total harvestable runoff	MCM	112048
2	Total harvestable runoff	M ha-m	11.2
3	Available water for protective irrigation	MCM	33614
4	Area that can be irrigated with two irrigation	M ha	22.41
5	Available water for ground water recharge	MCM	78434

4.0 STATE WISE RAINWATER HARVESTING DATA BASE

4.1 Northen States

4.1.1	Uttar Pradesh
4.1.2	Punjab
4.1.3	Haryana
4.1.4	Madhya Pradesh

Photo 4.1: Flowing overflow water above weir crest at Sahijana, Lucknow, Uttar Pradesh

Photo 4.2: A dugout pond for runoff harvesting, Punjab

Photo 4.3: Dugout pond for field level water harvesting, Haryana

Photo 4.4: A rainwater harvesting tank in district Panna, Madhya Pradesh

Photo 4.5: Straight drop spillway with Earthen embakement at Ranjeetpur block, Yamuna Nagar, Haryana

Photo 4.6: Earthen check dam, Sukhomajri, Panchkula, Punjab

Photo 4.7: Straight drop spillway, Punjab

Photo 4.8: A stop dam at Akoda Nadi, Khairoda, district Guna, Madhya Pradesh

Photo 4.9: Straight drop spillway, Uttar Pradesh

Photo 4.10: Masonry storage tank, Uttar Pradesh

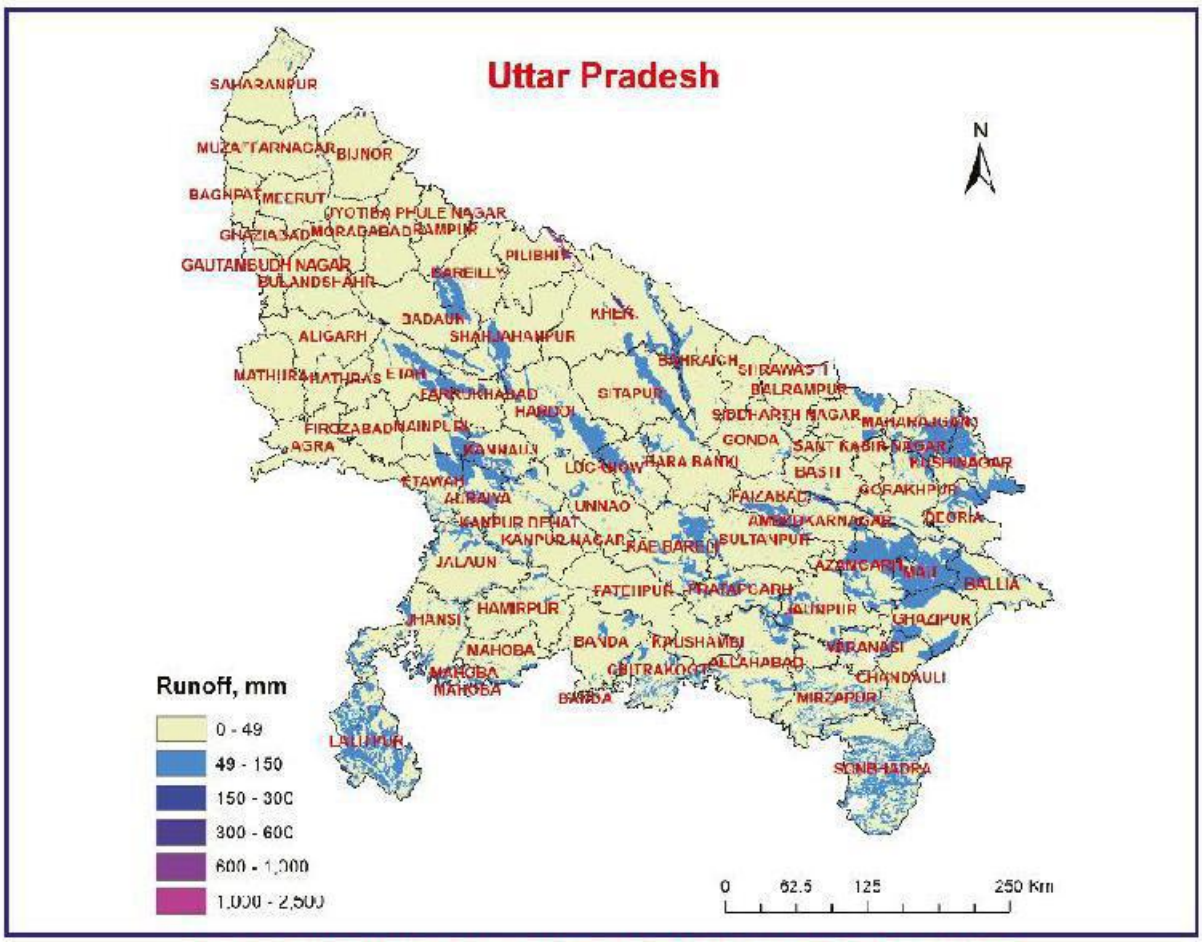
4.1.1 Uttar Pradesh

4.1.1.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	24.09		DES (2019)
1.2	District		No	75		GoUP (2021) DES (2020)
1.3	Gram panchayat		No	58073		
1.4	Villages		No	97941		
1.5	Total population		M	19.98		
1.5.1	Male	Female	M	10.44	9.53	
1.6	Livestock population		M	67.80		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	1.71 (7.1% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	3.17		
2.3	Barren & unculturable land		Mha	0.44		
2.4	Permanent pastures & grazing lands		Mha	0.07		
2.5	Culturable wasteland		Mha	0.39		
2.6	Land under misc. tree crops		Mha	0.27		
2.7	Fallow land other than current		Mha	0.59		
2.8	Current fallow		Mha	0.98		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	40193102		DES (2020)
3.2	Total operational holdings		'000'	23822		DES (220)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	19099	3008	1313	376		22
3.3	Net sown area (NSA)		Mha	16.53		DES (2019)
3.4	Gross cropped area		Mha	26.85		
3.5	Cropping intensity		%	162.4		
3.6	Rainfed area		Mha	2.15 (13.0% of NSA)		
3.7	Horticultural crops		Mha	2.4		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	14.39		DES (2019)
4.2	Gross irrigated area		Mha	21.68		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	2.18	0.08	10.74	1.27		0.12
4.3	Intensity of irrigation		%	150.64		
4.4	Annual extractable groundwater		BCM	65.32		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	48.59			0		4.95
4.5	Stage of groundwater extraction		%	70.18		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.21(1.45% of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	830		CGWB (2020)
4.7.1	Safe 540 (65%)	Semi-critical 151 (18%)	Critical 48 (6%)	Over-exploited 91 (11%)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	998 (792-1188)		Rathecha, 2016
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	19.19			14.18		5.0

[#]Area to be treated with watersheds

4.1.1.2 Rainwater harvesting potential



Map 4.1: Rainwater harvesting potential of Uttar Pradesh state

Table 4.1: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Uttar Pradesh

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
502-652	3.13	238.80	0.02
652-762	7.37	966.88	0.10
762-872	6.17	964.80	0.10
872-996	4.37	837.25	0.08
996-1353	2.22	587.23	0.06
Total		**3594.96**	**0.36**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		1078	
Area that can be irrigated with two irrigation (M ha)		0.72	
Available water for ground water recharge (MCM)		2516	

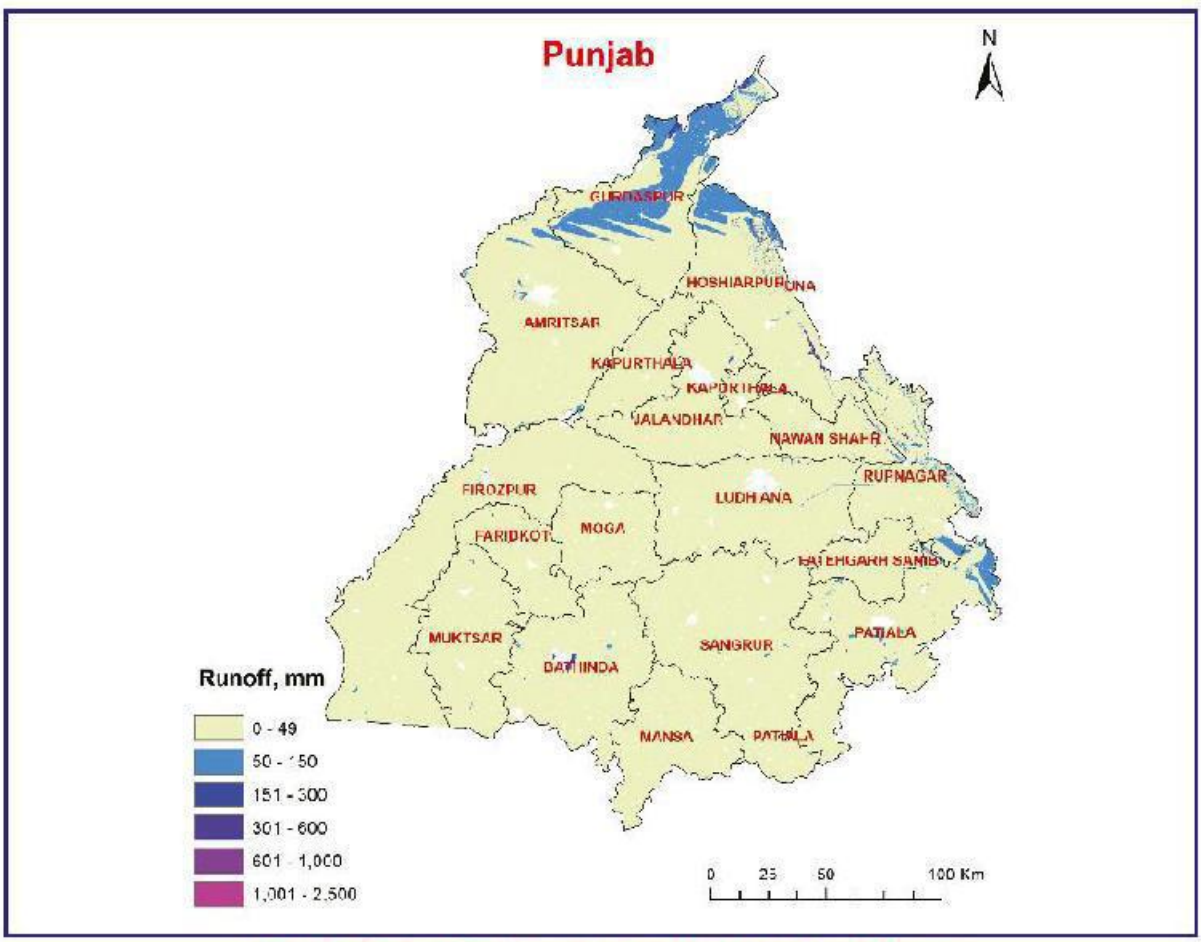
4.1.2 Punjab

4.1.2.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	5.04		DES (2019)
1.2	District		No	23		LGD, 2022
1.3	Gram panchayat		No	13241		
1.4	Villages		No	12581		
1.5	Total population		M	27.74		DES (2020)
1.5.1	Male	Female	M	14.63	13.87	
1.6	Livestock population		M	6.99		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	0.25		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	0.51		
2.3	Barren & uncultivable land		Mha	0.841		
2.4	Permanent pastures & grazing lands		Mha	0.804		
2.5	Cultivable wasteland		Mha	0.812		
2.6	Land under misc. tree crops		Mha	0.011		
2.7	Fallow land other than current		Mha	0.806		
2.8	Current fallow		Mha	0.886		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	15174928		DES (2020)
3.2	Total operational holdings		'000'	1092		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	154	207	368	305		58
3.3	Net sown area (NSA)		Mha	4.12		DES (2019)
3.4	Gross cropped area		Mha	7.86		
3.5	Cropping intensity		%	190.6		
3.6	Rainfed area		Mha	0.086 (0.19% of NSA)		
3.7	Horticultural crops		Mha	0.41		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	4.11		DES (2019)
4.2	Gross irrigated area		Mha	7.74		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1167	0	2944	0		0
4.3	Intensity of irrigation		%	188		
4.4	Annual extractable groundwater		BCM	21.58		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	34.56			0.28		1.01
4.5	Stage of groundwater extraction		%	165.77		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.05 (1.22% of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	138		CGWB (2020)
4.7.1	Safe 22 (16%)	Semi-critical 5 (4%)	Critical 2 (1%)	Over-exploited 109 (79%)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	592 (581-1080)		Data.gov.in, 2022
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[@] (Mha)			Treated area (Mha)		To be treated area (Mha)
	0.78			0.48		0.29

[@]Area to be treated with watersheds

4.1.2.2 Rainwater harvesting potential



Map 4.2: Rainwater harvesting potential of Panjab state

Table 4.2: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Punjab

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
193-330	1.30	86.01	0.01
330-457	1.34	143.54	0.01
457-591	1.13	181.78	0.02
591-759	0.82	141.72	0.01
759-1169	0.21	58.42	0.01
Total		611.47	0.06
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	183		
Area that can be irrigated with two irrigation (M ha)	0.12		
Available water for ground water recharge (MCM)	428		

