State of India's Rivers

For

India Rivers Week, 2016

RAJASTHAN

Author
Mr. Manu Moudgil

Contents

Maps

Tables

Figures

1. Introduction

1.1 State profile

Rajasthan is the largest state of India by area and forms North West end of the country sharing its border with Pakistan.

a. Area: The total area of Rajasthan state is 342,239 sq km
b. Administrative units: The state has been divided into 33 districts.
c. Population: The total human population of the state is 68.54 million. (Census 2011)
d. Total forest cover: 32,627 sq km
e. Climate: The Tropic of Cancer passes through its southern tip in the Banswara district.

In the west, Rajasthan is relatively dry and infertile; this area includes some of the Thar Desert, also known as the Great Indian Desert. In the south-eastern part of the state, the land is wetter, hilly, and more fertile. The climate varies throughout Rajasthan. On average winter temperatures range from 8° to 28° C (46° to 82° F) and summer temperatures range from 25° to 46° C (77° to 115° F). Average rainfall also varies; the western deserts accumulate about 100 mm (about 4 in) annually, while the southeastern part of the state receives 650 mm (26 in) annually, most of which falls from July through September during the monsoon season. (Source: www.rajasthan.gov.in)

Map No 1: District Division of Rajasthan

1.2 Physiographic features

State of Rajasthan is located in the north-western part of the subcontinent. Pakistan lies on its west and northwest, while it is bounded by the states of Punjab, Haryana, and Uttar Pradesh on the north and northeast. Uttar Pradesh and Madhya Pradesh form the east and southeast boundary and Gujarat lies on the southwest side.

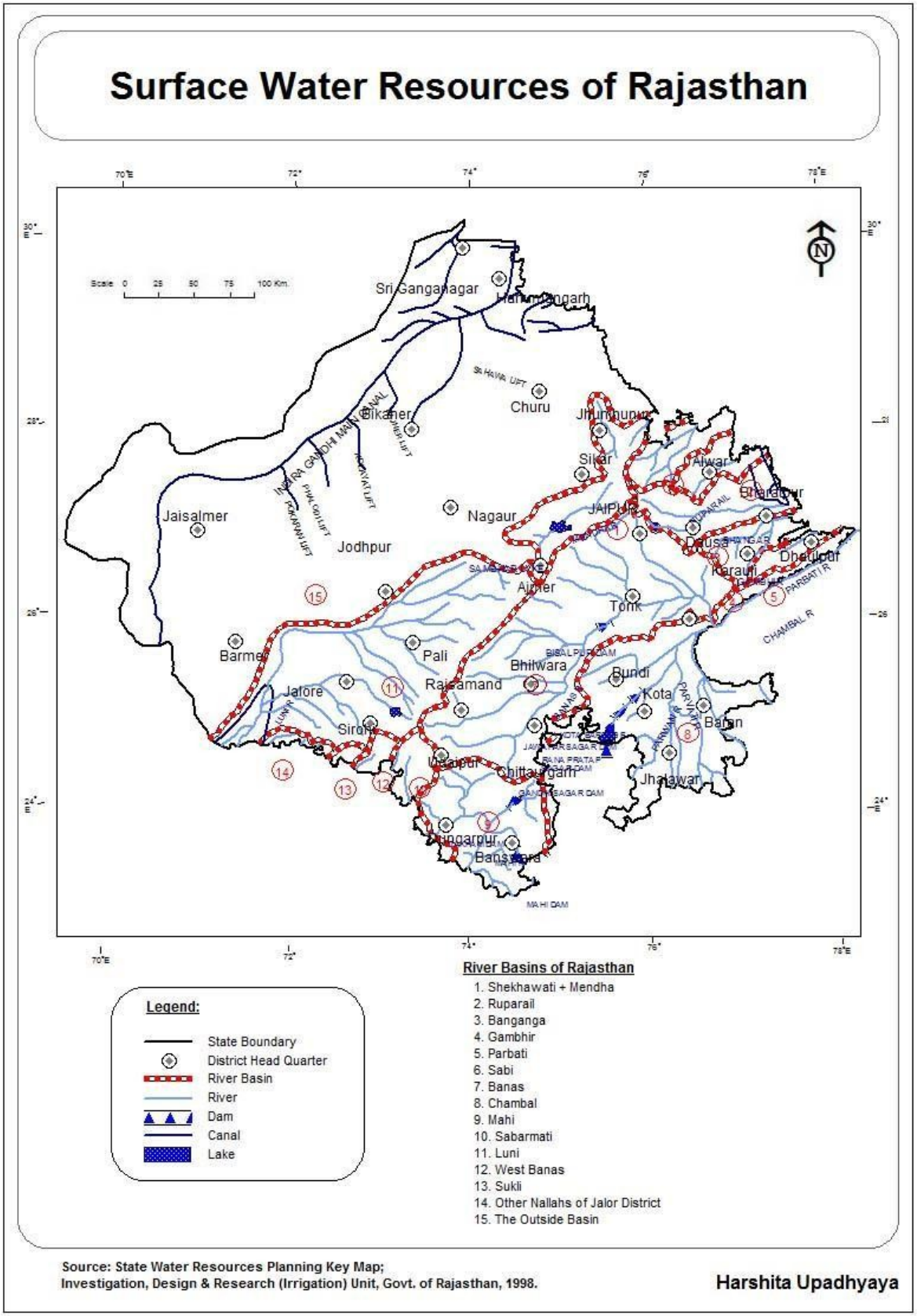
The Aravalli range of hills and mountains, from where most rivers originate, divides the state into two major parts, southeast and northwest. The Range does not intercept the moisture-giving southwest monsoon winds off the Arabian Sea, as it lies in a direction parallel to that of the coming monsoon winds, leaving the northwestern region in a rain shadow.

This makes western Rajasthan relatively dry and infertile; this area includes some of the Thar Desert, also known as the Great Indian Desert. In the south-western part of the state, the land is wetter, hilly, and more fertile.

Around two third of the northwest is covered by sand dunes while the floodplains of Mahi, Banas and Chambal river systems form the southeastern part.

Around 67 per cent of the state's area is affected due to desertification / and land degradation where the wind erosion (44.2%) is the maximum contributor followed by water (11.2%), vegetal degradation (6.25%) and salinisation (1.07%) (ISRO, 2007).
The Northwestern thorn scrub forests lie in a band around the Thar Desert, between the desert and the Aravallis. These expand from Western India - Pakistan boundary and steadily combine with the parched deciduous forests of Aravalli hills as well as the South East plateau. These forests are found in the districts of Pali, Jodhpur, Barmer, Jalore, Churu, Bikaner and Nagaur.

The Aravalli Range and the lands to the east and southeast of the range are home to the Kathiarbar-Gir dry deciduous forests ecoregion, with tropical dry broadleaf forests that include teak, Acacia, and other trees. Alwar, Bharatpur and Dholpur districts, are enclosed with this kind of forests. Intermittent expansion of definite species of parched deciduous forests is found beside the arid river beds of Nagaur, Jalore, Bikaner and Ganaganagar districts. The Central Indian sub - tropical hill forests are found in Sirohi, Rajasthan, frequently on the hills near Mount Abu. These forests have some evergreen and partially evergreen species of trees. Mixed Miscellaneous forests are also found in the South-Eastern and Eastern region of Rajasthan including Kota, Chittorgarh, Sirohi, Udaipur, Dungarpur, Banswara, Jhalawar and Baran districts.



Map No 2: Surface Water Resources Map of Rajasthan

2. Hydrology

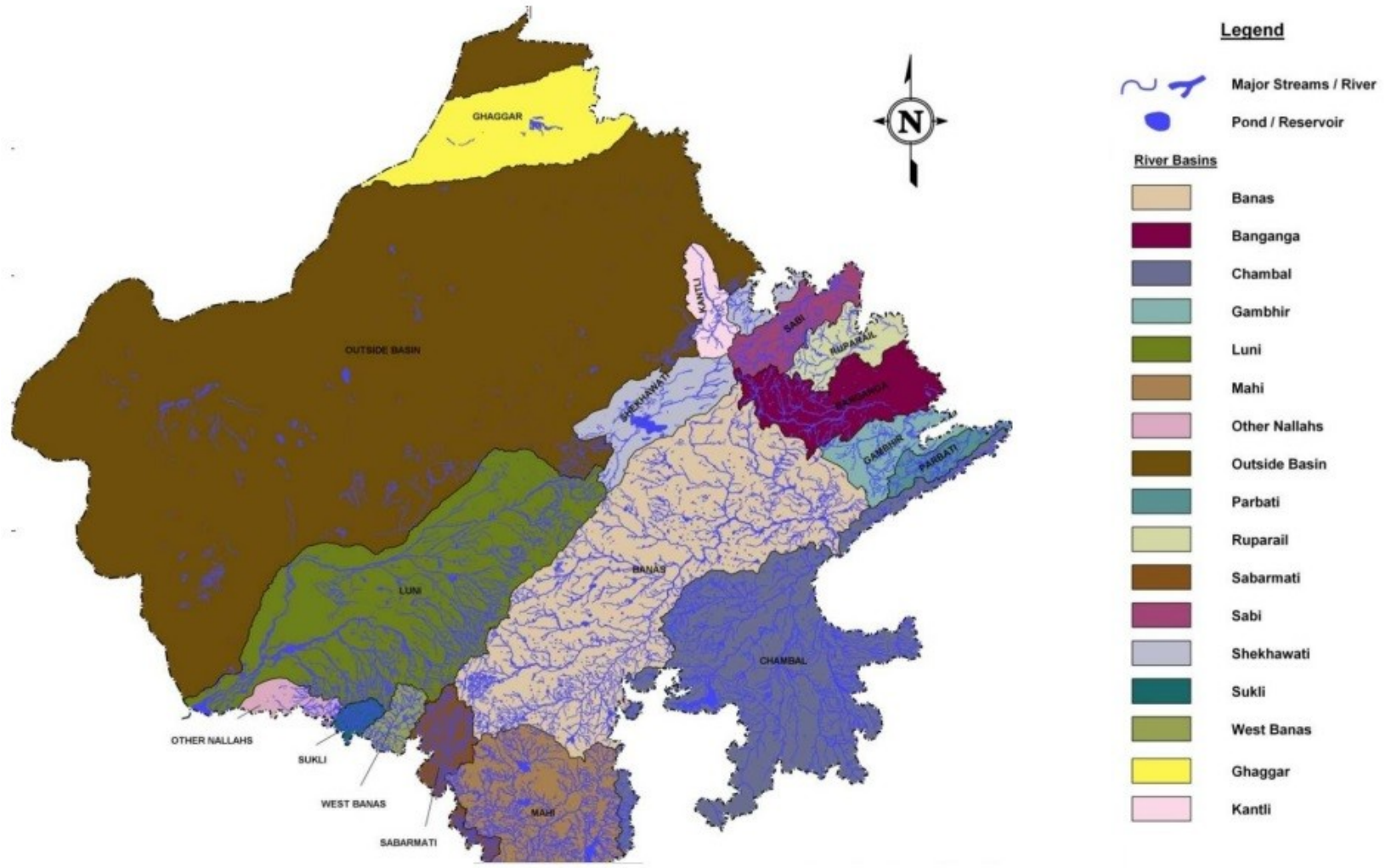
The Great Indian Water Divide in Aravalli distributes the river water of this region into the Bay of Bengal and the Arabian Sea. The rivers flowing in the west and south of Aravalli ranges, including Mahi, Som, Jokham and Sabarmati drain the water into the Arabian Sea. On the other hand, rivers flowing to the east, including Chambal and its tributaries, join the Bay of Bengal. There are also inland rivers like Luni and Ghaggar which drain out in the Rann of Kutch and Thar desert respectively.

Rivers in Rajasthan are mostly seasonal, but this fact explains little because a river is not just the surface flow, evident to a naked eye. All the rivers and their floodplains in this desert state are vast grazing grounds supporting millions of livestock. These unseen rivers also recharge the groundwater making well irrigation possible.

Modern-day development activities, however, are putting an enormous pressure on them. If deforestation has reduced the water flow, rampant sand mining has affected the water retention and seepage into subsurface channels. Aravallis also has large number of marble mines and processing units. While digging operations extensively damage the environment, discharge of a large amount of slurry by processing units also blocks water channels. Industrial and domestic wastewater has further affected the quality and biodiversity of rivers. Reduced water flow is in turn making it easier for the encroachers to infringe upon these riverbeds. This has also put most dams in the state in critical state as they are not getting water as per their designed dependabilities. This disrupts the water resources planning of the state and execution of contingency plan every year[1].

Only two river basins (Chambal and Mahi) are perennial. In the recent past, many perennial rivers in these two basins became seasonal due to over-abstraction of groundwater from the catchment area of the rivers rendering reduced water table leading to reduced or nil base flow,Rajasthan connects strongly with water through its heritage of lakes, ponds, stepwells, dugwells and taankas (underground tanks). Rivers thus have a limited presence in cultural and mythological landscape and are mostly seen as means of irrigation along their stretches. The region around Aravalis comprising south east Rajasthan has a stronger connection with rivers than the drier north-western and central plains. In fact, many of the forts had rivers as their natural defence against enemy attacks.

[1] Gupta NK et al; Declining trend of water inflow in the dams of Rajasthan state; Water Resources Department, Rajasthan: file:///C:/Users/0an4/Downloads/149-224-1-PB.pdf



Map No 3: River Basin Division of Rajasthan

As per the latest estimates, the total internal surface water resources of Rajasthan are estimated at 25.93 BCM1 (21.71 BCM at 50% dependability and 14.12 BCM at 75% dependability) of which about 16.05 BCM are considered "economically exploitable at 50% dependability. The state is allocated in addition, some 17.88 BCM in trans-boundary or inter-state river waters. The renewable groundwater resource (fresh, dynamic component) is placed at 10.61 BCM per year (10.79 BCM as of March 2009). The static reserve of fresh and saline groundwater reserves have been reported to be 32.9 BCM and 29.7 BCM respectively.

There are six major river basins in the State. 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 and Sabarmati 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. (Source: Water Resources Department, Rajasthan)

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

1. Luni Basin –Luni, Sukri, Rediya, Mithri, Bandi, Khari, Jawai, Guhiya and Sagi, and Jojari.
2. Banas Basin – Banas, Berach, Dain, Gudia, Kalisil, Khari, Kothari, Mashi, Morel, Sodra. Indravati, Sabari, Pranhita, Lower Godavari, and Wainganga sub basin;
3. Chambal Basin – Banas, Chakan, Chambal Downstream, Chambal Upstream, Kalisindh, Kunu, Mej and Parwati.
4. Mahi Basin- Anas, Bhadar, Jakham, Moran, Som and Mahi.
5. Sabarmati Basin- Sabarmati, Sei, Vatrak and Wakal

(Source: Study On Planning Of Water Resources Of Rajasthan- http://waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter5.pdf)

3. River Inter-Linking

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 and Rajasthan – Sabarmati Link Project.[2]

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[3].

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.

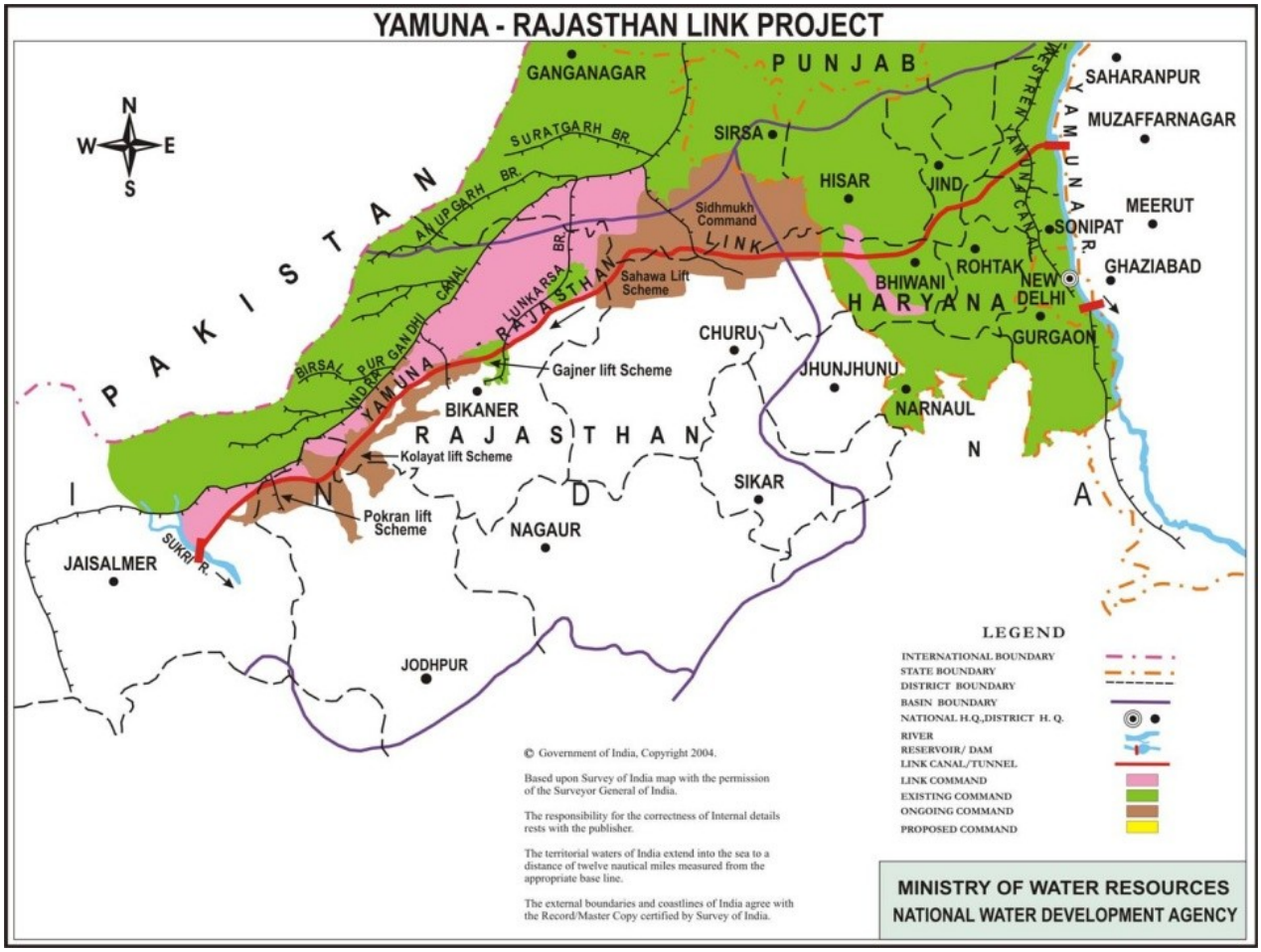
Three storage dams, namely: Kishau, Renuka and Lakhwar-Vyasi have been identified for which separate agreement will be executed in respect of each identified storage, within the framework of the overall allocation made in the agreement.

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.

[2] http://deshgujarat.com/2015/03/09/rajasthan-seeks-sabarmati-river-water-from-centre/

[3] http://timesofindia.indiatimes.com/city/jaipur/Linking-of-rivers-takes-shape-in-Rajasthan-Brahmani-to-be-connected-to-Banas/articleshow/43036291.cms



Map No 4: Yamuna - Rajasthan Link Project

The Indira Gandhi Nahar Project (IGNP)

The 649-km long main canal carrying waters from Satluj and Beas rivers of Punjab serves a large part of north west Rajasthan. The genesis of this canal can be traced back to the Indus Water Treaty between India and Pakistan which awarded the waters of Ravi, Beas, and Sutlej to India. From India's (annual) share of water, Rajasthan got 8.60 million acre–feet (MAF) of which the state government decided to utilise 7.59 MAF through a canal. Within Rajasthan, the canal is 445 km long covering seven districts. While IGNP Stage I was restricted to Sri Ganganagar, Churu, Bikaner and Hanumangarh, Stage II spans Jaisalmer and parts of Barmer. Crops of mustard, cotton, and wheat are now grown in this semi-arid and arid regions instead of traditional Jowar and Bajra which required less water. The canal is believed to have halted the advance of the Thar desert to some extent and brought prosperity which has also led to rise in population and number of habitations and agriculture markets. The first stage was proposed to serve 553 thousand hectare, including 46,000 hectare served through lift pumping.

The second stage has a proposed command area of 1,410 thousand hectare. Since Punjab is not releasing 0.60 Maf water of Rajasthan's share (8.6 Maf), and since the demand for drinking

water, etc. has increased, the state government took a decision in 2005 to complete the canal construction work in 16.17 lakh ha cultivable command area (excluding 0.50 lakh ha area opened for irrigation in Shahgarh area of Jaisalmer, which is being acquired by the Army). Out of this, 15.93 lakh ha (5.46 lakh ha in Stage-I + 10.47 lakh ha in Stage-II) has been opened for irrigation up to March 2011[4], But the water does not reach all the areas due to difficult terrain and faulty design of feeder canals[5].

The excessive irrigation in northern Rajasthan has also caused environmental degradation and creation of new wastelands with problems of water-logging, seepage from canals and poor drainage. These factors produced a rise in the water table and salinity of the land. Frequent malaria epidemics have been recorded in the Thar desert area, earlier known to be an unsuitable habitat for mosquitoes.[6]

The inter-state transfer of water from Punjab to Rajasthan also gets disrupted time and again due to political compulsions[7].

In 2004, the Punjab Assembly passed The Punjab Termination of Agreements Act, 2004, terminating all its water-sharing agreements with other states, a fall out of its rift with Haryana over the Satluj-Yamuna link canal. Such one-sided decision-making leaves the downstream states like Rajasthan at the mercy of Punjab.

In fact, Punjab has been questioning the share of Rajasthan in Ravi-Beas water as the latter is not a riparian state. Rajasthan's contention is that it's the basin rights, not riparian rights, which have been held supreme in India, especially in the case of Rajasthan, Punjab and Haryana. Rajasthan, thus, being a part of Indus basin rivers has a share on their waters. Similar argument was put forward by India when Pakistan was not accepting areas of western Rajasthan as part of Indus basin during negotiations on water sharing.[8] For India, Rajasthan canal was the kingpin of its case, otherwise it would have ended up with lesser share of Indus water. It was finally accepted that western Rajasthan will be considered part of Indus basin and hence a beneficiary. However, the domestic, inter-state sparring has a potential to impact this understanding.

While Punjab's action to dissolve all water sharing agreements is currently standing scrutiny in Supreme Court, the state's political leadership is ready to oppose a harsh court order.

[4] http://www.waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter12.pdf
[5] http://www.goimonitor.com/story/scam-canal
[6] http://www.downtoearth.org.in/indepth/mosquitoes-storm-the-desert-32694
[7] http://indianexpress.com/article/india/india-news-india/punjab-cuts-water-supply-to-rajasthan-to-fight-shortage-2870256/
[8] SPRI 2005; Water Conservation and Drought Proofing: Issues and Perspectives in Rajasthan

4. Groundwater

There are reported to be around 19 aquifers in the state, comprising local geo-hydrological units with domination of fractured sedimentary rock aquifers. Unlike Punjab and Haryana, there are no extensive alluvial aquifer systems in Rajasthan. The hard rocks occupy more than 50 percent of the area of the State in the west-central, south-eastern and southern parts. The storage of ground water in hard rocks is in the weathered mantle, joints and fractures which provide only limited storage space.

Therefore, only a part of the rainfall is available as ground water storage in many areas. The total actual renewable water resource is put at 11.56 BCM. The stage of groundwater development is 125 per cent which has resulted in over 68 per cent blocks being overexploited. Most of the districts are affected by varying degrees of salinity of groundwater except Sri Ganganagar and Hanumangarh. (Source: CGWB).

The hydrogeology and occurrence of groundwater greatly varies from one river basin to another and within the basins, owing to a great variation in topography, drainage, rainfall and geological setup. Most of the river basins are overexploited as far as groundwater resources are concerned. Mahi and Ghaggar river basins are considered safe while Sabarmati is at a critical stage.

Impact of seasonal rivers on groundwater

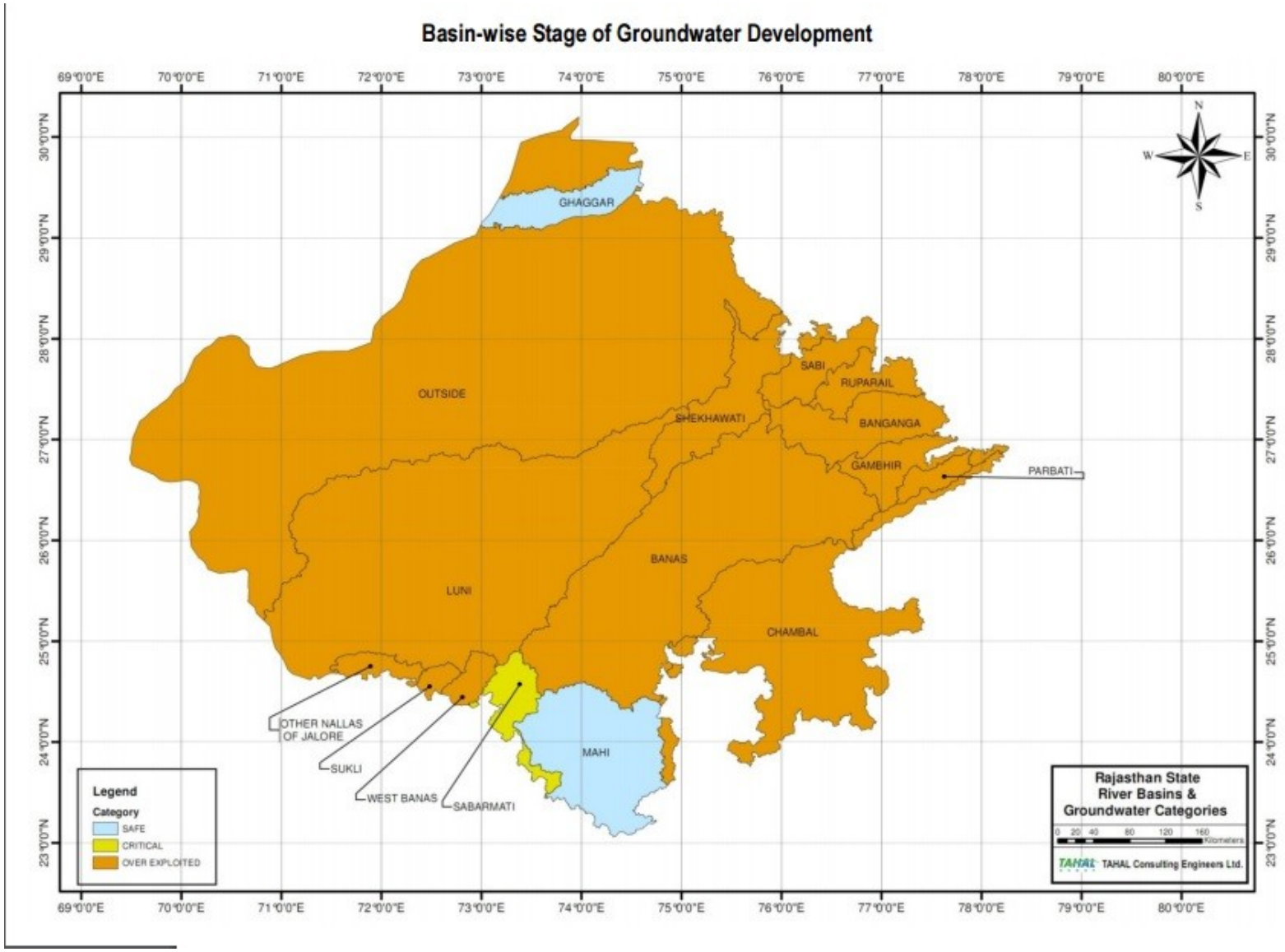
Seasonal river flows, when available, recharge the groundwater of the area. This also applies to canal irrigation as seepage helps raise the groundwater table.

