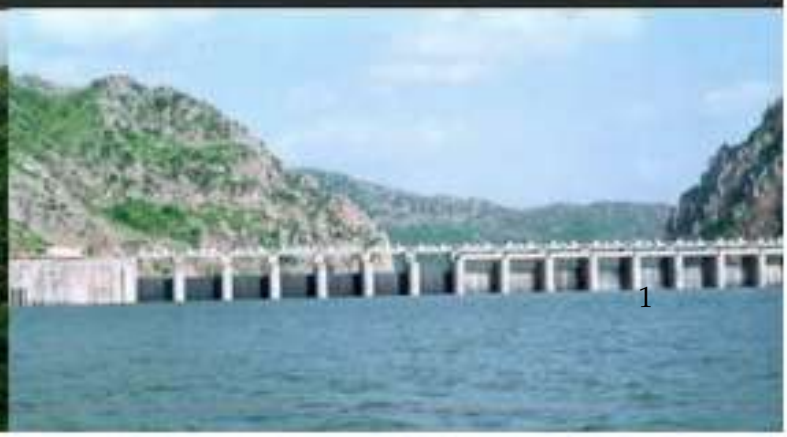
Geography of Rajasthan

BOOK BY RAJRAS



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Physical Divisions of Rajasthan

Rajasthan is the largest state in the Union of India and has more physical variations than any other state. It has regions of rolling sand dunes in the west to lofty rocks in the middle to fertile plains in the east. On the basis of the existing relief features, there are following physical divisions of Rajasthan:

1. Western Sandy Plains
2. Aravalli Range And Hilly Region
3. Eastern Plains
4. South-eastern Rajasthan Pathar (Hadoti Plateau)

1. Western Sandy Plains

The western sandy plains are divided into two major regions and 6 sub-regions as following

A. Sandy Arid Plain

- A1. Marusthali
- A2. Dune free Tract

B. Semi-Arid Basin or Rajasthan Bangar

- B1. Luni Basin
- B2. Shekhawati Region
- B3. Nagaur Upland
- B4. Ghaggar Plain

2. Aravalli Range And Hilly Region

Aravalli Range on basis of its general characteristics, form elements, relief, slopes and drainage pattern can be divided into following physiographic sub-units:

A. The North- Eastern Hill Tracts or Alwar Hills

B. The Central Aravalli Range

- B1. The Sambhar Basin or Shekhawati Low hills
- B2. The Merwara hills

C. The Mewar Rocky region and Bhorat Plateau

D. Abu Block region

3. The Eastern Plains

The eastern plains can be divided into 4 sub-regions:

A. Chambal basin

B. Banas Basin

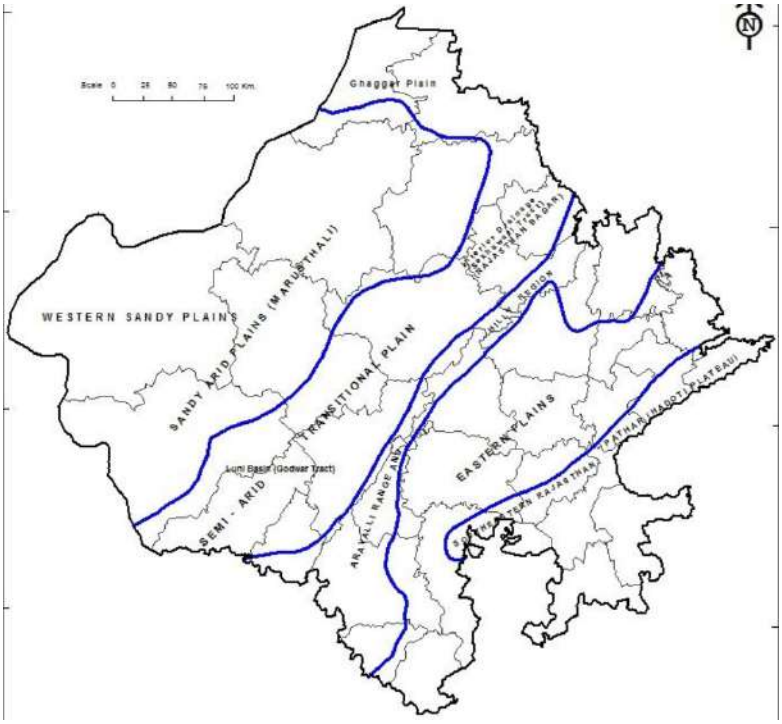
C. Mahi or Chappan Basin

4. South-eastern Rajasthan Pathar (Hadoti Plateau)

It has following sub regions:

A. Deccan highlands

B. Vindhyan region



1. Western Sandy Plains

- Districts: Hanumangarh, Sriganganagar, Bikaner, Jaisalmer, Barmer, Jalore, Sirohi, Pali, Jodhpur, Nagaur, Churu, Sikar & Jhunjhunu.
- The western sandy plains are divided into **two major regions and 6 sub-regions** as following

A. Sandy Arid Plain

- Area- 61% of total area of W.S.P.
- Population- 40%
- Minimum Rainfall- 50 Cm
- There are vast expanses of sand & rock outcrops mainly limestone are found in Jaisalmer, Barmer, Bikaner, Churu, Hanumangarh & Sriganganagar.
- Sandy Arid Plain further Sub-divided into **two sub-regions**.

A1. Marusthali

- District- Bikaner, Barmer, Jaisalmer, Jodhpur, Nagaur, Churu
- Area - 120500 Sq. Km (Thar Desert)
- Height of sand dunes – 6 m to 60 mLength of sand dunes – 3 km to 5 km
- Towards west this sandy arid Marushthali is known as Thar Desert. Shifting sand dunes is locally terms as Dharians.

A2. Dune free Tract

- Districts- Bikaner, Jaisalmer, Phalodi & Pokhran
- Area – 65 Sq. Km.
- Limestone & Sandstone rocks exposes (to lay open) here belong to Jurassic & Eocene formations.
- It is rocky but dune free tract.
- Small hills are found within a circle of 64 Km of Jaisalmer town
- Dry beds & banks could easily be tapped for ground water
- Grid conglomerate, gneiss, **schist & granite rocks are also exposed at places.**

B. Semi-Arid Basin or Rajasthan Bangar

- District – Jaipur, Jodhpur, Nagaur, Pali, Jalore, Barmer
- Area - 7500 Sq. Km
- Rainfall – 20 cm
- In it lies in the eastern part & drained by the Luni in its south-eastern portion.
- Gullying has given rise to conglomerate landscape. Its eastern part is covered with superficial sand deposits.
- Towards north lies the Shekhawati tract which is semi arid transitional plain characterized by inland drainage & stream with salt lakes like Sambhar, Didwana etc.
- In the extreme north **lies the Ghaggar Plain.**

B1. Luni Basin

- District - Barmer, Jalore, Jodhpur, Nagaur Area – 34866 .4 Sq. Km
- Basin is drained by the Luni River & its tributaries Bandi, Sagi, etc. Covers the area from its source to Tiwara (Barmer) where Sukari river meets it.

- It is a seasonal river
- Floods occur during the rains in Luni
- Topography is marked by hills with steep slopes & extensive alluvial plains.
- This area is locally known **as Naid (Rel) & is one of best alluvial plains.**

B2. Shekhawati Region

- District: Churu, Sikar, Jhunjhunu & Nagaur
- Live stock, Milk production & dairy are the occupation of this region
- Aravalli hills runs through this region from south to north, cutting into almost two halves.
- Topography of the Shekhawati tracts is characterized by an undulating sandy terrain traversed by longitudinal sand dunes. There is only one seasonal river kantli
- Here the sand dunes are of transverse type
- The calcareous substratum is exposed of the tract from the sea level is 450m.

B3. Nagaur Upland

- District: Nagaur
- Average Height of this region from sea level – 300 m to 500 m
- Rainfall – 25 cm in west to 50 cm in east
- This region is full of sand hills & low depressions.
- The temperature being High, the evaporation of the saline flood-water results in the deposits of the salt & soda in these depressions**.**

B4. Ghaggar Plain

- Districts- Hanumangarh & Sriganganagar (75% of district).
- No existing river or stream except ancient Ghaggar and region is known as Ghaggar plain.
- It is a sandy plain interspersed with sand-dunes (6-30m high) & small sand-hills.

2. Aravalli Range And Hilly Region

Rajasthan is bisected by Aravalli (Aravali) range into two major parts: Southeast Rajasthan and Northwest Rajasthan. The northwest consists of a series of sand dunes covers nearly two-thirds of the area. Aravali range is approximately 692 Kms long, running across Gujarat, Rajasthan, Haryana and Delhi. As a result Rajasthan has multiple peaks.

The Aravalli's in Rajasthan are divided into 4 main sections:

1. North-Eastern Aravalli Range
2. Central Aravalli Range
3. The Mewar Rocky region and Bhorat Plateau
4. Abu Block REgion

A. The North- Eastern Hill Tracts or Alwar Hills

- Districts- Jaipur, Sikar, Khetri, Alwar, Sawai Madhopur. Stretches from Delhi to isolated hills of Alwar & Jaipur.
- They are also called as **Alwar hills.**
- Average Height: 300 m to 670 m
- Valleys between the hills are wide & in some cases stretch for many kilometers.
- Flattered hill tops- form small plateau.
- Lake- Sambhar, Ramgarh, Pandupole
- Average elevation of 300-670 meters.
- To north & east it merges with Ganga-Yamuna Plains.
- **Hill Ranges**
    - Malkhet & Khetri Group of hills
    - Torawati Hills
- **Peaks of North-Eastern Aravalli Region:**
    - Raghunathgarh (Sikar) - 1055 meters
    - Khoh (Jaipur) - 920 meters

- Bhairach (Alwar) - 792 meters
- Barwara (Jaipur) - 786 meters
- Babai (Junjhunu) - 780 meters
- Bilali (Alwar) - 775 meters
- Manoharpura (Jaipur) - 747 meters
- Bairath (Jaipur) - 704 meters
- Sariska (Alwar) - 677 meters
- Siravas - 651 meters

2. The Central Aravali Range:

- Districts: Includes districts of Ajmer, south-western Tonk, Jaipur
- Length of central Aravalli range is 100 Km with width of 30 Km and valleys with depth of 550m.
- Height/Elevation- 700 m
- Highest Peak/elevation- 799 m in Rajgarh
- The central/Aravalli extends from Sambhar Lake to the bhorat Plateau, South of Deogarh Peak.
- Surrounded on
  - North by – Alwar Hills
  - East by Karauli table-land
  - South by Banas plains
  - West by Sambhar basin
- Hill ranges:
  - Shekhawati lower hills
  - Marwar Hills
- **Peaks of Central Aravalli Region**

- Goramji (Ajmer) - 934 meters
- Taragarh (Ajmer) - 870 meters
- Naag Pahar (Ajmer) -795 meters

- Central Aravalli Range is further sub-divided into **two geomorphic units**.

B1. The Sambhar Basin or Shekhawati Low hills

- District- Churu, Sikar, Jhunjhunu, Nagaure
- Average of Region- 400 m
- This region is full of sand hills & with in land drainage.

B2. The Merwara hills

- District- Jodhpur, Barmer, Jaisalmer, Nagaur, Ajmer
- Area- 4400 Sq. Km
- Average level- 550 m
- S.F.:- The Taragarh (873 m) overlooks the city of Ajmer. Marwar Hills appear in the parallel succession of hills in the **vicinity of Ajmer city.**

3. The Mewar Rocky region and Bhorat Plateau

- Includes district of Udaipur, South-eastern margin of Pali & Dungarpur districts.
- Area- 17007 Sq. Km
- Location- It is located from South East to South East
- Average Height- 1225 m
- S.F. – The highest portion of Aravalli range lies between the forts of Kumbhalgarh & Gogunda in the form of plateau locally known as '**Bhorat**'
- Altitude of Bhorat- 1225 m
- Bhorat plateau is one of the highest table lands of Aravalli

- Hill ranges
    - Mewar hills & Bhorat Plateau
    - Girwa Hills
    - Merwara Hills
- Peaks of Southern Aravali Range
    - Kumbhalgarh (Rajsamand) - 1224 meters
    - Dhoniya - 1183 meters
    - Hrishikesh - 1017 meters
    - Kamalnath (Udaipur) - 1001 meters
    - Sajjangarh (Udaipur)- 938 meters
    - Lilagarh - 874 meters

D. Abu Block region

- District- Abu, Sirohi
- Area 5180 Sq. Km
- Length- 10 km
- Breadth- 8 Km
- Location- West to Abu in Sirohi Sea Level- 1200 m
- S.F.: It contains granite
- It has been separated from the main Aravalli range by the wide valley of the West Banas.
- Hill ranges
    - Abu hills & Oria Plateau
- Peaks of Southern Aravali Range
    - Guru Shikhar (Sirohi) - 1722 meters
    - Ser (Sirohi) - 1597 meters

- Dilwara (Sirohi) - 1442 meters
- Jarga (Sirohi) - 1431 meters
- Achalgarh (Sirohi) - 1380 M

Top Peaks of Aravali Hills in Rajasthan

S. No	Peak Name	Height (meters)	District
1	Guru Shikhar	1732	Mount Abu, Sirohi
2	Ser Peak	1592	Sirohi
3	Delwara	1442	Sirohi
4	Jarga	1431	Udaipur
5	Achalgarh	1380	Sirohi
6	Kumbhalgarh	1224	Rajsamand
7	Raghunathgarh	1055	Sikar
8	Hrishikesh	1017	
9	Kamalnath	1001	Udaipur
10	Khoh	920	Jaipur
11	Taragarh	870	Ajmer
12	Bhairach	792	Alwar
13	Babai	780	Jhunjhunu
14	Bairath	704	Jaipur

5. Eastern Plains

- Districts- Tonk, Bundi, Amjer, Jaisalmer, Sawaimadohpur, Bhilwara, Chittorgarh, Kota, Bhatratpur.
- Percentage- 23.3% of total area of Rajasthan
- Location- South West of Rajasthan
- Eastern plain subdivided into **three regions**:

A. Chambal basin

- District- Kota, Bundi, Baran, Tonk, Sawaimadhopur, Dholpur
- Area- 4500 Sq. Km
- Average width- 10 Km

B. Banas Basin

- District- Udaipur, Chittorgarh, Bhilwara, Tonk, Jaipur, Alwar, Sawaimadhopur
- Average height- 280 – 500 m
- Area- 187400 Sq. Km
- It is an elevated peneplain plain drained by Banas & its tributaries.
- It is divided into two **sub-regions** mentioned below:

B.1. Mewar Plain:

- It is a dissected plain of Archean gneiss.
- Mewar plain gradually slopes towards the east & north-east, with an average elevation of 280-500 m.
- The Banas & its tributaries Berach, Menal, Bandi, Mansi, Kothari, Khari flow through this plain.

B.2. Malpura-Karauli Plain:

- It is flat upland, which Heron recognized as a —**Tertiary Peneplane**.
- It is composed of schist & guess with average elevation of 250-350 m
- Alluvial deposits are thick in larger parts of Kishangarh and Malpura.

C. Mahi or Chappan Basin

- District: Dungarpur
- Area: 7056 Sq. Kms.
- The regions lies to east of the Mewar hills & south of the Banas plain.
- The weastern part of Mahi Basin is hilly but central & eastern parts are fertile plains with extensive cultivation. These plains are also known as **Chhappan plains**.
- Average elevation of the region is bewteen 200-400 m.
- This dissected plain along with hill tracts of Banswara are Dungarpur are locally known as **Bagar**.

4. South-eastern Rajasthan Pathar (Hadoti Plateau)

- The region comprises of the eastern & southeastern part of the state & is known as **Hadoti**.
- This region locally called **Pathar** and **Uparmal**.
- Districts- Bhilwara, Bundi, Kota, Baran & Jhalawar districts.
- It contains about 9.6% of the area of Rajasthan.
- The Great Boundary Fault of the Aravallis forms its northwest boundary, which extends eastward across the Rajasthan border.
- River Chambal drains the large part of this area.
- This plateau is further sub-divided into two **sub-regions**.

A. Deccan highlands

- Districts- Bundi, Kota
- The western parts of the vindhyan plateau lie in the form of three concentric escarpments.
- Formed by the exposed rocks of three main sandstones with slate-stones in between.
- This physiography of south east of Rajasthan is also known as **Uparmal** (high or stony plateau)
- Region is frained by Chambal and its tributaries Kali Singh, Parwan and Parvati.
- Soil of the region is mostly black with visible deposits of Deccan Trap lava.

B. Vindhyan region

- Districts- Karauli, Sawai madhopur, Bundi, Kota
- The region presents an undulating topography strewn with boulders, blocks & depressions.
- The scarps are facing towards the southsoutheast between the Banas and the Chambal and extend towards the east over Bundelkhand.
- The scarp lands formed by massive sandstones.
- Average height of regions is between 350-550 m

Geology of Rajasthan

Rajasthan forms north-western part of the Indian Shield. The State exposes a variety of lithological and tectonic units ranging in age from Archaean to Recent times. Rajasthan is endowed with a continuous geological sequence of rocks from the oldest Archaean Metamorphic, represented by Bhilwara Supergroup (>2500 m. y.) to sub-recent alluvium & wind blown sand. The geological sequence of the state is highly varied and complex, revealing the co-existence of the most ancient rocks of the Pre-Cambrian age and the most recent alluvium as well as windblown sand.

GEOLOGY

Archaean

BHILWARA SUPERGROUP

Sand Mata Complex, Mangalwar Complex, Hindoli Group

Proterozoic

BHILWARA SUPERGROUP

Rajpura-Dariba Group, Pur-Banera Group, Jahazpur Group, Sawar Group; Ranthambor Group

ARAVALLI SUPERGROUP

Debari Group, Udaipur Group, Bari Lake Group, Kankroli Group; Jharol Group, Dovda Group, Nathdwara Group; Lunavada Group

DELHI SUPERGROUP

Railo Group; Alwar Group, Ajabgarh Group, Gogunda Group, Kumbhalgarh Group, Sirohi Group; Punagarh Group, Sindreth Group

VINDHYAN SUPERGROUP

Lower Vindhyan Group, Upper Vindhyan Group

MALANI IGNEOUS SUITE

MARWAR SUPERGROUP

Jodhpur Group, Bilara Group, Nagaur Group

Palaeozoic

Mesozoic and Cenozoic

Deccan Traps; Tertiary Alkaline Complex; Sedimentaries; Quaternary

The basement rocks - the Sandmata Complex, Mangalwar Complex and Hindoli Group of Bhilwara Supergroup - occupy central and south-eastern plains. They are Archaean in age and comprise in general, granulite-gneiss; amphibolite, metapelite, paragneiss, calc-silicate rocks and greywacke (the older granite-greenstone belt) and metavolcanic, metagreywacke (the younger granite- greenstone belt) respectively.

The Lower Proterozoic supracrustal rocks of the Jahazpur, Rajpura-Dariba, Pur-Banera and Sawar Groups of Bhilwara Supergroup rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits.

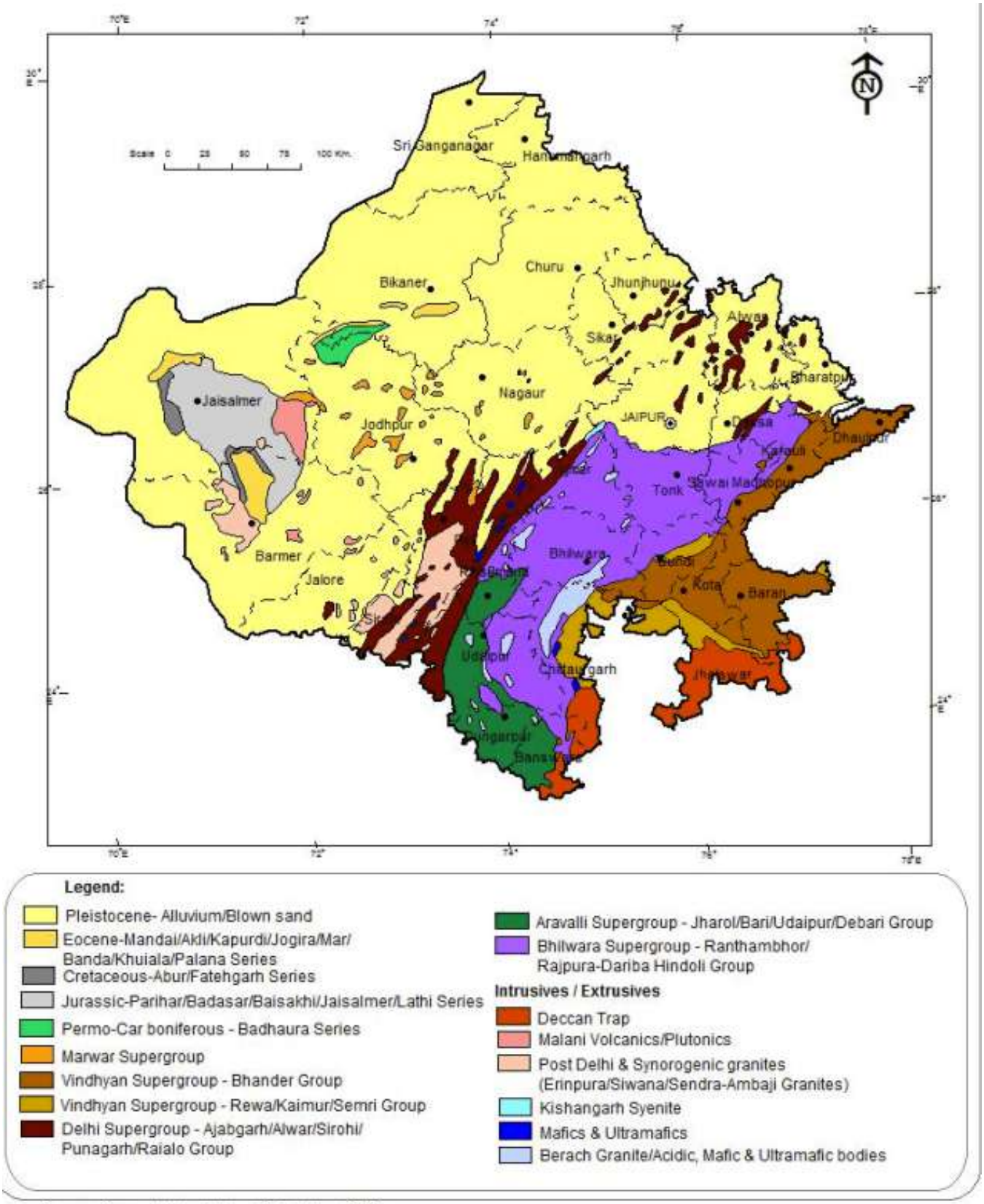
The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Supergroup) and the Delhi fold belt (the Delhi Supergroup) occupy the southern and south- eastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Supergroup is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlayered basic volcancics, whereas the Delhi Supergroup comprises mainly carbonates, metavolcanics, metasammites and metapelites, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of Sendra- Ambaji, Bairath, Dadikar, Harsora, etc. A number of base metal deposits are located in these belts as also other minerals.

The isolated hillocks of western Rajasthan constitute the Upper Proterozoic Malani Igneous Suite and the Erinpura Granite pluton. Eastern Rajasthan is characterised by the vast sedimentary stretch constituting the Vindhyans, which is juxtaposed against the rocks of the Bhilwara Supergroup along the Great Boundary Fault.

The northern and north-western parts of the State exhibit Upper Proterozoic-Early Cambrian rocks of the Marwar Supergroup which are overlain by sedimentary rocks of different ages of Palaeozoic and Mesozoic Era. Many industrial mineral deposits are found in these rocks. The Deccan Traps are restricted to the south-eastern part of the State in Chittaurgarh- Banswara area.

The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and Ganganagar-Palana shelf in the north.

The Quaternary sediments of aeolian and fluvial origin constitute the Thar Desert of Rajasthan.



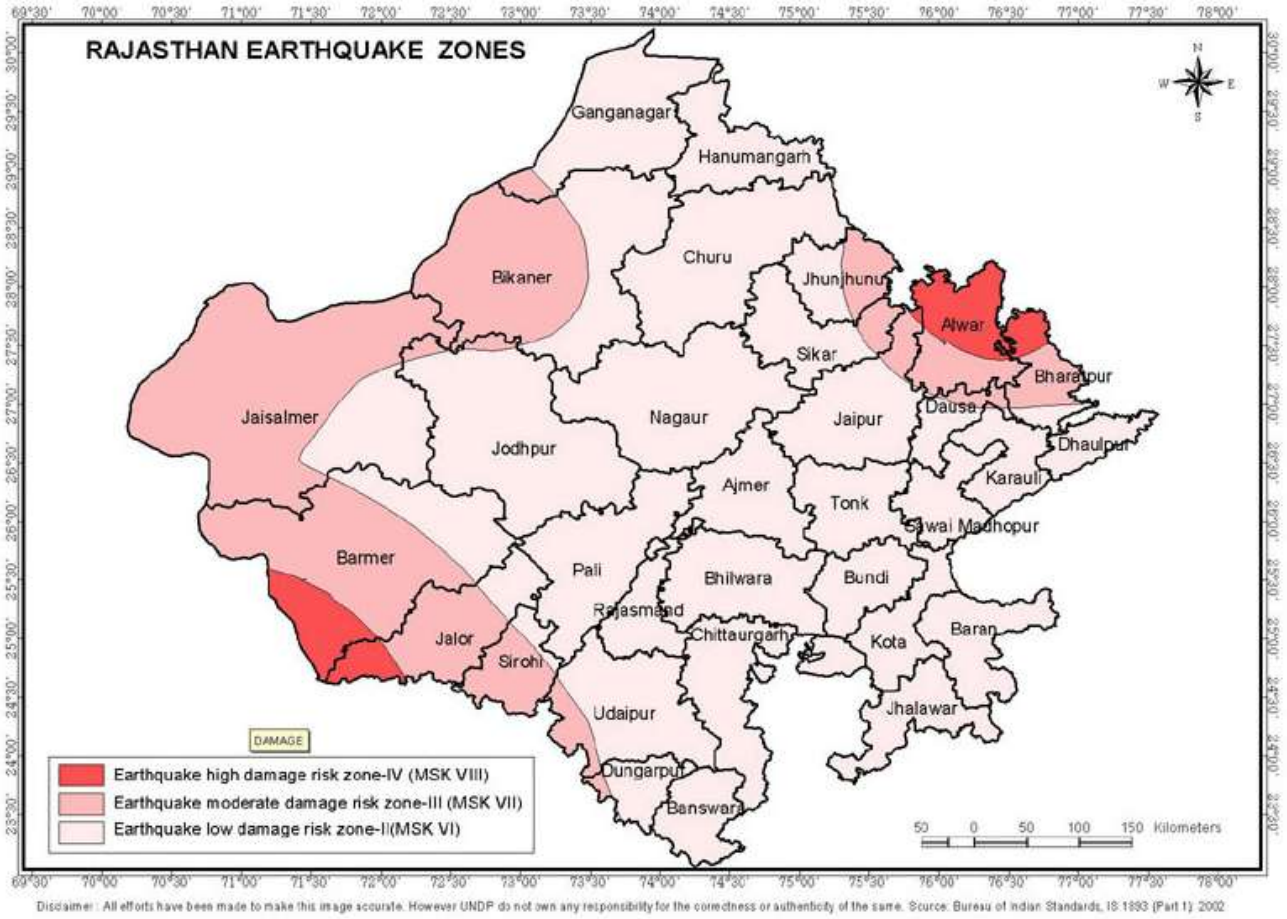
Source: Ground Water Atlas of Rajasthan, 1999

Earthquake Hazard in Rajasthan

According to GSHAP data, the state of Rajasthan falls in a region of moderate to high seismic hazard. As per the 2002 Bureau of Indian Standards (BIS) map, Rajasthan falls in Zones II, III & IV. Historically, parts of this state have experienced seismic activity in the M 5.0 range.

Classification of districts of Rajasthan according to seismic zones:

S. No.	Seismic Zone	Intensity (MSK)	Magnitude	District
1	IV [High Damage Risk Zone]	VII-VIII	6.0 - 6.9	Some parts of Barmer [Chohtan Block], Jalore [Sanchore Block] Alwar [Tijara Block], and Bharatpur [Block Nagar, Pahari]
2	III [Moderate Damage Risk Zone]	VI-VII	5.0 - 5.9	Some parts of Udaipur, Dungarpur, Sirohi, Barmer, Jaisalmer, Bikaner, Jhunjhunu, Parts of Sikar, Jaipur, Dausa, and Bharatpur.
3	II [Low damage Risk Zone]	IV-VI	4.0 - 4.0	Ganganagar, Hanumangarh, Churu, Jodhpur, Pali, Rajasamand, Chittorgarh, Jhalawar, Baran, Kota, Bundi, Sawai Madhopur, Karauli, Dholpur, Banswara, some areas of Bikaner, Udaipur, Jhunjhunu, Sikar, and Jaipur.



Largest Instrumented Earthquake in Rajasthan

- 15 August 1906 - Thar Desert, Rajasthan, Mw 6.2
- This event was located along the India-Pakistan border, in the vicinity of Janpalia, Rajasthan which is located north-northwest of Bakhasar.

Seismic Faults in Rajasthan

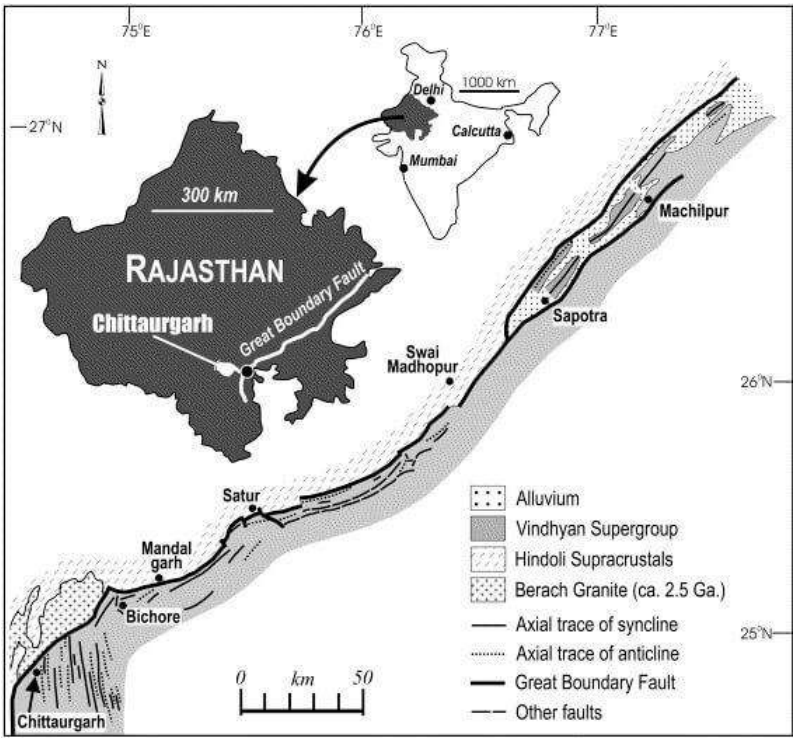
Several faults have been identified in Rajasthan, out of which many show evidence of movement during the Holocene epoch.

- The **Cambay Graben** terminates in the south-western part of the state.

- The **Konoi Fault** near Jaisalmer trends in a north-south direction and was associated with the 1991 Jaiselmer earthquake.

Several active faults criss-cross the Aravalli range and lie parallel to each other.

- The most prominent of them is the north-south trending **Sardar Shahar Fault** and
- The **Great Boundary Fault** which runs along the Chambal River and then continues in the same direction into Uttar Pradesh.



Climate of Rajasthan

Climatic Regions of Rajasthan

The climate of Rajasthan state has varied contrasts. Different experts, each with their own focus parameters, have divided Rajasthan into different climatic regions. However, three main approaches to climatic regions of Rajasthan are:

- Climatic Regions of Rajasthan based on Rainfall Intensity.
- Koeppen's Classification of climatic regions of Rajasthan.
- Thornthwaite's classification of climatic regions of Rajasthan.

Climatic Regions of Rajasthan based on Rainfall Intensity

The distribution of climatic regions of Rajasthan on the basis of rainfall and temperature variations includes following divisions:

Arid Region:

- The Arid region includes Jaisalmer district, northern parts of Barmer, western of the Phalodi Tehsil of Jodhpur, western parts of Bikaner and southern parts of Ganganagar district.
- Climate of the region is very severe and arid.
- Rainfall less than 10 cm in extreme west parts of regions and rest areas record less than 20 cm rainfall.
- The average temperature during summer is recorded more than 34o C and during winters it ranges in between 12 DegC to 16DegC.

Semi-arid Region:

- The average temperature during winter season ranges between 10 Deg C and 17 Deg C and the summer season temperature range 32 Deg C to 36 Deg C.
- As the region has erratic as well as torrential rainfall it brings floods too each time.
- Rainfall ranges 20 to 40 cm.
- The winter season is very short and arid in the northern parts of this region.

- This region comprises the western parts of Ganganagar, Hanumangarh, Jodhpur and Barmer districts.

Sub-humid Region:

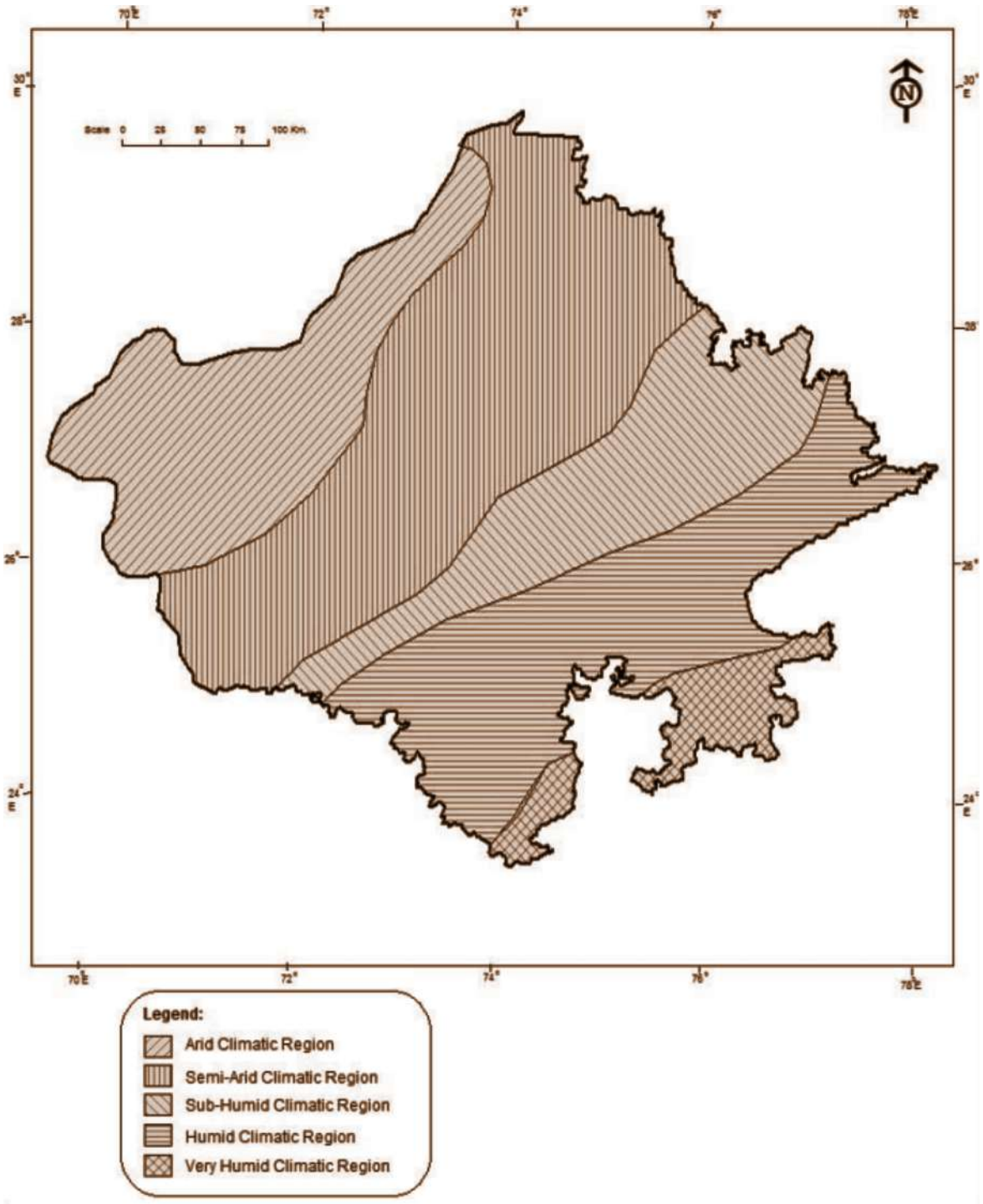
- In the semi arid humid region, rainfall is meager and the amount of rainfall is limited to a few monsoon months only.
- The rainfall is between 40 to 60 cm and the average temperature during summer season ranges from 28 Deg to 34 Deg C whereas it is recorded 12 Deg C in northern parts and 18 Deg C in the southern parts.
- Alwar, Jaipur, Dausa and Ajmer, eastern parts of Jhunjhunu, Sikar, Pali and Jalore districts, north-western parts of Tonk, Bhilwara and Sirohi districts are included in this category.
- This region has steppe type of vegetation.

Humid Region:

- This region receives winter rainfall associated with cyclones along with monsoon season rainfall which varies from 60 to 80 cm.
- Deciduous trees dominate the region.
- Humid region is found at the districts of Bharatpur, Dholpur, Sawai Madhopur, Bundi, Kota, Barmer and Rajsamand and the north-eastern parts of Udaipur.

Very Humid Region:

- Very Humid Region includes south-east Kota, Baran, Jhalawar, Banswara, south-west Udaipur and adjacent areas of Mt. Abu.
- Here, the summers are very hot and winters are cold and dry.
- Rainfall received is between 80 cm to 150 cm, which is mostly during the rainy season.
- Monsoon savanna type of vegetation is present in the region.



Koeppen's Classification of climatic regions of Rajasthan

Koeppen's classification for the World Climatic regions is totally based on the vegetation, as the effects of temperature and rainfall are directly evident and visible it. Here, the three categories are associated with Tropical climates, Dry (arid and semiarid) climates and Mild Temperate climates respectively.

Main Climates	Precipitation	Temperature
A: equitorial	W:desert	h: hot arid
B: arid	S: steppe	k: cold arid
C: warm temperate	f: fully humid	a: hot summer
D: continental	s: summer dry	b: warm summer
E: polar	w: winter dry	c: cool summer
	m: monoonal	d: extremely continental
		F: polar
		T: polar

The classification of Rajasthan according to Koeppen is as follows:

Aw or Tropical Humid Region:

- The southern parts of Dungarpur district and Banswara come under the region.
- Here, arid tropical grasslands and Savanna like region are found along with deciduous trees of Monsoon type.
- Winter season is arid and cool whereas summers experience scorching heat.
- Rainfall also mainly occurs in summer season.
- The temperature is more than 18 Deg. C in the coldest month records.

Bshw Climatic Region:

- This climatic region is semi-arid, where winters are dry and even in summers there is no sufficient amount of rainfall.
- Vegetation is of steppe type, characterized with thorny bushes and grasses.
- This region comprises the districts of Barmer, Jalore, Jodhpur, Nagaur, Churu, Sikar, Jhunjhunu and Hanumangarh.

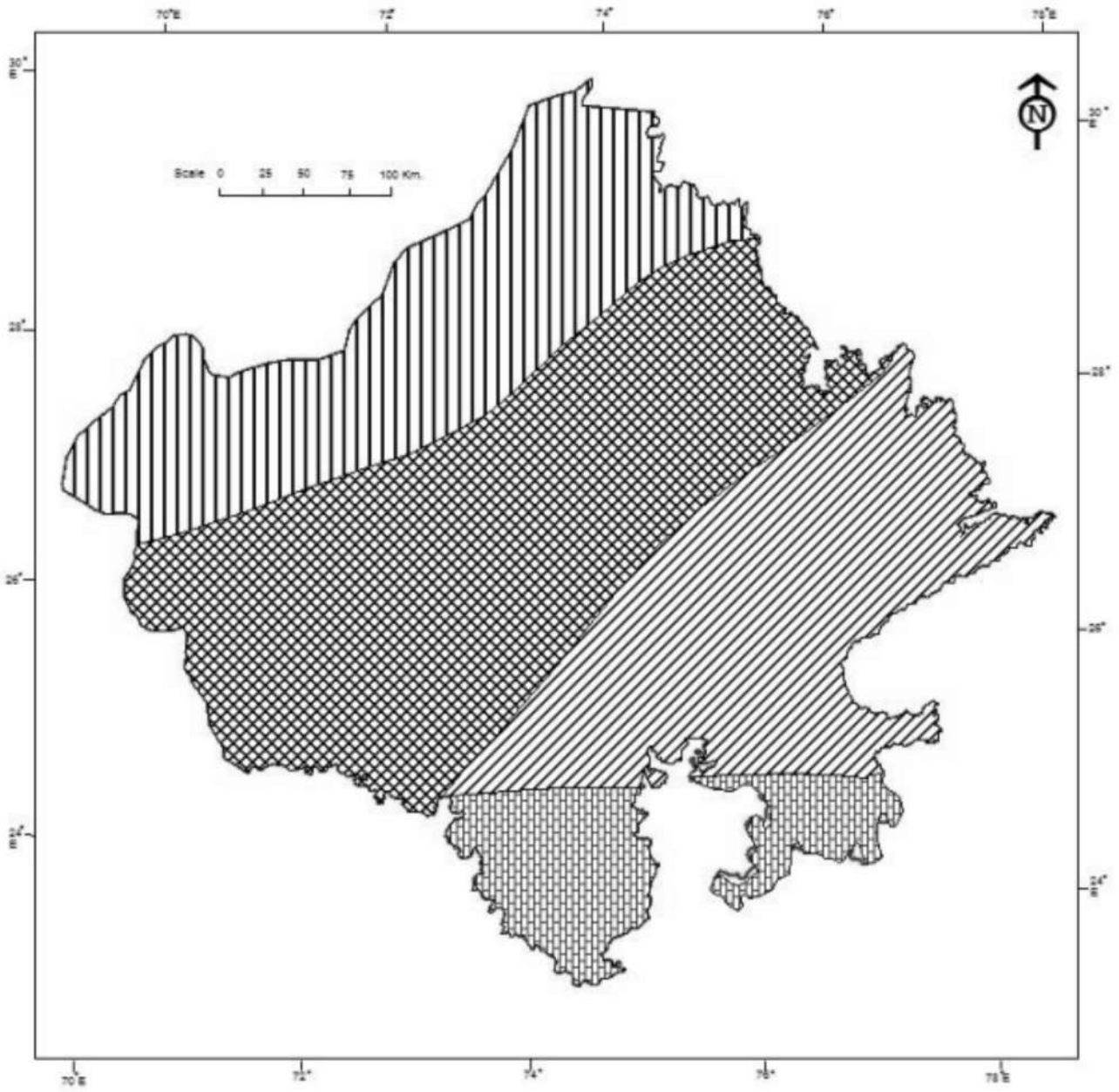
Bwhw Climatic Region:

- The region has arid-hot desert climate with very scanty rainfall.
- On the contrary the process of evaporation is very active.
- Thus, these areas are known as desert region, limited to western parts of Thar Desert.

- North-western Jodhpur, Jaisalmer, western Bikaner and western parts of Ganganagar district are included in this category.

Cwg Climatic Region:

- The south-eastern areas of Aravalli are the part of the region.
- Rains are limited to few monsoon months only.
- Seasonal winds do not bring rains to this region during winters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Aw Climatic Region
Bshw Climatic Region
Cwg Climatic Region

Thornthwaite's classification of climatic regions of Rajasthan

Thornthwaite took into account the amount of prepitation and evaporation along with seasonal and monthly distribution of temperature and rainfall which made it popular and widely accepted. Rajasthan may broadly be divided into the following four regions:

CA'w Climatic Region

- This region is characterized by wet summers and dry winters.
- Savanna and Monsoon type of vegetation are found here.
- This region includes south-eastern parts of Udaipur and districts of Banswara, Dungarpur, Kota, and Jhalawar.