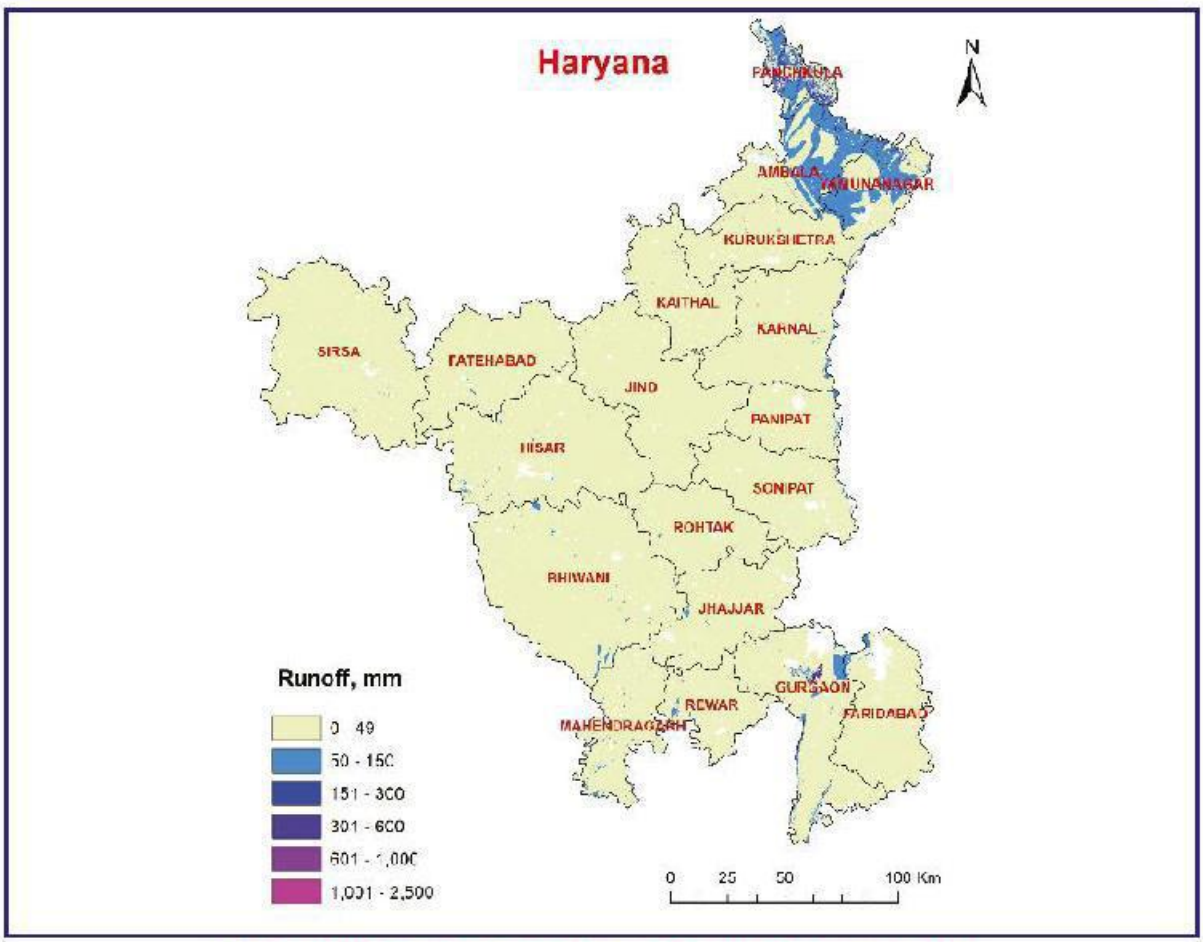
4.1.3 Haryana

4.1.3.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	4.42		DES (2019)
1.2	District		No	22		LGD (2022)
1.3	Gram panchayat		No	6225		
1.4	Villages		No	6841		
1.5	Total population		M	25.35		DES (2020)
1.5.1	Male	Female	M	13.49	11.85	
1.6	Livestock population		M	6.94		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	0.835 (8.8% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	0.156		
2.3	Barren & unculturable land		Mha	0.289		
2.4	Permanent pastures & grazing lands		Mha	0.074		
2.5	Culturable wasteland		Mha	0.854		
2.6	Land under misc. tree crops		Mha	0.021		
2.7	Fallow land other than current		Mha	0.035		
2.8	Current fallow		Mha	0.105		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	13831923		DES (2020)
3.2	Total operational holdings		'000'	1628		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	883	314	278	192		41
3.3	Net sown area (NSA)		Mha	3.6		DES (2019)
3.4	Gross cropped area		Mha	6.61		
3.5	Cropping intensity		%	183.4		
3.6	Rainfed area		Mha	0.33 (9.02% of NSA)		
3.7	Horticultural crops		Mha	0.47		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	3.27		DES (2019)
4.2	Gross Irrigated area		Mha	6.02		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1206.2	0	2956.4	0		0
4.3	Intensity of irrigation		%	183		
4.4	Annual extractable groundwater		BCM	9.13		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	11.53			0.34		0.63
4.5	Stage of groundwater extraction		%	136.91		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.63 (19.3% of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	128		CGWB (2020)
4.7.1	Safe 26 (20%)	Semi-critical 21 (16%)	Critical 3 (2%)	Over-exploited 78 (61%)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	528 (501-1080)		Data.gov.in, 2022
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area* (Mha)			Treated area (Mha)		To be treated area (Mha)
	2.00			1.30		0.70

*Area to be treated with watersheds

4.1.3.2 Rainwater harvesting potential



Map 4.3: Rainwater harvesting potential of Haryana state

Table 4.3: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Haryana

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
185-329	1.88	67.46	0.007
329-425	1.27	76.33	0.008
425-563	0.71	65.97	0.007
563-719	0.18	47.97	0.005
719-950	0.12	47.54	0.005
Total		**305.28**	**0.031**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		92	
Area that can be irrigated with two irrigation (M ha)		0.06	
Available water for ground water recharge (MCM)		214	

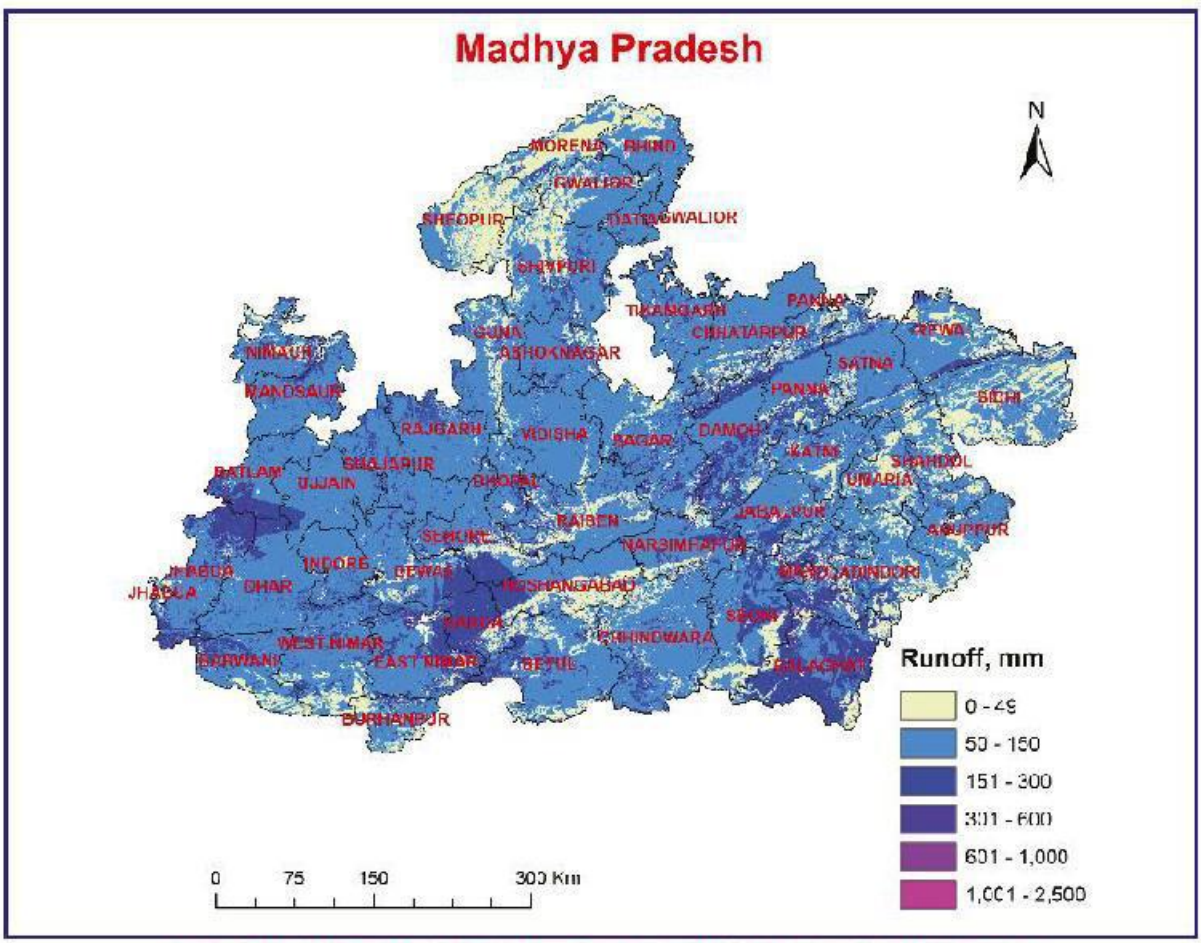
4.1.4 Madhya Pradesh

4.1.4.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	30.82		DRS (2019)
1.2	District		No	52		DES-GoMP (2019)
1.3	Gram panchayat		No	22961		
1.4	Villages		No	51527		
1.5	Total population		M	72.62		
1.5.1	Male	Female	M	37.61	35.01	
1.6	Livestock population		M	48.5		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	8.7 (28.22 % of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	2.26		
2.3	Barren & uncultivable land		Mha	1.35		
2.4	Permanent pastures & grazing lands		Mha	1.31		
2.5	Culturable wasteland		Mha	0.93		
2.6	Land under misc. tree crops		Mha	0.02		
2.7	Fallow land other than current		Mha	0.46		
2.8	Current fallow		Mha	0.49		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	37918858		DES (2020)
3.2	Total operational holdings		'000'	18003		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	4834	2724	1674	706		62
3.3	Net sown area (NSA)		Mha	15.20		DES (2019)
3.4	Gross cropped area		Mha	26.10		
3.5	Cropping intensity		%	171.71		
3.6	Rainfed area		Mha	3.85(25.3% of NSA)		
3.7	Horticultural crops		Mha	2.18		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	11.34		DES (2019)
4.2	Gross irrigated area		Mha	12.68		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1.91	0.35	4.3	3.4		1.37
4.3	Intensity of irrigation		%	111.81		
4.4	Annual extractable groundwater		BCM	34.47		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	17.43			0.22		1.24
4.5	Stage of groundwater extraction		%	54.76		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.57 (5.0 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	313		CGWB (2020)
4.7.1	Safe 218 (77 %)	Semi-critical 44 (14 %)	Critical 7 (3 %)	Over-exploited 22 (7 %)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	122 (976-1464)		Rakhecha, 2016
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	17.27			8.02		9.26

[#]Area to be treated with watersheds

4.1.4.2 Rainwater harvesting potential



Map 4.4: Rainwater harvesting potential of Madhya Pradesh state

Table 4.4: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Madhya Pradesh

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
507-713	5.3	2367.00	0.24
713-877	11.13	7285.11	0.73
877-1037	10.72	6936.94	0.69
1037-1235	2.06	1434.88	0.14
1235-1580	1.11	1100.45	0.11
Total		**19124.38**	**1.91**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		5737	
Area that can be irrigated with two irrigation (M ha)		3.82	
Available water for ground water recharge (MCM)		13387	