The hydrogeology and occurrence of groundwater greatly varies from one river basin to another and within the basins, owing to a great variation in topography, drainage, rainfall and geological setup[9]. Dynamic groundwater resource assessed for the year 2010 was found to be as 10,613.84 Mm3/yr of fresh water and 3,621.99 Mm3/yr of saline water. Banas basin had the maximum fresh dynamic water resource at 2,282.73 Mm3/yr, followed by Chambal (1,999.54 Mm3/yr) and Luni basins (1,493.18 Mm3/yr).

In fact, Rajasthan has tapped the potential of seasonal rivers and rivulets to some extent through check dams and anicuts to recharge the groundwater. Baadi village in Jodhpur district is one such example where construction of an anicut on a seasonal river helped replenish the groundwater which is inturn used for irrigation purposes.[10]

[9] Study on planning of water resources of Rajasthan

[10] http://www.indiawaterportal.org/articles/rajasthan-village-united-water#



Map No 5: Basin Wise Stage of Ground Water Development

5. Pollution Sources:

Water has been a transporter of wastewater. If rivers don't flow, any pollution generated gets stagnated at the place of its generation whether it's wastewater or solid wastes dumped in the urban or industrial areas. This accumulated pollution load also contaminates groundwater. Such pollution is emerging as a serious problem in many areas of Rajasthan. The quality of water in the rivers is highly dependent on the precipitation which is confined to only three months of monsoon every year and varies greatly. Structures built on these rivers for irrigation purposes have further reduced the flows.

Rivers such as Banas, Luni and Bandi are found to be polluted at different stretches due to industrial, domestic and agricultural pollution. The large quantities of untreated domestic sewage in Kota cause degradation of otherwise good water quality in the downstream stretch of the Chambal river. Since the pollution is predominately organic in nature, it leads to eutrophication resulting in mass killing of fishes and other aquatic life[11].

It is estimated that 469 MLD of industrial is generated in the State with four districts of Bhilwara, Jaipur, Barmer and Pali together generating over 50 per cent of the industrial wastewater. In terms of chemical loads, Udaipur ranks the highest followed by Chittaurgarh, Bhilwara and Kota mainly due to metallurgical industries in Udaipur and Chittaurgarh and textile dyes chemicals at Bhilwara and flyash chemicals contributed by thermal power plants in Kota. The biological oxygen demand load is maximum from Alwar district followed by Jaipur mainly due to presence of distilleries in Alwar and Jaipur districts.

The stretches of many rivers (which are mostly dry or have meagre flows) downstream of major towns are highly polluted, as follows:

- Chambal downstream of Kota
- Kothari downstream of Bhilwara
- Bandi downstream of Pali
- Jojhari downstream of Jodhpur
- Ahar downstream of Udaipur
- Darbhavati downstream of Jaipur
- Gambhiri and Berach downstream of Chittaurgarh

[11] http://www.hindustantimes.com/jaipur/rajasthan-pollution-takes-toll-on-aquatic-creatures-in-chambal-river/story-XD5r8bGgRNawNDOlm96FaJ.html

The two major sources of water pollution in Rajasthan are sewage and industrial effluents. None of the towns of the State, except parts of Jaipur, have full sewage collection, treatment and disposal system. Under Phase-I, the Rajasthan Urban Infrastructure Development Project (RUIDP) is undertaking construction of sewage systems along with treatment plants in five major cities of Jodhpur, Kota, Ajmer, Udaipur and Bikaner. Under Phase-II, RUIDP will cover 15 towns. In uncovered towns, the sewage and sullage water is carried through open drains running along the roads and it is ultimately discharged in to a tank or nala/river.

While large industries have their own effluent treatment plants, small-scale industries do not have treatment facilities. The government has installed common effluent treatment plants (CETP) for treatment of the effluents in industrial areas of Pali, Balotra, Jodhpur, Bhiwadi and Manpura-Machhedi in Jaipur district. CETPs have also been constructed in Jasol and Bithuja in Barmer district. The three CETPs of Pali are also proposed for upgrading.

Rajasthan is the second largest mineral producing state in India with about 42 major and 28 minor minerals produced here. Mining exerts pressures on the environment at many stages of the process i.e. exploration, extraction, processing, and post closer operations.

The mineral purification process generate tailing wastes, which are discharged into tailing ponds. The supernatants from tailing ponds flow into the natural drainage leading to a river or lake or percolate and pollute the groundwater. The wastewater of lead and zinc smelting is mainly characterised in having low pH and high concentration of Copper Zinc, Lead, Asenic and Fluoride ions.

A report by the Central Pollution Control Board (River Stretches For Restoration of Water Quality, 2015) measured water quality of 11 rivers at 17 locations and found 14 locations to be non-complying with respect to BOD. These 14 locations are on eight rivers of Banas, Ghaggar, Chambal, Kali Sindh, Parwati, Jawai, Ujad and Chappi and 20 towns or cities are located on these stretches.

According to Inter-state river water quality (Water Quality of Rivers at Inter-state borders, CPCB, 2015) report:

Water quality monitoring was carried out at six locations at the interstate boundary of Rajasthan with Haryana, Madhya Pradesh and Gujarat of the Ghaggar, Mahi, Chambal and Sabarmati. The BOD and DO level are within the prescribed range at all the locations while total coliform count exceeds at the Khedbrahma site on Sabarmati river near the Rajasthan-Gujarat border.

Table 1: Priority Level of River in Rajasthan

S.NO.	RIVER	STRETCH IDENTIFIED	TOWNS IDENTIFIED	APPROX LENGTH OF THE STRETCH (IN KM)	PRIORITY LEVEL
1.	BANAS	ALONG BISALPUR DAM, SWAROOPGANJ, NEWTA DAM	BISALPUR, SIROHI, SWAROOPGANJ, TONK, BHILWARA	60	I
2.	CHAMBAL	SAWAIMADHOPUR TO KOTA	SAWAIMADHOPUR, KOTA	65	V
3.	CHAPPI	CHHAPI DAM, JHALAWAR TO CHHAPIHERA	CHHAPIHERA, THONAWAD, ARNIA, METHOON, JHALAWAR	20	V
4.	GHAGGAR	SUREWALA TO HANUMANGARH	HANUMANGARH	15	V
5.	KALI SINDH	BAROD TO GADEPAN	BORKHERA, BALDARA	20	II
6.	PARWATI	KHATOLI, KOTA TO TODRA	MOHAMMADPUR, KHATOLI	10	III
7.	JAWAI	JAWAI DAM SENA TO GALTHANI	SENA, GALTHANI	10	V
8.	UJAD	MORI (BHIM SAGAR DAM) TO ANGHORA	MORI	2	V

The 60-km stretch on Banas river along Bisalpur dam, Swaroopganj, Newta dam is the most polluted in terms of BOD and has been put it in Class I which is of highest priority among all the polluted river stretches.

6. Climate Change (Rajasthan State Action Plan for Climate Change)

Trend analysis of one day extreme rainfall series based on the period 1951-2007, shows that the extreme rainfall amounts are increasing at many places over India. State of Rajasthan also shows pockets of increasing trend in extreme rainfall during this period. An overall increase in extreme rainfall events and their intensities during the period 1901-2000 have also been observed (Partha Sarthy, 1984).

Rajasthan is also showing warming trends for maximum temperatures and a cooling trend for minimum temperatures.

The state has the maximum probability of occurrence of droughts in India (RPCB, 2010).

Barring the districts of Banswara and Dungapur, all of the districts in Rajasthan come under high damage rise zone owing to high velocity winds. The regional model estimates the mean annual rainfall to decrease slightly, but the extreme rainfall is expected to increase in frequency and intensity. The 2071-2100 projections show an increase of 20mm for maximum one-day rainfall and 30 mm for maximum five-day rainfall.

The desert districts of Jaisalmer and Barmer, which get average annual rainfall of 200 to 277 mm, have been facing flash floods due to extreme weather events every couple of years, starting from 2006, 2010[12], 2013[13] and 2015[14]. The flood of 2006[15] is still remembered as it inundated several habitations and affected around 8 lakh[16] people in Barmer. The sub-soil hard pan formation in both the districts add to the does not allow water to percolate to deeper aquifers which increases the probability of flooding.

The flood water is believed to follow the route of seasonal rivers of the region, which have gone extinct now, but remain embedded in the oral history and culture of the region. The number of extreme events has increased in the desert region in the last decade with reports of flash floods

[12] http://indiatoday.intoday.in/story/army-rescues-villagers-in-floodhit-rajasthan/1/100675.html

[13] http://timesofindia.indiatimes.com/city/jaipur/Jaisalmer-district-faces-flood-like-situation/articleshow/21871478.cms

[14] http://archive.catchnews.com/environment-news/there-s-a-flood-in-india-s-desert-here-s-how-it-got-there-1438414292.html

[15] http://www.downtoearth.org.in/coverage/floods-cause-havoc-in-droughtprone-barmer-rajasthan-8407

[16] http://www.iisc.ernet.in/~currsci/mar102007/568.pdf

every couple of years. River basins like Sabarmati and Luni may experience acute water scarcity along with basins of Mahi which are likely to experience constant water scarcity and shortage[17].

People's Movements and Organisations

Rajasthan has hosted several organisations working on environment conservation. Alwar is known for work of Tarun Bharat Sangh (TBS) and Sambhaav to revive rivers through johads (ponds) and anicuts. Foundation for Ecological Security (FES), Society for Promotion of Wasteland Development (SPWD) and Seva Mandir have also been working on protection of watersheds especially community forests and pastures throughout south-east Rajasthan.

In last 25 years, TBS has constructed around 10,000 of johads with the contribution of villagers bringing a significant increased from an officially marked "dark zone" to "a water surplus" zone. It's the revival of rivulet Arvari that made a great impact, gathering support and admiration from all quarters for future conservation work. TBS also worked against limestone mining around Sariska National Park and filed a public interest petition in the Supreme Court. In 1991, the court issued an order against continuing mining in the ecologically fragile Aravalis. This was followed up by a notification by the Ministry of Environment and Forests in May 1992 banning mining in the Aravalli hill system. It eventually led to the closure of 470 mines operating within the buffer area and periphery of the Sariska National Park.

Sambhaav has been instrumental in revival of Nanduwali, a rivulet in Rajgarh area of Alwar district, through construction of johads and anicuts besides forest management work taken up by the villagers. The work is now being replicated in regions of Dausa district.

FES has been working with agro-pastoral communities, which are largely dependent on community resources for fodder, firewood and water. The commons are increasingly facing the issues of over-exploitation and illegal encroachments and pollution. FES assists village institutions to improve availability of natural resources through to undertake eco-restoration activities like plantations, forest and pasture management besides creating new livelihood opportunities.

SPWD has been working towards management of forest and water resources besides developing models underscoring environmental benefits of works under the rural job scheme. The scientific studies done by SPWD and FES have also been helpful in understanding the geographical changes occurring in this region.

[17] Gosain, A. K., Rao, Sandhya. & Basuray, D. 2006. Climate change impact assessment on hydrology of Indian River basins. Current Science, 90, no. 3, pp. 346-353

Seva Mandir is focussed on protection and development of common land in southern Rajasthan, which involves enhancement of watersheds and improvement of agricultural yields through eco-friendly means.

Gayatri Pariwar, a pan-India religious organisation, has been campaigning for protection of Banas river since 2012 through its various partner organisations and volunteers.

7. Suggestion

A minimum quality, quantity and distribution of water are required to maintain the components, functions and processes of aquatic ecosystems thriving in the river. Due to heavy abstraction of surface and groundwater in the catchment area of the rivers through building of dams and anicuts, the rivers and their many tributaries remain dry for considerable period in a year. This has resulted in heavy losses of biological resources. It's important that water resources are optimally managed and augmented to the extent necessary in the entire basin, including groundwater recharging, village ponds, water conservation, recycling of wastewater and economy in water use

8. Luni: The Saline One

'Rediya randka kare, Luni lahran khaye,
Baandi baapdi ka kare, Guhiya soon ghar jaye'
(Rediya makes lot of noise, Luni makes waves,
Baandi can't do any harm of anyone and Guhiya rises very fast, flooding the houses)
This couplet in Marwari depicts the water flows Luni and its tributaries must have carried in eras gone by.

Rajasthan encompasses a huge area of the Thar Desert. As a result, there are very few rivers in the western part of the state. Luni is one of the three major rivers flowing through Rajasthan and forms the only integrated drainage basin (34866 km²) in northwest arid India. But its biggest contribution is in being the first natural barrier against the eastward spread of sands. It separates the aridity of the west from humid climate of the east.[18]

Luni originates near Pushkar in two branches, the Saraswati and the Sabarmati, which join with each other at Govindgarh, and the river is then known as Luni. If flows for about 495 km in a south-westerly direction in Rajasthan and then disappears in the marshy land of Rann of Kutch.

The river basin extends over parts of Ajmer, Barmer, Jalore, Jodhpur, Nagaur, Pali, Rajsamand, Sirohi and Udaipur districts. It is the only river basin in the state along with Ghaggar that does not flow out to other water bodies. Major towns along the river area Govindgarh, Bilara and Balotra.

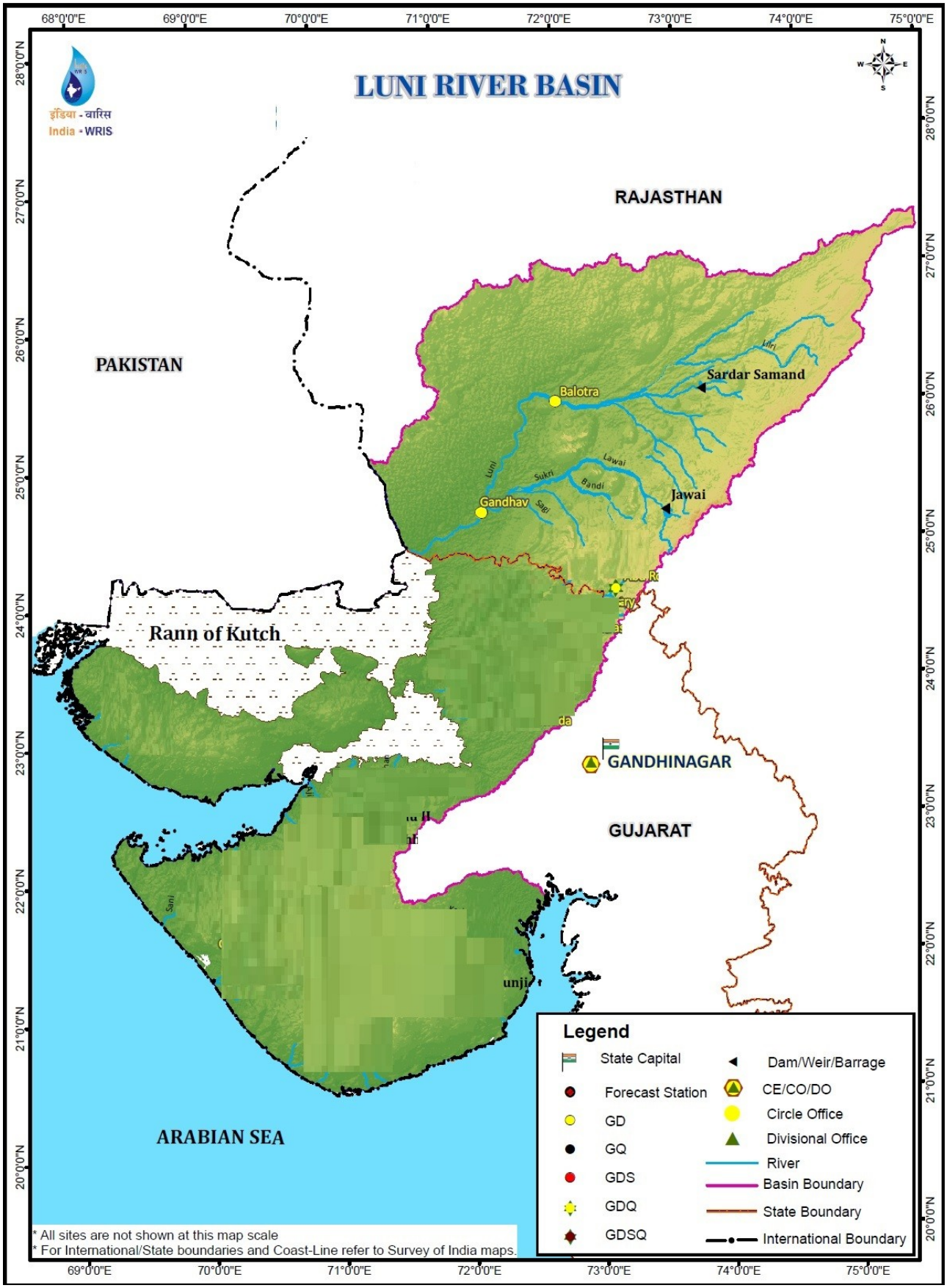
[18] Ecology and Archaeology of West India
https://books.google.co.in/books?id=V3sedhMJyYYC&lpg=PA157&ots=1tJ5FM9HaA&dq=Great%20Indian%20Water%20Divide%2C%20rajasthan&pg=PA157#v=onepage&q=Great%20Indian%20Water%20Divide,%20rajasthan&f=false

Map No 6: Basin of River Luni in Rajasthan

The total catchment area of the basin is 37,363 square km according to the 1:250,000 scale topographical maps published by the Survey of India. Luni River Basin lies to the west of the Aravali hills and forms part of the mid-west alluvial plain. Orographically, the eastern part of the Basin is marked by hilly terrain belonging to the Aravali chain. West of the hills lies a narrow alluvial plain which gently slopes westwards.

Luni derives its name from the Sanskrit Lavana meaning salt. It is believed that its waters are sweet only till Balotra town. The salinity, however, is more widespread today and is evident through water from dug wells along the flood plains.

The water of River Luni is sweet up to Balotra and becomes more and more saline further downstream. The main tributaries of Luni are Sukri, Rediya, Mithri, Bandi, Khari, Jawai, Guhiya and Sagi, and Jojari. The mean annual rainfall over the Luni Basin was computed as 320 mm, of which about 97% falls during the four Monsoon months. There are two Major (Sardar Samand and Jawai dam), nine medium and 344 minor irrigation projects in the Luni River Basin, as well as some small irrigation systems (covering less than 20 hectare) constructed and operated by Panchayat Samities (PS).



Map No 7: Luni River Basin

As many as four irrigation projects are ongoing. An additional area of 2514 ha will be irrigated on completion of these projects. As many as 25 more irrigation projects have been proposed in this basin to irrigate 8,399 hectare.

Table 2: Rivers and Their Length

Name of river	Length (in km)
Luni	511
Jojari (mithri)	83
Lolari	60
Guhiya & Sukri (hemavas)	125
Bandi (Hemavas)	135
Sukari	140
Mithri	71
Jawai	145
Khari bandi	84
Sukri bandi	85
Sugi	80
Source: Central Water Commission	

Statistically speaking, the annual runoff of river Luni, in general, appears to be a random variable; however values at Balotra reveal a decreasing trend of observed annual runoff. Elements of similar decreasing trend are also seen at Gandhav

8.1 Religious and Cultural connotations

Luni does not have any mythological reference which justifies absence of any important pilgrimage along its stretch except at Tilwara in Barmer district, but it's not related to the river. Tilwara is known for the shrine of 14th century warrior saint Rawal Mallinath and his wife Rani Rupade. The songs of their valour are still popular in western Rajasthan.

A cattle fair, called Shri Mallinath Pashu Mela, is held every year on the banks of Luni where people from as far away as Gujarat and Madhya Pradesh come for sale and purchase of livestock. Water fetched by digging just a few feet in the ground serves this large congregation of livestock.

It is believed that this water remains available and sweet only till the fair is on[19]. The very next day it turns saline and gradually recedes.

Another belief is that the quality of water fetched depends upon the digger as he is bound to find the same kind of water as in his native village[20]. The number of visitors is, however, declining over the years as bullocks are no longer used in the fields and transportation of camels has been prohibited under the Rajasthan Bovine Animal (Prohibition of slaughter and regulation of temporary migration or exports of camel) Act 2014.

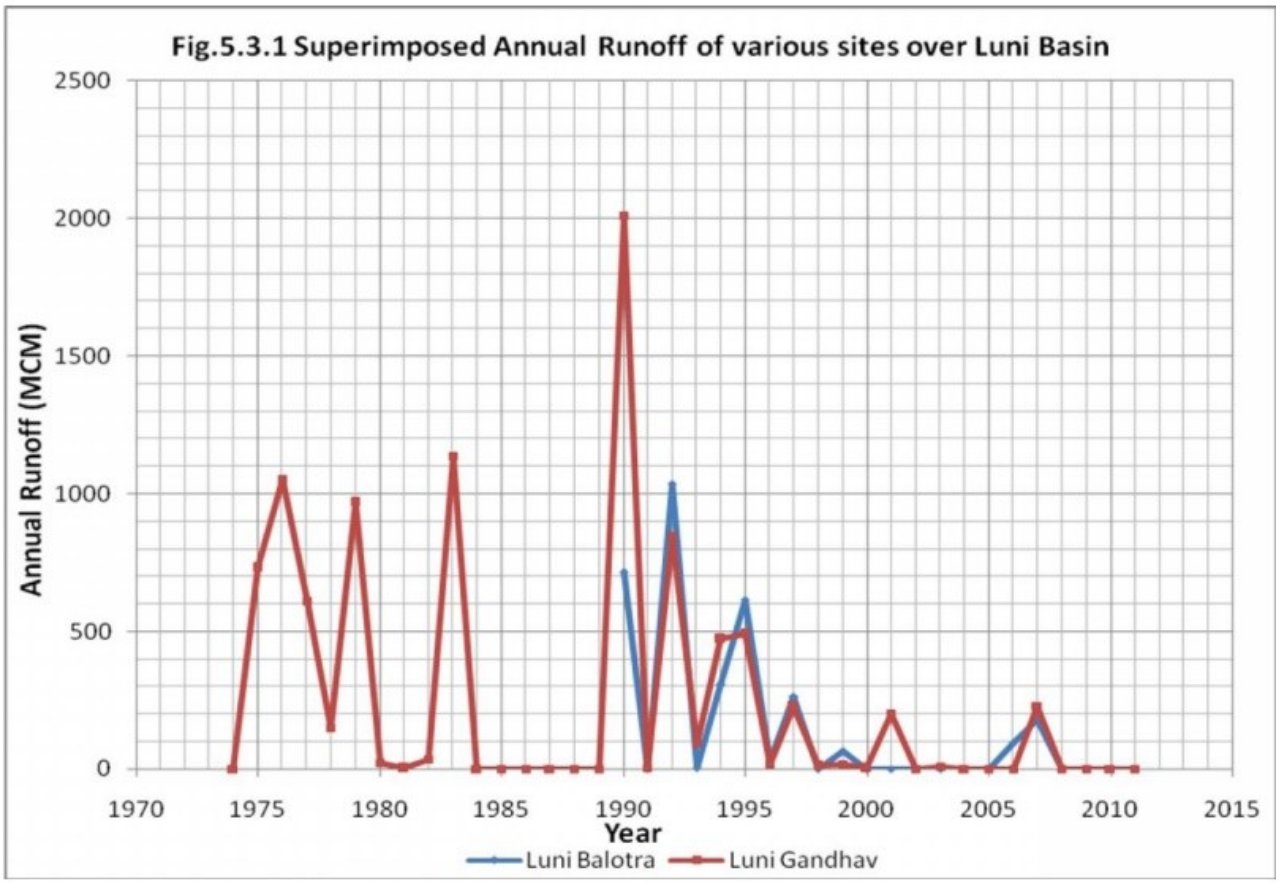


Figure 1: Annual Runoff of Various Site Over Luni River

Source: Central Water Commission

8.2 Change in land use over the years

The Luni riverbed is broad and shallow stretching the flood plain many kilometres wide which look more like a huge pastoral ground. Re-chargeable open shallow wells were the main source of

[19] Gazetter of Barmer

[20] Information from Rajaram Ghedu, Geedah village, Barmer

irrigation in its vicinity. The annual monsoonal flow of the river not only recharged these wells but also lowered their salinity allowing good production of rabi crops like wheat and gram.[21]

The wheat grown by this system was famous as 'kharchiya gehun' or salty-wheat. At certain places, underground channels, lined with perforated tiles, were also built from the riverbed up to the wells. These structures are, however, not visible today thanks to flood of 1979 which brought heavy loads of silt and sand, burying many wells and associated channels. The flood affected 939 villages while 25,000 persons were marooned. The city of Jodhpur was cut off for five days.[22]

Today, certain villages have houses built on platforms 10-12 feet high. At others, mass migration to a fresh site was essential[23]. Much of the silted agriculture land and wells were not reclaimed due to the effort required. Abandoned wells which either dried up or turned saline are a far cry from the wells that used to get recharged to water a winter crop.

Change in land use and transformation of pastoralists into cultivators with tubewell irrigation has greatly affected the river's ecosystem, may be more than the building of dams and anecuts or cutting of forests. Encroachments on the catchment as well as on the floodplains for cultivation have choked Luni.

8.3 Biodiversity

Luni hosts a diverse biotic life. From the desert mascot Khejri (Prosopis Cineraria) and Babool (Acacia Nilotica) to Jaalki (Salvidora Parsica), Jaal (Salvadore Oleiodes), Khair (Capparis Decidua) and Muraili (Alhagi Pseudalhagi)[24] are often found growing in stony and rocky tracts besides the succulent Thor (Euphorbia Caducifolia) which is often confused with cactus.

However, it's mainly the Prosopis Juliflora or vilayati babool, an invasive species which has infested the riverbed at the cost of other species as toxic secretion from its root zone does not let anything else grow. As the goat also does not eat juliflora, it grows undisturbed.