DA'w Climatic Region

- The region comprises south and eastern areas of Rajasthan, covering districts of Sirohi, east Jalor, Pali, Ajmer, Chittorgarh, Bundi, Sawai Madhopur, Tonk, Bhilwara, Bharatpur, Jaipur, Dausa, Alwar, Sikar and Jhunjhunu.
- Rainfall is meager and Semi-arid vegetation is found.
- Summers are marked by High temperatures.

DB'W Climatic Region

- It includes the northern areas of Rajasthan i.e. Ganganagar, Hanumangarh, Churu and Bikaner districts.
- The region has short and dry winters whereas summers are long and associated with good rains.
- Thorny bushes and semi-arid vegetation are found here

EA'd Tropical Desert Climatic Region

- This region is also known as Marusthali and includes Barmer, Jaisalmer, western Jodhpur, south-western Bikaner district.
- The climate is very hot and arid. Rains are deficient in every season.
- Only Xerophytic vegetation grows.

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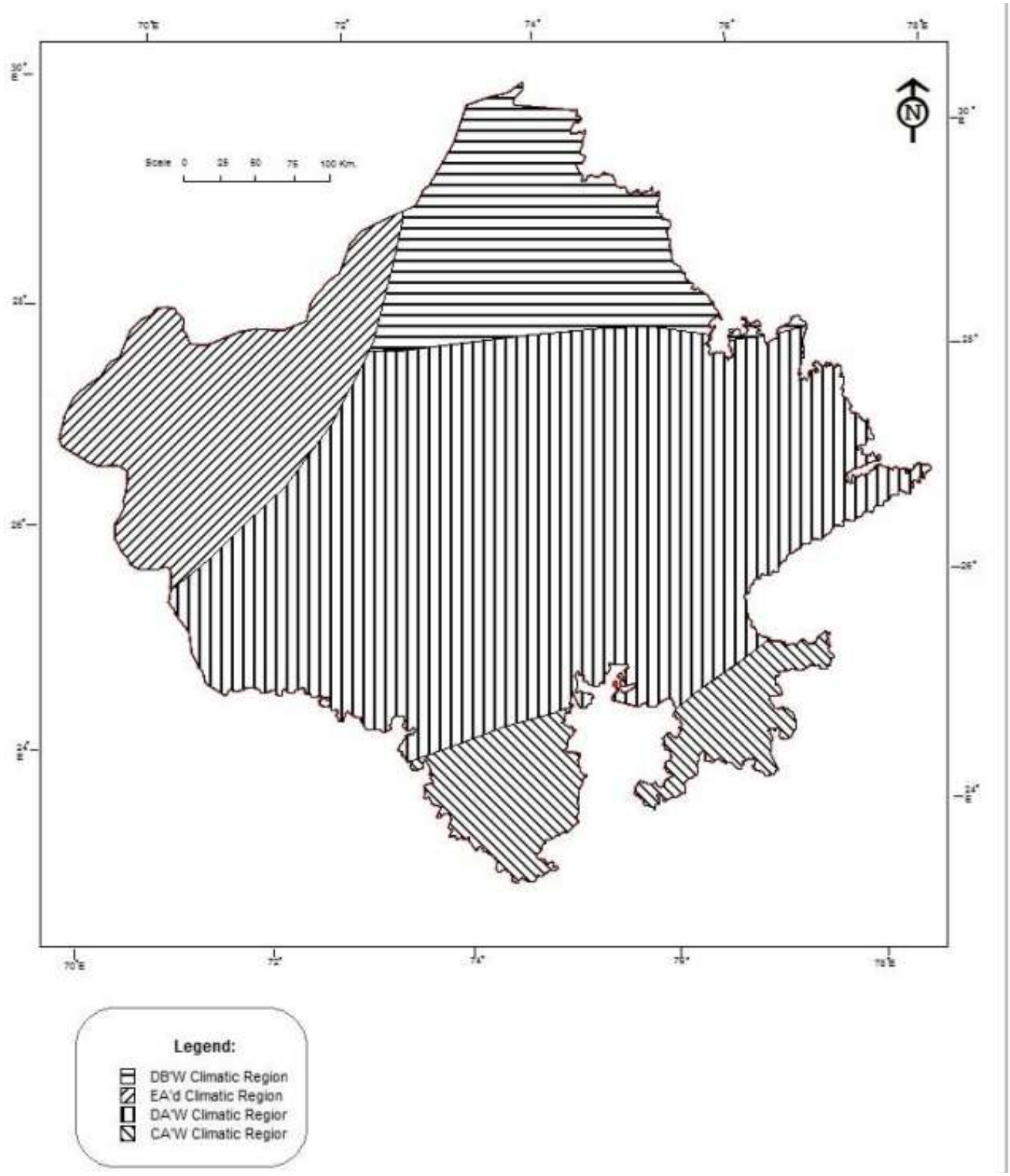
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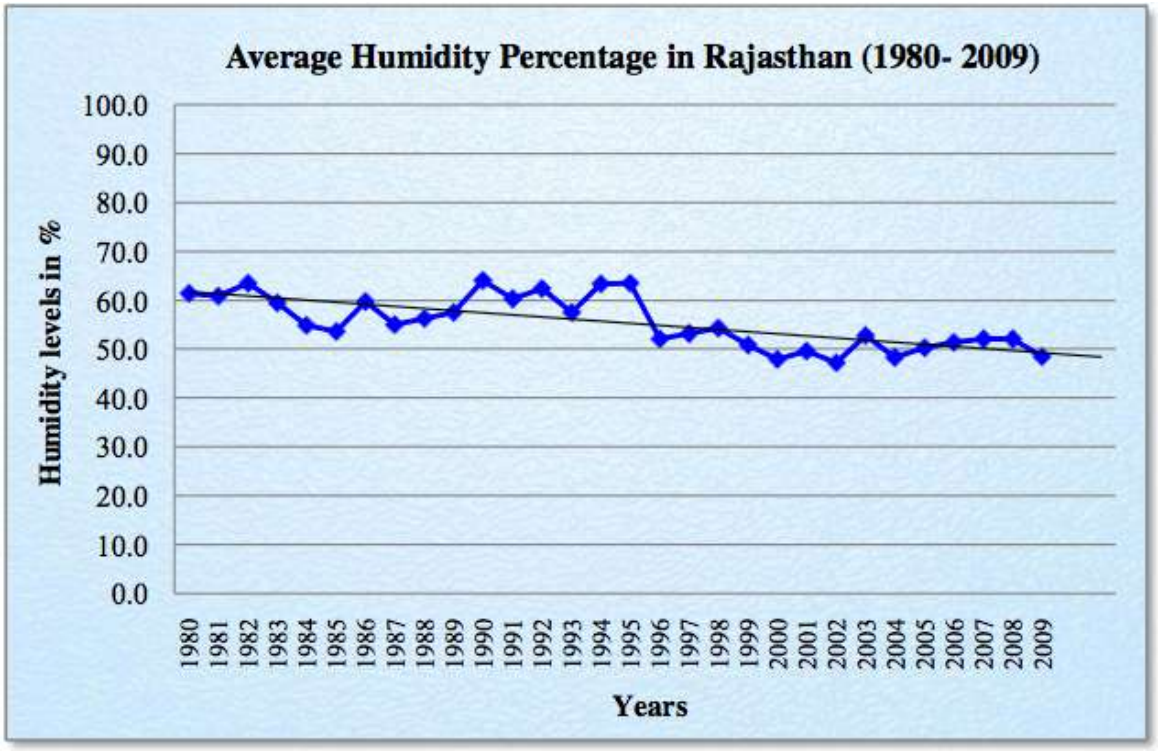
CA'W Climatic Regior

Average and Relative Humidity in Rajasthan

During the monsoon months, July to September the relative humidity is generally high in the state of Rajasthan. The humidity is about 45%-47% in June, which rises to a little less than 70% during August in West Rajasthan and to about 76%-77% in East Rajasthan. The Graph depicts the humidity regime in the state from 1980 to 2009. The average annual humidity percentage during these 30 years was 55.4 %. The trend line in the figure shows a gradual decrease in humidity percentage in the state from 1980 to 2009.



The diurnal variation in relative humidity is least during monsoon in the East Rajasthan; on the contrary it is higher in West Rajasthan. In the summer afternoons the relative humidity is least, i.e. about 20 to 30% in most of the state which makes the summer very dry and hot. In the winters (January and February) the diurnal variation is highest.

Air temperature and relative humidity conditions

The pleasant winters in the state witness mean night temperatures above 4.7oC to 10.6oC. During summers the western Rajasthan becomes the hottest place in the country with mean maximum air temperatures varying from 38.6oC to 42.6oC in May. The recorded extreme temperatures in the state

were -4.4oC to 50.0oC in the western Rajasthan and -2.8oC to 47.8oC in the eastern Rajasthan (Indian Meteorological Department, 2010).

The relative humidity in the arid region of Western Rajasthan is also quite high because of the unfavorable circulations of the atmosphere and low precipitation that occurs in the arid region as compared to other semi-arid and sub-humid regions.

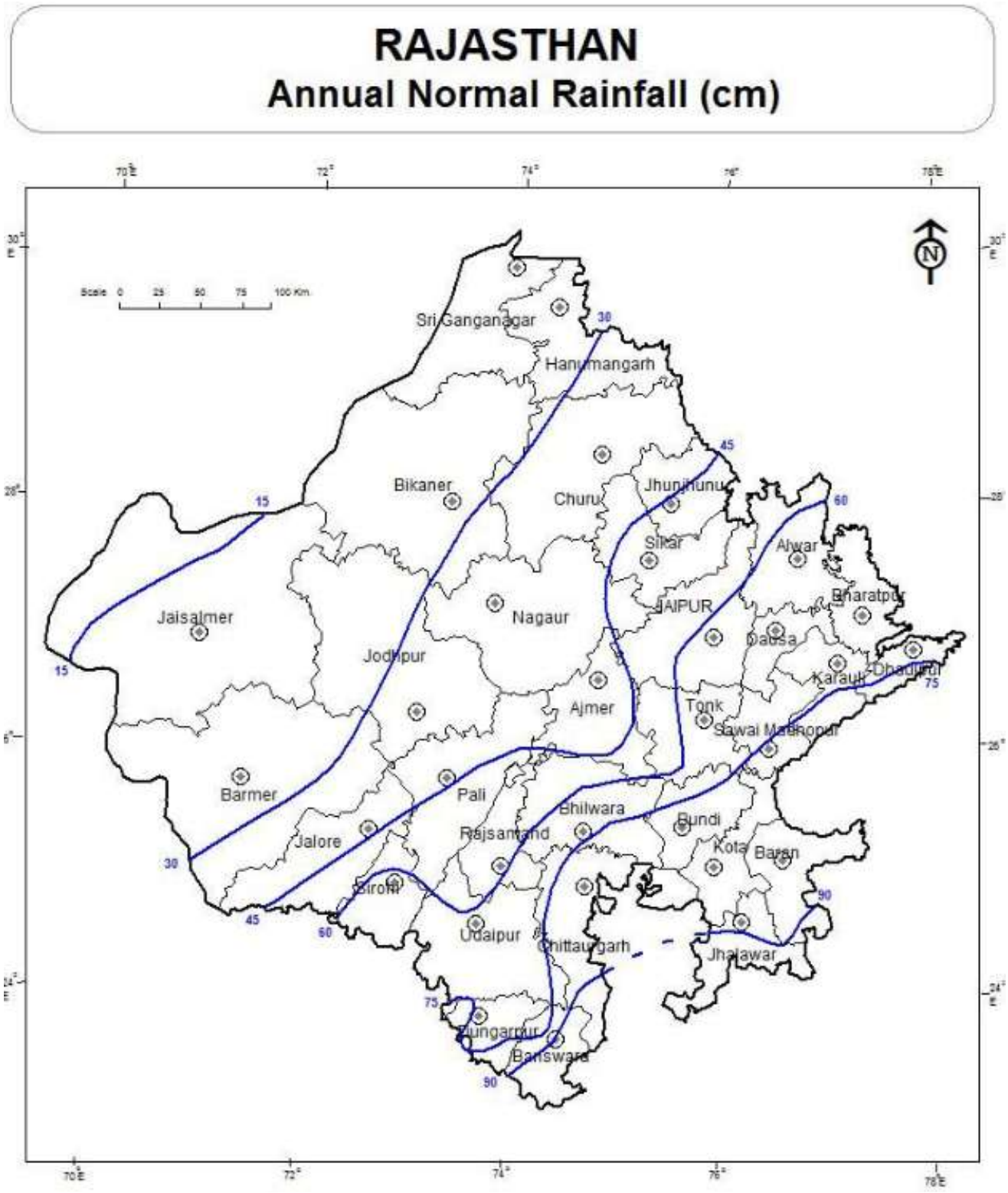
Rainfall in Rajasthan

The principal rainy season when the Rajasthan state receives 91% of its annual rainfall is during the South-West monsoon. The total normal annual rainfall in the state varies from 1000 cm over the South-Eastern parts to 14 cm over the extreme North-Western parts. The rest share of rainfall comes during the cold weather season about 2%, the summer season about 3% and during the post-monsoon season about 4% of the annual total rainfall respectively.

The onset of the southwest monsoon over the eastern parts of the state is witnessed almost by the last week of June which extends over the entire state by the first week of July. Amounting individually to about 34% of the annual rainfall each, July and August are generally the rainiest months. Around 1st September the withdrawal of the southwest monsoon begins from the northern western parts of the state and by 15th September it withdraws from the entire state. During cold weather season a small amount of rainfall i.e. 1cm and 0.7 cm in East and West Rajasthan is received. This respectively is of great significance for agriculture and if occurs in association with western disturbances which move from west to east across the northern parts of the country.

During the south-west monsoon period extending from June to September the state receives about 90% of the total rainfall. The cold weather period (January and February) receive the Remaining portion of rainfall which occurs in association with the local convective activity.

Below is the graph for annual normal rainfall in Rajasthan:

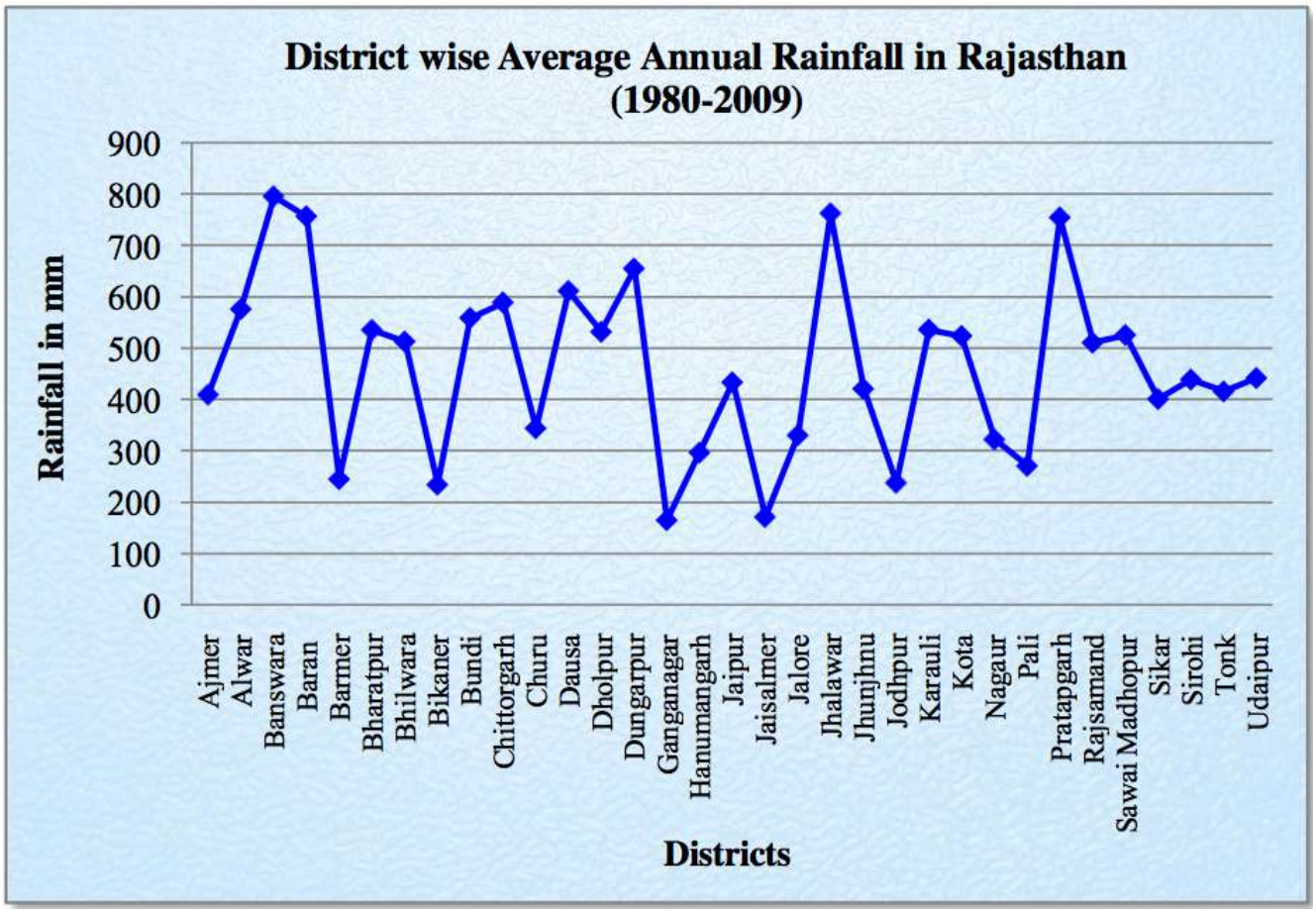


Distribution of Rainfall in Rajasthan:

There is a wide variation in the mean annual rainfall over Rajasthan as the extreme western parts of Jaisalmer district receive rainfall less than 100mm in contrast to more than 900mm in the eastern parts of Jhalawar and Banswara. The districts of East Rajasthan receive more rainfall than those of West Rajasthan. The mean annual rainfall in the East and West Rajasthan is about 64.9 cm and 32.7 cm respectively.

The maximum rainfall in the state is received in the Southern or South- Eastern districts of the state. On the west of Aravalli hills Pali and Jalore districts receive maximum amount of rain of 50 cm and 43 cm in West Rajasthan.

In the North or North-Western districts Jaisalmer district receives the lowest rainfall. Bikaner, Ganganagar, Jaisalmer receive annual rainfall of 26cm, 24cm and 17cm respectively. The adjoining areas of these districts constitute the driest zone of the state.

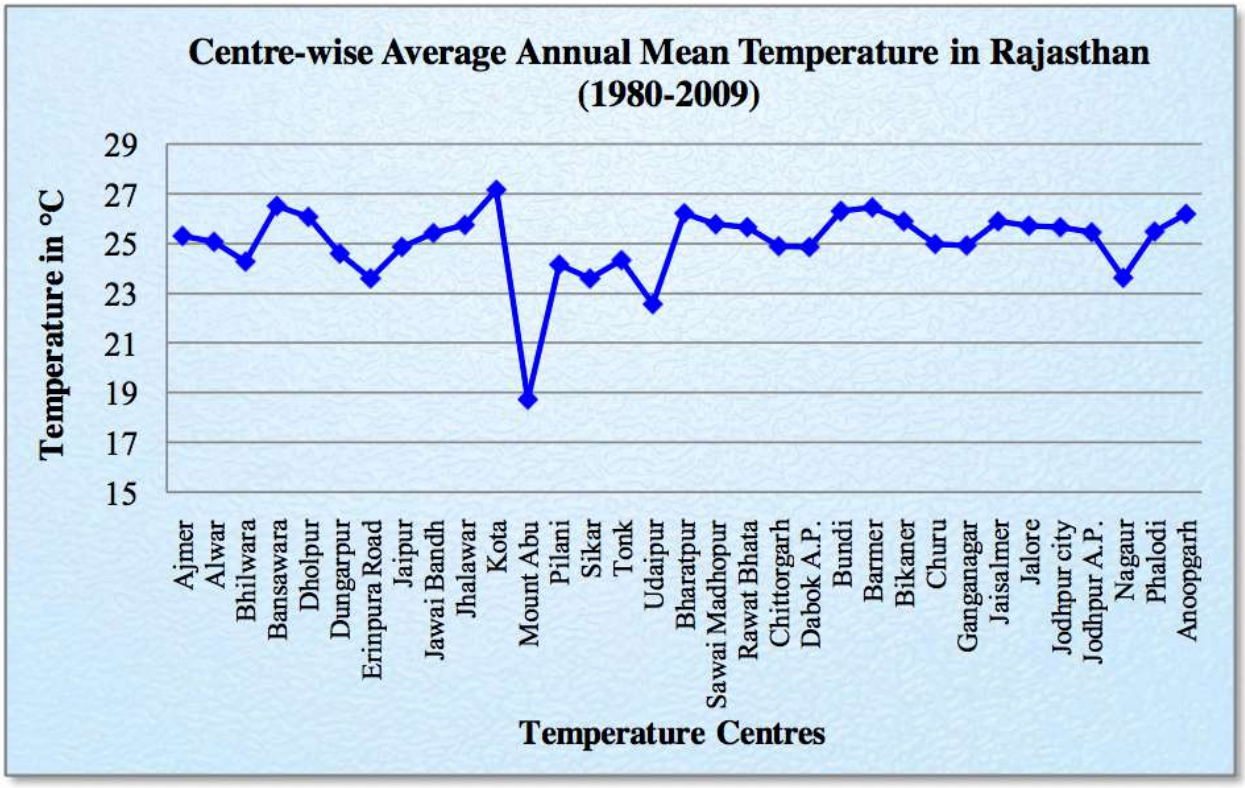


The lowest recorded annual rainfall in the past 100 years i.e. between 1900 and 2010 was 24 mm in the western Rajasthan and whereas it was never below 120 mm in the eastern Rajasthan.

Temperature Variation in Rajasthan

The Rajasthan state experiences more or less uniform day temperatures over the plains except during the winter when temperatures increase southwards and during monsoon season when temperatures increase northwards. During the southwest monsoon the night minimum temperatures are more or less uniform but generally they are lower in higher latitudes.

As compared to the plains the day and night temperatures over the plateau and at high level stations are lower. In the hottest month of May the mean maximum temperature is approximately around 41°C - 42°C in the plains, but it is 2°C to 4°C lower in the elevated and plateau regions of the state. The Graph depicts the average mean temperature of Rajasthan district-wise from the year 1980 to 2009.



The mean minimum temperature in the coldest month of January in the state is 7.4°C, which varies from 4°C in the north to 12°C in the south. With the arrival of western disturbances much lower winter temperature may be experienced. Minimum temperature 2°C - 5°C below the freezing point can be recorded at few stations of northern Rajasthan. In the past 50 years the lowest minimum temperature at a plain station ever recorded was -5.9°C at Jaisalmer on 12 January 1967 (12.8°C below the respective

normal for the coldest month), while the hill station of Abu had recorded the lowest temperature of -7.4°C on 12 December 1994 (13.1°C below the respective normal for the coldest month).

The maximum temperature rise rapidly from February onwards till May and minimum temperature from February onwards till June. The increase in maximum in the period from January to May ranges from 13°C to 20°C at individual stations as we proceed from south to north of the state. From the beginning of June to the end of July, the maximum temperature falls by about 3°C to 7°C whereas the minimum temperature falls only by about 3°C to 5°C from June to September. A slight rise in the maximum temperature is experienced in the month of September due to increased insolation.

Post-September the night temperatures start falling rapidly while day temperatures too start falling rapidly after October and by January both attain their lowest values. There is about 8°C to 15°C fall in minimum temperature and maximum temperature fall by 5°C to 7°C. In both cases, the fall increases from southern parts of the state to the northern parts. Smallest diurnal range of temperature is experienced during July and August of about 9°C in the state. After the withdrawal of the monsoon the diurnal range of temperature increases. The diurnal range is greatest in November month.

Solar Radiation and Sunshine Availability in Rajasthan

Solar Radiation

Rajasthan region receives abundant quantities of solar radiation especially the western parts of the state. The mean duration of bright sunshine in this region is 8.0 to 8.8 hr/day.

- The maximum sunshine period of 9.6 to 9.8 hr/day is in October for western part of Rajasthan whereas it is 10.0 to 10.5 hr/day during April and May for eastern part.
- In rainy month of August the sunshine is available only for about 4.4 to 7.1 hrs/day.

Cloudiness

- In a year, Rajasthan has 300-330 days of clear sunshine.
- Even during rainy season of July and August, the skies remain clear for 8-9 days/month in west Rajasthan and for 4-5 days/month in east Rajasthan.

- The cloud cover decreases to a great extent over the entire state during October.

Fog:

- Fog occurs occasionally due to lack of sufficient moisture in the region.
- The maximum frequency of occurrence of fog is during December and January in both Western and Eastern Rajasthan.
- During the monsoon season hill fog occurs at few places, when air is almost saturated and is easily cooled below the dew point while rising over high elevations.

Evapotranspiration

- The annual potential evapotranspiration values vary widely between eastern and western Rajasthan.
- In Dungarpur and Banswara districts the annual potential evapotranspiration is less than 1300 mm whereas it is more than 2000 mm in Jaisalmer district.

Wind Regime and associated phenomenon

Wind Regime and associated phenomenon

- The wind directions are mostly south-westerly during large part of the year whereas during winter they are northeast to north.
- During the winter season the Winds are light and variable but in summers especially around May to July strong winds prevail in the most parts of Rajasthan.
- Summers witness severe dust storm period too when the wind speed rises up to 60 kilometer per hour causing erosion from the dry soils.

Wind Velocity:

- There is a direct link between wind velocity and seasons.
- The wind speed reaches the highest in the month of June, which starts rising from the month of April. The wind speed starts gradually decreasing and comes to minimum in the month of November.
- In the Western Rajasthan, Jaisalmer has the highest mean monthly wind velocity followed by Jodhpur.
- On the eastern side Jaipur has the highest mean monthly wind velocity. For the most of the days during a year the Wind speed remains 1-19 km per hour all over the State (Indian Meteorological Department, 2010).

Dust storms

- For the occurrence of both thunderstorms and dust storms **convective activity** is essential. When the moisture is insufficient in the atmosphere, dry thunderstorms or dust storms occur.
- Dry and hot winds known as '**Loo**', blow in the afternoon, and very often, they continue to well into midnight. Dust storms in the evening are very common in May for south-eastern areas and in June for north-western part of state. Ganganagar has about 27 days of dust-storm followed by Bikaner and Jodhpur.
- Dust storms are mainly confined to the summer months of March-June.

Thunderstorms:

- Thunderstorms are associated more with eastern part of the state then the arid western areas.
- The maximum occurrences of thunderstorms are during July (with approach of Monsoon) in the state and minimal in the months from November to January.
- The average number of days of thunderstorms during the monsoon season is about 11 in West Rajasthan and 10 in East Rajasthan.
- The average annual number of thunderstorms in the West and East Rajasthan are 17.0 and 15.0.
- Hail is sometimes accompanied with Pre-monsoon and monsoon thunderstorms.

Atmospheric Sea Level Pressure and Winds:

- There is a very systematic manner in which the seasonal variations of atmospheric pressure take place over the state, with a maximum in the winter (January) and a minimum in the monsoon season (July).
- Except during the late summer and monsoon season the pressure gradient generally remains weak over the state.
- During winters the higher pressure is to the north and during summers the pressure decreases from south to north in Rajasthan.

Weather Seasons of Rajasthan

The geographical diversity of the state causes varied weather conditions even during same season. However, Rajasthan has four distinct weather seasons:

- The hot weather season (March to Mid June)
- The season of general rains (mid-June to September)
- The season of retreating monsoon (October - November)
- The cold season (December to February)

The Hot Weather Season

With the apparent northward movement of the sun towards the Tropic of Cancer in March, temperatures start rising in north India. April, May and June are the months of summer in north India.

Dry and hot winds known as '**Loo**', blow in the afternoon, and very often, they continue to well into midnight. Dust storms in the evening are very common in May for south-eastern areas and in June for north-western part of state. Ganganagar has about 27 days of dust-storm followed by Bikaner and Jodhpur.

- **Duration:** Season is initiated in March and prevails from April to Mid-June.

- **Average Mean Temperature:** The maximum daily temperature in the western parts of Marusthali mainly at Bikaner, Phalodi, Barmer, and Jaisalmer goes upto 40-45 deg C.
- **Rainfall:** Sometimes, the dust storms bring a welcome respite from the oppressing heat since they bring with them light rains and a pleasant cool breeze.

The Season of General Rains

As a result of rapid increase of temperature in May over the northwestern plains, the low pressure conditions over there get further intensified. By early June, they are powerful enough to attract the trade winds of Southern Hemisphere coming from the Indian Ocean. These southeast trade winds cross the equator and enter the Bay of Bengal and the Arabian Sea, only to be caught up in the air circulation over India. Passing over the equatorial warm currents, they bring with them moisture in abundance. After crossing the equator, they follow a southwesterly direction. That is why they are known as southwest monsoons.

As these winds approach the land, their southwesterly direction is modified by the relief and thermal low pressure over the northwest India. The monsoon approaches the landmass in two branches:

- (i) The Arabian Sea branch

- (ii) The Bay of Bengal branch.

While both of these branches aim to reach the low pressure area of northern plains, yet, Rajasthan has considerable less rainfall because of following reasons:

- The Bay of Bengal branch already gives up its moisture during its passage through Ganga plain. Further, as Aravali range stretches from south-west to north-east direction, so western part of Rajasthan lies in leeward side of the Bay of Bengal branch and receives little or no rain from this branch.
- The same Aravalli Range lies parallel to the direction of Arabian Sea branch and fails to interrupt this branch of monsoon. However, in he southern Aravallis, the mountains have slight east-west span thus Mount Abu in south receives highest rainfall.

Thunderstorms:

- Thunderstorms are associated more with eastern part of the state then the arid western areas.

The Season of Retreating Monsoon

The months of October and November are known for retreating monsoons. By the end of September, the southwest monsoon becomes weak as the low pressure trough of the Ganga plain starts moving southward in response to the southward march of the sun. The monsoon retreats from the western Rajasthan by the first week of September. It withdraws from Rajasthan, Gujarat, Western Ganga plain and the Central Highlands by the end of the month.

The retreating southwest monsoon season is marked by clear skies and rise in temperature. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as the 'October heat'.

- **Duration:** October - November
- **Average Mean Temperature:** The temperature is fairly uniform with maximum ranging from 33-36 deg C and minimum ranging from 17 - 21 deg C. November is slightly cooler.

The Cold Weather Season

- **Duration:** January - February

- **Average Mean Temperature:** Ranges from 12 deg. C in North of State to 16 deg. C in the south in January.
- **Winds:** During the cold weather season, the sun migrates to the southern hemisphere and creates high-pressure condition over the northern plain. As a result, winds start blowing from northwestern high pressure zone to the low air pressure zone over the Indian Ocean in the south.
- **Rainfall:** The pleasant weather conditions, however, at intervals, get disturbed by shallow cyclonic depressions originating over the east Mediterranean Sea and travelling eastwards across West Asia, Iran, Afghanistan and Pakistan before they reach the northwestern parts of India. On their way, the moisture content gets augmented from the Caspian Sea in the north and the Persian Gulf in the south. These cyclonic depressions have little effect in weather conditions of the state.

TRADITIONAL INDIAN SEASONS

In the Indian tradition, a year is divided into six two-monthly seasons. This cycle of seasons, which the common people in north and central India follow is based on their practical experience and age-old perception of weather phenomena. However, this system does not match with the seasons of south India where there is little variation in the seasons.

S.No.	**Seasons**	**Months (Indian Calendar)**	**Months (Gregorian Calendar)**
1.	Vasanta	Chaitra-Vaishakha	March-April
2.	Grishma	Jyaistha-Asadha	May-June
3.	Varsha	Sravana-Bhadra	July-August
4.	Sharada	Asvina-Kartika	September-October
5.	Hemanta	Margashirsa-Pausa	November-December
6.	Shishira	Magha-Phalguna	January-February

Water Resources of Rajasthan

Rajasthan faces one the greatest scarcity of water resources in the country. It has 13.88% of India's cultivable area, 5.67% of population and about 11% of country's livestock but it has only 1.16 % of surface water and 1.70% of ground water. Thus, Rajasthan a state with about 10% of land area has only around 1% of country's water resources.

Water Resources of Rajasthan:

The State's water resources are categorised in following terms:

1. Surface Water (SW):

1.1 Surface water (stream flows) generated from within Rajasthan boundaries:

- The surface water potential of the state from internal sources comprising 14 Rainfed river basins is estimated at 15.86 million acre feet.

(2010) Status of available surface water and storage created in Rajasthan

River Basin	Available Yield (in MCM)	Storage created (in MCM)
Shekhawati	104.7	89.72
Ruparail	179.5	101.64
Banganga	449.2	412.26
Gambhir	353.3	231.56
Parvati	138.1	157.28
Sabi	168.3	107.65
Banas	4039.3	3639.76
Chambal	5203	2906.77
Mahi	3149	2726.59
Sabarmati	799.9	200.09
Luni	451.8	1136.66
West Banas	406.1	79
Sukli	111.7	44.29
Other Nallah of Jalore	31.6	0
Outside Basin	468	9

Source: Irrigation Department, Government of Rajasthan, Jaipur.

- Surface Water Sources: Covered in Next Chapter.

1.2 Imported Surface Water:

- Imported water delivered to Rajasthan from other states by means of several projects under relevant inter-state agreements.

The share of Rajasthan in out of State rivers as per various inter-State agreements

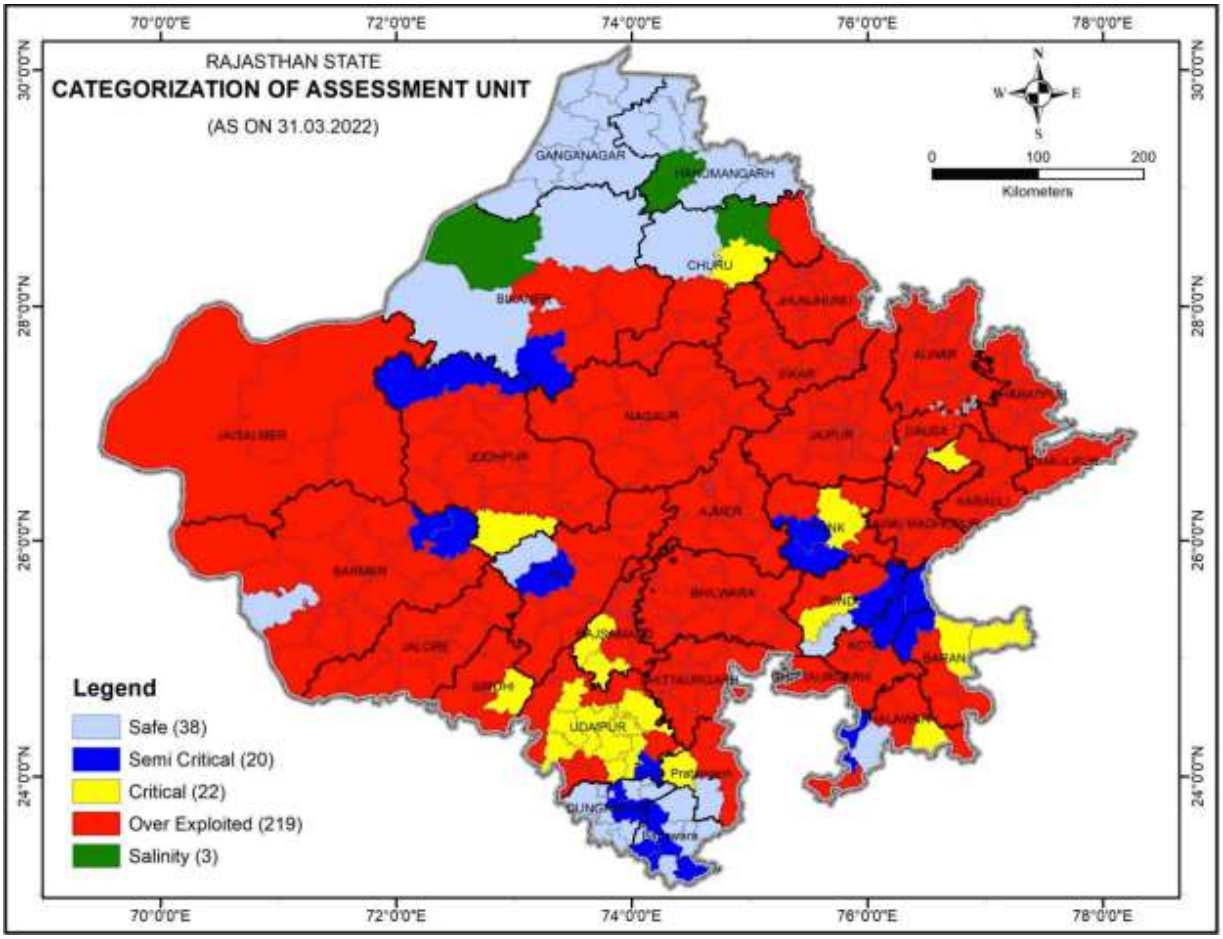
S.No	Resource	Allotted Water in MAF (Million Acre Feet)
1	Gang Canal	1.11
2	Bhakra Canal	1.41
3	Narmada	0.5
4	Ravi-Beas	8.6
5	Yamuna Water	0.91
6	Mahi Water	0.37
7	Chambal/Kota Barrage	1.6
	Total	14.5

2. Ground Water (GW):

- Groundwater availability in Rajasthan is highly variable, depending on hydrological conditions.
- The limited ground water resources in Rajasthan are increasingly being exploited for irrigation, Industrial and domestic uses.
- In 2022, out of 302 Blocks. the ground-water status was as follows:

Parameter	No. of Blocks
1. Over Exploited (greater than 100%)	219
2. Critical (90% - 100%)	22
3. Semi- critical (70%-90%)	20
4. Safe (Less than 70%)	38
5. Saline Water Blocks	03
Total	**302**

Source: Rajasthan economic review 2022-23



Major Issues related to Water in Rajasthan:

Scarcity of surface and groundwater

Rajasthan is the driest state with nearly 70 percent (2/3rd) of the area classified as arid and semi arid region. The annual average demand in 2010 in the state was of 31333.74 million cubic meter (MCM) with an availability of 10448.59 MCM annual average surface water (having 75% dependability) and 10563.01 MCM of annual average ground water. Hence there is gap of around 30% in demand and availability.

Uranium Contamination in Ground Water in Rajasthan

A recent news article published in *the Hindu & Times of India*, highlights a a study conducted by researchers at the *Duke University in North Carolina, United States, and the Central Groundwater Board of India*. The report raises concerns over presence of high uranium levels in their groundwater of State of Rajasthan along with 16 other north-western states including Punjab, Haryana etc.

The Problem:

Uranium levels in 75 out of 226 wells in Rajasthan and five out of 98 wells tested in Gujarat exceeded the WHO provisional health guidelines. According to WHO the safe drinking water standards are 30 micrograms of uranium per litre. As mentioned in the study India extracts more than a third of world wide groundwater resources and more than 90% of this is being used for irrigation. Long term exposure to uranium in drinking water can cause **kidney deceases**.

Causes of Uranium Contamination:

The main source of uranium contamination was "natural," but human factors such as declining ground water table and rising nitrate pollution contributes significantly to the rise in contamination.

It is demonstrated in the paper that the combination of different factors, like aquifer rocks containing uranium (granitic rocks or sediments derived from weathering of granitic rocks), oxidizing conditions that leach out uranium from the rocks and make it soluble, and the groundwater chemistry with high bicarbonate in which uranium is attached and thus become mobile, all contribute to the high uranium in groundwater in India.

Possible solution to Uranium Contamination:

- The first step towards solution could be first monitoring, than avoiding (using other water source) or treatment (RO desalination).
- Including uranium in the list of contaminants monitored under the Bureau of Indian Standards' Drinking Water Specifications.

Water use priority:

According to the document State Water Policy (SWP), February 2010, State Water Resources Planning Department, Rajasthan, Jaipur, water allocation priorities for water resources management and planning purposes, are as follows:

1. Human Drinking Water
2. Livestock drinking
3. Water other domestic,
4. Commercial and municipal water uses
5. Agriculture
6. Power generation Environmental and ecological
7. Industrial
8. Non-consumptive uses, such as cultural, leisure and tourist uses
9. Others

The above water allocation priorities were followed while carrying out water supply and demand balance block-wise and micro watershed wise.

Ground-Water Quality Issues:

Rajasthan is over-dependent on groundwater. The major problems associated with groundwater quality are fluoride, nitrate, and salinity. The worst affected districts with 50 percent or more concentrations are:

Fluoride:

- Tonk, Jaipur, Nagaur, Ajmer, Bhilwara, Sirohi, Bundi and Pali
- **Causes of High Flouride:**
    - Presence of rocks like Pegmatite , Gabbros etc. containing minerals like Fluorspar, Fluorite, Lepidolite, Tremolite.
    - Presence of calcite and dolomite which accelerate the leaching of fluoride to the groundwater.
    - The arid climate with high evaporation and insignificant natural recharge increase fluoride concentration in the groundwater.

Nitrate > 100 ppm:

- Churu, Nagaur, Jhunjhunu

Total Dissolved Solids (TDS) > 2000 ppm:

- Churu, Barmer, Bharatpur

Iron > 1ppm:

- Bhilwara, Jodhpur, Baran, Jaipur

Surface Water Quality Issues:

- The two major causes of surface water pollution are sewage water and industrial effluent.
- Rajasthan has clusters of textile printing units emitting wastewater containing dyes leading to heavy metal pollution of surface and groundwater.
- Industrial water pollution in the state is mainly con ned to Kota, Alwar, Udaipur, Jodhpur, Pali, Balotra, Sanganer, Bhilwara, Jhotwara, and Bagru areas.

Steps taken to Improve Water Resources of Rajasthan

Water Vision 2045

Water Resource Vision 2045 has been prepared to highlight the short term (upto 2015) and long term (upto-2045) thrust areas and action plan which are pre-requisites for successful implementation of the State Water Policy and Plan and achieving the objective of optimum use of every drop of scarce and precious utilisable water resource.

Government Organisations

- Water Resources Department
- Rajasthan River Basin & Water Resources Planning Authority
- Command Area Development & Water Utilization Department
- Rajasthan River Basin & Water Resources Planning Authority
- Ground Water Department
- Watershed Development and Soil Conservation Department
- Rural Development & Panchayati Raj Department
- Public Health Engineering Department (PHED)

Schemes to improve water availability

- Mukhya Mantri Jal Swavlamban Abhiyan
- Interlinking of Rivers
- Rooftop Rain Water Harvesting
    - Roof Top RWH has been made mandatory in State owned buildings of plot size more than 300 Sq.m with effect from 03.01.2006.
- Under the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) the activities related to water conservation and rain-water harvesting, drought proofing, construction of irrigation canals, rejuvenation of traditional water bodies and developing drainage in the waterlogged areas are being taken up.

- Construction of Dams & Reservoirs.
- Watershed development:
    - There are various programs in the state under which watershed development is done are: The Drought Prone Area Program, Desert Development Program, Integrated Wasteland Development Program (Plain), National Watershed Development Program for Rain-fed Areas, Pushkar Gap Project, Peoples Action For Watershed Development Initiatives, Combating Desertification Project and Integrated Wasteland Development Program.

Water Resource Management

Traditional Methods of Rain-Water Harvesting in Rajasthan

The traditional sources of water in Rajasthan include Nadi, Tanka, Johad, Bandha, Sagar, Samund and Sarovar. The large public wells known as Kohar, Jhalra, Baori, Beri, Saagar were owned by the community.