4.2 Western States

4.2.1	Gujarat
4.2.2	Maharashtra
4.2.3	Rajasthan

Photo 4.11: Check dam at Panchmahal, Gujarat

Photo 4.12: Earthen embakment with drop spillway, Gujarat

Photo 4.13: Gully plug in Maharastra state

Photo 4.14: Gabion structres for black soil in Maharashtra

Photo 4.15: Check dam with sluice gate for flow regualtion,Dahod, Gujarat

Photo 4.16: Farm pond at research farm Vasad, Gujarat

Photo 4.17: Embankment type farm pond with drop structure in Maharashtra

Photo 4.18: Gabion structures for black soil

Photo 4.19: Lift irrigation with check dam at Dahod, Gujarat

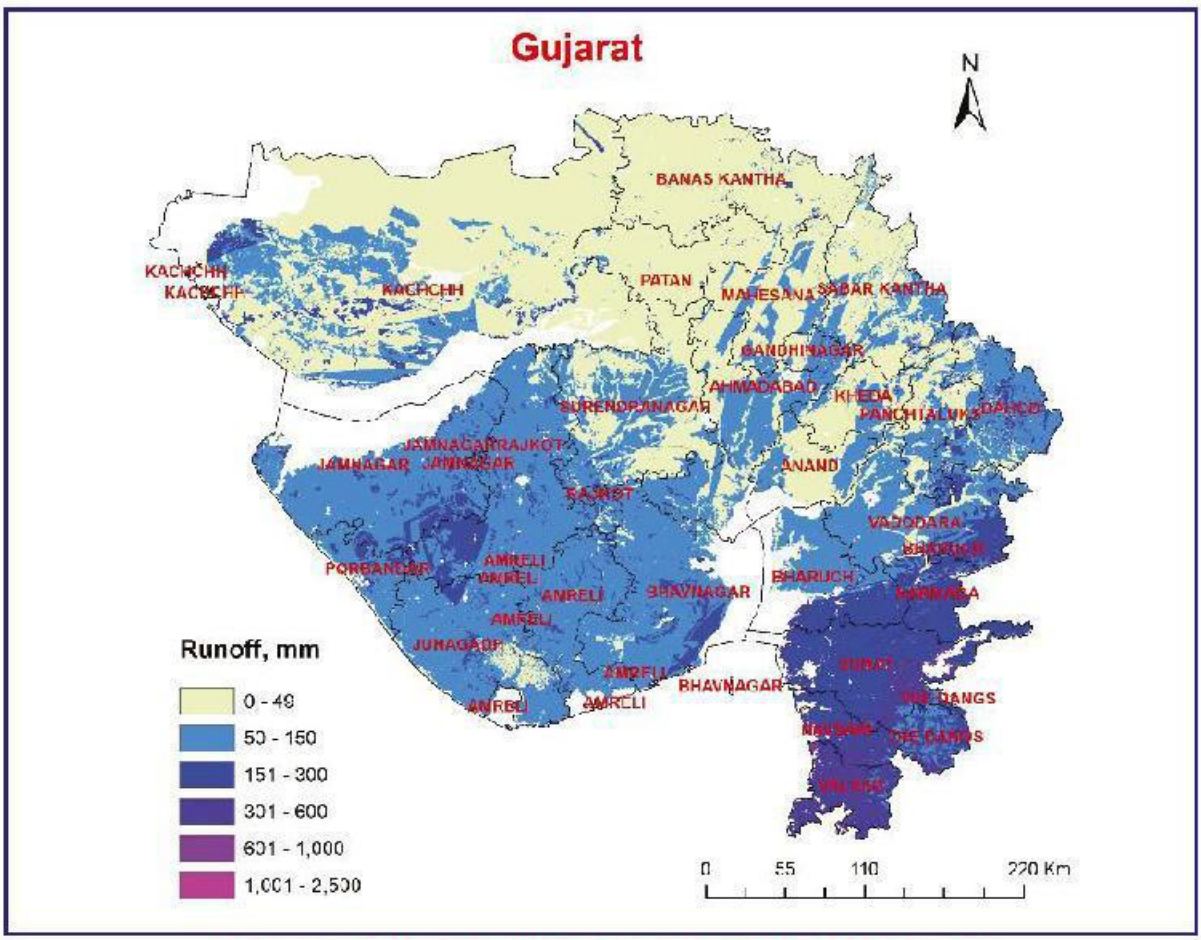
4.2.1 Gujarat

4.2.1.1 State profile

S. N.	Particular		Units	Value		Source
			1. Demographic Characteristics			
1.1	Geographical area (GA)		Mha	19.60		DES (2019)
1.2	District		No	33		LGD (2012)
1.3	Gram panchayat		No	14288		
1.4	Villages		No	18034		
1.5	Total population		M	60.43		DES (2020)
1.5.1	Male	Female	M	31.49	28.94	
1.6	Livestock population		M	26.9		DAHD (2018)
			2. Land Use Statistics			
2.1	Forest area		Mha	1.834 (9.35% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.171		
2.3	Barren & unculturable land		Mha	2.552		
2.4	Permanent pastures & grazing lands		Mha	0.851		
2.5	Culturable wasteland		Mha	1.360		
2.6	Land under misc. tree crops		Mha	0.804		
2.7	Fallow land other than current		Mha	0.816		
2.8	Current fallow		Mha	0.379		
			3. Agricultural Indicators			
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	14245958		DES (2020)
3.2	Total operational holdings		'000'	5321		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	2019	1616	1158	496		40
3.3	Net sown area (NSA)		Mha	10.382		DES (2019)
3.4	Gross cropped area		Mha	11.429		
3.5	Cropping intensity		%	110.9		
3.6	Rainfed area		Mha	6.87 (58.9 % of NSA)		
3.7	Horticultural crops		Mha	1.946		DES (2020)
			4. Water Resources			
4.1	Net irrigated area (NIA)		Mha	4.233		DES (2019)
4.2	Gross irrigated area		Mha	5.828		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	771	45	1122	2161		114
4.3	Intensity of irrigation		%	51		
4.4	Annual extractable groundwater		BCM	21.25		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	12.84			0.11		0.63
4.5	Stage of groundwater extraction		%	63.89		CGWB (2020)
4.6	Area under micro-irrigation		Mha	1.52 (35.90 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	248		CGWB (2020)
4.7.1	Safe 194 (78 %)	Semi-critical 11 (4 %)	Critical 5 (2 %)	Over-exploited 25 (10 %)		Saline 13 (5 %)
4.8	Annual rainfall (Range)		mm	540-961		DES (2020)
			5. Watershed Development (MoRD, DoLR, 2021)			
5.1	Treatable area[@] (Mha)			Treated area (Mha)		To be treated area (Mha)
	18.08			6.88		8.2

[@]Area to be treated with watersheds

4.2.1.2 Rainwater harvesting potential



Map 4.5: Rainwater harvesting potential of Gujarat state

Table 4.5: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Gujarat

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
268-450	5.52	1488.48	0.15
450-640	6.34	2418.22	0.24
640-1004	3.52	2486.68	0.25
1004-1550	0.78	1079.51	0.11
1550-2203	0.90	1601.83	0.16
Total		9074.72	0.91
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	2722		
Area that can be irrigated with two irrigation (M ha)	1.81		
Available water for ground water recharge (MCM)	6352		

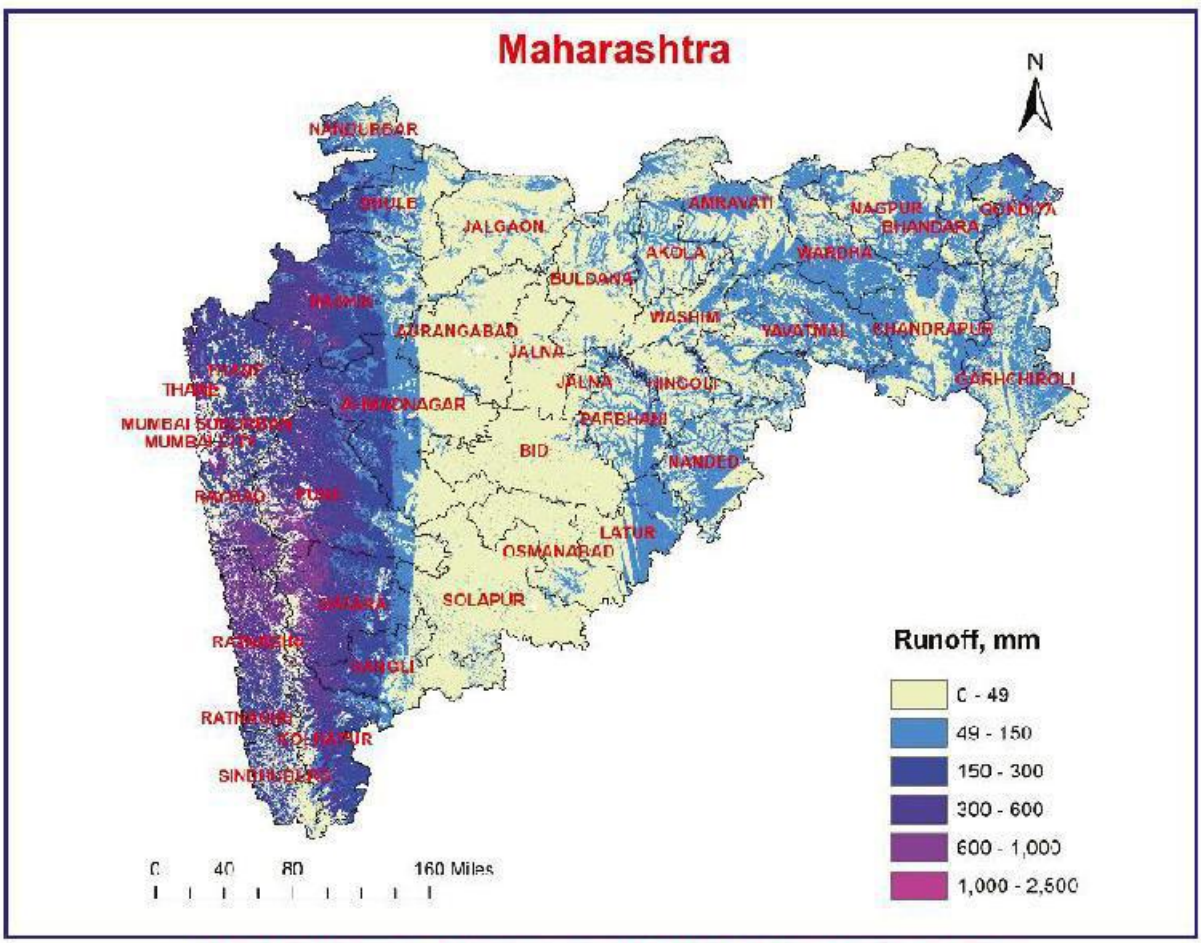
4.2.2 Maharashtra

4.2.2.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	30.77		DES (2019)
1.2	District		No	36		LGD (2012)
1.3	Gram panchayat		No	27899		
1.4	Villages		No	44528		
1.5	Total population		M	112.37		DES (2020)
1.5.1	Male	Female	M	31.4958.24	54.13	
1.6	Livestock population		M	33.8		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	5.17 (16.81 % of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.692		
2.3	Barren & uncultivable land		Mha	1.849		
2.4	Permanent pastures & grazing lands		Mha	1.323		
2.5	Culturable wasteland		Mha	0.524		
2.6	Land under misc. tree crops		Mha	0.272		
2.7	Fallow land other than current		Mha	1.260		
2.8	Current fallow		Mha	1.448		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	1822980		DES (2020)
3.2	Total operational holdings		'000'	15285		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	7816	4339	2327	734		70
3.3	Net sown area (NSA)		Mha	16.815		DES (2019)
3.4	Gross cropped area		Mha	19.139		
3.5	Cropping intensity		%	113.8		
3.6	Rainfed area		Mha	14.6 (86.9 % of NSA)		
3.7	Horticultural crops		Mha	8.947		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	3.145		DES (2019)
4.2	Gross irrigated area		Mha	4.515		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1047	-	2898	-		-
4.3	Intensity of irrigation		%	23.6		
4.4	Annual extractable groundwater		BCM	29.90		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	1510			0.803		1.22
4.5	Stage of groundwater extraction		%	54.62		CGWB (2020)
4.6	Area under micro-irrigation		Mha	1.88 (59.77 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	353		CGWB (2020)
4.7.1	Safe 271 (77 %)	Semi-critical 61 (17 %)	Critical 9 (3 %)	Over-exploited 11 (3 %)		Saline 1 (0 %)
4.8	Annual rainfall (Range)		mm	303-3052		DES (2020)
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	23.93			12.54		11.4

[#]Area to be treated with watersheds

4.2.2.2 Rainwater harvesting potential



Map 4.6: Rainwater harvesting potential of Maharashtra state

Table 4.6: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Maharashtra

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
406-740	11.01	2222.66	0.22
740-1320	11.16	4426.49	0.44
1320-2049	1.94	2636.23	0.26
2049-2765	3.34	5178.08	0.52
2765-3555	2.34	4435.80	0.44
Total		18899.25	1.89
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	5670		
Area that can be irrigated with two irrigation (M ha)	3.78		
Available water for ground water recharge (MCM)	13229		