[21] SALT RIVER: Diversity and Land Use on the Banks of the Luni; Institute for Development Studies, Jaipur

[22] Flash flood in the Luni; CAZRI, Jodhpur (http://krishikosh.egranth.ac.in/bitstream/1/02050128/1/18-(FLASH%20FLOOD%20IN%20THE%20LUNI).pdf)

[23] SALT RIVER: Diversity and Land Use on the Banks of the Luni; Institute for Development Studies, Jaipur

[24] Ibid

Luni is also home to a large number of grasses, and shrubs including members of Poaceae, Fabaceae, Amaranthaceae, Zygophyllaceae, Tiliacea, Solanaceae and Lamiaceae families.

Jawai dam is a crocodile sanctuary and a favourite place of sarus cranes, comb duck, spotbill duck, demmossile, common eastern crane, barheaded geese and migrating birds. The reservoir also supports the nearby wildlife sanctuary as panthers, bears, hyenas, jackals and jungle cats have been seen quenching their thirst at the dam.

8.4 Pollution

Luni and one of its main tributary, Bandi, pass through industrial towns of Balotra and Pali respectively. Both the townships are known for their textile, dyeing and printing units discharging highly-contaminated wastewater into the two rivers.

Luni: Bottlenecks exist in Balotra, the last big settlement on Luni in Rajasthan. The dry Luni riverbed is also being used by private bus operators to ply their vehicles. Hosting over 700 textile units, this industrial town's CETP was found to be operating without adhering to norms of pollution control. Later, NGT laid down the conditions for operations which included installation of primary treatment plant, payment of security deposit ranging from Rs 2-5 lakh per unit, connecting all dyeing units to the CETP, fixing of meter in the borewell and flow meter for the water pipeline and disposing the sledge in specified areas.

Figure 2: The dry Luni bed at Balotra

Bandi: Pali city is located South-West, around 70 km from Jodhpur in western Rajasthan. It has three major industrial zones. While phase I&II are located in North phase III lies at the bank of river Bandi.

Pali is the fifth most polluted industrial area as found in the Comprehensive Environmental Pollution Index of the country. It scored 82.71 points due to critical conditions of water and land.

A visit to the industrial area makes the impact evident as industrial solid waste lies piled up on the river banks. The black-coloured water contaminates several wells along with river stretch, turning the farm land in around 50 villages redundant. Several studies, including one by the Centre for Science and Environment, have indicted the textile industry for the high pollution levels

India's first common effluent treatment plant (CETP) was set up in Pali in 1982 to treat industrial effluents, but expansion of textile units means the treatment capacity never matches level of pollutants. Of the 800 textile units in the town, 600 are under Central Pollution Control Board's 'red category', denoting that they are highly polluting units.

The four CETPs in the city are based on dated technology and not working at full capacity. The high running cost also acts as a deterrent for unit owners to send their waste to the plants. Of the samples of water collected from different locations, around 80 per cent of the surface water samples were found unfit for drinking. In 2009, the Union Ministry of Environment and Forests declared the area as critically polluted and banned expansion of any industry in the area, but that has not helped deal with contaminants from existing units.

The area's livestock population also appears to be affected by skin, gastric and waterborne diseases. The Rajasthan Ground Water Department has found that since 1978, ground water pollution has increased by 15 km down the river since ground water also flows in the same direction as river water.

Even after years of litigation, the contentious issue is far from getting resolved even as the National Green Tribunal ordered shutting down of textile units operating without consent of the Rajasthan State Pollution Control Board.

Sri Kisan Paryavaran Sangharsh Samiti, a local farmers' group, spearheaded the campaign which included litigations against water pollution in and around Pali. On the other hand, a group of organisations, including Tarun Bharat Sangh and Jal Bhagirathi Foundation, led a river march to save Luni in 2008.

Figure 3: Bandi river stretch at Pali

500 textiles units flout green norms in Pali district, faces court ire

HT Correspondent, Jodhpur | Updated: Mar 08, 2014 15:54 IST

National Green Tribunal has ordered suspension of work in more than 500 textiles dying and printing industries in Pali district of Jodhpur region for not obtaining the proper consent of operation from the Rajasthan Pollution Control Board.

NGT bench comprising tribunal chairman Justice Swatanter Kumar, judicial member justice MS Nambiar and expert members prof PC Mishra and Dr RC Trivedi while hearing a petition filed by Shri Kishan Paryavaran Sangarsh Samiti of Jaipur has also sought a compliance report of its order on May 2, the next hearing of circuit bench in Jodhpur.

The order will affect roughly 80% of about 600 dying and printing units in the district.

There are around 600 textiles units working in Pali district and merely 64 units have been given consent to operate by the pollution control board. "These units working without consent or proper approval of the board are posing severe pollution as effluent of these units are causing pollution to Bandi river and Nehda Dam," petitioners told the tribunal.

Taking a serious note over the issue, the circuit bench of the NGT said that the industries which are operating without obtaining consent of the State Board under the provisions of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of

Pollution) Act, of 1981, as the case may be shall not be permitted to operate henceforth.
"The statutory duty of the board under these statutes is to ensure that pollution is prevented as well as controlled," NGT observed in its verdict.
Circuit bench is hearing around 106 cases during its three days long camp in Jodhpur ending on Friday. Bench heard 12 cases on the first day on Wednesday.
http://www.hindustantimes.com/jaipur/500-textiles-units-flout-green-norms-in-pali-district-faces-court-ire/story-4Rc6xih89lV6pctlPgnmJI.html

Jojari: Jojari river is another tributary of Luni that bears the brunt of being close to a city. The river flows close to Jodhpur and is the only outlet for sewage and industrial pollutants generated in and around the city.

Jodhpur is Rajasthan's second-largest city with a population of over 12 lakhs but it didn't have a sewage system till 2002. Even now, 40 per cent of the population lies outside the sewage network. The two STPs can treat only 50 per cent of the sewage while the rest makes its way into Jojari.

The textile dyeing, steel polishing and re-rolling industries of Jodhpur add to the water pollution as the Common Effluent Treatment Plant (CETP) set up in Sangaria district is receiving more waste than its 20 mld capacity. Jodhpur has 17 industrial clusters with over 212 textile units and 109 steel rolling mills.

As Jojari remains dry most of the time, its path joining it to the Luni has been completely obstructed in Barmer trhough encroachments by farmers and other infrastructure that has been built on its bed. This blockage causes the river to overflow in a good monsoon area resulting in water logging.
In 2014, the National Green Tribunal ordered the state authorities to formulate an action plan to achieve zero discharge from the industrial areas and also imposed a fine of Rs 5 lakh each (based on "polluter pays principle") on all industries operating without consent of the state pollution control board (SPCB)[25].

[25] http://www.downtoearth.org.in/news/ngt-seeks-action-plan-to-ensure--zero-discharge-from-jodhpur-industries-44307

8.5 Red (Critical), Pink (Threatened) and Blue (healthy) Status of rivers of Luni

The basin of the river Luni within the state would qualify for a Red status because of multiple points of high sewage and industrial pollution in its basin area. The seasonal character of Luni and its tributaries also impedes movement of these pollutants resulting in groundwater pollution thus adversely impacting the biodiversity and geomorphology besides the health and livelihood of residents.

Following is presented as the current state of Luni and its tributaries:

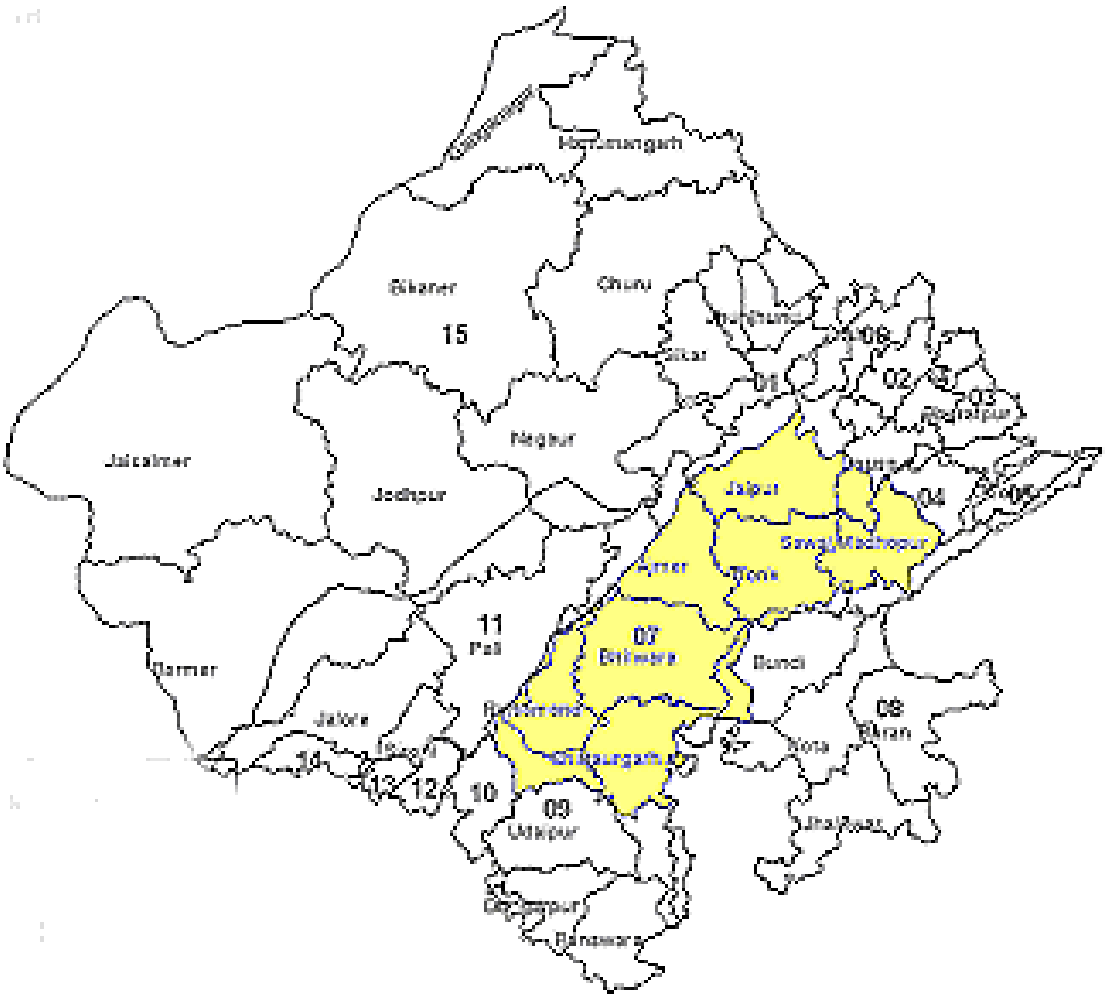
S. No	Tributary	Pollution level	Other threats	State
1	Luni	High	Change in land use	Red
2	Bandi	High	----	Red
3	Jojari	High	Encroachment	Red
4	Jawai	Low	----	Blue
5.	Sukri	Low	----	Blue
6.	Mithri	Low	----	Blue
7.	Khari	Low	----	Blue

9. Banas: Hope of the forest

Figure 4: Banas river near its source in Kumbhalgarh

Banas river has the largest catchment area (45,833 square km) in Rajasthan. Though ephemeral, it supports an extensive rural economy along its stretch. Banas is a unique river as it originates from the mountain ranges which form the Great Indian Water Divide. The east-flowing Banas drains the areas of Rajsamand, Udaipur, Bhilwara, Chittorgarh, Ajmer, Bundi, Jaipur, Tonk, Dausa and Sawai Madhopur before merging into Chambal which further meets Yamuna and then Ganga. Thus, East Banas is a river of the Bay of Bengal system. The West Banas has a shorter journey as it originates in Sirohi district and moves in south west direction through Gujarat and hence becomes part of the Arabian Sea system. Most of the literature, studies and media reports talking about 'Banas', are actually referring to East Banas.

Banas is a major tributary of the River Chambal, the two rivers meeting near village Rameshwar in Khandar Block in Sawai Madhopur district. The total length of the river is about 512 km. Two major towns of Nathdwara and Tonk are located on its banks. Kothari river, one of the tributaries of Banas, passes through the industrial town of Bhilwara while another tributary, Berach, passes through two major tourist cities of Udaipur and Chittorgarh.



Map No 8: Banas River Basin in Rajasthan

Name of river	Length (in km)
Banas	512
Berach	157
Kothari	151
Khari	192
Dai	96
Mashi	96
Sohadra	100
Morel	147
Khalisil	48
Dheel	64
Source: Water Resources Department, Rajasthan	

Map No 9: Banas River Basin

There are seven major, 33 medium and 1,219 minor irrigation projects on Banas river Basin besides several small irrigation systems constructed and operated by panchayat samitis.

9.1 Mythology and Culture

Several important pilgrimage spots exist along the stretch of Banas and hence the river has various mythological connections.

It is said that Sage Vashishth did intense meditation and got the river down from *Swarg Lok* (heaven). The river, 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. Banas is often called 'Banas Ganga' to signify that it is a form of Ganga or with reference to it being one of the tributaries of Ganga.

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' and people immerse ashes of their departed family members here instead of going to Ganga.

'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. Jarga ji stood at one place waiting for Baba Ramdev to return. Upon return after 12 years, the lord revived Jarga ji and gave a boon that this mountain range will be famous by his name. Bana river goes encircling these mountains near Kumbhalgarh. It is also believed that Banas appears as Ganga in the pond of Jarga ji temple on moonless night of Shravan month (The month of July-August according to Hindu calendar).

Lord Krishna also decided to stay here, the evidence of which is Nathdwara, the town built around the famous temple of Shrinath ji, an infant incarnation of Krishna. In the 17th century, the idol was being transferred from Vrindavan in Uttar Pradesh to protect it from the Mughal ruler Aurangzeb who, according to sectarian literature, wished to have the deity reside with him in Agra. When the idol reached the spot at village Sihad or Sinhad, the wheels of bullock cart carrying the idol sank axle-deep in mud and could not be moved any farther. The accompanying priests realised that the particular place was the Lord's chosen spot and accordingly, a temple was built there under the rule and protection of the then Maharana Raj Singh of Mewar.

The triveni dham near Mandalgarh in Bhilwara district where Berach and Menali rivers meet Benas 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. The pilgrimage spot also has old palaces build by Sisodia clan of Rajasthan.

At Sawai Madhopur, Rameshwaram Ghat is a famous pilgrimage spot as Banas merges into Chambal here.

Figure 5: Gayatri Pariwar performing a pooja at banks of Banas near Sawai Madhopur

9.2 History

Banas also has a strong connection to the ancient civilisation. Its tributary, Ahar, which is called Berach after appearing from Udaisagar lake near Udaipur, has thrown up evidences of settlements dating back to the Harappan and pre-Harappan eras cultural levels, thus exhibiting connection with Indus Valley civilisation.

Evidences of big palaces were found at Nagri, an ancient site around 16 km from Chittorgarh. Later, rulers of Mewar depended a lot on Ahar (Berach) as it offered natural defence to three

capitals, Chittorgarh, Aaghatpur and Udaipur. In 1613, Shahzada Khurram reached Mandalgarh and then followed Berach to attach Udaipur.

Today, however, Ahar is a pale shadow of its past as all the sewage of Udaipur town finds its way into the river. Ironically, Ahar civilisation so advanced that it made use of soak pits to manage the wastewater of toilets.

Various famous battles of Rajputs and Mughals were fought near Banas as it not only offered natural defence, but also the all essential water for the armies.

9.3 Biodiversity

Since Banas has a large basin covering various types of terrains, from hilly regions of Kumbhalgarh to plains of Sawai Madhopur, it hosts a diverse species of flora and fauna.

The Kumbhalgarh Wildlife Sanctuary harbours as many as 309 species of plants. Amongst the faunal species, there are 17 species of fish, seven species of amphibians, 19 species of reptiles, 126 birds and 22 species of mammals including wolves, leopards, sloth bears, hyenas, jackals, jungle cats, sambhar, nilgai, chausingha (the four horned antelope), chinkara and hare. It is also reputed as the only sanctuary where the Indian wolf is breeding successfully.

Predominant species among the trees in Banas basin are Dhok or Dhokara (Anogeissus pendula), Acacia leucophloea (Arunja/Ronj), Acacia catechu (Khair), Acacia nilotica (Desi babool), and Azadirachta indica (Neem). The area has also got a shrub cover, which largely comprises of species like Zizyphus numularia, Capparis decidua etc. The area is characterized by the grass species Aristida sp., signifying depleted water table and a state of degradation. In the shrubs/climbers category, the dominant species are Zizyphus numularia, Capparis decidua and C. horrida.

However, it's mainly the Prosopis Juliflora or vilayati babool, an invasive species which has infested the riverbed at the cost of other species as toxic secretion from its root zone does not let anything else grow. As the goat also does not eat juliflora, it grows undisturbed.

In the ground flora category, the most predominant species of the area is Aristida adscensionis (common needle grass) while other important grass/ herb species are Cenchrus setigerus (Birdwood grass), Elytraria caulis (Asian Scalystem), Dicoma tomentosa (Vajardanti), Justicia simplex and Indigofera cordifolia (Heart leaf indigo).

9.4 Change in inflow

In upper reaches of Banas, one can see several dug wells being fed by the river. Hosting Persian wheels and sometimes a motor pump, these wells are brimming with water especially during monsoon months. A good, healthy forest area also supports the river flow. However, on its entry into plains at Nathdwara, the river is repeatedly assaulted through rampant sand mining. This has greatly damaged the ecology of its riverbed and reduced the carrying as well as recharge capacity of the river.

In Sawai Madhopur, one can see mounds of sand on private farms during monsoon season. This sand is extracted before the rains as it becomes difficult to operate in flowing river. The farmers rent out their fields for Rs 20,000-25,000 per bigha per month.

Changes in the catchment area have also reduced the water inflow. Traditionally, the villagers relied on rainfed farming and livestock rearing which was based on sustainable use of natural resources. However, the shift to intensive agriculture has led to increase in encroachments on common pastures, community-protected forests and rivers' floodplains. Tubewell-based irrigation has also depleted the groundwater resource. All these factors have reduced the river flow and hence inflow to various dams and reservoirs, which are drying up almost every year.

Bisalpur dam in Tonk district was a bone of contention 10 years back when five people were killed protesting for release of water from the dam for irrigation purposes.[26] The current inflow to Bisalpur dam is 77.34 per cent of the designed inflow. This leads to rise in conflicts between urban and rural users as both want to lay claim to the resource[27].

9.5 Mining and pollution

Around 90 percent of the world's production of marble comes from India and approximately 85 percent of India's production is received from Rajasthan[28]. Most of the mining and processing activities involving marble are concentrated around Udaipur, a major basin area of Banas and its tributaries. Several instances of blockage of drainage channels, slope, landscape and vegetative

[26] 'Dying for Water'; Frontline. Accessed on September 1, 2016; 01:12 am; http://www.frontline.in/static/html/fl2214/stories/20050715002204600.htm

[27] 'Bisalpur Revisited- 10 years after protesters were shot, killing 5'; India Water Portal; Accessed on September 1, 2016, 01:06 am; http://www.indiawaterportal.org/articles/bisalpur-revisited-10-years-after-protesters-were-shot-killing-5

[28] Bapna RK; Marble Waste Minimization. Link

cover have been reported due to marble mining. Marble slurry poses serious threats as well. When dumped on land, it adversely affects productivity due to decreased porosity, water absorption and water percolation.

Slurry dumped areas cannot support any vegetation and remain degraded. During the rainy season, the slurry is carried away to rivers, drains and local water bodies, affecting the quality of water, reducing storage capacities and damaging aquatic life.

Figure 6: A Persian well in catchment area of Banas river

Gomti river, one of the tributaries of Banas, faces lot of pressure as marble units in Rajsamand district dump slurry on its bed. On the other hand, the textile industry of Bhilwara discharges heavy load of chemical pollutants into the drains that connect to Banas or into the groundwater channels[29] that also affect the river ecology.

[29] Central Ground Water Board; Groundwater Scenario: Bhilwara District; http://www.cgwb.gov.in/District_Profile/Rajasthan/Bhilwara.pdf

Bhilwara has 4,000 textile manufacturing units with production exports to 70 countries especially in Europe, South Africa and North American countries. A 2004 study[30] by the state public health engineering department found that most open wells in villages near the Kothari river that flowed beside the industrial belt had chromium, lead, iron, zinc and sodium above the norms set by the Bureau of Indian Standards. A similar scenario prevails today[31].

In a study done by Central Pollution Control Board[32], Banas river was among the top five rivers with lowest dissolved oxygen levels, an indicators of high pollution. Banas had dissolved oxygen at (DO) 0.5 mg per litre at Newta dam in Jaipur district. The optimum level for sustenance of aquatic life is 4 mg per litre. The DO level was better at Bisalpur dam (3.2 mg/l) in Tonk district, but it still did not meet the minimum standard level. The biological oxygen demand (BOD), which is amount of oxygen required by organisms to break down organic material, was 31 mg/l at Newta indicating high pollution and 4.2 mg/l at Bisalpur indicating moderate pollution.

CPCB has identified a 60-km stretch along Bisalpur Dam, Swaroopganj, Newta Dam for restoration, putting it in Class I which is the top most priority among all polluted stretches[33].

The proposed industrial area near Sawai Madhopur on the banks of Banas may further impact the water quality if pollution norms are not followed.

Berach river basin is affected by sewage pollution carried by its tributary, Ayadh, from Udaipur city and heavy metal pollution due to zinc smelters and mining. Gadwa and Daroli ponds situated in Berach river basin are polluted by heavy metal content of 1.5139 and 7.116mg/l respectively due to discharge of effluents from industrial units including Zinc smelter in Udaipur.

[30] Effluents from Bhilwara textile units flow unabated. Accessed on August31, 2016; 20:50 hrs http://www.downtoearth.org.in/news/effluents-from-bhilwara-textile-units-flow-unabated-6544

[31] Nahin ruk raha dushit paani ka aana. Rajasthan Patrika; Accessed on August 31, 2016; 23:20 hrs; http://rajasthanpatrika.patrika.com/story/bhilwara/water-pollution-not-to-be-stopped-346702.html

[32] Central Pollution Control Board: Status of Water Quality in India- 2011; http://www.cpcb.nic.in/upload/NewItems/NewItem_193_WaterQuality2011.pdf

[33] Central Pollution Control Board: River Stretches For Restoration Of Water Quality- 2014-15

Figure 7: Ayadh river carrying sewage of Udaipur city

9.6 Climate change

In 2016, Banas basin has registered good rain after a series of scanty rainfall years. So people in upper reaches had gradually shifted from rice and sugarcane crops to maize during kharif season and from wheat to mustard in rabi season. However, this year again the plan of farmers failed as they had not prepared a paddy nursery expecting less rain. On arrival of heavy rains, they had to take short cuts by putting seeds of rice near the hearth overnight for sprouting. These seeds were then dispersed in water-filled fields. However, the interest in farming is declining as more people prefer to work in industrial units and shops of cities than to continue with farming. Many fields have to be left fallow as due to decreased rainfall, disputes are rising among land owners and farmers who take the field on lease on irrigation cost. Lessees are increasingly asking for first irrigation from the land owner.

9.7 People's movements

A campaign under the banner of Gayatri Pariwar, a pan-India religious organisation, was launched in 2012 to conserve East Banas. Under this, members of the organisation hold religious ceremonies in villages situated on Banas to underscore the spiritual connection of the river. A meeting begins with brief introduction about mythology around the river and important pilgrimage spots before moving on to impacts of sand mining, deforestation and industrial pollution. In the end, villagers are encouraged to take a vow through a religious ceremony to plant

trees near the river and not to take up any exploitative activity that will damage the river ecology. Several afforestation campaigns have been initiated by the organisation members over last couple of years in the Banas basin.

Gayatri Pariwar has also been motivating government officials and elected representatives to take up policy decisions on river conservation.

नहीं रूक रहा दूषित पानी का आना

Patrika news network Posted: 2014-11-23 00:00:00 IST Updated: 2015-01-16 12:04:48 IS

भीलवाड़ा। प्रोसेस हाउस से निकलने वाले दूषित पानी को राजस्थान प्रदूषण नियंत्रण नहीं रोक पा रहा है। इसके चलते गुवारड़ी नाले में पानी की आवक बढ़ती जा रही है। मण्डल के कार्रवाई नहीं होने से जल श्रोत लगातार प्रदूषित हो रहे हैं। वहीं जिला प्रशासन मात्र खानापूर्ति कर आक्रोशित लोगों को शान्त करने का प्रयास कर रहा है।

प्रोसेस हाउस से प्रतिदिन रसायनयुक्त पानी छोड़ा जा रहा है। ग्रामीणों द्वारा इसके विरोध ग्रामीण के बावजूद प्रदूषण नियंत्रण मण्डल कोई कार्रवाई नहीं कर रहा है। इसके चलते सरकारी जमीन तथा बनास नदी में बेरोक-टोक दूषित पानी छोड़ा जा रहा है।

क्या कहता है नियम

नियमानुसार कोई भी औद्योगिक इकाई शर्तो का उल्लंघन करती है तो मण्डल नोटिस देकर 3, 7 या 15 दिन का समय देकर फैक्ट्री को बन्द कर सकता है। इसके लिए विभाग को किसी के पास जाने की जरूरत तक नहीं है।

दूषित पानी मानक आधार पर प्रदूषण मण्डल के अधिकारियों का मानना है कि कोई भी प्रोसेस हाउस दूषित पानी नहीं छोड़ रहा है। फिर भी कोई पानी छोड़ रहा है तो वह पानी मानक के आधार पर है। पानी के नमूने में सस्पेंडेड सॉलिड वेस्ट एक लीटर में 100 मिलीग्राम के आसपास तथा पीएच मान 5.5 से 9 के बीच आता है, जो तय मानक के अनुसार है।

बनास व कोठारी में जा रहा पानी

औद्योगिक इकाइयों की ओर से दूषित पानी बनास व कोठारी नदियों में छोड़ा जा रहा है। इससे नदियों में प्रदूषण की समस्या बढ़ती जा रही है। इस पानी से 50 से अधिक गांवों की जमीन बंजर हो गई एवं कुओं का पानी दूषित हो गया है। इस समस्या को लेकर बनास बचाओ आन्दोलन समिति के संयोजक दयाराम दिव्य का कहना है कि जिला कलक्टर रविकुमार सुरपुर तथा तहसीलदार को ज्ञापन देने के बाद भी कोई कार्रवाई नहीं की जा रही है।

http://rajasthanpatrika.patrika.com/story/bhilwara/water-pollution-not-to-be-stopped-346702.html

Bisalpur revisited--10 years after protesters were shot, killing 5

Despite many plans, neither rural nor urban are water secure thanks to the Bisalpur Dam since it was constructed in 2007.

By Amita Bhaduri

Ten years ago five farmers were shot protesting the diversion of waters from Bisalpur dam to Jaipur city, located about 130 kms away. People from villages en route the pipeline insisted that their drinking and domestic water needs be met before catering to urban demands. A crowd of around 2500 people had assembled at Soyla village in a gripping mark of unity – but five of them did not return home. This included Hansa Devi, a pregnant woman. The police had opened fire.