Lakes/Talaab

In Rajasthan traditionally, maximum conservation of water is in the form of lakes. Few of the lakes in Rajasthan that are world famous lakes include Lalsagar (1800), Kailana (1872), Takhatsagar (1932), and Ummedasagar (1931) Balsamand lake of Jodhpur; Jaisamand, Udai Sagar, Fateh Sagar, Rajsamand and Pichhola of Udaipur; Anasagar lake, Pushkar lake of Ajmer and Mansagar lake of Jaipur . These lakes conserved large quantities of water which is used for drinking, religious and recreational purposes.

A reservoir area of less than five *bighas* is called a *talai*; a medium sized lake is called a *bandhi* or *talab*; bigger lakes are called *sagar* or *samand*.

Bawari

In Rajasthan, Step wells are locally known as Bawari and jhalara. These are sweet water aquifers getting a regular recharge through rain water. Bawaris were mainly set up in cities and big towns to provide a water supply to the community through conservation of rain water. Bawaris and Sarovar have remained important sources of drinking water and irrigation respectively since ancient times.

Naadi & Pokhar

One of the oldest and still prevalent storage structure for rainwater harvesting is naadi or dug-out village pond or tank (Pokhar). Their Agor (catchment area) is also large. The water stored in a naadi acts as a source of groundwater recharge through seepage and deep percolation and is generally used for drinking by livestock and human beings. Naadi construction is more prevalent in the western Rajasthan.

Tanka

The tanka is circular or rectangular shape pond with a life span of 3-4 years, normally on bare ground to which surface runoff can be diverted. The area around it is a clean catchment. The traditional tanka is

constructed with lime plaster and thatched with bushes. Ranisar and Padamsar tanks of Jodhpur, forest tanks of Ranthambore, Sukhsagar Tank and Kalasagar tank and Padmini tank are few famous ones.

Khadeen

It was first developed in the 15th century in the Jaisalmer district, Khadeen is a most multi-purpose method of water conservation. The run-off from upland and rocky surfaces is collected in a khadeen from the adjoining valley against an embankment having a masonry water barrier for outflow of runoff excess. The standing water in a khadeen assists continuous groundwater recharge. On the Khadeen bed at least one crop is cultivated even in the arid region as it retains moisture and contains fine and fertile soil. In the immediate vicinity downstream the sub-surface water is extracted through bore wells.

Kui

To minimize the wastage of water, small well known as Kui or Beri is constructed near a water leaking and oozing tank. At Bikaner, Jaisalmer and Jodhpur 'Kui' are found in a large number. Its opening is covered by strips of wood and mostly they remain kaccha. Kuis or beris are normally 5 metres (m) to 12 m deep. Six or ten of kui's when constructed together constitute a ***PAAR System***. Rainwater harvested through PAAR technique is known as Patali paani.

Jhalras

The water of Jhalras was used in religious ceremonies, community bath and such other functions. Jhalras in Man Mandir at Jodhpur are well known. They do not have their own catchment area rather, the water reservoirs receive water from soakage of tanks or lakes situated at a higher level.

Johad

Johads are small earthen check dams that capture and conserve rainwater, improving percolation and groundwater recharge. Starting 1984, the last sixteen years have seen the revival of some 3000 *johads* spread across more than 650 villages in Alwar district, Rajasthan.

Traditional Roof-Water Harvesting

The houses in western Rajasthan during ancient times were constructed with stone and lime and the roof water was diverted to Tankas. The housing complexes and institutional buildings in urban areas have large roofs and the roof-top rainwater can be conserved and used for recharge of groundwater. Here an outlet pipe from the roof top to divert the water to the existing wells or special recharge wells in urban areas.

Modern Methods of Rain-Water Harvesting in Rajasthan

Rajasthan has a tradition of building, and maintaining rainwater harvesting (RWH) structures such as johad, kuis, and kunds. Traditionally, these structures supported life in this water stressed region, and were well supported in turn by a system of community ownership. Excessive reliance on government run systems has led to the gradual neglect of these structures and disintegration of the entire support mechanism. The relevance of RWH in addressing today's water crisis is unquestionable; however implementation models, design norms, and funding vary. The lack of financial models and capital limitations at the user end pose challenges in the rural individual context. In the urban setting, enforcement of RWH norms for large buildings has been a challenge. With the advancement of technology and increasing need for water new methods are adopted to conserve water using scientific techniques.

Water Harvesting Dams or Nalla bunds:

In ravine lands, a series of small barriers are constructed across selected Nalla sections of second order streams so as to obstruct the flow of surface water in the stream channel and water is retained on the surface for a longer period. These check dams act as a mini percolation tank which helps retention of the silt load, supplement irrigation, contributes groundwater recharge and enhances the overall biomass production of the system. These Water harvesting dams are promoted under the Watershed Management Program in Rajasthan.

Ditch and Furrow Method

In areas with irregular topography, flat bottomed, shallow and closely-spaced ditches or furrows there is maximum water contact area to recharge water from source stream or canal. This technique is less sensitive to silting.

Anicuts

A small water harvesting masonry dam constructed across a stream to hold sufficient water and submerge the upstream area during the rainy season is known as an Anicut. The stored water is used for drinking and recharging groundwater in adjacent wells. Lift irrigation is also practiced. Like in a khadin, if the submerged area is large then bed cultivation is practiced using the stored soil profile moisture.

Percolation Tanks

Percolation tanks are recharge structures for impounding surface runoff constructed on small streams with adequate catchment. These tanks are more feasible in hard rock regions which are highly fractured and weathered to quickly recharge the groundwater due to low evaporation losses. They can be dug in alluvial rock formations as well.

Sub-Surface Barriers

In the sandy bed of an ephemeral desert streams the sub-surface barrier is a suitable artificial recharge structure. It is constructed below the river bed on impermeable sub-surface strata and so the structure is secure from flooding and does not require periodic de-silting and has limited evaporation.

Harvesting and Conservation of Flash Floods:

Flash floods occur in response to very high rainfall or a cloudburst of short duration. Over-topping of defined courses of streams and spreading into flood plains causing immense damage are their characteristic features. These waters can be allowed to percolate inside the already existing aquifers of the water is diverted towards the run- off storage tanks. The water can be later put to agricultural or domestic purposes after basic purification.

In-situ Water Harvesting and Moisture Conservation:

In-situ water harvesting and moisture conservation is very useful in drought mitigation and in enhancing land productivity, which are field based, cost effective, location-specific soil and water conservation technology. Under this technique, Contour furrowing is practiced on mild slopes. Also, a large numbers of mini-storages are created across the slope which alleviate drought.

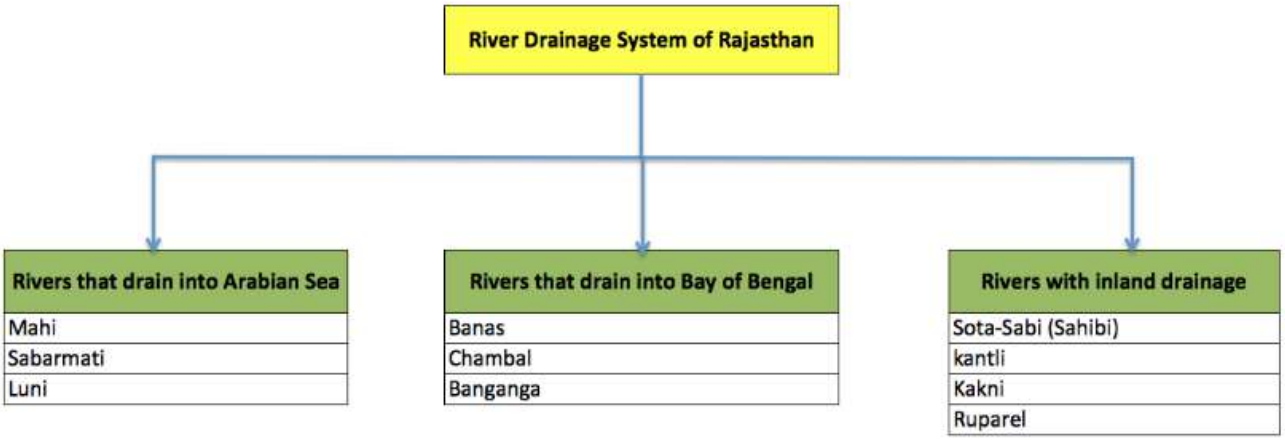
Contour bunding is recommended in the semiarid region of the state for soil and water conservation in rain-fed farming regions. Locally adapted, native, fast-growing perennial grasses with extensive root systems are planted against the slopes to act as Contour vegetative barrier. These grasses and shrubs form a dense hedge and conserve soil and water. This cheap and environmental friendly measure improves land productivity.

Recharge Shaft

In the areas where source of water is only seasonally available the recharge shaft allows water to stand in it for longer time and allowing it to percolate to recharge a nearby well or other water body. The recharge shaft is efficient and cost effective structure to recharge the aquifers directly

Rivers of Rajasthan

The rivers of Rajasthan can be divided into three main types based on their drainage pattern, they are rivers that drain into arabian sea, rivers that drain into bay of bengal and rivers with inland drainage. The most characteristic feature of the drainage system of Rajasthan is that nearly 60.2% of the area of the state has an inland drainage system.



The Aravalli range forms the main watershed for Rajasthan, dividing the drainage into the Arabian Sea and the Bay of Bengal. The Luni river system that rises from the western slopes of the Aravalli Range (near Ajmer) flows through the semi-arid transitional plains into the Rann of Kutch and Arabian Sea, while the Banas and other streams, rising from the eastern slopes of the Aravallis, join the Chambal. The Chambal, then flows into the Yamuna-Ganga river system which drains into the Bay of Bengal. The main watercourses like the Sabarmati, Banas, etc. and the tributaries of the Luni, are more or less parallel to the Aravalli Range.

Rajasthan River Basins

A river basin is the portion of land drained by a river and its tributaries. It is considered as the basic hydrological unit for planning and development of water resources. Rajasthan is a water scarce state but there are six major river basins in the State. Major Rajasthan River Basins include:

- *Banas basin* which is the largest, drains out 45,833 Sq km.
- *Luni basin*, which comes next, drains out 37,363 Sq km.
- *Chambal basin* drains out 31,360 Sq km.
- *Mahi basin* drains out 16,985 Sq km.
- *Banganga basin* drains out 8,878 Sq km.
- *Sabarmati basin* drains out 4,164 sq km.

There are more rivers like Sahibi, Ruparel and Ghaggar which have smaller catchment areas besides several streams which feed the bigger rivers.

Five of these rivers can be further divided into sub-basins as given below:

- **Banas Basin** – Banas, Berach, Dain, Gudia, Kalisil, Khari, Kothari, Mashi, Morel, Sodra.
- **Luni Basin** –Luni, Sukri, Rediya, Mithri, Bandi, Khari, Jawai, Guhiya and Sagi, and Jojari.
- **Chambal Basin** – Banas, Chakan, Chambal Downstream, Chambal Upstream, Kalisindh, Kunu, Mej and Parwati.
- **Mahi Basin**- Anas, Bhadar, Jakham, Moran, Som and Mahi.
- **Sabarmati Basin**- Sabarmati, Sei, Vatrak and Wakal

Inter-linking of Rajasthan River Basins

The National Water Development Agency (NWDA) under the Union Ministry of Water Resources, River Development and Ganga Rejuvenation is studying the preliminary level of the feasibility of the three river inter-linking projects in Rajasthan. The proposed links are:

- Parwati - Kalisindh -Chambal Link,
- Yamuna-Rajasthan Link Project
- Rajasthan – Sabarmati Link Project

Additionally, there's also a plan to divert water of Chambal to Bisalpur dam by linking its tributary, Brahmani river to Banas river upstream of Bisalpur.

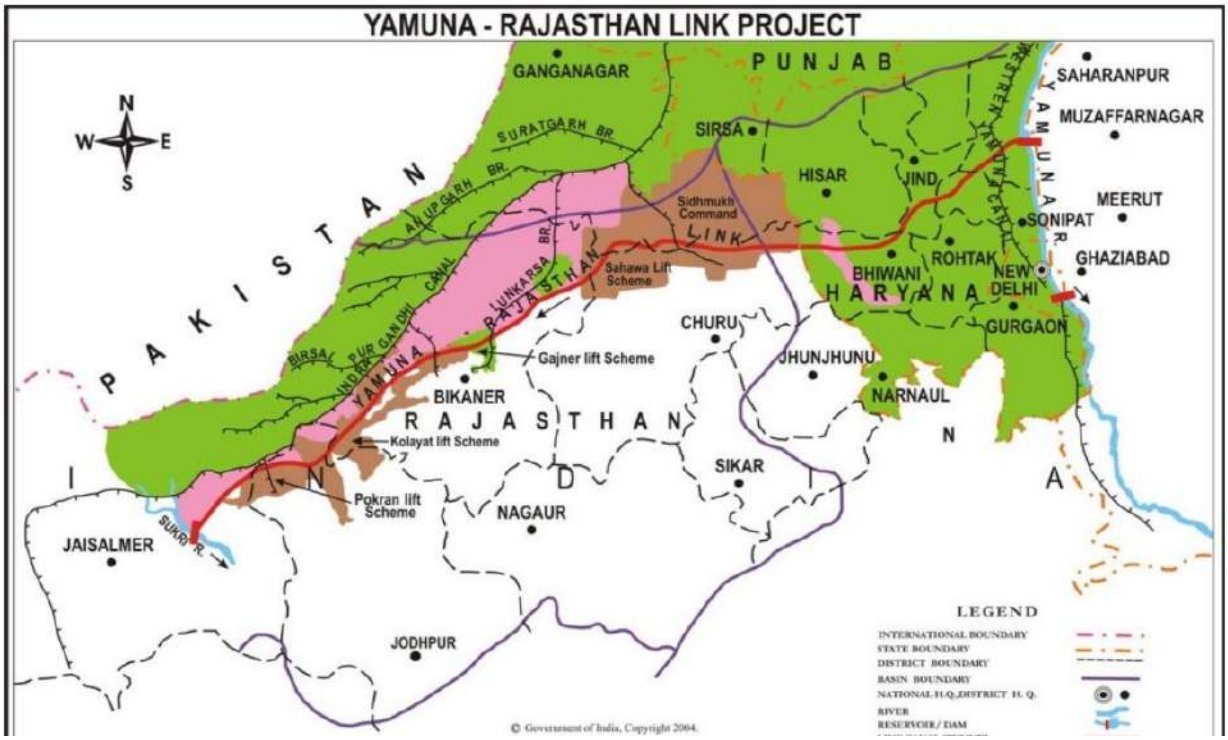
The Rajasthan River Basin and Water Resources Planning Act, 2015

In October 2015, the Rajasthan assembly passed the Rajasthan River Basin and Water Resources Planning Bill, 2015 by voice vote. The bill sought for the establishment of *State Water Resources Advisory Council* and *Rajasthan River Basin and Water Resources Planning Authority* for management and development of river basins and sub-basins on sustainable basis on integrated water resources management (IWRM) concept.

Rajasthan River interlinking: Current Affairs

Yamuna-Rajasthan Link Canal

The National Water Development Agency (NWDA) under the Union Ministry of Water Resources, River Development and Ganga Rejuvenation is studying the preliminary level of the feasibility of the three river inter-linking projects in Rajasthan. One of the suggested project in Rajasthan is the Yamuna Rajasthan Link Canal Project.



Rajasthan-Yamuna link canal

The Upper Yamuna Board, which is entrusted with management of Yamuna river upto Okhla in Delhi, has Rajasthan as one of the members besides Himachal Pradesh, Haryana, Delhi and Uttar Pradesh. Rajasthan has been allocated 1.119 BCM of the share.

Three storage dams, namely: Kishau, Renuka and Lakhwar-Vyasi have been identified for which separate agreement will be executed in respect of each identified storage, within the framework of the overall allocation made in the agreement.

Due to the restricted capacity of its existing canals, Rajasthan proposed to utilise its share of Yamuna water partly in Churu district and partly in Bharatpur district. Water in the Bharatpur District is conveyed through Gurgaon Canal in Haryana that takes off from Okhla Barrage near Delhi. A second point from where water to Bharatpur is diverted is from Agra Canal, near Mathura in UP. Agra Canal also off-takes from Okhla Barrage. There is another barrage, Tajewala, in Haryana State, so that at present Haryana utilizes most of Yamuna flows at Tajewala headworks and very little water is available at Okhla headworks for Agra Canal.

Regarding supplies to Churu district, Rajasthan has proposed to take its water from Western Yamuna canal of Haryana, taking off from Tajewala headwork. A final agreement about these proposals is under negotiations between the two States and no work on this canal system has been initiated.

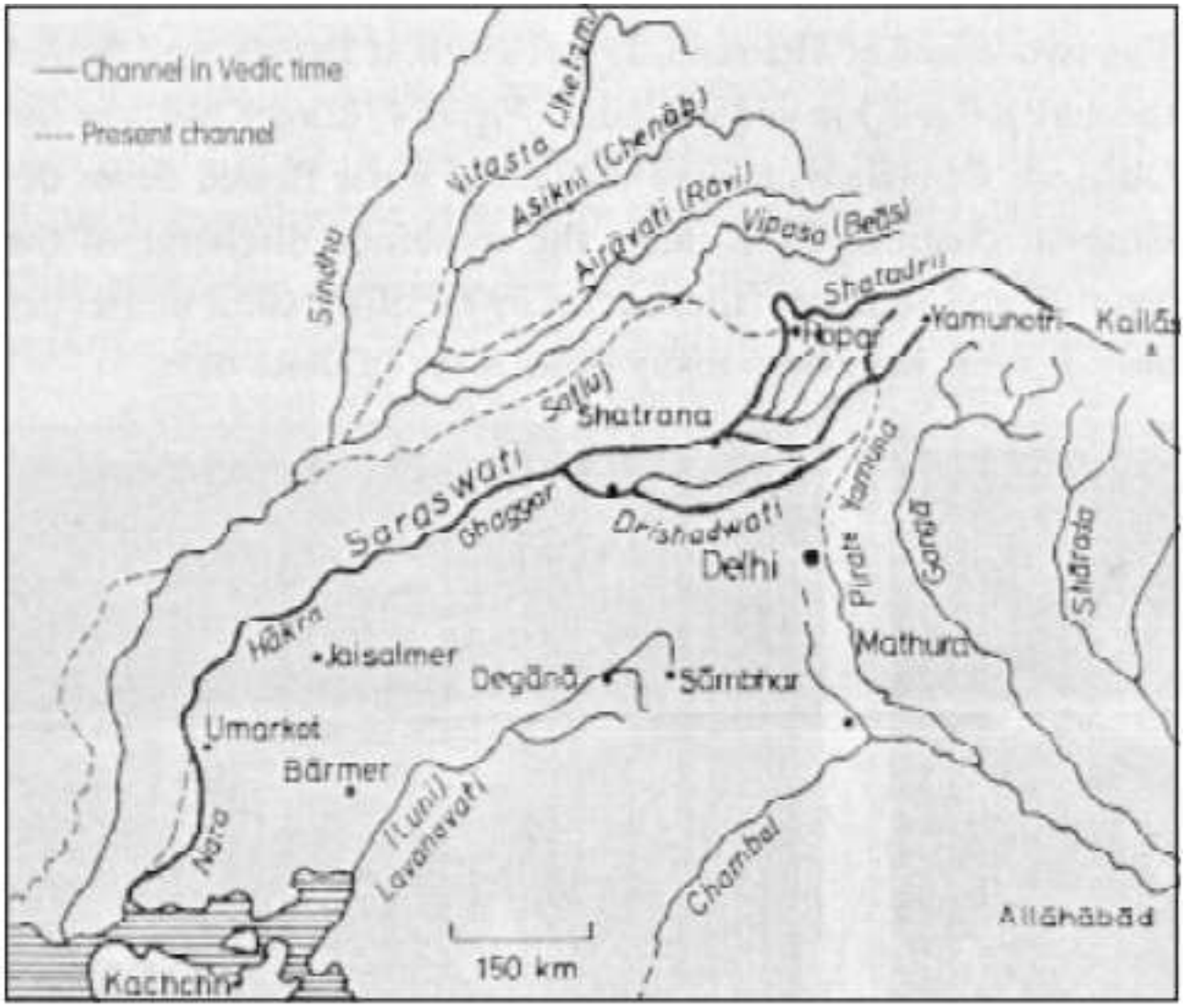
Rajasthan set to begin work on its first river-linking project

- Rajasthan Government has kicked off preparations for its first river-interlinking project – ensuring flow of excess rainwater in Chambal and Brahmani rivers to Bisalpur dam.
- Once operational, the project will ensure smooth drinking water supply to 19 towns and around 3000 villages in Jaipur, Ajmer, Tonk and Nagaur districts.
- **The Project:**
    - Construction of a dam to store monsoon flows in Brahmani river;

- A diversion system will be constructed to take water from the Brahmani dam to Bisalpur dam;
- A pump house to lift water from Jawahar Sagar dam on the Chambal river;
- A transmission system will be made to bring water from Jawahar Sagar dam to diversion system and Brahmani dam; and from here, water will be sent to the Bisalpur dam through a 54km tunnel, which will have a 20km open channel.

- The Bisalpur dam, completed in 1999 on the Banas river, caters to water needs of Ajmer and Jaipur.

Ancient rivers of Rajasthan



Whenever there is mention of ancient rivers of India, three rivers emerge in Hindu ethos, viz., Ganga, Yamuna and Sarasvati. In Vedic geography, there is a mention of Sapta Sindhu, i.e., seven rivers in which Sarasvati attains an important description. Most of these rivers exist even today except Sarasvati which has disappeared completely. Information on Prehistoric India comes from two distinct sources:

- The literary tradition represented in the main by the faithfully preserved corpus of Vedic texts headed by the Rigveda.

- The archaeological tradition ranging from the Aceramic Neolithic of Mehrgarh and the various phases of the Harappan civilization to the Iron Age Painted Grey Ware and the Northern Black Polished Ware cultures.

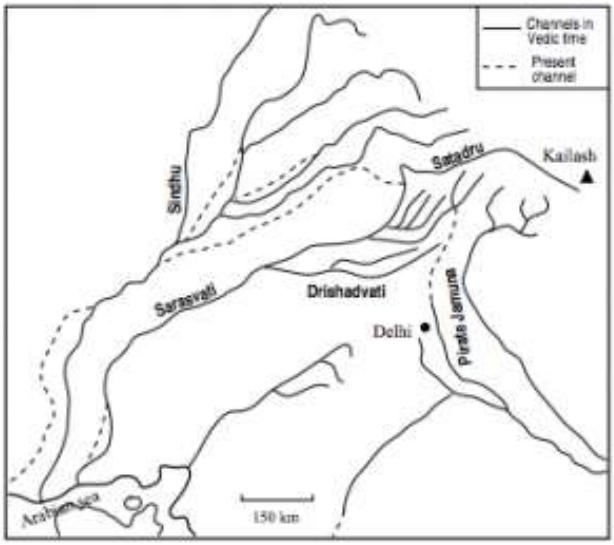
In recent times, a third-dimension or third perspective has been added in form of Scientific Research through use of modern Technology. This article looks at these two rivers from these three different perspectives.

Sarasvati and Drishadvati: In Ancient Indian Texts

Sarasvati River:

Ambitame, naditame, devitame, Sarasvati
Aprasasta iva smasi prasastim Amba naskriti. — (Rigveda – 2. 41. 16)

(O Sarasvati, you the best of mothers, the best of rivers, the best of gods ! Although we are of no repute, mother, grant us distinction.)



- During the vedic civilization, Aryans developed Rigveda, which describes about the " Sapta Sindhu " the seven rivers of NW India , traced from east to west as Sarasvati, Satadru (Sutlej), Vipasa (Beas), Parosni (Ravi) , Asikni (Chenab) Vitasta (Jhelum) and Sindhu (Indus) which started flowing consequent on the melting of the Himalayan glaciers at the end of Pleistocene.
- According to the Mahabharata, the Sarasvati dried up in a desert (at a place named Vinasana or Adarsana).
- In the Skanda Purana, the Sarasvati originates from the water pot of Brahma and flows from Plaksa on the Himalayas. It then turns west at Kedara and also flows underground. Five distributaries of the Sarasvati are mentioned.

- In the Manu Smriti, the sage Manu, escaping from a flood, founded the Vedic culture between the Sarasvati and Drishadvati rivers. The Sarasvati River was thus the western boundary of Brahmavarta.

Drishadvati River:

The Drishadvati river is hypothesized by Indologists to identify the route of vedic river, Saraswati, and the state of Brahmavarta. Brahmavarta is postulated as a state during vedic times, situated on the confluence of the revered rivers Saraswati and Drishadwati. Different literary sources that mention Drishadvati include:

- Latyayana Srautasutra has described drishadvati as a seasonal river, while Saraswati as a perennial river up to Vinasana.
- Brahmanas often mention the Drishadwati River. Brahmanas point out that Drishadwati River had its origin from the pot of Brahma i.e. Pushkar lake, near Ajmer. Pushkar has the most revered Brahma temple in India.
- In the Manu Smriti, Drishadvati river and the Sarasvati River define the boundaries of the Vedic state of Brahmavarta.
- According to Srimad Bhagavatam, the Drsadvati is one of the many transcendental rivers in India.

Sarasvati and Drishadvati: The Archaeological Findings

Sarasvati River:

- More than 1200 ancient settlements on Sarasvati river basin have been dug out giving clinching evidence of existence of a mighty river, which sustained maritime civilization and metal-based economy prior to 3000 BC.
- Archaeological Survey of India has dug out more than 2400 settlements at the ancient Indus-Sarasvati river basins but no ancient settlements have been found along the present day course of Yamuna or Sutlej.
- Land was fertile and barley etc were cultivated in the Sarasvati region even 7000 years back and same style of cultivating the fields continues till date in areas like Rajasthan & Haryana.

Drishadvati:

- The first serious attempt on Drishadvati river was made by Sir Alexander Cunningham (1871) who identified the Drishadvati with the present Rakhsi river while Rapson (1914) felt that the Drishadvati used to flow through the present course of Chautang river which originates in Siwaliks. Subsquently, Keith (1922) and Dey (1927) also supported the course of the Drishadvati as being the present Chautang river and then along the Hansi —Hissar branch of the western Yamuna canal.

Sarasvati and Drishadvati: Scientific Research

Remote sensing data from satellites and aerial cameras has been used by several organization (including Ground Water Department, Rajasthan) to map the palaeo-channels.

Benefits of such Research:

- The search has been significant for locating sources of good quality ground water in the water scarce western Rajasthan where most of the available sources suffer from poor water quality.

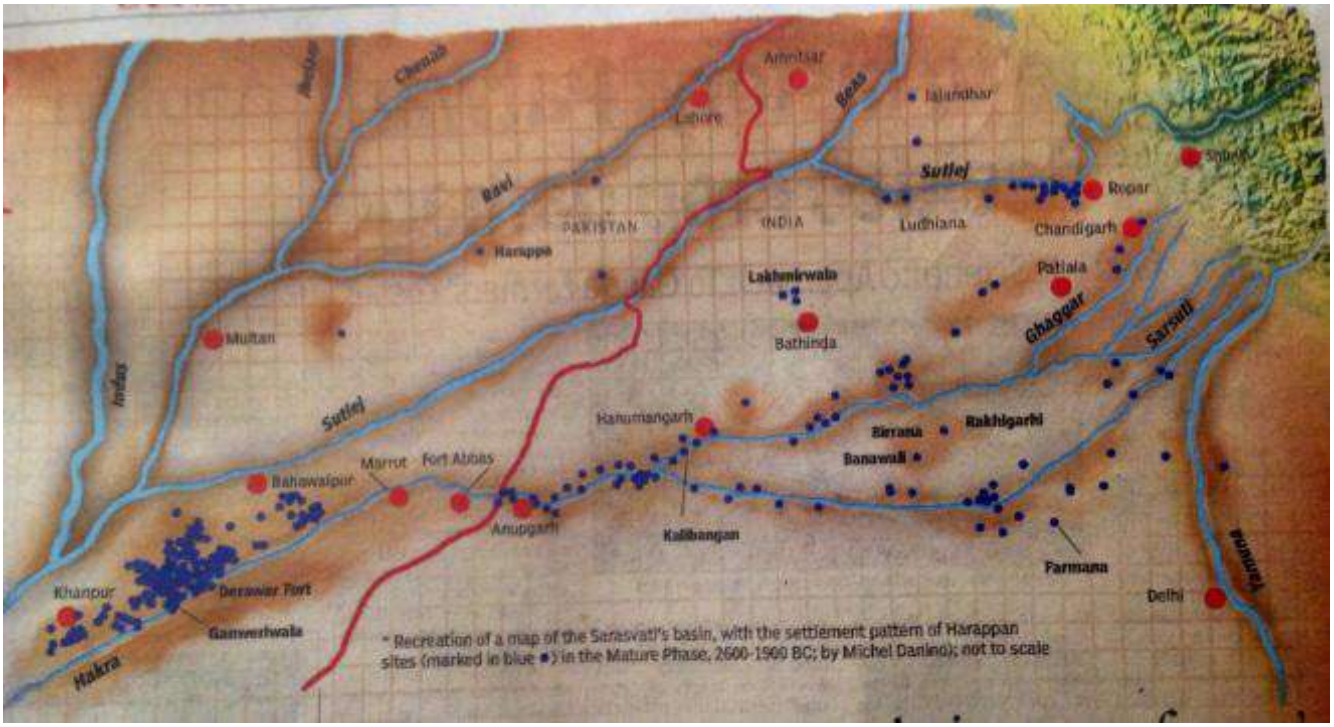
Methodology of Research:

- Mapping of palaeochannels using multi sensor remote sensing data from WIFS, MSS-I, LISS-III and PAN sensors from Indian remote Sensing Satellites IRS 1B and ID was carried out using digital image processing techniques.
- Drilling work at fourteen locations in Dharmikhu - Kuriaberi - Ghantiyali - Ranau Longewala - Ghotaru sections, and the radiocarbon age analysis of the water samples thus obtained.

Research Findings:

- Digital merging of high resolution PAN and medium resolution LISS Ill data and analysis of water samples on water quality, sediment type and age of groundwater confirmed presence of palaeochannels.
- Additionally it also confirmed occurrence of good quality drinking water along these palaeochannels. The salinity of water away from the palaeochannels rises sharply.

Ancient Sarasvati and present Ghaggar-Hakra System: Relation



Since the late 19th-century, scholars have postulated that the Ghaggar-Hakra River system is the remnant of Vedic Saraswati river. The main arguments are the:

- Supposed position east of the Indus, which corresponds with the Ghaggar-Hakra riverbed.
- Painted Grey Ware sites (ca. 1000 BCE) have been found in the bed and not on the banks of the Ghaggar-Hakra river, suggesting that the river had dried up before this period.
- The Indus Valley Civilisation (Harrapan Civilisation), which is named after the Indus, was largely located on the banks of and in the proximity of the Ghaggar-Hakra fluvial system

In 2016, K. S Valdiya committee constituted by Government of India on Palaeochannels of North-West India: Review and Assessment, concluded that Saraswati river had two branches eastern & western. The eastern branch included Sarsuti-Markanda rivulets in Haryana and the western branches included Ghaggar-Patiali channels. The committee considers that branches met near Patiala, at Shatrana, then flowed as a large river.

Contradictions:

However, in recent times, these views have been contradicted by geophysical research, which suggests that the Ghaggar-Hakra system, although having greater discharge in Harappan times which was

enough to sustain human habitation, was not watered by a Himalayan river—such as the Sarasvati—but rather by a system of perennial, but only monsoon fed, rivers.

Other research using dating of zircon sand grains has shown that late Pleistocene subsurface river channels near the present-day Indus Valley Civilisation sites in the Cholistan desert, in Pakistan, immediately below the dry Ghaggar-Hakra bed show sediment affinity with not with the Ghagger-Hakra river, but with the Beas river in the western sites and the Sutlej and Yamuna rivers in the eastern ones.

Sarasvati and Drishadvati: In recent NEWS

Saraswati River did exist, says K.S. Valdiya Committee

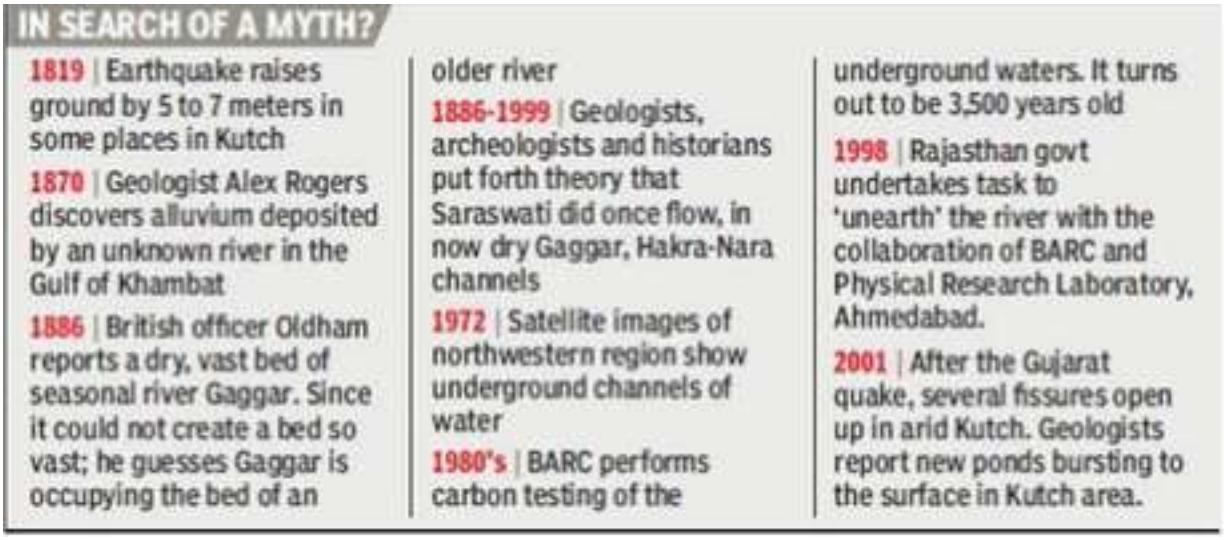
The seven-member expert committee of geologists, archaeologists and hydrologists, headed by Professor K.S. Valdiya of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), have found evidence of the course of the river Saraswati. The committee on "Palaeochannels of North-West India: Review and Assessment" had been appointed by Water Resources Ministry to map paleo-channels of north-west India including river Saraswati, a mythological river mentioned in the Rigveda and other literature of Hindu mythology.

Key Facts from the submitted report:

- Sarawati was a Himalayan river.
- Saraswati river had two branches the eastern branch included Sarsuti-Markanda rivulets in Haryana and the western branches were made of Ghaggar-Patiali channels.
- These branches met in Shatrana, 25 kilometres south of Patiala and "flowed as a large river" emptying out into the sea that is now the Rann of Kutch.
- It is assumed that River Saraswati originated from Adibadri in the Himalaya to culminate in the Arabian Sea through the Runn of Kutch.
- It was approximately 4,000 km in length with nearly 3000 km of length occurring in India and remaining one-third of the river lying in present-day Pakistan.

- During its six-month research, the committee came across "an unique" palaeochannel (a path abandoned by river when it changes its course) relating to present Ghaggar, Sarsuti, Hakra and Nara rivers.
- They also concluded that around 1700 "small and big" towns and villages were located around the palaeo-channel concerned during Harappa Civilization. "Some towns were spread over more than 100 hectares. These colonies were there for 5,500 years.

Timeline of Topic: Prior to K S Valdiya Committee:



IN SEARCH OF A MYTH?

1819 | Earthquake raises ground by 5 to 7 meters in some places in Kutch

1870 | Geologist Alex Rogers discovers alluvium deposited by an unknown river in the Gulf of Khambat

1886 | British officer Oldham reports a dry, vast bed of seasonal river Gaggar. Since it could not create a bed so vast; he guesses Gaggar is occupying the bed of an older river

1886-1999 | Geologists, archeologists and historians put forth theory that Saraswati did once flow, in now dry Gaggar, Hakra-Nara channels

1972 | Satellite images of northwestern region show underground channels of water

1980's | BARC performs carbon testing of the underground waters. It turns out to be 3,500 years old

1998 | Rajasthan govt undertakes task to 'unearth' the river with the collaboration of BARC and Physical Research Laboratory, Ahmedabad.

2001 | After the Gujarat quake, several fissures open up in arid Kutch. Geologists report new ponds bursting to the surface in Kutch area.

Terms:

Palaeo-Channel:

- **Paleochannel** is a remnant (remaining traces) of an inactive river or stream channel that has been either filled or buried by younger sediment.
- The word palaeochannel is formed from the words "palaeo" or 'old', and channel. Hence palaeochannel stands for ancient or vey old channel.
- Study of paleo-channels help in understanding movements of faults, earth quakes etc.

Rivers of Inland Drainage in Rajasthan

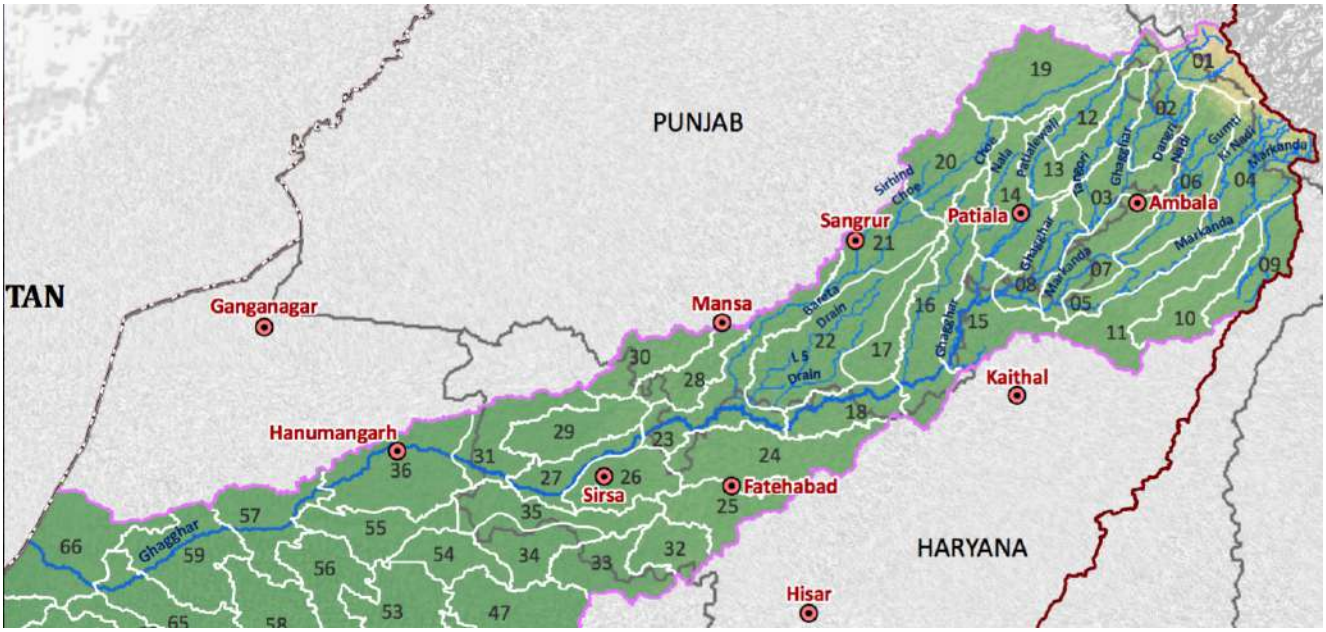
One of the most interesting feature about drainage system of Rajasthan is that nearly 60.2 percent of of the area of state has inland drainage system. Nearly all of this area lies wet of Aravalli divide and includes a large number of separate basins like Sota-Sahibi basin, Kantli basin, Barah Basin and streams in Luni basin.

Ghaggar-Hakra River

Ghaggar-Hakra River is a season river in India and Pakistan that flows only during the monsoon season. The river originates from kalka hills (Himachal Pradesh) and is known as **Ghaggar** before the Ottu barrage and as the Hakra downstream of the barrage.

Ghaggar-Hakra River Summary Sheet

Origin	Kalka Hills of Shivalik Range in Himachal Pradesh
Length	465 Kms
Discharge	Sand dunes in Bhawalpur district of Pakistan
States & Major Cities	Himachal Pradesh: Punjab: Ambala, Patiala Haryana: Hissar Rajasthan: Tibbi, Hanumangarh, Talwara, Anupgarh and Suratgarh
Tributaries	Chautang River, Kaushalya river, Sarsuti



Ghaggar Hakra River Course:

Ghaggar rises from Kalka hills of Shivalik Range in Himachal Pradesh and flows through Ambala, Patiala (Punjab) and Hissar (Haryana) districts. It enters Rajasthan and flows through Hanumangarh, Talwara, Anupgarh and Suratgarh. Ghaggar flows across the international border through Sri Ganganagar district and assumes the name, Hakra, near Fort Abbas City in Pakistan. The river finally enters into Bhawalpur district of Pakistan where it gets lost in sand dunes.

Ghaggar in History-Culture

- Few scholars identify Ghaggar with the vedic river of saraswati.

Kantli River:

- Kantli river originates from hills of Khandela hills of Sikar district and taking a northernly course runs into Jhunjhunu and ends in sand dunes near Churu district.
- Site of ancient OCP culture - Ganeshwar lies on bank of Kantli river.
- Catchment area of Kantli river is known as Torawati.

Kakni or Masurdi River:

- Kakni is a small seasonal river of Jaisalmer, that originates 27 south from Kotri village and flows for few kms draining into Bhuj lake.

Mantha River:

- Mantha river orginates from jaipur and flows into Sambhar lake.

Ruparel River or Ruparail River

- Ruparel river originates from Udainath hills in Thangazi tehsil of Alwar district.
- It traverses these hills northwards, turning towards the east and northeast before disappearing in Bharatpur District. It flows first through hills and subsequently through plains nearly up to Kusalpur in Bharatpur district.
- It has a total length of about 104 km.
- Also called as Varah or Lasvari river.
- Ruparail basin extends in a broadly W-E direction and is bounded by the Sabi River Basins in the northwest side and the Banganga River Basin in the southeast. The northern border is shared with Haryana State.
- The river has been in news, because of its disappearance and revival by efforts of Shri Rajendra Singh

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Rupangarh River

- Rupangarh river originates from Salemabad (Ajmer) and flows in northerly direction to drain into Sambhar lake.

Sota-Sabi or Sahibi River

- There are two branches, the Sabi branch rises from Sewar hills and the Sota branch rises from hills of Bairath.
- The two branches meet at Jalalpur.
- The river flows in northern direction through Kotputli tehsil, Bansur, Behror Kishangarh, Mundawar (Haryana) Rewari and empties into Najafgarh drain.
- Sabi basin is bounded in the northwest by Shekhawati River Basin and Ruparail and Banganga River basins in the southeast. The northern boundary is shared administratively with Haryana State. The Basin extends over parts of Alwar, Jaipur and Sikar districts. The total catchment area of the sabi basin is 4607.9 km2.
- It flows in Rajasthan for a distance of about 157 km before entering Haryana State.

Sabi River in History & Culture:

Several modern scholars identify the Sahibi River with the Drishadvati river of Vedic period. It is believed that the Drishadwati River had formed one border of the Vedic state of Brahmavarta while other was Saraswati river or the modern Ghaggar-Hakra river.

Several sites related to Indus Valley civilisation have been found along the route of Sahibi. Among the finds are handmade and wheel-made pottery dating back to over 3,000 years found on the banks of the Sahibi River at Jodhpura near Viratnagar in Jaipur district. Other findings include pottery found on the Sahibi riverbed at Hansaka in the Rewari district, Haryana. A red stone statute of Vamana Dev was unearthed in 2002 on the Sahibi riverbed near Bawal, Haryana.

Chambal River & its Tributaries

Chambal river is one of the cleanest perennial rivers of India. It originates at Janapav, south of Mhow town, on the south slope of the Vindhya Range in Madhya Pradesh. Chambal flows north-northeast through Madhya Pradesh, running for a time through Rajasthan, then forming the boundary between Rajasthan and Madhya Pradesh before turning southeast to join the Yamuna in Uttar Pradesh.