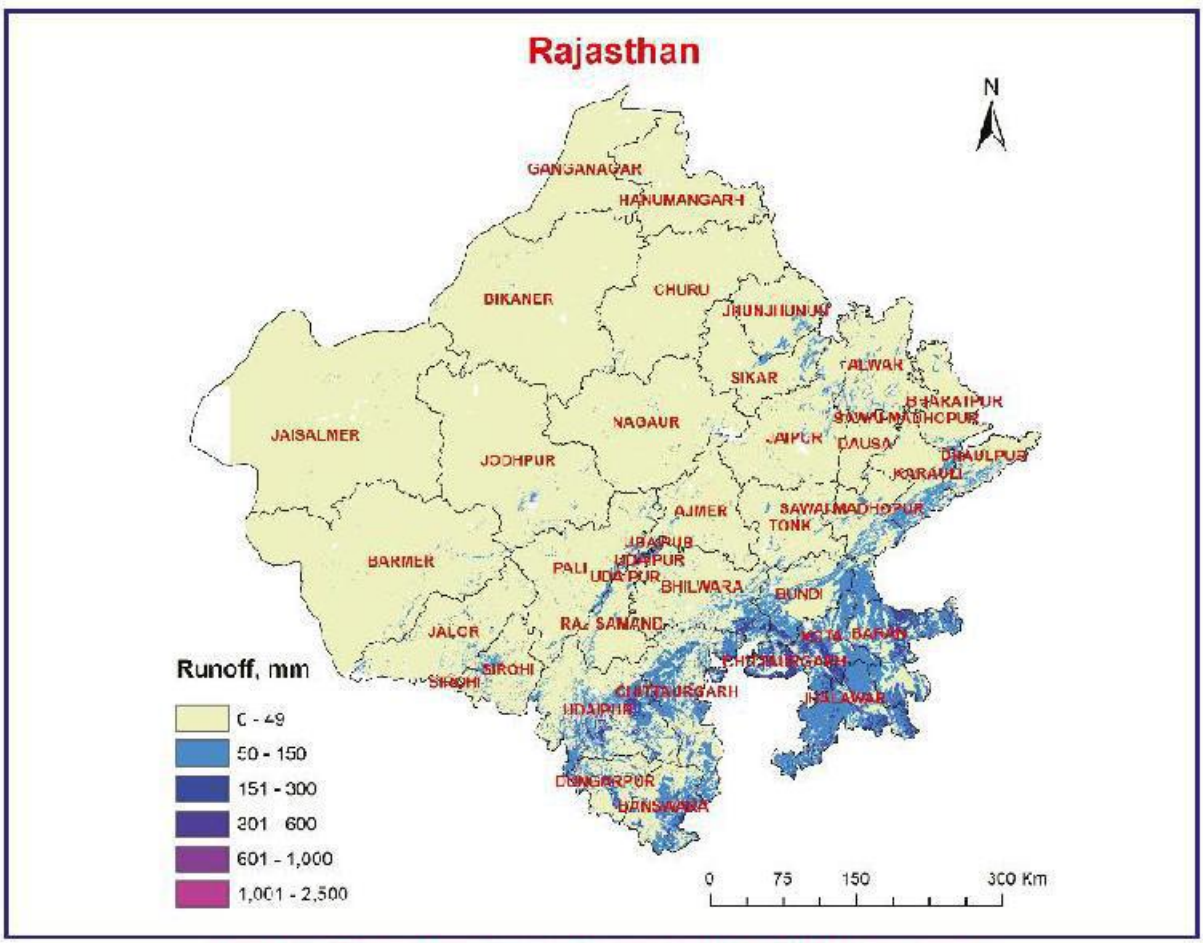
4.2.3 Rajasthan

4.2.3.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	34.22		DKS (2019)
1.2	District		No	33		DES-GoR (2020)
1.3	Gram panchayat		No	11341		
1.4	Villages		No	44672		
1.5	Total population		M	68.55		
1.5.1	Male	Female	M	35.55	33.00	
1.6	Livestock population		M	56.78		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	2.76 (% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.99		
2.3	Barren & unculturable land		Mha	2.38		
2.4	Permanent pastures & grazing lands		Mha	1.67		
2.5	Culturable wasteland		Mha	3.78		
2.6	Land under misc. tree crops		Mha	0.03		
2.7	Fallow land other than current		Mha	2.11		
2.8	Current fallow		Mha	1.79		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	26771824		DES (2020)
3.2	Total operational holdings		'000'	7685		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)	Large (10.0 ha and >)	
	3071	1677	1416	1131	359	
3.3	Net sown area (NSA)		Mha	17.78		DES (2019)
3.4	Gross cropped area		Mha	25.31		
3.5	Cropping intensity		%	142.4		
3.6	Rainfed area		Mha	9.50 (53.4 % of NSA)		
3.7	Horticultural crops		Mha	1.55		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	8.28		DES (2019)
4.2	Gross Irrigated area		Mha	11.02		
4.2.1	Canal	Tanks	Tube-wells	Other wells	Other sources	
	2.02	0.03	4.83	2.03	0.16	
4.3	Intensity of irrigation		%	133.1		
4.4	Annual extractable groundwater		BCM	11.99		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)	Domestic use (BCM)	
	14.85			-	1.92	
4.5	Stage of groundwater extraction		%	139.9		CGWB (2020)
4.6	Area under micro-irrigation		Mha	1.95 (23.6 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	295		CGWB (2020)
4.7.1	Safe 45 (15 %)	Semi-critical 29 (10 %)	Critical 33 (11 %)	Over-exploited 185 (63 %)	Saline 3 (1 %)	
4.8	Annual rainfall (Range)		mm	575 (185-950)		DES-GoR (2020)
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area* (Mha)			Treated area (Mha)	To be treated area (Mha)	
	24.55			12.45	12.10	

*Area to be treated with watersheds

4.2.3.2 Rainwater harvesting potential



Map 4.7: Rainwater harvesting potential of Rajasthan state

Table 4.7: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Rajasthan

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
129-229	10.02	359.00	0.04
229-363	7.79	193.32	0.02
363-509	7.10	537.61	0.05
509-666	4.66	863.59	0.09
666-857	3.60	1504.40	0.15
Total		**3457.92**	**0.35**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		1037	
Area that can be irrigated with two irrigation (M ha)		0.69	
Available water for ground water recharge (MCM)		2421	

4.3 Eastern States

4.3.1	Bihar
4.3.2	Odisha
4.3.3	West Bengal

Photo 4.20: Water harvesting pond -dugout in Nawada District of Bihar

Photo 4.21: Farm pond in Koraput District of Odisha

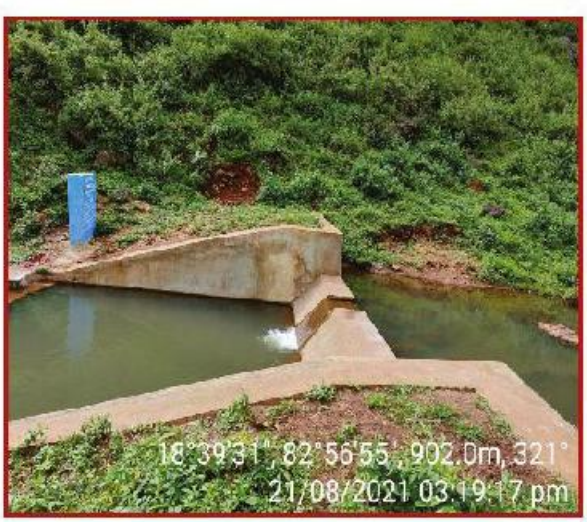


Photo 4.22: Check dam in Southern Odisha

Photo 4.23: Embankment type pond in Bihar

Photo 4.24: Farm pond in Bihar

Photo 4.25: Check dam in Southern part of Odisha

Photo 4.26: Farm pond at village Kusuma, Udawantanagar, Bhojpur, Bihar

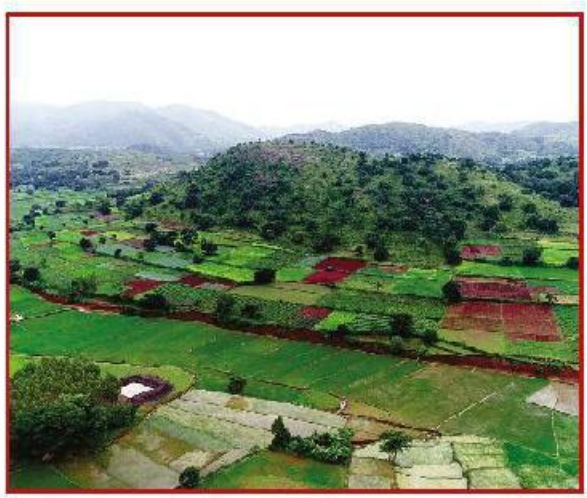


Photo 4.27: Stepped farm pond in Koraput District of Odisha

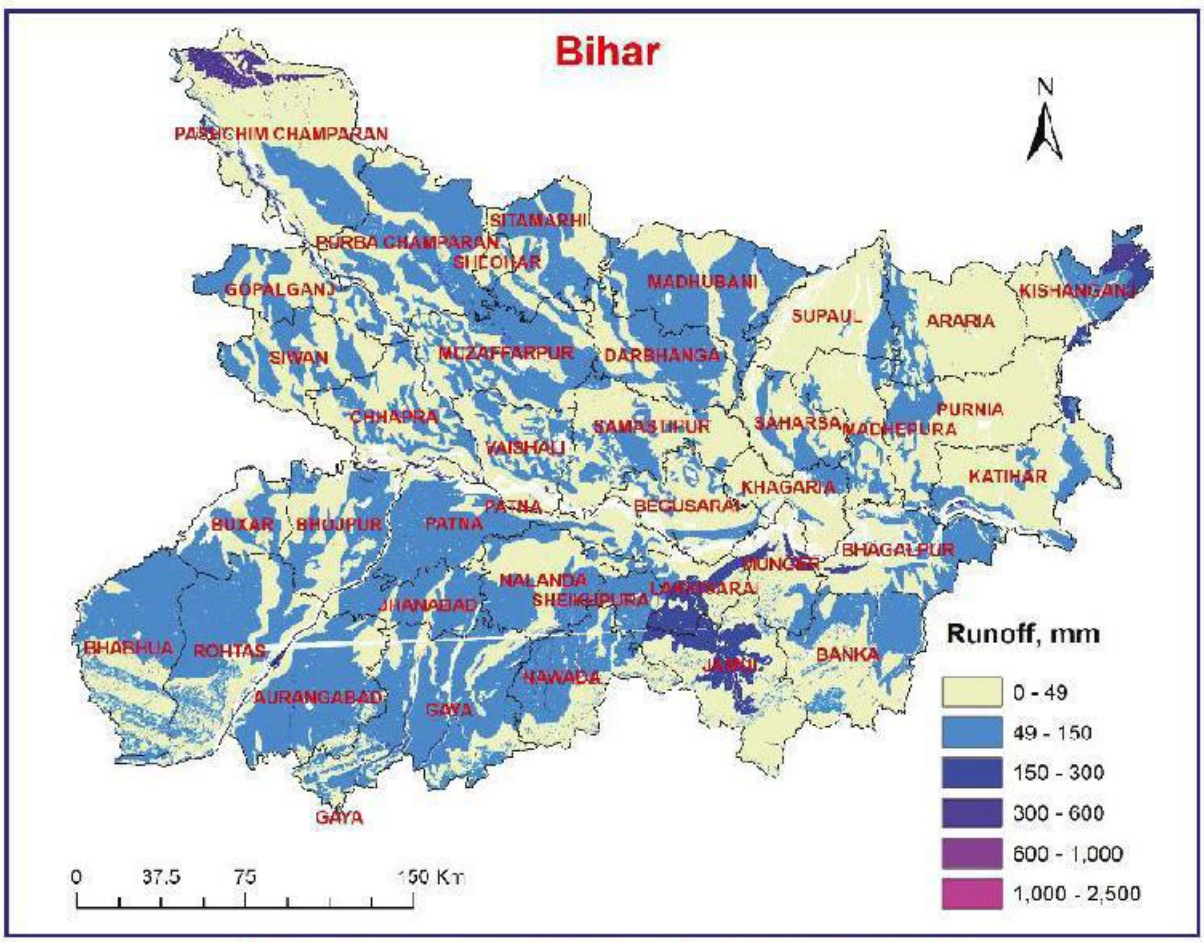
4.3.1 Bihar

4.3.1.1 State profile

S. N.	Particular		Units	Value		Source
			1. Demographic Characteristics			
1.1	Geographical area (GA)		Mha	9.42		DES (2019)
1.2	District		No	38		DES-GoBH, 2019
1.3	Gram panchayat		No	8386		
1.4	Villages		No	18521		
1.5	Total population		M	104.10		
1.5.1	Male	Female	M	54.28	49.82	
1.6	Livestock population		M	36.45		DAHD (2018)
			2. Land Use Statistics			
2.1	Forest area		Mha	0.62 (6.6% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.72		
2.3	Barren & unculturable land		Mha	0.43		
2.4	Permanent pastures & grazing lands		Mha	0.01		
2.5	Culturable wasteland		Mha	0.04		
2.6	Land under misc. tree crops		Mha	0.25		
2.7	Fallow land other than current		Mha	0.12		
2.8	Current fallow		Mha	0.99		
			3. Agricultural Indicators			
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	7399351		DES (2020)
3.2	Total operational holdings		000'	16613		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	14971	944	414	81		3
3.3	Net sown area (NSA)		Mha	5.17		DES (2019)
3.4	Gross cropped area		Mha	7.41		
3.5	Cropping intensity		%	143.34		
3.6	Rainfed area		Mha	2.05 (39.7% of NSA)		
3.7	Horticultural crops		Mha	1.18		DES (2020)
			4. Water Resources			
4.1	Net irrigated area (NIA)		Mha	3.11		DES (2019)
4.3	Gross irrigated area		Mha	5.49		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	0.97	0.06	1.96	0.02		0.11
4.3	Intensity of irrigation		%	176.3		
4.4	Annual extractable groundwater		BCM	28.99		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	19.78			0.66		1.83
4.5	Stage of groundwater extraction		%	45.76		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.12 (3.9 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	534		CGWB (2020)
4.7.1	Safe 432 (81%)	Semi-critical 72 (13%)	Critical 18 (3%)	Over-exploited 12 (2 %)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	1208 (2116-840)		DES-GoBH (2016)
			5. Watershed Development (MoRD, DoLR, 2021)			
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	3.63			1.44		2.19

[#]Area to be treated with watersheds

4.3.1.2 Rainwater harvesting potential



Map 4.8: Rainwater harvesting potential of Bihar state

Table 4.8: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Bihar

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
769-892	3.21	971.34	0.10
892-1042	2.65	1035.27	0.10
1042-1225	2.57	811.53	0.08
1225-1536	0.34	58.02	0.01
1536-2136	0.12	81.73	0.01
Total		**2957.89**	**0.30**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		887	
Area that can be irrigated with two irrigation (M ha)		0.59	
Available water for ground water recharge (MCM)		2071	