The incident deepened the rural-urban divide. The firing was opposed and the government promised to come up with a rural water supply scheme. Construction of the drinking water cum irrigation project with a storage of 38.7 thousand million cubic feet (TMC) was completed in 2007. The reservoir was supposed to provide drinking water to the urban centers apart from providing for irrigation. The planned water allocation from the reservoir was: 11.1 TMC and 5.1 respectively for the drinking and domestic water needs of Jaipur and Tonk, and Ajmer, Beawar, Kishangarh and Kekri. Allocation to villages en route was included after the protests. Apart from this, 8 TMC was for irrigating 81800 hectares of land in Tonk and Sawai Madhopur districts.

So how is the situation ten years since the Bisalpur firing? How has the project fared as regards irrigation, urban and rural drinking water supply?

Irrigation from Bisalpur

A study of the performance of dams in Tonk indicates that the actual inflow into the dam is 77.34 percent of the designed inflow because of the changed hydrological characteristics of the basin. “Like many other dams in the district this one too is receiving less water than its designed capacity”, says Prem Prakash Sharma of CECODECON, a Jaipur based NGO. The Rajasthan High Court too noted in the year 2004 that the water inflow in the dams (in Rajasthan) is declining year after year. While the demand from irrigation continues to increase, the dam's storage capacity will only decrease with time. This means that much less water is available than expected for irrigation purposes.

As per the Water Resources Department’s data the annual irrigation is 55,224 hectares, which is 67 percent of that planned. Irrigation water crisis occurs every now and then.

Only last year, the Irrigation Department had to stop drawing water for irrigation purposes and allowed water only for drinking water purposes during a dry spell of over 15-20 days. Less inflow

into the dam also means low rainfall and less river water. This is when the wells too run dry, and farmers can no longer grow wheat or jeera, the common crops grown in the area. There were isolated occasions when “water was discharged from the dam for irrigation that went into the tributary of the Chambal River”.

While irrigation in the command area of the dam suffered, the low inflow had implications for water bodies in the basin’s catchment from where it receives the flow. The Government of Rajasthan instead of accepting the design failure went ahead and banned 27000 private anicuts in the Banas basin. Through the 1990s and early 2000s the Government had provided technical and financial assistance to farmers to construct these minor anicuts. This policy reversal was ironic and can be attributed to the “need to redirect the flow of water from the rural to the urban".

Nothing significant has been done to improve the water efficiency in the command area. In the meanwhile, plansare underway on the “transfer of inter-basin water of two rivers — Brahmani and Banas — to feed the Bisalpur Dam”.

Jaipur still in the grip of a water crisis

Water started reaching Jaipur from the dam from 2009. The city was too dependent on groundwater after the Ramgarh Lake, the only surface water source for the city, dried up. The Bisalpur Jaipur Water Supply Project (BJWSP) was thereafter planned for transferring water from the Bisalpur Dam into the city. The consultant who designed the Bisalpur project admitted that it was by no means a long-term solution. It could cater to the city’s immediate drinking water needs till 2021 only. A Comptroller and Auditor General (CAG) report too highlighted the "deficiencies in planning, execution, monitoring and vigilance

by the Departments of Public Health Engineering (PHED) and Urban Development and Housing".

Over extraction of groundwater by the people as well as public agencies depleted the resource. Groundwater tables are falling at an alarming rate of up to six metres a year compelling users to drill deeper, as per astudy. Even now, the per capita water supply in Jaipur is 85 litres per capita per day (lpcd), which is way below the norms of 150 lpcd as recommended by the Central Public Health and Environmental Engineering Organisation, the CAG report notes.

Villagers en route too face water scarcity

Water is yet to be released through the planned rural drinking water supply networks. “Around 167 villages of Chaksu and Phagi blocks are yet to receive drinking water from the dam”, says Giriwar Singh Rathore of CECODECON. He has been shoring up a ‘Campaign for Bisalpur Water Supply’ here. “Many of the villages out here are faced with the grave problem of excess fluoride in drinking waters accessed through handpumps and tubewells”, says Ritu Tiwari of CECODECON.

Farmers are not buying assurances from the State Government any longer. Kisan Sewa Samiti, Chaksu, a CECODECON promoted federation has been struggling with this for the last three years. With Jaipur being a priority, the Kisan Sewa Sangh felt that the rural water supply had been largely ignored. This prompted them to engage with local elected represtatives and organise rallys on the issue. “I was determined to get water for the area and worked with Sarpanches for that. We submitted memoranda to PHED and the State Government. They were forced to take notice and promised to adress the problem”, says Moti Singh Rathore, Treasurer of Kisan Sewa Sangh. However, the promise of dam water for various uses has not materialized yet.

The rough schism between the farmers and the state is worrisome and a flash due to water scarcity can ignite the situation. If nothing else, the government must recall the stark reminder that is the Soyla shooting from ten years ago and respond quickly and positively.

http://www.indiawaterportal.org/articles/bisalpur-revisited-10-years-after-protesters-were-shot-killing-5

9.8 Red (Critical), Pink (Threatened) and Blue (healthy) Status of rivers of BAnas

The basin of Banas within the state would qualify for a Pink status. This is because on account of industrial pollution, mining operations and extraction of sand from its river bed, the inflow from the basin has reduced.

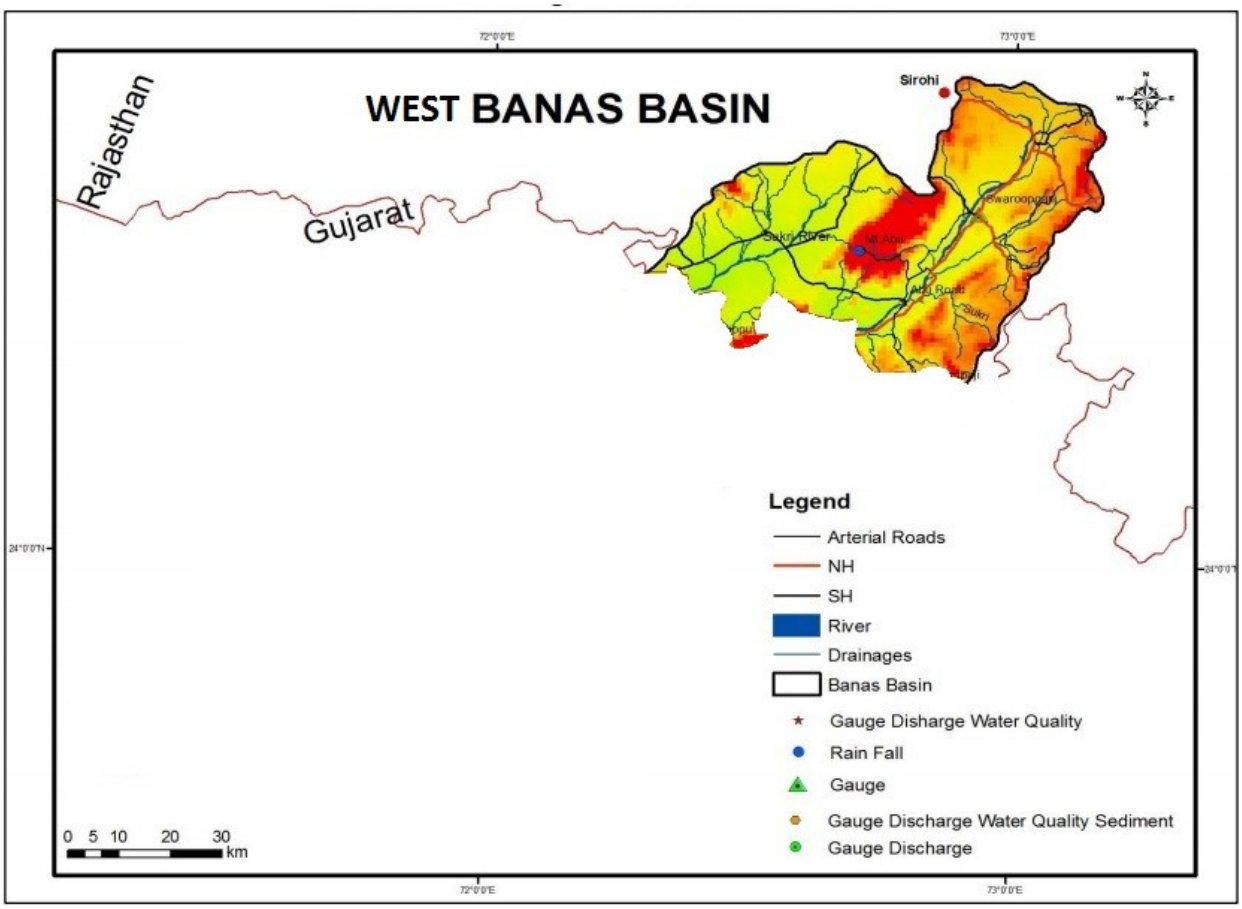
According to Inter-state river water quality (Water Quality of Rivers at Inter-state borders, CPCB, 2015) report, the 60 km stretch along Bisalpur dam, Swaroopganj and Newta Dam on Banas river is the most polluted stretch in Rajasthan with biological oxygen demand (BOD) ranging from 4.2 to 39.9 mg/l

Following is presented as the current state of tributaries of Banas:

S. No	Tributary	Pollution level	Other threats	State
1	Banas	High	Sand mining, Proposed industrial area near Sawai Madhopur	Red
2	Kothari	High	----	Pink
3	Berach	High	----	Pink
4	Dai	Low	----	Blue
5	Mashi	Low	----	Blue

10. West Banas

West Banas has a less tumultuous journey in Rajasthan as it travels through small villages in Sirohi district for about 78 km before entering Gujarat. The river originates from Aravalli hills and descends in a South West direction. The Aravalli hills and little Rann of Kuchch form its Eastern and Western extremity. In Rajasthan the basin consists of mainly hills covered with forests upto Mount Abu. Thereafter it passes through plains in Banaskantha District, Gujarat. In this reach the soil is sandy. Of its total catchment area of 8,674 sq.km, 3,269 sq km or 37.69 per cent lies in Rajasthan.



Map No 10: West Banas Basin

In the neighbouring Gujarat state, the district of Banaskantha (meaning throat of Banas) has been named after the river. Major tributaries in Rajasthan are Sipu and Balaram. Major structure on the river in Rajasthan is West Banas or Dhanari dam near Swaroopganj.

The dissolved oxygen level at Dhaneri dam was 3.6 mg per litre, which falls short of the minimum prescribed limit of 4 mg/l. The biological oxygen demand was found to be 9.2 mg/l.[34]

Table 3: Tributary Of West Banas

Tributary Name	Source of Origin	Length (km)	Catchment Area(sq.km)	Terrain
Sipu	Mount Abu Hills in Sirohi District	75	1420	Moderate Hilly
Balaram	Ambaji Hills of Aravalli Ranges	40	345	Undulating terrain with forests

10.1 Flora and Fauna

The basin is rich in biodiversity with the xenomorphic subtropical thorn forest at the foothills to subtropical evergreen forest along watercourses and valleys at higher altitudes.

The Mount Abu range has around 81 species of trees: 89 species of shrubs, 28 species of climbers and 17 species of tuberous plants of medicinal importance. It has a good floral biodiversity starting with 112 plant families with 449 genera and 820 species. The southwest area has a large bamboo forest consisting of 112 plant families. Some endemic, rare and threatened plants viz. Dicliptera abuensis, Maruadona (Strobillanthes callosus), Ischaemum kingii, Convolvulus blatteri, Nimmo (Ceropegia odorata), and Water Thyme (Hydrilla polysperma) are found here while some endangered species including Indrokh (Anogeissus sericea), Hairy Fruit Begonia (Begonia trichocarpa), Creedping Hemp (Crotalaria filipes) and Indigofera constrata also exist here.

The place is also rich in bryophytes and algae while naturally-growing edible fruits like Mango, Jamun, Karonda, Khajur, Kanti, Phalsa and several varieties of figs are found in abundance. Medicinal plants like Malkangani, Akalkara, Salam-misri, Safe! Musli, Marorphali, Bhringraj, Brahmi, Amla, Bahera, Katkaran. Ketki, etc. are found here. Amongst the bushes Ber , Amla and Khair together with Khejra , Babool jhal or Pilu and Khair or Karel, are found at isolated places. Thor and Dhak can also be spotted.

[34] Central Pollution Control Board: Status of Water Quality in India- 2011; http://www.cpcb.nic.in/upload/NewItems/NewItem_193_WaterQuality2011.pdf

A variety of fauna including highly rare, threatened and endangered species including the Panther, Sambhar, Jungle Cat, Small Indian Civet, Wolf, Hyaena, Jackal, Indian Fox, Common Langoor, Wild Boar, Pangolin, Ratel, Common Mongoose, India Hare Porcupine, Hedgehog, etc can be spotted.

Common birds of the area include Babblers, Barbets, Bee eaters, Cuckoos, Bulbuls, Buntings, Cormorants, Flowerpeckers, Woodpeckers, Kingfishers, Kestrels, Kites, Lapwings, Larks, Minivets, Munias, Mynas, Night Jars, Orioles, Owlets, Parakeets, Patridges, Pigeons, Quails, Flycatchers, Rollers, Shrikes, Tits, Vultures, Warblers, Robin, Rock chat Coot, Heron, Shikra, Sunbird, Tailorbird, Tree Pie, Waterhen, Peacoak, etc. Grey Jungle fowl and Red Spur fowl are also found abundantly in this sanctuary

Among reptiles Python, Cobra, Rat Snake, Russel's Viper, Indian Krait, Keelback. Cat Snake and a few Water Snakes are found while Crocodiles, Starred Tortoise, Indian Mud or Flap- shelled Turtle, Brooks Gecko, Rock Gecko, Common Garden Lizard, Monitor Lizard and Chameleon can also be seen.

10.2 Red (Critical), Pink (Threatened) & Blue (healthy) Status of rivers of West Banas

West Banas is assigned the health status of Pink. It encounters lesser threats due to absence of any big habitation and industrial township but climatically sparse vegetal cover, lack of any organised people's group, low level of chemical farming and presence of one dam on the main stem of the river raises concerns about its future.

11. Chambal: The cursed and the pristine

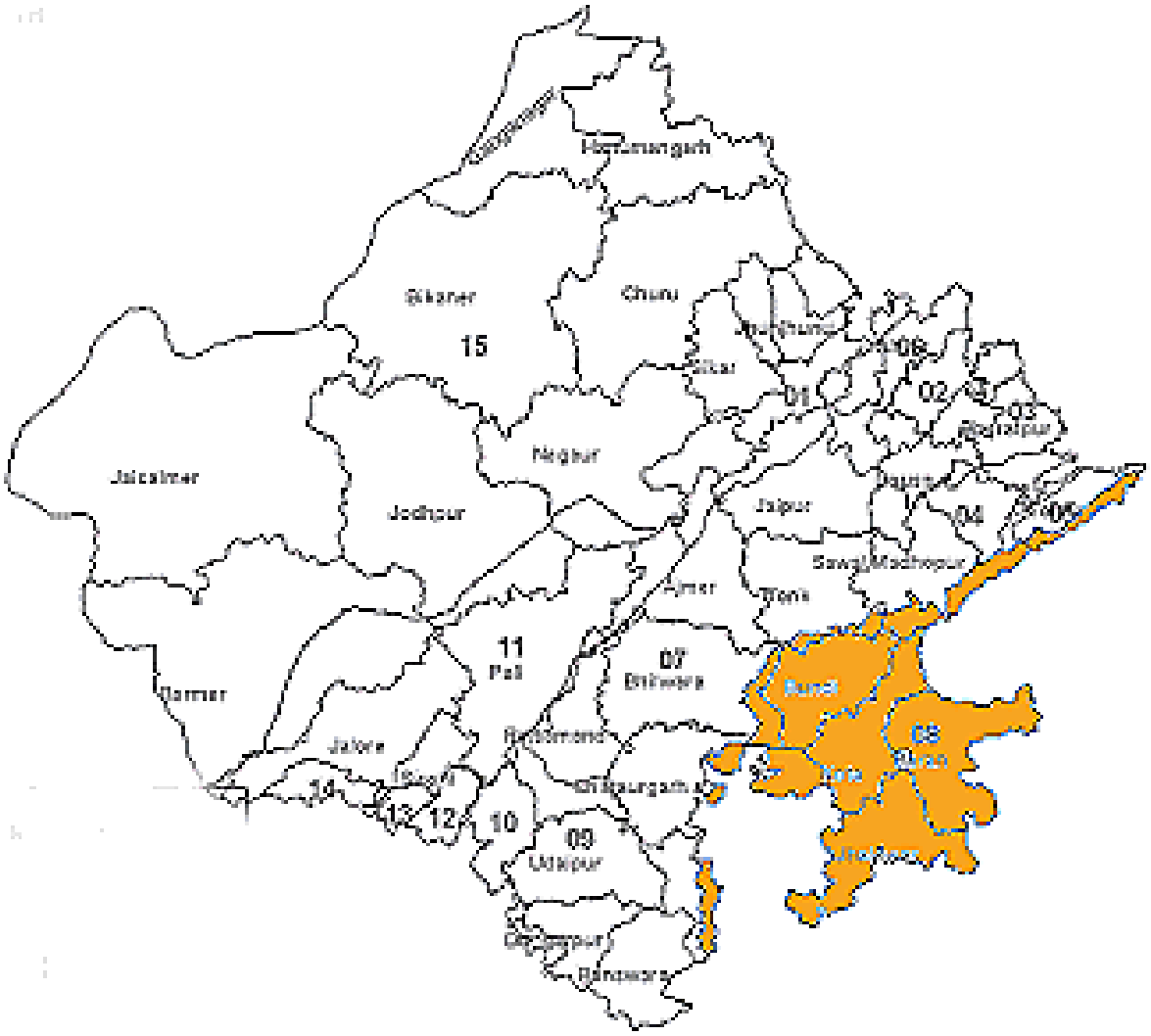
Figure 8: Bhainsrorgarh fort on Chambal near Kota.

Chambal is one of the cleanest perennial rivers of India and home to a rich diversity of flora and fauna. There are no major towns except Kota located on its banks in Rajasthan.

The river originates in Vindhyan ranges of Madhya Pradesh (MP) and meets Yamuna after traversing the territories of Rajasthan and Uttar Pradesh (UP) besides its parent state. The river flows for 320 km in a generally northerly direction before entering a deep gorge in Rajasthan at Chourasigarh, about 96 km upstream of Kota. The deep gorge extends up to Kota and the river then flows for about 226 km in Rajasthan and then forms the boundary between MP and Rajasthan for about 252 km. Thereafter, the river forms the boundary between MP and UP for about 117 km, flows in UP for about 40 km before joining Yamuna.[35]

[35] Water Resources Department, Rajasthan

Chambal extends over parts of Chittorgarh, Bhilwara, Bundi, Sawai Madhopur, Tonk, Jhalawar, Kota, Baran and Dholpur districts. Rajasthan has the largest catchment area of the river at 79,401 square km which is 57.86 per cent of the total catchment of the river. Its main tributaries, Banas, Mej, Kali Sindh and Parvati, also merge in Chambal within the borders of Rajasthan.

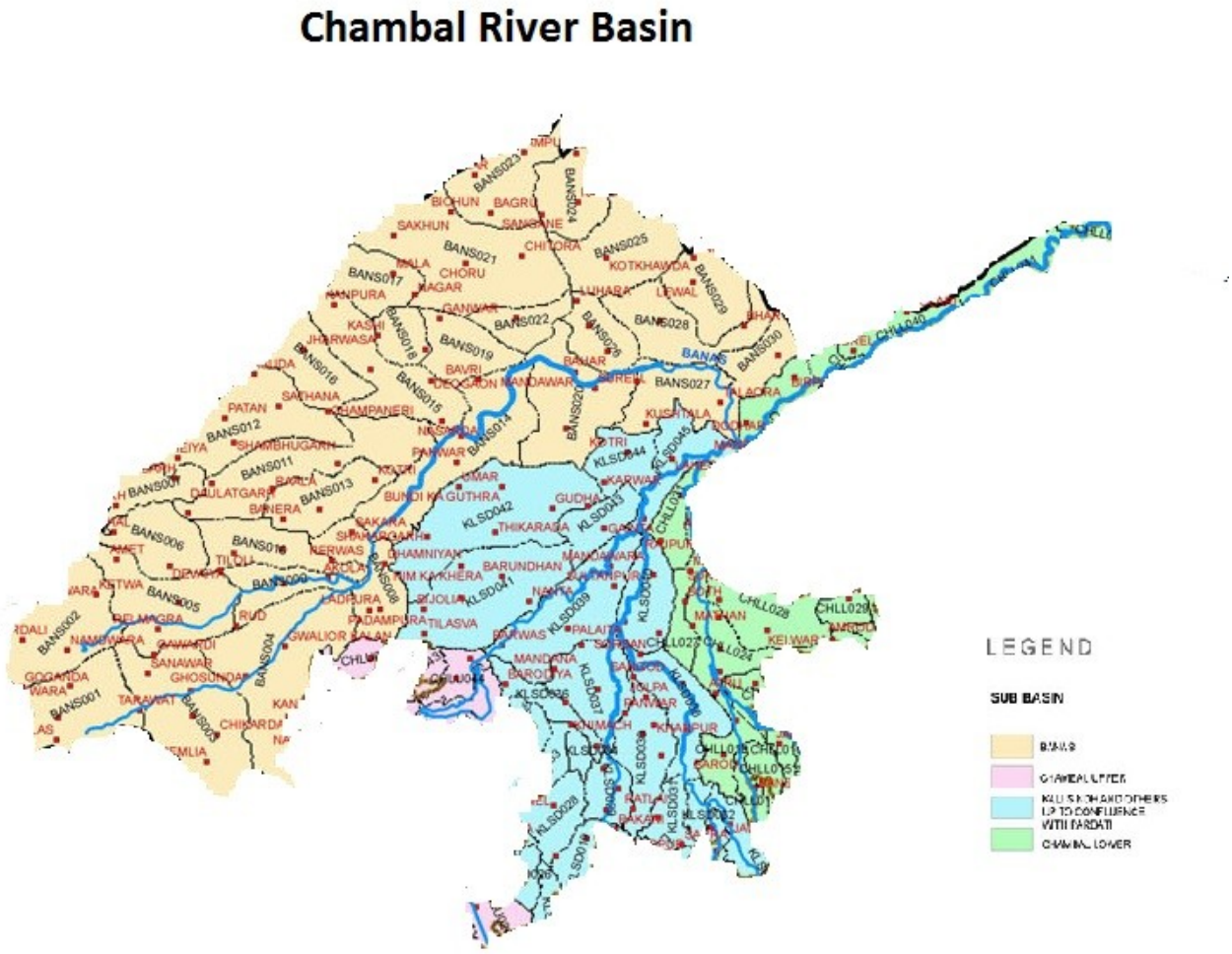


Map No 11: Chambal River Basin in Rajasthan

Name of river	Length (in km)
Chambal	322
Banas	512
Alnia	145
Kalisindh	159
Parwati	135
Source: Water Resources Department, Rajasthan	

The Chambal Valley Project conceived for utilisation of water available in Chambal River upto Kota Barrage has been executed jointly by Madhya Pradesh and Rajasthan. Rana Pratap Sagar with storage capacity of 2,899 mm^3 and Jawahar Sagar with storage capacity of 68 mm^3 are located in Rajasthan. Kota Barrage, downstream of Jawahar Sagar, has two canals to provide irrigation of 2.29 lakh hectare in Rajasthan and 2.29 lakh hectare in Madhya Pradesh.[36]

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.



Map No 12: Chambal River Basin

[36] Water Resources Department, Rajasthan; Study on Planning of Water Resources of Rajasthan; http://waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter12.pdf

This project envisages construction of three dams involving total submergence area of 17,308 hectare including 244.4 hectare forest area. A population of 27,055 people in 65 villages is likely to be affected.[37] It is believed that the project will also have adverse impact on the National Chambal Sanctuary which will be denied the water, sand and silt from the tributaries[38]. Sand banks, bars and spits are important resting and breeding sites for crocodilians, freshwater turtles and ground-nesting birds.

11.1 Geomorphology

The genesis of Chambal ravines is believed to have been made possible through upliftment of the region[39]. The upliftment of upheaval of the land mass may be due to contraction of the earth's crust, thermal changes in the lower part of the crust, isostatic balance or convection currents in the substratum.

As regards the lower Chambal valley, it is suggested that since the region is quite close to Himalayas, the intermittent upheavals or tectonic movements in the mountain range during Post-Pliocene era (2.58 million years ago) may have influenced the region. [40]

The river is found to have incised around 40-50 metres below the former flood plain. The sinuosity seems to be more between Kota and its confluence with Banas at Rameshwaram village. The depth of meanders and sinuosity increases beyond the confluence and the trend continues till Chambal meets Yamuna. The incised course seems to suggest that before the recent upliftment Chambal had attained mature condition and was meandering freely over the wide flood plain. But the last upliftment of the region gave new power to the river to start the fluvial cycle afresh.[41]

[37] National Water Development Agency; http://nwda.gov.in/index4.asp?ssslid=125&subsubsublinkid=45&langid=1

[38] Nair Tarun; Parching the Chambal River Basin: Unrelenting irrigation schemes wring the unique Chambal dry; http://conflicts.indiawaterportal.org/sites/conflicts.indiawaterportal.org/files/Parching%20the%20Chambal%20River%20Basin_Water%20Conflicts%20in%20India_Tarun%20Nair_for-publishing.pdf

[39] Sharma Hari Shanker; The Physiography of the Lower Chambal Valley and its Agricultural Development; Link

[40] Ibid

[41] Ibid

11.2 Mythology and History

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, the region was part of the kingdom of Shakuni, the maternal uncle of Kauravs. He helped Kauravs win a game of dice through cheating from Pandav brothers, who besides their kingdom also lost their wife Draupadi to the opponents. 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, the third most populous city in Rajasthan after Jaipur and Jodhpur.

Keshoraipattan near Kota is a famous pilgrimage spot dedicated to Lord Vishnu on banks of Chambal. Kartik Poornima, Bundi Utsav, Taijaji Ki Ghodi and Dhol Gyaras are some famous festivals in Keshoraipatan. Many devotees take a bath in the Chambal river on the full moon of Kartik, the month of October/November according to Hindu calendar[42].

Chambal has played its part in history of Mewar or Rajputana too. Bhainsrorgarh fort, located around 40 km upstream of Kota, stands on a rocky cliff which runs parallel to Chambal. The river around 500 yards wide and 40 feet deep acted as a good defence against any enemy attack[43]. However, the fort being vulnerable from the other side where the land slopes in a gentle curve allowed easy access to the fort. This is why it got overrun by Ala-ud-din Khilji who razed the place at that time, and the current buildings are a later creation. Historical accounts have it that after Khilji's invasion, no building, palace or temple was left standing within the fort precincts. Bhainsrorgarh had ceased to exist. The present palace and is currently a luxury hotel managed by family of one of the erstwhile aristocrats of Mewar. The fort area also houses a small habitation which is served by waters of Chambal lifted through a water pump.