It ends a confluence of five rivers, including the Chambal, Kwari, Yamuna, Sind, Pahuj, at Pachnada near Bhareh in Uttar Pradesh state, at the border of Bhind and Etawah districts.

Chambal River Summary Sheet

Origin	**Janapav** near Mhow (M.P) in the Vindhaya mountain range
Length	965 Kms (370 Kms in Rajasthan)
Discharge	Yamuna, Pachnada near Bhareh in Uttar Pradesh
States & Major Cities	Madhya Pradesh: Rajasthan: Kota Uttar Pradesh:
Right Bank Tributaries	Parbati, Kali Sindh, Shipra
Left Bank Tributaries	Banas, Mej
Major Dams	Gandhi Sagar, Rana Pratap Sagar, Jawahar Sagar, Kota Barrage

Chambal River in mythology:

Ancient name of Chambal is said to be Charmanyavati, which may be in reference to the story of king Rantideva sacrificing several cows on its banks.

In the epic Mahabarat, Charmanwati was the southern boundary of Panchala Kingdom. King Drupada ruled the southern Panchalas up to the bank of the Charmanwati river. The region was part of the kingdom of Shakuni, the maternal uncle of Kauravs. After her attempted disrobing at the hands of Kauravs, Draupadi cursed anybody who will drink water from the river. The infamy gathered by the river may have been the reason for absence of any big settlement on its banks except Kota.

Keshoraipattan near Kota is a famous pilgrimage spot dedicated to Lord Vishnu on banks of Chambal.

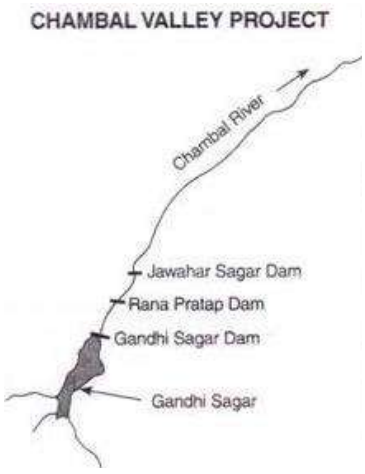
Chambal River Course:

Chambal River originates from northern slopes of *Singar Chouri peak*, at an altitude of 884.4 m, in the Vindyan Range. It flows in northerly direction through Madhya Pradesh (M.P.) for about 346 kilometres and enters Rajasthan near Chaurasigarh (Chittorgarh). Here the river falls 505 m and then enters a gorge for 113 Kms and leaves it near Kota.

From Kota, it makes boundary between Kota and Bundi district and then boundary between Rajasthan and M.P passing through Sawai Madhopur, Karauli and Dholpur. It eventually enters U.P. and flows for about 32 kilometres before joining the Yamuna near Bhareh.

Chambal River Basin:

Rajasthan has the largest catchment area of the Chambal river at 79,401 square km, which is 57.86 per cent of the total catchment of the river. In Rajasthan, Chambal basin extends over parts of Chittorgarh, Bhilwara, Bundi, Sawai Madhopur, Tonk, Jhalawar, Kota, Baran and Dholpur districts. On its south, east and west, the basin is bounded by the Vindhyan mountain ranges and on the north-west by the Aravallis.



The proposed *Parwati- Kalisindh-Chambal link* is one of the big projects being planned in the basin which will divert surplus waters of Parwati and Kalsindh to the Rana Pratap Sagar or Gandhi Sagar dam.

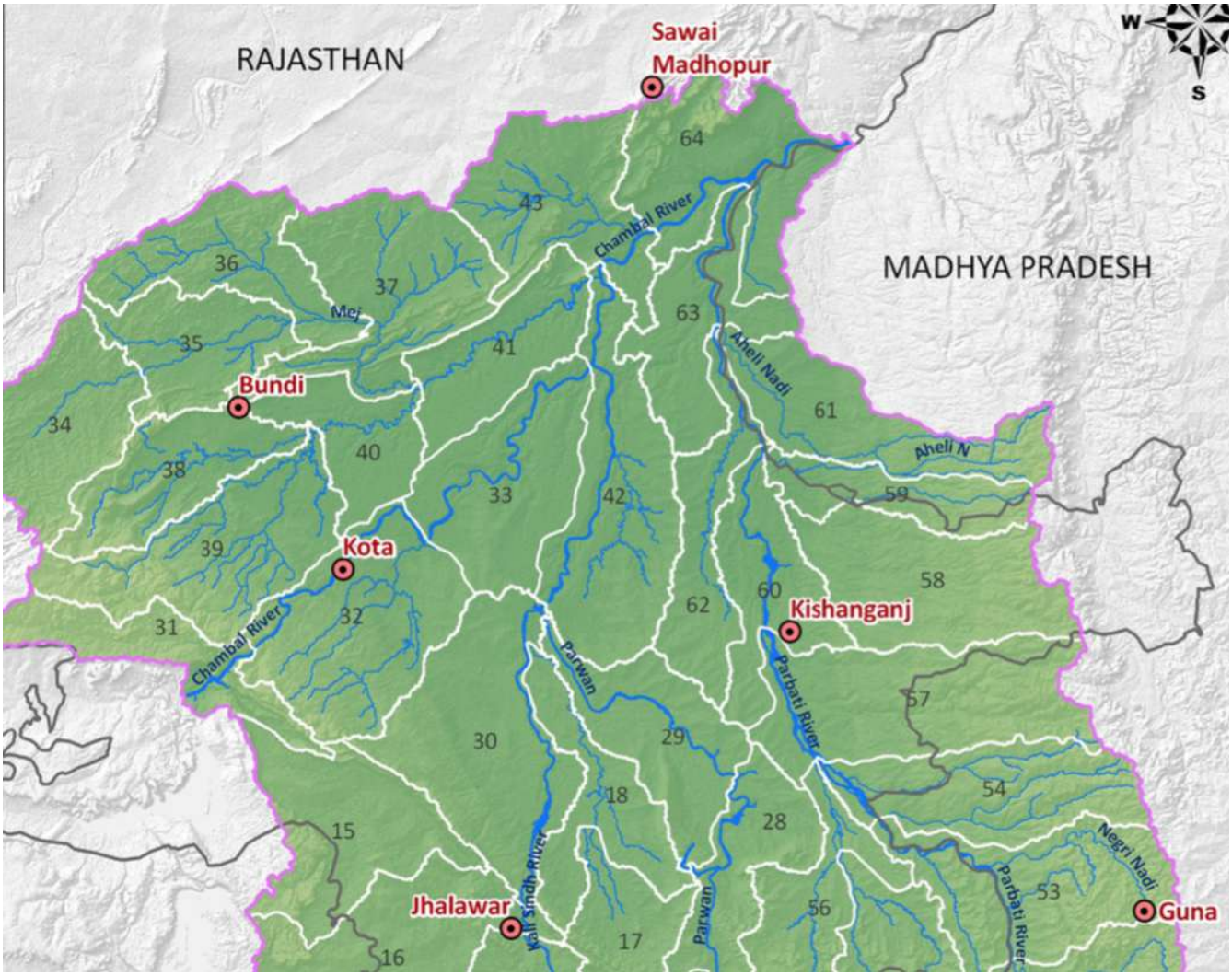
Chambal River Dams:

There are four main dams on chambal river located from south to north

1. Gandhi Sagar Dam
2. Rana Pratap Sagar Dam
3. Jawahar Sagar Dam
4. Kota Barrage

Chambal River Tributaries:

The tributaries of the Chambal include Shipra, Choti Kalisindh, Sivanna, Retam, Ansar, Kalisindh, Banas, Parbati, Seep, Kuwari, Kuno, Alnia, Mej, Chakan, Parwati, Chamla, Gambhir, Lakhunder, Khan, Bangeri, Kedel and Teelar.



Kali Sindh

Kali Sindh River Summary Sheet

Origin	Bagli (District Dewas) in Madhya Pradesh. Enters Rajasthan at Binda Village.
Length	278 Kms (145 Kms in Rajasthan)
Discharge	Chambal, Nonera village in Baran district in Rajasthan.

States & Major Cities	Madhya Pradesh: Rajasthan: Jhalawar, Baran
Tributaries	Parwan, Niwaj and Ahu

- **Parban River** is a tributary of Kali Sindh. that originates in Sehore district of Madhya Pradesh. Parban flows through Sehore, Shajapur and Rajgarh districts in Madhya Pradesh . It covers Jhalawar, Kota, Baran districts of Rajasthan and meets Kali Sindh in Baran district of Rajasthan.

Parbati River:

Parbati River Summary Sheet

Origin	Northern slopes of Vindhyan Range n **Sehore** district, M.P
Discharge	Chambhal, Paliya Village near Sawai Madhopur, Kota Border
States & Major Cities	Madhya Pradesh: Rajasthan: Kota

Mej River:

Mej river is a left bank tributary of Chambal River. It originates near Mandalgarh in Bhilwara and joins Chambal in Kota. The catchment area of Mej river extends over Bhilwara, Bundi and Tonk of Rajasthan.

Mej River Summary Sheet

Origin	Near Mandalgarh in Bhilwara, Rajasthan

Discharge	Chambal, in Lakheri, Kota
States & Major Cities	Rajasthan: Kota

River Interlinking Projects in Chambal:

Parwati- Kalisindh-Chambal link

- The proposed Parwati- Kalisindh-Chambal link is one of the big projects being planned in the basin which will divert surplus waters of Parwati and Kalsindh to the Rana Pratap Sagar or Gandhi Sagar dam.

Banas River & its Tributaries

Banas river originates in the Khamnor Hills of the Aravalli Range, near Kumbhalgarh in Rajsamand. It is a tributary of the Chambal River and is approximately 512 kilometres in length. It is also known as '*Van Ki Asha*' (Hope of forest). There is another river in Rajasthan with name of Banas, which flows in western direction and is also called as West Banas River.

Banas River Summary Sheet

Origin	Khamnor Hills, near Kumbhalgarh in Rajsamand.
Length	512 Kms
Discharge	Chambal near Rameshwar in Sawai Madhopur District
States & Major Cities	Rajasthan: Nathdwara, Jahazpur and Tonk.

Right Bank Tributaries	Berach, Menali
Left Bank Tributaries	Kothari, Khari, Dai, Dheel, Sohadara, Morel and Kalisil
Major Dams	Bisalpur

Banas River in Indian mythology

- It is said that Sage Vashishth did intense meditation and got the river down from Swarg Lok (heaven). The sage, concerned about its future, asked Lord Shiv how she will survive without water from glaciers. Shiv blessed her: —The forests will protect you and you in turn will nourish the forests. I will appear at various places on your banks to increase your influence. Hence the river got the name: Ban ki Aas' (hope of the forest) which later became Banas.
- Lord Parshuram, an avatar (incarnation) of Lord Vishnu, is linked strongly with Banas. Parshuram had killed his mother, Renukaji, on the order of his father. He went to several places seeking salvation. He saw that a calf, who had turned black on killing a man, turned white again after taking a dip in river Banas. Parshuram did the same and was relieved of the sin. The place is now called: Matrikundya' and falls in Bhilwara district. It is also known as the: Haridwar of Rajasthan'.
- Veeron ka Math' (monastery of the brave) is a holy place that abutts the origin point of Banas. It is said that here Parshuram gave arms training to Karan and Bhishm, the two heroes of epic Mahabharat.
- Jargaji, an important pilgrimage, is located around 10 km from the origin point. Jarga ji was a devotee of Baba Ramdev, chief deity of the Meghwal community.
- The triveni dham near Mandalgarh in Bhilwara district where Berach and Menali rivers meet Banas also holds great value.

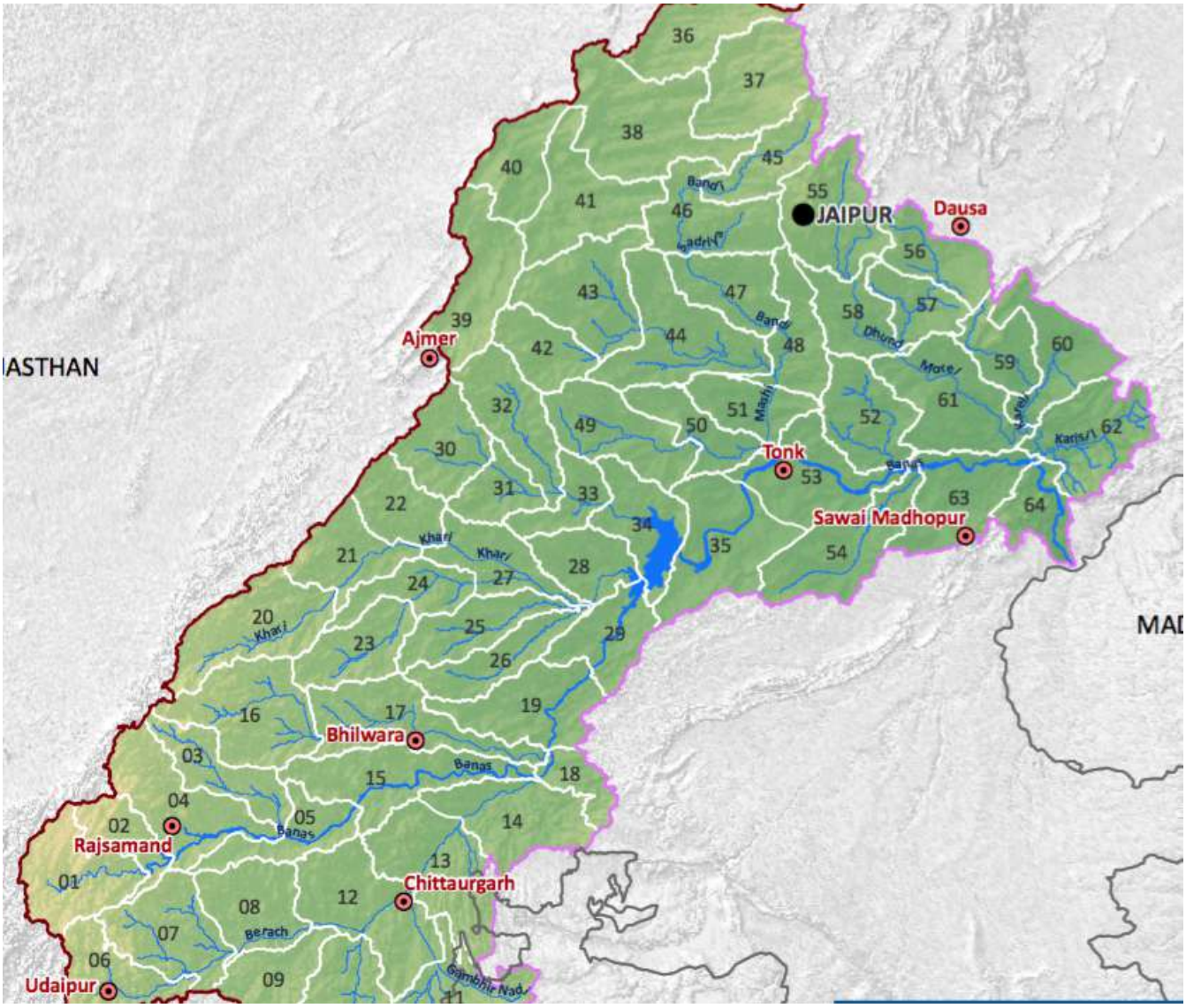
- The Gokaran Mahadev or Gokaraneshwar temple in tonk district is also of great significance as it is believed that Ravan, the famous anti-hero of epic Ramayan, meditated and offered his head to Lord Shiv here.
- At Sawai Madhopur, Rameshwaram Ghat is a famous pilgrimage spot as Banas merges into Chambal here.

Banas River Basin:

Banas lies completely within Rajasthan and has the largest catchment area (45,833 square km) in Rajasthan. Banas drains the east slope of the central portion of the Aravalli Range, and the basin includes all or part of Pali, Rajsamand, Udaipur, Tonk, Ajmer, Bhilwara, Bundi, Chittorgarh, Dausa, Jaipur and Sawai Madhopur districts.

Banas River Tributaries:

Major tributariesof Banas include the right bank tributaries of Berach and Menali and the left bank tributaries of Kothari, Khari, Dai, Dheel River, Sohadara, Morel and Kalisil.



Berach or Bedach

Berach originates at Gogunda hills in the Udaipur District and is known by name of Ayar river. It is called Berach after appearing from Udaisagar lake near Udaipur. It flows northeast through Udaipur, Chittorgarh and Bhilwara districts, joining the Banas near Bigod village of Bhilwara district.

Berach has significant historical significance with banks of Ahar having thrown up evidences of settlements dating back to the Harappan and pre-Harappan eras cultural levels, thus exhibiting connection with Indus Valley civilization. Additionally, evidences of big palaces were found at Nagri, an ancient site around 16 km from Chittorgarh.

Berach River Summary Sheet

Origin	Gogunda hills in Udaipur
Length	157 Kms
Discharge	Banas, near Bigod village of Bhilwara
States & Major Cities	Rajasthan: Udaipur and Chittorgarh
Right Bank Tributaries	Ahar, Wagli (Wagon), Gambhir and Orai
Major Dams	Gosunda Dam

Kothari River:

Kothari River rises from the Aravalli hills near Devgarh in the Rajsamand. It flows through Bhilwara and ultimately joins the Banas river at Nandrai in Kotri tehsil. The Meja dam on the Kothari river provides drinking water to the Bhilwara district.

Kothari River Summary Sheet

Origin	Aravalli hills near Devgarh in the Rajsamand
Length	380 Kms
Discharge	Banas River, Nandrai in Kotri tehsil
States & Major Cities	Rajasthan: Bhilwara

Major Dams	Meja Dam

Khari River

- Origin- Hills of Bijral village, North of Rajsamand district
- Length- 80 Km
- It meets near Banas river near Deoli (Tonk).

Dai River

- River Dai originates in the southeastern slopes of the Aravalli Range, near Nasirabad Tehsil of Ajmer.
- It flows southeast and then east in Ajmer District and for a short distance through Tonk District, before joining Banas River near Bisalpur village in Tonk District.

Dheel River

- Dheel River originates in the plains near Bauli village in Tonk District. It flows generally from north to south through Jaipur, Tonk and Sawai Madhopur.
- It joins the Banas near Philpura village in Sawai Madhopur district.
- River Gudia is its tributary.

Morel River

- One branch of River Morel originates in the hills near Dharla and Chainpura villages in Bassi Tehsil of Jaipur District and the second branch makes by receiving water from the catchment area of foothills of Paplaj Mataji mountains, district Dausa.
- It flows southeast and then southwest to meet river Dhund, and then again southeast through Jaipur, Dausa and Sawai Madhopur , eventually joining Banas river near Hadoli of Sawai Madhopur District.

KaliSil River

- The River Kalisil originates in the hills near Rajpura village in Sawai Madhopur District. The river flows generally southwest, partly through hills and partly in the plains of Sawai Madhopur District, finally joining the Morel River.

Major Dams on Banas River

- **Bisalpur Dam** is a gravity dam on the Banas River near Deoli in Tonk district, Rajasthan, India. The dam was constructed in 1999 for the purpose of irrigation and water supply.

Banganga River & its Tributaries

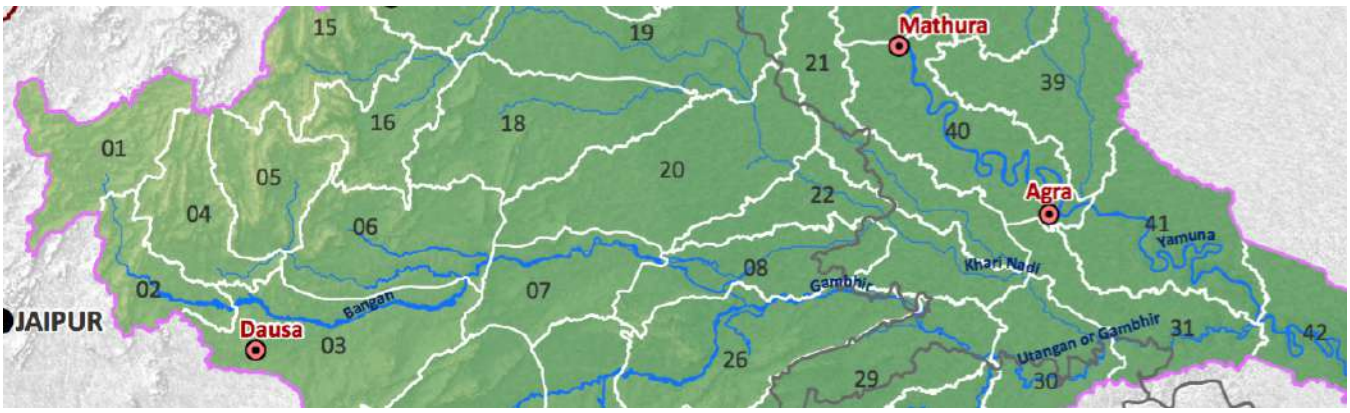
Banganga River originates from the Bairath hills in Jaipur. It passes through Modhapur, Bharatpur and Fatehabad and drains into Yamuna. Jamwa Ramgarh dam has been constructed across the river in Jaipur. The river Banganga has its multiple tributary rivers like Gumti Nala, and Suri rivers on the right side banks and Palasan and Sanwan rivers are on the left bank.

Banganga River Summary Sheet

Origin	Bairath hills in Jaipur, Rajasthan
Length	380 Kms
Discharge	Yamuna near Agra
States & Major Cities	Rajasthan: Dausa and Bharatpur Uttar Pradesh:
Right Bank Tributaries	Gumti Nala, and Suri rivers
Left Bank Tributaries	Palasan and Sanwan
Major Dams	Ramgarh Dam

Banganga in Culture-Mythology

It is believed that Pandav brothers of epic Mahabharat stayed at Bairath kingdom during their one year of secret exile. Arjun made the river flow when he stuck an arrow in the earth to meet water shortage in the region. The place is famous for the Banganga fair, which is held on the full moon day of Vaishakh (April-May) every year.



Banganga Course:

Banganga originates from Bairath in Jaipur district. It flows towards the south, through Ramgarh, up to the village of Ghat, then towards east through partly hilly and partly plain terrain in Dausa and enters Vair tehsil in Bharatpur. Its waster spreads out into several channels in Bharatpur. One of the main channel is diverted to Ajan Band (Bharatpur), which is also source of supply of water for Keoladev National Park. The river eventually flows up to Fatehbad in Agra district (Uttar Pradesh), where it flows into Yamuna.

A few studies have suggested that Banganga might have been part of the Ghaggar-Yamuna system. It might have been connected directly to Yamuna or through Chambal. Owing to some obstruction or neo-tectonic activities around Bharatpur, the flow was disrupted.

Another theory suggests that Yamuna suddenly migrated eastward and Banganga and another possible tributary, Sahibi, could not cope up with that pace. Now, both these rivers flood the area of Bharatpur and Farrukhnagar respectively.

Banganga Basin:

Banganga River Basin is located in the northeastern part of Rajasthan state with a total catchment area of 8,878.7 sq km. It is bounded by Ruparail and Sabi in its north; and the Shekhawati Basin in its west and the Gambhir and Banas River Basins in its south-southwest. The eastern border of the basin is marked by the Yamuna River Basin in Uttar Pradesh. Administratively, Banganga River Basin extends over parts of Alwar, Jaipur, Dausa, Sawai Madhopur and Bharatpur Districts.

Banganga Tributaries:

The main tributaries are Gumti Nalla and Suri River, joining the river on its right bank, and Sanwan and Palasan Rivers meeting the river on its left bank.

Suri River:

- Suri River originates in hills near Kanst village in Dausa and joins Banganga near Kailai Village.

Sanwan River:

- Sanwan river originates in hills near Angri village in Alwar district and joins banganga near village juthiara.

Palasan River

- Palasan river orginates in the hills near Rajpura village in Alwar district and joins banganga near village Indiana.

Banganga Dams:

- Jamwa Ramgarh dam has been constructed across the banganga river in Jaipur.

Luni River & its Tributaries

Luni is a major west-flowing river that originates from western slopes of Naga hills, at an elevation of 772m in Ajmer district of Rajasthan, where it is known as the *Sagarmati*. After passing Govindgarh, it meets its tributary Sarsuti, which originates from Pushkar Lake, and from then on it is referred to as Luni River.

The name Luni is derived from the Sanskrit word *lavanavari* ("salt river") and is so called because of its excessive salinity. The Luni river is not saline until it reaches Balotra, where high salt content in the soil impacts the river.

Luni River Summary Sheet

Origin	Naga hills in Ajmer district of Rajasthan
Length	511 Kms
Discharge	Rann of Kachchh
States & Major Cities	Rajasthan: Balotra Gujarat:
Right Bank Tributaries	Jojri
Left Bank Tributaries	Lilri, the Guhiya, the Bandi (Hemawas), the Sukri, the Jawai, the Khari Bandi, the Sukri Bandi, the Sagi
Major Dams	The Dantiwada dam, Sipu dam

Luni Course:

Luni River originates in Naga Hills of Aravalli Range, near Pushkar valley in Ajmer district. At Govindgarh it meets its tributary Sarsuti and travels in north-western direction towards Nagaur. Luni takes a turn and starts flowing in southwest direction through the aravalli hills in Pali and reaches plains of marwar region in Jodhpur. It continues in the same direction into Barmer and Jalore, eventually discharging into Rann of Kachchh, Gujarat. At Rann of Kutch, Luni forms a delta where the water spreads out and does not contribute any runoff.

The total length of Luni is about 511 kms.

Luni Basin:

- The Luni basin is bounded by Aravalli range and Gujarat plains on the east, by Rajasthan desert on north, and by the Arabian Sea on the south and the west.

- The total area of Luni basin is 32,879 Sq.km and includes several parts of the Ajmer region from Nagaur to Pali and then moving towards Jodhpur and Barmer before its entry into the Jalore district.

Luni Tributaries:

The main tributaries of Luni joining from left are the Lilri, the Guhiya, the Sukri, the Jawai, the Bandi (Hemawas), the Khari Bandi, the Sukri Bandi and the Sagi. Jojri is the only major tributary that joins the luni river from right.

Jawai River

- Jawai originates from the Aravalli Ranges in the Udaipur district of Rajasthan.
- Main tributaries of Jawai are Sukri and Khari river.
- Western Rajasthan's largest dam, the Jawai Dam, is located near Sumerpur in Pali district, on Jawai river
- Twin cities of Sumerpur and Sheoganj are situated on the banks of this river.

Bandi River

- The Rivers Khari and Mithai meet at pickup weir of Bombadra. This confluence gives rise to the Bandi River.
- After flowing for about 45 km, it joins the Luni near the Lakhar village.
- The Hemawas dam is located near Hemawas on this river.
- The district headquarters Pali is located on the bank of Bandi.

Sukri River:

- Sukri river originates from the western slopes of Aravalli Range in Pali District and flows through Jalore and Barmer before merging with the Majal in Luni river.
- Bankli Dam is located on this river in Jalore District.

Guhiya River

- Guhiya River is a small river in Pali, which runs only during the monsoon season.
- It rises in the foothills of the Aravalli Range near the villages of Khariya Neev and joins the Bandi River near the village of Phekaria.

Dams on Luni River:

- In 1892, Maharaja Jaswant Singh of Jodhpur constructed Jaswant Sagar in Pichiyak village, Jodhpur district to use the waters of Luni river.

Sabarmati River & its Tributaries

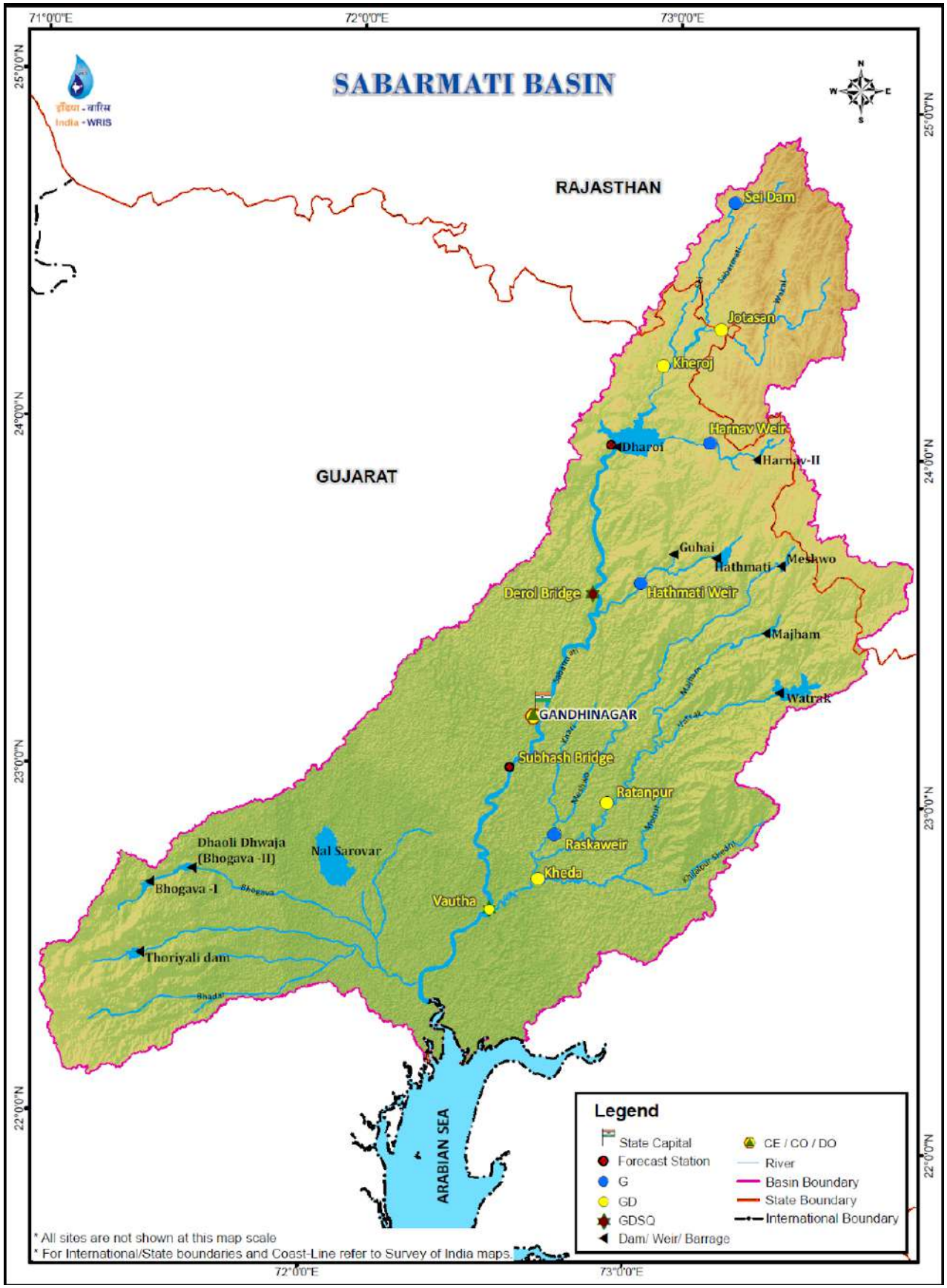
Sabarmati River is one of the major West flowing river of India, along with Narmada and Tapti, which originates from Aravali hill ranges in Rajasthan and after traveling 371 Km. meets the Gulf of Cambay (Khambhat) in the Arabian Sea. 48 km of the river length is in Rajasthan, while the rest 323 km is in Gujarat.

Sabarmati originates from Aravalli hills at an elevation of 762 m near village Tepur, in Udaipur district of Rajasthan. It flows generally in South – West direction in Rajasthan and enters the Gujarat State and passes through the plains and continues to flow in the same direction.

Sabaramati River Summary Sheet

Origin	Village Tepur, in Udaipur, Rajasthan
Length	371 Kms
Discharge	Gulf of Cambay (Khambhat)
States & Major Cities	Rajasthan: Gujarat: Ahmedabad

Right Bank Tributaries	Sei, Siri and Dhamni
Left Bank Tributaries	Wakal, Harnav, Hathmati, Khari, Watrak
Major Dams	Dharoi Dam


SABARMATI BASIN
RAJASTHAN
GUJARAT
ARABIAN SEA
GANDHINAGAR
Sei Dam
Jotasan
Kheroj
Harnav Weir
Dharoi
Harnav-II
Guhai
Hathmati
Meshwo
Derol Bridge
Hathmati Weir
Majham
Watrak
Subhash Bridge
Ratanpur
Raskaweir
Kheda
Vautha
Dhaoli Dhwaja (Bhogava -II)
Nal Sarovar
Bhogava -I
Thoriyali dam
Legend
State Capital
Forecast Station
G
GD
GDSQ
Dam/ Weir/ Barrage
CE / CO / DO
River
Basin Boundary
State Boundary
International Boundary
* All sites are not shown at this map scale
* For International/State boundaries and Coast-Line refer to Survey of India maps.
71°0'0"E
72°0'0"E
73°0'0"E
25°0'0"N
24°0'0"N
23°0'0"N
22°0'0"N

Sabarmati Basin:

The Sabarmati basin extends over states of Rajasthan and Gujarat having an area of 21,674 Sq.km with maximum length and width of 300 km and 150 km.The basin is bounded by Aravalli hills on the north and north-east, by Rann of Kutch on the west and by Gulf of Khambhat on the south. The basin is roughly triangular in shape with the Sabarmati River as the base and the source of the Vatrak River as the apex point.

Sabarmati River Course:

At the 51 km of its run, the river is joined by the Wakal on the left bank near village Ghanpankari. After flowing generally in the South – West direction at 67th km of its run, it receives the Sei on the right bank near Mhauri and then the Harnav on the left bank at about 103 km.

From respective sources beyond this confluence, Sabarmati flows through the Dharoi gorge. Emerging from the gorge it passes through the plains and is joined on its left bank at about 170 km from its source by the Hathmati, which is its major tributary. Continuing to flow in South – West direction, the river passes through Ahmedabad and about 65 km down stream, another major tributary, Watrak joins its on the left bank, flowing for a further distance of 68 km, the river outfalls in the Gulf of Khambhat in Arabian Sea.

Sabarmati Tributaries:

Sei

This is a right bank tributary of Sabarmati River.It rises in the Aravalli hills in Rajasthan and flows in South – West direction for a total distance of 95 km before it joins on its right bank. It drains an area of 946 sq km.

Wakal

This is a Left bank tributary of Sabarmati River.It rises in the Aravalli hills in Rajasthan and flows in South – West direction for a total length of 88 km. It joins Sabarmati on its left bank. It drains an area of 1625 sq km. The Menas is its main tributary.

Harnav

This is a Left bank tributary of Sabarmati River It rises in the Northern portion of the Kulalia hills of Rajasthan ranges and flows in South – West direction for a total distance of 75 km. Harnav joins the left bank of Sabarmati. It drains an area of 972 sq km.

Hathmati

This is a Left bank tributary of Sabarmati River This is a Left bank tributary of Sabarmati River It rises in SouthWest foot hills of Rajasthan range in Gujarat State and flows in South West direction for a distance of 122 km to meet the Sabarmati on its left bank.This tributary drains an area of 1526 sq km. The sub-tributary of Hathmati river is Guhai river, on which Guhai dam is constructed.

Watrak

This is a Left bank tributary of Sabarmati River It rises in Panchara hills in Dungarpur district of Rajasthan and flows in Southwest direction for a distance of 248 km and joins Sabarmati on the left bank. Meshwo, Mazam & Shedhi are sub-tributaries of Watrak river. Watrak and its tributaries drain an area of 8638 sq km. A line diagram of river system giving information of Sabarmati Basin & its tributaries and sub tributaries etc. indicating the location of major structures is enclosed.

Major Dams on Sabarmati River

There are several dams and reservoirs constructed on Sabarmati and its tributaries. The Dharoi dam is located on the main sabarmati river, while *Hathmati dam, Harnav dam, Guhai dam, Meshvo reservoir, Meshvo pick-up weir, Mazam dam and Watrak dam* are located on tributaries. The Kalpasar is planned project in the Gulf of Khambhat.

Dharoi Dam:

- Dharoi dam is located about 165 km upstream Ahmedabad in village Dharoi of Mehsana district.
- It was constructed in 1978.

- It has catchment area of 5540 km^2, out of which about 2,640 km^2 lies in Gujarat state.

Vasna Barrage:

- At distance 202 km.Vasna Barrage having 10619 sq.km. catchment area is situated.

Sabarmati River Concerns:

- The industrial city of Ahmedabad poses the danger of water pollution by industrial waste.

Mahi River & its Tributaries

Mahi is one of the major interstate west flowing rivers, along with Tapti River and the Narmada River, of India. The total length of Mahi is 583 km. It originates in the Mahi Kanta hills, from the northern slopes of Vindhyas at an altitude of 500 m near village Bhopawar, Sardarpur tehsil in Dhar district of Madhya Pradesh. Initially the river flows Northwards through Dhar and Jhabua districts of M.P. and then turns left and passes through the Ratlam district of M.P., then turning to North - West, it enters the Banswara district of Rajasthan and flows in South - West directions and thereafter enters the Panchmahal district of Gujarat state. Then the river continuously flows in the same direction through Kheda district of Gujarat and finally falls into the Gulf of Khambhat in Arabian Sea.

Mahi river also finds mention in India mythology. In Vayu Purana, this river is also known as Mahati. The name of the river seems to be derived from the lake from which it springs. This is often called the Mau or Mahu as well as the Menda. According to one legend, the Mahi is the daughter of the Earth and sweat of Indrdyumna, the King of Ujjain.

Mahi River Basin:

The Mahi basin extends over states of Madhya Pradesh, Rajasthan and Gujarat having total area of 34,842 Sq.km. It is bounded by Aravalli hills on the north and the north-west, by Malwa Plateau on the east, on the south by the Vindhyas and by the Gulf of Khambhat on the west.

The state wise distribution of the drainage area is shown in the following Table.

State	Drainage area (Sq. Km.)
Rajasthan	16453

Gujarat	11694
Madhya Pradesh	6695
Total	34842

Tributaries of Mahi:

Som

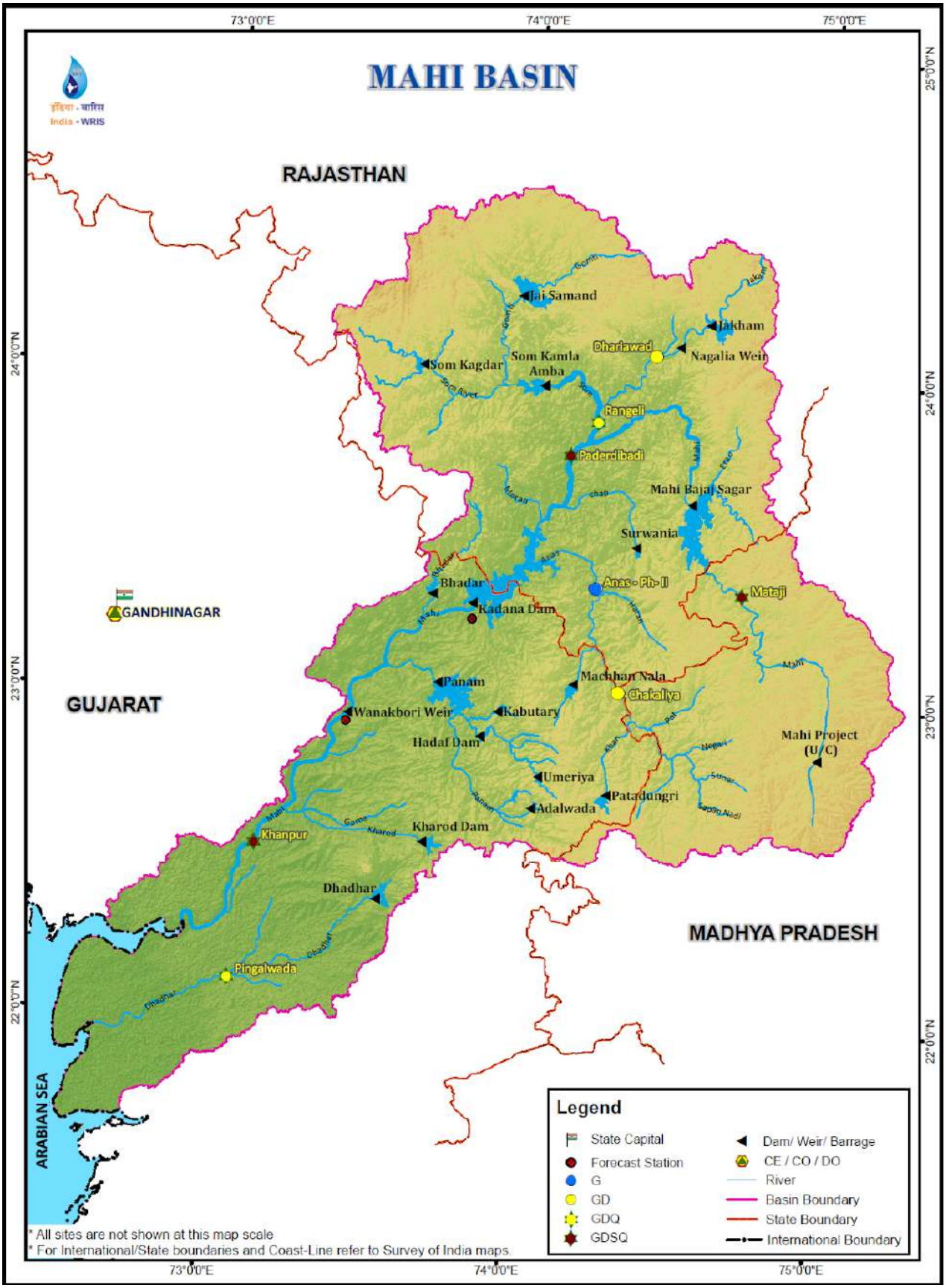
This is a right bank tributary of Mahi. Som river rises near Som on the Eastern slopes of the Aravalli hills in the Udaipur district of Rajasthan at an elevation of 600 m above m.s.l. and flows in the Eastern direction to join the main river Mahi on the right bank 6.3 km upstream of Paderdibadi site in Dungarpur district of Rajasthan. Its total length is about 155 km. The total drainage area of Som is 8707 sq.km. Gomti & Jakham are the major right bank sub tributaries of Som.

Anas

This is a Left bank tributary of Mahi. Anas River rises near Kalmora on the Northern slopes of Vindhyas in Jhabua district in Madhya Pradesh at an elevation of 450 m above m.s.l. and flows in the North - West direction and joins the main river Mahi on left bank in the Dungarpur district in Rajasthan. It has a total length of about 156 km and the total drainage area of 5604 sq.km.

Panam

This is a Left bank tributary of Mahi. Panam river rises near Bhadra on Northern slopes of the Vindhyas near Jhabua district in Madhya Pradesh at an elevation of about 300 m above m.s.l. and flows in the North - West direction and joins the main river on the left bank in the Panchmahal district of Gujarat. It has a total length of about 127 km and drainage area of about 2470 sq.km.


MAHI BASIN
RAJASTHAN
GUJARAT
MADHYA PRADESH
GANDHINAGAR
ARABIAN SEA
Jai Samand
Jakham
Dharlawad
Nagalia Weir
Som Kagdar
Som Kamla Amba
Rangeli
Paderdibadi
Mahi Bajaj Sagar
Surwania
Bhadar
Kadana Dam
Anas - Ph-I
Mataji
Panam
Machhan Nala
Chakaliya
Wanakbori Weir
Kabutary
Hadaf Dam
Mahi Project (U/C)
Umeriya
Patardungri
Adalwada
Khanpur
Kharod Dam
Dhadhar
Pingalwada
Legend
State Capital
Forecast Station
G
GD
GDQ
GDSQ
Dam/ Weir/ Barrage
CE / CO / DO
River
Basin Boundary
State Boundary
International Boundary
* All sites are not shown at this map scale
* For International/State boundaries and Coast-Line refer to Survey of India maps
73°0'0"E
74°0'0"E
75°0'0"E
25°0'0"N
24°0'0"N
23°0'0"N
22°0'0"N

Hydro-electric projects on Mahi River

There are two major hydro-electric projects constructed on Mahi River.

