

State of India's Rivers

For
India Rivers Week, 2016

ODISHA



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1.0 Introduction

Location, Size And Population

Odisha is located on the eastern coast of India, between $17^{\circ} 31'$ and $22^{\circ} 31'$ N latitude and $81^{\circ} 31'$ and $87^{\circ} 31'$ E longitude. It covers $155,707 \text{ km}^2$, which represents about 4.74% of the area of India.

The 2011 Census established the State's population at 41.9 million, 16% of which lived in urban centres. The average population density is 270 persons per km^2 , compared to 382 for India.

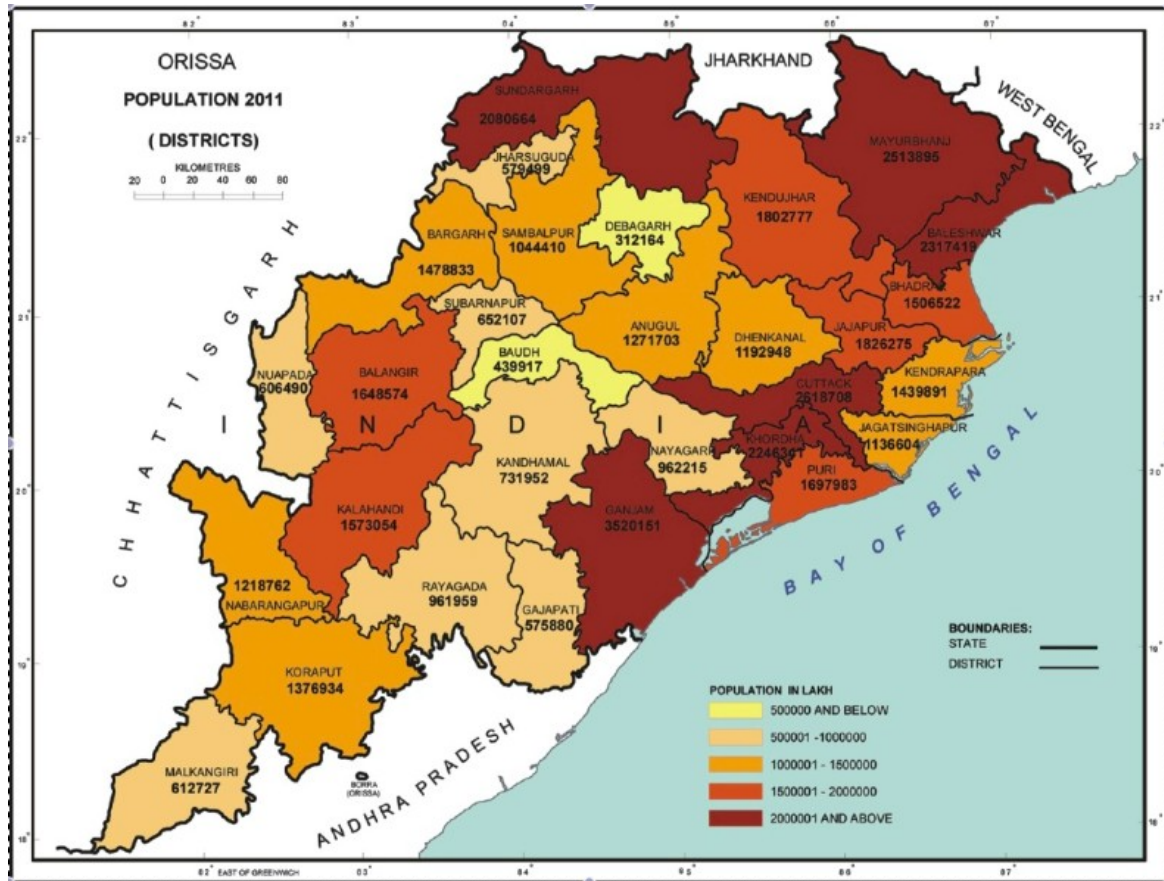


Figure 1 Odisha political and Population

Administration And Governance

Odisha is a land of possibilities. The State is endowed with bountiful of resources, people, land, water, forest, minerals and other minor resources. The State is divided into 30 districts, of which Mayurbhanj is the largest (1042 km^2) and Jagatsinghpur the smallest (197 km^2).

The districts are subdivided into 314 CD Blocks. There are 58 sub-divisions and 171 tahasils. According to 2001 census there are 51,349 villages and 6234 Gram Panchayats. (ORISSA STATE WATER PLAN, 2004)

1.1 Physiography

The State can be subdivided into four physiographic zones occupied by the districts as follows:

Physiographic Zone	Districts
Coastal zone	Balasore, Bhadrak, Jajpur, Kendrapara, Jagatsinghpur, Cuttack, Puri, Khurda, Nayagarh, Ganjam and Gajapati.
Northern plateau zone	Mayurbhanj, Keonjhar, Sundergarh
Central table land zone	Sambalpur, Deogarh, Jharsuguda, Bargarh, Dhenkanal, Angul, Bolangir, Sonepur
Eastern ghat zone	Kalahandi, Nuapada, Kandhamal, Boudh, Koraput, Rayagada, Nabarangpur, Malkangiri

Table 1: Physiographic Zones

1.1.1 Drainage Pattern

Odisha is drained by 11 major rivers and their tributaries, which are clearly separated by high ridges. The north of Mayurbhanj district is drained by Subarnarekha where as the south of the district and parts of Balasore district is drained by Budhabalang River. Districts of Kendujhar and Bhadrak drain into Baitarani. Sundargarh, Deogarh, Angul, Dhenkanal, Jajpur and Kendrapara drain into Brahmani river. Part of Sundargarh, Jharsuguda Sambalpur, Baragarh, Sonepur, Balangir, Nuapara, Cuttack, Jagatsinghpur, Khurda and Puri drain into Mahanadi. Kolab and Indravati drain Nabarangpur, Malkangiri and Koraput districts and Vansadhara and Nagavali drain Rayagara and parts of Gajapati districts. Ganjam is drained by Rushikulya River. In the upper reach of the rivers the slope is steep and there is no problem of drainage. But once the rivers reach the coastal plains the slope flattens and velocity reduces and drainage congestion occurs. (ORISSA STATE WATER PLAN, 2004)

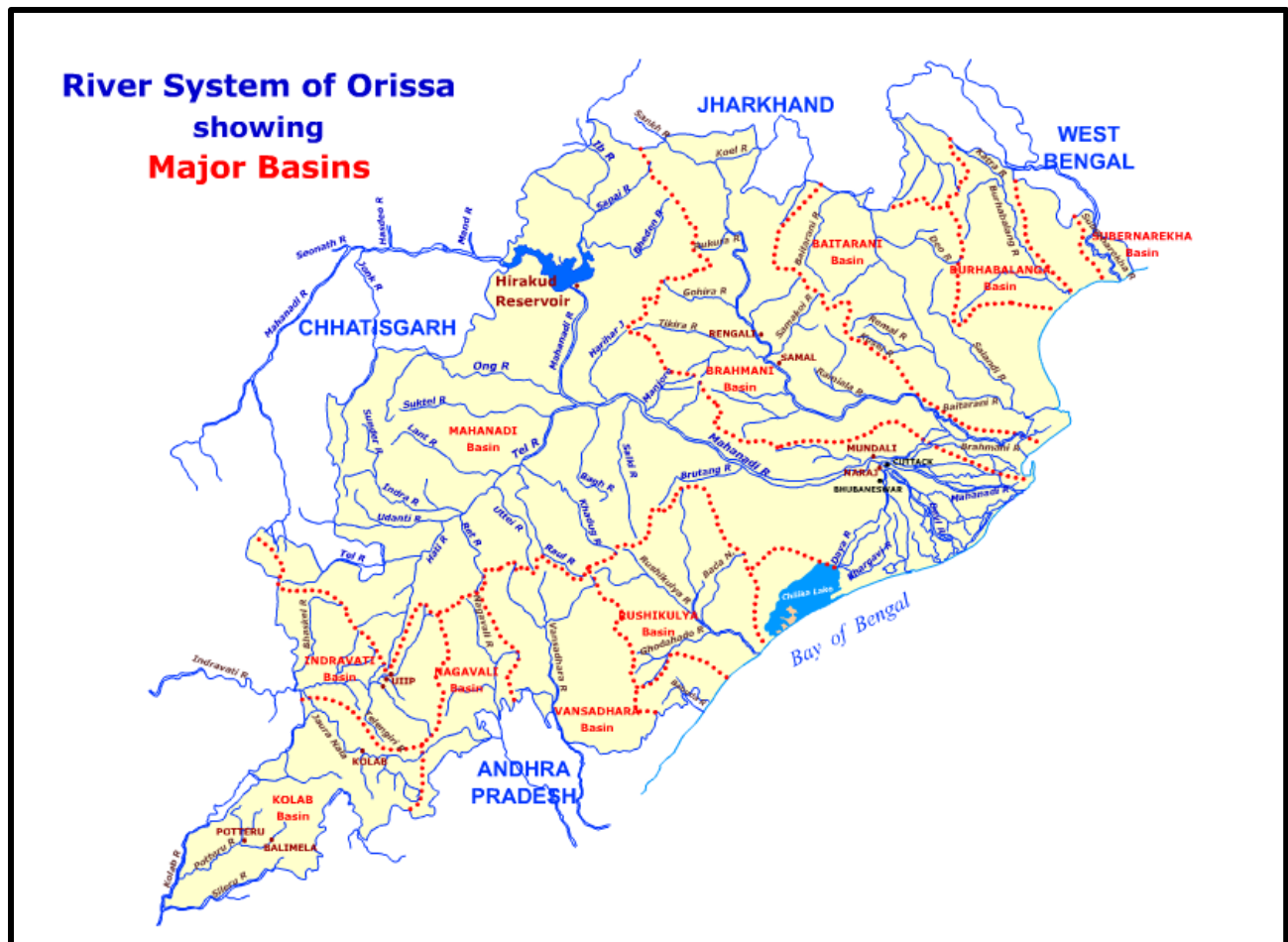


Figure 2 River system in Odisha

1.1.2 River Basins in Odisha

The area of the state falls in the catchment of the following 9 major river basins.

River	Origin	Out fall	Catchment Area inside Odisha sq.km	Length inside Odisha
Mahanadi	Nagri Town, Chhattisgarh	Bay of Bengal(Odisha State)	65,628	494
Brahmani	Vedvyas, Rourkela, Odisha	Bay of Bengal(Odisha State)	22,516	461
Baitrani	Dumuria Village, Keonjhar, Odisha	Bay of Bengal(Odisha State)	13,482	360
Rushikulya	Matabhari Village, Daringbadi hills, Kandhmal, Odisha	Bay of Bengal(Odisha State)	8,963	175

Vamsadhara	Tentulipadar(lanjigarh), Kalahandi, Odisha	Bay of Bengal(A.P State)	8,960	176
Nagavali	Lakhabahal, Kalahandi, Odisha	Bay of Bengal(A.P State)	4,500	125
Kolab	Sinkaran hills, Eastern Ghats, Koraput, Odisha	Godavari River	10,300	270
Indervati	Thuamul Rampur , Kalahandi, Odisha	Godavari River	7,400	167
Subernarekha	Nagri Village, Ranchi, Jharkhand	Bay of Bengal(Odisha State)	2,983	81
Budhabalanga	Similipal Hills, Mayurbhanj, Odisha	Bay of Bengal(Odisha State)	4,838	199

Table 2 River Basin Facts

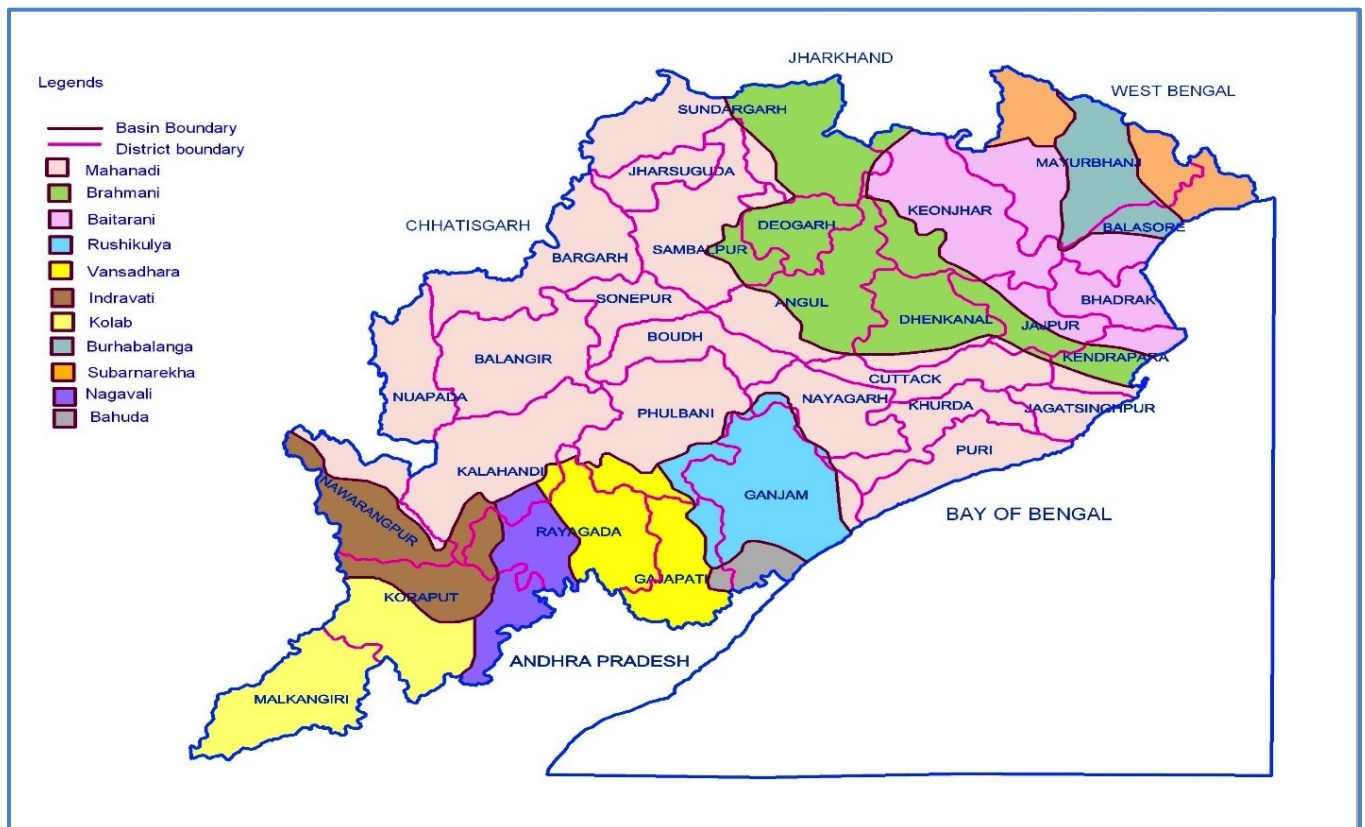


Figure 3 River Basin Area

1.1.3 Water Resources

Surface Water

Water resources of the State are derived from the annual rainfall in the State. The State receives 230.76 BCM of rainfall in a normal year. Water availability in the State on a 75% dependable basis works out to 95.54 BCM now, which will reduce to 85.89 BCM in future.

Ground water

According to the latest assessment, Odisha has annually replenishable ground water resource of 21 BCM (ham), out of which 12 BCM is taken as safe for use.

Thus, Average surface and ground water potential of the State is 141 BCM at present which is estimated to reduce to 129 BCM in 2050. (ORISSA STATE WATER PLAN, 2004)

1.1.4 Forest Area

The State has a total forest area of 58,135 km², which is about 37% of its geographical area. The Department of Forest and Environment manages 26,350 km² of Reserve forests area (RFs) under various working plans and schemes while 31,786 km² are Demarcated Protected Forests (DPFs) and Undemarcated Protected Forests (UDPFs) and other forests.

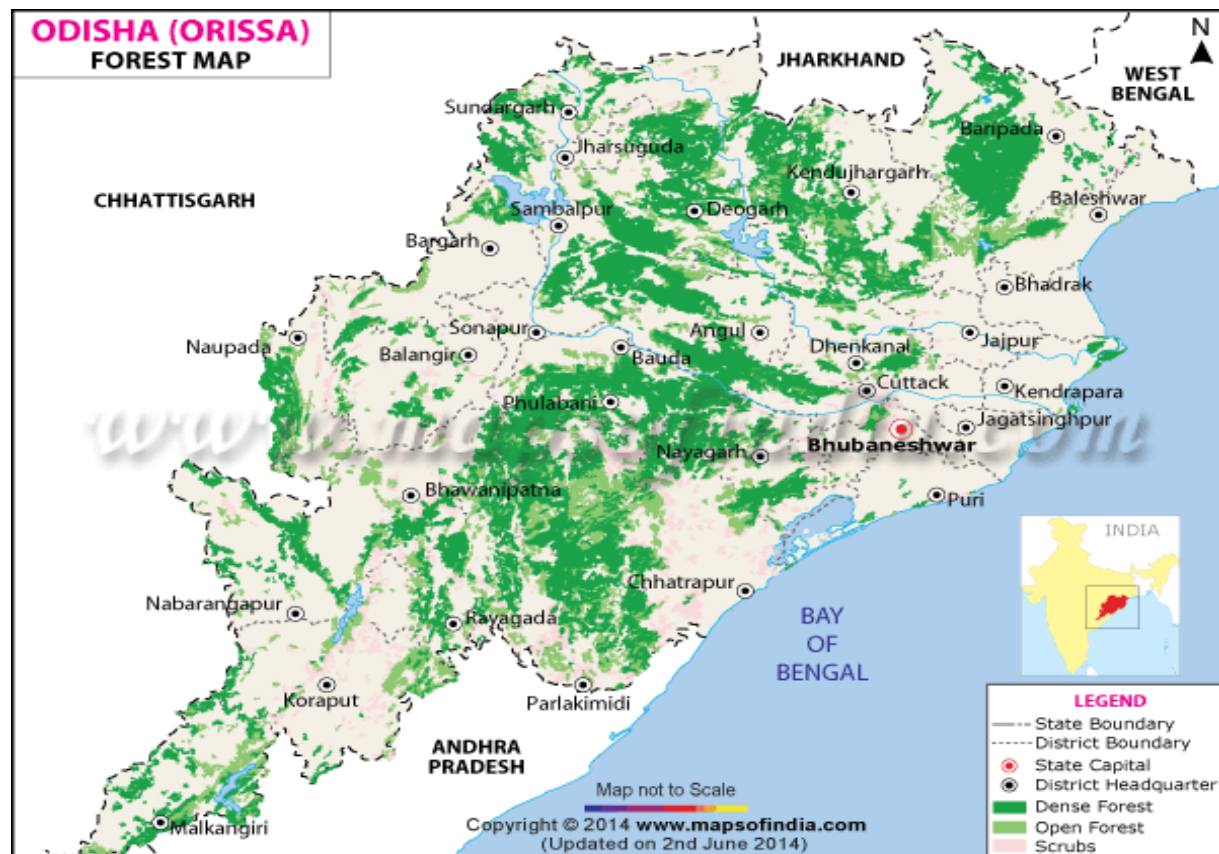


Figure 4 Forest Cover in Odisha

1.2 Climate

Set on the eastern sea board of India, Odisha has tropical monsoon type of climate like most other parts of the country.

The average temperature in the summers can be as high upto 40⁰C. The winters are quite enjoyable with minimum temperature of being almost around 16⁰ C. During the monsoon season Odisha gets an approx. 1450 mm of rainfall.

1.3 Governance

1.3.1 Institutional Structure

State Planning Board

State planning Board is the key Organisation of Government of Orissa, who provides policy direction in formulating the plan scenario both for short term and long-term developmental objectives. The Deputy chairman and members are nominated by the Government of Orissa. The Board has a member for Water Resources Development of the State.

Water Resources Board

The Government of Orissa constituted the Water Resources Board, the apex body in water sector with Chief Secretary of the State as Chairman. Important functions of the board are as follows.

- Formation of State Water Policy
- Integrated planning of water Resources
- Allocation of Water to various Water use sectors
- Prioritisation of Water Resources Development
- Environmental management plan

Water Resources Department

The Department of water resources is the nodal department of the state responsible for the water resources planning and implementation. Department takes care of planning, developing and managing the State's Water Resources for irrigation, bulk water supply, drainage and flood control with direct responsibility for implementation of Major, Medium and Minor Irrigation projects and their operation and maintenance.