11.3 Pollution and Environmental Flow

Chambal is a relatively clean river. In fact, it is of great value in diluting the pollution load of Yamuna. The sewage from Kota directly dumped through various drains remains the most contentious issue. The town produces around 100 MLD of sewage but has a capacity of treat only

[42] https://en.wikipedia.org/wiki/Keshoraipatan

[43] Tod James; Annals and Antiquities of Rajasthan

half of the load. The Kota thermal power station also contributes pollution as it uses once-throw-cooling technique that involves high discharge of water used for cooling[44]. But pollution levels in the river have not shown much variation from 1997 to 2010.[45] A 2011 report by Central Pollution Control Board assessing water quality of rivers, in fact, found an improvement in biological oxygen demand even as the dissolved oxygen was 2.8 mg per litre. The BOD downstream of Kota was 4.7 mg/l which dropped to 3.7 mg/l at Rameshwaram ghat in Sawai Madhopur. [46]

CPCB has identified 65-km stretch from Sawai Madhopur to Kota for restoration but has put it in Class V which is of least priority among all the polluted river stretches.[47]

Illegal sand mining in Dholpur district has, however, adversely impacted the river ecology.[48]

For the most part of the year, the Chambal does not flow below the Kota Barrage and has been reduced to a stagnant, shrunken sliver. While the Chambal is almost 400 metres wide along its lower reaches, several sections of the river below the Kota Barrage, are barely a few feet across and a few inches deep. It recovers from the deprivation only after the Kali Sindh and Parbati flow in.

For almost half a century, the Kota Barrage was the last of the indignities the Chambal suffered on her way through to the Yamuna and beyond. But today, this humiliation is prolonged and repeated by the illegitimate lift irrigation schemes at Dholpur and Pinahat (Nair and Krishna 2013), and the unquenching demands for many such more. The pretexts for these schemes are as fallacious as their EIAs. For instance, The Chambal – Dholpur – Bharatpur Water Supply Scheme was born as a result of water woes in Rajasthan's Bharatpur district; but what was being projected as water scarcity was an outcome of poor water management and caste hostilities between the politically influential Meenas (a

[44] Water Resources Department, Rajasthan; Study on Planning of Water Resources of Rajasthan; http://waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter14.pdf

[45] Jai Smita; Assessment of water quality at the three Stations of Chambal River ; International Journal Of Environmental Sciences Volume 3, No 2, 2012

[46] Central Pollution Control Board; Status of Water Quality in India 2011; http://www.cpcb.nic.in/upload/NewItems/NewItem_193_WaterQuality2011.pdf

[47] Central Pollution Control Board: River Stretches For Restoration Of Water Quality- 2014-15

[48] Times of India; Illegal mining rampant in Banas, Chambal rivers. Accessed on September 1, 2016; 07:42 pm http://timesofindia.indiatimes.com/city/jaipur/Illegal-mining-rampant-in-Banas-Chambal-rivers/articleshow/21663897.cms

Scheduled Tribe) and the traditionally pastoralist Gujjar community demanding Scheduled Tribes status in Rajasthan (Dutta 2011; Parihar 2007). Rather than deal with the real issues — of putting an end to caste feuds, restoring the now dry Banganga River, undertaking local water conservation measures, and ensuring equity in its distribution — the state of Rajasthan sought to band-aid the communal fissure by pumping water from the Chambal over 80 km away.[49]

The channelisation of the river to meet needs of Madhya Pradesh and Rajasthan has impacted the ecology. The water level recedes during non-monsoon months. In December 2016, the National Green Tribunal directed Madhya Pradesh and Rajasthan governments to provide their opinion if they would part with 10 per cent of their water share for maintaining the environmental flow in Chambal river in the lean period between January and June.[50]

The green panel also directed that the two state governments to work out the details in this regard, particularly with reference to their various requirements and the excess water that can be safely made available for maintaining environmental flow in Chambal.

11.4 Biodiversity

Chambal is home to a rich diversity of flora and fauna. The National Chambal (Gharial) Wildlife Sanctuary is famous for Gharials (Gavialis gangeticus), the freshwater fish-eating crocodiles, and the rare Ganges river dolphin. The sanctuary was founded in 1978 and is part of a large area co-administered by Rajasthan, Madhya Pradesh and Uttar Pradesh. Around 400 km of the river is within the reserve which hosts 21 reptiles, over 200 species of birds, 55 mammals and over 100 fish species among others.[51]

[49] https://thewire.in/91414/chambal-son-gharial-bansagar/

[50] http://www.hindustantimes.com/bhopal/saving-chambal-s-ecology-will-you-give-up-10-of-water-share-ngt-asks-mp-rajasthan/story-clvzixpiJTNjjmbt1R9uzK.html

[51] Nair Tarun; Parching the Chambal River Basin: Unrelenting irrigation schemes wring the unique Chambal dry; http://conflicts.indiawaterportal.org/sites/conflicts.indiawaterportal.org/files/Parching%20the%20Chambal%20River%20Basin_Water%20Conflicts%20in%20India_Tarun%20Nair_for-publishing.pdf

Figure 9: Chambal river near Kota

However, the population of Indian Skimmer (Rynchops albicollis) across Chambal River has declined to a dangerous level and sand mining is believed to be one of the reasons.[52]

The human-crocodile conflict is also rising as. In December 2007, over 110 carcasses of sub and young gharial adults were reported in the Chambal river, which harbours about 80 per cent of the global gharial population. No conclusive cause was established, though poisoning was suspected.[53]

The dams on Chambal have played havoc with an evolutionary process so fine-tuned to the changing seasons and natural flood pulses that a departure from these synchronies often has disastrous consequences for gharials, turtles and ground-nesting birds. The breeding adaptations of these species reflect seasonal changes in water levels; nesting takes place

[52] Times of India; Indian skimmers have stopped breeding in Chambal: Report. Accessed on September 1, 2016; 08:16 pm. http://timesofindia.indiatimes.com/city/bhopal/Indian-skimmers-have-stopped-breeding-in-Chambal-Report/articleshow/46803461.cms

[53] Indian Express; A gharial on the sandbank. Accessed on September 1, 2016. http://indianexpress.com/article/lifestyle/life-style/a-gharial-on-the-sand-bank/

when low water levels expose sand deposits, and hatching precedes the monsoonal floods. But erratic water releases in the past have inundated several nesting sites, and at other times, these sudden discharges have also washed away gharial hatchlings from the relatively protected confines of the National Chambal Sanctuary to the more hostile, over-fished waters of the Yamuna, Betwa and Ken, where interviews with fishermen have revealed the frequent deaths of young gharials in their nets, especially in the monsoons (Choudhury, et al. 2007; Nair 2012; Nair and Katdare 2013).[54]

There are projects which don't take into account the environmental value of the region. The Environment Assessment Document of the Dholpur Water Supply Sub-project did not acknowledge the National Chambal Sanctuary, in an attempt to by-pass a notification which states that projects located within 10 km from the boundary of protected areas requires Environmental Clearance from the National Ministry of Environment and Forests (MoEF).[55]

Chambal Water-sharing Agreement

Rajasthan has an agreement with Madhya Pradesh to equally share the water collected at the Kota Barrage, located about 0.8 km upstream of Kota city in Rajasthan. Water released after power generation at Gandhi Sagar, Rana Pratap Sagar and Jawahar Sagar dams, is diverted by the barrage for irrigation in Rajasthan and in Madhya Pradesh through canals on the left and the right sides of the river. The two states have, however, experienced rifts over the years. Rajasthan accused Madhya Pradesh of constructing several check dams in the catchment area without prior consultation thus reducing inflow of Gandhi Sagar dam[56]. On the other hand, Madhya Pradesh claimed that Rajasthan was drawing excessive water from the Kota Barrage leading to a serious water problem in its area[57].

[54] https://thewire.in/91414/chambal-son-gharial-bansagar/

[55] Nair Tarun; Parching the Chambal River Basin: Unrelenting irrigation schemes wring the unique Chambal dry. http://conflicts.indiawaterportal.org/sites/conflicts.indiawaterportal.org/files/Parching%20the%20Chambal%20River%20Basin_Water%20Conflicts%20in%20India_Tarun%20Nair_for-publishing.pdf

[56] http://archive.indianexpress.com/news/rajasthan-mp-faceoff-over-chambal-water/6876/0

[57] http://daily.bhaskar.com/news/MP-BHO-mp-rajasthan-to-settle-chambal-issue-2989654.html

11.5 River Inter-Liking to impact Chambal

Most of the river-interlinking projects are on tributaries of Chambal. Parbati, Newaj (a tributary of Kalisindh) and Kalisindh rivers are believed to have sizeable surpluses after meeting the existing and projected requirements for irrigation, domestic & industrial purposes within the basins upto 2050 AD.

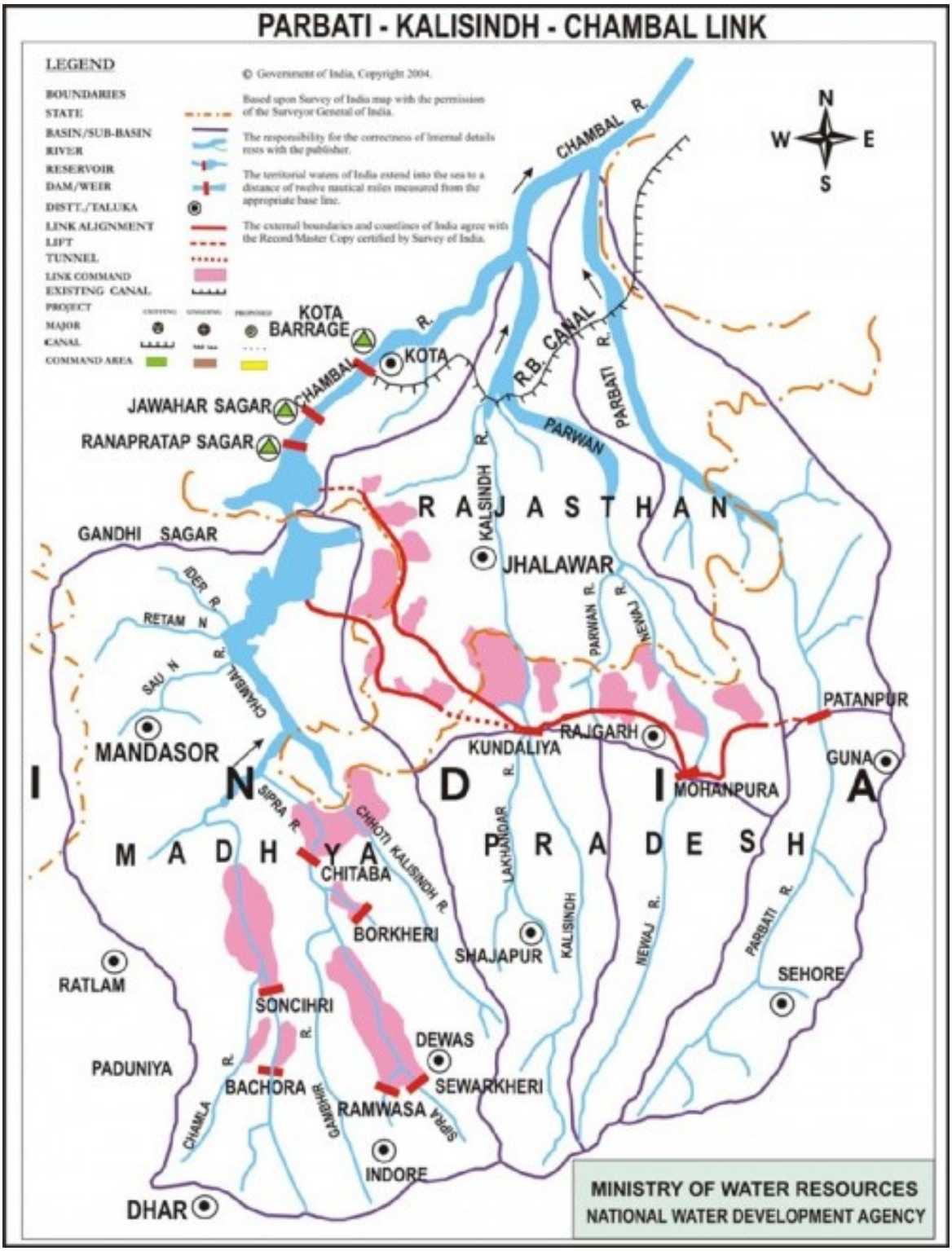
Thus the proposed Parbati-Kalisindh-Chambal link project will divert the waters of Parbati, Newaj and Kalisindh rivers to Chambal river at Gandhi Sagar or Rana Pratap Sagar dams after providing irrigation facilities in the enroute of link in the Rajgarh, Guna, Shajapur, Mandsaur, Morena or Bhind districts of Madhya Pradesh and Jhalawar, Kota and Chittorgarh districts of Rajasthan..

The project will comprise a diversion dam at Patanpur on river Parbati, a diversion dam at Mohanpura on river Newaj and a storage dam at Kundaliya on river Kalisindh. The water from Kundaliya dam will transfer water either to the existing Rana Pratap Sagar dam or the Gandhi Sagar dam.

The feasibility report of the Parbati – Kali Sindh – Chambal Link Project (National Water Development Agency 2004) notes that project affected people will be 'rehabilitated on proper location' and be provided with, among other things, 'life support systems, employment opportunities and recreation facilities' to 'reduce the resettlement problem' and 'improve the lifestyle of the people'. These are obviously mere platitudes[58] and self vindication to go ahead with the project any which way (e.g. Hemadri, et al. n.d.), as evident from the poor record of rehabilitation and restoration efforts in India. The feasibility report also notes that 244.4 hectares of forest will be submerged, and suggests 'the wood obtained from these forests can be utilised for construction of project, colonies etc.' The report then strangely concludes that 'there will be very little impact on the flora and fauna of the region'.

While water is the very essence of a river, this project assessment does not even consider the implications of diverting water from the Parbati and Kali Sindh Rivers. These rivers are the most crucial lifelines of this river sanctuary along with the now strangled Chambal.

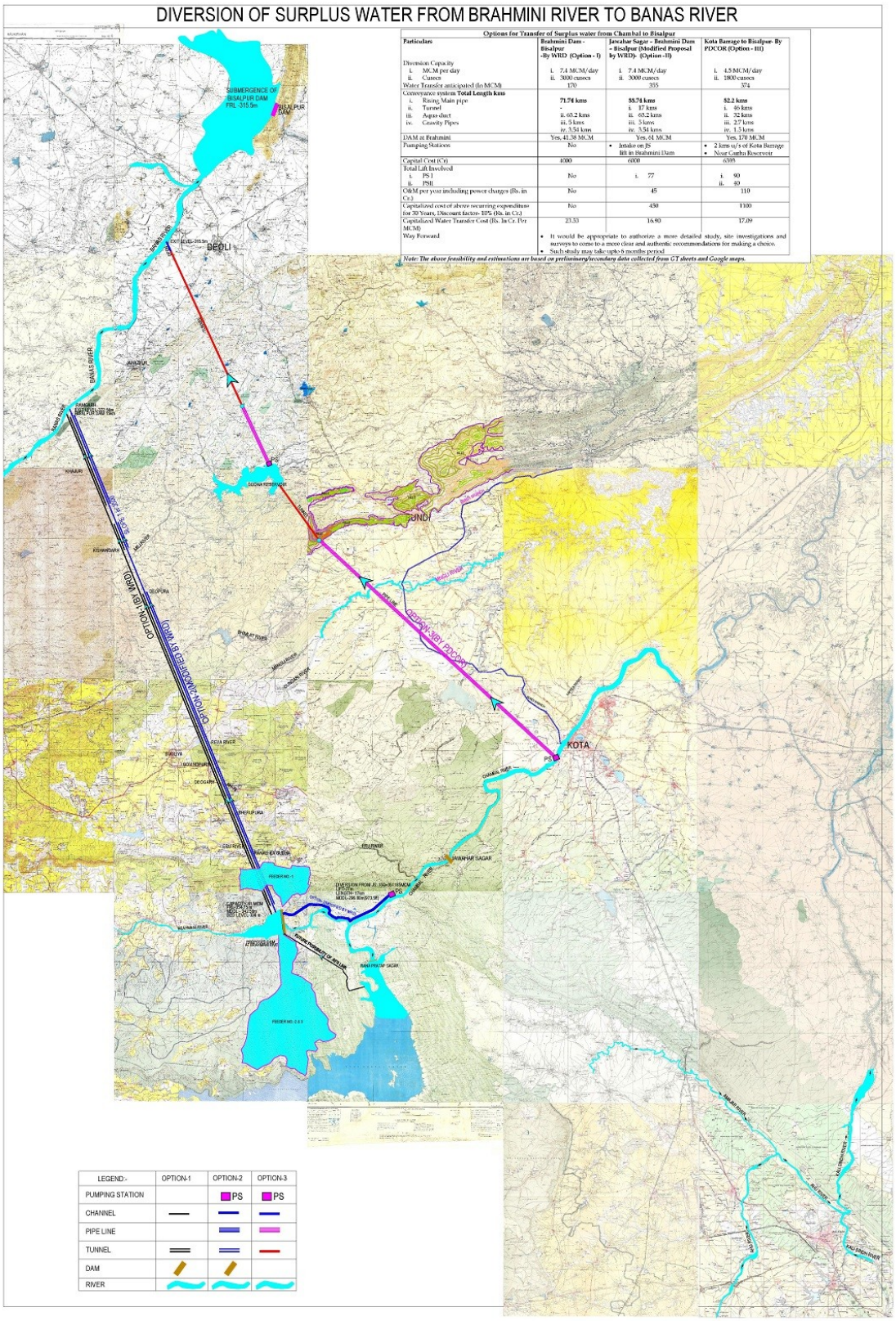
[58] https://thewire.in/91414/chambal-son-gharial-bansagar/



Map No 13: Parbati - Kalisindh - Chambal Link

Around 355 million cubic metre of water from Brahmini river will be diverted to Banas upstream of Bisalpur dam.[59]

[59] http://timesofindia.indiatimes.com/city/jaipur/Linking-of-rivers-takes-shape-in-Rajasthan-Brahmani-to-be-connected-to-Banas/articleshow/43036291.cms



Map No 14: Diversion of Surplus Water From Brahmini River to Banas River

On the other hand, Sawai Madhopur, Karauli, Alwar and Dholpur districts will be benefited through lifting of waters of Parwati and Kali Sindh rivers before they join Chambal. These rivers

will be linked to Banas, Gambhir and Parbati basins through two alignments, bypassing Chambal[60].

11.6 Performance of dams on Chambal

The three dams on Chambal namely Gandhi Sagar, Rana Pratap Sagar and Jawahar Sagar, have been performing below the proposed capacity[61].

A data of 25 years analysed by SANDRP showed that power from each of the project dropped by over 25 per cent. The three projects collectively were expected to generate 1177 million units or more in 90 per cent of the years, but the actual generation was only 554 MU which was even lower than 50 per cent of the design generation.

The percentage under performance for Gandhi Sagar, Rana Pratap Sagar and Jawahar Sagar has been 72.86 per cent, 47.71 per cent and 32.69 per cent respectively with Gandhi Sagar has been the worst performer.

The reservoir filling graphs of 2003 to 2010 showed that that Gandhi Sagar dam was filled to the capacity only once (2006), while Rana Pratap Sagar was filled closed to the full capacity only thrice. This underscores the overdesign of the two reservoirs and need for reduction of full reservoir levels.

11.7 Red (Critical), Pink (Threatened) and Blue (healthy) Status of rivers of Chambal

The basin of the river Chambal within the state would qualify for a Red status because of the threats faced by its tributaries from rampant sand mining, industrial and domestic pollutants and number of water harvesting structures including dams, barrages and anicuts which are affecting the environmental flow and biodiversity of the river.

According to Inter-state river water quality (Water Quality of Rivers at Inter-state borders, CPCB, 2015) report, the 60 km stretch along Bisalpur dam, Swaroopganj and Newta Dam on Banas river is the most polluted stretch in Rajasthan with biological oxygen demand (BOD) ranging from 4.2 to 39.9 mg/l

[60] http://waterresources.rajasthan.gov.in/riverbasin/PKCMap.pdf

[61] http://sandrp.in/dams/The_strong_case_for_reducing_Water_Level_of_Gandhi_Sagar_Dam_Dec_2010.pdf

The 20 km stretch between Barod and Gadepan on Kali Sindh river is the second most polluted stretch in Rajasthan with biological oxygen demand (BOD) ranging from 7.7 to 26.9 mg/l. The 10 km stretch between Khatoli to Todra on Parvati river is third most polluted with BOD at 15.4 mg/l. The 65 km stretch between Sawai Madhopur and Kota has also been termed polluted but placed on the lowest priority among all polluted stretches with BOD range: 3.5-4.1 mg/l. Non-polluted waters have BOD below 1 mg/l.

Hence, Chambal and its tributaries have the distinction of hosting the most polluted stretches in Rajasthan.

Table 4: Pollution Level of River

S. No	River	Pollution level	Other threats	State
1	Chambal	Low	Interlinking of tributaries.	Blue
2	Banas	High	Sand Mining	Red
3	Kali Sindh	High	….	Pink
4	Parwati	High	….	Pink

Parching the Chambal River Basin: Unrelenting irrigation schemes wring the unique Chambal dry

Tarun Nair

Description

The 960 km long Chambal River originates from the Singar Chouri peak in the northern slopes of the Vindhyan escarpment, 15 km West-South-West of Mhow in Indore District in Madhya Pradesh state, at an elevation of about 843 m. The river flows first in a northerly direction in Madhya Pradesh for a length of about 346 km and then in a generally north-easterly direction for a length of 225 km through Rajasthan. The Chambal flows for another 217 km between M.P. and Rajasthan and further 145 km between Madhya Pradesh and Uttar Pradesh. It enters Uttar Pradesh and flows for about 32 km before joining the Yamuna River in Etawah District at an elevation of 122 m, to form a part of the greater Gangetic drainage system (Jain et al., 2007).

The Chambal is a rainfed catchment and the total area drained up to its confluence with the Yamuna is 1,43,219 km2. The Chambal drainage area resembles a rectangle up to the junction of the Parvathi and Banas Rivers with the Chambal flowing along its major axis. The Chambal

Basin lies between latitudes 22° 27' N and 27° 20' N and longitudes 73° 20' E and 79° 15' E. On its south, east and west, the basin is bounded by the Vindhyan mountain ranges and on the north-west by the Aravallis. Below the confluence of the Parvathi and Banas, the catchment becomes narrower and elongated. In this reach, it is bounded by the Aravalli mountain ranges on the North and the Vindhyan hill range on the south (Jain et al., 2007). The entire Chambal River basin extends over Madhya Pradesh, Rajasthan and Uttar Pradesh covering around 93 tehsils and 24 districts (Hussain & Badola, 2001). According to Crawford (1969), the Chambal river valley is part of the Vindhyan system which consists of massive sandstone, slate and limestone, of perhaps pre-Cambrian age, resting on the surface of older rocks (Crawford, 1969). Hillocks and plateaus represent the major landforms of the Chambal valley. The Chambal basin is characterised by an undulating floodplain, gullies and ravines (Gopal & Srivastava, 2008). The Hadauti plateau in Rajasthan occurs in the upper catchment of the Chambal River to the southeast of the Mewar Plains. It occurs with the Malwa plateau in the east. Physiographically, it can be divided into Vindhyan scarp land and Deccan Lava (Malwa) plateau (Sinha et al., 1998). Badland topography is a characteristic feature of the Chambal valley, whereas kankar has extensively developed in the older alluvium (Heron, 1953).

The area lies within the semi-arid zone of north-western India at the border of Madhya Pradesh, Rajasthan and Uttar Pradesh States (Hussain, 2009), and the vegetation consists of ravine, thorn forest, a sub-type of the Northern Tropical Forests (Sub-group 6B/C2 of the revised classification of Champion & Seth, 1968). Since 1979, a 600 km stretch of the Chambal River between Kota barrage and Chambal - Yamuna confluence has been protected as the tri-state National Chambal Sanctuary. It is also an Important Bird Area (Birdlife International) - Site Code IN-UP-11 and IN-RJ-11 (Islam & Rahmani, 2004). The Chambal is one of the last remnant rivers, in the greater Gangetic Drainage Basin, which has retained significant conservation values (Hussain & Badola, 2001). It contains the largest contiguous and most viable breeding populations of the critically endangered gharial and red-crowned roofed turtle (http://madrascrocbank.blogspot.com; http://www.conservation.org). Other species of immediate concern include the Gangetic Dolphin, Narrow-headed Giant Soft-shelled Turtle, Three-striped Roofed Turtle, Indian Skimmer, Black-bellied Tern and Sarus Crane. Overall, the faunal and floral assemblage includes

21 reptiles, over 200 species of birds, 55 mammals and over 100 fish species, among others.

The conflict: Water impoundment & extraction

Humans live in high densities near waterways and extensively modify riparian zones, and consequently, species diversity of inland waters is among the most threatened of all ecosystems (Sala, 2000). The Chambal is one of the last remnant rivers, in the greater Gangetic Drainage Basin, which has retained significant conservation values (Hussain & Badola, 2001). However, this sanctuary suffers from hydrological modifications due to dams and from the diversion of river water for irrigation, and from activities like sand-mining; fishing, and persistent livestock and human presence (Hussain 2009, Nair 2010). The 7 major, 12 medium and 134 minor irrigation projects operating in the Chambal River basin, have greatly reduced river flow, and erratic water releases, in the past, have inundated several nesting sites (Hussain & Badola, 2001). These notwithstanding, 52 irrigation projects are under construction and 376 projects have been planned in the basin (Hussain 2009). Two major tributaries, the Parwati and Kali Sindh, are the main sources of water flowing in the Chambal in the downstream section. However, the new Parwati-Kali Sindh-Chambal Link proposes to divert the 'surplus' waters of the Parwati, Newaj and Kalisindh rivers to the Gandhisagar/Rana Pratap Sagar Dam on the River Chambal.

This will now deny the Chambal whatever water, sand and silt it receives from these tributaries. Sand banks, bars and spits are important resting and breeding sites, in the National Chambal Sanctuary for crocodilians, freshwater turtles and ground-nesting birds. And the loss of these sites has been a major cause for their population declines. Upriver dams also exacerbate the problem by preventing replacement sand from coming downriver while increasing erosion by periodic and unseasonable elevation of water levels.

Upstream and downstream effects of dams are well-known, stemming from inundation, flow manipulation, and fragmentation. Inundation destroys terrestrial ecosystems and eliminates turbulent reaches, disfavouring lotic biota. It can cause anoxia, greenhouse gas emission, sedimentation, and an upsurge of nutrient release in new reservoirs. Flow manipulations hinder channel development, drain floodplain wetlands, reduce floodplain productivity, decrease dynamism of deltas, and may cause extensive modification of aquatic communities. Dams obstruct the dispersal and migration of organisms, and these and other effects have been directly linked to

loss of populations and entire species of freshwater fish (Nilsson et al 2005).