Sl.No.	Project Name	River	State	District
1	Kadana Hydroelectric Project	MAHI	Gujarat	Fort Sonagadh
2	Mahi Hydroelectric Project	Mahi	Rajasthan	Banswara

Dams on Mahi River:

Banswara Dam or Mahi Bajaj Sagar Dam

- Named after Shri Jamnala Bajaj, Mahi Bajaj Sagar Dam is situated 16 kilometres from Banswara town in Banswara district Rajasthan, India. It is the second largest dam in Rajasthan.
- The dam was constructed between 1972 and 1983 for the purposes of hydroelectric power generation and water supply.
- There are large number of islands within the catchment area of the dam, so Banswara also called popularly called as "City of Hundred Islands".

Wanakbori dam

- The Wanakbori dam is established near Wanakbori village.
- The Wanakbori thermal power station uses the water of river mahi. There are 7 units for the production electricity.

Kadana Dam

- **Kadana Dam** is an earthen and masonry dam on the Mahi River in Mahisagar district of Gujarat, India.
- The dam was constructed between 1979 and 1989.

Mahi River Concerns:

- The silt brought down by the Mahi has contributed to the shallowing of the Gulf of Khambhat and the abandonment of its once-prosperous ports. The riverbed lies considerably lower than the land level and is of little use for irrigation.

West Banas River & its Tributaries

The West Banas river is another west flowing river that rises near Pindwara village in Sirohi district of Rajasthan at an elevation of 372.5 m above mean sea level. The river flows in a south–westerly direction and after travelling length of 266 kms, empties into little Rann of Kachchh.

West Banas River Summary Sheet

Origin	Near Pindwara village in Sirohi district, Rajasthan
Length	266 Kms
Discharge	Rann of Kachchh
States & Major Cities	Rajasthan: Gujarat:
Right Bank Tributaries	Sipu
Left Bank Tributaries	Batria, Sukli, Sewaran, Suket, Balaram and Khari
Major Dams	The Dantiwada dam, Sipu dam

West Banas Basin:

West Banas drains an area of 8,674 sq km out of which nearly 38 % lies in Rajasthan State and the remaining 62 % falls in Gujarat state. It is bounded by Luni basin in the north, Sarasvati basin in the south, Aravalli Hill ranges in the east and Arabian Sea in the west.

The number of principal tributaries, which contribute significantly, is seven. Sipu is the only major tributary on the right bank. The other six tributaries namely Batria, Sukli, Sewaran, Suket, Balaram and Khari drain into the main channel from left bank. Hence draining system on the left bank of the Banas river is more extensive as compared to the right bank area.

West Banas Tributaries:

Sipu:

- Sipu is the prinicipal tributary of the Banas rising from Sirohi and Mount Abu hills in Sirohi district of Rajasthan state.
- About 30% of Mount Abu hills direct runoff drains into Sipu river while about 70% of mount Abu hills direct runoff flows into Banas river.
- The confluence of Sipu river and West Banas river is 12 km downstream of dantiwada dam.

Khari:

- Kahri river rises from Palanpur (B.K.distric) and drains into the Banasa river through Mehsana district at 80 km downstream of dantiwada dam.

Sukli:

- The Sukli triburtary rises from aravalli hills near Pindwara of Sirohi district (Rajasthan) and drains into the Banas river downstream of Swaroopganj dam and 9 km upstream of Abu road of Rajasthan state.

Batria:

- The river rises near Ambaji hills of Aravalli range and drains into Banas, 3 km upstream of Abu road.

Dams on West Banas River

- The **Dantiwada dam** and **Sipu dam** are the main irrigation structures existing on the main channel of West Banas river.

Gambhir River & its Tributaries

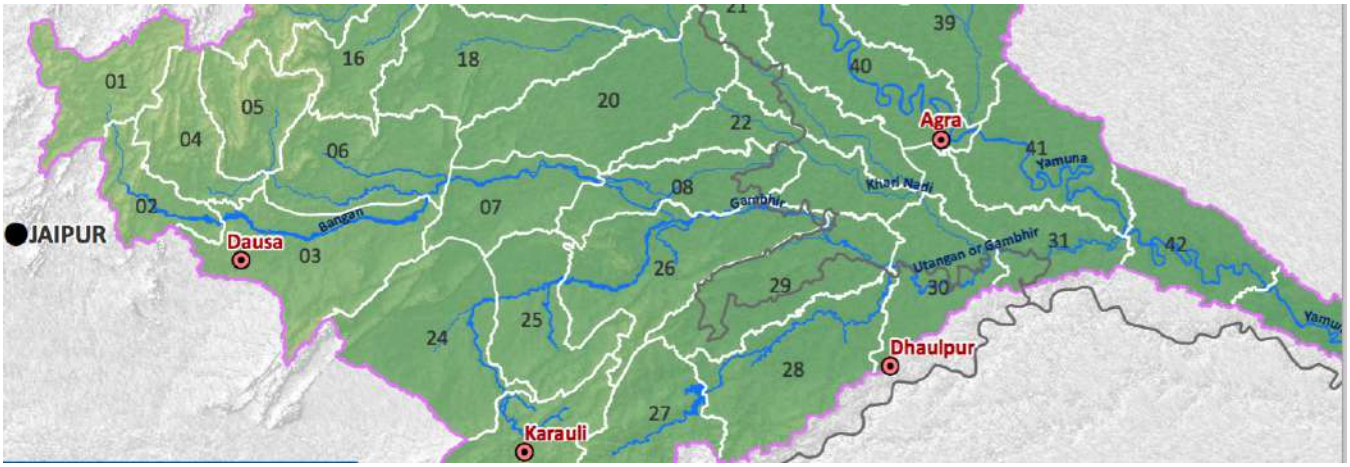
Gambhir river also referred to as Utangan River is a river that originates in the hills near Hindaun in Karauli, Rajasthan and flows around Hindaun City. The river supplies water for Keoladev Ghana Bird Century in Bharatpur, Rajasthan. Gambhir is a seasonal river but becomes perennial after its confluence with the Parbati, outside Dhoulpur District.

Gambhir River Summary Sheet

Origin	In the hills near Hindaun in Karauli, Rajasthan
Length	288 Kms in Rajasthan
Discharge	Yamuna
States & Major Cities	Rajasthan: Hindaun in Karauli, Bayana city in Bharatpur
Tributaries	Sesa, Kher and Parbati.
Major Dams	Panchana Dam

Gambhir River Course:

The river originates in the hills near Hindaun in Karauli, Rajasthan. It flows in south to north direction up to Kanjoli village (Toda Bhim), then turns northeast up to village Mertha and enters into Uttar Pradesh. The river again enters Rajasthan near Catchapaura village in Dholpur and subsequently forms the boundary between Uttar Pradesh and Rajasthan. It then enters Mainpuri District in UP to finally joins Yamuna river.



Gambhir River Basin:

Gambhir or Utangan River Basin is located in northeastern part of Rajasthan. It is bounded by the Banganga river basin in the north, Banas river basin in the south west, Chambal and Parbati in the southeast; Uttar Pradesh state constitutes part of the boundary in the northeast. The Basin extends over parts of Bharatpur, Dausa, Dhaulpur, Karauli and Sawai Madhopur Districts. It is a small river basin and its approximate total catchment area is 4,316 square km.

Gambhir River Tributaries:

Important tributaries of the river are Sesa, Kher and Parbati (*Different from Parbati, tributary of Kali Sindh*).

Parbati River:

- Parbati River rises in hilly terrain near Chhawar village in the Sawai Madhopur. It runs for 123 km and falls into the Gambhir River near Kharagpur in Dholpur, Rajasthan.

Important Dams:

Panchana Dam:

- The Panchana Dam is situated at Gambhir river, near Karauli district (a tributary of Yamuna). The dam is situated at 12 km north to Karauli in the eastern part of Rajasthan. It is an important man-made wetland system, formed by the confluence of five rivers, named Barkhera, Bhadrawati, Attaki, Bhansawat and Manchi.

Dravyavati River

Dravyavati River originates from the *western slope of Amber hills* at the foothills of the Nahargarh Fort in Jaisalya village and flows through the west side from Jaipur city, north to south over a length of 47.5 km to meet *river Dhund*. Most of the Jaipur's population stays in the 10 km of the periphery of this river. The river collects storm water from all the adjoining areas such as Ambabari, major portion of Walled City, Sanganer town and Pratap Nagar, etc.

Pollution in Dravyavati River

Dravyavati River, which is also known as "*Amaanishaah naala*", has lost its flow and purity of water in past couple of decades. Sewerage mixed with domestic waste water and industrial waste from various city areas drains into the river through Nahri ka Nullah, Jawahar Nullah and various streams that feed through structured/unstructured sewerage system of the colonies.

Rejuvenation:

To change the fate of the river and make Jaipur a better city, Jaipur Development Authority (JDA) had proposed a *project for Rejuvenation of Dravyawati River.* Further in August 2016, JDA has given a contract to a consortium of Tata Projects and Shanghai Urban Construction Group at a project cost of Rs1,676 crore to complete the project by October 2018. Activities included in Project include:

- Amortization of 170 MLD polluted water.

- Check dams & fall structures will be constructed to brake the flow of water during Monsoon, prevent soil erosion and improve the depleting water-table of the city. 85 such check dams and 122 fall structures shall be constructed.
- Nearby land of this project will be developed with Parks, Parking, Theaters, Fountains etc.
- The consortium will be responsible for the maintenance of this project for 10 years from the completion of the project.

Rajasthan Rivers by Districts

Rivers of Rajasthan are mostly seasonal, however, these seasonal rivers recharge the groundwater making well irrigation possible. All the rivers and their floodplains in Rajasthan also serve as vast grazing grounds that support millions of livestock. Most of the Rivers originate from the Aravali hills and flow either in east or west. Those Rivers flowing in east merge with Yamuna. Those flowing in west fall into Gulf of Khambhat or lost in desert. Even after being a desert state, apart from Bikaner almost each district has multiple rivers.

This post contains list of Rivers of Rajasthan by District.

- **Ajmer** - Sagarmati, Saraswati, Khari, Dai, Banas, Rupangarh
- **Alwar** - Sabi (Sahibi), Ruparail, Kali, Gauri, Sota, Arvari, Chuhar
- **Banswara** - Mahi, Annas, Chaini
- **Barmer** - Luni, Sukri, Mithri
- **Baran** - Parbati(Parvati), Parwan
- **Bharatpur** - Chambal, Barah, Banganga, Gambhiri, Parvati, kukund
- **Bhilwara** - Banas, Kothari, Berach, Menali, Mansi, Khari
- **Bikaner - no river**
- **Bundi** - Kural (mangli), Mej, Brahmani, Ghoda Pachhad
- **Chittorgarh** - Banas, Berach, Brahmani, Bagan, Gambiri, Gunjali
- **Churu - no river**

- **Dausa** - Banganga, Morel
- **Dholpur** - Chambal, Parbati, Gambhir(Utgan)
- **Dungarpur** - Som, Mahi, Soni
- **Hanumangarh** - Ghaggar
- **Jaipur** - Banganga, Bandi(Mashi), Dhund, Morrel, Sabi (Sahibi)-Sota, Sakha, Mantha
- **Jaisalmer** - Kaknei, Chingan, Lathi, Dhoa, Dhogri
- **Jalore** - Luni, Bandhi, Jawai, Sukri, Sagi
- **Jhalawar** - Kali Sindh, , Chhoti Kali Sindh, Ahu, Niwaj, Parwan
- **Jhunjhunu** - Kantli
- **Jodhpur** - Luni, Mathdi, Jojri, Gunaimata
- **Karauli** - Gambhir, Chambal, Banas
- **Kota** - Chambal, Kali Sindh, Parvati, Au Niwaj, Parwan
- **Nagaur** - Luni, Mantha, Harsor
- **Pali** - Lihri, Bandi, Sukri ,Jawai
- **Pratapgarh** - Jakham, Siwan, Mahi
- **Rajsamand** - Khari, Kothari, Banas, Chandrabhaga
- **Sawai Madhopur** - Chambal, Banas, Morel, Gambhiri
- **Sikar** - Kantli, Mantha, Pawta, Kavant
- **Sirohi** - West. Banas, Sukri, Posliya, Khati, Kishnavati, Jhula, Survata
- **Sri Ganganagar** - Ghaggar
- **Tonk** - Banas, Mashi, Bandi
- **Udaipur** - Banas, Ahar, Berach, Wakal, Gomti, Som, Jakham, Sabarmati, Sei

List of Rivers in Rajasthan

Now, the List of Rivers of Rajasthan and districts in catchment of each River. Precaution has been taken to list districts from source of river to the discharge. Example Luni river originates in Ajmer then goes to Nagaur, then Jodhpur, then Pali, then Barmer, then Jalore and then goes to Gujarat hence Luni is listed as: Luni River (Ajmer, Nagaur, Jodhpur, Pali, Barmer, Jalore)

- Ahu (Jhalawar, Kota)
- Andheri (Jhalawar, Kota)
- Anas (Banswara)
- Arvari (Alwar)
- Aurai (Chittorgarh)
- Brahmani (Chittorgarh)
- Banas (Rajsamand, Chittorgarh, Bhilwara, Ajmer, Tonk, Sawai Madhopur, Karauli)
- Bandi River: (Jaipur, Tonk) | (Sirohi, Jalore) | (Pali) - Three rivers are named Bandi
- Banganga (Jaipur, Dausa, Bharatpur,)
- Berach (Udaipur, Chittorgarh, Bhilwara)
- Chaini (Banswara)
- Chambal (Chittorgarh,Kota, Bundi, Sawai Madhopur, Karauli, Dholpur)
- Chandrabhaga (Rajsamand, Bhilwara)
- Chuhar River (Alwar)
- Dai (Ajmer, Jaipur)
- Dhogri (Jaisalmer)
- Dhundh (Jaipur)
- Gambhiri (Karauli, Sawai Madhopur, Bharatpur, Dholpur)
- Gauri River (Alwar)
- Ghaggar (Hanumangarh, Ganganagar)
- Ghoda Pachhar (Jhalawar, Bundi)

- Gomti (Udaipur)
- Gunaimata (Jodhpur)
- Harsor (Nagaur)
- Jakham (Pratapgarh, Udaipur, Dungarpur)
- Jawai (Pali, Sirohi, Jalor)
- Jojari (Jodhpur)
- Kakney (Jaisalmer)
- Kakund (Bharatpur)
- Kali Sindh (Kota)
- Kali River (Alwar)
- Kalisindh (Jhalawar)
- Kantli (Sikar, Jhunjhunu, Churu)
- Kapalganga (Sirohi)
- Khari River (Rajsamand, Bhilwara)
- Kothari River (Rajsamand, Bhilwara)
- Krishnawati (Sirohi, Sikar)
- Kural River (Bundi)
- Kyasari (Jhalawar)
- Lathi River (Jaisalmer)
- Lilri (Pali)
- Luni River (Ajmer, Nagaur, Jodhpur, Pali, Barmer, Jalore)
- Mahi River (Banswara, Pratapgarh, Dungarpur)
- Mandha River (Sikar)
- Mangli (Bundi)
- Mansi (Bhilwara)

- Masi (Tonk, Jaipur)
- Mej (Bundi)
- Menali (Bhilwara)
- Morel (Jaipur, Dausa, Sawai Madhopur)
- Niwaj (Jhalawar, Kota)
- Parban (Jhalawar, Kota, Baran)
- Parbati (Baran, Kota)
- Parvati (Bharatpur, Dholpur)
- Piplaj River (Jhalawar)
- Ruparel (Alwar, Bharatpur)
- Sabarmati (Udaipur)
- Sabi (Sikar, Alwar, Jaipur)
- Sagarmati (Ajmer)
- Sagi (Jalor)
- Sanwan (Dausa)
- Saraswati (Ajmer)
- Sindh River (Alwar)
- Sohadara (Tonk)
- Som (Udaipur, Dungarpur)
- Sota (Sikar, Alwar)
- Sukri (Pali, Sirohi, Barmer, Jalor)
- Wakal (Udaipur)
- West Banas (Sirohi)

Important Lakes in Rajasthan

Rajasthan is the most arid state of India with average yearly rainfall less that 100 cm . However, Rajasthan has a large number lakes mostly artificial as well as historical, signifying a tradition of conserving natural resources and respecting nature. The lakes in Rajasthan can divided into types Saline and Fresh water lakes.

Types of Lakes in Rajasthan:

- Saline (Salt) Water lakes
    - This are considered as remains of Tethys Sea.
    - Deedwana, Lunkaransar, Sambhar, Panchpadra etc.
- Fresh (Sweet) Water lakes
    - They have either developed naturally or artificially and get replenished by rainwater.
    - Pichhola, Jaisamand, Rajsamand, Ana Sagar etc.

Now,

A. Saline (Salt) Water lakes in Rajasthan

Sambhar Lake

- Location: Phulera, Jaipur
- Built by: As per mythology, Scambhari Devi,
- Highlights:
    - Ramsar Wetland
    - Largest in-land salt-lake in India
    - Touches border of Jaipur, Ajmer and Nagaur.
    - Rivers mantha, rupangarh, khari, khandela drain their water into this lake.
    - The lake produces 8.7% of Salt produced in India.

- Lake is managed by Sambhar Salts Limited, a joint venture of Hindustan Salts and the Government of Rajasthan.

Panchpadra Lake:

- Location: Barmer
- Built by: Natural
- Highlights: Its sodium chloride level is marked at 98%.

Lunkaransar Lake:

- Location: Bikaner
- Built by: Natural
- Highlights: It is a playa lake formed due to deflation.

Deedwana Lake:

- Location: Nagaur
- Built by: Natural
- Highlights: Salt produced is non-edible grade because of high fluoride.

Tal Chappar:

- Location: Churu
- Built by:
- Highlights: Has Talchhapar Wild Life Sanctuary.

Other Salt lakes:

- Nagaur District: Degana, Kuchaman
- Jodhpur: Falaudi
- Sikar: Rewasa
- Jaisalmer: Kavod

B. Fresh Water lakes in Rajasthan

Ana Sagar Lake, Ajmer:

Anasagar Lake is a scenic artificial lake, commissioned and built by Arnoraj Chauhan, son of Ajaypal Chauhan, between 1135 and 1150 AD. Arnoraj was also known as Anaji, which gives the lake its name. Many years later, Mughal Emperor Jahangir added his touch to the lake by laying out the Daulat Bagh Gardens near the lake. Emperor Shah Jahan too, contributed to the expansion by building five pavilions, known as the Baradari, between the garden and the lake.

Lake Foy Sagar, Ajmer:

A beautiful artificial lake that appears flat, Lake Foy Sagar was built by an English engineer, Mr. Foy in 1892 AD. Interestingly, this work was taken up to provide famine relief through wage employment to locals. Lake Foy Sagar offers a beautiful view of the Aravalli range.

Pushkar lake, Pushkar, Ajmer

According to Hindu scriptures, the sacred Pushkar Lake is described as 'Tirtha Raj', the king of all pilgrimage sites. No pilgrimage is considered to be complete without a dip in in the holy Pushkar Lake. Semi-circular in shape and about 8-10 metres deep, Pushkar Lake is surrounded by 52 bathing ghats and over 400 temples and is truly a magnificent sight to behold.

Siliserh Lake, Alwar

The water palace of Siliserh with a lake surrounded by low wooded hills is on route to Sariska. It lies 12 Kms. Southwest of Alwar. The tranquil lake is nestled in the hills; the sparkling ripples of the lake cover an area of about sq. Kms , surrounded by thick forest and magnificent cenotaphs on its embankment. A royal hunting lodge /palace was built by Maharaja

Vinay Singh for his Queen Shila in 1845. It has been converted into a tourist bungalow and is an attractive sot for a peaceful holiday.

Anand Sagar lake, Banswara

This artificial lake, also known as Bai Talab was constructed by Lanchi Bai, the Rani of Maharaval Jagmal Singh. Located in the eastern part of Banswara, it is surrounded by holy trees known as 'Kalpa Vriksha', famous for fulfilling the wishes of visitors. The ‘chattris’ or cenotaphs of the rulers of the state are also scattered nearby.

Dailab Lake, Banswara

On the banks of this beautiful lake stands the summer residence of the former rulers. A major part of the lake itself is covered with lotus flowers.

Jait Sagar Lake, Bundi

Located close to the Taragarh Fort, this picturesque lake is surrounded by hills and covered with pretty lotus flowers that bloom during winter and monsoon.

Kanak Sagar Lake, Bundi

About 67 kilometres from the town of Bundi lies this wonderful flat lake. There is also a town named after the lake. One can spot several migratory birds here such as bar headed goose and Demoille cranes all through the year.

Nawal Sagar lake, Bundi

Nawal Sagar Lake is an artificial lake that is a major tourist attraction and can even be seen from the Taragarh Fort. There is a half-submerged temple dedicated to Lord Varun Dev in its centre. What makes the lake unique is that one can see the reflection of nearby palaces and forts in its waters.

Gaib Sagar Lake, Dungarpur

The lake is famous for the shrine of Shrinathji that rests on its banks. The shrine complex contains numerous exquisitely carved temples and one core temple, the Vijay Rajrajeshwar Temple. This temple of Lord Shiva displays the skilled craftsmanship of the famed sculptors or 'shilpkars' of Dungarpur.

Gadsisar Lake, Jaisalmer

Gadisar Lake was constructed in the 14th century by Maharawal Gadsi Singh to meet the water needs of his arid lands. Considering its importance, many small temples and shrines were constructed around it, transforming it into a pilgrimage centre and a tourist attraction.

Balsamand Lake, Jodhpur

Balsamand Lake is about 5 kilometres from Jodhpur on the Jodhpur-Mandore Road. Built in 1159 AD, it was planned as a water reservoir to cater to Mandore. The Balsamand Lake Palace was built on its shore later as a summer palace. It is surrounded by lush green gardens that house groves of trees such as mango, papaya, pomegranate, guava and plum. Animals and birds like the jackal and peacock also call this place home.

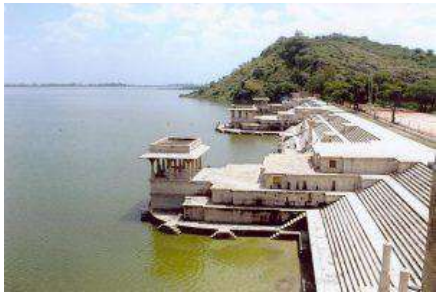
Kailana Lake, Jodhpur

Situated on Jaisalmer road, this small artificial lake is an ideal picnic spot. It is like a canvas with a splash of romantic colours. The beauty of the lake stays with you long after you've experienced it.

Kishore Sagar lake, Kota

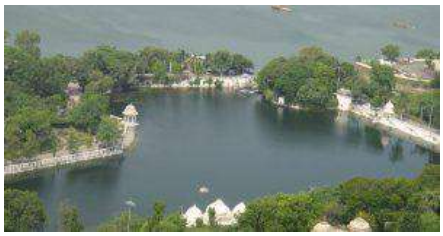
Kishore Sagar Lake is one of the lakes in Kota which was built in 1346 by the prince of Bundi named Dher Deh. The Jagmandir Palace was built by one of the queens of Kota between 1743 and 1745, and is situated in the middle of the Kishore Sagar Lake.

Rajsamand Lake, Rajsamand



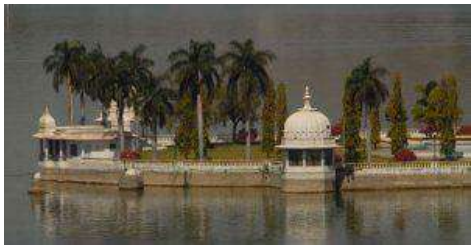
Maharana Raj Singh an able administrator of the fifth generation of Maharana Pratap constructed rajsamand lake in 1662 AD, which is a beautiful example of sculpture and public utility works. The banks known as "Nouchoki" consist of 25 carved stone 'RAJ PRASHASHTI' the longest stone inscription in Sanskrit in the world.The stairs, footrest, artistic gates and 'Mandaps' are made of beautiful carved marble and the sculpture imparts a new look every time. The whole construction is based on the number 9 which is considered to be the absolute number in Hindu philosophy & mythology. It took 14 years for completion and cost more than 12.5 million rupees at that time. rajsamand District is a district of the state of Rajasthan in western India.

Doodh Talai, Udaipur



The road that takes visitors to Pichola Lake has another popular destination – the Doodh Talai Lake. The lake is nestled between several small hillocks which themselves are tourist attractions. The Deen Dayal Upadhyay Park and the Manikya Lal Verma Garden are part of the Doodh Talai Lake Garden.

Fateh SagarLake, Udaipur



This delightful lake, bordered by hills and woodlands, lies to the north of Lake Pichola. This artificial lake is connected to Lake Pichola by a canal. The lake houses the beautiful Nehru Island as

well as an islet on which stands the Udaipur Solar Observatory. It was inaugurated by the Duke of Connaught and was initially called Connaught Bundh.

Jaisamand Lake, Udaipur

Jaisamand Lake is known for being the second largest man-made sweet water lake in Asia. It is popular among the locals as a weekend picnic destination. Locals say that the lake was constructed to halt the waters of Ruparel River. This lake boasts of a large island, which is home to various species of birds, at its centre.

Pichola Lake, Udaipur

Pichola was the name of a village that was submerged and lent its name to the lake when it was expanded. The islands of Jag Niwas and Jag Mandir as housed in this lake. Along the eastern banks of the lake lies the City Palace. A boat ride in the lake around sunset offers a breathtaking view of the Lake and City Palaces.

Udai Sagar Lake, Udaipur

Udai Sagar Lake is one of the five striking lakes situated in Udaipur. Located about 13 kilometres to the east of Udaipur, the construction of this lake was started in 1559 by Maharana Udai Singh. The lake is actually a result of a dam being built on the river Berach to supply adequate water to the Maharana's kingdom. Udai Sagar Lake is 4 kms in length, 2.5 kilometres in width and about 9 meters at its deepest.

Important Dams of Rajasthan

S.No	River	Dam Name	District
1	Ahu	Gagrin Dam	Jhalawar
2	Alnia Hukud	Alnia Dam	Kota
3	Amlabala/ Local nala	Sindroo Dam	Pali
4	Arav/ Erau	Bhanwar Semla Dam	Pratapgarh
5	Banas	Bisalpur Dam	Tonk
6	Banas	Bithan Dam	Jalor
7	Banas	Dindoli Dam	Chittaurgarh
8	Banas	Gosunda Dam	Chittaurgarh
9	Banas	Matrakundia/ Matrikundia/ Matrikundial Dam	Chittaurgarh
10	Banas	Nand Samand Dam	Rajsamand
11	Banas/ Bandi	Hingonia Dam	Jaipur
12	Banas/ Dundh	Sheel Ki Dungri/ Dogri Dam	Jaipur
13	Banas/ Local Nala	Chaparwara Dam	Jaipur
14	Banas/ Local Nala	Morasagar Dam	Sawai Madhopur
15	Bandi (Sukri)	Bandi Sandhara Dam	Jalor

16	Bandi/ Mashi	Mashi Dam	Tonk
17	Bandi/ Sumer	Hemawas Dam	Pali
18	Banganga	Chandrana Dam	Jaipur
19	Banganga/ Local nala	Kharad Dam	Jaipur
20	Banganga/ Local Nala	Madho Sagar Dam	Dausa
21	Banganga/ Ruparail	Jaisamand Dam	Alwar
22	Banganga/ Sawa	Sainthal Sagar/ Sainthal/ Sinthalsagar Dam	Jaipur
23	Banqanga	Ram Garh Dam	Jaipur
24	Began	Pachki Baori Dam	Bundi
25	BERACH	Badgaon Dam	Udaipur
26	Berach	Bagolia Dam	Udaipur
27	Berach	Bhopal Sagar Dam	Chittaurgarh
28	Berach	Fateh Sagar Dam	Udaipur
29	Berach	Madhar/ Madar Dam	Udaipur
30	Berach	Udai Sagar Dam	Udaipur
31	Bethali/ Benthali	Benthali/ Bethli/ Bethali Dam	Baran
32	Bhimlat	Abhaypura Dam	Bundi

33	Bhimlat	Bhimlat Dam	Bundi
34	Bilas	Bilas Dam	Baran
35	Brahmani	Dorai Dam	Chittaurgarh
36	CHAMBAL	Aklera Sagar Dam	Baran
37	Chambal	Jawahar Sagar Dam	Bundi
38	Chambal	Ranapratap Sagar Dam	Chittaurgarh
39	Chambal/ Kul	Gopalpura Dam	Baran
40	Chambal/ Local nala	Man Sarowar Dam	Sawai Madhopur
41	Chandrabhaga	Chandrabhaga Dam	Bhilwara
42	Chauli	Chauli Dam	Jhalawar
43	Chhapi	Chhapi Dam	Jhalawar
44	Dai	Lassaria Dam	Ajmer
45	Daya	Daya Dam	Udaipur
46	Dhoond/ Dhundh	Kanota Dam	Jaipur
47	Galwa	Galwa Dam	Tonk
48	Gambhir/ Local Nala	Surwal Dam	Sawai Madhopur
49	Gambhiri	Gambhiri Dam	Chittaurgarh

50	Gambhiri/ Panchana	Panchana Dam	Karauli
51	Gararda	Gararda Dam	Bundi
52	Ghanerow/ Tri. of Sukli	Kana Dam	Pali
53	Gomti	Jai Samand Dam	Udaipur
54	Gomti Banas	Rajsamand Dam	Rajsamand
55	Guhiya/ Sukli	Sardar Samand Dam	Pali
56	Gulandi	Gulandi Dam	Jhalawar
57	Jakham (mahi)	Jakham Main Dam	Pratapgarh
58	Jawai	Jawai Dam	Pali
59	Juggar Banas	Juggar Dam	Karauli
60	Kalisil Banas/ Kalisindh	Kalisil Dam	Karauli
61	Khari	Arwar Dam	Bhilwara
62	Khari	Basundni Dam	Ajmer
63	Khari	Godana Dam	Sirohi
64	Khari	Kala Bhata Dam	Rajsamand
65	Khari	Khari Dam	Bhilwara
66	Khari	Ora Dam	Sirohi

67	Khari	Ummed/ Umaid Sagar (Baran) Dam	Baran
68	Kothari	Ladki/ Larki Dam	Bhilwara
69	Kothari	Meja Dam	Bhilwara
70	Kothari (Banas)	Kothari Stage I Dam	Bhilwara
71	Krashnauti	Dhanta Dam	Sirohi
72	Krishnawati	Angore Dam	Sirohi
73	Kundal	Mandawara Dam	Sirohi
74	Lhasi	Lhasi Dam	Baran
75	Luni	Girinanda Dam	Pali
76	Luni	Jaswant Sagar Dam	Jodhpur
77	Luni & WFR	Giroliya Dam	Pali
78	Maghai	Sadari Dam	Pali
79	Mahadev Nalla	Mahadev Dam	Sirohi
80	Mahi	Mahi Bajaj Sagar Dam	Pratapgarh
81	Manali	Govta Dam	Bhilwara
82	Mangu	Phacharia Dam	Sirohi
83	Mansi	Sareri/ Sareru Dam	Bhilwara

84	Mej River	Bundika Gothra Dam	Bundi
85	Mej River	Paibala Pura Dam	Bundi
86	Moral/ Gandi/ Ganoli	Domti Kokra Dam	Bhilwara
87	Moran	Lodisar Dam	Dungarpur
88	Morel	Dheel Dam	Sawai Madhopur
89	Morel	Morel Dam	Sawai Madhopur
90	Nagdi	Nagdi Dam	Bhilwara
91	Nahari/ Local Nala	Deopura Dam	Sawai Madhopur
92	Nekhadi/ Local Nala	Kantaliya Dam	Pali
93	Nori/ Local nala	Kantri Dam	Dungarpur
94	Odher/ Local nala	Needar Dam	Karauli
95	Orai	Orai Dam	Chittaurgarh
96	Parbati	Parbati Dam	Dhaulpur
97	Parbati	Ram Sagar Dam	Dhaulpur
98	Parbati	Urmila Sagar Dam	Dhaulpur
99	Phuphadia	Kharda/ Kharda Bund/ Bandh Dam	Pali
100	Piplad	Piplad Dam	Jhalawar

101	Raipur Luni	Raipur Luni Dam	Pali
102	Roop Rail/ Siliberi	Silibari Dam	Alwar
103	Ruparel	Ruparel Dam	Chittaurgarh
104	Sabi/ Local Nala	Chittoli Dam	Jaipur
105	Sei	Sei Diversion Dam	Udaipur
106	Sisarma	Swaroop Sagar Dam	Udaipur
107	Sivani	Bajrang Garh Dam	Pratapgarh
108	Sivani	Chacha Kheri Dam	Pratapgarh
109	Sivani	Hamja Kheri Dam	Pratapgarh
110	Sohadra	Tordi Sagar Dam	Tonk
111	Som and Gomti	Som Kamla Amba Dam	Udaipur
112	Sukhri/ Sukri	Bankali Dam	Jalor
113	Sukli	Sukli Selwara Dam	Sirohi
114	Takli	Takli Dam	Kota
115	Telera	Burdha Dam	Bundi
116	Tokra	Tokra Dam	Sirohi
117	Tr. of Lilari	Babara Dam	Pali

118	Tr. of Sukhri	DANDIA/ Dadia (Hariom Sagar) Dam	Pali
119	Tr. of Sumer/ Tri. of Mithri	Juna Malari Dam	Pali
120	Unli	Jetpura Dam	Bhilwara
121	Wagon	Wagon Dam	Chittaurgarh
122	West Banas	Bhula Dam	Sirohi
123	West Banas	Chandelas/ Chandelao Dam	Sirohi
124	West Banas	Girwar/ Giriwar Dam	Sirohi
125	West Banas	Kui Sagna Dam	Sirohi
126	West Banas	Moongthala Dam	Sirohi
127	West Banas	West Banas Dam	Sirohi
128	Yamuna/ Gambhiri	Baretha Bund Dam	Bharatpur
129		Bassi Dam	Chittaurgarh
130		Bhimsagar Dam	Jhalawar
131		Buchara Dam	Jaipur
132		Chandsen/ Chandsen Bheru Dam	Tonk
133		Chatra Sagar Dam	Pali
134		Chikalwar Dam	Udaipur

135		Dugari Dam	Bundi
136		Galai Sagar Dam	Sawai Madhopur
137		Galwania Dam	Tonk
138		Gudha Dam	Bundi
139		Harish Chandra Sagar Dam	Kota
140		Harsora/ Harsora Bund Dam	Alwar
141		Kalakho Dam	Dausa
142		Kalisindh Dam	Jhalawar
143		Mangalsar Dam	Alwar
144		Manohar Thana Dam	Jhalawar
145		Maoroli Bund Dam	Dausa
146		Mata Ji Ka Kheda/ Khera Dam	Rajsamand
147		Moti Sagar Dam	Tonk
148		Narayan Sagar Dam	Ajmer
149		Phool Sagar Jalia/ Jali/ Jaliyan Dam	Ajmer
150		Raipur Patan Dam	Sikar
151		Rondh Dam	Dausa

152		Sawan Bhado Dam	Kota
153		Silised Dam	Alwar
154		Som Kagdar Dam	Udaipur
155		Surwania / Surwawia Dam	Banswara
156		Tasai Dam	Alwar
157		Utawali Dam	Baran

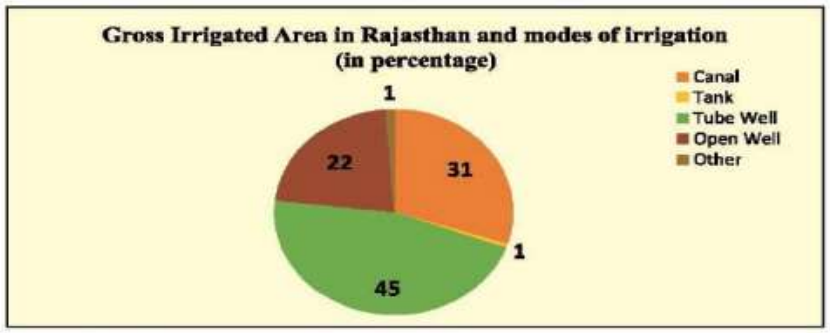
Irrigation in Rajasthan

Rajasthan has Net Cropped area of 254.37 Lac hectares, out of this, approximately 59.64% of area is rain-fed (151.72 lakh hectares) and only 40.36% is irrigated area (102.65 lac hectares) (1). However, this 40.36% irrigated area contributes more than 50 percent of agricultural output.

In Rajasthan even now 69 per cent of irrigated land is irrigated through tube wells and open wells using ground water. This dependence on tube wells and open wells places enormous stress on groundwater. In contrast, the share of surface irrigation in total gross irrigated area as per annual progress report of WRD was only 31 per cent.

Main sources of irrigation in Rajasthan are:

- Open Wells: 23.32 %
- Tube-wells: 49.00 %
- Canals : 31.80 %
- Tanks: 0.69 %
- Other sources: 1.22 %

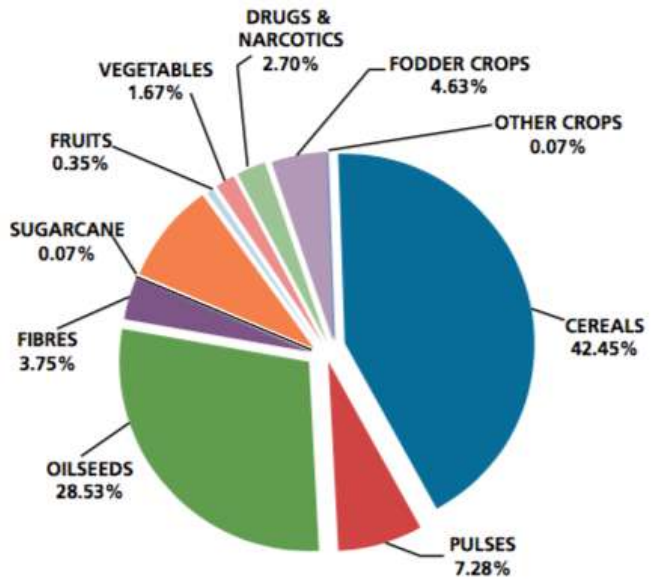


Source: Annual progress report of WRD 2019-20

As can be seen above, 69% of irrigation is through tube-wells and wells placing enormous stress on groundwater. It is particularly alarming that share of tube-wells over the last four decades has shot up from 1 percent in 1967-68 to 49 percent.

Irrigation in Rajasthan by Crops:

- Of the total irrigated area, 35.79 percent is under wheat, 23.65 percent under rape seed and mustard, and 5.8 percent under grams.



Rajasthan Irrigation Potential

The state's estimated irrigation potential is 5.1 million hectares, of which 3.1 million hectares is already achieved. This gap of two million hectares cannot be further addressed by groundwater, which is fully exploited.

Acts related to Irrigation:

- The Rajasthan Irrigation and Drainage Act, 1954

Organisations related to Irrigation:

- Irrigation Management & Training Institute, Kota
- Watershed Development and Soil Conservation Department
- Command Area Development & Water Utilization Department
- Indira Gandhi Nahar Department

Major Canal Irrigation Projects of Rajasthan

Irrigation is an important input by itself for agriculture like fertilisers, improved seeds etc which imparts confidence to the farmers to adopt improved agricultural practices. The State government has given high priority to the development of surface water resources during the last four decades of

planned development. A large number of irrigation projects have been planned and executed in different parts of the State.

Major Canal Irrigation Projects in Rajasthan:

Indira Gandhi Nahar Pariyojana (INGP)

Indira Gandhi Nahar Pariyojana (IGNP) started in 1958 and the irrigation facility started in 1961. The area of the project spans over four districts of Rajasthan, namely - Ganganagar, Bikaner, Hanumangarh and Jaisalmer. Its main aim is to assist in agricultural activities and provide drinking water, but it also envisages regional development and ecological improvement by arresting desertification.

- Read in Detail about: Indira Gandhi Nahar Pariyojana in Next Chapter

Bhakra Nangal System

The Bhakra Nangal system is a complex system of several dams, reservoirs, inter-basin transfer linkages, powerhouses and a vast canal network. Sutlej waters were distributed between Punjab and Rajasthan as per the Bhakra Nangal Agreement 1959 with Rajasthan's entitlement at 15.22 percent.Forty-nine percent of the project's canal command area (CCA) is in Haryana, 35 percent in Punjab, and 16 percent Rajasthan. In Rajasthan, this translates to 372,000 hectares or 1.45 percent of state's cultivable area, served by the 1,219 km long Bhakra-Sirhind canal distribution system. Only two districts of Sriganganagar and Hanumangar are covered by the project.

Bikaner / Gang Canal

The 114 km-long Gang Canal was the rst to come into existence and became fully operational in 1928, with a 1,251 km long distribution system to serve Sri Ganganagar district. Along with the Bikaner feeder, it provides water to a command area of 300,000 hectares with 65 percent intensity.

Chambal Valley Project

The Chambal Valley Project is a major multipurpose project, constructed across the river Chambal by the State of Rajasthan and Madhya Pradesh for irrigation and hydro - power generation. The Project includes:

- Jawahar Sagar Dam Project
- Rana Pratap Sagar Dam
- Kota Barrage

Chambal command area in Rajasthan is spread over six panchayat samitis (groups of villages) in Kota, Bundi and Baran districts.

Gurgaon Canal Project:

To utilize 500 cusecs of Yamuna Waters through Agra Canal during the rainy season for irrigation Gurgaon Canal Project is being constructed. This will facilitate the irrigation of Kharif crops in 185 villages of Deeg and Kaman tehsils of Bharatpur district. The States of Uttar Pradesh, Haryana, Rajasthan and Delhi have signed an agreement regarding the sharing of Yamuna waters.

Sidhmukh Nahar Project

Sidhmukh Nahar Project is for providing irrigation facilities to Sidhmukh Nohar areas in northern part of the state. The project is undertaken with the assistance of European Economic Community.

Indira Gandhi Canal

Indira Gandhi Canal Project:

- Aim: To rejuvenate to great desert.
- This project previously known as **Rajasthan Canal Project**.
- It covers an area 600 Km long and 45 Km wide of the Thar Desert in North West of Rajasthan.
- RCP was first conceived on 29 October, 1948.
- RCP was taken up by the Central Water and Power Commission in 1951.
- It was came to reality in 1951-53
- The physiographic of the area is characterized by vast stretches of undulating windblown sand dunes, which sometime rise above 60 m.
- Parameters:
    - Area to be irrigated annually- 29 Lakh acres.
    - Length of main canal- 445 Kms.
    - Length of branches- 832 Kms.
    - Depth of water- 6.25 m.

- Bed width lined canal- 38 m.
- Discharge at head- 18500 cusses
- Length of distributaries and minors- 547 Kms.