1.3.2 Policy and Legal Framework

The rules and acts relating to Odisha made by state and central government are given below

- Orissa Irrigation Act – 1959
- Orissa Pani Panchayat Act – 2002

- Land Acquisition Act – 1894, amended from time to time
- Forest Conservation Act – 1980, amended up to 1992
- Environment Protection Act – 1986, amended up to 1994
- River Boards Act – 1956
- Inter-state Water Disputes Act – 1956

Organogram of Water Resource Department, Odisha

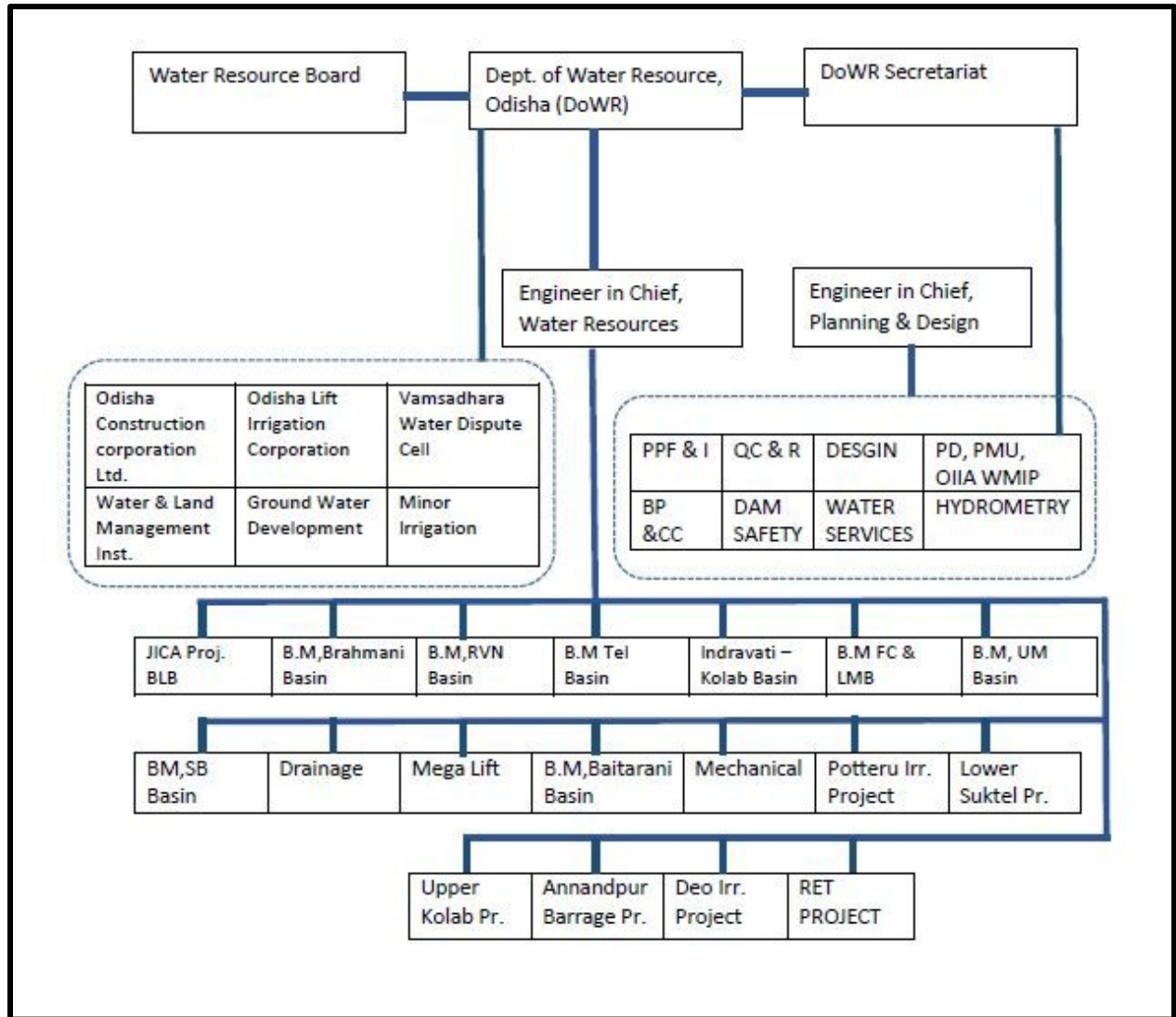


Figure 5 Department of Water Resources, Odisha- Organogram

1.4 River Conflicts

Odisha has interstate river conflicts with all its neighbouring states. In fact, Odisha is a party to a

conflict which has forced formation of river tribunal. The state is home to many interstate rivers like Subarnarekha, Mahanadi, Brahmani, Indravati, Kolab, Sileru, Nagavali, Vanshadhara and Bahuda. Serious conflicts have emerged over Jhanabati project, Bahuda, Balimela project, Jaunra, Upper Sileru project, Machhakunda and Ib river issues. The majority of conflicts arise for sharing water, sharing hydro electricity and flood control.

Some kind of agreements have been reached for sharing of rivers like Mahanadi, Ib, Subarnarekha, Bahuda, Vanshadhara, Nagavali, Indravati and Kolab. For other interstate rivers like Brahmani, Baitarini, Budhabalanga and Rushikulya, there are no such agreements. (Pati, 2010)

Agreement Year	River	States
1983	Mahanadi	Madhya Pradesh, Odisha
1978	Subarnarekha	Bihar, Odisha, West Bengal
1978	Bahuda	Odisha, Andhra Pradesh
1962	Vanshadhara	Odisha, Andhra Pradesh
1978	Nagavali	Odisha, Andhra Pradesh
1978	Indravati (Godavari)	Maharashtra, Madhya Pradesh, Odisha, Andhra Pradesh
1975	Kolab	Odisha, Andhra Pradesh
1980	Godavari (Polavaram)	Odisha, Andhra Pradesh

Table 3 River Agreements Source: (Pati, WATER RESOURCES OF ODISHA, 2010)

River Basin	Conflicts	Year
Mahanadi	Barrage Construction by Chhattisgarh	2016
Mahanadi	Water resource Department allocated 1,38,000 cumsec water to POSCO from Jobra Barrage at Cuttack	2014
Mahanadi	Sason Canal water supply irregularities	2008
Mahanadi	Suffocation of Bheden River due to excess water withdrawal by industries and ash dumping on river	2000- till date
Mahanadi	People vs government on POSCO,IOCL water supply	2011-12
Mahanadi	Dam displacement due to Hirakud Dam	1950s till date
Vamsadhara	Dispute on the barrage over Mahendra Tanaya	2008
Kolab	Orissa government objected to the Pollavaram dams construction on grounds that it will cause large-scale submergence and displacement in several villages and agricultural lands of Malkangiri in the state	2006- till date
Inderavati	Joura Nala Conflict	2001

Brahmani	Minning on the catchment areas of Brahmani	2001
Brahmani	Nalco Ash pond Collapse	2012
Brahmani&Baitarani Delta	River erosion and frequent floods	2009
Baitarani	Water transfer through slurry pipes by BRPL Industry.	2012
Baitarani	Irrigaion Divide on Ananadpur Barrage	
Baitarani	Kanupur Dam water divide between industries and agriculture	2010
Rushikulya	Execess pollution due to industries	
Rushikulya	Water Scarcity at Ganjam and very slow ongoing project	1986 – till date
Nagavalli	Rubber dam on river Jhanjabati	2016
Budhabalanga	Exploitation of water by industries	2015

Table 4 Conflicts over the basin



Figure 6 Conflict Areas on Rivers of Odisha

1.5 Social Environmental Movements Around River

River	Movements	Objective/Activities	Remark
Mahanadi	Mahanadi Banchao Mancha	Movement against diversion of water to industries; announced a massive farmers' agitation in the Mahanadi deltaic region in Odisha ¹ (2011-12) PIL in highcourt to restrain Chhatisgarh government from constructing any dam and barrages in the upstream basin of river Manahadi till disposal of the case ² (2016)	2011-12
Brahmani	Brahmani Banchao Andolan	Demands the cleaning and renovation of the riverbed from Kantabandha and Kaipada and ensuring the function of the Jokadia barrage on the river, raising the barrage height by three metres, so that the river gets enough water (2011) ³	2011
Mahanadi & Other Rivers	Odisha Nadi Surakha Samukya	Demanding the flow of Mahanadi should be ensured without any obstructions; The people of C.G and Odisha citizens should have a say in resolution of Mahandi issue. ONSS tied with civil societies of C.G to ensure peacefull resoultio of the problem; The competeion between odhisha and C.G to allocate water to industries. ⁴	2016
Baitarani River	Baitarini Bachao Abhiyan	Demanded that not a drop of the Baitarini would be allowed to be taken for the industries. The river is for the farmers and the locals, the water cannot be piped away ⁵	2010

¹<http://www.indiawaterportal.org/news/mahanadi-banchao-andolan-which-spearheading-movement-against-diversion-water-industries-has>

²<http://timesofindia.indiatimes.com/city/cuttack/PIL-filed-over-Mahanadi-controversy/articleshow/53564086.cms>

³http://www.telegraphindia.com/1110825/jsp/orissa/story_14419403.jsp

⁴<http://ommcomnews.com/public/odisha-chhattisgarh-social-bodies-join-hands-to-solve-mahanadi-river-dispute->

⁵http://103.16.143.39/udayIndiaArchive/english/content_11november2012/cover-story.html

Baitarani River	Baitarini Suraksya Manch	Protesting the Essar company's construction in the river ⁶	2012
Brahmani & Baitarani	Khandahar Suraksha Sangram Samiti	To save catchment areas in the khandar hills from mining activities which have catchments to both the rivers. ⁷	2016
Suktel River(Tributary of Mahanadi)	Lower Suktel Budi Anchal Sangram Parishad	Resisting due to loss of land, forest and livelihoods, besides displacement of people from their native land. To drop major dam project and search for minor projects ⁸	2001
Rushikulya River	Rushikulya Bachao Mancha	Linking of the Rushikulya river with the Mahanadi river to save the Rushikulya from drying up and also check floods in the Mahanadi ⁹ .	1986
Chilika Lake	Chilika Bachao Andolan (Save the Chilika Movement)	Fishermen resistance in the early 90's to the Integrated Shrimp Farm Project (ISFP) ¹⁰	1993
Baitarani	The Keonjhar Citizens Forum	Drawing attention regarding unkept promises, deliberate delays on the Kanupur Dam Project	2010
Brahmani	District Action Group of Angul and Dhekanal	Rising Pollution levels in the districts due to effluents from the industries contaminating drinking water and environment	2005

Table 5 Social and Environmental Conflicts

⁶<http://aryaputras.blogspot.in/2012/12/green-tribunal-restrains-essar-steel-to.html>

⁷http://www.orissabarta.com/index.php?option=com_content&view=article&id=21406%3Acall-for-united-movement-to-save-khandadhar&Itemid=85

⁸<https://ejatlas.org/conflict/lower-suktel-irrigation-project-orissa-india>

⁹<http://www.thehindu.com/news/national/other-states/pm-asked-to-take-steps-for-river-linking-in-odisha/article7017242.ece>

¹⁰http://www.mcrg.ac.in/Toolkit/inside_pgs/case_study.html

2.0 River Narratives

2.1 The Mahanadi

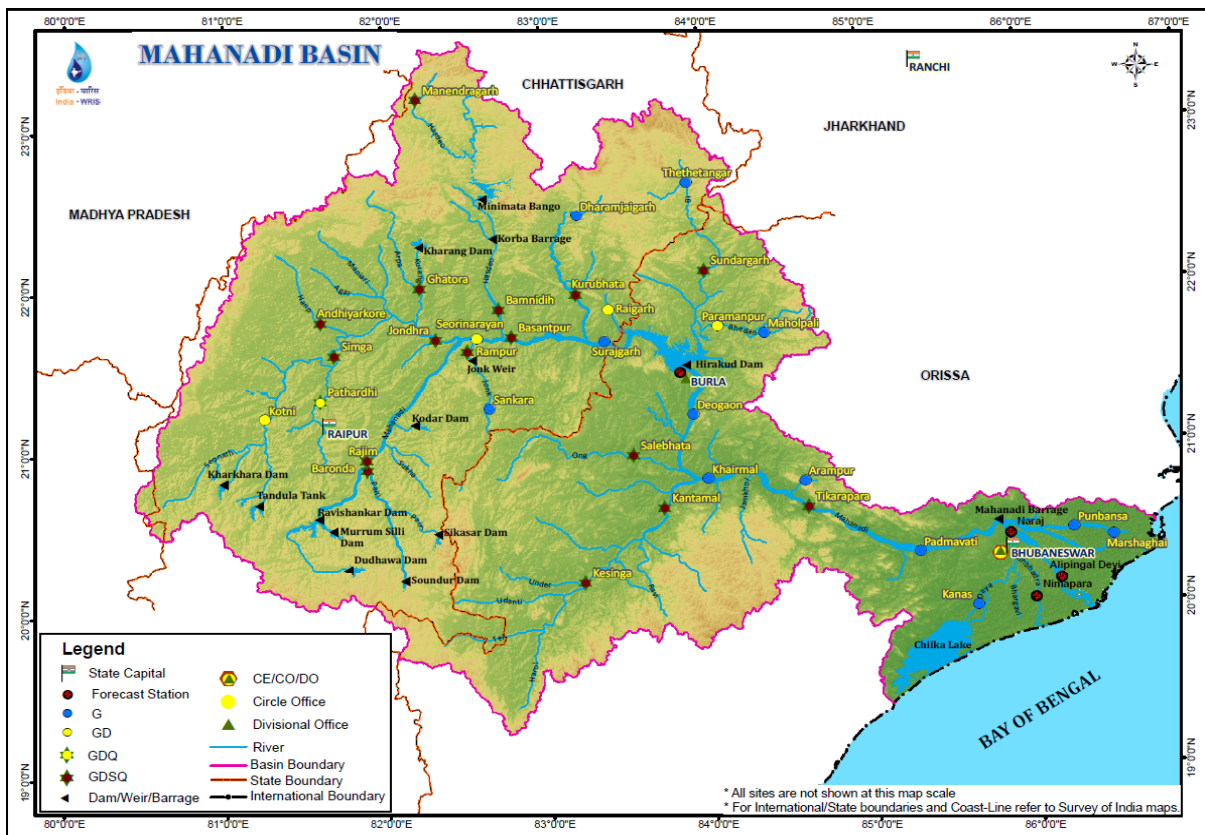


Figure 7 Mahanadi Basin

2.1.1 Mythology & Folklore

There is a beautiful mythology behind river Mahanadi, the originating place of Mahanadi River near the Ashram of Maharishi Sharangi. Mahanadi is also called as holly Ganga in Chhattisgarh and Odisha. Mahanadi also is also called ‘Ganga Chitrotpala’ in the ancient historical documents. It is said that once all the sages of this area came to this area for taking holly bath in the Ganges during Mahakumbh. The Mahrashi Sharani was under meditation and penance at that time. The sages waited for several days to draw the attention of the Maharishi but the Maharishi’s meditation was not

disrupted. Thereafter sages went for holy bath. While returning after the bath, all the sages brought some holy water with them. Finding that Maharishi Sharangi was still in meditation, they filled the Maharishi's kamandal (vessel) with water, and returned to their respective places. After sometime when the meditation of the Maharishi Sharangi was disrupted, the water of the Kamandal fell down on the ground with the stroke of his hand. This water began to flow towards east and was converted into a stream. This stream was called Mahanadi which is said to fulfil the desires of millions of people.

2.1.2 Historical Aspects

The Greek Geographer Ptolemy (middle of the 2nd Century A.D.) in his book "Geographike" refers to a town named "Sambalaka" situated on the bank of the 'Manada'. 'Sambalaka' and 'Manada' may perhaps be identified as modern Sambalpur and the river Mahanadi, respectively.

Balaram Dev a great warrior, built a new kingdom independent of Patna at Sambalpur on the bank of river Mahanadi. Balaram Dev made a very strong fort on the bank of river Mahanadi. He made Sambalpur the nerve-centre of Central Eastern India.

Mahatma Gandhi visited Sambalpur on December 23, 1928. A mass meeting was held on the Mahanadi bed in front of Brahmapura temple. The women of Sambalpur organised a separate meeting to receive Mahatma Gandhi.

In the Vedic Age, Emperor Vaibaswatamanu handed over south Kosala to his daughter, of whose four sons, Vinitaswa set up on the bank of the Mahanadi his capital known as Vinitaswapura or Vinitapura (modern Binka) of the Somavamsi charter. (*Koshala Itihasa Katha* Vol.1). (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.1.3 Tourist Places/ Religious Places

Goddess Patharasini of Arjunda

Arjunda is a Village situated on the Bank of River Mahanadi and at the northern end of the Barapahar Forest range. It is in Ambabhona Block in Baragarh district of Odisha. Surrounded by dense Forest, it is in between the Bandijharia stream and the Kedarnath stream. Patharasini is worshipped here in a Temple. The Chandrasini of Chandrapur, Padmasini of Padampur and Patharasini of Arjunda are sisters according to a legend. It is a famous tourist spot. Boating facility is an added attraction to it.

Padmasini Temple of Padampur

There is an ancient temple on the bank of River Mahanadi at Padampur, the birth place of famous Sanskrit poet and dramatist Bhababhuti of 8th Century. The deity of this temple is Goddess Padmasini (Durga). The art and architecture of this small temple is quite different from other temples in Odisha

Koilighugar water fall (Lakhanpur)

The Koilighugar water fall is situated 55 kilometer away from Jharsuguda in the Lakhanpur block near the village Kushmelbahal. A rivulet named Ahiraj takes origin from the Chhuikhanch forest and while flowing through its rocky belt falls from a height of 200ft. creating the water fall of Koilighugar. It is a picturesque beauty spot with its sylvan back drop.

Gopalji Temple Inscription

The Gopalji temple which stands in front of the dilapidated palace of Sonapur on the Mahanadi is one of the *Astavismu* temples of Subarnapur town dating back to the later half of the 17th century. On the lintel at the entrance to the temple, we have a massive stone inscription which contains the genealogy of the Chauhan rulers of Sonapur from Achal Sing Deo to Sudhansusekhar

Godhaneswar

2 kilometer from Subalaya in in Sonapur district of Odisha, stands the Godhaneswar temple on the left bank of the Mahanadi. The Swayambhu Lingam appears to emerge from a rock which carries the hoof-marks of a cow. Like the legend surrounding the appearance of Subarnameru and Champeswar, the arrival of Godhaneswar is associated with the Lingam and the black cow. And yet it tells a slightly different tale. This temple was built by Prithvi Singh (1781 – 1841), may be in the last lap of the 18th century.

Papakshaya Ghat

This ghat is located on the bank of the Mahanadi near Binka town, 32 km. from Sonapur. This place is both holy and historical. Legend has it that Anangalohima dev III (1211-38), Gajapati of Puri took a holy dip in the Mahanadi on a solar eclipse day and was cured from a dread disease or *brahmahatya dosa* for killing a Brahmin General during the war with the Kalachuris, then rulers of Subarnapur. It is further said that the



Figure 8 Leaning Temple of Huma

Gajapati, dream-directed by Lord Jagannath came all the way with his retinue ,building *Yojanika* Siva temples (temples built every 12 miles or a *yojana*) from Puri to Subarnapur, the remains of which can still be found here and there on the right bank of the Mahanadi.

Leaning Temple of Huma

Amazing temple dedicated to Lord Shiva is located on the left bank of Mahanadi. It is the only leaning temple in the world which attracts many tourist for its Architecture. The place also has famous Kudo fish species found on its ghat. People enjoy feeding the fishes on the ghat.

Gokulananda Tourism Center

Also known as (Gokulananda picnic spot), is a tourism center situated in Sidhamula village, in Nayagarh districts, Odisha. This center is situated on the bank of river Mahanadi. The temple is on the top of the hill. It is nice to watch the panoramic view of the hill and flowing water of Mahanadi from the hill as well as from Sidhamula Bridge.

Nilamadhav Temple

Sri Nilamadhava Temple is very old and famous Vishnu temple which is near to the bank of Mahanadi in Kantilo in Nayagarh district, Odisha. Temple is present near to the twin hills with a surrounding forests and is famous picnic spot in state.

Sonepur town

Sonepur town also called as Subarnapur is bestowed with beautiful temples with ancient mythologies

Some of the temples worth watching in the town are as follows:

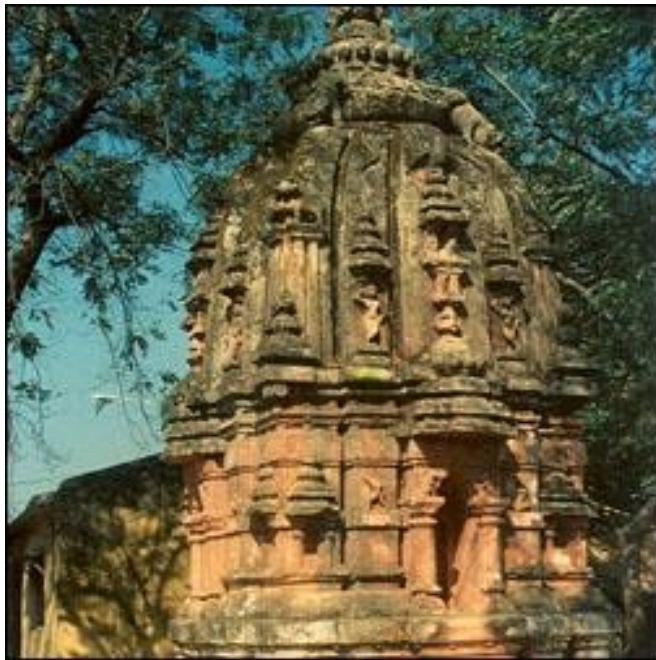


Figure 10 Sashisena Temple

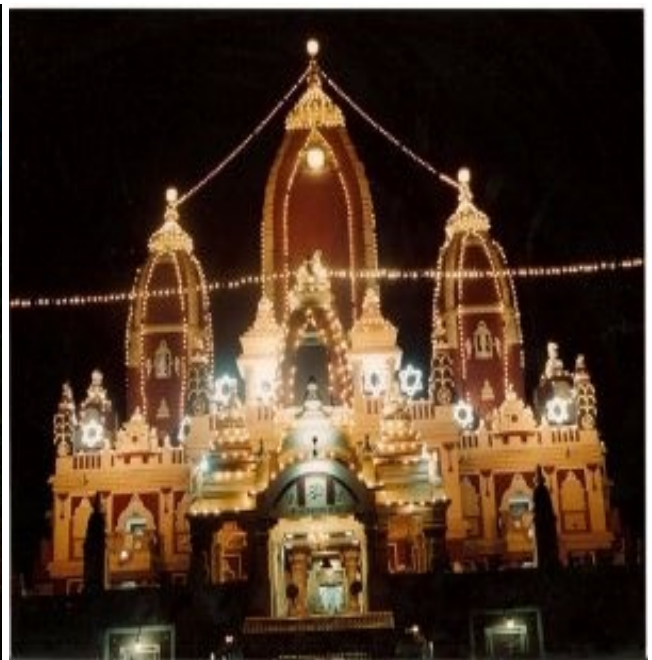


Figure 9 Hariharnath Temple



Figure 12 Jatesingha Temple

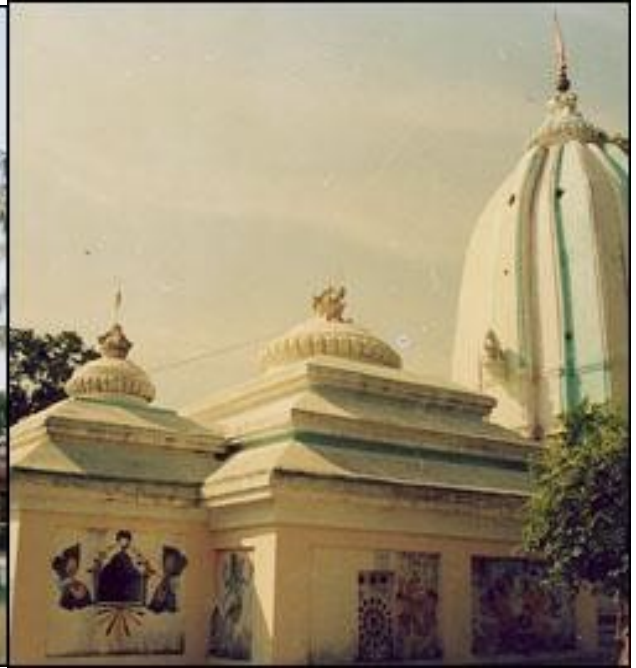


Figure 11 Rameswar Temple

Charchika of Banki

Charchika Temple is one of the oldest Shakta places in Orissa. It is located in a small town of Banki of Cuttack district in Odisha. The presiding deity is an eight-armed goddess Chamunda, locally known as Maa Charchika Devi. She is seated on a prostrate human body and wearing a garland of humanskulls.