In the face of increasing proposals for water extraction and impoundments on the Chambal, and nation-wide river-linking aspirations, the above threats will only be exacerbated. Effects of low flow –

a) Habitat fragmentation for aquatic species.
b) Isolated pools vulnerable to anthropogenic activities e.g. Netting, dynamiting (Dubey & Mehra, 1959; Humraskar & Velho, 2009).
c) Fish stocks determined by low water carrying capacity of deep pools.
d) Increased access to people for river crossing by foot and tractor, fishing, sand mining (Nair, 2010).
e) Reduced number of inaccessible islands, resulting in increased nest destruction of skimmers, gharial, turtles, terns, pratincoles (Sundar 2004, Nair 2010).

Effects of irregular/unnatural flow regimes -

a) Flooding of nesting habitat during critical times. Affects ground-nesting species. Eg: terns, skimmers, pratincoles, gharial, batagur turtles. Gupta (1998) mentions faulty operational procedures of the Gandhisagar Dam.

b) Insufficient flooding to maintain morphology of deep pools.

c) Insufficient flooding to maintain siltation rates/sand bank formation.

'The Guidelines for sustainable water resources development and management from the Central Water Commission (CWC) of Government of India in 1992 suggested that the minimum flow in the river should not be less than the average of 10 days minimum flow of the river in its natural state. Unfortunately, this did not have force of law and the CWC itself has not been adhering to these guidelines while giving techno economic clearance to irrigation and hydropower projects.'(Dams, Rivers and People, 2008). Despite being signatory to the Farakka Barrage Treaty with Bangladesh, India does not release the promised volume of water (Ramachandran, 2006). The Chambal is part of the Gangetic basin and hence, the river discharge/flow rates are classified and difficult to obtain. Therefore, it is highly likely that the 1992 guidelines are not being adhered to.

According to the Wildlife Institute of India (2010) study report, 'The average quantity of water

used for irrigation by Rajasthan and Madhya Pradesh through the creation of Gandhi Sagar dam and water abstraction via Kota Barrage has decreased by 22.6% and 41.4% respectively in last 17L18 years, whereas the use of water for non-irrigation (industrial and drinking water purpose) has increased three folds (Gupta and Attari, 2007) resulting in shortage of water in the downstream. By the year 2002L03 the net water use for nonLirrigation purpose was almost 41% (Gupta and Attari 2007).'

Current status

Despite the failures and incompetency of existing irrigation projects in the Chambal Basin (Gupta, 1998; Gupta & Kawadia, 2003), the Irrigation and Water Resource Departments of Rajasthan, Madhya Pradesh and Uttar Pradesh continue to propose water impoundment and extraction schemes, often using fraudulent Environment Impact Assessments. As a case in point, the Environment Assessment Document of the Dholpur Water Supply Sub-project does not acknowledge the National Chambal Sanctuary, in an attempt to by-pass a notification which states that projects located within 10 km from the boundary of protected areas requires Environmental Clearance(EC) from the National Ministry of Environment and Forests (MoEF). The document also categorically states that "As there is no significant flora and fauna in or around Chambal River, there should also not be any ecological impacts from the increase in abstraction"; and that " There are no uncertainties in the analysis, and no further studies are required to comply with Asian Development Bank procedure or national law" (RUIDP 2008).

Several new project proposals lie before the Standing Committee of the National Board of Wildlife awaiting approval.

Highest and lowest points With increasing demands for freshwater and proposals for water abstraction, the conflict is set to escalate. The three state governments, especially Rajasthan and Madhya Pradesh, have been unrelenting in their efforts to exploit the Chambal waters. And unfortunately, active 'watchdog' groups are absent in the region.

A Wildlife Institute of India (2010) study reports that in the present flow regime, 78.1% and 82.1% of the river stretch between Jaitpura and Panchhnada respectively, was found to be suboptimal for adult gharial and river dolphins respectively. Abstraction of water will further reduce the flow and may fragment the riverine habitat affecting the large aquatic vertebrates such

as river dolphins, gharial and mugger. The discharge of Chambal River after Kota barrage is zero. Only after the confluence with Parvati near Pali, does the Chambal River regain some flow. During the present study in the months of June-July the mean flow of the river was 16.38 ± 1.99 m3/sec only. Data provided by the Central Water Commission shows that the flow at Udi often reaches as low as 6.13 m3/sec. The combined water requirements of the 4 lift irrigation projects (Pinahat, Dholpur, Aisah & Kanera) is ca. 31.5 m3/sec. If these projects become operational, there will be no flow in the river and there will be deficit in water availability in the downstream stretches of the river.

The opposing stands India's water use policy seems to be based on the surmise that all freshwater is for human disposal and that no quantity of it shall be 'wasted' into the sea. The political and administrative class, who are largely insensitive and feign ignorance towards ecological concerns, are under the impression that only large-scale water impoundment and abstraction can solve the country's water requirements, without any concern to the ecological and socio-economic costs involved, which are in any case considered as externalities. As mentioned earlier, 7 major, 12 medium and 134 minor irrigation projects are operating in the Chambal River basin, a further 52 are under construction, and 376 projects including the Parwati-Kali Sindh-Chambal River link have been planned. These disruptions to natural flows, flood pulses and other hydrological processes are not only a dire threat to the unique faunal assemblages of the Chambal, but also have serious implications for downstream fisheries, that provide livelihood and sustenance to millions of dependent people. Numerous studies have documented how large dams and river-linking have displaced people, destroyed fisheries and damaged ecosystems. Yet, there seems to be no paradigm shift in an effort to maintain the integrity of rivers and ensure long-term water security.

Scope for dialogue

Natural hydro-biological processes and the interactions of the various aquatic biotic communities regulate the quality of freshwater, and this needs to be appreciated be all stakeholders. Rivers must be maintained as functional, dynamic entities; and river basins need to be recognised as single ecological units. Binding guidelines in the form of legislation, combined with coordinated policies across sectors, are required to mitigate the impacts of land use and water abstraction,

through integrated river basin management. If we are serious about restoring our rivers, then we need to restore water flows and fisheries too; abandon all plans for river-linking, and decommission existing irrigation projects (in phases), discontinue further construction and reject all proposed water impoundment and extraction projects.

http://conflicts.indiawaterportal.org/sites/conflicts.indiawaterportal.org/files/Parching%20the%20Chambal%20River%20Basin_Water%20Conflicts%20in%20India_Tarun%20Nair_for-publishing.pdf

12. Banganga

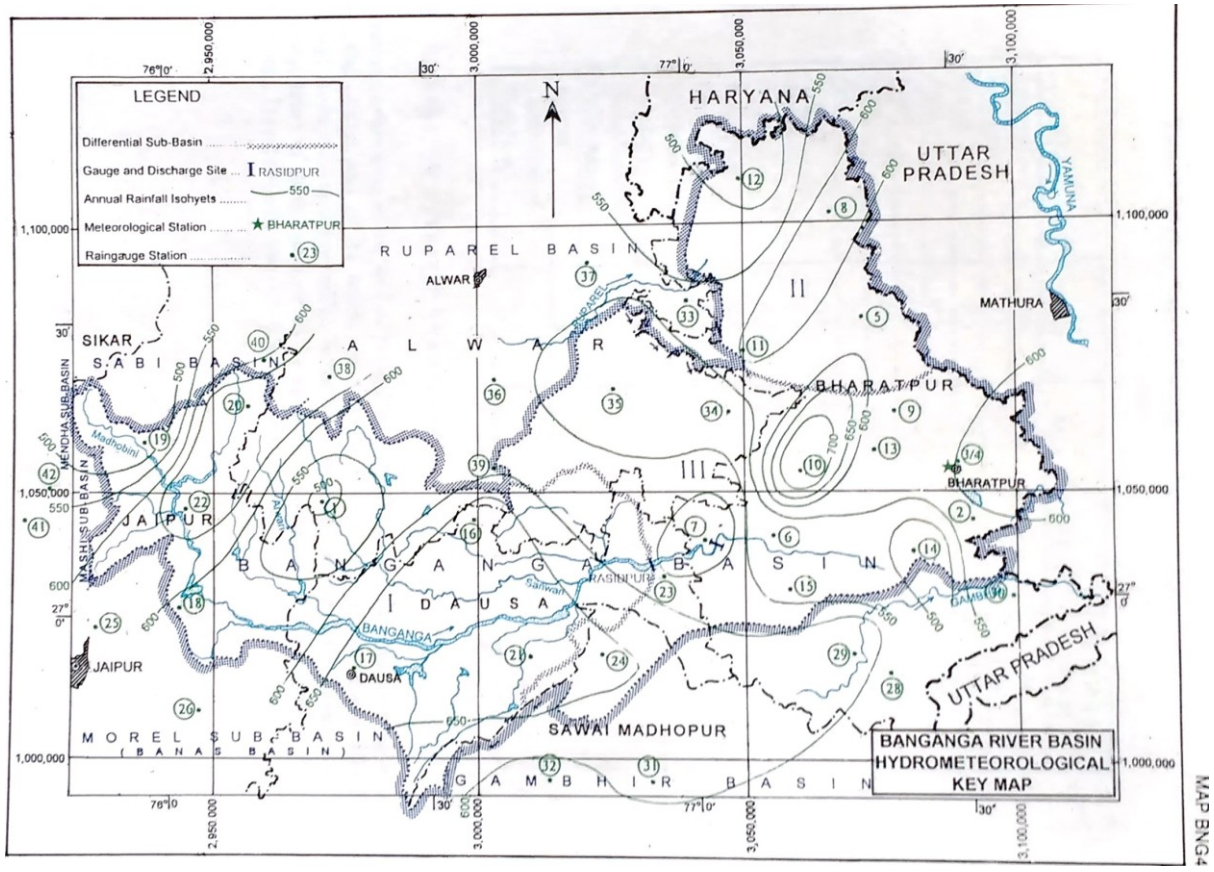
Banganga is a river originating from near Bairath (Viratnagar) in Aravali hills north of Jaipur and drains inland. Its basin extends over parts of Alwar, Jaipur, Dausa, Sawai Madhopur and Bharatpur districts. The total catchment area of the basin is 8,878 km^2.

The total length of the river is 240 kms with main tributaries being Gumti Nalla and Suri River, joining it on its right bank, and Sanwan and Palasan Rivers, on its left bank

Map No 15: Banhanga River Basin in Rajasthan

Bharatpur and Dausa are the two major towns falling in the river basin. Ramgarh lake was the main reservoir which got supply from Banganga and served the drinking water needs of Jaipur

city. However, it dried out in the year 2000[62] due to low water inflow thanks to huge number of encroachments in the catchment area.[63]



Map No 16: Banganga River Basin

Name of river	Length (in km)
Banganga	240
Gumti	24
Suri	98
Sanwan	95
Palasan	48
Source: Water Resources Department, Rajasthan	

There is one major project, 10 medium and 177 minor irrigation projects in Banganga river basin, as well as several small irrigation systems (covering less than 20 ha) constructed and operated by Panchayat Samities.

[62] Sebastian, Sunny. "Jaipur Lake a scorched bed now". The Hindu. Accessed on September 1, 2016; 9.00 pm. http://www.thehindu.com/thehindu/2000/05/01/stories/0401221j.htm

[63] Singh, Ajay ;"Damned" Ramgarh still dry". Times of India. Accessed on September 1, 2016; 9.00 pm. http://timesofindia.indiatimes.com/city/jaipur/Damned-ramgarh-still-dry/articleshow/15626741.cms

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[64]. Another theory suggests that Yamuna suddenly migrated eastward and Banganga and another possible tributary, Sahibi, could not cope up with that pace.[65] Now, both these rivers flood the area of Bharatpur and Farrukhnagar respectively.

Figure 10: Banganga near Dausa. Irrigation pumps have been dug to fetch water from the river

12.1 Mythology and Culture

Banganga originates from a place close to Bairath or Viratnagar, around 85 km from Jaipur. 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.

[64] Sharma Hari Shanker; Tropical Geomorphology: A Morphogenetic Study of Rajasthan

[65] Sing Upinder; Delhi: Ancient History

12.2 Biodiversity

Banganga river basin has a rich biodiversity and it also hosts Sariska Wildlife Sanctuary. It comprises of scrub thorn and dry deciduous forest with Dhok tree ((Anogeissus pendula) being in majority. Other trees include the salar (Boswellia serrata), kadaya (Sterculia urens), dhak (Butea monosperma), gol (Lannea coromandelica), ber (Ziziphus mauritiana), khair (Acacia catechu), bargad (Ficus benghalensis), arjun (Terminalia arjuna), gugal (Commiphora wightii) and bamboo. Shrubs are numerous, such as kair (Capparis decidua), adusta (Adhatoda vesica) and jhar ber (Ziziphus nummularia)..

Leopards, wild dogs, jackals, hyenas, jungle cat, caracal, chital, sambhar, nilgai, chinkara, four-horned antelope, wild boar, hare, langur, rhesus monkeys and a few tigers can also be seen especially in the sanctuary area. Commonly spotted birds are peacocks, parakeets, red jungle fowl, quail, grey partridge, white-throated kingfisher, sand grouse, treepie, golden-backed woodpecker, crested serpent eagle and the Indian eagle-owl.

12.3 Modern-day pressures

Gravel and sand mining have been two most destructive activities on Banganga. Just like other seasonal rivers of Rajasthan, the riverbed of Banganga has been encroached at various places by adjacent farm owners who keep expanding their area by dumping more soil. Near Dausa, wells have been sunk right into the riverbed from where water is lifted through motor pumps and supplied to nearby fields.

Jamwa Ramgarh dam near Jaipur has been dry since 2006. Constructed in 1903, the Ramgarh dam was commissioned by Jaipur king Madho Singh II. But it started supplying water to the city only in 1931. The Ramgarh lake or reservoir shot to international fame in 1982 when the reservoir or lake hosted the rowing events of Asian Games.

The four rivers, Roda, Banganga, Tala and Madhoveni, which used to bring their water to the dam, have gone dry over the years thanks to deforestation, mining and other developmental activities.

After the Rajasthan High Court took suo moto congnisance of the drying up of Ramgarh Lake in 2011, it was found that its catchment area, spread over 700 sq km, had as many as 405 anicuts and around 800 encroachments, including education institutes and farm houses.

The High Court directed reduction in heights of the anicuts to maximum of 2 metre and removal of all encroachments so that the lake could be restored to the 1982 status. The

anicuts, mostly owned by the Rajasthan Panchayati Raj Department, were reduced to the height of 2 metres, but it had little impact on the flow of rivers as encroachments have already obstructed their paths. Only 20 per cent of these encroachments were removed.

The drying up of lake has greatly impacted the wildlife. Last year, a crocodile walked out of Ramgarh lake and reached Jamwa Ramgarh village, a distance of seven kilometers. The lake used to have around 100 of its species at one time.

12.4 Red (Critical), Pink (Threatened) and Blue (healthy) Status of rivers of Banganga

The basin of the river Banganga within the state would qualify for a Pink status because of excessive encroachment on their riverbeds because of their seasonal flow, number of water harvesting structures including dams, barrages and anicuts on the tributaries and sand mining.

Figure 11: A Sambhar near the Sariska Wildlife Sanctuary

Nanduwali, a tributary of Banganga is witnessing better days now with villagers coming together to revive the local ecology. From a once dried up rivulet, Nanduwali has started flowing again thanks to such community efforts.

A river comes to people

Nanduwali in east Rajasthan started flowing again when the villagers decided to work with nature and not against it. The river is now lifeline to those settled on her banks

Gajanand Sharma is excited about the monsoon this year. He is building an anicut on the small stream that runs through his farm. “After the rain, the land will be filled with water and then I will sow wheat and reap record production in this area,” he prophesises. This forecast doesn’t come from his knowledge of astrology, but that of geology, gained over the years.

Anicut is a cement wall erected perpendicular to the natural flow of a river or a stream. The excess water overflows the walls while the water it can hold, gradually seeps down the earth,

raising the groundwater level and replenishing wells. The water also brings fertile silt from upstream, enriching the land beneath it. This monsoon, Sharma's farm at Ghewar village on the southern edge of Sariska Tiger Sanctuary in Alwar district of Rajasthan will witness this. The anicut will also recharge over a dozen wells downstream; the reason why the neighbouring farm owners too have chipped in with labour and finances.

Besides anicuts, the region has several johads (ponds), medhbandhi (farm bunds) and a rich forest, that turn 20 villages in a radius of 160 square kilometres water surplus. The most evident indicator of the ecological wealth here is Nanduwali, the river which had gone completely dry once, but filled up again after the water table rose and seeped into its channels.

When it was worse

There was a time when these farmers believed that crops grow only with the rainfall on their farms and in wells. They had little knowledge about the underground movement of the water and how that can be enhanced.

"We were heavily dependent on rain and were reaping very little harvest. Only one third of the land could be cropped. Wells would dry up frequently forcing us to migrate to earn a living," recalls Sharma who spent five years in Delhi doing odd jobs.

The condition of the lower caste families was worse. They either had no land or an infertile patch allotted from the common land belonged to the village. The women would walk 2.5km to Nandoo village, which had more upper caste families, who gave them butter milk in return for managing animal waste. Men would work on others' farms and get a small share of whatever grew in the good monsoon year. Those with fields and livestock also saw difficult times forcing them to sell their buffaloes because they could not afford to feed them. Huge money had to be spent on the transportation of fodder. Many families replaced the buffaloes with goats.

Today, Ghewar is dotted with pucca houses, good strength of livestock and abundant vegetable farms. A tourist resort has also come up on the outskirts offering rural life experience to the city bred looking for a break from the urban life. Water is available at 40-50 feet despite the monsoon deficit of over 40 per cent last year.

But it's not just about the water-harvesting structures or the wealth attained that make Ghewar and surrounding villages unique. Had it been so, many regions in Rajasthan have seen a spurt of watershed-management activities and subsequent growth in agriculture. But the real test takes place when these structures break down and the financial support withdrawn.

Beginning of a change

Brothers Kunj Bihari and Satish Kumar from Nandoo village wanted to make their region water surplus. But the weak local economy and a divided society were the biggest barriers to their aspiration.

"Despite being a local, it took me one year to gain the confidence of the people. Even though johads are heritage of this region, the loss of traditional wisdom made people doubt if building johads and conserving the forest can assure more water in the wells. The real task was to make all castes sit and work together," says Kunj Bihari.

Another challenge was to make the villagers self-reliant. Sambhaav Trust, which supported the work initially, was clear that the society has to partly fund the rejuvenation work. The villagers did not have money to contribute, but they chipped in with labour as part of their 25 per cent share.

The good result yielded from the first johad built in Ghewar village helped. "In the first year, the water level of a well near the johad went up by 50 feet. This was real evidence of what we had been trying to explain. Once they started trusting us, all social boundaries were broken because everybody wanted to prosper. They were ready to meet all conditions," Kunj Bihari says.

The brothers also depended a lot on the knowledge of the elderly, who recalled the systems once prevalent to connect the society with nature. In the past, the full moon and the new moon days were always kept for volunteer work which included strengthening johads or tree plantation. "We revived these traditions along with physical work. After all these years,

everybody has realised the connection between social unity, ecology and farm production," Kunj Bihari says.

Reconnecting with tradition

New red leaves are sprouting out of Dhaak (Butea monosperma/ flame of the forest) trees but the canopies of Kadam (Neolamarckia cadamba), Dhonk (Anogeissus pendula) and Khejri (Prosopis cineraria) are mature enough to merge and shield us from the harsh summer sun. Peacocks raise a ruckus as we drive towards the Hanuman temple in Jahaj region, north of Nandoo. The unmetalled road, full of rocks and shrubs, give way to moistened earth until it merges with water. This is the point of origin of Nanduwali river, which nourishes the farms and the wells of several villages in the region. Around 20 small streams join the river in its onward journey towards Manglasar dam.

It's difficult to imagine today that the whole stretch was once dry, but easy to comprehend why it's flowing again. There was no plan to revive Nanduwali, but nature responded positively to the conservation efforts of the villagers.

In bygone times, the region used to have forests and grazing areas demarcated for specific purposes. If Dev Bani was a sacred grove never to be damaged, Rakhat Bani, a protected forest area, was to be used only during droughts. Kaankar was a forest area that separated the two villages and Charagah was the area for pasture. Dharadi pratha was another custom in which every caste had a sacred tree species. "Our caste has Khejri as its dharadi. We would pray to it on auspicious occasions, plant and nourish more of it and won't allow anybody to harm it in

front of us," Kunj Bihari says.

In these villages, all these traditional practices were revived and special forest -protection committees were formed which penalised those who disobeyed the rules. This put a halt on the corrupt forest officials who allowed the villagers to cut trees in exchange for grains and ghee.

Thankfully, nature responded very well to such efforts. Today, there is little revenue land which is not covered by trees. Pipalvani is a stretch with hundreds of young pipal trees protected by the villagers. "More than plantation, it's the protection from grazing that has helped with the green cover. Once villagers recognised the connection between forest, water and farming, they were willing to work with nature," Kunj Bihari says.

A credible indicator of this transformation is that while the out migration has stopped, the in migration has started. Many people from villages as far as 50km, are taking fields on lease here. "Now only youth go out for higher education or jobs. It's different from compulsive migration for survival 20 years back," Kunj Bihari says.

There are 15 families of Raika community in this area. Raikas are nomadic camel herders at the bottom of the caste hierarchy living on whatever they get through occasional selling of camels. But they are now settled here and grow vegetables, wheat and mustard on 20 bigha of land which fetch them good money. "The land had no irrigation source earlier, but the construction of a johad nearby raised the water table. Now we have wells which irrigate the crops throughout the year," says 30-year-old Jai Singh Raika. Buffaloes have replaced the camels and the community has pucca houses now.

The resilient society

Gradually, when water conservation improved the agriculture production, the locals took over the financial responsibility. For the last three years, Sambhaav Trust has not spent money on the anicuts and johads that are being built.

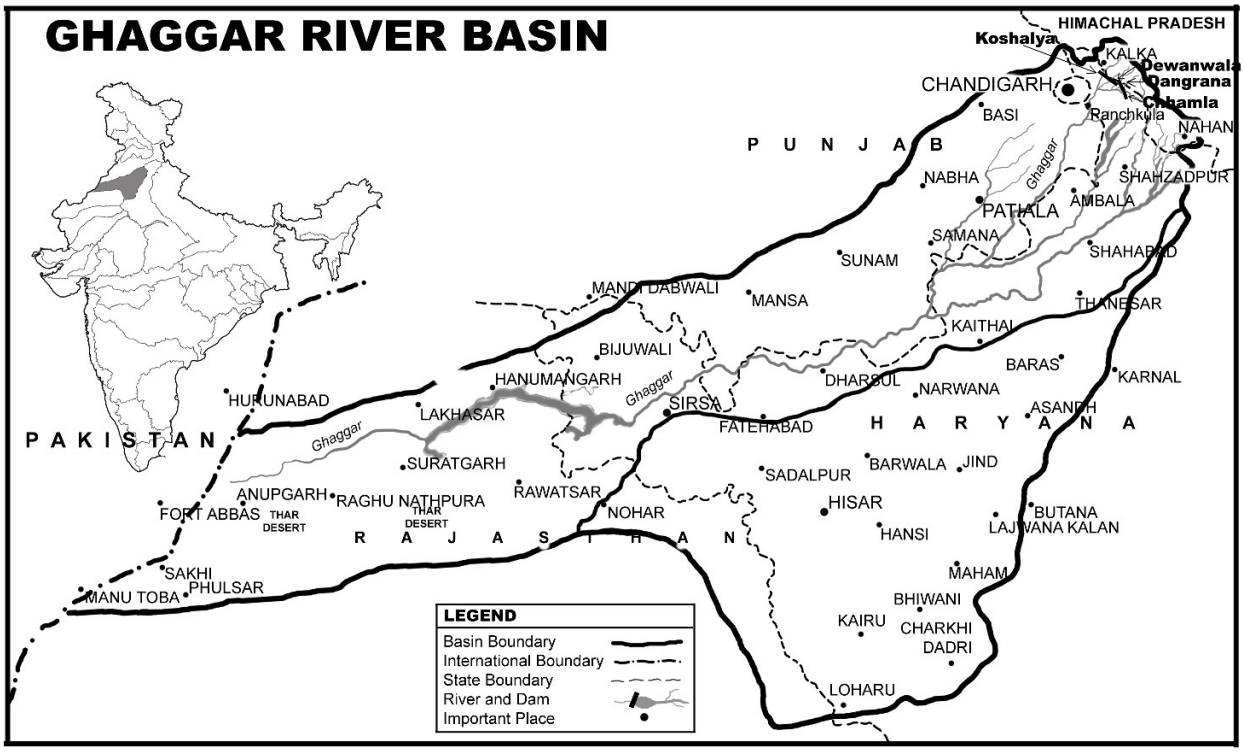
The locals build and maintain these structures and protect forests on their own while Kunj Bihari acts as a technical guide whenever the need arises. “Everybody is an engineer here. They not only know about the surface and the underground trajectory of water, but also the components of structures that can be built,” Kunj Bihari says.

This knowledge has also led to better monitoring of government works as villagers are aware of the discrepancies in accounts and engineering. “Many times, the work done under the rural job scheme is of bad quality. Once we started objecting to that, not much work gets sanctioned for our villages. We are happy with that. At least public money is not being wasted,” says Sharma.

The success story has travelled far and wide. Today, both Satish and Kunj Bihari are guiding the neighbouring regions in similar efforts. Just like Nanduwali nourishes the fields and the lives on its course, the people living on its banks are empowering others with their knowledge.

13. Ghaggar: The lost river

Ghaggar is an inter-state river originating in Shivalik hills of Himachal Pradesh and flowing through Punjab and Haryana before entering Rajasthan in Hanumangarh district. Being a seasonal river, flowing only during monsoon, Ghaggar is termed as 'naali' or drain in Rajasthan villages.