Indira Gandhi Canal Stage I:

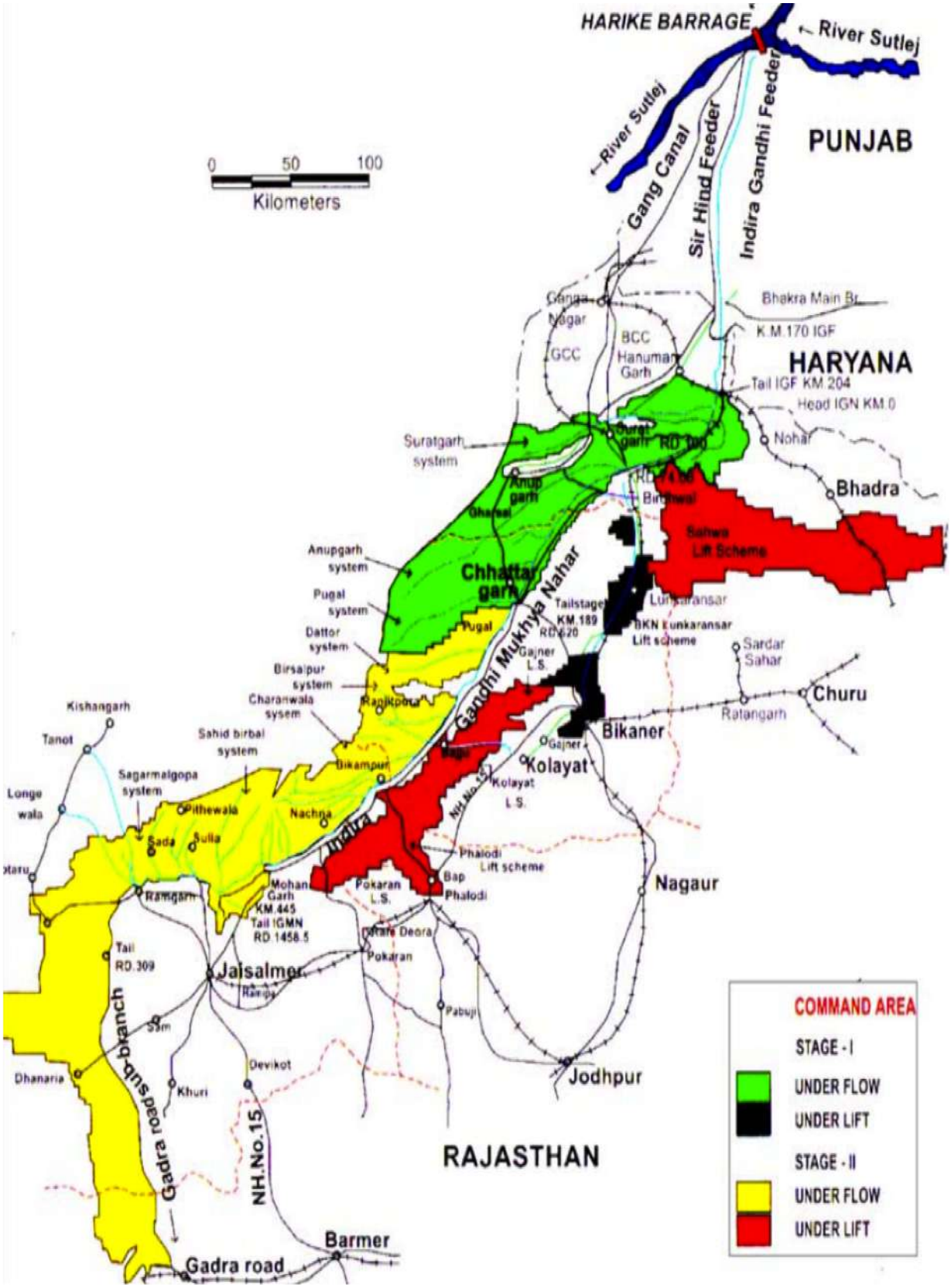
- This stage comprising construction of 204 Km long feeder canal, 189 Km long main canal and 3454 Km long distributaries.
- Origin- from the **Harike dam** situated on the confluence of rivers Sutlej & Beas.
- **Feeders:** Ferozpur Feeder and Makhu Canal at 3 km downstream of confluence of the rivers Sutlej and Beas
- Provide Irrigation- First stage has been providing irrigation facilities to 5.63 lakh hectares.
- A culturable command area of 5.5 lakh hectare.
- End- Comes to an end near **Masitawali in Hanumangarh**. This is called Rajasthan feeder

Indira Gandhi Canal Stage II:

- The **IGNP stage-II** starts from the tail of stage-I i.e. from Km 189 of IGNP main canal.
- Indira Gandhi Nahar Project, Stage-ll comprises of **256 km long** (Km189 to Km445) main canal. (**Chhatargarh to Mohangarh**). Completed
- This stage of estimates to provide flow into 7.0 lakh hectare to culturable command area up to Gardra Road in Barmer district
- It lift irrigation in block to 3.12 lakh hectare. Culturable command area under 5 lifts schemes up to 60 m. Reservation of 1800 cuses of water for drinking water supply and industrial usages.
- Water released up to Tail near Mohangarh in Jaisalmer district on 1st January, 1987 by assuming a total length of 649 Kms.
- With the completion of **Lathi Series water** has started flowing and it is being used for cultivation.

- Form Mohangarh point a new branch is being taken out which is 90 Kms. in length and has been named as **Leehva branch**. It has been extended up to Gardra town in Barmer. The region is undulating and therefore **Seven lift canals** have been constructed to lift up the water up to 60 m.
- The lift canals are
    - Bikaner-Lunkaransar
    - Gajner lift canal
    - Nohar-Saheve lift canal
    - Kolayat lift canal
    - Phalodi lift canal
    - Pokaran lift and
    - Bangarsar lift canal

- On completion, irrigation potential of about 19.63 lakh hectares are would be created every year.
- Irrigation facilities were created in 15.73 lakh hectares by the end of March, 2009.
- Agriculture output of about Rs. 1750 crore is produced annually with the help of this project.
- It also provides drinking water.
    - **Kunwar Sain lift canal** is providing drinking water to **Bikaner city** and 99 villages situated out of the project area.
    - **Gandhelilsheva lift scheme** is providing drinking water to 175 villages of **Churu district**.
    - **Jodhpur lift scheme** is providing drinking water to **Jodhpur city** and enroute town and villages.
    - After completion of project, 1.80 crore population of eight districts of Western Rajasthan will avail drinking water facility.


HARIKE BARRAGE
River Sutlej
River Sutlej
Gang Canal
Sir Hind Feeder
Indira Gandhi Feeder
PUNJAB
0 50 100
Kilometers
Ganga Nagar
BCC
GCC
Hanuman Garh
Bhakra Main Br.
K.M.170 IGF
HARYANA
Tail IGF KM 204
Head IGN KM 0
Suratgarh system
Suratgarh
RD 100
Nohar
Bhadra
Anup garh
Ghaggar
Bithnok
Sahwa Lift Scheme
Anupgarh system
Chhattar garh
Pugal system
Pugal
Tailstage KM 189
RD 420
Lunkaransar
BKN Lunkaransar Lift scheme
Dattor system
Gajner L.S.
Sardar Sahar
Birsalpur system
Ranjitpura
Charanwala sysem
Gandhi Mukhya Nahar
Churu
Ratangarh
Kishangarh
Tanot
Sahid birbal system
Bikampur
Bikaner
Gajner
Kolayat
Kolayat L.S.
Sagarmalgopa system
Longe wala
Pithewala
Nachna
Sada
Sulla
Indira
Phalodi Lift scheme
Phalodi
Bap
Pokaran L.S.
Nagaur
Ramgarh
Mohan Garh KM.445
Tail IGMN RD 1458.5
Dikare Deora
Pokaran
Tail RD.309
Jaisalmer
Pabuji
Sam
Devikot
Dhanaria
Khuri
Jodhpur
Gadra road sub-branch
NH.No.15
RAJASTHAN
Barmer
Gadra road
COMMAND AREA
STAGE - I
UNDER FLOW
UNDER LIFT
STAGE - II
UNDER FLOW
UNDER LIFT

Eastern Rajasthan Canal Project: ERCP

"Eastern Rajasthan Canal Project" is an ambitious project of Rajasthan State for which a Detailed Project Report has been prepared to transfer surplus water of (Kunnu, Kul, Parwati, Kalisindh and Mej) river sub basins to Banas, Morel, Banganga, Kalisil, Gambhir and Parbati river sub-basin during monsoon period. This scheme will ensure availability of water for drinking purpose in 13 districts for year 2051 and will bring about 2.0 lakh hectare new area under command of Rajasthan by micro irrigation system.The estimated cost of the project is Rs 37247.12 crore.

About 49 percent of the 3510 million cubic meters of water available under the project; A provision of 1723.5 million cubic meters of pure water has been kept for drinking water, through which Availability of drinking water will be ensured in 13 districts of Rajasthan (about 40 percent population of the state) namely Jhalawar, Baran, Kota, Bundi, Sawai Madhopur, Ajmer, Tonk, Jaipur, Dausa, Karauli, Alwar, Bharatpur and Dholpur by the year 2051.

Background of Eastern Rajasthan Canal Project: ERCP

The surface water of Rajasthan has been divided into 15 River basins and one outside basin area. It is estimated that out of fifteen river basins surplus water is available only in *Chambal and Mahi* basin. Within Chambal basin, during rainy season Kunnu, Kul, Parbati, Kalisindh, Mez, and Chakan sub-basins are also having surplus yield, while Banas, Banganga, Ghambhiri and Parbati sub-basins are deficit in yield.

Hence, Eastern Rajasthan Canal Projects (ERCP) is planned to harvest surplus yield available in the Southern Rajasthan rivers and transfer to deficit basins in South-Eastern Rajasthan.

Eastern Rajasthan Canal Project: ERCP

- The project will link the Kalisindh, Gambhiri and Parbati rivers
- ERCP is planned to meet the Drinking / Irrigation and Industrial water needs of the 13 districts of Southern & South Eastern Rajasthan viz. Jhalawar, Bara, Kota, Bundi, Sawai Madhopur, Ajmer, Tonk, Jaipur, Dausa, Karauli, Alwar, Bharatpur and Dholpur of Rajasthan for Humans and Live stock till year 2051.
- The project will help to irrigate nearly 10 lakh acres of land, giving a boost to agriculture in the state,
- Additional Benefits:
  - Will enhance availability of surface water & Ground water in the region.

- Will also take care of Flood / Drought situation in the area.
- Would also boost the Delhi-Mumbai Industrial Corridor (DMIC) in Alwar district and generate employment for youths of the state.

- The state is likely to seek 60 percent financial assistance from the Centre to the project under national project scheme.

main component

6 barrages and 1 dam proposed to be built under the project the barrage will be constructed mainly for water diversion and the dam will be constructed for storing water.

Kunnu Barrage: Filling capacity 56.97 MCM on Kunnu River in Shahbad Tehsil, District Baran in Rajasthan.

Ramgarh Barrage: Filling capacity 50.49 MCM on Kul River in Kishanganj Tehsil, District Baran in Rajasthan.

Mahalpur Barrage: Filling capacity 162.20 MCM on Parvati River in Mangril Tehsil, District Baran in Rajasthan.

Navnera Barrage: A barrage with a storage capacity of 226.65 MCM is to be constructed on the Kalisindh River in Peepalda Tehsil, District Kota in Rajasthan. The filling capacity of this barrage is maximum under the project. Due to the important barrage for refraction, its construction work has been started.

Mej Barrage: Filling Capacity 50.80 M.C.M on Mej River in Indragarh Tehsil, District Bundi.

Rathod barrage: on Banas river in chauth ka Barwada tehsil, district Sawaimadhopur with filling capacity of 143.09 MCM.

Dungri Dam: A dam of 2099 M.C.M. storage capacity is to be constructed on Banas river in Tehsil Khandar, District Sawai Madhopur, which will be the main dam for water storage under "East Rajasthan Canal Project". With the water stored in this dam, 2 lakh hectare new irrigated area will be developed under the project based on micro irrigation.

The total length of the feeder/canal system under the project is 1268 km. Is. Out of which length of gravity feeder is 965 km, length of tunnel is 4.5 km, length of pumping main is 141 km. And the length of the natural stream is 157.5 km. Pumping stations are to be constructed at 15 places in the project. ,

Medium Scale Irrigation Projects

S.no	River	Dam Name	District
1	Ahu	Gagrin Dam	Jhalawar
2	Alnia Hukud	Alnia Dam	Kota
3	Amlabala/ Local nala	Sindroo Dam	Pali
4	Arav/ Erau	Bhanwar Semla Dam	Pratapgarh
5	Banas	Bisalpur Dam	Tonk
6	Banas	Bithan Dam	Jalor
7	Banas	Dindoli Dam	Chittaurgarh
8	Banas	Gosunda Dam	Chittaurgarh
9	Banas	Matrakundia/ Matrikundia/ Matrikundial Dam	Chittaurgarh
10	Banas	Nand Samand Dam	Rajsamand
11	Banas/ Bandi	Hingonia Dam	Jaipur
12	Banas/ Dundh	Sheel Ki Dungri/ Dogri Dam	Jaipur
13	Banas/ Local Nala	Chaparwara Dam	Jaipur
14	Banas/ Local Nala	Morasagar Dam	Sawai Madhopur
15	Bandi (Sukri)	Bandi Sandhara Dam	Jalor
16	Bandi/ Mashi	Mashi Dam	Tonk
17	Bandi/ Sumer	Hemawas Dam	Pali
18	Banganga	Chandrana Dam	Jaipur
19	Banganga/ Local nala	Kharad Dam	Jaipur
20	Banganga/ Local Nala	Madho Sagar Dam	Dausa
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27	Berach	Bhopal Sagar Dam	Chittaurgarh
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33	Bhimlat	Bhimlat Dam	Bundi
34	Bilas	Bilas Dam	Baran

35	Brahmani	Dorai Dam	Chittaurgarh
36	CHAMBAL	Aklera Sagar Dam	Baran
37	Chambal	Jawahar Sagar Dam	Bundi
38	Chambal	Ranapratap Sagar Dam	Chittaurgarh
39	Chambal/ Kul	Gopalpura Dam	Baran
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50	Gambhiri/ Panchana	Panchana Dam	Karauli
51	Gararda	Gararda Dam	Bundi
52	Ghanerow/ Tri. of Sukli	Kana Dam	Pali
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68	Kothari	Ladki/ Larki Dam	Bhilwara
69	Kothari	Meja Dam	Bhilwara
70	Kothari (Banas)	Kothari Stage I Dam	Bhilwara
71	Krashnauti	Dhanta Dam	Sirohi
72	Krishnawati	Angore Dam	Sirohi
73	Kundal	Mandawara Dam	Sirohi
74	Lhasi	Lhasi Dam	Baran
75	Luni	Girinanda Dam	Pali
76	Luni	Jaswant Sagar Dam	Jodhpur

77	Luni & WFR	Giroliya Dam	Pali
78	Maghai	Sadari Dam	Pali
79	Mahadev Nalla	Mahadev Dam	Sirohi
80	Mahi	Mahi Bajaj Sagar Dam	Pratapgarh
81	Manali	Govta Dam	Bhilwara
82	Mangu	Phacharia Dam	Sirohi
83	Mansi	Sareri/ Sareru Dam	Bhilwara
84	Mej River	Bundika Gothra Dam	Bundi
85	Mej River	Paibala Pura Dam	Bundi
86	Moral/ Gandi/ Ganoli	Domti Kokra Dam	Bhilwara
87	Moran	Lodisar Dam	Dungarpur
88	Morel	Dheel Dam	Sawai Madhopur
89	Morel	Morel Dam	Sawai Madhopur
90	Nagdi	Nagdi Dam	Bhilwara
91	Nahari/ Local Nala	Deopura Dam	Sawai Madhopur
92	Nekhadi/ Local Nala	Kantaliya Dam	Pali
93	Nori/ Local nala	Kantri Dam	Dungarpur
94	Odher/ Local nala	Needar Dam	Karauli
95	Orai	Orai Dam	Chittaurgarh
96	Parbati	Parbati Dam	Dhaulpur
97	Parbati	Ram Sagar Dam	Dhaulpur
98	Parbati	Urmila Sagar Dam	Dhaulpur
99	Phuphadia	Kharda/ Kharda Bund/ Bandh Dam	Pali
100	Piplad	Piplad Dam	Jhalawar
101	Raipur Luni	Raipur Luni Dam	Pali
102	Roop Rail/ Siliberi	Silibari Dam	Alwar
103	Ruparel	Ruparel Dam	Chittaurgarh
104	Sabi/ Local Nala	Chittoli Dam	Jaipur
105	Sei	Sei Diversion Dam	Udaipur
106	Sisarma	Swaroop Sagar Dam	Udaipur
107	Sivani	Bajrang Garh Dam	Pratapgarh
108	Sivani	Chacha Kheri Dam	Pratapgarh
109	Sivani	Hamja Kheri Dam	Pratapgarh
110	Sohadra	Tordi Sagar Dam	Tonk
111	Som and Gomti	Som Kamla Amba Dam	Udaipur
112	Sukhri/ Sukri	Bankali Dam	Jalor
113	Sukli	Sukli Selwara Dam	Sirohi
114	Takli	Takli Dam	Kota
115	Telera	Burdha Dam	Bundi
116	Tokra	Tokra Dam	Sirohi
117	Tr. of Lilari	Babara Dam	Pali

118	Tr. of Sukhri	DANDIA/ Dadia (Hariom Sagar) Dam	Pali
119	Tr. of Sumer/ Tri. of Mithri	Juna Malari Dam	Pali
120	Unli	Jetpura Dam	Bhilwara
121	Wagon	Wagon Dam	Chittaurgarh
122	West Banas	Bhula Dam	Sirohi
123	West Banas	Chandelas/ Chandelao Dam	Sirohi
124	West Banas	Girwar/ Giriwar Dam	Sirohi
125	West Banas	Kui Sagna Dam	Sirohi
126	West Banas	Moongthala Dam	Sirohi
127	West Banas	West Banas Dam	Sirohi
128	Yamuna/ Gambhiri	Baretha Bund Dam	Bharatpur
129		Bassi Dam	Chittaurgarh
130		Bhimsagar Dam	Jhalawar
131		Buchara Dam	Jaipur
132		Chandsen/ Chandsen Bheru Dam	Tonk
133		Chatra Sagar Dam	Pali
134		Chikalwar Dam	Udaipur
135		Dugari Dam	Bundi
136		Galai Sagar Dam	Sawai Madhopur
137		Galwania Dam	Tonk
138		Gudha Dam	Bundi
139		Harish Chandra Sagar Dam	Kota
140		Harsora/ Harsora Bund Dam	Alwar
141		Kalakho Dam	Dausa
142		Kalisindh Dam	Jhalawar
143		Mangalsar Dam	Alwar
144		Manohar Thana Dam	Jhalawar
145		Maoroli Bund Dam	Dausa
146		Mata Ji Ka Kheda/ Khera Dam	Rajsamand
147		Moti Sagar Dam	Tonk
148		Narayan Sagar Dam	Ajmer
149		Phool Sagar Jalia/ Jali/ Jaliyan Dam	Ajmer
150		Raipur Patan Dam	Sikar
151		Rondh Dam	Dausa
152		Sawan Bhado Dam	Kota
153		Silised Dam	Alwar
154		Som Kagdar Dam	Udaipur
155		Surwania/ Surwawia Dam	Banswara

156		Tasai Dam	Alwar
157		Utawali Dam	Baran

Soils of Rajasthan

Soil is one of the most important natural resources as mankind is dependent on soil for food. By definition, soil is the top-most layer of earth crust. The soils of Rajasthan have developed under the arid and humid climate over the bed rocks of complex nature predominately through the process of **Laterization**.

Classification of Soils:

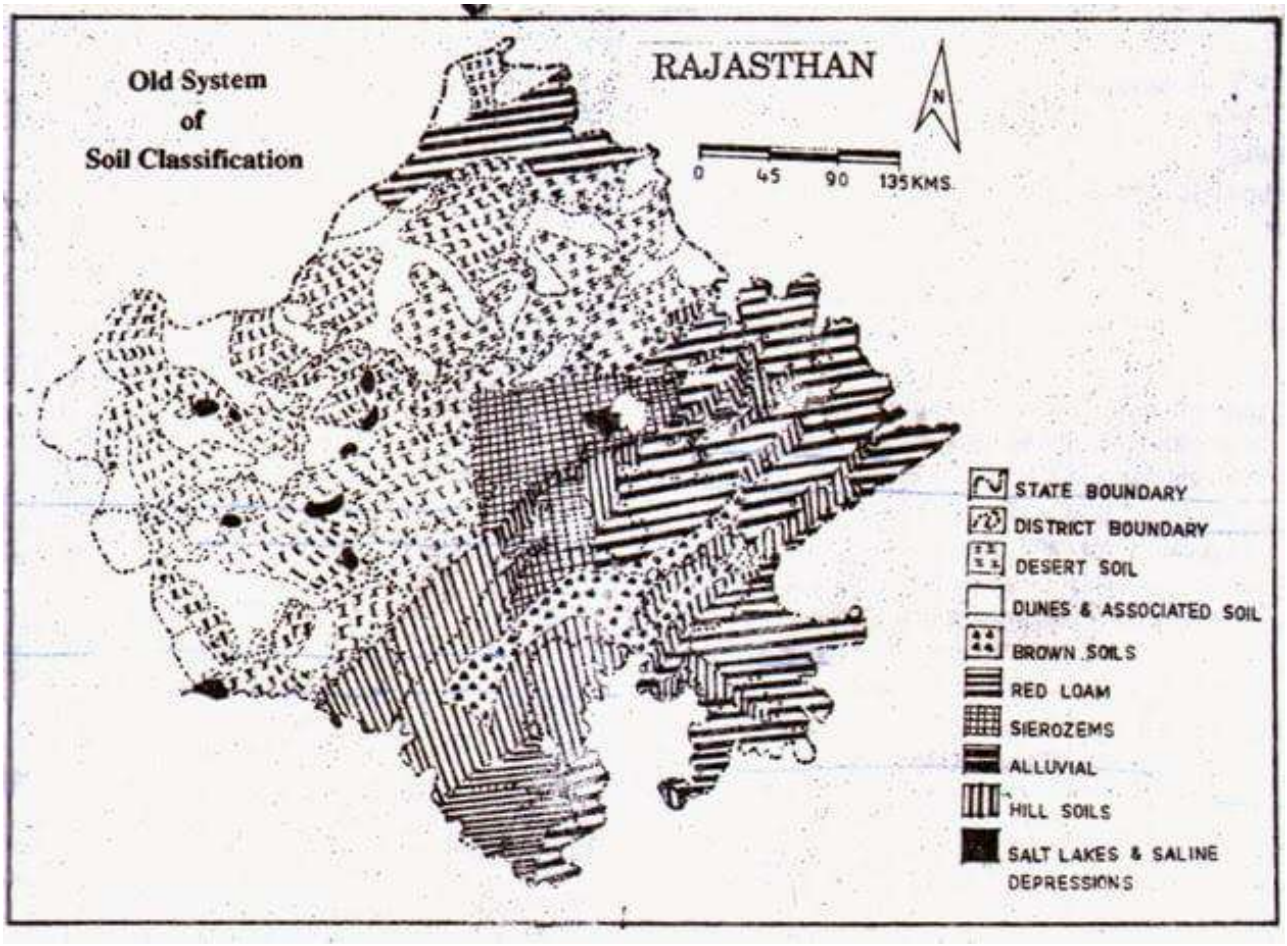
In India, two system of classification are dominant. They are:

- Old System of soil classification
- New comprehensive system of soil classification

Old System of soil Classification

The old system of classification was developed by scientists (Thorpe & Smith) of U.S department of Agriculture in 1949. The classification is based upon *differences in climate and mineralogy*. As per this system, soils of Rajasthan can classified into 8 types:

1. Desert Soils
2. Dunes and Associated Soils
3. Brown Soils
4. Sierozems
5. Red Loams
6. Hill Soils (Lithosols)
7. Saline Sodic Soils (Solonchaks)
8. Alluvial Soils/and Black Soils



Desert Soils

- **Districts**- Nagaur, Jodhpur, Jalore, Barmer, Hanumangarh, Sriganganagar, Churu, Jhunjhunu and Sikar.
- **Rainfall**- Less than 400 mm
- **Texture**- Sandy to Sandy loam
- It contains a high percentage of soluble salt & has high Ph value.
- It has varying percentage of calcium carbonate & generally poor in organic matter.
- These soils are pale brown, single grained, deep and well drained.
- Calcium carbonates sometime occur in form of *Kankar nodules* which increases with depth.
- In most of the desert soils nitrogen is low. Range - 0.02% to 0.07%

- It is not fertile but it can be made fertile for agricultural crops and plants where water supply is regular by putting phosphates with nitrates Under normal rainfall Kharif crops (summer) are grown but failure of crops due to low rainfall is common.

Dunes and Associated Soils

- **Districts** - Barmer, Bikaner, Jaisalmer, Jaipur, Jodhpur, Churu
- **Texture** - loamy fine sand to coarse sand and may or may not be calcareous.
- These soils are yellowish brown in colour sandy to sany loam, deep and well drained
- Calcium carbonate, sometime occur in the form of Kankar nodules which increases with depth.
- Cultivation is practiced in rainy season on the slopes of low to medium high dunes and usually rainfed Bajra or Kharif pulse are grown.
- These have been grouped separately from desert soils as they are only deposited sand and little profile development has taken place.
- Dunes are of varying heights from low shifting dunes to high and very high stabilized dunes.

Brown Soils

- **Districts** - Tonk, Bundi, Sawai Madhopur, Bhilwara, Udaipur and Chittorgarh
- **Annual Rainfall** - 50 cm to 75 cm is sufficient for Kharif crops.
- **Texture** - Sandy loam to clay loam.
- **Colour:** Ranges from grayish brown to yellow brown.
- Major area of these soils is in the catchment area of Banas River.
- They are rich in calcium salts but have poor organic matter
- Use of fertilizers becomes essential to get good harvest
- As the ground waters are saline, soils irrigate with these waters have accumulated salts
- Tank irrigated soils have also developed problem of high water table.
- Rabi crops are grown under irrigation.

Sierozems

- **Districts** - Pali, Nagaur, Ajmer, Jaipur, Dausa (lies on both the side of Aravalli Hills)

- **Annual Rainfall** - 50 cm to 70 cm
- **Texture** - Sandy loam to Sandy clay
- **Color:** They are mostly yellowish brown
- The rainfall in the area in higher than the desert of the extreme west
- Natural vegetation is also seen at some places.
- The soils are suitable for cultivation but for low rainfall and high evaporation.
- Kharif crops are rainfed and Rabi crops are grown through well irrigation.
- In the Kharif crops Bajra, Jowar, pulses are grown and in Rabi crops wheat, mustard & vegetables are grown.

Red Loams

- **Districts** - Dungarpur, Banswara & parts of Udaipur, Chittorgarh
- **Rainfall** - 70 cm to 100 cm
- **Texture** - Sandy loam to sandy
- These soils are reddish in colour with granular/crumb structure & well drained.
- These soils have rich content of iron-oxide and devoid of calcium salts because calcium salts soluble in water and are easily washed away.
- Soils are suitable for maize, chilies, wheat, barley and rapeseed cultivation
- Parent material of these soils is the red sandstone or yellow sandstone which is found in Vindyan rocks.

Hill Soils (Lithosols)

- **Districts** - At the foot hills of Aravalli in Sirohi, Pali, Nagaur, Udaipur, Rajsamand, Chittorgarh, Bhilwara and Ajmer
- **Colour** - Reddish to yellowish red to yellowish brown
- **Texture** - Sandy loam to clay and well drained.
- Cultivation of crops in these soils is very much restricting due to shallow nature of these soils and presence of stones on the surface.

- Soil erosion due to water is another problem of these soils

Saline Sodic Soils (Solonchaks)

- Saline Sodic soils are seen in the far flood plains of river Ghaggar and in Luni Basin.
- **Districts** - In the natural depressions like the Pachpadra, Sambhar, Deedwana, Ranns of Jalore and Barmer
- **Colour** - Dark grey to pale brown
- Water table is sometime close to surface
- Cultivation is not possible due to the impeded drainage and high degree of salinity
- The only vegetation consists of some salt tolerant grasses and shrubs

Alluvial Soils/and Black Soils

- Districts - Sriganganagar (soil deposited by Ghaggar), Kota, Bundi, Baran, Jaipur.
- The soil is deficient in lime, phosphoric acid and humus.
- It varies from clayey to sandy loam in texture.
- The top soil contains *'kankar'* which lie either on sands or sandy clays.
- A wide variety of crops including wheat, rice, cotton and tobacco are grown in this soil.

New comprehensive system of soil classification

New soil taxonomy (properties) based comprehensive system of soil classification was developed by Soil Survey Staff in 1976. This new system has 10 soil orders, which are subdivided into 47 suborders and then 230 great groups, these great-groups are then subdivided into family and series. Under the new system, most soils of Rajasthan belong to only 5 orders - aridsols, alfisols, entisols, inceptisols and vertisols. These are further classified into sub-orders and great-groups as mentioned below:

Order - Suborder - Great group

1. Aridisols
    - Orthids
        - Camb-orthids

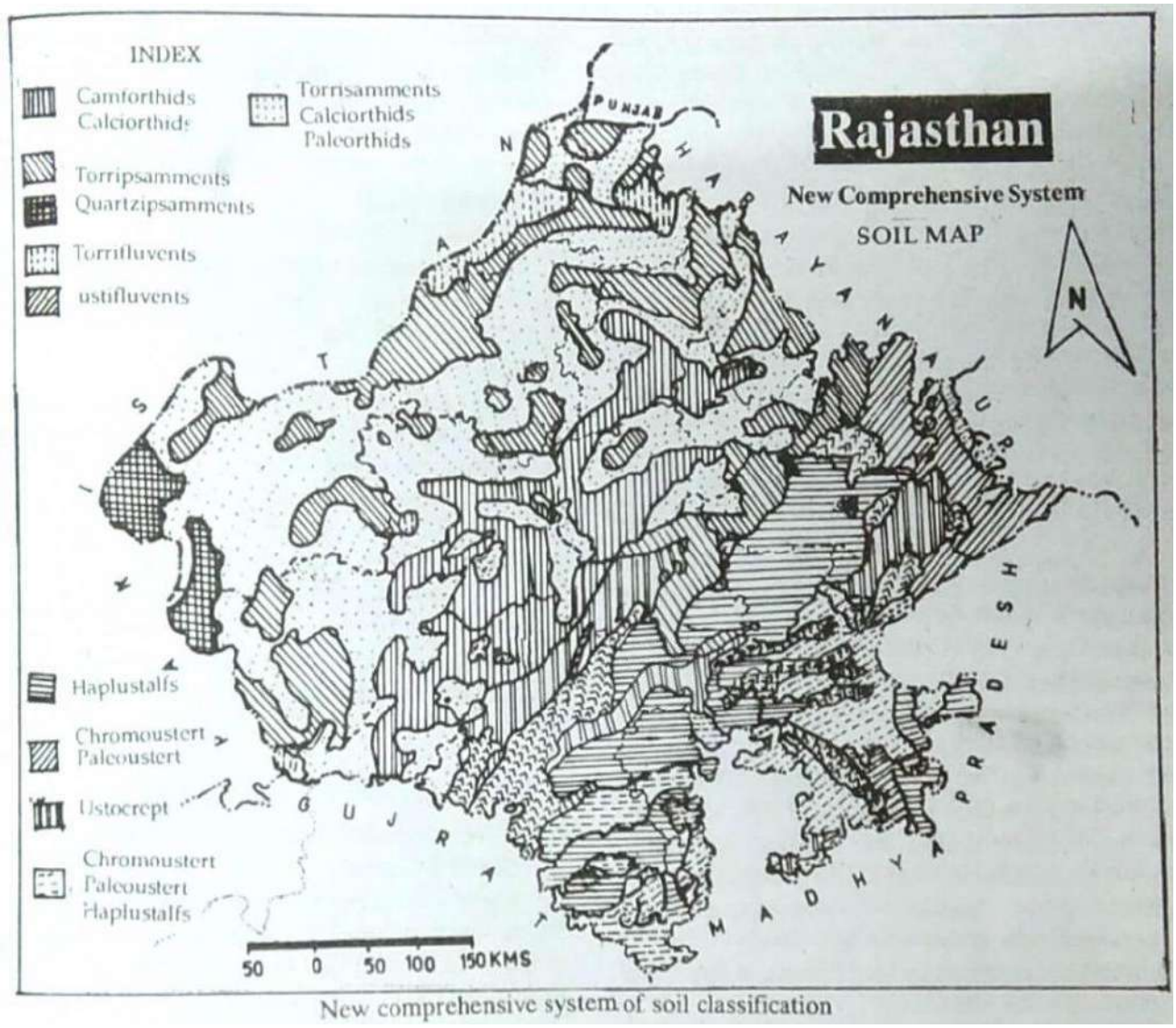
        - Calci-orthids
        - Sal-orthids
        - Pale-orthids

2. Alfisols
    - UStalfs
        - Hapl-ustalfs

3. Entisols
    - Psamments/Fluvent
        - Torripsam
        - Quartzipsam
        - Torrifluvents

4. Inceptisols
    - Ochrepts
        - Ust-ochrepts

5. Vertisols
    - Usterts
        - Chrom-usterts
        - Pell-usterts



New comprehensive system of soil classification

1. Aridisols

- Aridisols are mineral soils mostly found in dry climatic.
- **Districts:** These occur extensively in the western half of Rajasthan divided by the Aravalli axis and some parts of Alwar, Jaipur and Ajmer districts which fall on the eastern half.
- Aridisols are found in association with soils of order **Entisols**.
- Major portion of Aridisols in Rajasthan is covered by the suborder **Orthids** .
- They commonly have horizons of accumulation of soluble salts and carbonates.

1.a. Camborthids

- These are brownish to reddish in colour.
- These are youngest of aridisols.

1.b. Calciorthids

- Calciorthids occur in the range of 100 to 500 mm rainfall range in the state.

1.c. Salorthids

- These soils are found scattered in Ghaggar flood plain in Sriganganagar, near Runn of Kachch area in Jalore and Barmer.
- These are salty soils of wet places in deserts.
- Vegetation is usually salt tolerant grasses and shrubs.

1.d. Paleorthids

- These soils have a petrocalcic horizon, very close to surface and quite thick.
- Their color changes from reddish brown to nearly white.
- These soils occur in small patches around Jaisalmer, Barmer and Nagaur.

2. Alfisols

- **Districts:** Parts of Jaipur, Alwar, Bharatpur, Sawai Madhopur, Tonk, Bhilwara, Chittorgarh, Banwara, Udaipur, Dungarpur, Bundi, Kota and Jhalawar.
- These are mature soils with medium to maximum profile development.
- **Color:** Reddish to Brownish
- **Annual rainfall:** 500 to 900mm
- Most of the area covered Alfisols in Rajasthan comes under only one suborder - ustalfs and one great group -
    - 2.a. Haplustalfs

3. Entisols

- Entisols lack well developed horizons and have minimum profile development.
- **Districts:** Entisols are **dominant soil** of the state. All districts in western half are covered in some or major part by these soils.
- In Rajasthan, important suborders are: Psamments, Orthents and Fluvent.

3.a. Torripsam

- These occur on sand dunes and in flood plains.

3.b. Quartzipsam

- These occur on the western border of Rajasthan covering small parts of Jaisalmer and Barmer.

3.c Torrifluvents

- These Soils occur with Calciorthids and Salorthids in the Ghaggar area of Sriganganagar district.
- **Annual Rainfall:** Does not exceed 300 mm.

4. Inceptisols

- **Districts:** Along the foothills of the Aravalli in the districts of Sirohi, Pali, Udaipur, Bhilwara, Chittorgarh and in some parts of alluvial plains in Udaipur, Alwar, Sawai Madhopur and Jhalawar.
- **Color:** Reddish and brownish.
- In Rajasthan these soils are classified as:
    - 4.a. Ustochrepts

5. Vertisols

- **Districts:** Jhalawar, Kota, Bundi and small part of Sawai Madhopur, Bharatpur, Dungarpur, Chittorgarh and Banswara.
- They are clayey soils that develop deep wide cracks when dry and become sticky & plastic when wet.
- They are compact and very slowly permeable in the lower layer.

- Soils of Rajasthan come under sub-order of **Usterts** and associated with two great-groups.
    - 5.a Chromusterts
    - 5.b Pellusterts

Conservation of Soils of Rajasthan

Rajasthan is the state with highest area under desertification (land degradation) with respect to country's total geographical area (TGA). The state has 62.90% of the TGA under desertification/ land degradation for the period of 2011-13. The desertification/ land degradation area in Rajasthan has decreased about 0.29% since 2003-05.

Definitions & Differences:

Soil Degradation

- Soil degradation is the decline in soil quality caused by its improper use, usually for agricultural, pastoral, industrial or urban purposes.
- Soil degradation is a serious global environmental problem and may be exacerbated by climate change. It encompasses physical (soil erosion), chemical (salinity and alkalinity, pollution) and biological deterioration (pollution and deterioration of vegetal cover).

Soil Erosion

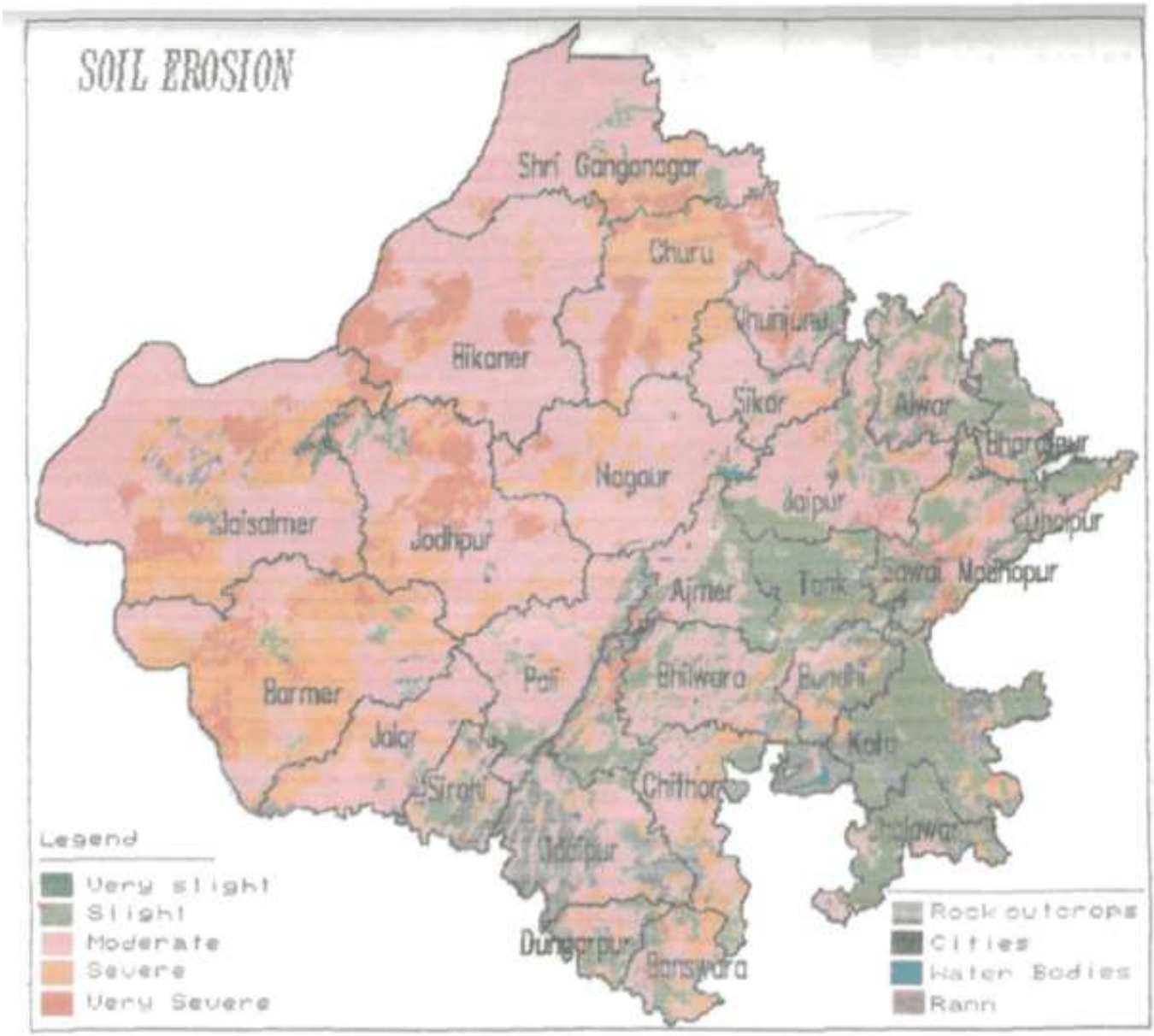
- Soil erosion is the removal of top soil by agents like wind and water.
- Top soil has most of the nutrients necessary for a plant's growth. With depth, the fertility of the soil decreases. Thus, erosion results in reduction of fertility of the soil by washing away the fertile top layer.

Desertification

- UNCCD defines desertification as 'land-degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities'.
- Loss of soil cover, mainly due to rainfall and surface runoff, is one of the biggest reasons for desertification.

Problems of Soils in Rajasthan

The degree of degradation and its severity are influenced by special variability and its niche with the surrounding. The terrain factors like slope, aspect, topographic position are found to be dominant factor while intensity and distribution of rainfall are climatic factors, determining the extent and severity of degradation.



Wind Erosion & Shifting Sand Dunes:

- Wind Erosion is the **most significant cause** of land degradation/desertification in Rajasthan.
- The wind erosion is playing a prominent role, in the western flank of the state and is found active with full force in the core of desert, causing sand blasting, sand drifting, which results active dunes and interduneal plains.

Water Erosion

- Severity of water erosion is found at the peak in central highland, including Aravalli landscape and Bundelkhand upland.
- This causes loss of top soils through sheet and rill erosion.
- It also causes terrain deformation through gully and ravine land. Example: Ravine Lands along the Chambal River & its tributaries.

Water Logging:

- With the introduction of canal irrigation system water table of the area is rising at an average rate of about 0.8 m per year.
- As a result of this large area has become water-logged and this area is increasing every year, it is a serious problem particularly in deep black soils.

Sodicity of Soil:

- Sodality of the soil and high residual sodium carbonate content of irrigation water are the main problems.

Salinity & Alkalinity:

- The Salinity & Alkalinity is found maximum in the Aravalli and Bundelkhand alluvial plains where the quality of ground water and poor management practices about the secondary salinization.
- Salinity is due to high permanent water table.

Steps for Soil Conservation in Rajasthan

Adequate Drainage:

- The solution for **salinity & Alkalinity** of soil is to provide of soil is to provide adequate drainage.

Use of Gypsum:

- Use of gypsum which is abundantly and cheaply available in Rajasthan, is economical and long term solution to the problem of **Alkalinity**.

Afforestation:

- Large scale planting of saplings which act as wind breaks & also prevents soil erosion through water.

Shelter Belts:

- In dry regions rows of trees are planted to check wind movement to protect soil cover.

Contour Barriers:

- Stone, gross, soils are used to build barrier along contours. Trenches are made in front of the boomers to collect water.

Grass Development:

- Plantation of trees & grasses on marginal and sub marginal land.

Wind strip cropping:

- Grass and crop strip at right angle to wind direction.

Stubble Mulching:

- Crop stubbles are left in the field and next crop planted with minimum tillage.

Contour Bonding:

- Ravine land can be made cultivable by leveling followed by contour bonding
- The medium and deep gullies can also be converted into productive wood lands.

Proper Drainage System in canal Project Area:

- The problem of water logging can be checked and overcome by introducing proper drainage system in the canal project area.

DryFarming:

- Dry Farming is a method of conserving soil moisture preventing soil erosion.

RockDam:

- Rock Dam is built to slow down its flow of water.

Mulching:

- A layer of organic matter is made on soil. It helps to retain soil moisture.

Intercropping:

- Different crops are grown in alternative rows to protect the soil form rain wash

Terrace Farming:

- Broad flat steps or terraces are made on the steep slopes so that flat surfaces are available to grow crops.
- They reduce surface run off & soil erosion.

Contour Plugging:

- Plugging parallel to the contours of a hill slope to form a natural barrier for water to flow down the slope

Agro-climatic Zones of Rajasthan

The entire country has been delineated into 126 agro-climatic zones by the Indian Council of Agricultural Research (ICAR). Similarly, Rajasthan has been divided into 10 agro-climatic zones. These zones have been classified on the basis of agro-climatic parameters like rainfall, temperature regime, topography, soil characteristics, cropping pattern and irrigation availability. The Agro-climatic zones of Rajasthan are as follows:

1. Arid North Western Sandy Plain
2. Irrigated North Western Plain
3. Hyper Arid Partial Irrigated Zone
4. Transitional Plain of Inland Drainage
5. Alluvial Plain of Luni Basin
6. Semi Arid Eastern Plain
7. Flood Prone Eastern Plain
8. Sub Humid Southern Plain and Aravallis
9. Humid Southern Plain
10. Humid South Eastern Plain

Arid North Western Sandy Plain

- **Rainfall:** The mean annual rainfall in this zone is 100 to 400mm. The zone has erratic and uncertain rainfall witnessing frequent droughts.
- **Area:** The plain is characterized by vast sandy plain with sand dunes, sandy plain pediments and palayas present in the region. The vast area covered with sand dunes has coarse textured soil with CaCO3 and gypsum. This physiographic zone is located in the north western part of the state covering Jaisalmer, Barmer, Bikaner and Jodhpur districts.
- Groundwater is deep and saline but at few places tube-well water is used for irrigation.
- Rain-fed agriculture is practiced in some pockets and livelihood is primarily livestock based.