She displays *khadga*, *shula*, *katari* and *varadamudra* in

her four right hands whereas the four left hands represent severed head, blood-cup, "damru" and leaving a finger of the remaining hand soaked in blood. This temple is situated on the top a small hillock Ruchika Parvata on the bed of the Renuka river in the small town of Bankiin Cuttack district of Orissa.

(Wikipedia, 2016)

Bhatarika Temple

Bhatarika Temple in sasanga village, baramba, Athgarh, Cuttack District, India is dedicated to the Hindu Goddess Maa Bhatarika worshipped as a demonstration of Shakti. The temple is situated on the banks of the River Mahanadi. As per Puranic tradition Parasuram facing certain defeat at the hands of Saharasjuna prayed



Figure 13: Charchika Temple



Figure 14: Bhatarika Temple

to Durga who appeared in this spot to impart her divine power to the aid of Parashuram.(Destinations of Odisha, 2016)

Dhableswar Temple

Dhableswar Temple is dedicated to the worship of Lord Shiva. It is situated at a distance of 37 kilometers from the city of Cuttack, in the exotic island of Dhableswar. It is one of the famous weekend tours from Cuttack. The temple, located on the banks of the by the River Mahanadi, is embellished with stone carvings that date back to the early 10th and 11th century. The serene ambiance, in which the temple is situated, inspires spiritual feeling among one and all.

(Wikipedia, 2016)



Figure 15: Dhableswar Temple

Bhubaneswar

Bhubaneswar the capital city of Odisha is an ancient city in India's eastern states, formerly Orissa.



Figure 16 Dhauligiri Famous Buddhist Pilgrimage in Bhubaneswar

Many temples built from sandstone are dotted around Bindu Sagar Lake in the old city, including the 11th-century Hindu Lingaraja Temple. Outside Rajarani Temple are sculpted figures of the guardians of the 8 cardinal and ordinal directions. The city is also called the temple city of India. Jain antiques, weaponry and indigenous pattachitra paintings fill the Odisha State Museum.

Cuttack

The former capital and the second largest city in the eastern Indian state of Odisha. Cuttack city is rich in its culture, history and heritage. An important part of Odisha's history is best reflected by Cuttack. Four rivers including Mahanadi and its distributaries Kathajodi, Kuakhai, Birupa run through the city. Festivals like Durga puja, Bali Yatra, Kali Puja and kartikeswar Puja are celebrated with great pomp and show.

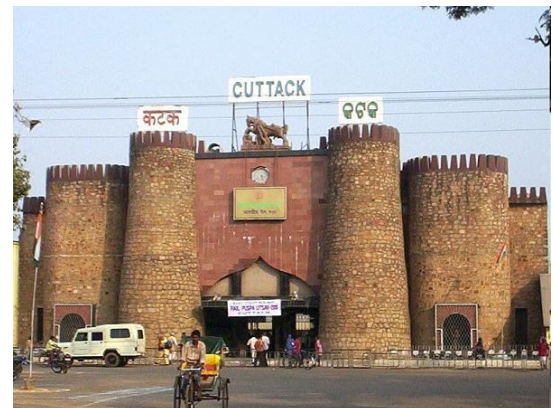


Figure 17:Fort structure of Cuttack Station

Chiplima and Ghanteswari



Figure 18: Maa Ghanteswari temple

Maa Ghanteswari temple is a temple in the vicinity of Sambalpur city in Orissa, India. As the name suggests there are bells everywhere. People offer bells to goddess Ghanteswari or the Deity of Bells, after fulfillment of their wishes. A large number of pilgrims from across the state visit the temple. It is known as the 'lighthouse without light', built by the early sailors, for whom the bells served as warning against heavy winds.

The special significance of this place lies in the great number of small bells hanging all around. Maa Ghanteswari Temple is situated 33 kilometres (21 mi) southwest of the district capital Sambalpur on the bank of Mahanadi River. The Chipilima Hydro Powerplant (CHEP) is located near the temple on the same river bank.

Sambalpur and Samaleswari

Sambalpur town on the bank of Mahanadi is a land of temples- the temples of Liakhai, Madanohan, Satyabadi, Bariha, Brahampura, Dadhibamana. Tamini and Gopalji Reveals the influence of Vaishnava tradition in Sambalpur. The temple of Budharaja Hills, Maneswar, Gupteswar, Balunkeshwar, Loknath, Samaleswari, Pataneswari, Batamangala, Budhimaa, Mahamayi etc symbolizes the co-existence of Shiva and Parvati.



Figure 19 Samaleswari Temple

Hirakud Dam



Figure 20 Hirakud Reservoir

The **Hirakund Dam** near Sambalpur is a major landmark on the banks of the Mahanadi. The dam is the longest in the world when it was constructed in 1957. Today, it is a major tourist attraction for travellers. The Hirakund dam regulates the flow of Mahanadi and produces hydroelectricity. The dam has formed a manmade lake, which is 55 km long.

Satkosia, Tikara Pada

Satkosia spreads along the magnificent gorge over the mighty river Mahanadi in Odisha. Established in 1976 as a wildlife sanctuary, Satkosia is a paradise of immense scenic charm. It is one of the best ecosystems in the country, representing a diverse floral and faunal extravaganza. Satkosia gives intense nature camping experience, overnight stay is fascinating and unforgettable. The place is full of natural beauties. River Mahanadi, the largest river in the state is at its most beautiful and also most fearful shape at Satkosia. A Nature Interpretation Centre at Tikarpada supplements an ecotourist's search for subject and thrill. One can gain vast knowledge about the Gharial Crocodile



Figure 21 Satkosia Gorge

from the Gharial Research and Conservation Unit. Boating (in permissible area) on the river Mahanadi and viewing the majestic gorge and towering mountains on the both sides, one can sight plenty of crocodiles basking on the sand banks. Nature lovers and bird watchers can walk around and discover the unspoiled wilderness through the nature trail.

2.1.4 Morphology

Like many other seasonal Indian rivers, the Mahanadi too is a combination of many mountain streams and thus, its precise source is impossible to pinpoint. However its origin point is said to lie 6 kilometres from Pharsiya village at an elevation of 1,450 ft. above sea level south of Nagri town in Dhamtari district of Chhattisgarh. For the first 80 kilometres of its course, the Mahanadi flows in a northerly direction and drains the Raipur district and touches eastern portions of Raipur city. It is a rather narrow river at this stage and the total width of its valley does not exceed 500–600 metres. After being joined by the Seonath, the river flows in an easterly direction through the remaining part of its journey. It is joined by the Jonk and Hasdeo rivers before entering into Odisha, after covering about half of its total length. Near the city of Sambalpur, it is dammed by the largest earthen dam in the world, the Hirakud Dam. The dam measures 24 kilometres including the Dykes. It also forms the biggest artificial lake in Asia, with a reservoir holding 743 square kilometres at full capacity, with a shoreline of over 640 kilometres.

It then skirts the boundaries of the Baudh district and forces a tortuous way between ridges and ledges in a series of rapids until it reaches Dholpur, Odisha. The rapids end here and the river rolls towards the Eastern Ghats, forcing its way through them via the 22 kilometres long Satkosia Gorge. The Satakosia Gorge ends at Badamul of Nayagarh. Dense forests cover the hills flanking the river

here.

The river enters the Odisha plains at Naraj, about 11 kilometres from Cuttack, where it pours down between two hills that are a mile apart. A barrage has been constructed here to regulate the river's flow into Cuttack. The river traverses Cuttack district in an east-west direction. Just before entering Cuttack, it gives off a large distributary called the Kathjori. The city of Cuttack stands on the spit separating the two channels. The Kathjori then throws off many streams like the Kuakhai, Devi and Surua which fall into the Bay of Bengal after entering Puri district. The Kathjori itself falls into the sea as the Jatadhar. Other distributaries of Mahanadi include the Paika, Birupa, Chitroptala River, Genguti and Luni. The Birupa then goes on to join the Brahmani River at Krushnanagar and enters the Bay of Bengal at Dhamra. The Mahanadi proper enters the sea via several channels near Paradeep at False Point, Jagatsinghpur. The combined Delta of the Mahanadi's numerous distributaries and the Brahmani is one of the largest in India.

Tributaries and Distributaries

The important tributaries of Mahandi inside Odisha are Ib, Ong, Tel, Jira, Bagh, Salki, Kuanria, Hariharjore, Sagada, Ret, Hati, Indra, Suktel, Utei, Remal, Udanti, Lanth, Sapua etc.

Ib- Ib is principal tributary of the river Mahanadi, enters Sambalpur District from Jharsuguda District in the north and then merges with Hirakudreservoir about 26 kilometres north of Sambalpur. Total catchment area of Ib is 2765 sq.km and travels a distance of 251 km before falling into Hirakud.

Bheden (or 'Bonam') - Bheden is a tributary of Ib that flows from Kuchinda Sub-Division and joins Ib near Rampur.

Tel- It rises in the north of Nawrangpur District, it enters the district a few kilometers west of Dharamgarh near Chhilpa and flows through an alluvial tract. It meets the Udanti River on its left bank. About eight kilometers from this point of confluence, it runs almost northeast and forms the boundary between Bolangir and Kalahandi for a fairly long distance and then enters Bolangir near Risida, Kumbharpada. Its water level decreases very much during the summer. It travels a distance of 296 sq.km and has total catchment area of 22781 sq.km.

Hati- It starts from hill tracks of Jaipatna range near Pandi PRF and then passes through plain area of Junagarh range where it joins river Tel near Amathola. This river also gets the discharge water of Upper Indravati project and surplus water of the canals for which there is a good flow of water throughout the year. During rainy season it poses serious problem of flood disrupting the road connectivity.

Ong- Ong that originates in Nuapada District. It flows in a wide-semi-circle from west to east and leaves the Baragarh District a few miles to the east of Gaisilet eventually joining the Mahanadi in Subarnapur District. It travels a distance of 204 km and has catchment area of 5031 sq.km

Suktel- Suktel origins from the slopes of the Gandhamardan range and flows through the subdivisions of Patnagarh and Balangir. It meets the Tel a few miles south of its confluence with the Mahanadi in Subarnapur District.

Distributaries

The Major distributaries of Mahanadi are Kathajodi, Birupa, Kuakhai, Daya, Bhargavi, Kushabhadra, Biluakhai, Devi, Kandala, Chitrotpala, Luna, Karandia, Paika and Badagenguti. All the major branches and sub-branches including Mahanadi falls into Bay of Bengal except Daya & Bhargavi which fall into Chilika Lake.

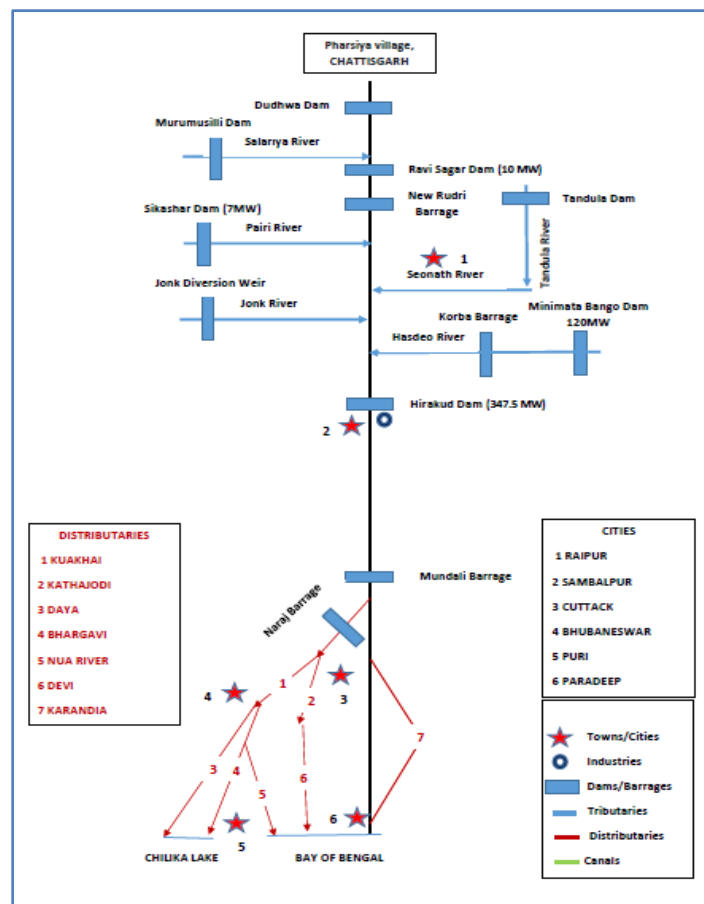


Figure 22 Mahanadi Flow Diagram

Dams and Projects

Sl No	Name of Dam	Year of completion	River	Volume content of dam in TCM	SlNo	Name of Dam	Year of completion	River	Volume content of dam in TCM
1	HIRAKUD	1957	Mahanadi	19330	17	KARANJKOTE	1979	Karanjkote nalla	82.40
2	BHATRAJORE	1980	Bhatrajore	150.00	18	DUMERBAHAL	1983	Trb to Ong	65.09
3	BUDHABUDIANI	1980	Budhabudiani	435.00	19	KOSKA	1988	Bandha pathar	274.80
4	DHULIPAUNSI A	1997	Dhu'sia Nalla	60.78	20	MATHAN PAL	-	Konda	2260
5	LAAIGAM	1991	Gouduni nalla	NA	21	PADAMPUR NALLA	1988	Padampur nalla	4.87
6	JHUMUKA	1978	Jhumukanalla	124.60	22	SAIPALA	1978	Trb to Ong	203.76
7	BALASKUMPA	1977	Tributary of Pilasalki		23	SUNDAR	1978	Trb to Ong	
8	DEBIJHARAN	1987	Debijharan nalla	84.50	24	TANGARAKAN A	1981	Vamsadhara	156.05
9	HAGURI	1910	Haguri Nalla	210.72	25	BHETABAR	1991	Kankadajhar	295.92
10	KALIJODI	1999	Kalijodi nalla	92.18	26	KANGANI NALLA	1975	Kangani nalla	
11	KANTESIR	1996	Kantesir nalla	61.65	27	BANKSAL	1967	Banksal nalla	110.00
12	KUMBHO	1995	Dharkuta Nalla	48.22	28	MAHARANISAGAR	1975	Maharani sagar n.	107.60
13	LAUPAL	1982	Laupal	130.00	29	SARAPA	1980	Karanda nalla	165.00
14	MAHISNALLA	1982	Mahisanalla	156.16	30	BEHERA	1983	Behera Nalla	29.50
15	GHAGARA	1974	Ghagara nalla	205.05	31	BENIKPUR	1986	Uttei	80.50
16	TALKHOL	1978	Sanjo nalla	154.50	32	CHHATENJORE	1982	Chhatenjore	124.35

Table 6: Dams and Projects on Rivers

2.1.5 Biodiversity

The Northwestern and southern parts of the Seonath sub-basin and Northern parts of the Hasdeo sub-basin are covered with forested hills. In the Seonath sub basin as well as Hasdeo sub-basin dry Sal forest are seen mostly on the flat grounds below the ghats while moist Sal forest are seen in the higher elevations. Deciduous type forest are seen in the Jonk, Ib, Tel and Middle Mahanadi sub basins. The commonly available species in the forests in the basin are Teak, Tamarind, Mahul, Mango, Tendu, Char, Jamun, Kusum, Bija (Peasal), Simul, Saaj, Haldu, Palas, Asan and Bamboo.

The animal species found in the basin are lion, deer, rabbit, bear, fox, wild buffalo and reptiles. Different state in basin area has planned to develop forestry in the basin as a major thrust towards ecological balance, energy conservation and economic stability of rural population. There are many sanctuaries eg. UshaKothi, Khatasuno, Sotkosia falling in this basin area.

Fish Fauna There are about 56 different major species of fishes found in the different stretches of Mahanadi River. 20 species are considered as only ornamental fishes, 30 species as only food fishes and 6 species as both ornamental and food fishes. It is observed that fish species like

Amblypharyngodon mola (Ham.), Catla catla (Ham.), Cirrhinus mrigala (Ham.), Labeo rohita (Ham.), Osteobrama cotio (Ham.), Puntius sophore (Ham.) and Wallago attu (Bl. & Schn.) are found almost in all the sites of the selected stretches. (Singh, 2014).

As many as 110 species of fish in Odisha's Hirakud Dam Reservoir (HDR) here have become extinct over the decades largely due to rampant fishing, discharge of industrial effluents into the reservoir and over-drawing of water by industries. (Odisha Sun Times Bureau, 2016)

2.1.6 Impact of human activities on the river system

In 1950, Odisha used to get 71 billion cubic meter water of Mahanadi from Chhattisgarh, which has reduced by 10 billion cubic meter water by now. With increasing population and number of industrial units coming up in both the States, the dependency on Mahanadi river water has also increased significantly.

Disproportionate use of Mahanadi river water by the residents and industrial units established in the Mahanadi Basin will be a matter of concern in the times to come

Uninterrupted human intervention in and around the river basins has affected not only the health of the rivers, but it has also affected the human health and environment. (Swamy, 2014)

2.1.7 Conflicts over Mahanadi

Interstate Disputes

Mahanadi Dispute 2016: News of Seven pick-up weirs across river Mahanadi just upstream of the Hirakud Dam and other projects by Chhattisgarh has worried administration of Odisha. Government of Odisha raised strong objection on the proposed structures depicting severe adverse impact on flow of water into Hirakud Reservoir. Odisha has called for the Prime ministers intervention to be critical over the projects by Chhattishgarh for the interest of riparian communities of Odisha. (Time of India, 2016)

There have been serious opposition to the recent projects started by Chhattisgarh which includes mass movements, strikes, dharnas, etc. There are also civil society movements to save Mahanadi River where the CSOs from both Odisha and Chhattishgarh have joined hands. Ruling government of Odisha has been trying to resolve the issue bby raising the issue time and again in different for a. Even the ruling party and the opposition party representatives have visited Chhattisgarh to understand the issue and fathom the degree of impact these projects will have on the riparian communities in Odisha.

The dispute over Mahanadi river water between Odisha and Chhattisgarh escalated with the ruling Biju Janata Dal (BJD) raising the issue in both the houses of Parliament even as Chhattisgarh Chief Minister Raman Singh asserted that the state has every right to utilise its water. Chief Minister also agreed that his government is ready for talks with the Odisha government over the issue. He also

mentioned all the projects over Mahanadi had been clearance by the CWC.

Union water resources minister Uma Bharti assured that Odisha's interest will not be sacrificed. Centre had convened a tripartite meeting between officials of Odisha, Chhattisgarh and Central Water Commission (CWC) over the issue on July 29. Originally, Centre had convened the meeting on July 7 2016. The meeting was, however, deferred after request from the Odisha government.

The Congress team led by leader of the Opposition Narasingh Mishra made an on the spot visit to the site of barrages and dams being constructed by the Chhattisgarh government. Officials from the Chhattisgarh government accompanied the Odisha team during the visit and provided several documents. The leader of the opposition also criticised the Odisha government for not providing any document even after his request. Mishra alleged that the Odisha government had remained silent over the issue even though it was aware about the construction activities of Chhattisgarh government since 2007. However, Team confirmed that Chhattisgarh government is constructing six barrages over river Mahanadi on its side solely to cater to the water requirement of industries.

The dispute has also furthered all non-BJD political parties in Odisha on 10 August 2016 to urge the President to direct the Chhattisgarh government to stop the construction and to save the lives of millions of people living downstream. Meanwhile, Congress had also called for a bandh on 16th August 2016 to demand the Centre's intervention for halting construction of barrages and dams on the Mahanadi.

After the 29th August meeting made no headway, Union Water Resources Minister MS. Uma Bharati convened another meeting between the Chief Ministers of Odisha and Chhattisgarh. This too did not make much of a headway as the demand by CM Odisha to set up an independent expert team to investigate the matter and till this committee submits report the construction of the barrages should stop. While the meeting reached an agreement to have a joint monitoring committee, but Chhattisgarh did not agree to stop the construction. Union Minister for Water Resources committed that an Joint Committee will be formed to do a stocktake as to which are the projects of both the states those needed Technical Advisory Committee approval and have not got it. Then the next course of action will be taken. Even this has not gone well with Odisha CM and Odisha government poses that the talk was a failure and mulling other options.