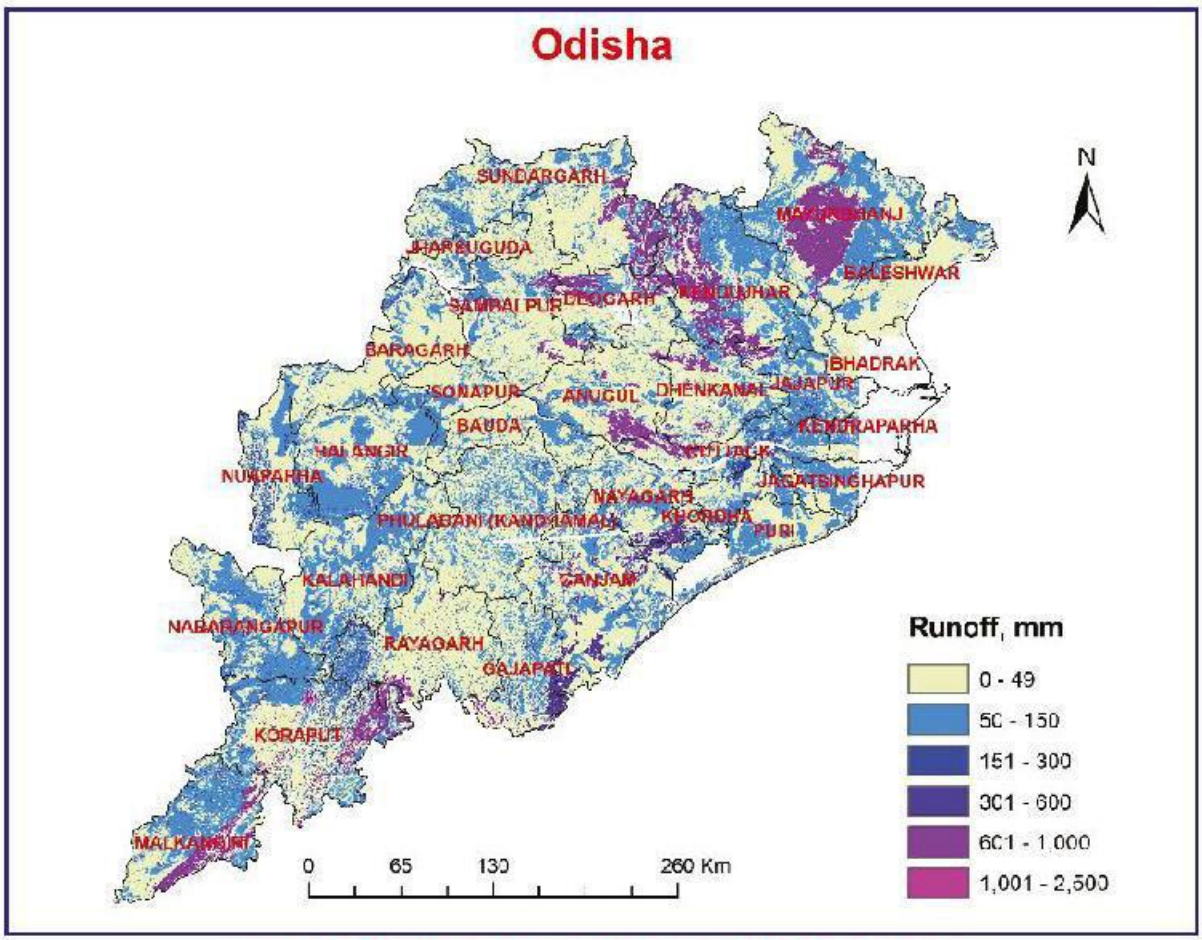
4.3.2 Odisha

4.3.2.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	15.57		DES (2019)
1.2	District		No	30		DES-GoO (2021)
1.3	Gram panchayat		No	6758		
1.4	Villages		No	47677		
1.5	Total population		M	41.97		
1.5.1	Male	Female	M	21.21	20.76	
1.6	Livestock population		M	18.14		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	5.81 (37.32 % of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.48		
2.3	Barren & unculturable land		Mha	1.02		
2.4	Permanent pastures & grazing lands		Mha	0.52		
2.5	Culturable wasteland		Mha	0.59		
2.6	Land under misc. tree crops		Mha	0.25		
2.7	Fallow land other than current		Mha	0.74		
2.8	Current fallow		Mha	1.09		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	9486561		DES (2020)
3.2	Total operational holdings		'000'	4966		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	3637	887	287	51		4
3.3	Net sown area (NSA)		Mha	4.01		DES (2020)
3.4	Gross cropped area		Mha	4.53		
3.5	Cropping intensity		%	113		
3.6	Rainfed area		Mha	2.91 (73% of NSA)		
3.7	Horticultural crops		Mha	1.32		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	1.09		DES (2019)
4.2	Gross irrigated area		Mha	1.31		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	-	-	-	-		1.09
4.3	Intensity of irrigation		%	120.34		-
4.4	Annual extractable groundwater		BCM	28.99		CGWB, 2019-20
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	5.28			0.14		1.15
4.5	Stage of groundwater extraction		%	42.18		CGWB, 2019-20
4.6	Area under micro-irrigation		Mha	0.31 (28.4 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	314		CGWB (2020)
4.7.1	Safe 283 (96%)	Semi-critical 5 (2%)	Critical 0	Over-exploited 0		Saline 6 (2%)
4.8	Annual rainfall (Range)		mm	1451 (1286-1668)		GoO (2019)
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	5.27			4.50		0.77

[#]Area to be treated with watersheds

4.3.2.2 Rainwater harvesting potential



Map 4.9: Rainwater harvesting potential of Odisha state

Table 4.9: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Odisha

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
853-979	2.78	1460.33	0.15
979-1072	4.15	1516.57	0.15
1072-1171	4.50	1889.74	0.19
1171-1292	2.29	2304.36	0.23
1292-1512	0.91	952.62	0.10
Total		8123.61	0.81
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	2437		
Area that can be irrigated with two irrigation (M ha)	1.62		
Available water for ground water recharge (MCM)	5687		

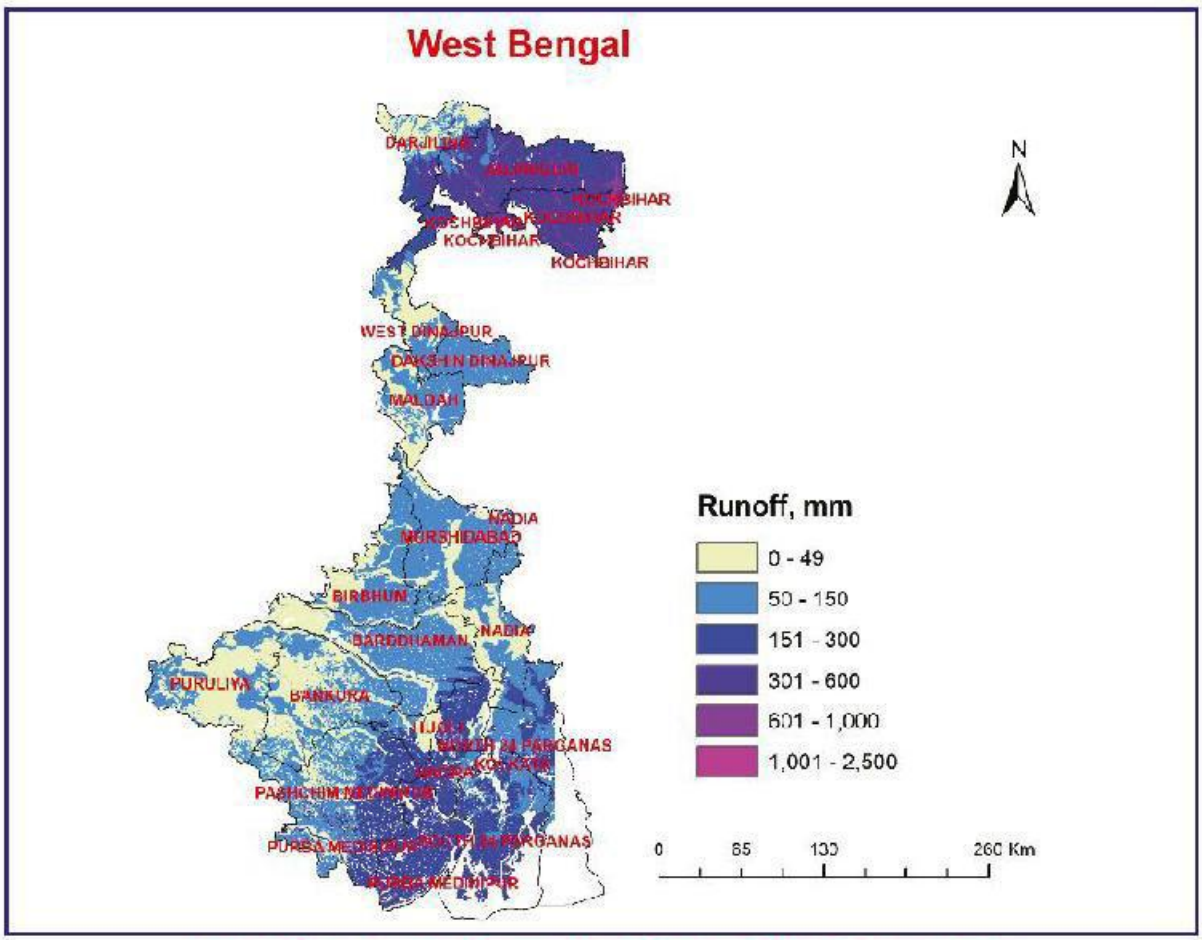
4.3.3 West Bengal

4.2.3.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	8.88		DES (2019)
1.2	District		No	23		GoWB (2015)
1.3	Gram panchayat		No	3347		
1.4	Villages		No	40218		
1.5	Total population		M	91.29		
1.5.1	Male	Female	M	46.81	44.47	
1.6	Livestock population		M	37.42		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	1.18 (13.3 % of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.88		
2.3	Barren & unculturable land		Mha	0.01		
2.4	Permanent pastures & grazing lands		Mha	0.002		
2.5	Culturable wasteland		Mha	0.01		
2.6	Land under misc. tree crops		Mha	0.05		
2.7	Fallow land other than current		Mha	0.01		
2.8	Current fallow		Mha	0.38		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	27426217		DES (2020)
3.2	Total operational holdings		000'	7243		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	5998	971	256	18		1
3.3	Net sown area (NSA)		Mha	5.25		DES (2019)
3.4	Gross cropped area		Mha	9.96		
3.5	Cropping intensity		%	189.8		
3.6	Rainfed area		Mha	2.14 (40.8 % of NSA)		
3.7	Horticultural crops		Mha	1.97		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	3.11		DES (2019)
4.2	Gross irrigated area		Mha	6.53		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	-	-	-	-		3.11
4.3	Intensity of irrigation		%	210.0		-
4.4	Annual extractable groundwater		BCM	26.56		CGWB (2020)
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	18.84			NA		1.60
4.5	Stage of groundwater extraction		%	44.60		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.09 (2.9 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	268		CGWB (2020)
4.7.1	Safe 191 (71%)	Semi-critical 76 (28%)	Critical 1 (0.52%)	Over-exploited 0		Saline 0
4.8	Annual rainfall (Range)		mm	1698 (1968-3411)		GoWB (2015)
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area* (Mha)			Treated area (Mha)		To be treated area (Mha)
	6.37			1.06		5.31

*Area to be treated with watersheds

4.3.3.2 Rainwater harvesting potential



Map 4.10: Rainwater harvesting potential of West Bengal state

Table 4.10: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of West Bengal

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
1034-1303	4.6	1852.88	0.19
1303-1808	1.49	1360.33	0.14
1808-2370	0.25	256.92	0.03
2370-2737	0.41	745.01	0.07
2737-3112	0.65	1771.41	0.18
Total		5986.56	0.6
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		1796	
Area that can be irrigated with two irrigation (M ha)		1.2	
Available water for ground water recharge (MCM)		4191	