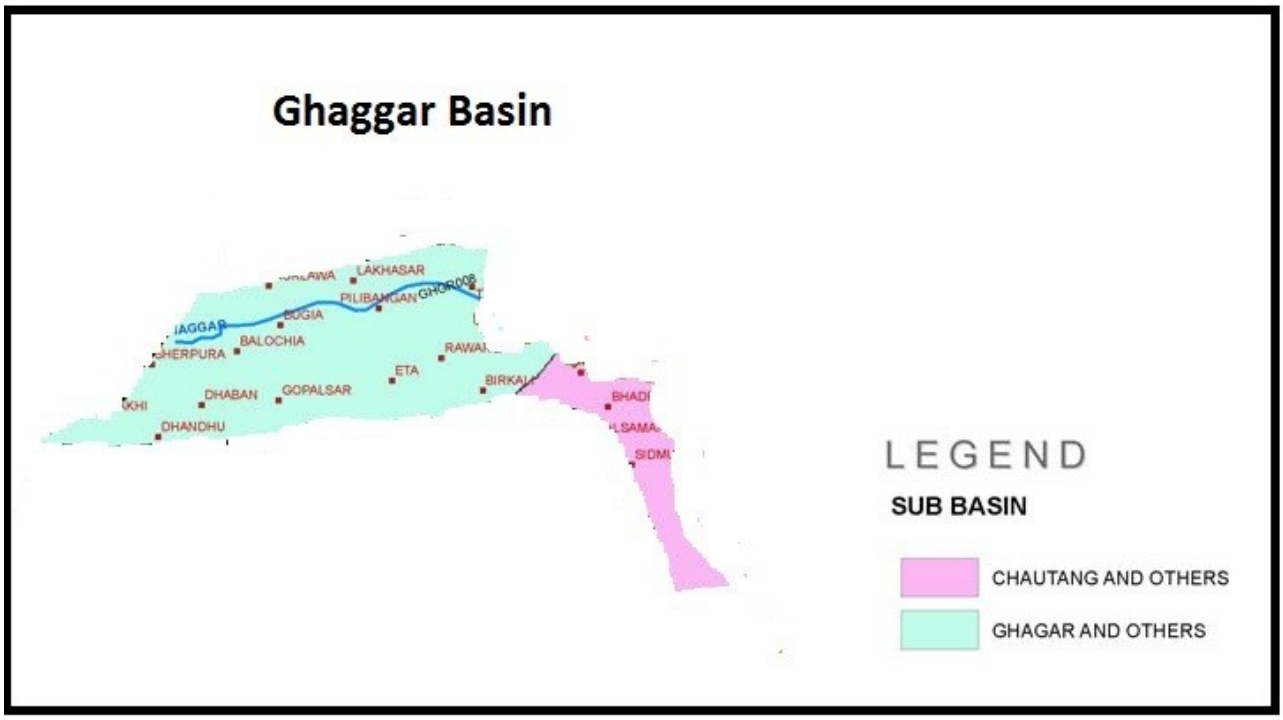


Map No 17: Ghaggar River Basin in Rajasthan

The main tributaries of the river are Kaushalya, Markanda, Sarsuti, and Tangri fall in Haryana. Ghaggar flows across the international border through Sri Ganganagar district and assumes the name, Hakra, near Fort Abbas City in Pakistan. Ghaggar-Hakra has been a focus of extensive investigations by scientists and archaeologists after many settlements of Harappan and pre-Harappan periods were found along and inside the riverbed. Ghaggar has also been identified with the Saraswati, one of the main rivers mentioned in Vedic hymns.

Total basin area of Ghaggar is 32,132 sq km of which Rajasthan hosts around 30 per cent (9,853.15 sq km) in Hanumangarh and Sri Ganganagar districts. The Ottu barrage is a masonry weir on the river in Haryana just before it enters Rajasthan. This creates a large water reservoir which feeds the Northern Ghaggar canal and the Southern Ghaggar canal to irrigate the areas of Rajasthan. The barrage was constructed by princely state of Bikaner with help of British government in 1896-97 to meet the agriculture needs of the state.

Ghaggar basin partly overlaps the command area of IGNP and Bhakhra Canal. Supplies to some of Bhakhra and IGNP canals come from Ghaggar whenever there is surplus water in it[66]



Map No 18: Ghaggar River Basin

The region is known for growing cotton and bajra (pearl millet) in the kharif season, but the monsoonal revival of Ghaggar allows cultivation of paddy in the farms along its banks.

13.1 Floods in Ghaggar

The Ghaggar river course in Rajasthan generally used to remain dry due to less inflows and sandy soils but it has revived and is causing more and more floods. The process began with occasional short duration floods of lower intensities in 1950 and since then the frequency and duration of floods have been on the increase. In 1958 flood season, the water travelled 60 kms beyond Hanumangarh. In 1962, the flood water nearly touched the Pakistan border which is about 308 kms from Hanumangarh along the Nali bed and in 1964 it crossed into Pakistan. This can be because of the development of irrigation systems in Punjab, Haryana and Rajasthan and also due to formation of embankments on both sides of the river in upper states, large quantities of water arrive in Ghaggar Nali in Rajasthan causing floods[67].

[66] http://www.waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter12.pdf

[67] http://www.waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter12.pdf

13.2 Biodiversity

Most of the basin area consists of farm land. With availability of water through canals, irrigated forest plantation has been taken up. Trees likes Shisham, Mulberry, Eucalyptus is being grown on the banks of the canals, distributes and minors, Roadside plantation has also been taken up. Main forest produce is Ber, Kinno, Timber and firewood.

Vegetation available on sand dunes include shrubs like Aak, Bawali, Gekhru, Phog (Calligonum polygiionoides), kheemp (Leptadenia pyrotechnica) Kair bushes, Kikar, Khejri, Royara and Babul trees are to be mainly found on the sand dunes. In the towns Neem and Peepal and Sirus trees also grow.

The birds mostly found in the district are pigeons, crows, sparrows, peacocks and parrots. The irrigated plantation in the district provide shelter to the black bucks, Chinkaras and Neelgai. Fish species usually found in the canals and their distributors are alabeo rohit, mastacembulus armatus and ophiocephalus barrilious.

13.3 Pollution levels

High pollution in the upstream states of Punjab and Haryana is a major concern related to Ghaggar. Along its course of 464 km, it receives discharge from various cities and runoff from agricultural lands. However, in Rajasthan, the river starts flowing only during the monsoon season and there is no heavy discharge into the channel except possible agrochemical run off from the farms along its course.

The National Green Tribunal (NGT) recently take suo-motu cognisance and summoned Punjab, Haryana, Himachal Pradesh and Chandigarh to submit status reports on the polluted Ghaggar. The Baltana drain that empties sewage and industrial waste from Chandigarh, SAS Nagar, and Panchkula cities into the river contributes the highest biochemical oxygen demand (BOD) load to the river.[68]

A study done in Haryana found high concentrations of hexachlorocyclohexane (HCH) and dichlorodiphenyltrichloroethane (DDT) insecticides in the water samples of Ghaggar river. [69] According to Inter-state river water quality (Water Quality of Rivers at Inter-state borders, CPCB,

[68] http://www.hindustantimes.com/punjab/ngt-accepts-rights-panel-case-looking-into-ghaggar-pollution/story-LupbDFi42BoxaE5N8huIFI.html

[69]https://www.researchgate.net/publication/23689230_Pesticide_pollution_of_River_Ghaggar_in_Haryana_India

2015) report, the 4.6 km stretch between Surewala and Hanumangarh was found to have BOD at 4.6 and hence was put in least priority category among all the polluted stretches.

Figure 12: Ghaggar river near Kalibanga helps farmers grow paddy during monsoon

Religious and historical connections : Indus civilisation and Saraswati

Ghaggar-Hakra has been linked to Saraswati, a river mentioned in hymns of Rig Vedas, the ancient Indian holy scriptures. The Rig Vedas mention Saraswati to be flowing between the Yamuna in the east and the Sutlej in the west. Chautang, one of the tributaries of Ghaggar, has also been identified with vedic Drishadvati river. Satellite images have confirmed that a more significant river once followed the course of the present day Ghaggar. Indian Remote Sensing satellite data along with digital elevation models were combined with historical maps, archaeological sites, hydro-geological and drilling data to chart this river's course, which is believed to have died a premature death about 5,000 years ago.

The Rajasthan Ground Water Department retraced an ancient network of paleo channels buried 60 metres below the ground. A geophysical survey undertaken in the Tanot and Longewala areas

of Thar desert area indicated the existence of coarse sediments pointing to the possibility of the existence of a river in the region.[70] The disappearance of Saraswati can be explained through climate change studies which have traced changes in Indian monsoon over 5,000 years.

Several archaeological sites across Ghaggar-Hakra floodplains, including Kalibanga in Rajasthan, suggest existence of a civilisation starting from pre-Harappan to mature Harappan periods, a time span of 6,700 years, in this area. The scientists found that the Indian monsoon was weak till 9,000 years back due to which people might have indulged only in small farming and pastoralism. Later, the rains intensified, feeding Ghaggar-Hakra, which supported intensive agriculture on their floodplains--starting from the present-day Haryana through Rajasthan, the desert region of Cholistan and Sindh (both in Pakistan now) and emptying into the Arabian Sea through Gujarat. Better farm production would have led to the flourishing of the civilisation through well-planned urban settlements like Bhirrana, Harappa and Mohenjo Daro (in Pakistan) and Lothal (in Gujarat).

However, monsoon started declining again around 7,000 years ago and a harsh drought ensued 4,000 years ago leaving even large rivers dry. The river flow declined and Ghaggar-Hakra could have become seasonal or gone completely dry. People adapted to less rain through crop diversification and migration to smaller, rural settlements, especially in the Himalayan foothills, between the courses of Yamuna and Ganga.[71]

Though the link between Saraswati and Ghaggar are not yet definitive, the Rajasthan government hopes that once the sequence of the paleo channels and river flow is established, it could solve the water scarcity in arid areas of the state. It feels the channels can help transport surplus water from Punjab and Haryana during the monsoons, and store it for future use. Haryana government has already set up the Saraswati Heritage Development Board and is releasing water into what is believed to be route of the river, thus making Saraswati flow again, even if artificially.[72]

[70] http://www.downtoearth.org.in/coverage/saraswati-underground-15455

[71] http://www.indiawaterportal.org/articles/climate-change-when-past-presents-itself

[72] http://indianexpress.com/article/india/india-news-india/saraswati-river-haryana-govt-saraswati-heritage-development-board-finding-saraswati-river-2926797/

13.4 Red (Critical), Pink (Threatened) and Blue (healthy) Status of rivers of Ghaggar

The basin of the river Ghaggar within the state would qualify for a Red status because it is more of a drain than a river due to its seasonal nature and excessive extraction in upstream states of Punjab and Haryana leaving little for flow in Rajasthan.

An early metropolis

Kalibangan, an important Harappan site belonging to the early and mature periods, was excavated between 1961 and 1969. By T.S. SUBRAMANIAN

OUR plan was to visit the Harappan site of 4MSR in Rajasthan, where excavation is under way, by travelling by train from New Delhi to Sri Ganganagar and then driving down to 4MSR. When we told P.S. Sriraman, Superintending Archaeologist-in-charge,

Jodhpur Circle, Archaeological Survey of India (ASI), about our plans to visit 4MSR from Sri Ganganagar, he told us: "You have made a mistake. You should get down at Suratgarh railway station, which is 80 km beyond Sri Ganganagar and drive down from Suratgarh to 4MSR. Kalibangan lies on the way. Anyway, you have to cross Kalibangan to reach 4MSR. Do visit Kalibangan, which was a big Harappan site, which the ASI excavated from 1961 to 1969. We have a good site museum at Kalibangan."

That was music to the Frontline team's ears. Behind the spacious site museum of the ASI in

Kalibangan lie three big rolling mounds which, in their innards, had concealed a big Harappan town that belonged to the Early Harappan period (3000 BCE–2600 BCE) and the Mature Harappan period (2600 BCE–1900 BCE). Pravin Singh, Assistant Archaeologist, ASI, Kalibangan, led us to the mounds. "You put your foot anywhere on the mounds, and you will trample on a prodigious amount of pottery," he said. He knew the rolling, desolate mounds like the back of his hand. The entire Harappan town at Kalibangan was built of mud bricks, Pravin Singh stressed. He took us to the KLB-1 mound, which housed the citadel where the ruling elite lived and the KLB-2 mound where the lower town was built. (Kalibangan in the Rajasthani language means black bangles. Nearby is Pilibangan, which means blue bangles).

It was eerie visiting the greatly eroded mounds, with millions of potsherds, broken terracotta bangles, and idli-shaped terracotta cakes lying everywhere. Rows of Harappan bricks or terracotta drainpipes jutted out of the eroded mounds, giving us an insight into how the town would have been built with mud bricks more than 4,500 years ago.

Sriraman calls Kalibangan an important Harappan site and ranks it "on a par with Dholavira, Rakhigarhi and Lothal". It was a site that belonged to both the Early Harappan and the Mature Harappan phases. It did not have a Late Harappan phase, he stressed. "It was a typical Harappan settlement, with fortification walls, an upper town and a lower town," Sriraman said.

Like 4MSR, situated about 120 km away, Kalibangan was built on the banks of the now-dry Ghaggar river. According to Michel Danino, a specialist in Harappan civilisation, Amalananda Ghosh, who became the ASI Director General in 1953, spent two winters in 1950 and 1951 exploring the valleys of Saraswati and Drishadvati rivers, as he called the Ghaggar and the Chautang rivers respectively, and identified the Harappan culture of Kalibangan in about December 1950. Professor B.B. Lal, B.K. Thapar and J.P. Joshi excavated the mounds for nine field seasons from 1961 to 1969.

The late B.K. Thapar, in his article entitled "Kalibangan, A Harappan Metropolis Beyond the Indus Valley", says that "the excavations at Kalibangan brought to light the grid layout of a Harappan metropolis, perhaps truly 'the first city' of the Indian cultural heritage." The significant part of the evidence from the excavation, according to Thapar, "relates to the discovery of a non-Harappan settlement immediately underlying the occupational remains of the Harappan citadel (KLB-1). Kalibangan thus became the fourth site, after Amri, Harappa and Kot Diji, all in Pakistan, where the existence of a preceding culture below that of the Harappan has been recognised."

"An outstanding discovery" of the excavations at Kalibangan, Thapar said, was the discovery of a ploughed field, situated south-east of the settlement, outside the town wall. The ploughed field

revealed a criss-cross pattern of furrows. The nine field seasons of excavation revealed a series of seven fire altars, residential buildings for the elite, drains and wells built with baked bricks, large quantities of beads, copper artefacts, and so on.

Sriraman said the ASI had plans to refurbish the site museum at Kalibangan, add more galleries displaying the artefacts found there and provide more facilities to tourists.

http://www.frontline.in/arts-and-culture/heritage/an-early-metropolis/article7053426.ece

14. Sabarmati: The maiden river

Sabarmati originates from Aravalli hills near village Tepur in Udaipur district of Rajasthan. 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 total length of river from origin to outfall into the Arabian Sea is 371 km of which 48 km lie in Rajasthan with principal tributaries of Sei and Wakal. To its east lie the Banas and Mahi basins, to its north the Luni Basin and to its west the West Banas Basin. Its southern boundary in Rajasthan is the border with Gujarat State. The catchment area in Rajasthan is 4,164 sq km, which is 19 per cent of the total catchment of the river and extends over parts of Udaipur, Sirohi, Pali and Dungarpur districts.

Map No 19: Sabarmati River Basin in Rajasthan

Table 5: Tributary of Sabarmati River

Name of tributary	Length (in km)	Catchment Area (sq km)	Terrain
Sei	95	946	Hilly covered with forest
Wakal	88	1625	Mainly hilly in upper reaches and undulating terrain in remaining portion

Map No 20: Sabarmati River Basin

14.1 Mythology

The cultural and religious connection to Sabarmati is stronger in Gujarat as cities have thrived along its banks. In comparison, the Rajasthan journey of the river goes through hills of Aravalli ranges and does not go through any urban or cultural centre. In Gujarat, it is believed that Lord Shiv brought the goddess Ganga to the state and that caused the Sabarmati to come into being. A shloka from a manuscript of Shvbhramati Mahatmya of Padmapurana calls the river Kashyapi Ganga:[73]

14.2 Biodiversity

The basin comprises tropical dry deciduous forests of miscellaneous species with rich growth of bamboo. The river basin is inhabited by major tribes of the state, including Bhils, Garasias, Damors, and Kathodias, who are custodians of local indigenous knowledge and use plants for various purposes e.g. rituals and festivals, in weather forecasting, mythological belief, etc..

The variety of plants found in the basin include Babul (Acacia nilotica), Silk Cotton tree (Bombax ceiba), Flame of the Forest (Butea monosperma), Kair (Capparis decidua), Mango (Mangifera indica), Mahua (Madhuca indica), Oleander (Nerium oleander), Sandalwood (Santalum album), Jamun (Syzygium cumini), Khejri (Prosopis cineraria), Dhoob grass (Cynodon dactylon) and Daabh grass (Desmostachya bipinnata).

The important woody vegetation along the watercourses comprise Chironji tree (Buchanania lanzan), Karanj (Pongamia pinnata), Arjuna (Terminalia arjuna), Banyan (Ficus bengalensis) and Palm (Phoenix sylvestris). The upper and middle slopes of the hills bear Saaj (Terminalia tomentosa), Mohin (Lannea coromandelica), Dhaora (Anogeissus latifolia) and Tendu (Diospyros melanoxylon).

Tribals are able to forecast weather through plants as mentioned below:

1. Acacia nilotica: Luxuriant flowering indicates good rains and bumper crop of groundnut.
2. Bombax ceiba: Luxuriant fruiting indicates good rains and there will be bumper crop in the coming season.
3. Butea monosperma: Luxuriant fruiting during April-May indicates good rains and bumper crop of Maize.

[73] http://timesofindia.indiatimes.com/ahmedabad-times/The-sacrificial-maiden-river/articleshow/20998055.cms

4. Capparis decidua: Luxuriant flowering and fruiting indicates good rains and bumper and healthy crop of cotton.
5. Hordeum vulgare: The seeds are sown in a pot at temple on the occasion of "Navratri sthapna" (March-April) and the pot is divided in to four partitions as per the four directions. The partition towards which good seed germination takes place will indicate good rains in that direction of the village.
6. 6. Mangifera indica: Luxuriant fruiting indicates good rains in the coming rainy season.
7. Madhuca indica: Luxuriant flowering indicates good rains in the coming rainy season.

Around 202 bird species including two critically endangered vulture species and white-winged Black Tit Parus nuchalis are found here. The Phulwari Wildlife Sanctuary also harbours five near threatened species in the waterbodies and streams but their numbers are not significant.[74]

The key reptilian species of the sanctuary are the marsh crocodile Crocodylus palustris, Monitor Lizard Varanus bengalensis and Indian Rock Python Python molurus. Among primates, Common Langur. Leopard, Sloth Bear, Golden Jackal, Hyena, Indian Fox and Wild Boar are common. Chinkara (Gazella bennettii) and four-horned antelope (Tetracerus quadricornis) are the herbivores which provide food for the top carnivores. Large Brown Flying Squirrel (Petaurista petaurista) has also been spotted in the sanctuary.

The fish varieties that can be found are carp fish including rohu (Labeo Rohita), katla (Catla Catla) and mrigal (Cirrhina Mrigala besides Mahseer (Naziritor). Other fish like sanwal (Opheocephalus), singada (Mystus Seenghala) and singi (Heteropneutes Fossilis) are also available.

14.3 Diversions and Erosions

There are 47 minor irrigation projects as well as some small irrigation systems (covering less than 20 ha) constructed and operated by panchayat samities. Around 15 minor irrigation projects with a total storage capacity of 15.4 mm^3, are under construction in this basin while 26 minor and three medium irrigation projects and one lift scheme, with a total live storage capacity of 180 mm^3, have been proposed in this basin.

[74] http://www.birdlife.org/datazone/sitefactsheet.php?id=18356

Sei dam on Sei river a major irrigation project with gross storage capacity of 31.34 Mm^3 and live capacity of 24.16 Mm^3 .

In 1971, Dewas-I project was undertaken to divert water from Wakal river to Udaipur city's domestic and industrial needs. However, rising population and tourist inflow of the city disturbed the water balance again and Mansi-Wakal lift water project was initiated in 1989 to divert more water from the Sabarmati basin. This invited a long-drawn protest by residents of six villages whose land was to be submerged by two medium-sized dams on the Mansi and Wakal rivers[75]. The main contention was that Udaipur was trying to fill its lakes to attract tourists and for industrial use.[76]

Though the protest could not go beyond 2001, it forced the authorities to include drinking water supply scheme for the affected villages in the plan which was originally meant only for urban and industrial sectors.

By 2012, Dewas-II project, which involved tunnel of 11.25 km, was completed to supply 400 million cubic feet water to the city. But it still does not seem to be enough and plans are afoot to further divert water from Sabarmati basin towards Udaipur and other cities. Dewas III and IV which involve construction of a dam of 500 mpft capacity[77] have already been approved while next stage of Mansi-Wakal is also proposed.

In fact, government of Rajasthan has asked the Centre to allocate Sabarmati river water to the state under river interlinking project[78]. The link is proposed as an extension of Yamuna-Rajasthan link to transfer 5,924 MCM of water at tail end of Yamuna-Rajasthan link for the benefit of southern Rajasthan and Gujarat. The proposed link passes through Jaisalmer, Barmer and Jalore districts of Rajasthan and Banaskantha, Mehsana and Gandhinagar districts of Gujarat to irrigate about 7,38,600 ha, out of which 5,35,000 ha. lies in Rajasthan.

Sabarmati will be further affected by proposed plan to divert water from its tributary Wakal to Jawai dam.[79]

The basins of Mansi and Wakal have undergone severe degradation in last 40 years due to loss of tree cover and intensification of agriculture practices. The high level of siltation in

[75] http://www.downtoearth.org.in/news/rajasthan-gets-a-narmada-29381

[76] http://www.indiawaterportal.org/articles/water-water-everywhere

[77] http://udaipurtimes.com/dewas-phase-3-4-to-start-soon/

[78] http://deshgujarat.com/2015/03/09/rajasthan-seeks-sabarmati-river-water-from-centre/

[79] http://waterresources.rajasthan.gov.in/riverbasin/JAWAI.pdf

these rivers has reduced their depths and carrying capacities resulting in severe floods during a good monsoon year. While the top soil is lost, the rivers swell fast and also recede fast leaving little time for the people to react. During non-monsoon months, the surface water flow is considerably reduced as compared to earlier situation of stagnant pools along the stretch throughout the year.

14.4 Pollution:

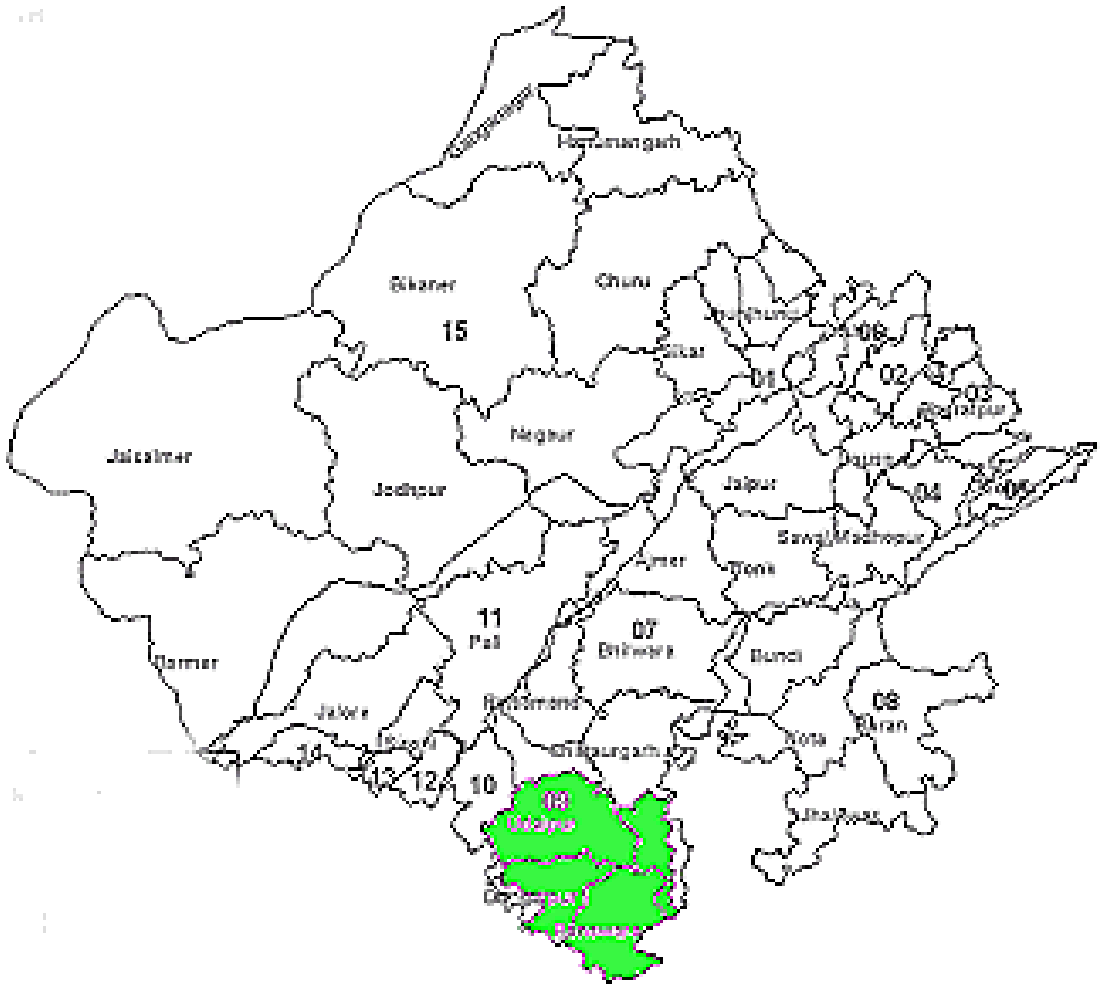
The course of Sabarmati in Rajasthan goes through sparsely populated villages and forest ranges and hence does not harbour high levels of pollution. According to Inter-state river water quality (Water Quality of Rivers at Inter-state borders, CPCB, 2015) report, the water samples from Khedbrahma site in Sabarkantha (Gujarat), near the Rajasthan border, exceeds the prescribed limit of total coliform count.

14.5 Red (Critical), Pink (Threatened) & Blue (healthy) Status of rivers of Sabarmati

Sabarmati is assigned the health status of Blue because it encounters less threats due to absence of any big habitation and a basin endowed with good forest area. However, further proposed diversion of water from its tributaries, Mansi and Wakal, to meet needs of the urban areas of south Rajasthan will impede its flow.