Meanwhile, civil societies of Odisha and Chhattisgarh had come for a meeting at Chhattisgarh and Odisha respectively demanding the flow of Mahanadi should be ensured without any obstructions, the people of Chhattisgarh and Odisha citizens should have a say in resolution of Mahanadi issue. Civil societies of Odisha and Chhattisgarh to ensure peaceful resolution of the problem.

People vs Industries:

Industry Vs Agriculture around Hirakud

The frequent irregularities of irrigation water supply to the Sason canal command from 2005 to 2007, and growing industrialisation and increasing water intake from the reservoir by industry, led to several protests by the farmers. In 2005, farmers organised a huge gathering at Sambalpur and Bargarh towns against industrial water use. Later on, farmers in western Odisha joined the protest to make it a massive farmers' movement over their right to irrigation water. On 15th August 2006, farmers' organisations and unions from the Sason canal command and other parts of western Odisha came together and formed the Western Odisha Farmers' Coordination Committee (WOFCC), which coordinated the farmers' movement from then on.

In Hirakud about 30,000 farmers stormed the reservoir in Sambalpur in November, 2007 to protest against increasing diversion of water meant for irrigation in favour of industry. The issue also rocked the State Assembly and Congress moved a motion in the house on alleged atrocities against farmers and diversion of water. The Chief Minister intervened and subsequently it became the election manifesto.

This is regarded as the watershed event in the industry vs. agriculture conflict in the state. With massive participation of farmers' groups and other civil society institutions, protests over non-availability of water from the dam have snowballed into a social movement since then.

Conflicting parties involved- Farmers, State Government, and Industries. (River Basin Transact, 2010)

Suffocation of Bheden River

The effluents from industries including fly ash are directly being dumped into the river severely suffocating it. Illegal withdrawal by industries also threaten the existence of Bheden River. Locals affected by the pollution and reduced flow have been regularly protesting against the industrial activities. Some Organisation like Water Initiative of Odisha, Anchalik Paribesh Surakshya Samiti, Chetanashila Nagrik Mancha, Lok Mukti Sangathan, Ib Paribesh Milita Kriyanusthan Committee, etc have also been regularly raising their voice against the issues.

Conflicting parties involved- Villagers, Industries, Govt (OPCB & Dist Admn). (River Basin Transact, 2010)

The local residents of both Jharsuguda and Kolabira block of Jharsuguda district and adjoining areas of Sambalpur district as well as some part of Jharsuguda municipality have been opposing industries to save the river, agricultural fields, forests and the overall environment around Beheden River a tributary of Mahanadi. The conflict is created mainly due to water drawn from the river and hazards of pollution by industries. Before the summer season, the Bheden river dries up. The people who are directly or indirectly dependent upon the river are affected due to water scarcity. Most of the land on

the riverbank irrigated by lift irrigation is impacted due to the shortage of water. Rabi crop and crop in the summer season. Though there is no political support to the protest against environmental degradation, the people are forming groups and staging dharnas and rallies, organising meetings, submitting a memorandum, etc. on a regular basis in short intervals. Various non-government institutions and environmentalists are leading the affected population. People are not united under a single umbrella, but the process of unity is in progress. There are symptoms of violent rebellion in the future.

People vs Administration

People vs government on POSCO water supply.

The water resources department had informed POSCO that it can draw 138,000 cumecs (cubic metre per second) of water from the Mahanadi River at Jobra barrage for the project work. During the first phase, POSCO will get 69,000 cumecs water from December 2018. From 2021, during the second phase, POSCO will get another 69,000 cumecs. POSCO will also receive 3,400 cumecs water from the river Hansua from June 16, 2016 till December 2018 for the construction work. This allocation angered the civil society, farmers and activists who fear allocating water to POSCO through barrages, will create water logging, which will affect the agriculture in the nearby blocks of Cuttack and Jagatsinghpur. (River Basin Transact, 2010)

Now that the setting up of the POSCO plant has been abandoned by the steel major, the resistance to drawal of water is not there on the ground.

Flood in non-traditional area due to river linkage

40 thousand people of 8 Panchayats are remaining waterlogged for four months in rainy season due to discharge of Indravati water into Hati river after power production, which subsequently drains to Tel. Generation of power in Indravati, now causing flood in Hati around Dharmagarh in Kalahandi. The affected people are searching a new place to reside. The administration is not taking this issue seriously and now these people are migrated to Tilakmal village to acquire the land for residence, but they face stiff opposition from the Govt officials and they have lodged case against them. The district administration is also writing letter to the OHPC to stop the power generation.

Conflicting parties involved- OHPC, District Admin, Villagers in Catchment & Command area (River Basin Transact, 2010)

River Bank Erosion

The Pattamundai and Rajnagar blocks of Kendrapara district are mostly affected by river bank erosion. The majority of the villagers are poor farmers and lack basic facilities. Over the years, their crops, livestock, and houses were repeatedly swept away by the rivers.

The protest of these river bank-erosion hit villagers against the government has been attracting huge public participation. They have submitted memorandums of protest to the state government several

times. The affected communities are demanding compensation package and a permanent solution towards the checking of river erosion.

Conflicting parties involved- Villagers, WRD, Revenue Department, Sand miners

Water logging due to canal irrigation

Water logging is a perennial problem in 5 blocks of Puri district causing extensive damage to crops. Dredging of river mouths of Daya, Bharagabi, Makara, Luna, Ratnachira for speedy discharge of rain water into Chilika lake is taken up to address the issue. However the process is being stalled by some others and there have been farmers' protest around that.

Farmer rallies, protests, assembly questions, media coverage etc. has taken place around this issue.

Conflicting parties involved- Farmers, Politicians, Chilika Dev Authority

Dams and displacement

Lower Suktel Irrigation project is being undertaken on river Suktel, a tributary of river Mahanadi. Nine thousand families will be displaced for this project. Some people of the displaced area allege that they are not compensated properly; others are still not ready to endorse the idea of getting displaced due to the irrigation project in the area. In the process, those opposing the project and those in support of project are at war with each other and the administration.

The affected people have formed Lower Suktel Budi Anchal Sangrami Parishad to raise their voice against the project. Protests and movements are continuing along with court case for legal remedy.

Conflicting parties involved- Activists, Affected peoples, To-be-benefited farmers, Political Parties & Govt.(River Basin Transact, 2010)

Mahanadi Godavari Link

The possibility of the Mahanadi – Godavari Interlinking project has also resulted in formation of resistance groups. The ambitious project being vigorously pursued by the Union Government aims at construction of a storage reservoir on Mahanadi River at Manibhadra and a link canal from this reservoir to Dolaiswaram on the river Godavari. The 827.700 km long link canal is proposed to take off from the right hand of the reservoir Manibhadra. Out of 12165 Mm³ of water proposed for diversion from the Manibhadra reservoir, 3790 Mm³ would be used for en route irrigation in Orissa and Andhra Pradesh States. It is envisaged to provide irrigation to a culturable command area of 256770 ha and 107189 ha utilizing 3184 Mm³ and 606 Mm³ of water, respectively in Orissa and Andhra Pradesh States. The link canal power house with an installed capacity of 70 MW will generate 197 million units of energy every year. Apart from irrigation, it is also proposed to provide about 802 Mm³ of water for meeting the future domestic and industrial requirements in the enroute command area of the link canal. Transmission loss in the link canal is estimated to be 1073 Mm³. It is envisaged that after meeting the projected requirements, out of the total diversion of 12165 Mm³, a quantum of 6500 Mm³ would be finally transferred to the Godavari River through the link canal.

(Source: National Water Development Agency - NWDA)

Manibhadra alone will displace more than a lakh population and at the cost of Odisha more than half of the water will be diverted to Godavari river while the requirement of Mahanadi basin is yet to be met has resulted in strong public sentiment against this project. While the government of Odisha is taking a cautious step, there are media reports, discussions and demonstrations against this project. The Union government is trying to make changes to the design to reduce the human impact of the project. But this in the coming years, in the back drop of OdishaChhattaishgarh project is expected to lead to massive public unrest in the state of Odisha.

2.2 The Brahmani Basin

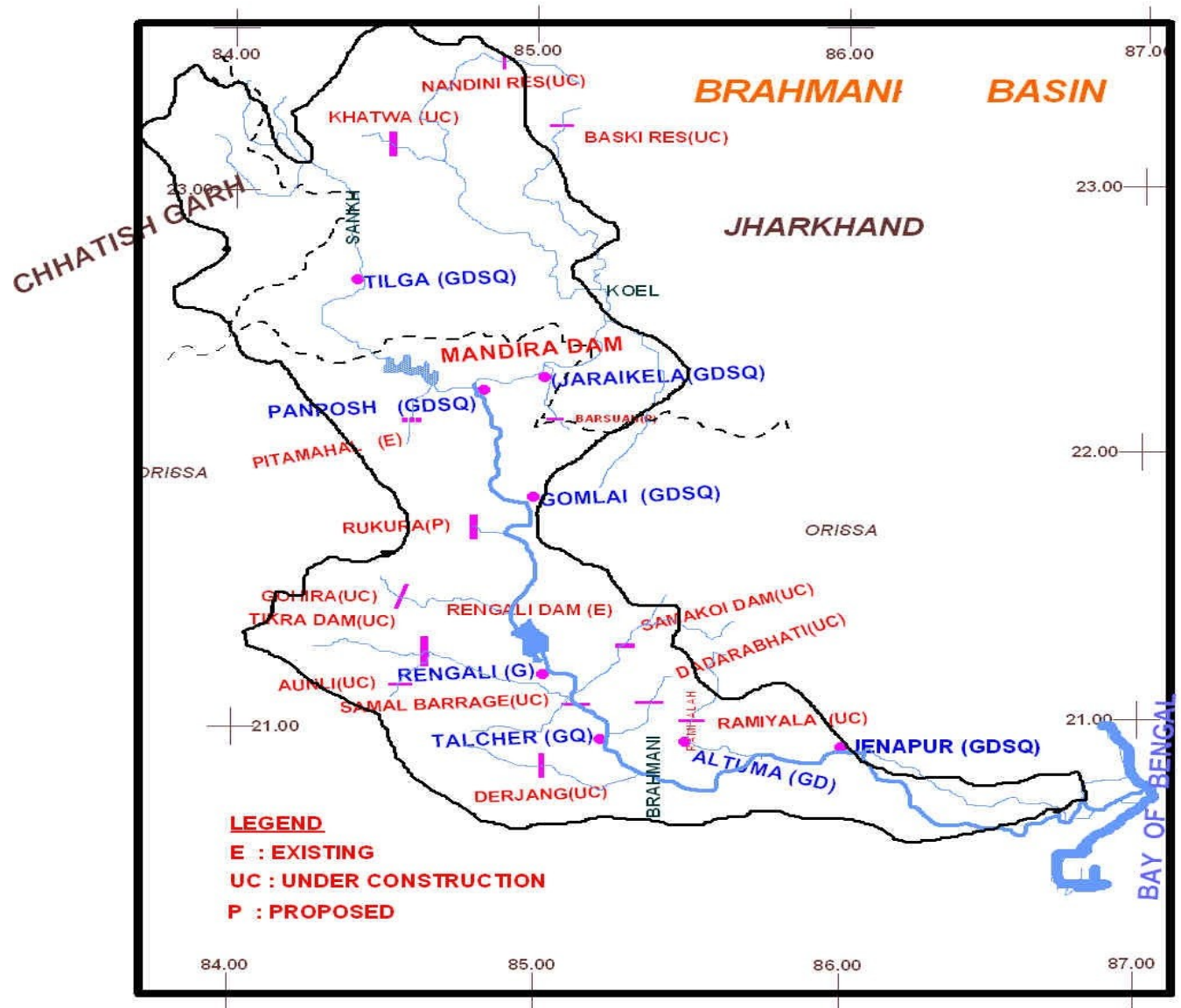


Figure 23 Brahmani Basin

2.2.1 Mythology/ Folklore

The place Vedavyas is associated with the Hindu mythology that in the dim past the sage Parasara Muni was camping on a hillock and now named as Parasara Munda on the north side of the river Brahmani. He used to come to the holly confluence for performing the daily ablutions and meditation by boat. It so happened one day that he was alone in the boat ferried by the teen aged daughter of the boat man.. Her name was Mastchhyagandha and she was extremely beautiful. The sage was attracted towards her and could not control his lusty passion. The great sage Vyasa was born out of the union between Parasara and Mastchhyagandha. Mastchhyagandha became a Brahmin because of her union with Parasara Muni. Therefore, the river emerging from the holly confluence was christened as the river Brahmani. Later Vyasa turned into a sage and composed many religious scriptures including Puranas. He is the author of the famous Hindu epic “The Mahabharat” which is perhaps the greatest epic of the mankind. As the birth place of sage Vyasa, the place of confluence (of Sankh and Koel river near Panposh) got the name of Vedavyasa.(ODISHA DISTRICT GAZETTEERS, 2014-16)

2.2.2 Historical Importance

Brahmani valley was an ideal environment for their settlements in pre historic period like Stone Age as archaeology department have reported stray tools such as palaeoliths, microliths, neoliths, copper and bronze materials abundantly in Dhenkanal districts in Brahmani basin.

Legendary story of Baji Rout on Brahmani River: On the day of occurrence about 20 armed policemen came to Bhuban for suppressing the popular agitation against the ex-ruler of Dhenkanal. They perpetrated a lot of torture on the people at Bhuban. While they were going back, large number of people chased them. When they reached the ferry ghat at Nilakanthapur, the people chasing them had already drawn nearer and were about to attack them. The policemen commanded the boatman to ferry them at once. The people from behind were shouting to the boatman not to let them cross the river. The boatman and some other people of the village who were present there refused to ferry the policemen. The policemen tried to snatch away the boat and to cross the river by rowing themselves. But the people resisted. They held fast the ropes of boat. From among the few thus resisting, Baji Rout came to the forefront and denied them the boat. The policemen now found that the infuriated mob following them had almost reached the spot, In the face of imminent danger of attack from the mob; they opened fire killing Baji Rout and eight others who held the rope. Then they crossed the river by rowing the boat themselves.(ODISHA DISTRICT



Figure 24: Dam on Brahmani River

GAZETTEERS, 2014-16)

2.2.3 Tourist Places/ Religious Places

Samal Barrage

It is located at a distance of 40 kms from Angul and 20 kms from Talcher. The panoramic view with deep solitude is a panacea to group picnicker. A barrage has been constructed here to harvest the Brahmani water for irrigation purpose. Brahmani Right Canal and Left Canal originate from this place. A mini hydro power plant is coming up at this place through private initiative.

Ratnagiri

An isolated and extraordinary Buddhist hillock Ratnagiri, an inexhaustible emporium of Buddhism and exceedingly rare Buddhist sculptures and monuments, unparalleled in the world, was foremostly explored by Mr. Manmohan Chakravarty, the then SDO of Jajpur in the year 1906. The principal focus of attention is the excavated Mahastupa (mainstupas) of exceptionally ancient brickwork being the unique object of



Figure 25: Ratnagiri Fort

worship and obeisance (reverence) of the Buddhist world. The Buddhist heritage of Odisha is rich and varied both in sculptures and architectures. The available remains in this region bear eloquent testimony to the extraordinary achievements of the Buddhist communities that flourished for over two millennia. Much of the artistic heritage probably still remains buried but what has been unearthed so far make an exciting story of intense faith and extraordinary artistic achievement. Ratnagiri is one among such ancient Buddhist settlements revealing the crowning glory of the past.

Kualo

Kualo or Karmula was the ancient capital of Dhenkanal. Kualo is situated in north of Dhenkanal town at a distance of 32 kilometres on the right side of the river Brahmani. The kingdom was ruled by the Shulki kings who held Stambha epithets and were the fiduciaries of the Bhaumaka kings. Their primary deity was Lord Siva. Hence we see eight Siva temples at Kualo known as Ashta Sambhu. These eight Siva lingas are known as Kanakeswar, Swapneswar, Aisneswar, Kapileswar, Baidyanatheswar, Baneswar and Lokanatheswar.

Sarang

It is situated on the left bank of river Brahmani about 3 kilometres (2 miles) south of Talcher town. The village is important because of its antiquities. Close to the village on the bed of river Brahmani, is the image of Vishnu in sleeping posture. The image is caved on the rocky bed of Brahmani river and measures 32feet (975 cm) from head to feet. It is considered to be a work of 8th or 9th century A.D. At this point in the right bank of the Brahmani there



is also a temple dedicated to Paschinmeswar, where there is sitting image of Dhyani Buddha, built with several pieces of stone.

Figure 26: image of Vishnu in sleeping posture

Vedvyasa

Vedvyas temple is situated near Rourkela and is famous because this is the spot where Ved Vyas had saged the Mahabharat. The temple draws the crowd in multitude not only from Orissa but from neighboring states of Chhatisgarh and Jharkhand. Ved Vyas temple is situated close to the confluence of three rivers Shankh, Koel and Sarasvati to form River Brahmani. A visit to Vedvyas Temple gives a greater insight into the various cultures and traditions of Rourkela.

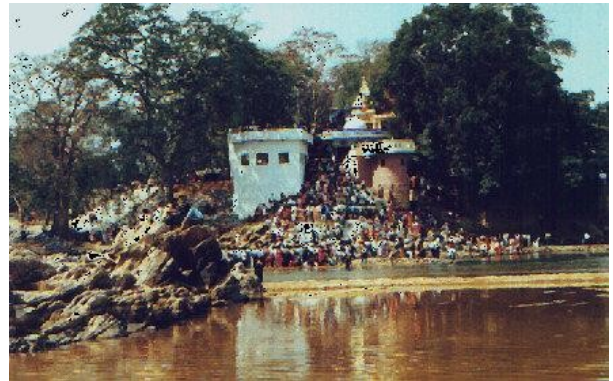


Figure 27: Vedvyas temple

Joranda Sunya Mandir

Joranda Gadhi is a temple built in a location where three villages meet: Joranda, Natima and Patna. The temple is dedicated to the supreme lord. The followers of mahima dharma worship him as Sunya Brahma or the shapeless lord. No idol worship is permitted in this sect. The temple is dedicated to the supreme lord. Many people of other sects believe that the followers of this sect worship Surya, the sun god, but it is absolutely false. The temple was built in the early 20th century, but the shrine existed from the early 14th century. It is the Samadhi Peetha of Mahima Goswami, who spread the Mahima Dharma. Mahima Dharma is a distinct religion in the tradition of Indian religions, although the principles of the sect may seem similar to those of Panchashakha, Buddhism, Tantra and Jainism. They recognize how enormously sacred for



Figure 28: Joranda Sunya Mandir

them the Bhagavata Purana is. They respect all Gods. Joranda mela is celebrated by mainly Mahima Dharma people. This festival held on full-moon day of Magha (Magha Purnima Day) which falls in January-February every year.

2.2.4 Morphology

Brahmani is the second largest river in Odisha. The river originates as two rivers, Shankha and Koel, from Chota



Figure 29 Mahima Dharma Followers

Nagpur Plateau in Jharkhand and later joins Saraswati at the sacred place known as Vedvyas, located nine kilometers from industrial city Rourkela to form Brahmani. The river has a total length of 799 km of which for 541 km it traverses in Odisha. Below the confluence at Vedvyas, river Brahmani heads its way generally in southeast direction up to sea and traverses a total length 461 km (INDIA9, 2016). Below Jenapur, Brahmani River bifurcates into Brahmani (Kimiria) and Kharsuan its major deltaic branch on its left. River maintains its geometry (channel width, depth & slope) on the main arm, while Kharsuan has developed as a deeper and narrower channel. Although the two rivers join almost one hundred km in the downstream, Kharsuan is 15 km shorter in length and therefore is steeper and faster flowing channel. The river receives flood spills from the adjacent Baitarani, before finally discharging into the Bay of Bengal near Dhamra. (Country Policy Support Programme (CPSP), 2005). A branch from River Mahanadi- Birupa too joins Brahmani.

Tributaries and Distributaries

There are 45 major tributaries of the Brahmani, of which the important ones are Sankha, Chandrinalla, Katangamundanalla, Rukura, Badjore, Kaunishnalla, Kalanalla, Usthalinalla, Chudakhainallah, Gohira, Chilanti river, Tikira, Singadajore, Bangaru river, Nandiranalla, Nigra river, Bangusinghanalla, Barha, Daunri, Kumaria, Kelua river, Birupa, Hansua, Kharsuan, Patasala in right side and Koel, Suidihi, Champalijore, Kuradihi, Amrudi, Korapani, Mankada, Ambahari, Samakoi, Gambhiria, Rajjore, Indrajeet, Ramiala, Pandra, Kharasuan, Daudi in the left side.

Important Tributaries

Koel and Sankha having their origin in Chhotanagpur region of Jharkhand and Chhatishgarh joined together at Panposh near Rourkela of Sundargarh District and downstream go by the name Brahmani. The meeting place of Sankha and Koel is regarded as a sacred place. The river flows for 240 kilometres (150 mi) before it meets the Koel River in Odisha.

Ramial-It is the biggest tributary of the river Brahmani originating from Benamunda Reserve Forest of Keonjhar District. Flowing through Kamakhyanagar, Kankadahad Bhuban Block it meets the river Brahmani at Bhuban.

Lingarajora- This is a feeder of the Brahmani on its right. It originates from Similipathar of Angul District and flowing through Hindol Sub-Division meets Brahmani at Meramundali.

Badajora- This is a feeder of the Brahmani. It originates from forest area of Kantapal of Hindol Sub-Division and joins the rivers Brahmani at Bangurisingha.

Daunsinala- This is a feeder of the river Brahmani. It originates from Aswakhola Forest Block; flowing through Matiasahi it joins the river Brahmani at Kathapal.