4.4 Southern States

4.4.1	Tamil Nadu
4.4.2	Kerala
4.4.3	Karnataka
4.4.4	Andhra Pradesh
4.4.5	Telangana

Photo 4.28: Farm pond with dry stone lining in Tamilnadu

Photo 4.29: Traditional water harvesting pond in Kerala

Photo 4.30: Open dug well in Karnataka

Photo 4.31: Traditional water harvesting in Telangana

Photo 4.32: Check dam with downstream apron, Raipalli, Bidar Karnataka

Photo 4.33: Water harvesting pond, Kerala

Photo 4.34: Dugout pond - field level water harvesting, Andhra Pradesh

Photo 4.35: *Surungam* traditional water harvesting system, Kerala

Photo 4.36: Poly lined farm pond, Telengana

Photo 4.37: Collection well for sub surface water harvesting, Tamil Nadu

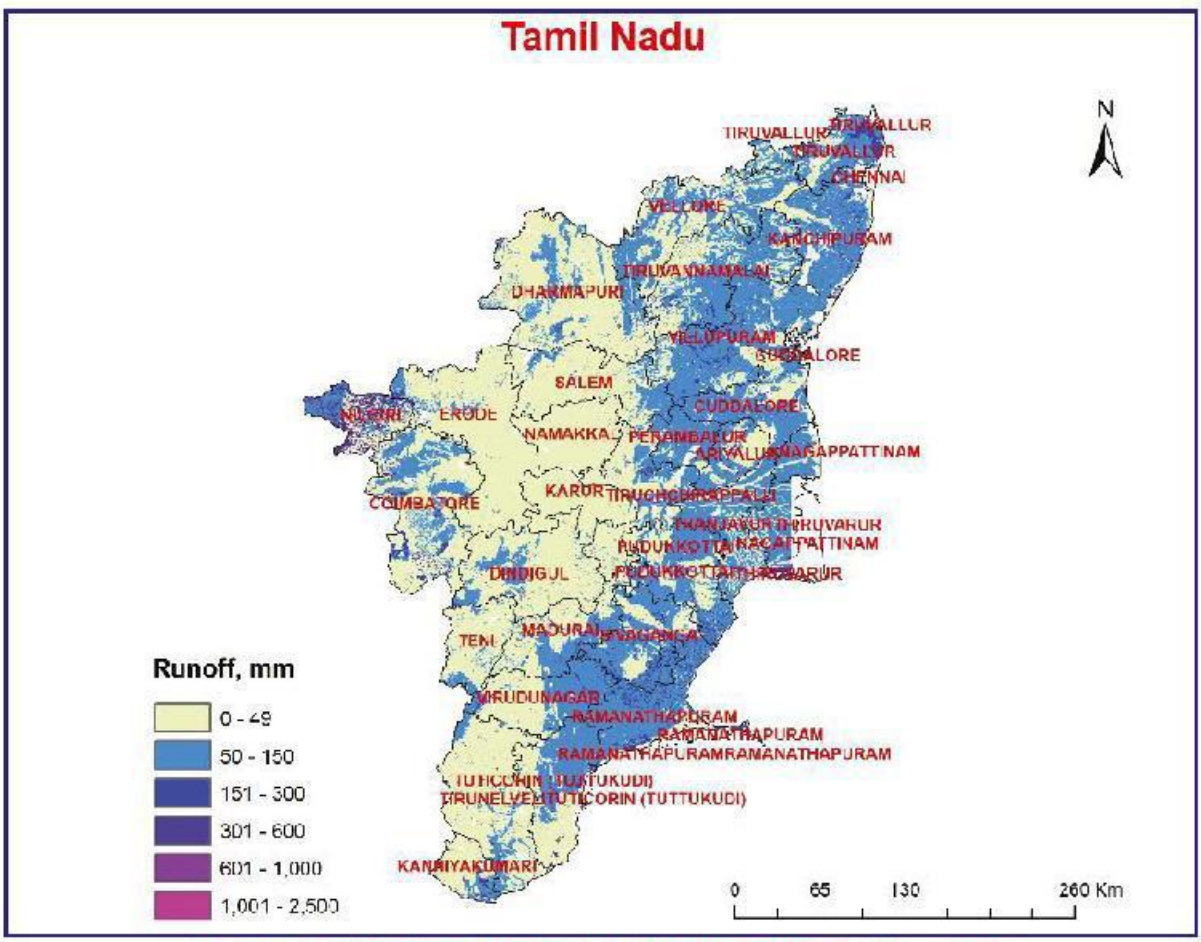
4.4.1 Tamil Nadu

4.4.1.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	13.01		DKS (2019)
1.2	District		No	38		GoTN (2022)
1.3	Gram panchayat		No	12618		
1.4	Villages		No	17689		
1.5	Total population		M	72.15		
1.5.1	Male	Female	M	36.14	36.01	
1.6	Livestock population		M	24.45		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	2.16		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	2.28		
2.3	Barren & unculturable land		Mha	0.46		
2.4	Permanent pastures & grazing lands		Mha	0.11		
2.5	Culturable wasteland		Mha	0.32		
2.6	Land under misc. tree crops		Mha	0.23		
2.7	Fallow land other than current		Mha	1.93		
2.8	Current fallow		Mha	1.05		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	23057017		DES (2020)
3.2	Total operational holdings		'000'	7938		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	6224	1119	452	128		15
3.3	Net sown area (NSA)		Mha	4.56		DES (2019)
3.4	Gross cropped area		Mha	5.67		
3.5	Cropping intensity		%	123.8		
3.6	Rainfed area		Mha	2.02 (44.3% of NSA)		
3.7	Horticultural crops		Mha	1.42		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	2.57		DES (2019)
4.2	Gross Irrigated area		Mha	3.18		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	0.64	0.32	0.52	1.09		0.01
4.3	Intensity of irrigation		%	123.74		CGWB (2020)
4.4	Annual extractable groundwater		BCM	18.20		
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	13.86			0		1.67
4.5	Stage of groundwater extraction		%	80.94		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.94 (36.58 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	1165		CGWB (2020)
4.7.1	Safe 427 (37%)	Semi-critical 163 (14%)	Critical 79 (7%)	Over-exploited 462 (40 %)		Saline 35 (3%)
4.8	Annual rainfall (Range)		mm	978 (714-936)		SCR 2019-20
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area[@] (Mha)			Treated area (Mha)		To be treated area (Mha)
	6.40			3.65		2.75

[@]Area to be treated with watersheds

4.4.1.2 Rainwater harvesting potential



Map 4.11: Rainwater harvesting potential of Tamil Nadu state

Table 4.11: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Tamil Nadu

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha^{-m}
516-792	5.44	1314.10	0.13
792-1019	5.33	1985.79	0.20
1019-1288	0.75	205.31	0.02
1288-1622	0.42	161.23	0.02
1622-2323	0.30	172.96	0.02
Total		3839.38	0.38
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	1152		
Area that can be irrigated with two irrigation (M ha)	0.77		
Available water for ground water recharge (MCM)	2688		

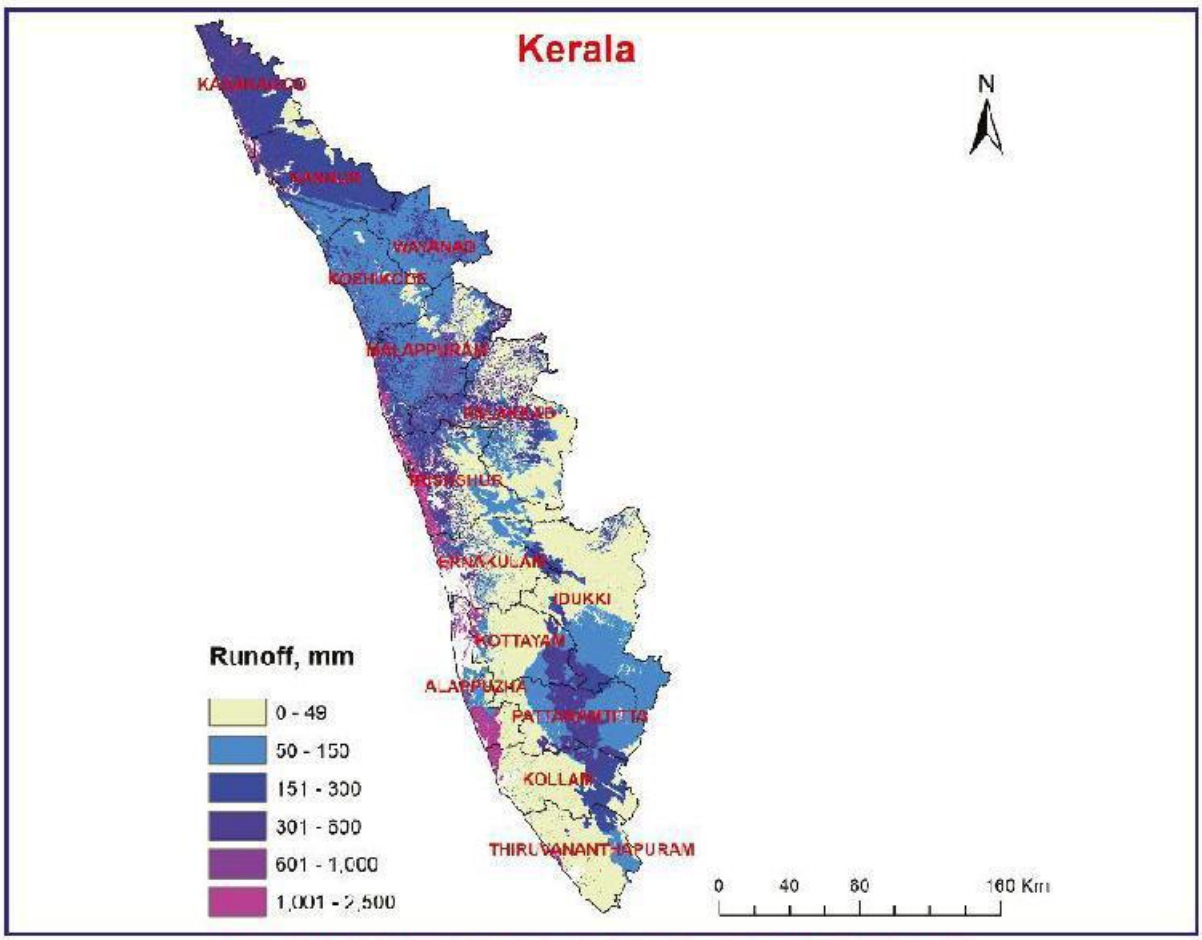
4.4.2 Kerala

4.2.2.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	3.89		DES (2019)
1.2	District		No	14		DoO-GoKL (2022)
1.3	Gram panchayat		No	941		
1.4	Villages		No	1670		
1.5	Total population		M	33.41		
1.5.1	Male	Female	M	16.03	17.38	
1.6	Livestock population		M	2.90		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	1.08		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	0.56		
2.3	Barren & unculturable land		Mha	0.01		
2.4	Permanent pastures & grazing lands		Mha	-		
2.5	Culturable wasteland		Mha	0.18		
2.6	Land under misc. tree crops		Mha	-		
2.7	Fallow land other than current		Mha	0.05		
2.8	Current fallow		Mha	0.06		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	NA		DES (2020)
3.2	Total operational holdings		'000'	7583		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	7333	181	56	11		2
3.3	Net sown area (NSA)		Mha	2.03		DES (2019)
3.4	Gross cropped area		Mha	2.57		
3.5	Cropping intensity		%	126.4		
3.6	Rainfed area		Mha	1.63 (80.30% of NSA)		
3.7	Horticultural crops		Mha	1.68		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	0.41		DES (2019)
4.2	Gross irrigated area		Mha	0.52		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	0.08	0.05	0.04	0.12		0.11
4.3	Intensity of irrigation		%	126.81		CGWB (2020)
4.4	Annual extractable groundwater		BCM	5.21		
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	1.22			0.01		1.44
4.5	Stage of groundwater extraction		%	51.27		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.03 (7.32 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	152		CGWB (2020)
4.7.1	Safe 119 (78%)	Semi-critical 30 (20%)	Critical 2 (1%)	Over-exploited 1 (1 %)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	3080 (1971-3519)		Website source
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area* (Mha)			Treated area (Mha)		To be treated area (Mha)
	2.05			1.46		0.58

*Area to be treated with watersheds

4.4.2.2 Rainwater harvesting potential



Map 4.12: Rainwater harvesting potential of Kerala state

Table 4.12: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Kerala

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
601-1152	0.61	566.93	0.06
1152-1727	0.90	502.65	0.05
1727-2338	0.86	698.12	0.07
2338-2972	0.66	890.97	0.09
2972-3655	0.61	832.15	0.08
Total		**3490.83**	**0.35**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)	1047		
Area that can be irrigated with two irrigation (M ha)	0.7		
Available water for ground water recharge (MCM)	2444		