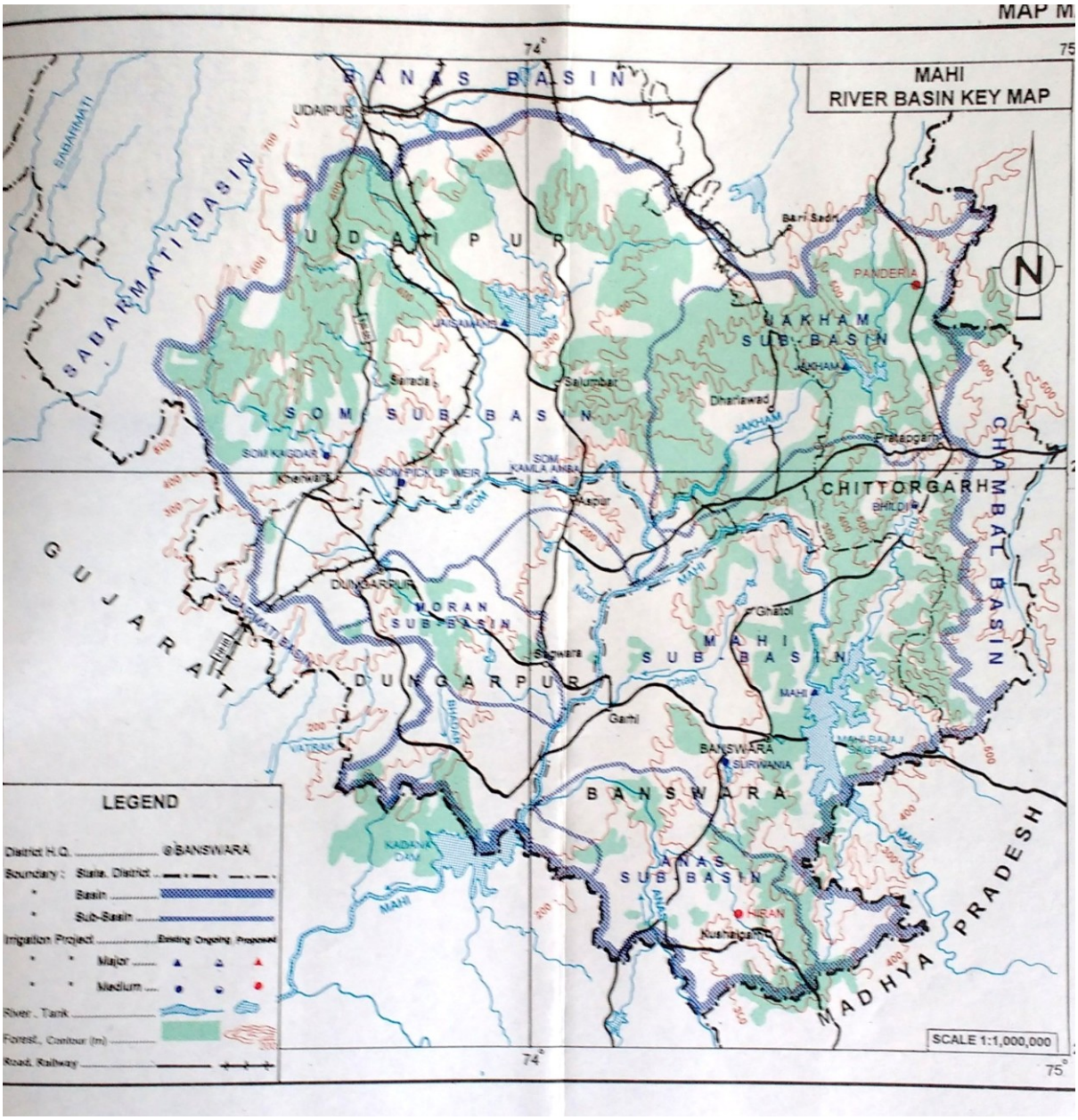
15. Mahi River

Mahi is one of the important rivers of western India rising in Madhya Pradesh and flowing through Rajasthan and Gujarat. Mahi basin is bound on the North and the North-West by the Aravalli Hills, on the East by the ridge separating it from the Chambal basin, on the South by Vindhyas and on the West by the Gulf of Cambay. In Rajasthan, the basin consists of hills, forests and eroded terrain. The river traverses 174 km and makes a 'U' shaped loop in Rajasthan before entering Gujarat.



Map No 21: Mahi River Basin in Rajasthan

Of the total drainage area of 34842 sq km, 47.22 per cent (16,453 sq km) lie in Rajasthan where two important tributaries Som from right and Anas from left join it upstream of Kadana Dam.



Map No 22: Mahi River Basin

Table 6: Tributary of Mahi River

Name of tributary	Length (in km)	Catchment Area (sq km)	Terrain
Som	155	8707	Mainly hilly covered with protected and reserved forest.
Anas	156	5604	Hilly and partly covered with forests

Besides Som and Anas, there are other rivers which feed Mahi. Jakham originates near Chotti Sadari in Chittorrgarh district and flows through the hilly region of Udaipur District in a south-western direction and joins river Som near Bilara village. Moran river originates in the southern hills of Dungarpur town and joins Mahi river near Galiakot village. Bhadar river originates from Kanguwa village in Dungarpur district and flows from north to south and enters Gujarat near Kokhakra village in Dungarpur District, where it joins the Mahi near Karanta village in Gujarat. The catchment is situated in Dungarpur district.

15.1 Dams and Canals

In Rajasthan, there are 37 dams, seven medium and five major irrigation projects and one weir in the Mahi basin. This includes the Mahi Bajaj Sagar hydroelectricity and irrigation project near Banswara town with live storage capacity of 1833.5 MCM. The project is named after renowned freedom fighter and national leader late Shri Jamnalal Bajaj. The Kadana dam in Gujarat with live storage capacity of 1203 MCM also lies close to the border of Rajasthan. There are 271 minor projects in the Mahi basin as well.

The two reservoirs on Mahi river

The basin also comprises the famous Jaisamand Lake which was built in 17th century by Maharana Jai Singh of Udaipur through damming of the Gomati river in the 17th century.

15.2 Inter-state agreement and conflict

The concept of Mahi Bajaj Sagar project was mooted in 1960s. The plan was to harness the potential of Mahi river for development of tribal dominated Rajasthan state. An inter-state bilateral agreement was executed between Rajasthan & Gujarat in the year 1966. Out of total projected yield at Mahi Dam site, 13 TMC is reserved for Madhya Pradesh. The live storage vis-a-vis construction cost of dam upto 278.95 metre was to be shared between Gujarat and Rajasthan in 40:9 ratio, while Rajasthan enjoys unequivocal right over additional 7.0 TMC storage available between 921 feet and 915 feet as the difference in construction cost of dam is borne exclusively by the Rajasthan state.

The share of Gujarat state is channelised through Power House II located about 40 km from Banswara town on the bank of Anas river, a major tributory of Mahi river which converges into it down stream of Mahi dam. Post generation releases from PH II move to Kadana reservoir of Gujarat state. Thus, there is well established mechanism for sustained replenishment of Kadana reservoir round the year. Out of total 80,000 ha. originally envisaged as command area of Mahi Project, 44,060 ha. is under Left Main Canal system and rest 35,940 ha. is taken care of by Right Main Canal system.[80]

Rajasthan has objected to construction of an irrigation canal by Gujarat from Kadana dam to divert excess monsoon water. Rajasthan claims that it's a violation of the 1966 water-sharing agreement which calls for consent before construction of any project or scheme for use of Mahi's water[81].

As Narmada Project takes shape, the Mahi river basin in Gujarat will obtain water from Narmada, and two-third of Mahi's water available at Kadana reservoir will be taken to the arid region of Jalore and Barmer districts through a high level Kadana canal[82].

[80] http://waterresources.rajasthan.gov.in/4mahi.htm

[81] http://timesofindia.indiatimes.com/city/ahmedabad/Rajasthan-Guj-draw-battle-lines-over-Mahi-waters/articleshow/11114224.cms

[82] http://www.waterresources.rajasthan.gov.in/SPWRR/chapter/Chapter12.pdf

15.3 History and Cultural connection

Baneshwar dham is the most revered pilgrimage in this basin which falls near Aspur in Dungarpur district. The temple is at a small delta formed by Som and Mahi rivers. 'Baneshwar' means the ‘master of the delta’ which is derived from the Shiva Linga worshipped in the Mahadev temple in Dungarpur. A fair is organised from Magh Shukla Ekadashi to Magh Shukla Purnima and is visited by the Bhil tribes of this region.

Baneshwar fair in its present form is combination of Shaivite and Vaishnav branches of Hinduism. While a fair used be held in praise of Baneshwar Mahadev (Lord Shiv), another fair started after the construction of the Vishnu Temple by Jankunwari, daughter-in-law of Mavji, a highly revered saint considered to be an incarnation of Lord Vishnu. The large congregation pays homage to all the deities with equal reverence.

On Magh Shukla Ekadashi, a 16-cm silver image of Mavji on horseback is also brought here. The river water supposedly becomes holier when the Mathadhish takes a bath. Hence, people bathe along with him in the river. The Bhils also consign the ashes of their dead at the confluence of the rivers as the spot is considered equivalent to Ganga.

15.4 Biodiversity

The basin has a mixed tree cover ranging from subtropical evergreen forest of Banswara to Dry Tropical Forest of Pratapgarh. Several of the trees found here include salar, tendu (Diospyros melonoxy Roxb.), bad, peepal, babool, neem, arinja (Acacia leucophaea), siras, churail, kachnar, gulmohar, amaltas, bakayan, ashok, mahua, semal, goondi, khejadi (Prosopis spicigera), kumta (Acacia rupestris), amla, bamboo, sindoor, chironjee, rudraksha and bel trees. Around 108 varieties of high value medicinal herbs are also found here.

A large number of residential and migratory birds are found in this region, including little grebe, little cormorant, Indian darter (snake bird), various types of herons and egrets, painted stork, gray hornbill, magpie robin, purple sunbird and munia. Among the mammals, the flying squirrel (Petaurista philippensis) can be seen gliding from one tree to another around sunset in the Arampura forest, 17 km away from Dhariyawad. At Seeta Mata Forest Reserve, variety of deer, caracals, wild boars, pangolins, Indian leopards, striped hyenas, golden jackals, foxes, jungle cats, porcupines, wild bears, and neelgai can be seen.

The Jaisamand Wildlife Sanctuary, located in the basin, also boasts of a rich wildlife including panther, wild boar, deer, four-horned antelope, mongoose and various species of migratory birds. Major carps, catfishes and murrels are commonly found in the water bodies of this region.

15.5 Pollution

Mahi river is facing a big problem of pollution due to discharge of industrial waste in and around Vadodra city of Gujarat[83]. But in Rajasthan the river is in a good state as there are no major towns or industrial estates on its short journey of 174 km. This is also one of the perennial rivers in Rajasthan besides Chambal and hence is perhaps, though its own biological processes, fully able to deal with the pollutants entering its waters. The extraction of sand and other minor minerals from the floodplains is a concern which if not regulated may leave a big impact in future.

According to CWC Status of Trace and Toxic Metals in Indian Rivers, 2014 report, water from Mahi river was tested at two water quality monitoring stations. At Paderdibadi in Dungarur district, the water was found to exceed the permissible limit of iron[84].

15.6 Red (Critical), Pink (Threatened) & Blue (healthy) Status of rivers of Mahi

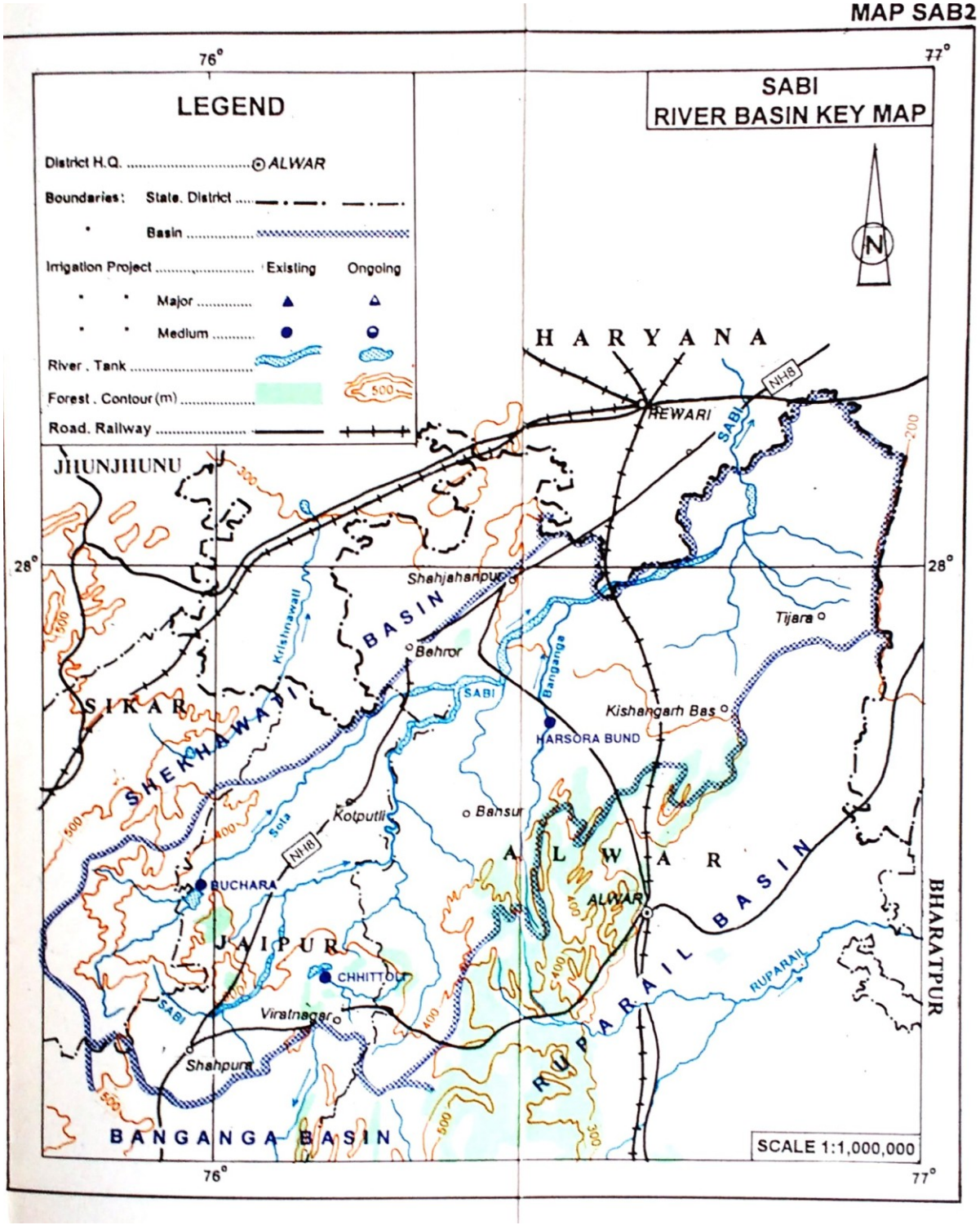
Mahi is assigned the health status of Red. There are multiple dams and reservoirs besides anicuts on more than half of its tributaries. The main stem also has two major dams, Mahi Bajaj Sagar near Banswara and Kadana on the border with Gujarat. Even though there are only two small towns in the Rajasthan area of the Mahi basin, they do impact pollution levels of the river.

[83] http://www.ijste.org/articles/IJSTEV2I6052.pdf

[84] http://www.cwc.nic.in/main/downloads/Trace%20&%20Toxic%20Report%2025%20June%202014.pdf

16. Sabi or Sahibi Basin

Sabi (also called Sahibi) River originates from the eastern slopes of the Saiwar Protected Forest hills in Sikar district of Rajasthan and covers around 157 km in the state before its onward journey to Yamuna through Haryana and Delhi.



Map No 23: Sahibi River Basin

Its main tributary is the Sota river which meets Sabi at Jalalpur. River Sabi is ephemeral. In its headwaters section, erosion of the hills results in phenomenon known as “river piracy”; gully waters from the western slopes i.e from across the Saiwar Protected Forest water divide, which would normally flow westwards, are captured or diverted to the Sabi drainage system along the eastern slopes of the water divide.

16.1 History and 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 Jodhpur 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.

16.2 Impact of Urbanisation and Development

Being located between two big urban centres of Jaipur and Delhi, the basin has seen a hectic development activity over last 25 years resulting in growth of peri-urban areas and industrial townships like Bhiwadi, Neemrana and Behror. Proliferation of beer factories, rock mining and real-estate business has not only led to increase in water demand but also changed the ecological and economic landscape. While several smaller streams have vanished due to constructions, local villagers moved from agro-pastrol livelihood to intensive farming growing cash crops and vegetables due to easier access to townships.

The undulating fields have been levelled which might have also impacted the natural drainage while encroachment on the common land, which includes catchment area of the river, increased. While stone mining has been banned, the operations continue illegally thus impacting the Aravalli hills and the forest cover.

Several smaller dams have also been constructed throughout the hills of Rajasthan to store rainwater thus restricting the flow of water. It is now rare for water overflow from monsoon rains to reach up the Masani Barrage, built in Haryana to control floods in Sahibi[85].

16.3 Flora and Fauna

The varieties of trees found in the basin are Babul, Dhonk, Kumtha, Reonjh, Khair, Kair, Chilla, Hingot, Papri, Salar, Khejra, Siras, Rohira, Shisham, Neem, Phog, Pipal, Thor, Aak, Grasses found are Dhoob, Bharut, Baru, Lapla, Kaladhumani and Moonj.

Wild dogs, jackals, hyenas, jungle cat, caracal, chital, sambhar, nilgai, chinkarahare, langur and rhesus monkeys can be seen. Commonly spotted birds are peacocks, parakeets, red jungle fowl, quail, grey partridge, white-throated kingfisher, sand grouse, treepie, golden-backed woodpecker, crested serpent eagle and the Indian eagle-owl.

Figure 13: The Masani barrage constructed in Haryana to control floods in Sahbi river is witnessing little water now even in peak monsoon season.

[85] http://www.tribuneindia.com/2007/20070919/haryana.htm

16.4 Red (Critical), Pink (Threatened) & Blue (healthy) Status of rivers of Sahibi

Sahibi is assigned the health status of Red because it rarely flows now. Change in landscape, urbanisation, introduction of industries and intensive agriculture has affected the catchment area. It was always a seasonal river with occasional flooding during monsoon but now the river does not run even in peak monsoon season due to increased water demand and several structures built in the basin to store water. This has impacted the biodiversity which was dependent on its waters.

Groundwater revival comes a cropper

By Dr S S Grewal

An NGO's effort to recharge the groundwater in an area finds little success with water-guzzling crops that rule the market.

Water crisis is a reality in most of India. After the summer of droughts come the monsoon floods. Take Maharashtra, for instance. If at one time it is desperately searching for drinking water, at another time, its capital, Mumbai is wading through knee-high water. How do we overcome these annual crises? Unfortunately, the answers are not so easy to find.

The most common solutions suggested include rain water harvesting, groundwater recharge, efficient use of water at domestic, industrial and farm level and recycling and reusing water.

Then, there are the solutions suggested to curb wastage of water in agriculture--crop rotation or replacement, usage of sprinklers and drip irrigation, laser-levelling the land and no free electricity to farmers to control its consumption. Though these suggestions do the rounds every year, not much has materialised on the ground to mitigate the crisis. When the drinking water crisis escalates in hot summer months, particularly in urban areas, the cries get louder. The problem is forgotten when the monsoon arrives.

In a news report appeared on The Tribune on May 1, 2016 titled Water Wars, a very gloomy, yet factual picture was painted about the ongoing crisis. A pertinent question was raised at the end of it--What have we done to conserve and preserve water? That prompted me to share some of the attempts by the NGO, Society for Promotion and Conservation of Environment (SPACE), in this area in the last 10 years. These projects, however, oscillates between success and failure.

An initiative in Aravali hills

Our operational area was 35 water-stressed villages in the foot of Aravali Hills of Tijara block of Alwar district, Rajasthan. The challenges included the barren Aravali hills denuded of its character from the grazing and fuel-wood extraction; Meo-Muslim community with large family sizes; wastelands used only for livestock grazing; literacy which is only five percent in women and 20 percent in men and poverty and drudgery of women beyond description.

As the pastoral economy shifted to settled agrarian economy, the flat lands in the valleys were levelled where irrigation expanded at an alarming rate, disregarding the inhospitable environment like low rainfall and sandy soil. We selected 35 contiguous villages along the hills, starting from Bhiwadi to Tijara. The area around Bhiwadi came under intense industrial growth since 1995. As a result, the factories and builders started exploiting the already sparse groundwater. As the surface and sub-surface flow of water is from Tijara towards Bhiwadi, more extraction by industries lowered the water table in upper areas. A corporate company, SRS pvt ltd, which had established a plant near Bhiwadi, came forward to spend a part of the earnings on social welfare activities. They funded our project.

It is good that barren Aravalis, with 500mm of average rainfall, produce heavy runoff in five to six flood-producing storms a year which could be harvested to recharge ground water. We constructed 205 earthen dams to harvest rainwater from the Aravali hills. Financial support was provided to farmers to level 1500 hectares of privately-owned wastelands in the foot of

the Aravali hills. The best agricultural practices to increase the income of 6500 poor farmers were promoted. We also planted three lakh trees on field bunds and raised 50000 fruit trees.

All reclaimed lands were sprinkler irrigated and rubberised pipes were used to transport water to avoid high seepage loss in the sandy soil. We formed 170 self help groups of women who were federated at the block level. These federations were linked to banks for flow of credit for livelihood activities. Even the landless were provided support for goat rearing. The farmers started planting fruit trees like kinnow and guava which had good market value and vegetable crops on the field bunds. The water resources were created for the livestock near the grazing area.

A farmer earned Rs1.23 lakh for the first time from an acre of kinnow orchard. The profit included Rs 25000 by selling kinnow juice in the village. One woman farmer sold 200 mature aruneem plants after six years of care for Rs 1 lakh. When asked what she did with that money, she said she purchased one Murrah buffalo for half the money and spent the rest on fixing marriages of two of her seven sons. The major part of the income was invested on farm development, house construction, children's education, purchase of Murrah buffaloes and bikes.

These are our success stories; but failures are as many.

Our dilemma

Thanks to the proximity of these villages to Gurgaon and Manesar, the vegetables--especially chilli and onion--fetched good income. The traditional bajra (pearl millet) needed no irrigation and mustard needed not more than two irrigations, and that too, with only sprinklers. Chilli and onion needed nine and 11 irrigations respectively. The result? In one of the villages which was part of our projects, there are 128 borewells now, when in 1970, they had just two. Fifty new borewells were installed on the reclaimed land. Sixty percent borewells have been converted to submersible motors.

In spite of 40 water-harvesting dams in a big village Gualda, 60 new borewells have come on the reclaimed land. Water table goes up in monsoon because of the harvested runoff and then start going down as wheat and vegetable crops are irrigated. The downward spiral continued for five years with net drop of 5.5 metres in ground water. We have no paddy, vegetables fetch good income but consume lot more water.

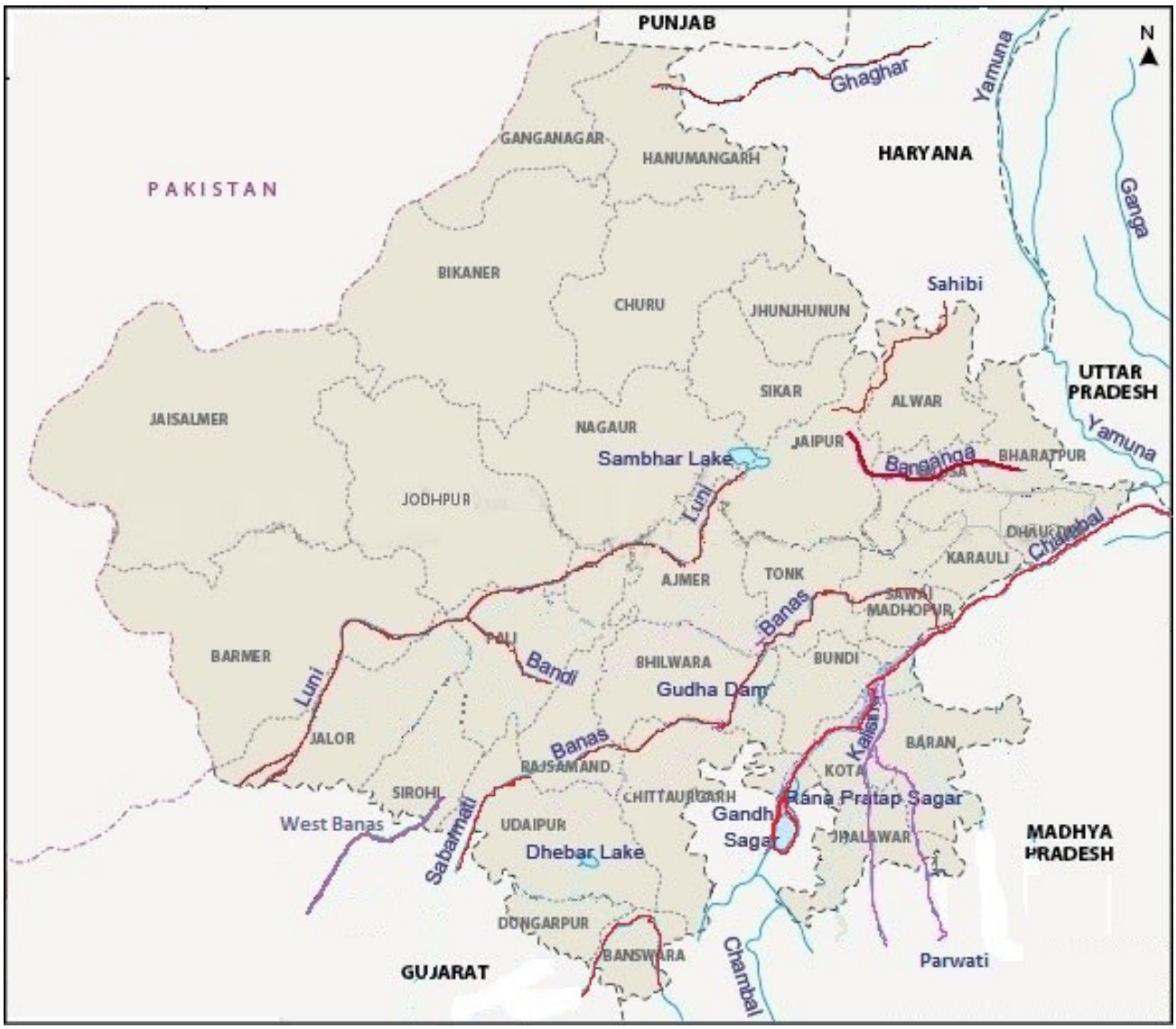
The lands were levelled and bunded for more production but this resulted in in-situ rainwater conservation and soil profile recharge. But runoff from such levelled lands did not reach the storage reservoirs resulting in lesser groundwater recharge when dams were constructed around privately-owned lands which were levelled subsequently. The Punjab story was repeated in Rajasthan. We harvest rainwater but water table continues to go down.

The farmers should have continued with bajra and sarson (mustard) for the sake of groundwater. Unfortunately, there is no profit in bajra or sarson. Promoting the agro-industry based on indigenous products seems to be the only way forward.

Author is former director of regional station of Punjab Agriculture University, Ludhiana and president, SPACE

http://www.indiawaterportal.org/articles/groundwater-revival-comes-cropper

17. River map of Rajasthan based on health risk assessment



Map No 24: Rivers Health in Rajsathan


INTACH