Deulinala- This is a feeder of the river Brahmani. It originates from Kapilash Forest Block. Passing through Ramai Forest Block it joins Brahmani at Joranda, Kathapal.

Karchamulanala- This nala originates from Ranjagarh Forest Block of Dhenkanal District and Daitary Forest Block of Keonjhar District. Passing through eastern and southeastern direction on the border of above two Districts it meets Brahmani at Damsalnala.

Prjects/Dams

Sl.No	Name of Dam	Year of completion	River/ Tributaries	Volume content of dam in TCM
1	MANDIRA	1993	Sankh	26732.00
2	PANSAPAL	1988	Pansapal nalla	108.50
3	KUKURPETA	1975	Bara nalla	678.00
4	BADJORE	1983	Badjore nalla	90.00
5	DAMSAL	1982	Kharkhai	239.60
6	GUNDURAPASI	1984	Gundurupasi nalla	151.00
7	KANSABANSA	1990	Kansabansa	960.00
8	KALAKALA	1975	Gabapala	165.15
9	DERJANG	1978	Lingara & Mathili	11825.00

10	JODABADIA	1988	Jodabadia nalla	177.69
11	PITAMAHAL	1976	Pitamahal	896.00
12	RENGALI	1984	Brahmani	789.00

Table 7 Projects/ Dams on Brahmani (source: DOWR)

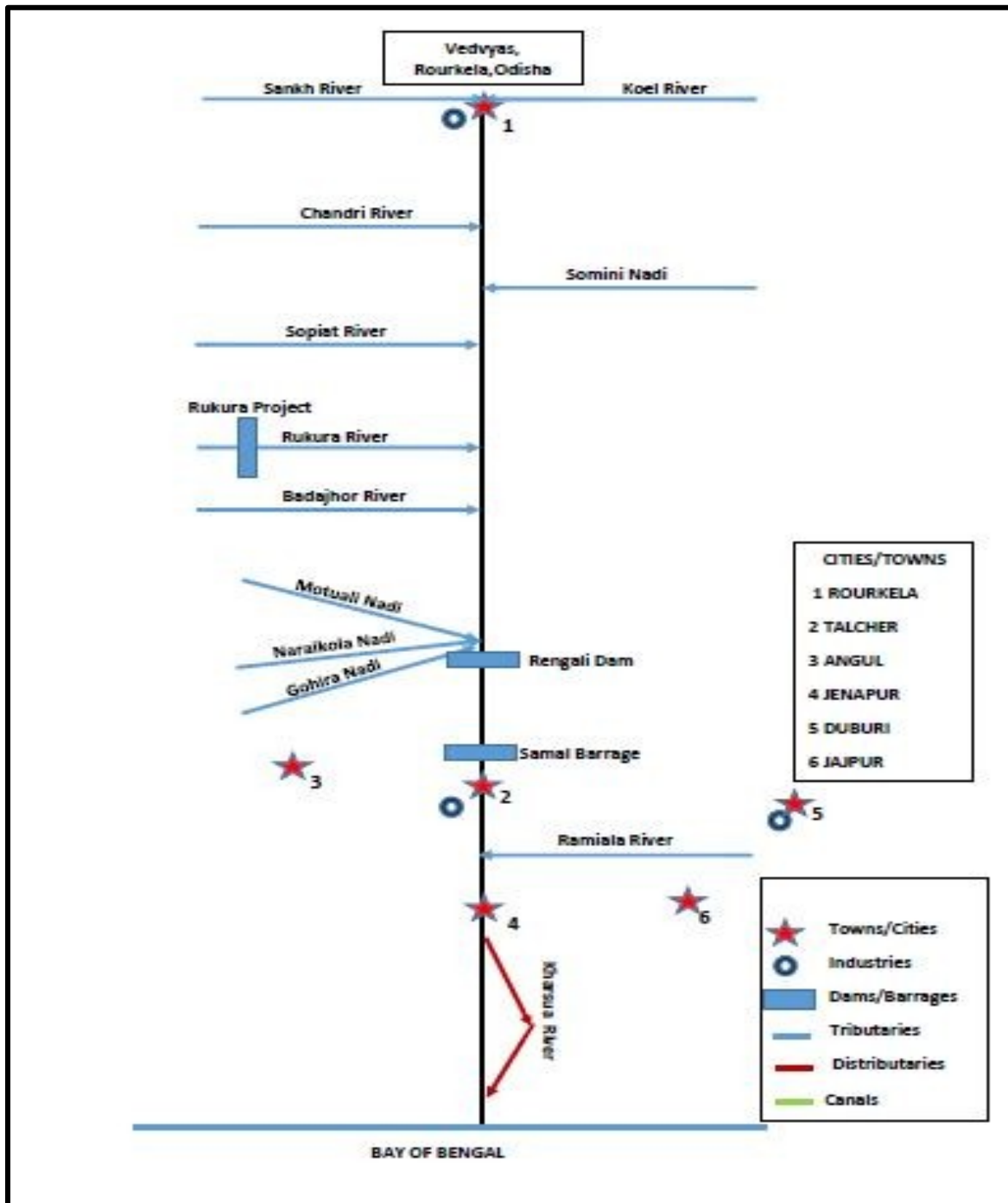


Figure 30 Brahmani Flow Diagram

2.2.5 Biodiversity

The basin is rich in forests occupying as much as 37% of the basin total area.

Mangroves

Near the Brahmani-Baitarani delta are located mangrove ecosystems including the famous Bhitarkanika National Park and a wildlife sanctuary. About 215 sq.km of the mangroves in this region has been listed as RAMSAR SITE in November 2002.

Flora: Mangroves, with trees like sundari, thespia, casuarinas, and grasses like the indigo bush, and more are found on the lower part of the river.

Fauna: The Bhitarkanika Park is home to the saltwater crocodile, white crocodile, Indian python, King Cobra, black ibis, wild pigs, rhesus monkeys, chitals, darters, cobra, and water monitor lizard. Olive ridley sea-turtles nest on Gahirmatha and other nearby beaches.

Bhitarkanika has one of the largest populations of endangered saltwater crocodile in India and is globally unique in that 10 percent of the adults exceed 6 m length. Nearly 1671 saltwater crocodiles inhabit the rivers and creeks. Around 3,000 saltwater crocodiles were born during 2014 annual breeding and nesting season. (Bhitarkanika National Park, 2016)

Other Forest and Protected Areas

Bamra-Gangpur Forest, Khajurdihi Range, Budhabahal Range, Purunapani Range, Rengali Range, Malayagiri Forest Range and Kamakhya Forest Range are prominent forest covers in Brahmani river basin.

2.2.6 Conflicts over River Brahmani

Industries vs locals

Sundergarh

Mining activities in the Brahmani catchment area Sundergarh (Bonai area) resulted in conflict between The Brahmani Basin Mining Companies, Primitive Tribal Group (PTG) and Activists. A number of small and medium scale mining activities are going on in this area resulting in drying up of perennial springs and mining activity is leading to pollution of water bodies apart from large scale water exploration. The livelihood of the PTG residing in this area is also affected.

Due to various mining activities the agricultural land and the fishing as a livelihood have been affected and the people of this area have agitated against the mining authorities. Now many political parties and Civil Society Organisations are involved with this issue and have been raising their voice.

Angul Talcher area – Ash pond breach

In October 2011, the residents of 32 villages on the periphery of NALCO in Angul district, along with NGO leaders, social activists, leaders of various political parties and leaders of the workers' union, strongly protested against the ash pond collapse and ash slurry contamination which led to

loss of property of the people and threat to their lives. They demanded immediate cancellation of the order of extension of the term of NALCO Chief Managing Director (CMD)-in-Charge BL Bagra up to December 2011. Pratap Pradhan, District Congress President, strongly condemned the “irresponsible acts” of the NALCO authorities resulting in frequent breaches in the ash pond and ash slurry leak. Ramesh Jena, Indian National Trade Unions Congress (INTUC) leader and president of the Nalco Shramik Union, called upon people to intensify their protests against the ash pollution. Sasmita Behera, president of the State Mahila Morcha, Swapna Sarangi, team leader of the Foundation for Ecological Security and Rabindra Prasad Pattanaik, president of the Citizens’ Action Forum and president of the District Bar Association demanded stern action against the NALCO management. (Choudhury, et al., 2012)

Citizen Action against Industrial Pollution in Angul-Talcher area

Angul Tcher area is one of the most polluted industrial areas of the state. Due coal mining, Coal bases fertilizer plant, thermal power plant, steel plants, Aluminium Smelter at Angul and many other subsidiary plants air and water of the region has been polluted much beyond permissible limits. In the early 1990s the citizens were organized and resisted the industrial houses in a massive scale. This initiative also led of Brahmani Bachao Aandolan. The citizens’ initiatives had limited impact in terms of closing down of FCI plant, stoppage of release of ash slurry to river Nandiarra, provisioning of clean drinking water to the water scarce and fluoride affected villages in the vicinity of the plants. District Action Group (a federation of 21 NGOs of Angul and Dhenkanal) spearheaded thecitizens action project that was supported by Indo- Norwegian Environment Programme.

Occupational displacement of Fisherfolk

Fishermen living all along the banks of the river have been complaining that their fish catch is still not sufficient after taking measures to reduce effluents and they are afflicted with different skin diseases caused by bathing in the river. The industries are still using the river as their drain, and the water is not worth drinking. Industrialisation in the Angul-Talcher area has in no way led to any direct benefit to the fishermen communities in undivided Dhenkanal district. Dwindling fish population in the river has destroyed their financial prospects. A growth in the population in the industrial region has given rise to a demand for fish, but the fish catch is not sufficient. There is no fish left in the Brahmani for fishermen to make use of this increased demand for their economic betterment. After the campaign of the District Action Group (DAG) of Angul-Dhenkanal, the fishing community formed an association and sent a memorandum to the President of the World Bank through the Institute of Policy Studies, an NGO in Washington DC, USA. Ms. Daphne Wyshem discussed the issue with the President of the World Bank and persuaded him to ensure the livelihoods of the affected fishing community. The World Bank India office visited the area and

discussed the issue with the fishermen and members of DAG, and decided to submit an action plan to restore livelihoods. However, due to some unavoidable circumstances, the action plan could not be submitted. (Choudhury, et al., 2012)

Government vs local

The state government has leased the Khandadhar hill, one of the major deposits of iron ore, to a multinational South Korean company POSCO-India. It planned to mine the Khandadhar and Chhelitoka mountains. According to local people, the mining operation would severely affect more than 52 villages in the area, and disturb its natural balance. People fear that the main stream of Khandadhar will dry up due to mining. The small irrigation dam on Korapani helps the villagers in Lahunipara block, where people believe that the POSCO mining operation will draw water from the Khandadhar stream. People fear that with mining in the mountains, water sources will perish, thus impacting their socio-economic status.

Social and Environmental Movement

River Bank Erosion: The Dhoyia Anchal Vikas Parishad organised a grand rally and staged a dharna in front of the sub-divisional office (irrigation) Rajkanika, Kendrapara on 28 December 2009. Similarly, the affected communities and villagers of Nilakanthapur protested against the government several times. The major concern in Pattamundai, Rajnagar, Aul, Rajkanika and Mahakalpara blocks of Kendrapara district today is the erosion of riverbanks, displacing at least 100 families every year. Erosion now threatens homes, roads, agricultural fields and other surrounding infrastructure. Badly eroded river banks of the Brahmani continue to cause severe problems for people in the villages of Pattamundai and Rajnagar blocks of Kendrapara district. Some of the areas of these villages in Pattamundai block have already been devoured by the rivers, displacing about a thousand people. A majority of the villagers are poor farmers and lack basic facilities. Over the years, their crops, livestock, and houses were repeatedly swept away by floods. Consequently, floods have reduced the villagers' asset base, increasing their vulnerability every year, and put their lives at risk. (Choudhury, et al., 2012)

Man Animal Conflict

Villagers in the delta regions of Brahmani have been living in fear since four decades where, river erosion and frequent floods have compounded fears of estuarine crocodiles entering the villages in rainy season. People have been demanding to strengthen the river banks since long. State government in 1984 planned to strengthen spurs on the river bank, only some portion of spur was packed and major work was left. In 2003 villagers staged a five day fast unto death near the banks demanding quick measures from government. Chief minister Naveen Patnaik visited Chandibaunsamula village and laid foundation stone for packing stones and spurs on river banks. It is reported that 12 years have passed and work is still to be completed. (Odisha Post, 2016)

Peoples' resistance to Rengali displacement

Rengali project expected to generate 100 mw of electricity initially and provide flood protection to a 2,600 sq km area, benefiting a population of 10.8 lakh. The cost of the mammoth project, originally estimated at Rs 58 crore, but has risen to a whopping Rs 180 crore in 1984.

All these costs and benefits do not mean much to the poor people who have been uprooted in the name of development. Many of them decide to go on a fast to death from next month to draw attention to their plight. The project has displaced about 50,000 people from over 10,053 families of 116 villages, besides submerging agricultural land in 149 villages. The total area of land to be submerged is 41,400 hectares, out of which as much as 28,000 hectares have already gone under water.

The psychological problems for the villagers arising from being displaced from their homes seem to be equally acute. As far back as 1978, the Government announced a policy for payment of compensation and rehabilitation of those affected by the project. But when half the affected population rejected the Government's proposals and sat on a month-long dharna, blocking construction work, the Government stated: "Unless rehabilitation work is complete there will be no submersion of the area." Sambalpur lawyer P.R. Dubey pointed out that six years later half the targeted area has been submerged but the Government's rehabilitation promise was not kept. (India Today, 2016)

2.3 The Baitarani

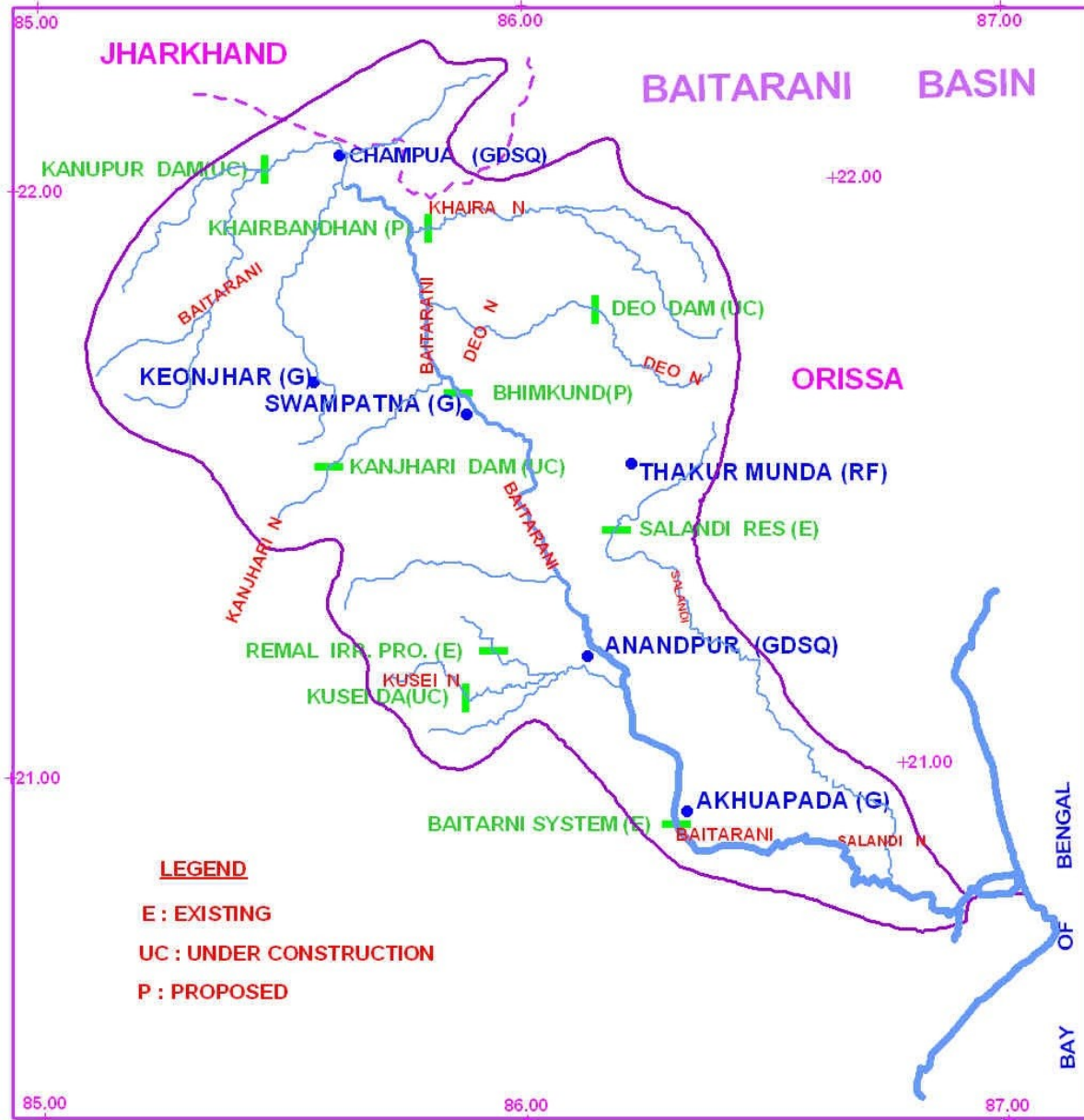


Figure 31 Baitarani River Basin

2.3.1 Mythologies/ Folklore

The Garuda purana and various other Hindu religious texts depicted Baitarani River lies between the earth and the infernal Naraka, the realm of Yama, Hindu god of death and is believed to purify one's sins. The river was created only for the sinful souls. It is extremely difficult to cross and the other bank cannot be seen. If a soul cannot cross the Baitarani River then he cannot be taken to hell. He is stuck at its shore. Thus this prevents him from getting reborn on earth as human or animal. These souls are considered as the ghosts who have not passed on and are stuck. There are a few ways to cross this river. It is important to note that as mentioned in the description of the river, only those souls who have sinned have to cross this river.

The person who commits good deeds in his life and does not have to cross this river.

A sinner who has done certain meritorious deeds can get a boat to cross the river after travelling on the terrible way of Yama for some time. These deeds include donating a cow, food, wealth or any sacrifice etc.

It is said that even though a person is a sinner, if he is following a real spiritual guru, the sinner can cross the river holding his Guru's hand.

If the sinner cannot cross using the above two methods, he has to wait many years till it is decided that he will cross or the servants of Yama drag him through the river.

The descendants of the sinful soul can help him cross the river by chanting the name "*Shree Gurudev Datta*". (Vaitarna River, 2016)

2.3.2 Historical Importance

It was during the rule of this King, that the source of the River Baitarani was discovered and a temple of Brahmeshwar Siva was constructed close to it. From that time onward, that place is considered to be very sacred and people gather there on many occasions to take bath in the reservoir, known as Brahmakunda which has been built near the temple of Brahmeshwar.

The great epic, the Mahabharata, mentions of only one place i.e modern Jajpur in the context of pilgrimage of the five Pandavas. It refers to the river Baitarani that flows beside the sacred Virajah-Tirtha (Later on Viraja) where Kalinga people lived. The city of Viraja or modern Jajpur beside the river Baitarani has been famous as a great Pitrutirtha since ancient times, which is probably a work of 4th-3rd century B.C. Apropos of the said tradition the five pandavas along with their consort Draupadi came over to Virajatirtha, took their bath in the sacred river Baitarani and offered pindas to their ancestors. There is a well in close proximity of goddess Viraja inside the campus which is known as Nabhikupa or Nabhigaya where pindas are offered to ancestors.

Tato vaitaranim gachhet Sarvapap Promochinim Virajam

Tirthmasadya....Ete Kalinga Kaunteya Yatra Vaitarani Nadi.....(Note from Mahabharata)

In 736 A.D. the Bhaumakaras emerged as a very strong political force from Viraja or Modern Jajpur and established a far-flung empire covering the whole of present day Odisha and probably some more areas beyond that. The genealogy of the Bhaumakaras reveals that, as many as eighteen rulers including six females have reigned over a period of two hundred and fourteen years. Their kingdom included Dandabhukti (Midnapur), North and South Toshali (Odra), South Kalinga and Kangoda, extending upto Mahendragiri in the south. The capital city was known by the name of Guahadeva Pataka or Guheswara Pataka on the bank of the river Baitarani at now Jajpur.

Sulaiman Karrani, the Afghan ruler of Bengal defeated Mukundadeva Gajapati of Eastern Chalukya dynasty, a Hindu ruler. The worst danger came upon Jajpur when Kalapahar, the general of Sulaiman ravaged the Hindu and Buddhist monuments. He marched from Puri to Jajpur with his army after the fall of Mukundadev, he did not leave a single shrine untouched in the whole region. The temple city of Jajpur and its suburbs were reduced to ruins. Temples were mercilessly demolished and dismantled, idols were defaced, pounded down and cast into the river Baitarani.

Jajati-II: 1025A.D to 1045A.D. was in charge of Jajpur kingdom as desired by the Cholas. Jajati-II, popularly known as Jajati Keshari, was reputed as a great builder of temples and sculptures. He had performed an Ashwamedha sacrifice on the bank of river Baitarani, which marked the emergence of Tantrism and tantric in Jajpur. Due to non-availability of Vedic Brahmins to perform the sacrifice, he brought 10,000Brahmins from Kanauj to practise rituals on the bank of river Baitarani.

A fierce battle on the banks of the river Baitarani was fought between British colonel Harcourt and the *Paikas* of Kendrapara under the leadership of two Muslim commanders Murad Khan and Saha Beg Khan. However paikas were defeated on 12th March 1804. Kanika Paik Rising was the first popular Revolt against the British Raj not only in the District of Kendrapara but also in the whole of Odisha.(ODISHA DISTRICT GAZETTEERS, 2014-16)

2.3.3 Tourist Places/ Religious Places

SAREI:

Two holes on the bed of river Baitarani attract people to get bath and holy view of Lord Siva on its bank. 50 km from Keonjhar town, the landscape provides an exiting framework for picnic and merry making. Brave people dare to enter in one hole to come out through the other to prove righteousness.