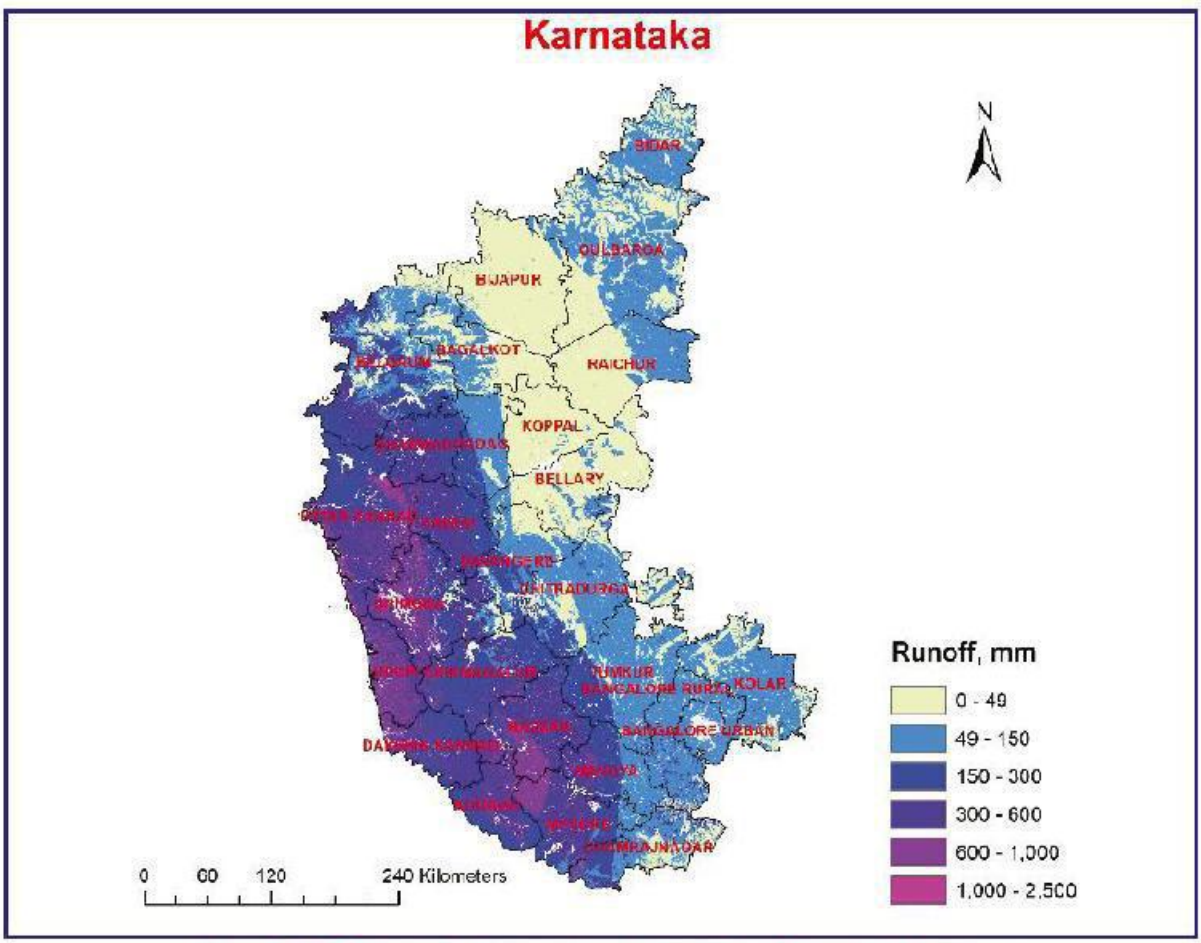
4.4.3 Karnataka

4.4.3.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	19.18		DES (2019)
1.2	District		No	31		FPMSD-GoK (2021)
1.3	Gram panchayat		No	6010		
1.4	Villages		No	29348		
1.5	Total population		M	61.10		
1.5.1	Male	Female	M	30.97	30.13	
1.6	Livestock population		M	29		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	3.87 (16% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	1.58		
2.3	Barren & unculturable land		Mha	0.77		
2.4	Permanent pastures & grazing lands		Mha	0.87		
2.5	Culturable wasteland		Mha	0.48		
2.6	Land under misc. tree crops		Mha	0.25		
2.7	Fallow land other than current		Mha	0.57		
2.8	Current fallow		Mha	0.94		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	19655955		DES (2020)
3.2	Total operational holdings		'000'	9680.74		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	4767.13	1213.73	1192.72	451.44		55.70
3.3	Net sown area (NSA)		Mha	10.66		DES (2019)
3.4	Gross cropped area		Mha	13.55		
3.5	Cropping intensity		%	127		
3.6	Rainfed area		Mha	6.63 (62.2% of NSA)		
3.7	Horticultural crops		Mha	2.36		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	4.03		DES (2019)
4.2	Gross irrigated area		Mha	4.74		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1.19	0.13	1.81	0.32		0.56
4.3	Intensity of irrigation		%	117.6		CGWB (2020)
4.4	Annual extractable groundwater		BCM	14.79		
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	9.39			-		0.95
4.5	Stage of groundwater extraction		%	69.87		CGWB (2020)
4.6	Area under micro-irrigation		Mha	1.77 (43.9 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	176		CGWB (2020)
4.7.1	Safe 97 (55%)	Semi-critical 26 (15%)	Critical 8 (5%)	Over-exploited 45 (26%)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	1248 (562-4119)		PFMSD (2021)
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area[@] (Mha)			Treated area (Mha)		To be treated area (Mha)
	12.97			7.85		5.12

[@]Area to be treated with watersheds

4.4.3.2 Rainwater harvesting potential



Map 4.13: Rainwater harvesting potential of Karnataka state

Table 4.13: Total harvestable runoff, available for irrigation and ground water recharge potential in the of Karnataka

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
464-1010	9.78	3040.53	0.30
1010-1781	2.32	2125.32	0.21
1781-2617	1.98	3548.06	0.35
2617-3485	1.80	4427.82	0.44
3485-4561	2.61	7782.53	0.78
Total		20924.26	2.09
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		6277	
Area that can be irrigated with two irrigation (M ha)		4.18	
Available water for ground water recharge (MCM)		14647	

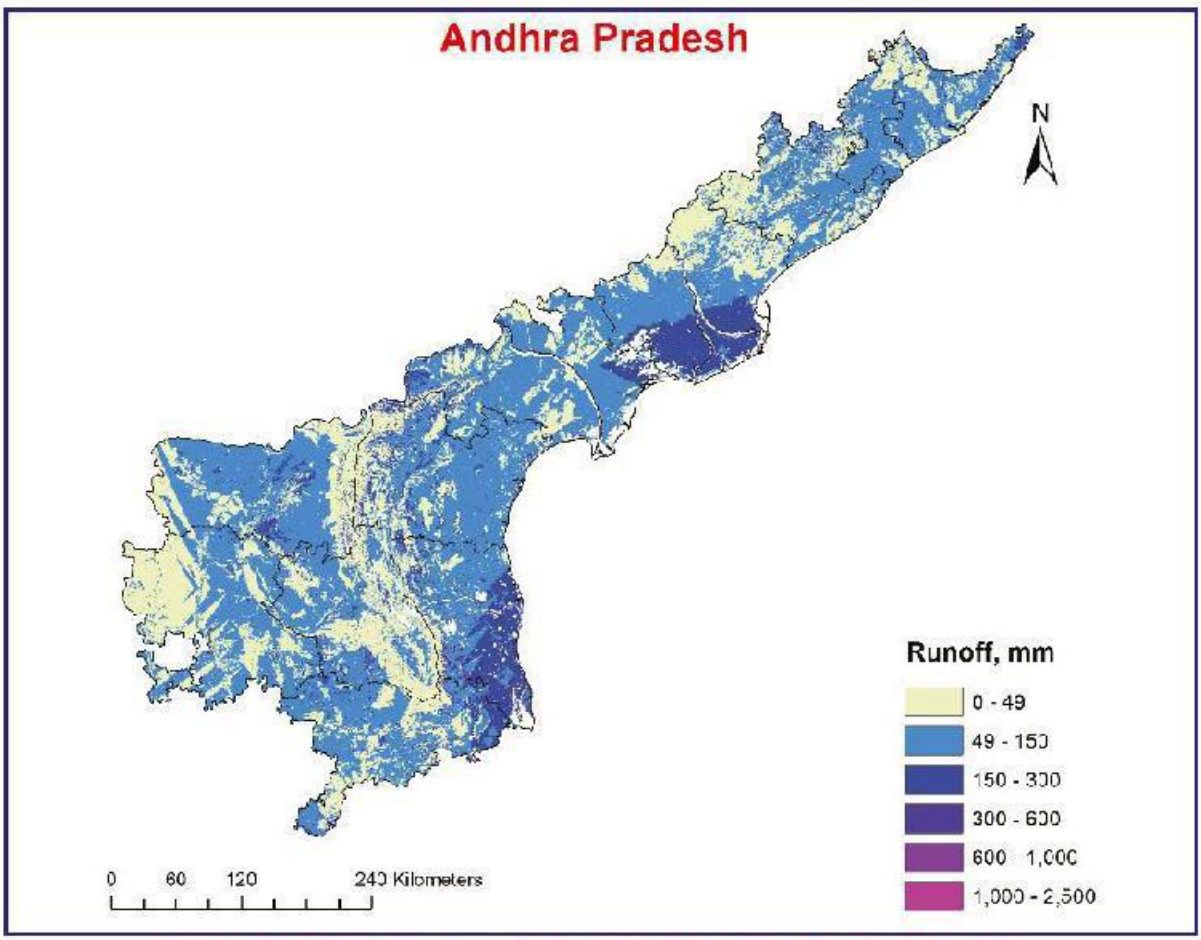
4.4.4 Andhra Pradesh

4.4.4.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	16.29		DES (2019)
1.2	District		No	13		DES-GoAP (2020)
1.3	Gram panchayat		No	13365		
1.4	Villages		No	17464		
1.5	Total population		M	49.58		
1.5.1	Male	Female	M	24.83	24.74	
1.6	Livestock population		M	34		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	3.69 (22.7% of GA)		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	2.05		
2.3	Barren & unculturable land		Mha	1.34		
2.4	Permanent pastures & grazing lands		Mha	0.28		
2.5	Culturable wasteland		Mha	0.41		
2.6	Land under misc. tree crops		Mha	0.16		
2.7	Fallow land other than current		Mha	0.93		
2.8	Current fallow		Mha	1.45		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	38948127		DES (2020)
3.2	Total operational holdings		'000'	9523.91		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	5984.04	1646.25	769.84	189.83		14.75
3.3	Net sown area (NSA)		Mha	6.04		DES (2019)
3.4	Gross cropped area		Mha	7.29		
3.5	Cropping intensity		%	121		
3.6	Rainfed area		Mha	3.25 (53.8% of NSA)		
3.7	Horticultural crops		Mha	1.52		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	2.79		DES (2019)
4.2	Gross Irrigated area		Mha	3.63		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	1.30	0.23	1.10	0.04		0.11
4.3	Intensity of irrigation		%	130		CGWB (2020)
4.4	Annual extractable groundwater		BCM	20.15		
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	7.85			0.14		0.90
4.5	Stage of groundwater extraction		%	44.15		CGWB (2020)
4.6	Area under micro-irrigation		Mha	1.90 (68.1 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	670		CGWB (2020)
4.7.1	Safe 581 (75%)	Semi-critical 50 (8%)	Critical 24 (4%)	Over-exploited 45 (7%)		Saline 40 (6%)
4.8	Annual rainfall (Range)		mm	966 (552-1217)		DES-GoAP (2020)
5. Watershed Development (MoRD), DoLR, 2021)						
5.1	Treatable area* (Mha)			Treated area (Mha)		To be treated area (Mha)
	6.37			3.44		2.93

*Area to be treated with watersheds

4.4.4.2 Rainwater harvesting potential



Map 4.14: Rainwater harvesting potential of Andhra Pradesh state

Table 4.14: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Andhra Pradesh

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
401 - 547	2.36	706.73	0.07
547 - 665	3.28	1461.80	0.15
665 - 775	2.94	1534.62	0.15
775 - 866	3.45	1724.81	0.17
866 - 1042	3.11	1843.41	0.18
Total		7271.36	0.73
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		2181	
Area that can be irrigated with two irrigation (M ha)		1.45	
Available water for ground water recharge (MCM)		5090	