Irrigated North Western Plain

- **Area:** This plain extends in the northern part of the state in Ganganagar, Hanumangarh and north western part of Bikaner district.
- As the zone is irrigated by network of Indira Gandhi Canal, Bhakra and Gang canal, it is intensively cultivated.
- The plain is dominantly covered by the medium and fine textured deep to very deep soils. The bed of River Ghagghar stretching from Suratgarh to Anupgarh is fine textured and intensively cultivated. I
- n addition, in the southern and eastern part the region there is vast Aeolian plain covered with dunes with small area of deep buried pediments.

Hyper Arid Partial Irrigated Zone

- **Rainfall:** The normal rainfall in the zone is 185 to 390 mm.
- **Area:** This zone is spread in the arid region of Bikaner, Jaisalmer and parts of Churu, where the farmers have partial dependence on the sources of irrigation.
- The region has desert soil characterized by sand dunes and aeolian soil. The soil is loamy coarse in texture and with calcareous characteristics.

Transitional Plain of Inland Drainage

- **Rainfall:** The zone has average rainfall of 300-400mm.
- **Area:** This plain is spread in the central part of the state covering western, eastern and northern part of Nagaur and entire Sikar, Churu and Jhunjhunu districts.
- There is no drainage out of this area.
- The zone is covered with sandy plain, sand dunes and occasional hills. The area distinguishes from western sandy plain in having better Livelihood of villagers depends mainly on livestock rearing along with some rain-fed farming.

Alluvial Plain of Luni Basin

- **Rainfall** ranges between 400 and 500mm.
- **Area:** The physiographic zone is located in the central part of the state where a number of ephemeral streams and River Luni and its tributaries flow through this area covering Pali, Jalore, part of Nagaur, Jodhpur and Barmer districts.
- Water is saline in this zone.
- Cultivation of cash crops is Rainfed or done with the help of tube-wells. Dominant soils are medium to fine textured.

Semi Arid Eastern Plain

- **Rainfall:** Average Rainfall in the zone about 500- 700mm.
- **Area:** This plain is drained by the river Banas and its tributaries.
- The zone is spread in the eastern part of the state covering Jaipur, Ajmer, Dausa and Tonk districts. The plain is sandy plain.
- Occasional sand dunes and buried pediments and scattered hills with substantial area under alluvium are features of this zone.

Flood Prone Eastern Plain

- **Rainfall:** The rainfall in the zone is 600-700mm.
- **Area: T**his zone extends in Alwar, Bharatpur and Dholpur districts. Soils are yellowish-brown to dark yellowish brown, sandy loam to clay loam and non-calcareous.
- This zone developed on the alluvium deposited by the river Yamuna and its tributaries and is spread over the eastern part of the state and forms western fringe of the Indo-Gangetic plain.
- A large area of this zone is under kharif and rabi crops.

Sub Humid Southern Plain and Aravallis

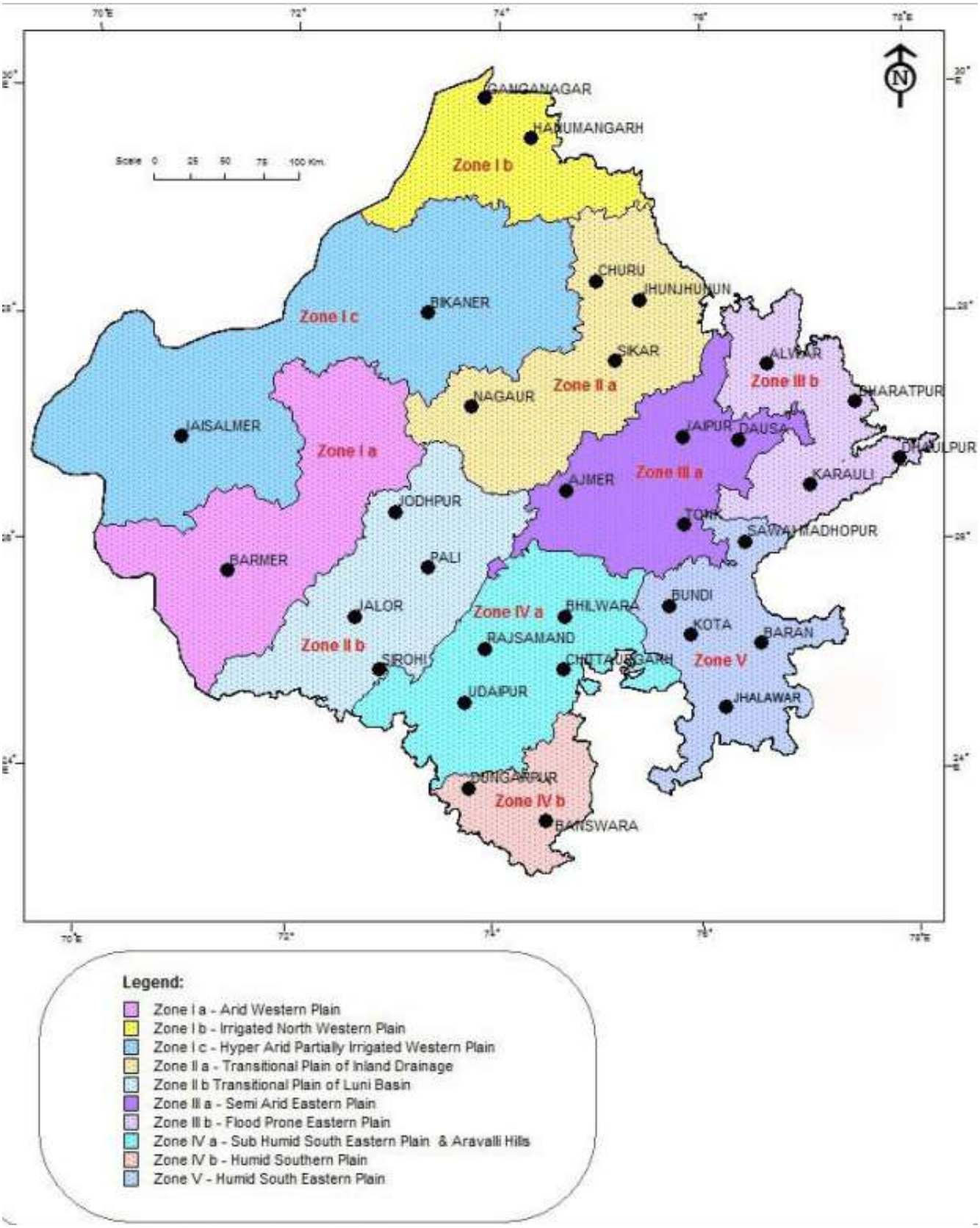
- The zone receives 700-900mm rainfall.
- High hills are scattered through the zone and there is a contiguous appearance of the Aravalli hills, running south to north.
- The zone extends in the southern part of the state in Bhilwara, Rajsamand, Sirohi, Udaipur and Chittorgarh districts.
- Hills and pediments are under hills for rest which support natural vegetation cover including trees, shrubs and grasses.
- Cultivated land occurs in between the hills.
- Medium to fine textured deep soils are dominant in this region.

Humid Southern Plain

- This zone receives 900-1000mm rainfall.
- This plain characterized by hills and valley fills is spread in the southern part of the state in Dungarpur, Banswara and Pratapgarh districts.
- In Banswara and Pratapgarh districts the soils formed from lava flow of basalt are also found.
- In between, scattered areas of deep buried pediments are also encountered.
- The hills are covered with thick density of trees, shrubs and grasses.

Humid South Eastern Plain

- This zone receives the highest rainfall in the state of around 700-1000mm.
- **Area**: South-eastern part of the state covering Sawai Madhopur, Karauli, Jhalawar, Baran, Kota and Bundi districts.
- The landscape is characterized by hills pediments and vast alluvial plain formed by the rivers Chambal, Parbati, Parwan, Kalisindh and their tributaries. Because of these rivers deep gullies and ravines have been formed. Because of the presence of fine textured alluvium deposited by the rivers in this zone the land is very productive


GANGANAGAR
HANUMANGARH
Zone I b
CHURU
JHUNJHUNUN
BIKANER
Zone I c
SIKAR
ALWAR
Zone II a
Zone III b
BHARATPUR
NAGAUR
JAISALMER
JAIPUR
DAUSA
Zone I a
DHAULPUR
Zone III a
AJMER
KARAULI
JODHPUR
TONK
SAWAIMADHOPUR
BARMER
PALI
BUNDI
JALOR
Zone IV a
BHILWARA
KOTA
BARAN
Zone II b
RAJSAMAND
SIROHI
CHITTAURGARH
Zone V
UDAIPUR
JHALAWAR
DUNGARPUR
Zone IV b
BANSWARA
Legend:
Zone I a - Arid Western Plain
Zone I b - Irrigated North Western Plain
Zone I c - Hyper Arid Partially Irrigated Western Plain
Zone II a - Transitional Plain of Inland Drainage
Zone II b Transitional Plain of Luni Basin
Zone III a - Semi Arid Eastern Plain
Zone III b - Flood Prone Eastern Plain
Zone IV a - Sub Humid South Eastern Plain & Aravalli Hills
Zone IV b - Humid Southern Plain
Zone V - Humid South Eastern Plain

Land Use pattern of Rajasthan

Land use pattern of an area affects vegetation, land quality, local weather and quality of life. It is very important to understand the land use pattern of any area and the dynamics of its shift overtime. This determines the ensuing per unit load on agriculture land, forest land, periphery areas to cities and factors responsible for land degradation. The land use pattern of a region determines the ecological balance in the region and helps to understand the environmental status as well.

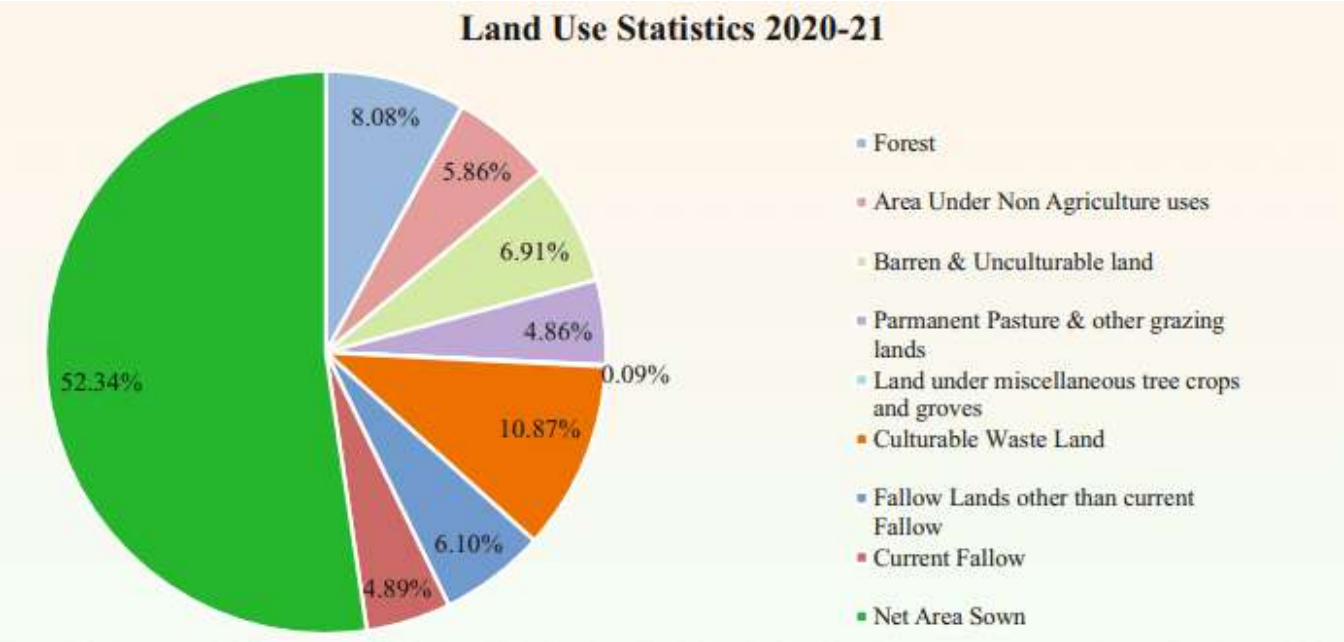
Located in north-west part, Rajasthan is the largest state of country, having a geographical area of 3,42,239 hectares which constitutes 10.41% of area of the country. Land use pattern in Rajasthan is as follows:

Land Use Pattern in Rajasthan

S.NO	Land Use	Area(in Lakh Hectare)	Percentage
1	Net Sown Area	179.48	52.34
2	Area under Forests	27.72	8.08
3	Non Agricultural Uses	20.10	5.86
4	Permanent Pastures & other grazing land	16.67	4.86
5	Land under misc trees & grooves	0.30	0.09
6	Culturable Wasteland	37.27	10.87
7	Fallow Lands (other than current fallow)	20.93	6.10
8	Current Fallows	16.75	4.89
9	Barren & Uncultivable Land	20.93	6.10
	Reporting Area for Land Utilization	342.89	100

	Total Geographical area of Rajasthan	342.89	-

*** As per GOR, Economic Review 2022-23, Page18.*



Land use pattern in Rajasthan: Analysis

Net-Sown Area:

- More than half of the total report area is under agriculture operation which proves that Rajasthan is still essentially an agricultural state.
- The high density (above 50%) districts are Alwar, Jaipur, Bharatpur and Tonk in eastern Rajasthan and Churu , Jalore, Jhunjhunu, Sikar, Nagaur and Ganganagar, Hanumangarh in western Rajasthan.

Area under Forests:

- Area under forest in Rajasthan is small, the concentration of forests being more in the districts adjoining Aravallis — like Ajmer, Banswara, Bundi, Chittorgarh, Pali, Sawai Madhopur, Sirohi, Udaipur and Kota.

- Due to low rainfall and aridity forest areas are few and almost negligible in the arid zone districts of Barmer, Bikaner , Churu, Sri Ganganagar, Jaisalmer, Jalor and Jodhpur.
- In rest of the districts the area under forest varies from 1 to 2% and are concentrated in the favourable locations of foothill slopes.

Non Agricultural Uses

- These include settlements, building, roads, other lands appropriated for non-agricultural use — like mountains and shifting dunes, etc.

Permanent Pastures & other grazing land

- The availability of permanent pasture and grazing land determines the status of livestock economy in the regions. It constituted about 5 per cent of the reporting area in Rajasthan.
- In Irrigated North Western Plain, the grazing land is also found negligible.
- The Sub humid Southern Plain is endowed with pastures and grazing lands in one-tenth of the reporting area. Largely, it constituted about 4 to 7 per cent across the zones.
- Hanumangarh and Ganganagar have the least area whereas Barmer, Jodhpur and Bhilwara have the largest area under this category.

Land under misc trees & grooves

- Area under fruit crop fall under this category of land use.
- In Rajasthan, the area under fruit crops is also negligible i.e. less than one per cent.
- Churu and Rajsamand districts have no land under miscellaneous trees, crops and groves. Districts Nagaur, Jalore and Hanumangarh cover the least whereas Dungarpur, Ganganagar and Jhalawar cover the maximum area under the same category.

Culturable Wasteland

- Culturable wastelands are wastelands that can be brought under cultivation by providing irrigation.
- Culturable Wasteland is highest in Ajmer, Alwar and Jaisalmer and minimum at Hanumangarh, Jhunjhunu and Bharatpur.

Fallow Lands:

- A *fallow* field is *land* that a farmer plows but does not cultivate for one or more seasons to allow the field to become more fertile again.
- Fallow lands includes two types of fallow lands - Current fallow lands & Other fallow (*long-fallow*) lands.
- Current year fallow are the lands that have been left fallow for the current year, while other fallow lands include lands that have been left fallow for more than a year.
- In arid regions, except in the districts where irrigation is practised the extent of such fallow land is very high; Barmer, Bikaner, Jaisalmer, Jodhpur dominate this category.

Change in land use pattern in Rajasthan:

- In general there is an increase in total area under cultivation in Rajasthan.
- Permanent pastures and grazing lands and miscellaneous trees and grooves are declining having serious unfavorable implications for the ecology of Rajasthan.
- Although growth in forest area is positive in all the regions of Rajasthan still forest area is only 7.8% of total geographical area, which is well below the minimum norms of 33% of geographical area under forests as set under the National Forest Policy (1952).
- There has been declining growth in barren and other unculturable lands. Land that is being released from barren and unculturable land is shifting towards non-agricultural sector.

Natural Vegetation-Forests of Rajasthan

The forests of Rajasthan cover approximately an area of **32,865 sq km** which is **9.60%** of the total geographical area of the state. The state has teak forests, which is northern most limit of teak zone in India. Apart from meeting the fuelwood and fodder demand, forest resources of Rajasthan contribute Rs.7160 million to the state domestic product (SDP).

The forests of Rajasthan are spread unequally in Northern, Southern, Eastern and South Eastern parts, and the western region of Rajasthan is devoid of any forest cover. Most of the forests are in hilly regions of Udaipur, Rajasamand, Kota, Baran Sawai Madhopur, Chittorgarh, Sirohi, Bundi, Alwar, Jhalawar and Banswara districts.

However, The extent of **Natural Forests** in Rajasthan is not only one of the lowest in the country but also in terms of productivity of forest, it is the lowest. On the contrary The State is endowed with the largest chunk of wasteland which is about 20% of the total wastelands of the country.

The forests of Rajasthan can be divided into four broad forest types.

- Tropical Thorn Forests,
- Tropical Dry Deciduous Forests,
- Bamboo-Forests
- Central India Sub-tropical hill forests.
- Mixed Miscellaneous Forests

Tropical Thorn Forests of Rajasthan

- Tropical thorn forests are found in arid and semi-arid regions of western Rajasthan, namely Jodhpur, Pali, Jalore, Barmer, Nagaur, Churu, Bikaner etc.
- These extend from western Indo -Park border and gradually merge with the dry deciduous mixed forests of the Aravalli hills and the south-eastern plateau.
- The main species found in this kind of forests are ***Acacia nilotica , Acacia leucophloea, Prosopis cineraria, Capparis aphylla, Zizyphus spp., Flacourtia spp.*** etc.

Tropical Dry Deciduous (Dhol) Forests

- These forests are mostly found in small patches in few parts of the state. the northern and eastern slopes of aravalli ranges, mostly in Alwar, Bharatpur and Dholpur districts, are covered with this type of forests.
- Sporadic growth of certain species of dry deciduous forests is found along the dry river beds of Jalore, Nagaur, Ganaganagar and Bikaner, districts.
- The main species found in this kind of forests are ***Babul***

Bamboo Forests

- Bamboo covers about 2.5% of the area occurring mostly in Chittorgarh, Udaipur, Kota & Abu hills.

Central Indian Sub - tropical Hill Forests

- These forests which are most abundant in central India, as in Madhya Pradesh, parts of Gujarat and Maharashtra, are found in Sirohi district of Rajasthan also, mostly on the hills girding Mt. Abu.
- These forests have **semi-evergreen** and some evergreen species of trees.
- The vegetation of Mt. Abu consists of many plants which are similar to the sub - tropical region of Himalayas. Around Mt. Abu, they are well represented between 700 to 800 m altitudes.

Mixed Miscellaneous Forests

- These forests are mostly found in south-eastern and eastern part of Rajasthan including Chittorgarh, Kota, Udaipur, Sirohi, Banswara, Dungarpur, Baran and Jhalawar districts.
- Average rainfall in these forest is more than 60cm and cover approximately 20% of the forest cover.

- These Forests mainly have ***Anogeissus pendula, Anogeissus latifolia, Terminalia tomentosa, Terminalia arjuna, Terminalia chebula, Albizia lebbeck, Dalbergia paniculata*** etc. and its associates.

Administrative Classification of Forest of Rajasthan

As per Forest Survey of India, *State of Forest report 2021*, Rajasthan has recorded forest area of about **32,863 square kms**. This forest area forms **9.60%** of state's geographical area and about **4.23%** of India's forest area. On the basis of Legal status, the Government has classified this forest area into three types:

- Reserved Forests - 12,176 Sq. Kms
- Protected Forests - 18,543 Sq. Kms
- Unclassified Forests - 2,144 Sq. Kms

Reserved Forest:

- These forests are under the direct supervision of the government.
- No public entry is allowed for collection of timber or grazing of cattle.
- Rajasthan has 12,176 sq kms or 37% of forest as Reserved Forest.

Protected Forest:

- These forests are looked after by the government, but the local people are allowed to collect fuel-wood/timber and graze their cattle without causing serious damage to the forests.
- Rajasthan has 18,543 sq kms or 56.4 % of forest area under Protected Forests.

Unclassified Forest:

- The unclassified forests are those in which there is no restriction on the cutting of trees and grazing of cattle.
- Rajasthan has 2,144 sq kms or 6.5% of area has Unclassified forests.

The Forest Survey of India (FSI), brings out bi-annual state of forests report. In the report, the FSI classifies forest as:

- Very Dense Forests (VDF) - 0.02%
- Moderately Dense Forests (MDF) - 1.29%
- Open Forests (OF) - 3.57%
- Scrubs - 1.41%
- Non-Forest Area- 93.72%

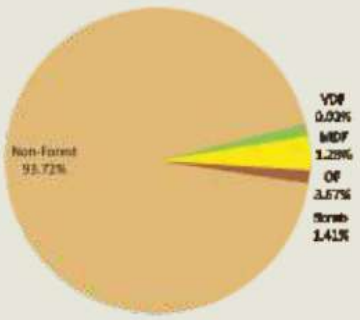


Figure 13.22.1
Forest Cover of Rajasthan

Table 13.22.2 Forest Cover of Rajasthan (in sq km)

Class	Area	% of GA
VDF	78.15	0.02
MDF	4,368.65	1.28
OF	12,208.16	3.57
Total	**16,654.96**	**4.87**
Scrub	4,808.51	1.41

Very Dense Forests (VDF):

- The Lands with forest cover having a canopy density of 70% and more are called Very Dense Forests (VDF).
- In Rajasthan, there are only **78.15** Sq kms of very dense forests.
- Percentage VDF: 0.02%

Moderately Dense Forests (MDF):

- The Land with forest cover having a canopy density of 40-70% is called the Moderately Dense Forest (MDF).
- In Rajasthan, there are only **4368.65** Sq kms of moderately dense forests.
- Percentage MDF: 1.28%

Open Forests (OF):

- The Lands with forest cover having canopy density of 10-40% are called Open Forests.
- In Rajasthan, there are only **12,208.16** Sq kms of open forests.
- Percentage OF: 3.57 %

Scrubs:

- The degraded forest lands which have a Canopy density of less than 10% are called Scrubs.
- In Rajasthan, there are about **4,808.51** Sq kms of scrubs.
- Percentage Scrubs: 1.41%

Non-Forest Area:

- Rest of the area, included all other lands except forest area.
- Percentage Non-Forest: 93.72%

The report also identifies, variation of forests with altitude.

Table 13.22.6 Altitude-wise Forest Cover in Rajasthan (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,24,954	27	2,567	9,384	11,978	4,065
500-1000	17,070	51	1,688	2,776	4,515	739
1000-2000	215	0	114	48	162	5
Total	**3,42,239**	**78**	**4,369**	**12,208**	**16,655**	**4,809**

(based on SRTM, Digital Elevation Model, 30 m, 2016)

Important Terms to understand:

Forest Cover:

- Forest Cover All lands which are more than 1 hectare in area and with a Canopy density of more than 10% irrespective of the ownership and legal status is called Forest Cover.

Recorded Forest Area:

- The area recorded as "forests" in the Government records is called Forest Area or Recorded Forest Area.

Canopy and Canopy Density

- The cover of branches and Foliage formed by the crown of trees is called Canopy. The percentage area of land covered by the canopy of trees is called Canopy density.

ISFR 2021 also ranks districts of Rajasthan in terms of their forest cover. Accordingly,

Rajasthan's District with Maximum total forest area:

Ranking	District	Forest Area
1	Udaipur	2753.39
2	Alwar	1195.91
3	Pratapgarh	1033.77
4	Baran	1010.05
5	Chittorgarh	990.05

Rajasthan's District with Maximum Percentage of Forest area:

Ranking	District	Percentage of Area
1	Udaipur	23.49%
2	Pratapgarh	23.24%
3	Sirohi	17.49%
4	Karauli	15.28%
5	Baran	14.45%

Rajasthan's District with least total forest area:

Ranking	District	Forest Area
1	Churu	77.69
2	Hanumangarh	92.97
3	Jodhpur	109.25
4	Ganganagar	115.09
5	Dausa	116.60

Rajasthan's District with Least Percentage of Forest area:

Ranking	District	Forest Area
1	Jodhpur	0.48%
2	Churu	0.56%
3	Jaisalmer	0.84%
4	Bikaner	0.92%
5	Hanumangarh/Nagaur	0.96%

Wildlife of Rajasthan

Though a large percentage of the total area of Rajasthan is desert and there is little forest cover, Rajasthan has a rich and variety of animal and plant species. This post is collection of information on wildlife of Rajasthan. We shall update important current affairs in the same post.

Wildlife of Rajasthan: The Basics

- **State Animal of Rajasthan:** Camel
    - Why: To prevent slaughter, illegal trade and transportation of Camels, as their numbers are dwindling (decreasing) sharply.
    - Camel Festival: Bikaner 9-10 January.
    - Pushkar Mela: 5-day Camel & Livestock Trading fair.
- **Rajasthan State Bird: Great Indian Bustard**
    - Locally called as Godawan
    - Critically endangered (IUCN) and protected in India under Schedule I of wildlife protection act, 1972.
    - 2014 Wildlife Institute of India (WII) survey counted 44 great Indian bustards in Rajasthan and according to 2015, Forest department report it is 13.
    - Currently found only in Rajasthan, Gujarat & Maharashtra.
    - Rajasthan Government has launched **Project Great Indian Bustard** for Protection of GIB
    - Rajasthan Government allocated 12 Crore and Bank of Japan allocated 3 crores.
    - Under the GIB Project, closures will be made at many places in Khudi Rasla, Pokhran and Shahgarh of Jaislmer district for safe habitat of bird.
    - 2015, **Dr. Pramod Patil** won green Oscar for efforts in conservation of GIB.

Wildlife of Rajasthan: Current Affairs

- International Biodiversity Day celebrated on 22nd May.
- Tiger Conservation: 2015 MoEF report put the number of tigers in Rajasthan at 52

- To create awareness about animals and birds, each of the 33 districts of Rajasthan has been represented by an **animal mascot**. The forest department published news regarding animal mascot in March 2016: Below is the list:

DISTRICT	Mascot	DISTRICT	Macot
Ajmer	Kharmor bird	Jhalore	Bear
Alwar	Sambar deer	Jhalawar	Gagroni Parrot
Banswara	Bronze winged Jacana	Jhunjhunu	Kala teetar
Baran	Indian Crocodile (Mugger)	Jodhpur	Demoiselle Cranes
Barmer	Fox	Karauli	Ghariyal
Bharatpur	Sarus Crane	Kota	Mongoose
Bikaner	Sandgrouse	Nagaur	Rajhans
Bhilwara	Peacock	Pali	Panther
Bundi	Golden Pheasant	Pratapgarh	Flying Squirrel
Chittorgarh	Gosingha	Rajsamand	Wolf
Churu	Blackbuck	Sawai Madhopur	Tiger
Dausa	Rabbit	Sikar	Shahen
Dholpur	Indian Screamer	Sirohi	Jungli murgi
Dungarpur	जांघिल (Don't know English name)	Sri GangaNagar	Chinkara
Hanumangarh	Little KingFisher	Tonk	Hans
Jaipur	Cheetal deer	Udaipur	kabr Bijju
Jaisalmer	Great Indian Bustard- Godawan		

Threatened (Endangered) Species of Wildlife of Rajasthan:

S.NO	Species Name	Districts
1	Tiger	Sawai Madhopur, Alwar
2	Leopard	All Rajasthan
3	Sloth Bear	Sawai Madhopur, Dholpur, Jalore
4	Common Giant Flying Squirrel	Sita Mata WLS, Pratapgarh | Fulwari ki Naal WLS, Udaipur
5	Three Striped Palm Squirrel	Fulwari ki Naal WLS, Udaipur
6	Smooth Indian Otter	Ghana (Bharatpur), Chambal River
7	Chousingha or Four Horned Antelope	Kumbhalgarh WLS
8	Mouse Deer	Fulwari ki Naal WLS, Udaipur
9	Gangetic Dolphin	Chambal River
10	Caracal	Sariska NP,Alwar | Ranthambore NP, Sawai madhopur
11	Ratel	Sariska NP,Alwar | Ranthambore NP, Sawai madhopur | Pratapgarh
12	Fishing Cat	Ghana (Bharatpur)
13	Rusty Spotted Cat	Sariska NP, Alwar | Sajjangarh WLS, Udaipur
14	Amur Falcon	Mount Abu
15	Brown Cheeked fulvetta	Mount Abu
16	Malabar Whistling Thrush	Mount Abu
17	Indian Yellow Tit	South Rajasthan
18	White Naped Tit	Mid & South Rajasthan
19	Orange Headed Thrush	South Rajasthan
20	Indian Blackbird	South Rajasthan
21	Indian Purple Rumped Sunbird	Udaipur, Banswara
22	Black headed Munia	Ghana(Bharatpur), Udaipur

23	Green Avadavat	Kumbhalgarh, Mount Abu
24	Grey Jungle Fowl	Kumbhalgarh, Todagrah-Raoli, Phulwari & Mount Abu WLS
25	Painted Spurfowl	Vindhyanchal hills & Sariska
26	Aravalli Red Spurfowl	South Rajasthan
27	Siberian Crane	Ghana (Bharatpur)
28	Red Whiskered Bulbul	Mount Abu
29	Great Indian Bustard	National Desert Park, Jaisalmer
30	White Rumped Vulture	All Rajasthan
31	Indian Vulture	South Rajasthan
32	Red-headed Vulture	South-East Rajasthan
33	Slender Racer Snake	Udaipur
34	Dumeril's Black-headed Snake	Khumbhalgarh |Udaipur
35	Green Keelback Snake	South Rajasthan
36	Isaballine	South Rajasthan
37	Ghariyal	Chambal River WLS
38	Common Tree Frog	Bansi, Sita Mata WLS Pratapgarh
39	Giant Wood Spider	Sita Mata WLS, Pratapgarh | Fulwari ki Naal WLS, Udaipur

Wildlife Protected Areas of Rajasthan

Despite being a desert state, Rajasthan has good network of protected areas. The Protected Areas are declared under **Wildlife (Protection) Act, 1972.** There are 3 National Parks, 27 Wildlife Sanctuaries, and 18 Conservation Reserves in the State. Besides this, 4 Biological Parks at Jaipur, Udaipur, Kota and Jodhpur have also been developed. Now, Wildlife Protection Act provides for 4 types of Protected areas:

- National Park - 3 in Rajasthan
- Wildlife Sanctuary - 27 in Rajasthan
- Conservation Reserves - 18 in Rajasthan
- Community Reserves -

Apart from these above 4, based on UNESCO's Man and Biosphere (MAB) the government has nominated 5th type: Biosphere Reserve. But unfortunately, Rajasthan does not have any Biosphere reserve.

1. National Parks of Rajasthan

S.NO	Year Est.	National Park	Area (Sq.KM)	Districts
1	1980	Ranthambore NP	282.03	Sawai Madhopur
2	1981	Keoladeo Ghana NP	28.73	Bharatpur
5	2003	Mukundhara Hills (Darrah) NP	199.55	Kota, Chittorgarh

2. Wildlife Sanctuaries of Rajasthan

S.No.	Wildlife Sanctuary Name	Districs	Year Est.	Area(SqKm.)
1	Sariska Sanctuary	Alwar	1955	491.99
2	Darrah Sanctuary	Kota , Jhalawar	-	227.64
3	Van Vihar Sanctuary	Dholpur	1955	25.60
4	Jaisamand Sanctuary	Udaipur	1955	52.34
5	Mount Abu Sanctuary	Sirohi	1960	326.10
6	Kumbhalgarh Santuary	Rajsamand , Udaipur , Pali	1988	610.528
7	Talchappar Sanctaury	Churu	1971	7.19
8	Sitamata Sanctuary	Udaipur , Chittorgarh	1979	422.94
9	National Gharial Sanctuary	Kota, Bundi, Sawaimadhopur, Karoli, Dholpur	1979	564.03
10	Nahargarh Sanctuary	Jaipur	1980	52.40
11	Jamwramgarh Sanctuary	Jaipur	1982	300.00
12	Jawahar Sagar Sanctuary	Kota , Bundi , Chittorgarh	1975	194.59951
13	Desert National Sanctuary	Jaisalmer , Barmer	-	3162.00
14	Ramgarh Vishdhari Sanctuary	Bundi	1982	303.05
15	Bhensrodgarh Santuary	Chittorgarh	1983	201.40
16	Keladevi Sanctuary	Karoli , Sawai Madhopur	1983	676.82
17	Shergarh Sanctuary	Baran	1983	81.67
18	Todgarh Raoli Sanctuary	Rajsamand , Ajmer , Pali	1983	495.27
19	Pulwari ki Naal Sanctuary	Udaipur	1983	511.41

20	Sawai Madhopur Sanctuary	Sawai Madhopur	-	131.30
21	Sawaiman singh Sanctuary	Sawai Madhopur	1984	113.07
22	Band Baretha Sanctuary	Bharatpur	1985	199.24
23	Sajjangarh Sanctuary	Udaipur	1987	5.19
24	Bassi Sanctuary	Chittorgarh	1988	138.69
25	Ramsagar Sanctuary	Dholpur	1955	34.40
26	Kesarbagh Sanctuary	Dholpur	1955	14.76

4. Conservation Reserves of Rajasthan

S.NO	Conservation Reserve	Area (Sq.KM)	Districts
1	Bisalpur Conservation Reserve	48.31	Tonk
2	Jodbeed Gadhwala Bikaner Conservation Reserve	56.4	Bikaner
3	Sundhamata Conservation Reserve	117.4	Jalore, Sirohi

4	Gudha Vishnoiyan Conservation Reserve	2.31	Jodhpur
5	Shakambari Conservation Reserve	131	Sikar, Jhunjunu
6	Gogelav Conservation Reserve	3.58	Nagaur
7	Beed Jhunjunu Conservation Reserve	10.4	Jhunjunu
8	Rotu Conservation Reserve	0.72	Nagaur
9	Jawai Bandh	19.78	Pali
10	Ummed Ganj Conservation Reserve	2.78	Kota
11	Bansiyal Kethadi Conservation Reserve	70.18	Junjhunu
12	Bansiyal - Khetri Bagore Conservation Reserve	39.66	Junjhunu
13	Jawai Bandh Leopard Conservation Reserve-II	61.98	Pali

14	Mansa mata Conservation Reserve	102.31	Jhunjhunu
15	Rankhar Conservation Reserve	72.88	Jalore
16	Shahbad Conservation Reserve	189.39	Baran
17	Shahabad Talahatee Conservation Reserve	178.84	Baran
18	Beed Ghaas Phuliakhurd Conservation Reserve	0.8579	Bhilwara
19	Baghdarrah Crocodile Conservation Reserve	3.6871	Udaipur
20	Wadakheda Conservation Reserve	43.31	Sirohi
21	Jhalana-amagarh		Jaipur
22	Ramgarh kunji sunwaans		Baaran
23	akhar gaanv		Ajmer

24	Sorsen		Baaran
25	hamirgarh		Bhilwara
26	Kheenchan gaanv		Jodhpur
27	Baanjh aamli	146.21	Baaran

Livestock of Rajasthan

Service Sector majorly drives economy of Rajasthan but agriculture and allied activities continues to be chief source of livelihood in rural region. 55% of total area of Rajasthan is desert and so livestock is the main source of livelihood. Other than providing source of livelihood, livestock also provides food security and insurance against poverty. Development of livestock sector has a significant beneficial impact in generating employment and reducing poverty in rural areas.

This Post includes description and details, regarding various animals found in Rajasthan. Our aim is to cover, in this single post, basic information and relevant details with regard to both ecologically and economically relevant animals of Rajasthan.

Livestock of Rajasthan: The Basics

- **What is Livestock?**
    - Livestock are animals that are domesticated and raised in an agricultural setting to produce commodities such as food, fiber, and labor.
    - They include cattle, goats etc
    - The breeding, maintenance, and slaughter of these animals, known as *animal husbandry*
- **What is Mixed Farming?**
    - Mixed farming is a farming system, which involves the growing of *crops* as well as the *raising of livestock*
- **What are the advantages of Mixed Farming?**
    - Mixed Farming offers highest return on farm business, as the by-products of both farm and livestock are properly utilized.
    - It provides work throughout year.
    - Provides efficient utilization of land, labor, equipment and other resources.
    - Crop by-products such as bus, straw, fodder are used for feeding of livestock and in return they provide milk.
    - Manures available from livestock are useful in maintenance of soil fertility.

- It helps in supplying all the food needs (food security) of the family members.
- Intensive cultivation is possible.
- Provides livelihood security in case of drought, floods.
- Milk cattle's provide draft animals for crop production and rural transport.
- Mixed farming increases social status of the farmer.

- **Importance of Livestock in Economy of Rajasthan:**
  - Livestock provide 35% of draft power in the state.
  - Rajasthan has 40% of Sheep stock in India.
  - More than 80% rural families keep livestock in their households.
  - Contribution of animal husbandry sector to the GDP of the State has been estimated to be approximately **8 %.** (Source: Animal Husbandry, Dept.)
- **Strengths of livestock of Rajasthan:**
  - Rajasthan Produces *10% and ranks 2nd* in Milk production in India.
  - Rajasthan ranks 2nd in per capita milk availability.
  - Rajasthan contributes *35% and ranks 1st* in wool production in India.
  - 25% of Country's sheep belong to Rajasthan
  - Rajasthan produces 10% of meat in India.
  - Rajasthan Ranks 14th in egg production in India
  - Constraints in development of Livestock in Rajasthan.
  - Livestock is an unorganized sector and holdings are very small, further much of the livestock belongs to economically weaker section which restricts it to being just source of livelihood.
  - Markets for livestock are also unorganized and suffers from inadequate investment by Public (State) & Private sector.
  - Inadequate availability of quality breeds

- Lack of health &nutrition support, along with frequent occurrence of natural calamities that result in high occurrence of diseases and mortality.
- Rajasthan is majorly an arid region and there is inadequate availability of fodder & feed resources
- Inadequate infrastructure in terms of cooperatives, veterinary and knowledge support.

Types of livestock on basis of their utility:

- **Dairy (Milch) breeds:**
  - Cows (Females): Gives high amount of milk
  - Bull (Males): are not good for work at farm
  - Examples: shahiwal, Red Sindhi, Gir and Deoni
- **Draught breeds:**
  - Cows yield poor milk production
  - Bulls are good at draught and are used for carrying out agricultural work like tilling, irrigation and carting.
  - Examples Kangayam, Umblacherry, Amritmahal, Hallikar.
- **Dual Breeds:**
  - Cows are good at milk production
  - Bulls are good at doing work
  - Examples Ongole, Hariana, Tharparker, Kankrej, Krishna valley, Rathi and Goalo Mewathi.

Different types & breeds of Livestock available in Rajasthan:

Breeds of Cows in Rajasthan:

- Nagauri
  - Origin from Suhalak area Nagaur.

- This species gives less milk.

- Kankrej
  - Kankrej is found in Rajasthan's southwestern districts of Barmer, Sirohi & Jalore.
  - Gives daily average of 5-10 litres of milk.
  - The bull of this variety has good draught capacity.
- Tharparkar Breed
  - Origin of the breed: Malani (barmer)
  - Cows excellent production of milk.
- Rathi Breed
  - Rathi belongs to northwestern rajasthan and is found in Sr Ganganager, Bikaner, Jaisalmer.
  - Essentially a Milch variety that is cows are good at milk production but males lack draught power.
- Gir Breed
  - Gir breed comes from Gir forests of Saurashtra in Gujarat.
  - In Rajasthan it is found in Southeastern Ajmer, Chittorgarh, Bundi, Kota

Breeds of Sheep in Rajasthan:

- Jaisalmeri
  - Found in Jaisalmer
- Naali
  - Found in Hanumangarh, Churu, Bikaner & Jhunjhunu.
  - Yields large quantity of wool
- Maalpuri
  - Found in Jaipur, Dausa, Tonk, karauli & Sawai madhopur

- Magra
    - Gives approximately 2 Kg of Wool per year
    - Found in Jaisalmer, Bikaner, Churu, Nagaur
- Pugal
    - Originated from Pugal in Bikaner
- Chokla or Shekhawati
    - Also referred to as Marino of India
    - It yields best quality wool and gives around 1-1.5 Kg per year.
- Sonari or Chanothar
    - Found in Banswara, Bhilwara, Dungarpur and Udaipur

Breeds of Camel in Rajasthan:

- Bikaneri
    - Found in Bikaner, Gangangar, Hanumangarh & Churu
- Jodhpuri
    - Found mostly in Jodhpur & Nagaur districts
- Nachna:
    - This breed is fast-runner variety of camels
    - Origin from Nachna Village in Jaisalmer
- Jaisalmeri
    - Camels of Jaisalmeri breed are found in Jaisalmer, barmer, and jodhpur
- Kutchi
    - Camels of this variety are mainly found in Barmer & Jalore
- Jalori
    - Camels of this variety are mainly found in Jalore & Sirohi

- Mewari
    - This breed is extensively used for carrying loads
    - Camels of this variety are mainly found in Udaipur, Chittorgarh, Partapgarh & Ajmer
- Gomat
    - This breed to camel is famous for distant-transport and it is also a very fast runner
    - Camels of this variety are mainly found in Jofhpur and Nagaur
- Gurha
    - Found in Nagaur & Churu
- Kherupal
    - Found in Bikaner & Churu
- Alwari
    - Camels of this breed are mostly found in East-Rajasthan.