RAJNAGAR:

Nestled on the bank of river Baitarani, the small site unveils vestiges of a medieval palace. 27km

from Keonjhar town, the destination is visited mostly for darshan of Lord Dadhibaman and Raghunath Math besides Chadhei kudoor a resting place of migratory birds.

PARAMESWAR TEMPLE OF PATNA:

The temple is built on the bank of river- The Baitarani is another attraction for tourists. The devotees take bath in the holy river of Baitarani and have darshan of Lord Parameswar. So many other small temples are in the premises of the main temple. Though, the temple has been built in recent past, the sculpture seen in the temple is very attractive. The spot attracts many visitors throughout the year.

JHADESWAR TEMPLE:

Right to the Anandapur Town, Jhadeswar temple is situated on the bank of the river Baitarani, amidst scenic beauty where Lord Shiv is worshiped. Though the then King Trilochan Bhanj had built a mandap and engaged Pujaks for worshipping Lord Shiv. The mandap was damaged by flood and in the year 1850, King Gadadhar Bhanj re-built the mandap and subsequently, in the year, 1880, King Dhanurjay Bhanj had built a temple here, but when the temple got damaged in the flood of 1927, Chhotray Laxminarayana Bhanj had built the present temple. The spot continues to attract the visitors throughout the year.

RAGHUNATH JEW TEMPLE OF BIRGOBINDAPUR:

Legendary Raghunath Jew temple is situated in the village- Biragobindapur of Gohira Panchayat under Ghasipura Block on the bank of the river- the Baitarani, which is 7 K.Ms distance from Ghasipura. Lord Shree Ram, Goddess Sita and Laxman are worshiped here. Legend speak that after victory in Kanchi war, the King of Kendujhar Gobinda Bhanj carried Maa Tarini, Shree Madan Mohan with him from Kanchi and while returning to Kendujhar from Puri, on the way at Biragobindapur, the elephant on which Raghunath Jew sat did not move forward and sat down. The King built temple there for Lord Raghunath Jew. Bir Gobindpur is famous for this.

Bhitarkanika, Kendrapara, Odisha

The combined delta of rivers like Brahmani and Baitarani have given birth to Bhitarkanika forest sanctuary. The natural habitat and mating place for foreign birds bagahara, the vast seashore of Satabhaya, the natural and world famous Olive Ridley sea turtle breeding farm of Ekakulanali/ Gahiramatha, the favourite point Lighthouse, on the basin of the Mahanadi, as to the historical monument in the uninhabited island of Hukitola and the natural scenic spots of Jambu attract and fascinate many tourists and travellers.



Figure 32: Combined Delta of Rivers Brahmani and Baitarani

2.3.4 Morphology

The Baitarani originates from the Gonasika/Guhtaganga (Stone looking like the nostril of a cow) hills near Dumuria village in the hill ranges of Kendujhar district of Odisha at an elevation of about 900 m. it is east ward flowing rivers of peninsular India, flowing eastward and joining the Bay of Bengal. The uppermost part of the river, about 80 kilometres in length, flows in a northerly direction, then it changes its path suddenly by 90 degrees and flows eastward. The beginning portion of Baitarani acts as the boundary between Orissa and Jharkhand. The basin is surrounded by the Brahmani basin on the South and West, the Subarnarekha basin on the North, the Burhabalanga and the Bay of Bengal on the east. The river is flashy in nature having a total length of 440 km, with the upper reach up to Anandpur in the hilly region. There is a considerable fall in elevation from RL 367m at Champua in Kendujhar district to RL 28m at Anandpur. The river is known as Dhamra in its lower reaches.

Tributaries and Distributaries

There are 65 small tributaries of Baitrani river out of which 35 join from left side and 30 join from right bank.(Baitrani, 2016) The main tributaries of Baitarni joining from left are the Salandi and the Matai. (River Basin Atlas of India, 2012)

Salandi River- Salandi River is one of the prime tributaries of Baitarani River which comes under the state of Odisha. It originates via Meghasani hills of Similipal pass present in Keonjhar district. This is more than 140 kms lengthy and it also has a catchment area of 1790 sq.km

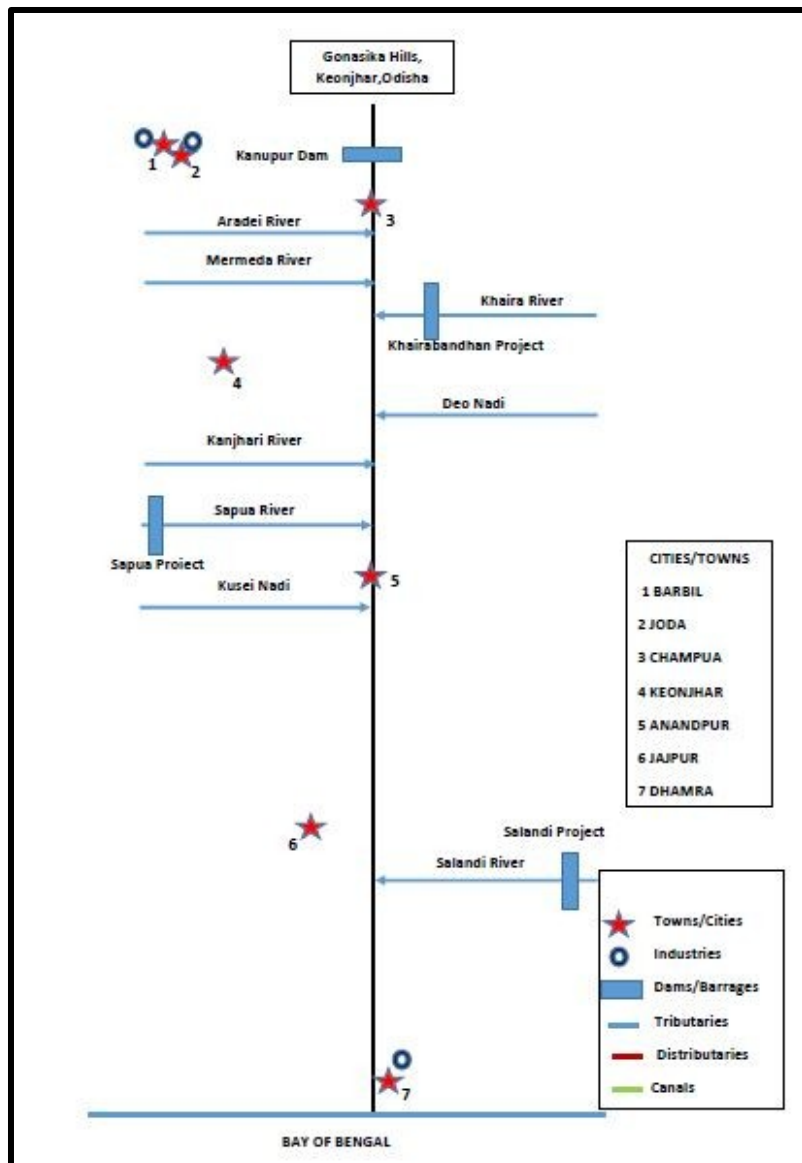


Figure 33 Baitarani Flow Diagram

Projects/ Dams

SINo	Name of Dam	Year of completion	River/ Tributaries	Volume content of dam in TCM
1	SALANDI	1965	Salandi	601.00
2	SANASIALINAI	1987	Sanasialinai	162.00
3	ARADEI	1980	Aradei nalla	220.00
4	SANMACHHAKANDANA	1978	Machakandana	286.00
5	CHHAMUNDIA	1983	Chhamundi	48.90
6	TENAR	1984	Tenar nalla	NA
7	LAXMIPUR	1986	Nissar nalla	40.96
8	RAGHUBEDA	1994	Raghubeda nalla	600.00

Table 8 Projects/ Dams on Baitarani(source: DOWR)

2.3.5 Biodiversity

Baitrani river origin is itself is very rich in Biodiversity. The upper basin which flows through the Gonasika Hills in Kendujhar district is full of varied flora and fauna. Elephants, Tigers, Porcupines, Bears and snake varieties are abundant in upper areas. This wonderland supports dense mangroves (63 species), largest population of estuarine crocodiles (1130 as per 2001 census) and is the home to the largest 22-23feet long crocodiles, rare white crocodiles (locally known as Sankhua), poisonous snakes such as King cobra, Banded krait, Cobra, etc, non-poisonous snakes like Python, Rat snake etc, varieties of resident and migratory birds (217 species) and a lot of mammalian species i.e. Spotted deer, Sambar, Wild boar, Fishing cat, Jungle cat, etc. Besides, various other species of endangered mammals, birds, reptiles and other groups of animals also inhabit the area. Bhitarkanika thus harbors an interesting assemblage of flora-fauna of both common and endangered variety.

Mangroves

Near the Brahmani-Baitarani delta are located mangrove ecosystems which was symbolised by its cone shaped root called pneumatophore including the famous Bhitarkanika National Park and a Wild Life sanctuary. About 215 sq.km of the mangroves in this region has been listed as RAMSAR SITE in November 2002.

Flora: Mangroves, trees like sundari, thespia, casuarinas, and grasses like the indigo bush, and more are found on the lower part of the river.(Bhitarkanika National Park, 2016)

Other Forest and Protected Areas

Ghatgaon Forest range

Salandi reserve forest

Harichandanpur telkoi resrve forest

Aquatic diversity

Baitrani has one of largest population of estuarine crocodiles and is the home to the largest 22-23 feet long crocodiles, rare white crocodiles (locally known as Sankhua). Olive Ridley Turtle have one of the largest nesting home on the deltaic region formed by Baitrani and other rivers.

2.3.6 Conflicts over River Baitarani

People vs Industries:

Water transfer through slurry pipes

Conflict is about BRPL which requires 480 CUM per hour for its pellet plant in jajpur-Keonjhar and Essar for 12 million tonne iron ore slurry transportation to its plant site at Paradeep. This would substantially reduce the water levels of the basin and river. Thus requirement for basic activities like

agriculture, drinking and common use will be seriously affected. Keonjhar Citizen Forum and other CSOs have made representations to the WRD in this matter. Villagers suggest Essar to lay a parallel pipeline from Paradeep to bring water from sea for preparation of slurry.

Conflicting parties involved- BRPL, Essar, Villages, KCF and WRD.

Irrigation Vs Industry and Mining

Kanupur is a long awaited irrigation project in the district. While it is yet to be completed, Jindal has almost laid a nine-kilometer pipeline to draw water from this. With a predominant mining catchment, siltation rate is very high and it is expected to be silted up very fast defeating whole purpose of irrigation. The Keonjhar Citizens forum is continuously follow this issue. Farmers and locals in the region have protested against the delay in project execution.

Conflicting parties involved- Industries, Water Resources Department, and Villagers.

(Baitarani Initiative, 2016)

People vs administration

Irrigation divide

The designed area of irrigation from Anandpur barrage is only 6200 Ha in Keonjhar, whereas the same for Bhadrak and Balasore district is 53,800 Ha. The lean season flow of Baitarani at Anandpur is 3.900 Cusec, appears to be far too inadequate for this barrage project. The Keonjhar Citizens forum is continuously following this issue and has filed memorandum before Chief Minister and other authorities.

Conflicting Parties involved- Water Resource department, Keonjhar Citizens Forum, Farmers

Escapes: While provide escape to downstream villages and urban areas, put tremendous pressure on upstream villages and agriculture lands. There is more than 4 ft. of sand casting in thousands of acres of lands along with creation of new rivers near an escape in the Baitarani in Bhandari Pokhari, provided to save downstream Jajpur town. Conflict among villagers, WRD, and urban dwellers have taken substantial increase in current times.

Conflict parties involved-Villagers, WRD, and urban dwellers have taken substantial increase in current times.

(Baitarani Initiative, 2016)

2.4 The Subarnarekha

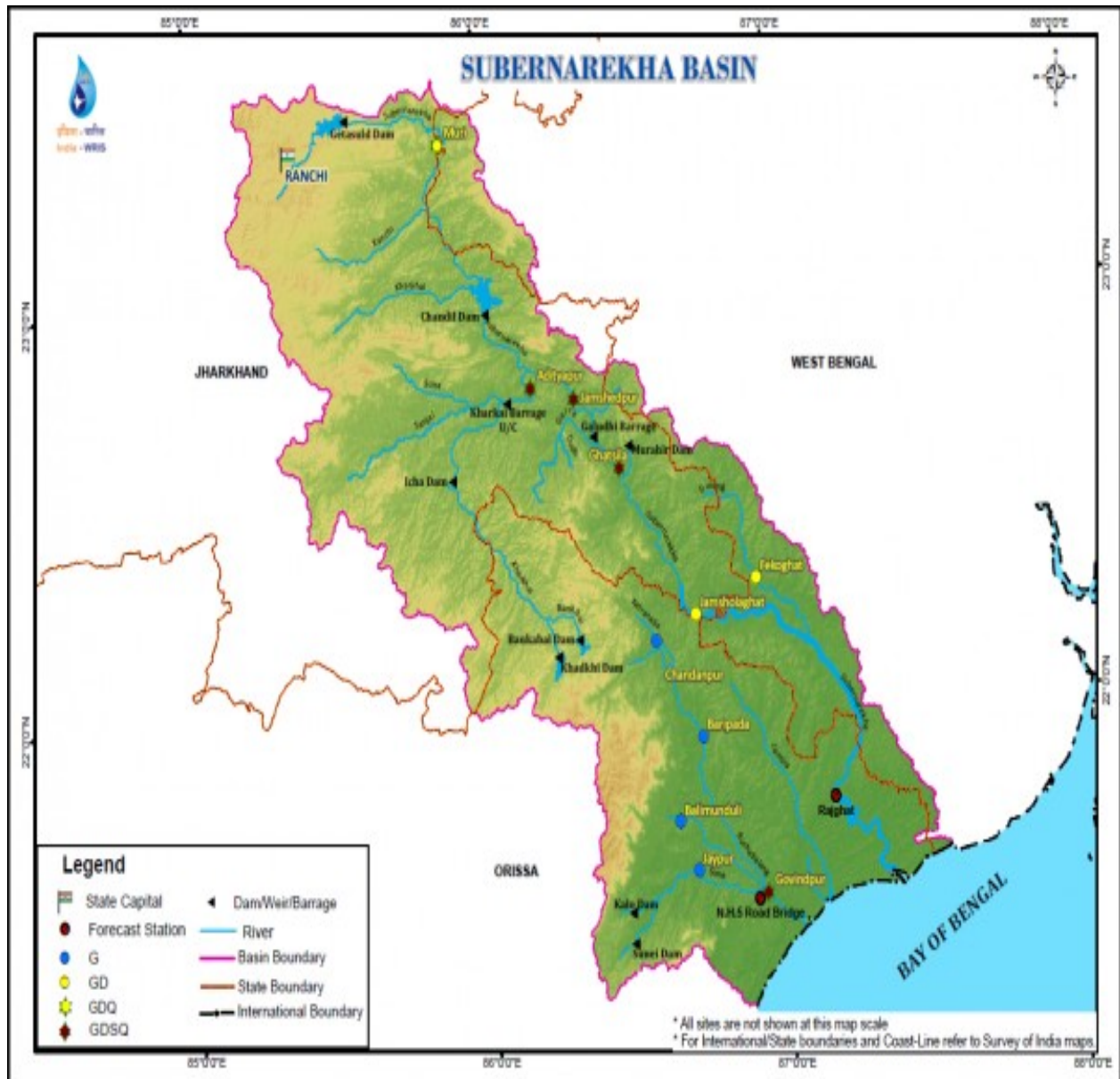


Figure 34 Subarnarekha Basin

2.4.1 Mythologies/ History

The name Subarnarekha means a streak of gold. While some believe that the river is named so because of the fertile soil on its banks, others trace the origin of the name to the particles of gold occasionally found in its sandy bed.

The deposits of the Subarnarekha upstream towards the north of Balasore at Jamsola and Jharpokharia are highly rich in Pleistocene and paleo-antiquities of pre-historic period.

Daud Khan, the second son of Sulaiman Khan Karrani, who succeeded governorship of Bengal, threw off all allegiance to the Emperor of Delhi and declared himself independent. In the struggle, Daud Khan was driven out of Bengal by the forces of Emperor Akbar under Munim Khan. Finally, a decisive battle was fought at Tukaroi on the bank of river Subarnarekha on the 3rd March, 1575. The Mughals became victorious, but suffered losses. Munim Khan himself was wounded.

The river Subarnarekha became the northern boundary of Odisha from 1727 to 1739 and from 1742 A. D. river Subarnarekha was fixed as the line of demarcation between Odisha and Bengal due to various battles between rulers.

A few centuries ago the Subarnarekha was a noble estuary which was admirably suited for a harbour and was consequently one of the first places to attract European mercantile enterprise. Here at the close of the 16th century the Portuguese established themselves at Pipili and the harbour was also the rendezvous of the Arakanese pirates and later the English appear to have made a settlement there. But the Subarnarekha was the first to silt up. By the beginning of the 18th century A.D. the silting up of its mouth had ruined Pipili, and the settlement was abandoned. (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.4.2 Tourist Places/ Religious Places

Kumbhigari

Kumbhigari or Bhusandeswar, a village situated between the Bay of Bengal and the Subarnarekha river in Bhograi area of the Balasore district is noted for the worship of Bhusandeswar Siva Linga. In summer season people usually visit the place in large numbers for worship. The Siva Linga is made of well polished black chlorite stone and is designed in three separate sections. The total height of the



Figure 35: Kumbhigari

Linga is about 3.6576 meters (twelve feet). The striking feature of this Siva linga is its colossal size which can be compared with the Siva Linga in the temple of Bhaskareswar in Bhubaneshwar. Makara Sankranti is observed here with much pomp and ceremony.

Raibania



Figure 36: Raibania Fort

Raibania group of medieval forts is situated 14.5 km north of Jaleswar and 3.2 km. from the right bank of the river Subarnarekha. The traditional view regarding the fort goes back to the Puranic age when king Virata was ruling over this land. He is said to have enshrined goddess Kichakeswari in this fort which was later on removed by a Bhanja ruler of

Mayurbhanj who installed the deity in a temple at Khiching. Ruins of this fort still indicate the shrine of Kichakeswari. The presiding deity Kichakeswari of the temple at Khiching can be assigned to the 10th-11th centuries A. D.

(ODISHA DISTRICT GAZETTEERS, 2014-16)

Talasari Beach

Located in Baleswar district of Odisha and at a distance of 10 Km from Digha, the Talasari beach is pristine, serene and has been bestowed with spectacular panorama. There are secret beaches, beaches which are beyond the reach of contamination, beaches that refresh our senses and Talasari is one such place. This virgin beach has sand dunes, calmer waves amid several palm trees, coconut trees, cashew trees.



Figure 37 Talasari beach

2.4.3 Morphology

Subarnarekha River is a multi-state river flowing over the state of Jharkhand, Odisha and West Bengal. However Subarnarekha is the smallest of the multi-state river in terms of length in India. The basin is bounded by the Chhotanagpur plateau on the north and the west, by the ridges separating it from Baitarani basin on the south, by the Bay of Bengal on the south-east and by the Kasai Valley of Kangsabati River on the east.