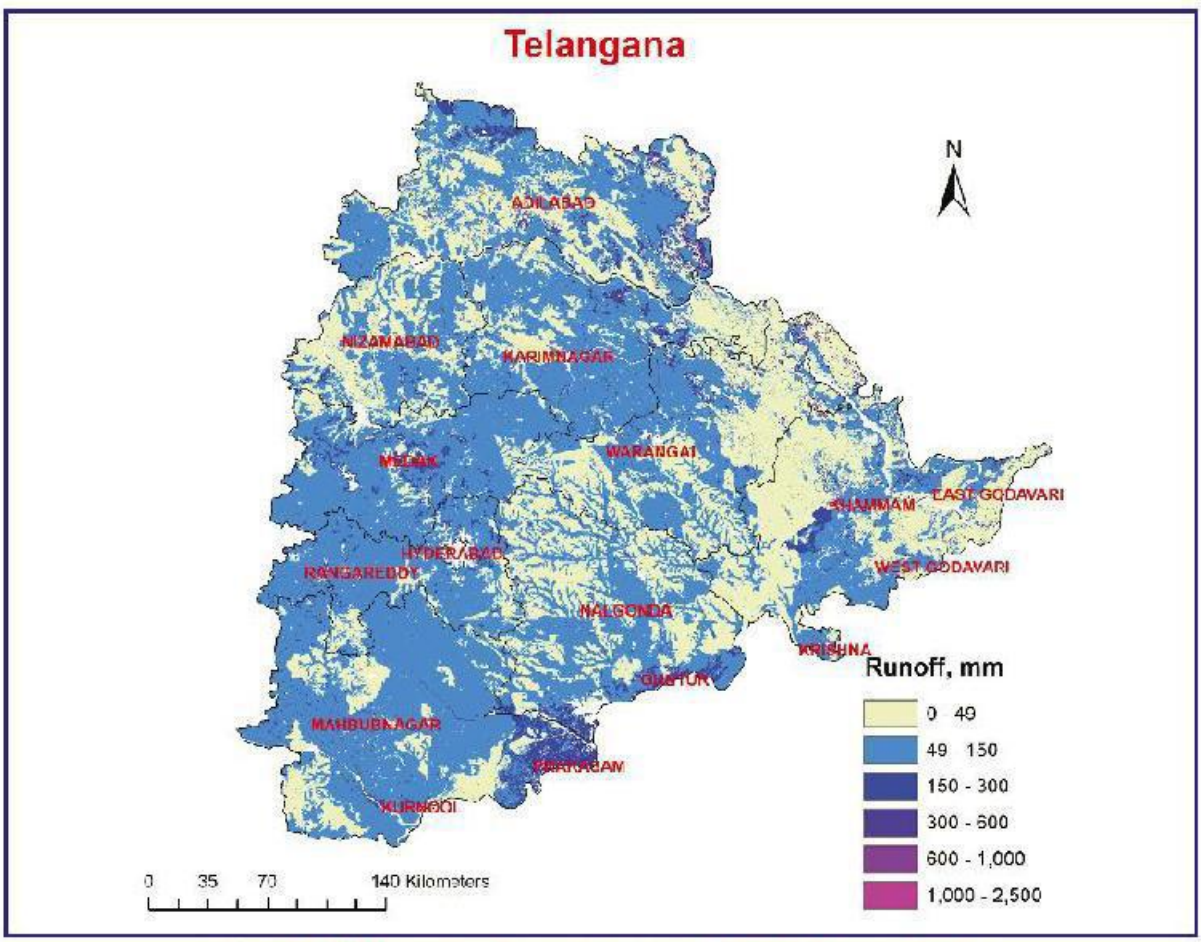
4.4.5 Telangana

4.4.5.1 State profile

S. N.	Particular		Units	Value		Source
1. Demographic Characteristics						
1.1	Geographical area (GA)		Mha	11.21		DES (2019)
1.2	District		No	33		GoTL (2021)
1.3	Gram panchayat		No	12769		
1.4	Villages		No	28268		
1.5	Total population		M	35.00		
1.5.1	Male	Female	M	17.61	17.39	
1.6	Livestock population		M	32.63		DAHD (2018)
2. Land Use Statistics						
2.1	Forest area		Mha	2.70		DES (2019)
2.2	Area under non-agri-cultural uses		Mha	0.84		
2.3	Barren & uncultivable land		Mha	0.61		
2.4	Permanent pasture & grazing lands		Mha	0.38		
2.5	Culturable wasteland		Mha	0.18		
2.6	Land under misc. tree crops		Mha	0.11		
2.7	Fallow land other than current		Mha	0.75		
2.8	Current fallow		Mha	1.06		
3. Agricultural Indicators						
3.1	GAV of agriculture and allied sector at current prices		Rs in Lakh	18439162		DES (2020)
3.2	Total operational holdings		'000'	5948		DES (2020)
3.2.1	Marginal (< 1 ha)	Small (1.0-2.0 ha)	Semi- Medium (2.0-4.0 ha)	Medium (4.0 -10.0 ha)		Large (10.0 ha and >)
	3840	1489	564	126		9
3.3	Net sown area (NSA)		Mha	4.66		DES (2019)
3.4	Gross cropped area		Mha	5.77		
3.5	Cropping intensity		%	123.90		
3.6	Rainfed area		Mha	2.45 (53% of NSA)		
3.7	Horticultural crops		Mha	0.45		DES (2020)
4. Water Resources						
4.1	Net irrigated area (NIA)		Mha	2.21		DES (2019)
4.2	Gross irrigated area		Mha	3.13		
4.2.1	Canal	Tanks	Tube-wells	Other wells		Other sources
	0.43	0.24	1.85	0.48		0.10
4.3	Intensity of irrigation		%	141.63		CGWB (2020)
4.4	Annual extractable groundwater		BCM	12.37		
4.4.1	Irrigation use (BCM)			Industry use (BCM)		Domestic use (BCM)
	7.09			-		1.00
4.5	Stage of groundwater extraction		%	65.45		CGWB (2020)
4.6	Area under micro-irrigation		Mha	0.37 (16.7 % of NIA)		DES (2020)
4.7	Assessment units for groundwater status		No	584		CGWB (2020)
4.7.1	Safe 278 (48%)	Semi-critical 169 (29%)	Critical 67 (11%)	Over-exploited 78 (13 %)		Saline 0 (0%)
4.8	Annual rainfall (Range)		mm	905 (614-1212)		Web source
5. Watershed Development (MoRD, DoLR, 2021)						
5.1	Treatable area[#] (Mha)			Treated area (Mha)		To be treated area (Mha)
	8.66			3.45		5.21

[#]Area to be treated with watersheds

4.4.5.2 Rainwater harvesting potential



Map 4.15: Rainwater harvesting potential of Telangala state

Table 4.15: Total harvestable runoff, available for irrigation and ground water recharge potential in the state of Telangana

Annual Rainfall (mm)	Area (M ha)	Harvestable Runoff	
		MCM	M ha-m
512 - 612	4.06	1439.31	0.14
612 - 721	2.13	819.85	0.08
721 - 827	1.74	732.91	0.07
827 - 937	2.16	976.77	0.10
937 - 1102	0.90	412.42	0.04
Total		**4381.25**	**0.44**
Available water for irrigation & ground water recharge			
Available water for protective irrigation of (MCM)		1314	
Area that can be irrigated with two irrigation (M ha)		0.88	
Available water for ground water recharge (MCM)		3067	

WAYFORWARD

Water resource challenges faced by India can only be addressed by adopting an informed approach that considers all uses and sources of water from a hydrologic perspective. This requires sound information and knowledge on the water resource database and its uses. The hydrologic complexities can no more be ignored in our development work, rather initiatives are required to employ such data for useful work.

Data-based planning offers a good pathway forward. It leads to right problem identification, employ appropriate data in assessing the existing status and, formulate a solution for managing the water resources locally or if a local solution is not possible, it helps in recommending a broader area development plan.

Rainwater harvesting implies augmentation of available water as artificial recharge in springs or aquifers and/or creating new source within the area by impoundment of surface water albeit on a small and decentralized scale. An ideal information required to assess the potential of water resources in a hydrologically defined boundary are water availability in different types of sources, capacity of source to yield required amount of water, contributing area/catchment area of the source, fluctuations in availability of water, identification of water surplus/water scarce zones in the catchment, future scenario of water availability, and effects of weather (rainfall) aberrations.

A new version of the Green Revolution which is knowledge-intensive, and builds the capacity of farmers to manage agricultural land for higher productivity and resource input efficiency has to be initiated. It should also entail increased biological and genetic knowledge along with improved land and water management practices for optimum water-nutrient-energy efficiency.

Extensive data, information and knowledge systems at various spatial and temporal scales need to be generated and shared among wide and-diverse networks. Improved understanding of system behavior needs to be accompanied by effective decision-making tools for various stakeholders.

National Water Mission is one among the eight missions under National Action Plan on Climate Change (NAPCC) which focuses on 20% improvement in water use efficiency through pricing and other measures to deal with water scarcity as a result of climate change. In view of this various ministries are addressing the water resource issue through dedicated programmes/schemes.

The Ministry of Rural Development, Department of Water Resources, MoWR, RD & GR and the Ministry of Agriculture & Farmers' Welfare are promoting 'Mission Water Conservation" to ensure gainful utilization of funds. These efforts strive to ensure synergies in Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), and erstwhile Integrated Watershed Management Programme (IWMP) now PMKSY-Watershed Development Component and Command Area Development &Water Management (CADWM), given their common

objectives. Types of common works undertaken under these programmes/ schemes are water conservation and management, water harvesting, soil and moisture conservation, ground water recharge, flood protection, land development, Command Area Development & Watershed Management.

It would be prudent to further develop some useful tools to employ the spatial and GIS-based data generated as rainwater harvesting potential in effective implementation of "Mission Water Conservation" so as to strengthen the efforts of the Central Government.

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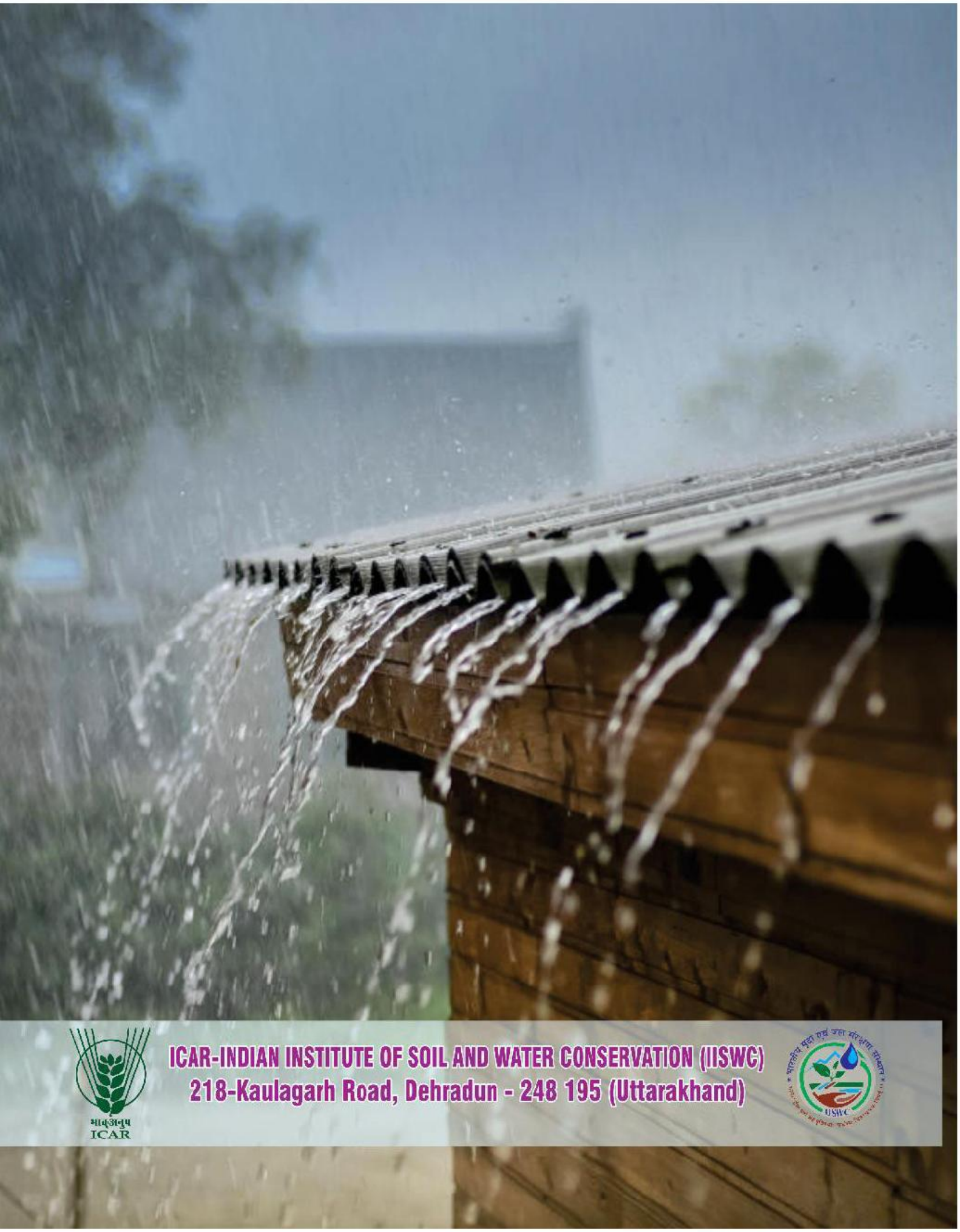
ABBREVIATIONS

BCM	:	Billion Cubic Meters
CADWM	:	Command Area Development & Watershed Management
CGWB	:	Central Ground Water Board
DAHD	:	Department of Animal Husbandry & Dairying
DEM	:	Digital Elevation Model
DES	:	Directorate of Economics and Statistics
DoLR	:	Department of Land Resources
DoP	:	Department of Panchayat
DPSPM	:	Department of Planning, Statistics and Programme Monitoring
GA	:	Geographical Area
GIS	:	Geographical Information System
GoAP	:	Government of Andhra Pradesh
GoBH	:	Government of Bihar
GoK	:	Government of Karnataka
GoKL	:	Government of Kerala
GoMP	:	Government of Madhya Pradesh
GoO	:	Government of Odisha
GoR	:	Government of Rajasthan
GoTL	:	Government of Telangana
GoTN	:	Government of Tamil Nadu
GoUP	:	Government of Uttar Pradesh
GoWB	:	Government of West Bengal
HSG	:	Hydrologic Soil Group
ICAR	:	Indian Council of Agricultural Research
IISWC	:	Indian Institute of Soil and Water Conservation
IIWM	:	Indian Institute of Water Management
IMD	:	India Meteorological Department
IWMP	:	Integrated Watershed Management Programme
LGD	:	Local Government Directory
M	:	Million

MCM	:	Million Cubic Meters
MGNREGS	:	Mahatma Gandhi National Rural Employment Guarantee Scheme
Mha	:	Million hectares
MoAFW	:	Ministry of Agriculture and Farmers' welfare
MoWR	:	Ministry of Water Resources
NAPCC	:	National Action Plan on Climate Change
NASA	:	National Aeronautics and Space Administration
NBSS &LUP	:	National Bureau of Soil Survey and Land Use Planning
NIA	:	Net Irrigated Area
NRM	:	Natural Resource Management
NSA	:	Net Sown Area
PMKSY	:	Pradhan Mantri Krishi Sinchayee Yojana
PPMSD	:	Planning, Programme Monitoring and Statistics Department
RD & GR	:	River Development & Ganga Rejuvenation
RWH	:	Rainwater Harvesting



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