Livestock Census 2019

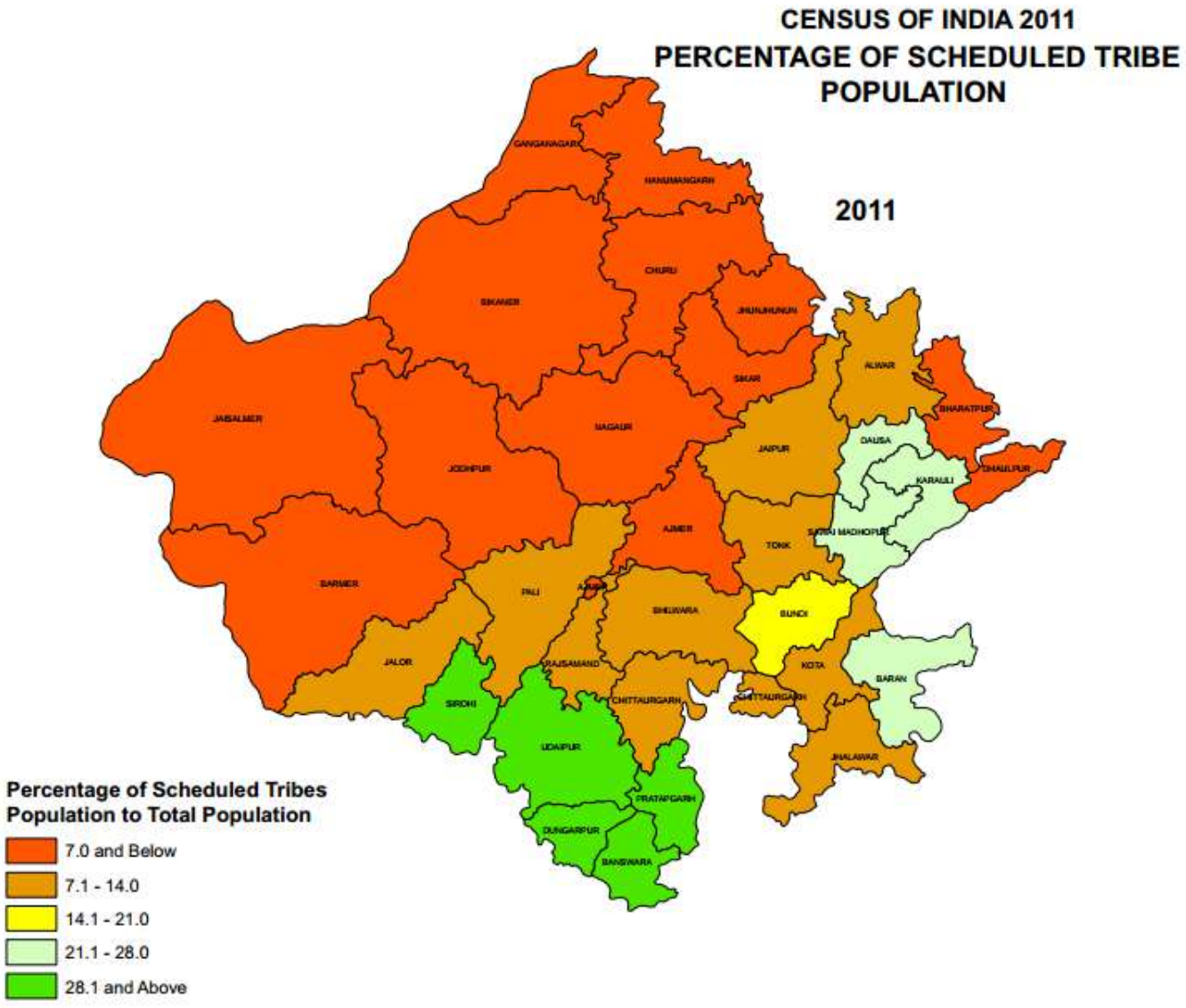
- It was 20th Livestock Census of Rajasthan
- There are 568 lacs Livestock (includes Cattle, buffalo, Sheep, Goat, Horse & Ponies, Mules, Donkeys, Camel, Pig)
- Rajasthan has Poultry of 146 lacs.
- Barmer has the highest number of livestock in Rajasthan & Dholpur has minimum number of Livestock
- Rajsamand and Dausa have highest livestock density of 292 per square kilometer

Summary of Livestock Population in rajasthan according to Census - 2019

S.NO	Variety	State Rank in India	Population (In Millions) 2019
1	Livestock	2	56.8
2	Poultry	17	14.6
3	Cattle	6	13.9
4	Buffalo	2	13.7
5	Sheep	4	7.9
6	Goat	1	20.84
7	Pig		
8	Camel	1	0.213
9	Horses & Ponies	3	0.034
10	Mules		0.001
11	Donkeys	1	0.23
12	Mihtun	–	0
13	Yak	–	0

Tribes of Rajasthan

Rajasthan has been home to numerous tribal & nomadic communities, the tribes of Rajasthan constitute approximately **13.5%** of Rajasthan's population. Each of these tribes can be identified by their own culture, customs, trades, fairs & festivals. Bhils & Minas constitute the majority of population of the tribes of Rajasthan.



Schedule Tribes of Rajasthan

1. Bhils

Bhils are the largest tribe in Rajasthan. Banswara is the main area where Bhils in large numbers. The Bhils are considered to be fine archers. Infact, Bhil bowmen even found a reference in the great epics Mahabarata and Ramayan. The Bhils were originally food gatherers. However, with the passage of time, they have taken up small-scale agriculture, city residence and employment. The major fairs of Bhils are the **Baneshwar fair** (held near Dungarpur) and Holi. The Ghoomar dance is one well-known aspect of the Bhil culture.

2. Minas

The name Mina is derived from *Meen*,meaning 'fish' in Sanskrit, and the Minas claim descent from the Matsya Avatar, or fish incarnation, of Vishnu. The main reference of belief is based on the scripture of the Matsya Purana. Before the rise of Rajputs during medieval period, Rajasthan had multiple mina kingdoms. The Minas are spread across the geography of Rajasthan, however, traditionally are concentrated in the shekhawati region surrounding Jaipur.

Main Kingdoms of Meenas (in the Rajasthan)

S.No	Name of the Kingdom	Clan name of the Meena Rulers
1	Khoh-Gong	Chanda Agnivanshi
2	Maach	Sira
3	Gatoor & Jhotwada	Nandla (also called Bad-Goti)
4	Amer	Soosawut/Susawat
5	Nayala	jhirwal
6	Naen\Nahn	Gomladu
7	Ranthambore	Tatu
8	Bundi	Ushara (Parihar Meenas or Pratihar)
9	Mawar	Meena
10	----	Nandla

3. Damor

- DAMOR Also described as Damoria, belong to mostly Dungarpur, Udaipur districts and in lesser numbers in Churu and Ganganagar districts of Rajasthan.
- The Indo-Aryan language, Vagri, is their mother tongur and they are also conversant with Gujarati and Mewari.
- Damors are mainly cultivators and manual laborers.

4. Dhanka

5. Garasia

- Garasias is a small tribe inhabiting Abu Road area of southern Rajasthan.

6. Kathodi

- They are basically tribe of Maharashtra and found mostly in Udaipur district of Rajasthan

7. Kokna

8. Koli

9. Nayaka

10. Patelia

11. Seharia or Sahariya

- Sahariyas are considered as the most backward tribe in Rajasthan and are the only group included in Particularly Vulnerable Tribe (PGT) from Rajasthan.
- Believed to be of Bhil origin, they inhabit the areas of Kota, Dungarpur and Sawai Madhopur in the southeast of Rajasthan. Their main occupations include working as shifting cultivators, hunters and fishermen.

Denotified Tribes of Rajasthan:

British in 1871 passed Criminal Tribes Act and labeled over 200 of such communities as notified tribes for criminal tendencies. Post Independence, Government repealed the Criminal Act but introduced another law, the Habitual Offenders Act (1953) around 150 tribes have been labeled as *de-notified*

tribes. These are tribes that have failed to integrate into Indian Society and so do not have sustainable livelihood means. Hence, they frequently engage towards criminal activities.

- **Baori**
- **Kanjar**
    - Hadoti Region
- **Sansi**
- **Bagri(Bawaria)**
- **Mogia**
- **Nut**
- **Naik**
- **Multanis**
- **Bhat**

Nomadic Tribes of Rajasthan

- **Baldias (Banjaras)**
    - The Banjaras are nomadic caravan runners who travelled with balaads or oxen-laden caravan and who continued travelling wherever their caravans were in demand.
- **Pardhis**
- **Domabaris**
- **Gadias Lohars**
    - Gadiya Lohars are wandering blacksmiths that are named after their attractive bullock carts called gadis. Gadhiya lohars are found are Kathodi and Rabaris in Mewar region.
- **Iranis**
- **Jogi Kalbelia**
- **Jogi Kanphata**
- **khurpalts**
- **Shikkeligar**

- **Ghisadis**

Semi Nomedic Tribes of Rajasthan

- **Sarangiwala Bhopas**
- **Rebaris**
    - The Rabaris are still nomadic, an equally colourful sub-group that still travels over the desert in search of pastures for its flocks of sheep and camels.
    - Their tradition is that their ancestor was brought into existence by Lord Mahadeva in order to tend the first camel, which had just been created by Parvati for her amusement.
    - Their two main divisions are Menu and Chalkais.
    - The Menu deals only in camels and occupies a superior position to that of the latter. They can marry the daughters of Chalkias without giving their own in return.
    - The Chalkias keep larger herds of sheep and goats. Raika farms, called Dhanies, lie scattered over the countryside.
- **Raths**
- **Mangalias**
- **Bhayas**
- **Kannis**
- **Janglus**
- **Jalukus**
- **Jhangs**
- **Sindlus**
- **Jogis (other then those included in Nomedic Tribes.)**
- **Ramaswamies**
- **Bharaddi-Jadhavs**

Government & Tribes of Rajasthan:

The framers of the Constitution took note of the fact that certain communities in the country were suffering from extreme social, educational and economic backwardness arising out of age-old practice of untouchability and certain others on account of this primitive agricultural practices, lack of infrastructure facilities and geographical isolation, and who need special consideration for safeguarding their interests and for their accelerated socio-economic development.

These communities were notified as **Scheduled Castes and Scheduled Tribes** as per provisions contained in **Clause 1 of Articles 341 and 342** of the Constitution respectively.

Schedule Tribes:

Scheduled Tribes are those, which are notified as such by the President of India under Article 342 of the Constitution. The first notification was issued in 1950. The President considers characteristics like the tribes' primitive traits, distinctive culture, shyness with the public at large, geographical isolation and social and economic backwardness before notifying them as a Scheduled Tribe.

Schedule tribes of Rajasthan:

1. Bhil, Bhil Garasia, Dholi Bhil, Dungri Bhil, Dungri Garasia, Mewasi Bhil, Rawal Bhil, Tadvi Bhil, Bhagalia, Bhilala, Pawra, Vasava, Vasave
2. Bhil Mina
3. Damor, Damaria
4. Dhanka, Tadvi, Tetaria, Valvi
5. Garasia (excluding Rajput Garasia)
6. Kathodi, Katkari, Dhor Kathodi, Dhor Katkari, Son Kathodi, Son Katkari
7. Kokna, Kokni, Kukna
8. Koli Dhor, Tokre Koli, Kolcha, Kolgha
9. Mina
10. Naikda, Nayaka, Cholivala Nayaka, Kapadia Nayaka, Mota Nayaka, Nana Nayaka
11. Patelia
12. Seharia, Sehria, Sahariya.

Primitive Tribal Groups:

75 of the 698 Scheduled Tribes are identified as **Primitive Tribal Groups** considering they are more backward than Scheduled Tribes. They continue to live in a pre-agricultural stage of economy and have very low literacy rates. Their populations are stagnant or even declining.

- *Seharia tribe of Rajasthan have been included in PTG*

Schedule V:

To ensure the protection of aboriginal customs, culture of the tribes and prevent alienation of their lands and natural resources to non-tribals article 244 of the Constitution has the provision for declaration of Schedule V & Schedule VI areas.

Schedule V areas can be declared in any state except Assam, Meghalaya, Tripura and Mizoram. Consequently, 5th schedule areas have been declared in in 9 states of India namely Andhra Pradesh, Jharkhand, Gujarat, Himachal Pradesh, Maharashtra, Madhya Pradesh, Chattisgarh, Orissa and Rajasthan. *In Rajasthan: Banswara, Dungarpur (fully tribal districts), Udaipur, Chittorgarh, Siroi (partly tribal areas) have been declared as part of Schedule V areas*.

Schedule VI has been used to declare schedule areas in Assam, Meghalaya, Tripura and Mizoram

Acts & Rules for protection of tribes:

- Forest Rights Act 2006
- Protection of Civil Rights Act, 1955
- Protection of Civil Right Rules, 1977
- SC/ST (Prevention of Atrocities) Rules, 1995
- SC/ST (Prevention of Atrocities) Act, 1989
- PESA 1996
- THE CONSTITUTION (EIGHTY-NINTH AMENDMENT) ACT 2003

Schemes related to development of tribes of Rajasthan:

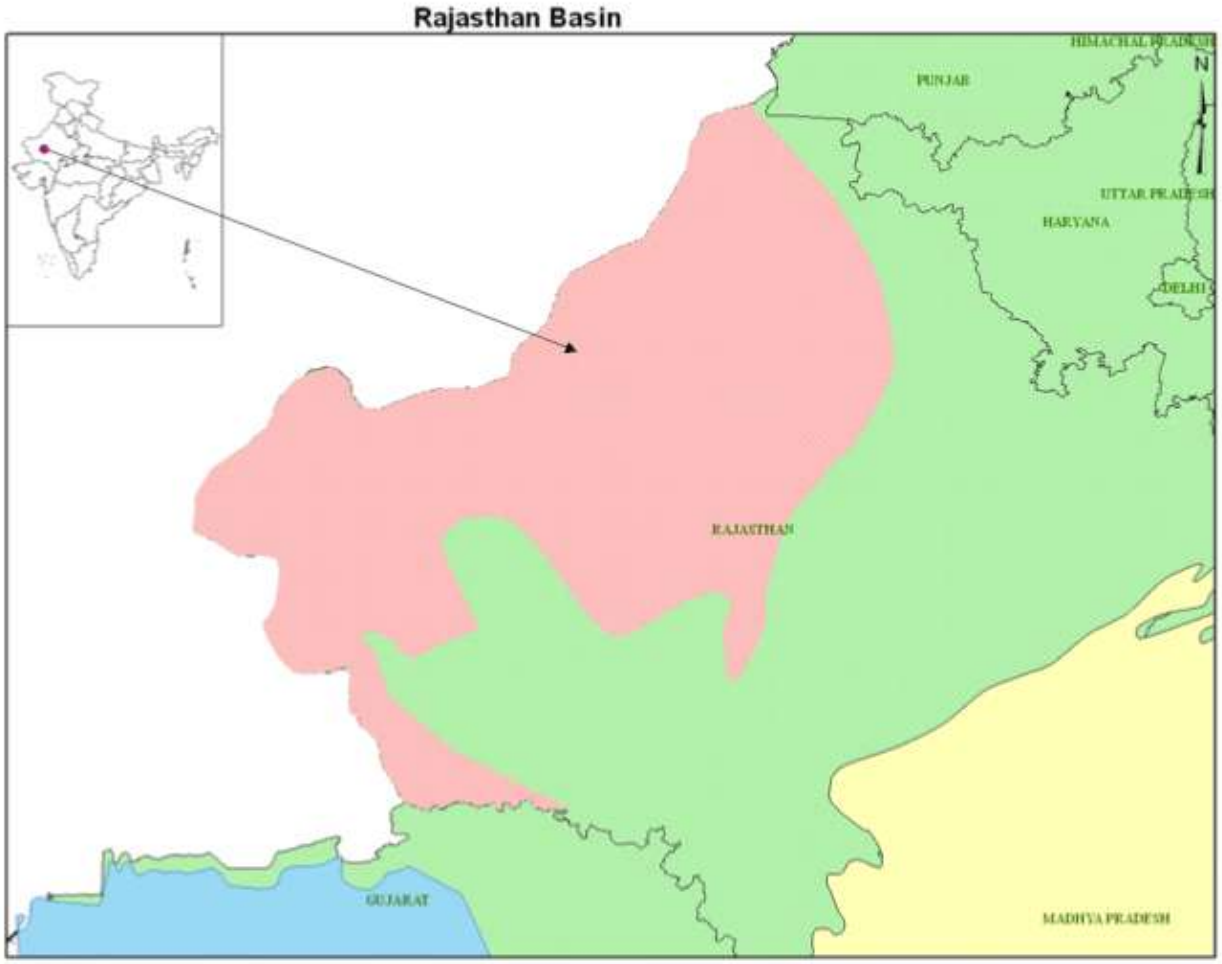
- List of Schemes

Hydrocarbon Rajasthan Basin

The Rajasthan Basin (Hydrocarbon) is a sedimentary basin located in western Rajasthan with a geographical extent of about 126,000 square kilometres. This basin is one of India's major sources of petroleum and natural gas. As per estimates 480 million tonnes Oil in-place reserves (3.5 Billion Barrels) have been proved in 25 discovered fields of Barmer-Sanchore Basin.

Rajasthan Basin Location:

Rajasthan Basin forms the eastern flank of Indus geosyncline and comprises the sedimentary tract to the west and northwest of Aravallis upto Indo-Pakistan border. This pericratonic basin also forms a part of the great Thar Desert.



Rajasthan Basin: Sub-Basins:

Rajasthan Basin has been sub-divided into four potential Petroliferous basins, separated from each other by basement ridges/faults. These four Basins are spread over in 14 Districts of Western & Eastern Rajasthan. The Ministry of Petroleum & Natural gas has upgraded the first three petroliferous basins into **category- I**, i.e. equivalent to the Bombay High, Cambay Basin and Assam, which are potential for hydrocarbons prospects.

Sr. No	Basin	Basin Coverage
1	Jaisalmer Basin	District Jaisalmer and part of jodhpur
2	Barmer – Sanchore Basin	Districts Barmer and Part of Jalore.
3	Bikaner – Nagaur Basin	Districts Bikaner ,Nagaur, Ganganagar/ Hanumangarh and Part of Churu.
4	Vindhyan Basin	Districts Kota, Jhalawar, Baran, Bundi and Part of Bhilwara etc.

Jaisalmer Basin

- Age of Jaisalmer basin: Mesozoic & Cenozoic
- Districts: Jaisalmer and part of jodhpur
- Type of Basin: Pericratonic Basin
- Depressions: The Jaisalmer Basin has been subdivided into 3 depressions:
    - Shahgarh Depression
    - Kishangarh Shelf
    - Miajlar Depression

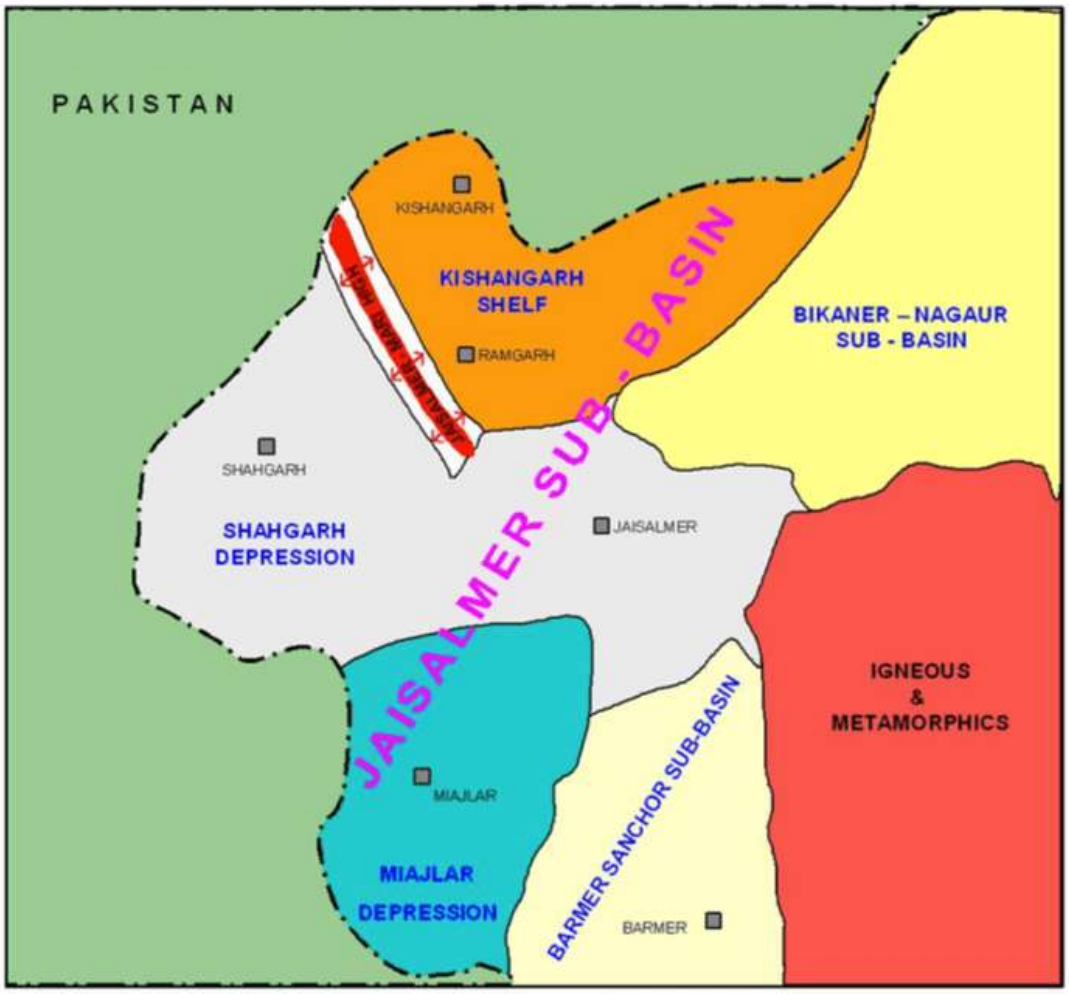


FIG. 23 THE THREE DEPRESSIONS OF JAISALMER SUB - BASIN

Barmer – Sanchore Basin

- **Age** of Barmer-Sanchore Basin: Tertiary
- **Districts:** Barmer and Part of Jalore.
- **Type of Basin:** Intracratonic Basins
- **Depressions:** The Barmer-Sanchore Basin has been subdivided into 2 depressions:
    - Barmer Depression in the north and
    - Sanchor Depression in the south

- **Oil Fields:** 38 oil fields discovered in Barmer-Sanchore Basin namely Mangla, Bhagyam, Shakti Ashwariya Guda, Saraswati, Raageshwari, Kaameshwari, Vijaya, Vandana, GRF, NI, Bhagyam South-1, NH-2, N-R-4, NE, GS-V-1 & Tukaram.

Bikaner – Nagaur Basin

- Age of Bikaner-Nagaur basin: Paleozoic
- Districts: Bikaner ,Nagaur, Ganganagar/ Hanumangarh and Part of Churu
- Type of Basin: Intracratonic Basins
- The major tectonic element in Bikaner- Nagaur Sub-basin is an almost east-west trending basement ridge, 'the Bikampur Arch'

Vindhyan Basin

- Districts: Kota, Jhalawar, Baran, Bundi and Part of Bhilwara etc.
- Vindhyan basin covers three main regions: Son valley, Bundelkhand and Rajasthan.

Mines & Minerals of Rajasthan

Rajasthan Mines & Minerals: The Basics

- Rajasthan has deposits of 79 different types of major and minor minerals. Out of these, 57 minerals are being currently mined.
- Rajasthan is leading producer of:
    - Zinc
    - Feldspar
    - Wollastonite
    - Silver
    - Rock Phospate
    - Gypsum
    - Red Ochre
- RSMML:
    - Public Sector Mining carried on by - RSMML - Rajasthan State Mines & Minerals Corporation.
    - Engaged in mining & marketing of Industrial Minerals.
- 70% of Boone-China tableware is produced in Rajasthan
- Rajasthan is leading producer of both **Cement grade & Steel Grade Limestone** production in India

Now we shall start with discussion of each Mineral in detail. First, we shall discuss important minerals and then other minerals alphabetically.

URANIUM MINERAL in Rajasthan:

- In Rajasthan Uranium mines have been discovered at:
- Sikar - Rohil, Khandela, Ghateswar
- Kho-Dariba in Alwar

- Umra
- Ajmer, Dungarpur, Banswara

LEAD - ZINC - SILVER MINERALS in Rajasthan

- Rajasthan Rank: 1
- Largest Deposit in India: Rampura- Agucha (Bhilwara district)
- Deposits in Rajasthan:
    - Rampura-Agucha (Bhilwara district)
    - Rajpura-Dariba and **Sindesar Khurd**(High Silver Content) (Rajsamand district)
    - Zawar (Udaipur),
    - Sawar and Kayar-Ghugra (Ajmer district)
    - Basantgarh and Deri (Sirohi district)
- Production: Hindustan Zinc Limited (Smelters in Chanderia, Dariba & Debari)
- Uses:
    - Lead - Lead-acid batteries, coloring agent in stained glasses, Fishing Sinkers, Roofing
    - Lead - In electronics its use as soldering agent Shielding from X-ray in laboratories
    - Remember Lead-pencil Doesnot have lead. (UPSC Prelims)

COPPER MINERAL in Rajasthan:

- **History Trivia:**
    - On the basis of excavations at **Ganeshwar, located east of Khetri** in north Rajasthan, ascribe the earliest Indian copper mining to Indus valley civilization (3000-1500 BC)
    - Copper metallurgy has been mentioned in Arthashastra & Ain-i-Akbari
    - Copper Ore: Cuprite, Chalcopyrite
- Second: Rank of Rajasthan in Copper Production in India.
- Most important Copper reserves in India:
    - Malanjkhand, Balaghat, Madhya Pradesh (makes MP, 1st in Production)

- **Deposits of Copper in Rajasthan:**
    - Jhunjhunu - Madan Kudan-Kolihan- Banawas-Chandmari-Dholamala, Akwali and Muradpur-Pacheri
    - Bhilwara - Devpura-Banera
    - Sirohi - Basantgarh
    - Alwar - Kho-Dariba
    - Udaipur - Anjani, Bedawal, Chari-Manpura
- Production by - Hindustan Copper Limited (HCL) under Ministry of mines
- **Uses of Copper:**
    - Ductility, high conductivity of heat and electricity - electrical wires
    - Copper+Tin = Bronze (Statute, Indus Valley, Mohenjaodaro dancing girl)
    - Copper+zinc = Brass (More hard)
    - Stainless Steel: Iron + Nickel + Copper + Chromite +….
    - Morel Metal: Copper + Nickel
    - Duralumin: Copper + Aluminium
    - 3rd most abundant mineral in human body (serves as a cofactor for enzymes involved in hemoglobin and collagen formation and is involved in incorporating iron into the structure of hemoglobin. It strengthens blood vessels, bones and nerves.)

MINERAL TUNGSTEN in Rajasthan:

- Ore: wolframite & scheelite.
- One: Rank of Rajasthan in Tungsten Production in India
- **Deposits of Tungsten in Rajasthan**:
    - **Degana (Nagaur) -** Best in Country
    - Sirohi - Balda , Uduwaria
    - Ajmer- Pali - Alniawas-Sewariya, Pipaliya, Motyia
- **Uses of Tungsten:**

- Bulb Filament
- High-speed alloy
- Hard-Steel alloys- machine tools, high speed cutting tools, special steel for defense purposes.

MINERAL MANGANESE in Rajasthan:

- Ore: Pyrolusite
- Karnataka: Largest deposit in India
- Rajasthan very less
- Largest Production: Odisha - Bonai-Keonjhar Belt
- **Deposits of Manganese in Rajasthan**
  - Banswara
- **Uses of Manganese:**
  - Raw material for manufacturing steel alloys
  - Manufacturing of bleaching powder, insecticides, paints, and batteries.

MINERAL IRON-ORE in Rajasthan:

- Ore: Found in Dharwad and Cuddapah rock systems of the peninsular India.
- Ore Quality-wise ranking: Haematite,> Magnetite, >Limonite & > Siderite
- Largest Deposit in India: Barabil-Koira Valley in Odisha
- **Deposits of Iron-Ore in Rajasthan**
  - Jaipur - Morija-banol - Neemla-Raisalo
  - Bhilwara - Pur banera belt
  - Udaipur - Natha ki Pal, Thur Hunder
  - Sikar - Dabla
  - Dausa –Lalsot

MINERAL LIMESTONE in Rajasthan:

- Deposits in Rajasthan:
- Limestone occurs in almost all the districts of the State, but important deposits are located in:
    - Ajmer: Sheopura, lulwa & Kesarpura
    - Bundi: lakheri and Stur
    - Chittaurgarh: Nimbhahera, Parsoli
    - Jodhpur: Bilara & Basa
    - Nagaur: Mundwa & Gotan
    - Pali: Deoli Hulan
    - Sirohi:Abu road
    - Jaisalmer: Khuiala and Bandha
- Uses:
    - One of the most important industrial mineral
    - Required in the manufacture of lime, cement.
    - Chemicals soda-ash, caustic-soda, bleaching powder, calcium carbide
    - Fertilizer - Ammonium Nitrate
    - As flux in iron and steel, ferro-alloy and other metallurgical industries.

MINERAL-GOLD in Rajasthan:

Deposits in Rajasthan: Banswara - Bhukhia-Jagpura-Delwarabelt

BERYLLIUM in Rajasthan:

- Ore: Beryl (Silicate of Beryllium and aluminum)
- Rajasthan : Principal state of Production
- Deposits of Beryllium in Rajasthan
- Ajmer: Lohagarh, Gujarwara

- Udaipur: Acheiwas
- Bhilwara: Titoli, Deora Guda
- Nagaur
- Use:
- As moderator in Nuclear Power Reactors.
- Green transparent variety of beryl is **emerald** which is a precious stone

Note: In Jan 2016, illegal mining of Beryllium in Ajmer & Nagaur came in NEWS.

BISMUTH in Rajasthan:

- Deposits of Bismuth in Rajasthan:
    - Narda, Neem-ka-Thana tahsil, Sikar district
- Use:
    - Medical Preparations
    - Radar Equipments
    - To make alloys required in production Atomic Bomb

MICA in Rajasthan:

- Deposits in Rajasthan:
    - Beawer-Ajmer belt: Dhand
    - Bhilwara belt: Bagor-Lesva
    - Dungarpur-Banswara belt: Chota-Padri
    - Tonk belt: Dholi & Bhojapura
    - Kaunthal belt:falls in Udaipur district. Chief mines Bhagwanpura and Ran
- Use: Mica is used extensively in electrical and electronic industry due to its excellent dielectric strength and insulating properties

Now we shall discuss the other minerals found in Rajasthan alphabetically.

Asbestos in Rajasthan:

- Rajasthan accounts for about 96% of the country's total production of asbestos, whereas Andhra Pradesh and Karnataka, the other producing States contribute the remaining 4%.
- Deposits in Rajasthan:
- Mainly located in Southern parts of Rajasthan
    - Ajmer: Kanwali in Kota Reserve forest area, Arjanpura, Nai-Khurd
    - Alwar: palpur, Dhalawar
    - Bhilwara: Barana
    - Dungarpur: Dewal, Mundwara
    - Sirohi: Bori-ki-Bhuj
    - Udaipur: Kagdar-ki-Pal,Rakhabdeo,Jogi-ka-Gudha,Antalia,Bhauva
    - Pali: Kanotia-Ramgarh

Baryte in Rajasthan:

- World Baryte Reserves -India ranks 3rd.
- World Baryte Production: India ranks 2nd.
- World's largest single Baryte deposit: Mangampet in Andhara Pradesh
- Deposits in Rajasthan
    - Alwar: Rajgarh belt,
    - Bharatpur: Hathori, Karwan and Ghatri blocks.
    - Bhilwara: Barliyas deposit,
    - Bundi: Umar deposit
    - Pali: Punagarh hill
    - Sikar: Kharagbingur
    - Jalore: Karara
    - Udaipur: Delwara-Nathdwara belt

- Uses
- Vital to petroleum industry which consumes more than 80% of the world's baryte production.

Bauxite in Rajasthan:

- Deposits in Rajasthan
- Very insignificant in Rajasthan
    - Kota: Baselio, Majola, Sherol-khera
- Uses:
    - Extraction for Aluminum
    - Refractory & Chemical Industries

China Clay in Rajasthan:

- Rajasthan contributes 50% of share of Production of china clay in India.
- Deposits in Rajasthan
    - Bikaner: Mudh, Chandi, Kotri-Marh-Gura area
    - Barmer: Bolia, Gunga
    - Nagaur: Khajwana
    - Sawai Madhopur: Raesena , Basu
    - Sikar: Buchara
    - Chittor: Eral & Sawa
- Uses:
    - China clay is used in Industries like ceramic, refractory, textile, paper, rubber and pesticides.

Dolomite in Rajasthan:

- Deposits in Rajasthan
    - Ajmer: Kajla Kabra
    - Alwar: Jhiri, Dhani & Nizra

  - Bhilwara: Kosithan
  - Jaipur
  - Jaisalmer,
  - Jhunjhunun,
  - Nagaur- Jodhpur- Pali
  - Sawai Madhopur
  - Udaipur:
- Used as flux material in the iron and steel industry

Feldspar in Rajasthan:

- Deposits in Rajasthan
  - Ajmer: Pink variety from Tatarpur & Khairthal
  - Alwar,
  - Jaipur: Dudwa near Neem-ka-Thana
  - Pali: Kalalia, Khinwal
  - Sikar: Dudawas and Haridas-ka-Bas
- Uses:
  - Chiefly used in the ceramic and glass industries and in insulator making.

Fluorite in Rajasthan:

- Deposit of Flourite Rajasthan 2nd and Gujarat 1st
- Deposits in Rajasthan
  - Dungarpur: Mando-ki-Pal-Kahila belt
  - Jalore: Karara (Karda):
  - Jhunjhunu: Chokri Chapoli:
  - Sikar: Salwarai
  - Sirohi: Balda

- Uses:
    - Finest-grade of fluorite is used for enameling iron, manufacture of opaque and opalescent glasses and for the production of hydrofluoric acid.
    - Transparent fluorite is used in the manufacture of lenses.

Fuller's Earth in Rajasthan:

- Fuller's earth,is also known as Multani Mitti, in general hindi.
- Deposits in Rajasthan
    - Barmer: Kapurdi & Alamsaria
    - Bikaner: Palana, Kesardasar and Marh
    - Jaisalmer: Manda & Mandai

Graphite in Rajasthan:

- Graphite is also called as Black lead
- Orissa is leading producer with 77% & Rajasthan share is less than 1%.
- Deposits in Rajasthan
    - Ajmer, Alwar, Banswara and Jodhpur
- Uses
    - Crucible Industry - electric furnaces

GYPSUM in Rajasthan:

- Rajasthan: 90% of total production in India
- Deposits of Gypsum in Rajasthan:
    - Jaisalmer: Sri Mohan Garrh
    - Barmer: Utarlai & Kavas, Chittar-Ka-Par and Thob
    - Ganganagar: Siramsar, Mahala, Pallu,
    - Nagaur: Bhadwasi, Dhakoria, Kharat, Mandava,
    - Bikaner: **Jamsar** (largest deposit in State)

    - Churu
    - Pali
- Used in making:
    - Portland Cement
    - Plaster of Paris
    - Paints
    - Fertilizer

Ilmenite in Rajasthan:

- India main deposits of ilmenite located along coast of Kerala.
- Deposits in Rajasthan
    - Ajmer, Nagaur, Pali, Jodhpur and Sikar
    - Very less quantity
- Uses:
    - It is used for extraction of **Titanium Metal**
    - Manufacture of Pigments

Kyanite in Rajasthan:

- Deposits in Rajasthan
    - Ajmer: Chainpura and Madaoria
    - Bhilwara: Bari Harnoi & Pur
    - Dungarpur: Chotti Padri & Sagwada
    - Jaipur: Near Tunga
    - Pali
    - Udaipur: Kishangarh and Sansera
- Uses
    - In electronics, electrical insulators and abrasives.

Magnesite in Rajasthan:

- Deposits in Rajasthan
    - Sarupa-Chhaja in Ajmer district
    - Bhimana in Pali district
    - Lewa-ka-Gurha in Udaipur District
- Uses:
- Chief Source of Magnesium
    - Can withstand high temprature and used in manufacture of refractory bricks used in steel-making furnaces, in the manufacture of some special types of cement (sorel cement) and in glass and rayon industry.

Nickel in Rajasthan:

- Nickel is recovered as a by-product.
- Deposits in Rajasthan
    - Found along with the copper ores in the Khetri Copper Belt in Jhunjhunu
    - The serpentinite rocks at Rakhabdev-Kherwara area south of udaipur.
- Uses
    - Production of Stainless-steel
    - Catalyst in making alloys and coins and in the storage of batteries.
    - Nickel-compounds are widely used in electroplating, chemical and ceramic industry.

Ochre in Rajasthan:

- Deposit in Rajasthan
    - Bikaner, Chittaurgarh, Jaisalmer, Jhunjhunun, Jodhpur, Nagaur and Udaipur
- Used:
    - Directly as paint material or to give colour, body and opacity to paint, cement, linoleum, rubber, glasses,
      enamels, plastics etc.

Potash in Rajasthan:

- Deposits in Rajasthan:
    - Bikaner, Hanseran, Arjunsar, Gharsisar, Jaitpur, Satipura, Bharusari and Lakhasar.
- Uses:
    - One of the key elements in Fertilizers

Pyrite-Pyrrhotite - Sulphur in Rajasthan:

- Deposits in Rajasthan
    - Sikar - Saladipura
- Uses:
    - Manufacture of sulphuric acid which is used mainly in the manufacture of superphosphate fertilizer and also in several other chemical industries.

Rock Phosphate in Rajasthan:

- Rock phosphate, popularly known as phosphorite
- Deposits in Rajasthan
    - Udaipur: Jhamar Kotra (largest in the country),Maton, Kanpur, Karbaria-ka-Gurha and Dakan Kotra.
    - Banswara: Sallopat and Ram-ka-Munna
    - Chittorgarh: Jaoda deposit:
    - Jaisalmer: Birmania, fatehgarh, Rupsi & Nibh Dungar
    - Jaipur: Achraul
- Uses:
    - Essential ingredient in the manufacture of superphosphate, a fertilizer,

Silica Sand in Rajasthan:

- Deposit in Rajasthan
    - Jaipur-Dausa: Banskhch hill near Jhir

- Bundi-Kota-Sawai Mahopur Districts: Manjora, Mohanpur, Patori and Guneshri.
- Tonk: Bher & Siwad
- Jaisalmer: Lathi
- Bikaner: Marh
- Jodhpur: Bhakarion-ki-Dhani

- Uses
  - Making glass
  - Acidic remi-mass

Steatite in Rajasthan:

- Steatite, talc and soapstone are the three terms used in trade for a hydrous silicate of magnesium.
- A purer variety of compact and massive talc is steatite.
- Deposits in Rajasthan
  - Jaipur-Dausa Districts: Dogetha-Jharna & Geejgarh
  - Bhilwara: Gheruia & Chainpura
  - Sawai madhopur: Dhaota & Dwain
  - Udaipur-Dungarpur: Rishabhadev

Tin in Rajasthan:

- Ore: Cassiterite
- Deposits in Rajasthan
- Bhilwara District: Paroli & Johna Sili
- Uses:
  - Tin oxide is used as polishing material for marble and granite
  - Alloy
  - Chemical Industry

Vermiculite in Rajasthan:

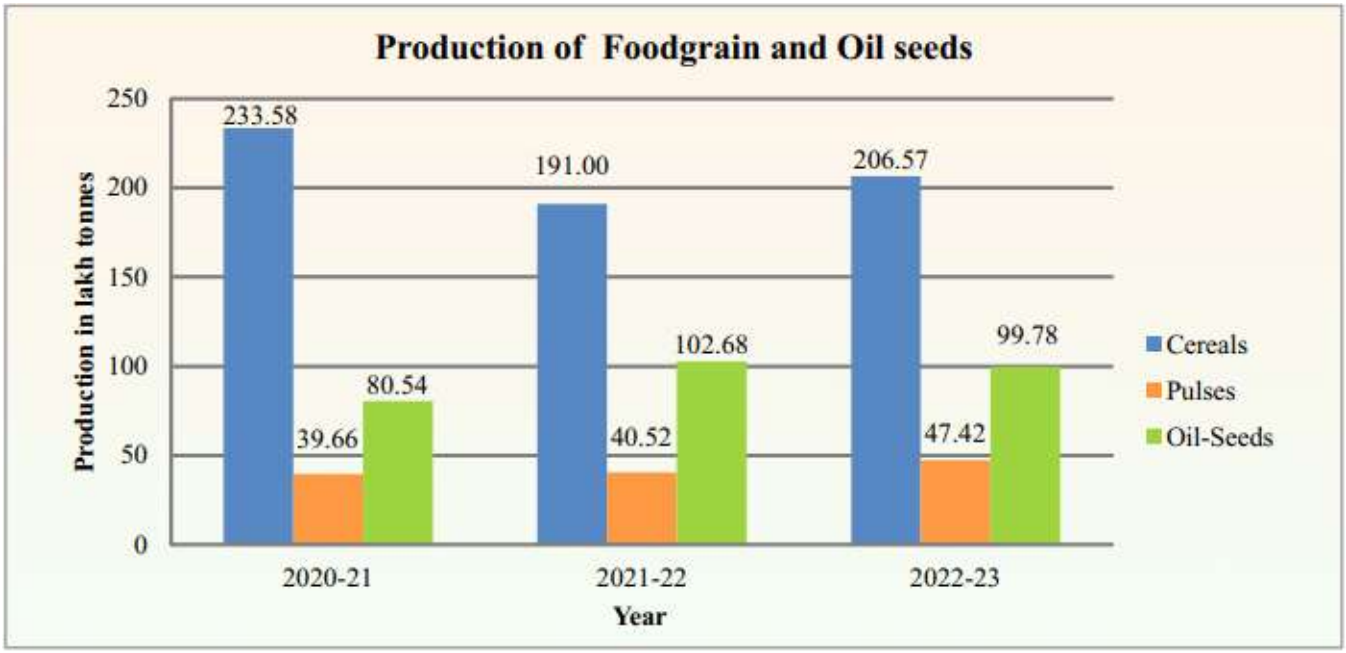
- Deposits in Rajasthan: Ajmer - Gudas
- Uses:
    - When Vermicultie is heated, its volume increases more than 12 times
    - The mineral is used where some extreme lightness and low-heat conductivity are required.
    - Insulators

Wollastonite in Rajasthan:

- Rajasthan is the only Wollastonite producing state in India
- Deposits in Rajasthan
- Pali-Sirohi: Khera-Uparla, Belka Pahar near Khila in Sirohi district.
- Ajmer: GolaAlipura
- Uses: It is used in the ceramic, enamel, glass, matches, paints, paper, plastics and plywood industries; in the preparation of artware, ceiling tiles, floor tiles, insulators, as an extender of short-fibred asbestos or as a replacement for non-fibrous materials.

Agriculture Snapshot of Rajasthan

- **75 per cent** population of the State resides in the rural areas and about **62 per cent** depend on agriculture and allied activities for their livelihood.
- Snapshot of production of foodgrain and oil-seeds in Rajasthan:
    - Cereals: 206.57 Lakh tonnes
    - Pulses: 47.42 Lakh tonnes
    - Oil-Seeds 99.78 lakh tonnes



Monsoon

Agriculture in Rajasthan is primarily rain-fed i.e. dependent on monsoon which is very erratic in nature; also period of monsoon generally remains short. Due to unstable weather conditions and precarious water regime, farmers have to depend on both rainfall and ground water. The rainfall pattern indicates that during the current monsoon season, the onset of monsoon was arrived earlier by 5 days. The normal date of arrival of monsoon in the state was 15th June, but it arrived on 10th June. It covered the whole state till first week of July, 2022.

The actual rainfall in the period from 1st June to 30th September, 2022 in the state was 594.20 mm, as compared to normal rainfall of 430.80 mm, which is 37.93 per cent more than the normal rainfall. In

Rajasthan, during the entire monsoon season 2022, there have been abnormal, excess or normal rains in most of the districts.

Agricultural Production

- As per preliminary forecast for the year 2022-23, the total food grain production in the State is expected to be 253.99 lakh tonnes which is an increase of 9.71 per cent as compared to production of 231.52 lakh tonnes for the previous year.
- The kharif **foodgrain** production in the year 2022-23 is expected to be at the level of 97.98 lakh tonnes and The rabi foodgrain production is expected to be 156.01 lakh tonnes
- Production of **kharif cereals** during the year 2022-23 is expected to be 77.84 lakh tonnes and Production of **rabi cereals** is expected to be 128.73 lakh tonnes
- Production of **kharif pulses** is estimated to be 20.14 lakh tonnes during the year 2022-23 and production of **rabi pulses** is expected to be 27.28 lakh tonnes
- Oilseeds includes Groundnut, Sesamum, Soyabean and Castor seed in kharif season and Rape & Mustard, Taramira and Linseed in rabi season. The production of oilseeds duing the year 2022-23 is estimated at 99.78 lakh tonnes
- Production of **kharif oilseeds** is estimated to be 33.64 lakh tonnes during the year 2022-23 and production of **rabi oilseeds** is likely to be 66.14 lakh tonnes in the year 2022-23
- Production of Sugarcane is likely to be 2.18 lakh tonnes during the year 2022-23
- The production of Cotton is likely to be 25.53 lakh bales during the year 2022-