After originating near Piska/Nagri, near Ranchi, the capital of Jharkhand, the Subarnarekha traverses a long distance through Ranchi, Sareikela, Kharsawan and East Singhbhum districts in the state of Jharkhand. Thereafter, it flows for shorter distances through Paschim Medinipur district in West Bengal state for 83 kilometres. It flows in Balasore district of Odisha for 79 kilometres and joins

the Bay of Bengal near Talsari. The rain-fed river covers total length of the river is 395¹¹ kilometres and total drainage area of 29,196 square kilometres¹². (India-Wris, 2016)

Sl.No.	Name of the River/ Tributary	Bank	Length (km)	Catchment area (sq. km)	% w.r.t total
1.	Subernarekha	Main Stream	395	7,383	39.0
2.	Kanchi	Right	76	1,096	5.8
3.	Karkari	Right	110	1,341	7.0
4.	Kharkai	Right	136	6,611	34.9
5.	Raru	Right	52	680	3.6
6.	Garru	Right	58	640	3.4
7.	Dulang	Left	84	1,200	6.3
8.	Kalo		-	-	-
9.	Nesa	-	-	-	-
			Total	18,951	100.0

Table 9 Treibutaris of Subarnarekha

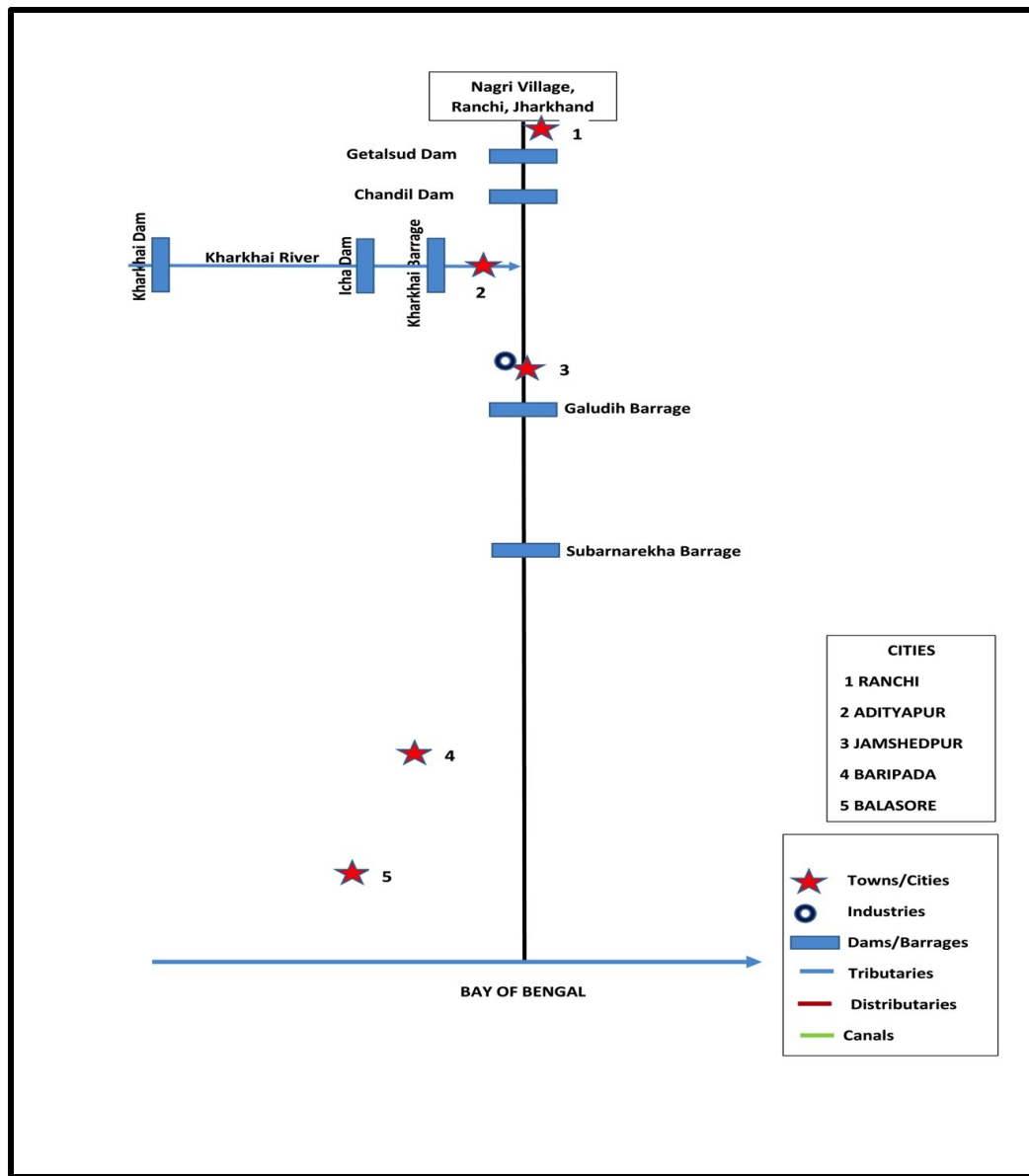


Figure 38 Subernarekha Flow Diagram

Projects/ Dams

SINo	Name of Dam	Year of Completion	River	Volume content of dam
1	KHADAKAI	1984	Khadakai	NA
2	ARIKUL	1986	Arikul Nala	318.84
3	KALO	1980	Kalo River	983.33
4	NESA	1978	Nesa	304.83
5	PAUNZIA NALLA	1988	Paunsia nalla	120

Table 10 Projects/ Dams on Subarnarekha (Source: DOWR)

Subarnarekha irrigation project

The Subarnarekha irrigation project is not making desired progress due to fund crunch and drastic cut in Central assistance under the accelerated irrigation benefit programme (AIBP). The project estimated to cost `82 crore in 1981 has now escalated to `5,629 crore due to time and cost overrun while irrigation potential for only 32,000 hectares (ha) has been created after more than three decades.

The project on completion will provide irrigation to a cultivable command area (CCA) of 1,09,630 ha in Balasore and Mayurbhanj districts with an annual irrigation of 1,87,460 ha at an irrigation intensity of 171 per cent.

An inter-State project, Odisha Government signed a tripartite agreement with Bihar (now Jharkhand) and Bengal on August 7, 1978 for construction of the multi-purpose irrigation project.

However, the project in the State was taken up in 1987 from its own resources. In 1995-96, the National Bank for Agriculture and Rural Development (Nabard) sanctioned funds for a dam at Jambhira and a portion of the canal system.

Subsequently, it was included as a Central Government-sponsored AIBP scheme in 1996-97. The project is getting 81 per cent Central assistance. So far, it has received Central assistance to the tune of `1,310.05 crore.

The Subarnarekha irrigation project, which got approval of the Planning Commission in 1995, was scheduled to be completed by 2001-02 with an estimated project cost of ` 1013 crore. As of now, `2,800 crore has been spent on the project.

The State Government needs another `950 crore for completion of the irrigation project

The State Government had made a provision of `320 crore for the project of which `196 crore was utilised till the end of 2014. Though it has set a target to create additional irrigation potential for 10,000 ha, only 1,250 ha was brought under irrigation.

Chief Minister Naveen Patnaik inaugurated the first phase of the project in 2013 which is feeding water to arable lands of five blocks of Mayurbhanj district namely Saraskana, Bangiriposhi, Baripada, Shuliapada and Kuliana.

The project will take about two more years to complete if the Governments of West Bengal and Jharkhand cooperate. (Express News Service, 2015)

2.4.4 Biodiversity

Flora

The mangrove of Subarnarekha river mouth has been notified as protected reserve forest over an area of 563 ha. The notable mangroves species are *Avicennia officinalis*, *Aegiceras corniculatum*, *Ceriops decandra*, *Acanthus, illicifolius*. *Bruguiera gymnorrhiza*, *Rhizophora mucronata*, *Sonneratia apetala*, *Bruguiera cylindrical* and *Excoecaria agallocha*.

Fauna

Several studies have found about 162 species of intertidal macrofauna (invertebrates and vertebrates) belongs to 119 genera and 80 families were identified from this estuary. Major faunal group present in this estuary is as follows:

Cnidarians comprises 6 species, Annelids with 26, Arthropods as 29 species, Molluscs as 82 species, Whereas Echiurids, Sipunculids and Brachiopods represent as a single species. Similarly, intertidal Macrofauna of Subarnarekha Estuary consists of 97 Echinoderms of 6 species.

Among the vertebrates Fishes represent as 8 species belongs to 7 genus and 4 families, whereas Intertidal snakes were found here only 2 species, 2 genera and two families.(MITRA , Mishra, & Pattnayak, 2010)

2.4.5 Impact of Human Intervention

2.4.6 Future of River

Cyclone Phailin-induced breaching of the sand spit is causing significant changes in estuarine geomorphology, resulting in a decline in the number of Olive Ridley turtles nesting in the subsequent year.

It was observed that the number of Olive Ridley turtles declined significantly during 2014. Nesting drastically reduced to 25,000 in 2014 from a total of 3, 00,000 turtles in 2013. (Scientific Correspondance, 2016)

2.5 The Rushikulya

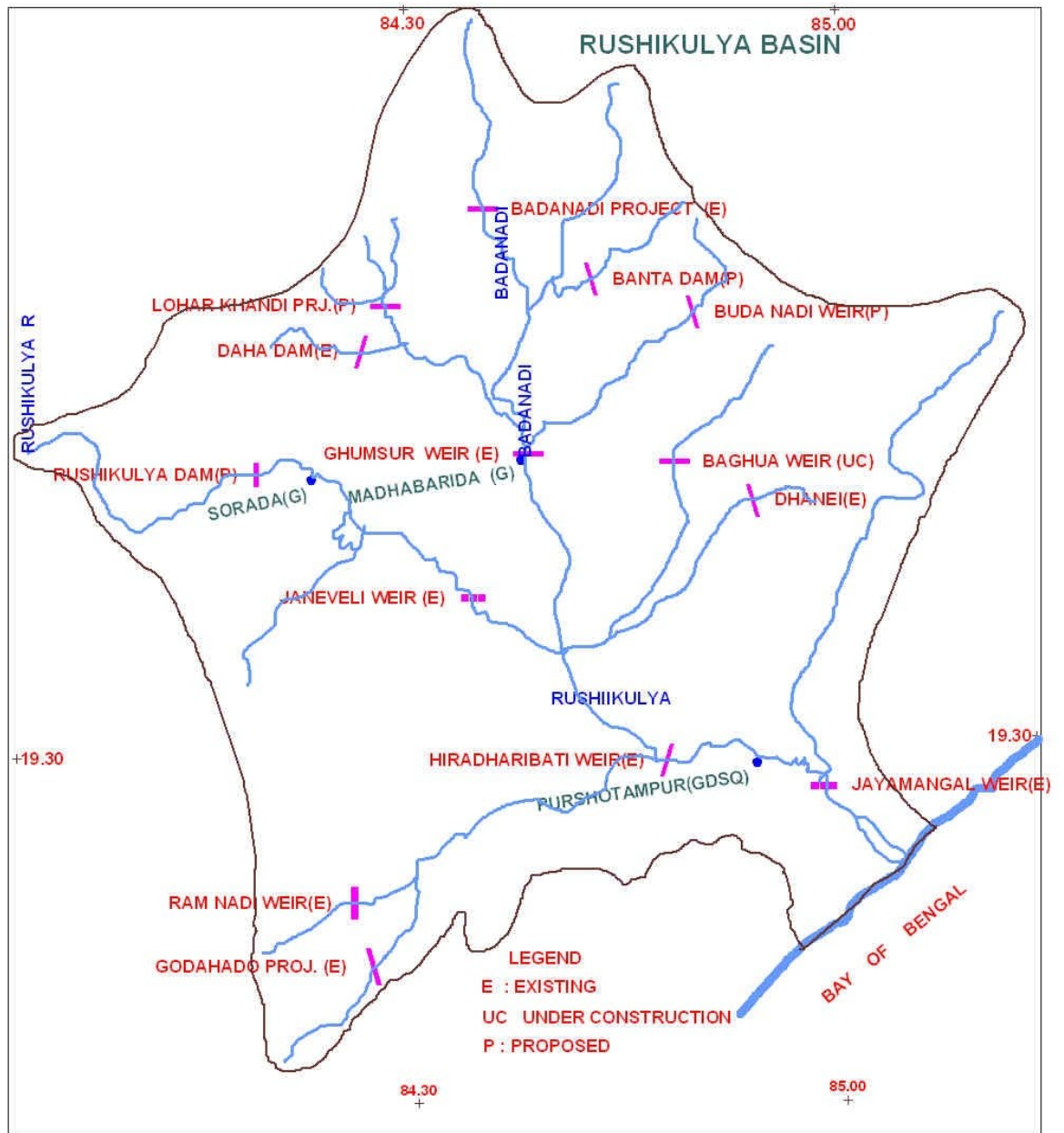


Figure 39 Rushikulya Basin Map

2.5.1 Mythology/ History/ Folklore

Rushikulya has its origin in Rushimal Mountain. Rushimal Mountain is situated near the village Tamangi of Daringbadi block. There is a chuan or cave with water source from where River Rushikulya originates. It is described in different Hindu purans that Rushikulya is 100 years senior to river Ganga. So on the auspicious day of Chaitra Sukla Tryodashi with addition of 24 lunar mansion star on Saturday gives a golden opportunity to attain spiritual benefit by having a holy dip in it.

Ashoka, the emperor of Magadha invaded Kalinga, in the third century B.C and divided Kalinga into two parts such as Toshali and Samapa, for better administration after converting himself from Chandashoka to Dharmashoka. He left two rock addicts at Dhauli in Puri District of Toshali and at Jaugada near Purusottampur of Ganjam District of Samapa. The inscription of Jaugada speaks that the old capital of Samapa was situated on the bank of holy river Rushikulya

Ganjam

Ganjam town is situated on the mouth of the river Rushikulya that is at a distance of 32 kms to the north-east of Brahmapur. The name Ganjam is derived from the work Ganj-e-Am meaning a common market place. Popularly called as Ganja it was the chief town and headquarters of the Ganjam district till the beginning of the 19th century during the British rule. It was a famous port busy with maritime activities since the days of Ashoka. It was an outlet for the sailors and traders of Kalinga who carried on brisk trade with South East Asian islands.

2.5.2 Tourist Places/ Religious Places

Kotgarh sanctuary, Lakhari Elephant sanctuary, Bhetnoi-Balipadar reserve in the basin are declared to be sanctuary and game reserve by Government of Odisha.

Gopalpur beach is one of the famous beaches in Odisha coast. It is a languorous beach with coconut groves. Beach festival at Gopalpur is another yearly attraction. Rowing, Scuba Diving, Swimming, Paddle Boat, Water Scooter are some of the major sports and fun rides being provided for tourists as well as professionals.

The Trideveswara temple

Trideveswara temple stands on the bank of the river Rushikulya and is regarded as the tutelary deity of the Pandya Brahmins of the locality. The sanctum of the temple does not contain any deity or Shivalinga but the circular pedestal marked by three symbols is worshipped. The bull preserved in

the Jagamohana of the temple has been associated with the Lanchana of Risabhanatha. An Odia inscription is found depicted in the Natamandapa of the temple. Local people regard the Trideveswara as Brahma, Vishnu and Maheswara and worship accordingly.

Brahmanachai

Brahmanachai is a small village on the bank of the river Rushikulya and is at a distance of 5 km. from Aska on the Aska-Brahmapur road. A cluster of temples dedicated to Vishnu, Shiva, Surjya, Ganesh, Sri Chaitanya and Shakta gods and goddesses are found together here within a spacious compound. The Brahmeswara Shiva temple is built on the ruins of an earlier temple. The Shakti pitha within the sanctum of Narmadeswara Shiva temple contains eleven Lingas known as “Ekadasa Rudras” in the locality. The Surya temple is in the form of a Chariot. Most of the temples are of recent origin and are devoid of any architectural or sculptural peculiarity.

Biju Patnaik Park at Bhanjanagar dam is a beautifully developed park with recreational centres attracts tourists from nearby towns.



Figure 40 Biju Patnaik Park

Jaugada

Jaugada, situated 19° .33′ N and 84° .50′ E on the bank of river Rushikulya is very near to village



Figure 41 Lac fort

Pandia. It is at a distance of 10 km. from Purushottampur. The place is of great historical importance as one of the famous rock edicts of Ashoka is located here. Jaugada or Jatudurga (Lac Fort), as it was known in classical times is said to be associated with Mahabharata episode. Tradition ascribed that the fort of Jaugada was

built by Duryodhana of Mahabharata fame. Its name Jau or Lac is from a tradition that it was made of Lac and was, therefore, impregnable as no enemy could scale the walls as they were smooth and slippery.

Jaugada stands as the symbol of the entire historical heritage connected with the Rushikulya Valley civilization. From the bank of this river, silver coins of the pre-Mayuryan Age have been discovered. The Ashokan inscription at Jaugada is incised on a rock face some 30 feet long and 15 feet high elevated about 12 feet on a mass of granitic gneiss.

One can find inscriptions on rocks written in the Prakrit language using Brahmi script. The place is visited by researchers, scholars and tourists in large numbers.

Palur

Palur was an ancient sea-port situated at a distance of 32 km from Brahmapur in the Chatrapur Sub-Division of the district. It is situated on the mouth of the river Rushikulya. The Odia merchants sailed to far-off Java, Sumatra, Bali and other South-East Asian islands from Palur and had flourishing trade during ancient times. The temple of Bateswara Mahadeva, assigned to 10th century A.D, is situated on the seashore at Palur. The temple is half buried and has been given a thick coating of plaster for which the decorative designs of the outer wall is not visible.

Suruda (Sorada) Reservoir

There is a reservoir at Sorada which is part of the Rushikulya Canal system for irrigation purpose. The reservoir has a storage capacity of 35 m.cumic, the water of which feeds the Rushikulya canal and drops regulated water to the Rushikulya River through Johoranallah for irrigation purpose. Goddess Maa Khunteswari is adorning on hill top of the reservoir. Besides, there is a temple of Lord Panchanana which is situated in the cemetery ground of Sorada in the northern side of river Rushikulya. Five Lingas are worshipped in the temple as Panchanana. Every year in the Kartika Purnima and Shivaratri day devotees in large numbers come to this place to worship the deities. Jagneswar Temple at Ramanabadi under Sorada Tahasil amidst eco-scenic environment is adding another attraction of the place Sorada.

Taratarini

The shrine of the twin Goddesses Tara and Tarini is situated on the top of a hillock 708 feet high on the south of the river Rushikulya. The Taratarini Pitha is located at a distance of 35 kms from Brahmapur and 30 km. from Chhatrapur by road. A flight of 999 steps on the eastern side of the hill leads to the top of the mountain where the shrine of Tara-Tarini is situated. This part of the hill is called as Dahihandi. There is also a zigzag motorable road by which one can approach the shrine at the hill top. The view of the surrounding landscape from the top of the hill is quite enchanting. The



Figure 42 Tara Tarini Temple

verdant hill girdled by the quietly flowing Rushikulya and the long stretch of fertile plain encircled by mountains is a beholding sight. The place has achieved tremendous popularity for the worship of the twin Goddesses Tara and Tarini. Both the deities are crudely fashioned in stone but attached with silver eyes. The Tara-Tarini Pitha is considered as a Shakti Pitha of the Tantric cult.

Religious Importance: It is believed that at this Pitha the breast of Sati fell for which the two deities have this peculiar shape. This famous Shakti Pitha had a tradition of human and animal sacrifices even till the advent of the British in Odisha. The Temple erected for the deities is of modern origin

2.5.3 Morphology

The Rushikulya originates at an elevation of about 1000 metres near Matabarhi village from Daringbadi hills in Kandhamal district of Odisha. The place from where the river originates, Daringbadi is called the 'Kashmir of Odisha'. The river flows in southeast direction through Ganjam district along the towns of Surada, Dharakote, Aska, Pitala, Purusottampur, Taratarini, Alladigam, Brahmapur, Ganjam and finally through Chhatrapur block before draining at Bay of Bengal. It has a length of 165 km while the total catchment area is 7700 km². There are eight tributaries of river Rushikulya namely Baghua, Dhanei, Badanadi, Padma, Joro Nadi, Boringa Kharakhari and Ghodahada. It has no delta as such at its mouth.

The river, which may be called as the life-line of the Ganjam district, passes through narrow strips of cultivable lands and then emerges into the plains below the South-Eastern railway line. Since the hills of the district are close to the sea, the rivers flowing from the hills are not very large and so they are subject to the sudden flood.

Tributaries and Distributaries

The prominent tributaries of the river Rushikulya are Padma, Boringanallah, Joro, Badanadi, Baghua, Dhanei, Kharkhari and Ghodhado.

Padma- Padma joins Rushikulya on its right. It originates from Kuduma hill ranges at an elevation of 500m. The river has a drainage area of 663 sq.km.

Bada Nadi- Bada nadi originates from Karasingi Hills at an elevation of 200 m. the river meets

Rushikulya at Madhabarida. There is an anicut on this stream near Madhabarida where the drainage area is 2353 sq.km,

Joro Nadi- It originates from Darinbadi hill ranges at an altitude of 500m. It meets Padma River down stream of Saroda. The length of the river is 35 km and has a catchment area of 40 sq.km.

Boringa Nallah- It is a left tributary of Rushikulya River. It starts fro Daringbadi Tahasil. There is a Reservoir on this Nallah near Bhanjanagar. The catchment area of Bhanjanagar Reservoir is 65 sq.km. The river joins Badanadi at Madhabarida.

Dhanei River- It originates from Khundabala Hills at an elevation of 500m. Down the stream river Baghua joins Dhanei and both fall in to Rushikulya. The length of the river Dhanei is 55 km.

Baghua River- It originates from Gochha hill ranges at an altitude of 500m. the catchment area is oblong shaped and has 204 sq.km area. The atream joins Dhanei river before draining combinedly to Rushikulya river. The length of the river is 52 km.

Kharakhari River- It originates at an altitude of 400 m. and flows through Khalikote and Chhtrapur Tehsil. It joins Rushikulya River at Patapur of Purusottampur Block. The drainage area of the river is 387 sq.km and its length from origin to confluence is 50 km.

Ghodahada River- the river originates at an altitude of 800 m. from Ramagiri of Tangiri hills. The total length of the river is 72 km. there is an anicut on this river at Hinjlicut. This anicut is called aajayamangal anicut.

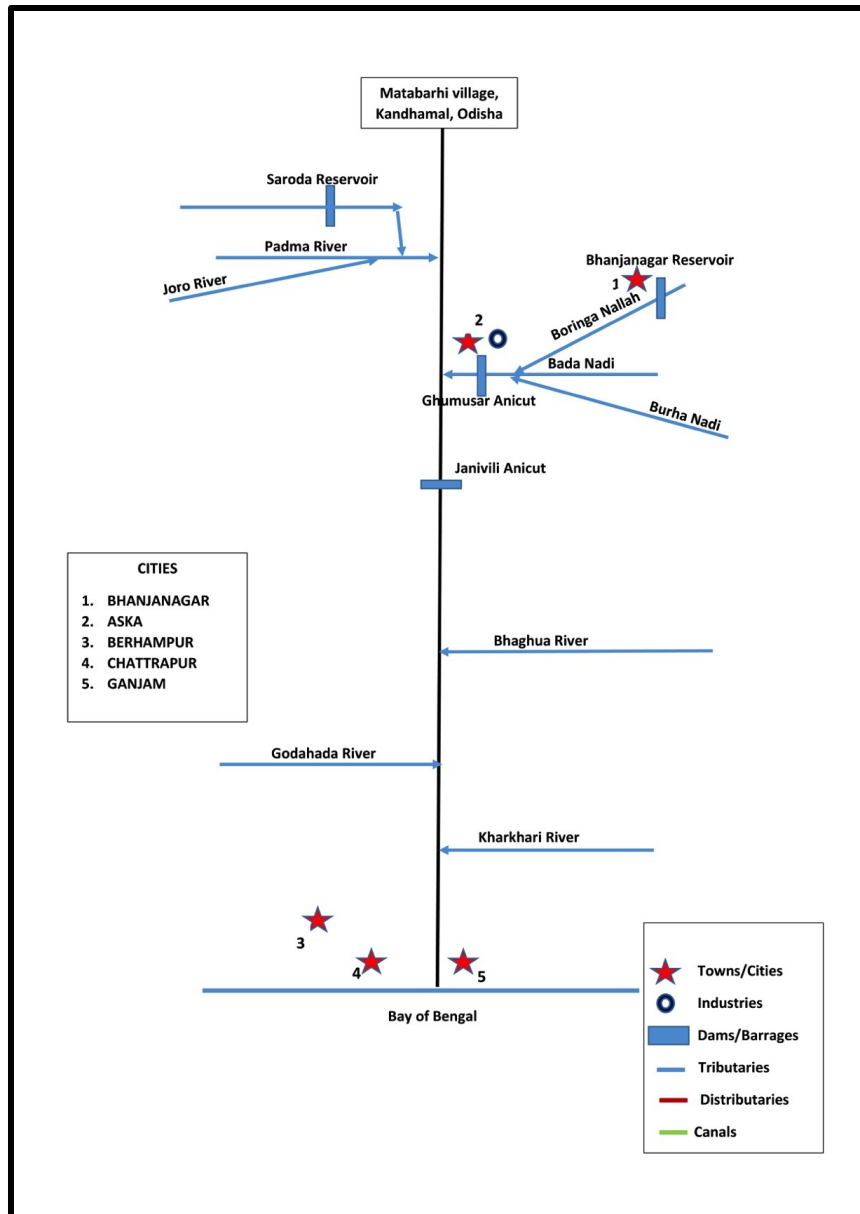


Figure 43 Rushikulya Flow Diagram

Projects/ Dams

SINo	Name of Dam	Year of completion	River	Volume content of dam in TCM
1	BHANJANAGAR	1966	Baranganalla	740.00
2	SORODA	1963	Padma	1700.00
3	DHANEI	1965	Dhanei	152.64
4	GANIANALLA	1973	Ganianalla	149.70
5	GHODAHADA	1974	Ghodahada	1394.00
6	ALIKUAN	1975	Badanalla nalla	345.50
7	JHARANAI	1975	Jharanai	183.00
8	KANHEINALLA	1975	Kanheinalla	207.47
9	LANKAGADA	1975	Bhusunda nalla	172.15

10	RAMAGUDA	1977	Ramaguda nalla	178.40
11	BAGHUA (MI)	1980	Baghua	241.68
12	SALIA	1970	Salia	382.05
13	KUANRIA	1988	Kuanria	730.00

Table 11 Projects/ Dams on Rushikulya (source: DOWR)

2.5.4 Biodiversity

Out of 8963 sq.km of the basin area, 3697.31 sq.km is covered with forest. It is about 41.25 % of total basin area thus having an enormous potential for rich biodiversity. In general vegetation can be divided into trees, shrubs, grasses, climbers and medicinal plants. Predominant forests include bamboo and sal forest in basin. There are about 68 medicinal plant species in the basin which are used by the forest dwellers for self-use and sale. The important wild life species found in Ganjam District having highest conservational importance are Elephants, Olive Ridley Turtles, Dolphins, Marsh Crocodiles, Indian Sloth Bear, Pangolins, Fishing Cat, Black Bucks, Peacock and Star Tortoises, etc.

Dolphins

In the coastal water of Berhampur Division Dolphins are seen in the mouth area of Rushikulya. The species found are Bottle Nose, Spinner Dolphin, Hump back Dolphin. Dolphin Census in 2015 along the 54 km long coastal stretch in Berhampur Division starting from Prayagi to Sonapur reported presence of 24 dolphins.

Olive Ridley Turtles

During February or March for a span of about seven days mass nesting of Olive Ridley Turtles occurs near mouth of the river Rushikulya. This is the Rushikulya rookery and it has emerged as the second most important nesting ground of Olive Ridley turtles in Odisha after Gahiramatha. In 2014-15 it is estimated that 3.09 lakh turtles have come over to this place for mass nesting. Now there are efforts by the local people for the conservation of the turtles nesting here.

Fish

The population of Giant fresh water turtle in Golia of Buguda Range is estimated about 250 in numbers. Besides this the Division is also having very rich population of peacocks of about 2,000 nos. mostly concentrated in Pakidi DPF of Aska Range.

2.5.4 Conflict over Rushikulya Basin

Flood management has come out as a huge issue in the basin due to recent chain of cyclonic events and sub-tropical monsoon climate. Odisha faces serious floods nearly every year. There are no

embankments on the high risk areas of river Rushikulya to save agriculture and prevent the loss of property.

Pollution of the Rushikulya River due to industrial effluents containing harmful elements like Mercury is increasing. Salinity levels of river water at the mouth of Rushikulya River is increasing which is hindering the crop yields at coastal areas. Farmers have been reporting this to the concerned officers regarding the changes several times.

Protest against Pipalpanka Dam in the Ganjam District for TISCO.

Pipalpanka dam was proposed to be developed to meet the water requirement of the Tata Iron and Steel Company's (TISCO) steel plant at Gopalpur. While the locals were demanding for construction of the dam at Pipalpanka it was avoided by the Water Resources department on the pretext of the soil there not suitable for dam construction. But later on the dam was proposed to be developed for Gopalpur plant. Allegation were made that water demands of the locals will be affected due to upcoming proposal.(River Basin Rushikulya, 2016) If the proposed Pipalpanka dam project for TISCO (Tata Iron and Steel Company) will be constructed, it will have disastrous consequences not only on drinking water but also on existing irrigation system which covers about 70 percent geographical area of the district.(Pati, Water Resources of Odisha: Issues and challenges, 2010)

Water scarcity in Ganjam district has turned critical in recent years as river Rushikulya provides water for irrigation, drinking purposes and domestic uses of villages in 14 blocks and 8 small urban centres. The reduction in water availability has led to escalation of conflicts of interest. In summer, people of the district are deprived of getting minimum supply of water from the Rushikulya system. Rushikulya Bachao Manch with other social organisations has been protesting for completion of the projects, promised by state government to meet the needs of water demands for Berhampur city.

2.6 The Indravati

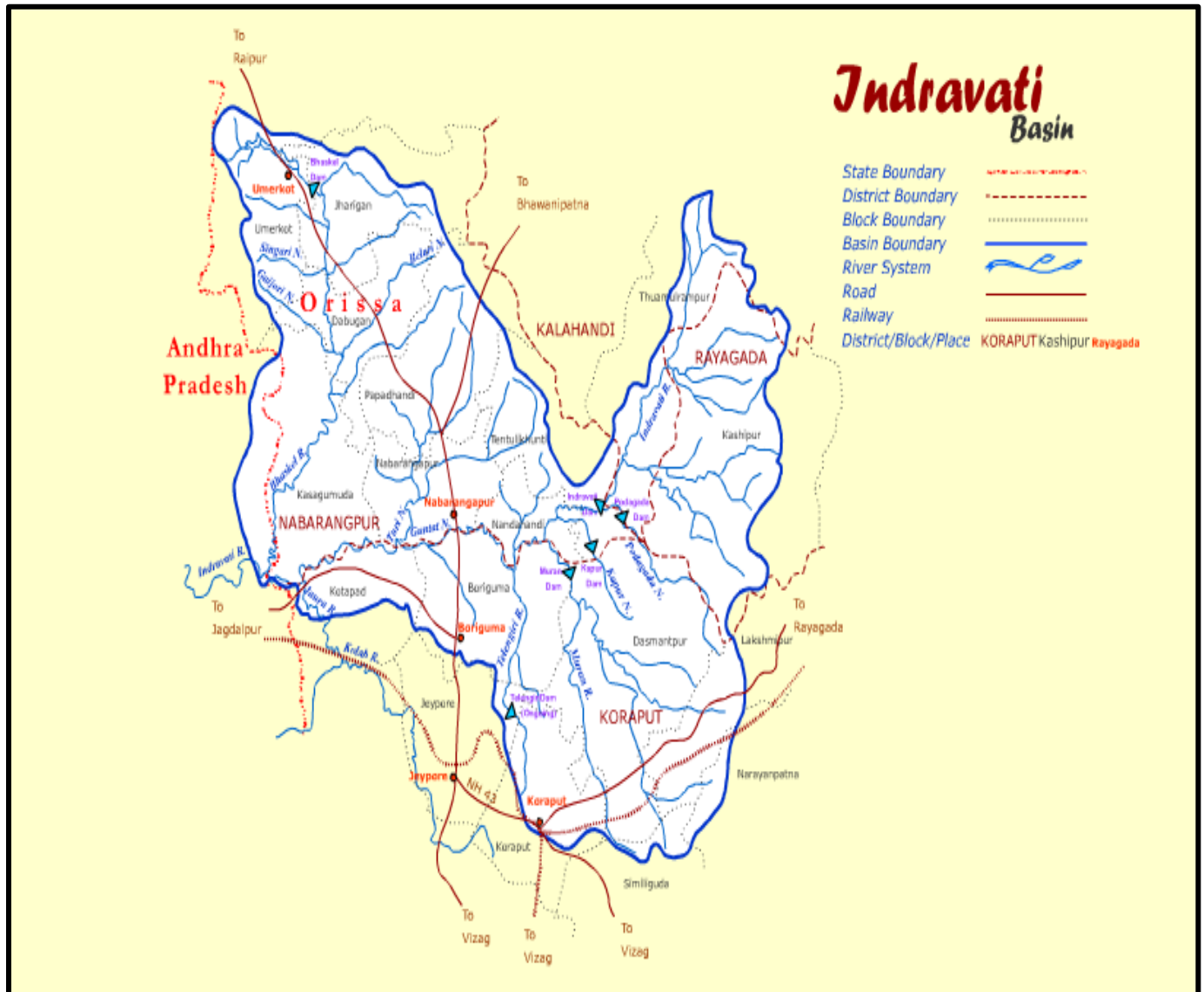


Figure 44 Inderavati Basin

2.6.1 Mythology

There is a beautiful Hindu mythological story behind the formation of Indravati River. Once upon a time the place was full of Champa and Chandan trees, which fragranced the whole forest. Such a beautiful place on earth attracted Lord Indra and Indrani. They went down from heaven to stay on this beautiful place for a while. They deeply enjoyed the beauty of nature. While wandering in the jungle Indra went to a small village named Sunabeda (Nuwapada district in Odisha). There he met with a beautiful girl Udanti. At the first sight, they fell in love with each other and Indra disagreed to go back. On the other side, due to separation Indrani cried sorrowfully and expressed her pain to the nearby people. People knew well about the Indra and Udanti so they informed the same to Indrani and suggested her to stay there. Indrani got angry over Indra and poured scorn on Indra and Udanti so that they never meet again and she stayed there as Indravati River, which flows till date. And, Indra and Udanti rivers are also flowing there separately, without meeting each other due to curse of Indrani. (Odisha Files, 2016)

2.6.2 Historical Facts

The neighbouring areas have yielded evidences of Early Man at Chitrakot on the river Indravati in the Bastar district of Madhya Pradesh. Evidence of a flourishing microlithic industry of the Late Stone Age Culture has been discovered (krishaswami, V.D., 1954). This place is hardly forty miles to the west of the Bastar-Koraput border.

Maurya Period

Indravananka land has been placed in between the river Indravati and the Tel. The region was habituated by the Atavikas. The Avatikas had high standard of civilization and culture. Kalahandi was the core of the Atavikas or forest dwellers. It was a recruiting ground of mercenary soldiers. Archaeological remains of Kalahandi demonstrate *its prosperity in ancient period diachronically to its present day poverty and backwardness*. Various ethnic people lived on this landmass. They were *Andhras, Nisadas, Vidyadharas* and probably *Nagas* in ancient time. (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.6.3 Tourist Places/ Religious Places

Indravati Project:

Indravati Reservoir extends over an area of 110 sq.kms, which is approximately 43 kms long in NNE-SSW direction and 9 kms wide at its widest point. In the south Bafalamali Mountain majestically stands as a wall and the reservoir is surrounded by



Figure 45 Indervati Project

several small and big mountains with scenic beauty offering experience of calm and serenity. It is an ideal place for boating and to experience the lifestyle of tribal people staying inside the reservoir in small villages. There is availability of local traditional boats as well as power boats to ferry the visitors inside the reservoir. It is indeed an incredible marvel of natural beauty to bewitch the visitors.

Mardiguda

The origin of Indravati River in three streams beneath a mango tree surrounded by Champak trees at Mardiguda is sufficient to bewitch visitors. This spot is surrounded by Mountains inhabited by tribal families. There is Nilakantheswar Shiva and Manikeswari Temple and a residential Saraswati Sisumandir at Thuamul nearby. This spot is in Thuamul Rampur Block about 65 Kms from Bhawanipatna. It is an incredible nature's marvel that a small stream becomes a big river and a gigantic multipurpose dam (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.6.4 Morphology

The river Inderavati rises at an elevation of 914 metres from a small rivulet at Thuamul Rampur in the Kalahandi district of Odisha on the western slopes of the Eastern Ghats. It has a well-defined course from its origin to its confluence with Godavari River. River starts with south-east direction in Odisha. Then flows west-ward through the Kalahandi, Nabarangpur and Koraput districts for 164 kms and after forming the boundary between Odisha and Chattisgarh states for 9.5 kms, enters the Bastar district of Chattisgarh. After flowing 233 kms in Chattisgarh, it turns south and flows along the boundary of Chattisgarh and Maharashtra for about 129 kms and joins Godavari River at the junction of the boundaries of Maharashtra, Chattisgarh and Telangana states. During its total course of 535.80 kms the river drops by 832.10 metres. Its bed level at its junction with the Godavari River at an elevation of 82.3 m compared to the level in Kalahandi from where it takes off is 914 metres. Most of the river course is through dense forests of Nabarangpur & Bastar also known to be the greenest places in India. The right bank Tributaries of River Inderavati are Bande, Kotri, Nibra, Gudra, Baordhig, Narangi, Bhaskel and important right bank tributary includes Nandi raj. (Nabarangpur District Panchyat, 2016)

Tributaries of Indervati

The major tributaries of river Indravati are Keshadhara Nalla, Kandabindha Nallah, Chandragiri Nalla, Golagar Nalla, Poragarh Nalla, Kapur Nallah, Muran River, Bangiri Nallah, Telengi Nallah, Parlijori Nallah, Turi Nallah, Chourijori Nallah, Damayanti Sayarh, Kora river, Modang river, Padrikundijori river, Jaura river & Bhaskel river.

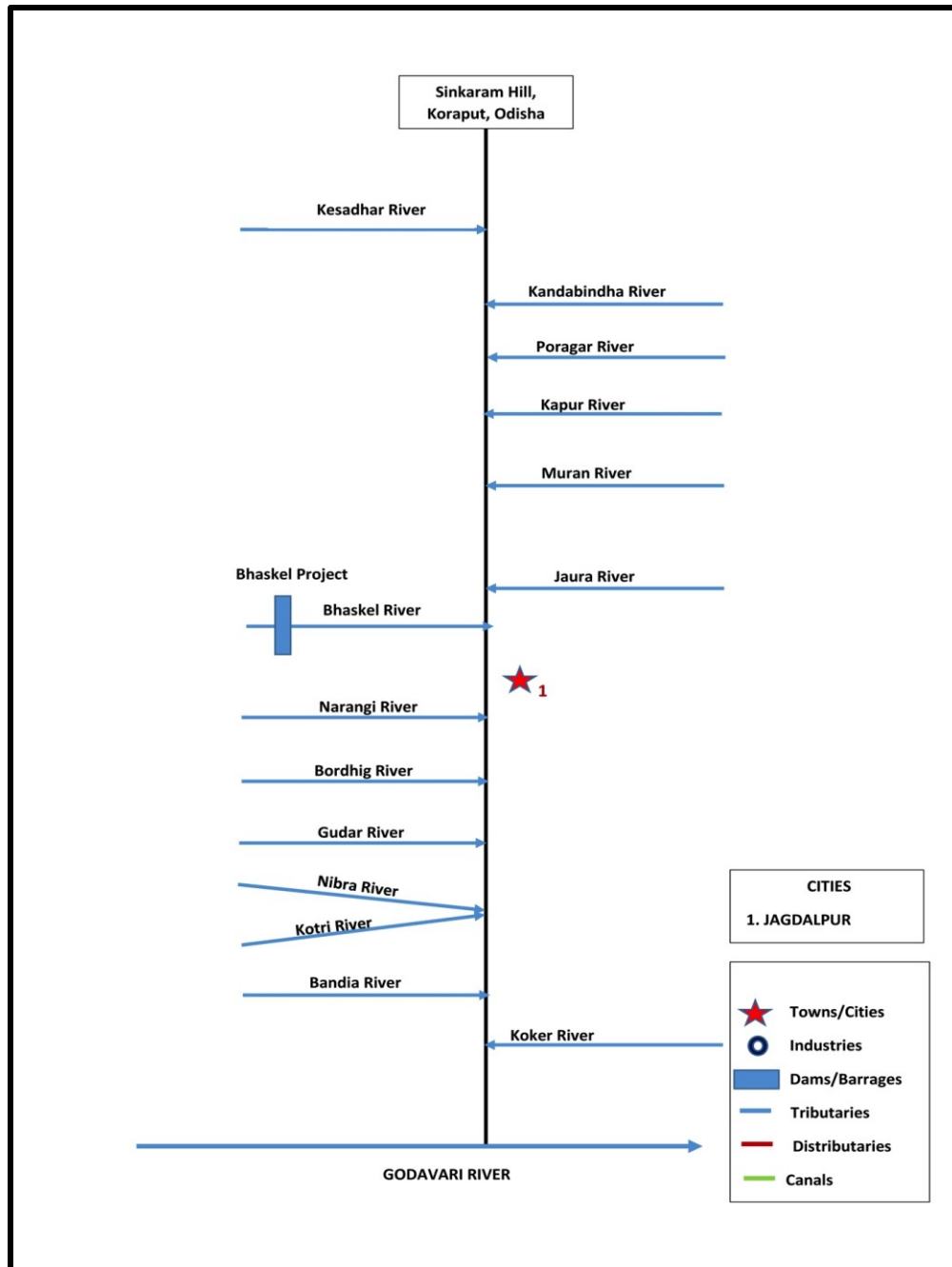


Figure 46 Inderavati Flow Diagram

Dams and Projects

SINo	Name of Dam	Year of Completion	River	Volume content of dam
1	Indravati Dam	1996	Indravati	332

Table 12: Dam on River Indravati

2.6.5 Biodiversity

Inderavati National Park and Tiger Reserve: Inderavati national park and tiger reserve are located in the neighbouring state of Chhattisgarh state. The reserve attained the status of a national park in 1981 and a tiger reserve in 1983 got its name from the Inderavati River, which flows from east west direction and forms the northern boundary of the tiger reserve with the state of Maharashtra. The park and reserve has a total area of about 2800 km².

Inderavati River is the life source for the flora and fauna of National Park best known for its unique and miscellaneous wildlife and bird species including some of the rarest species such as Wild Buffalos and Hill Mynas.

2.6.6 Impact of Human Interventions

Jaura Nala used to flow in northward direction, feeding the Indravati River and connecting Kolab River and Indravati River. Inversion in the direction of flow of Jaura Nala took place around 1994-95 resulting in the draining of Indravati river water into Jaura Nala. Now the local people call the Jaura Nala as Ulta Jaura Nala (meaning Jaura Nala flowing in reverse direction).

The draining of Indravati River in Jaura nala resulted in two major consequences:

Availability of less water downstream in the Indravati River.

Excess water and sediment load in Jaura Nala.

(Vansutre, Deshmukh, & Hari, 2014)

Future of the Indravati River

As it can be seen in the Google earth images, if the present situation continues, the day is not very far in the future, when the lifeline of Baster (Indravati River) will be dead. Indravati recharges the groundwater in the region and helps in maintaining the ecological equilibrium in the region. The life source for the flora and fauna of Indravati National Park and major habitat would be lost and wildlife movement would be completely ended if the river dries up. The wild buffalo, which prefers the cool habitats along the river, will soon vanish.

2.6.7 Conflicts over the basin

State level

A total of five hydroelectric projects (Kutru I, Kutru II, Nugur I, Nugur II and Bhopalpatnam) were planned on the stretch of Indravati River at various points in time. But none could see the light of the day due to ecological concerns raised in various fora.

According to Interstate Agreement as per Godavari Water Disputes Tribunal (GWDT) Report, the State of Odisha has to ensure 1.3 x10⁹ cubic meters(45,000×10⁶ cu ft) (45 TMC) of water at the Odisha–Chhattisgarh border.

Social Movements

Inderavati Dam Conflict:

Though a tribal district, where education and awareness are lacking, the people of Koraput were not adequately informed about the benefits and implications of the project. The initial impression was that any loss due to the dam will be compensated by the construction of minor/medium irrigation projects. At the time, they had no idea of large scale evacuation, displacement and loss of the precious forest cover which shapes their livelihood in many ways. Initially, some villagers who were legal owners of their land accepted the compensation given by the government and migrated. Others, particularly the tribal population, whose ownership of land was not in the government records, stayed back and occasionally resisted the construction of the project. The movement gathered momentum in the early 1990s, but by then almost half of the work was complete. Under the banner of the Indravati Gana Sangharsha Parisad (IGSP), the protesters started demanding better compensation. The IGSP continued to protest in a sporadic manner in the first half of 1990s and managed to get some concessions for better rehabilitation measures from the government, but remained silent afterwards. This issue also drew the attention of political parties, and the debate continued sporadically for a decade both at the central and state level. (River Basin Transact, 2010)

Joura Nala conflict

After construction of the dam on the Indravati river, the downstream flow reduced considerably, affecting the livelihoods of the people living in this part of the the river basin. The Joura riverbed is about 0.4 metres below the Indravati riverbed. Due to this natural gradient, water drains from the Indravati into the Joura. As a result, the flow in the downstream areas of the Indravati in Chhattisgarh is reduced, which aggravates the situation. People in Chhattisgarh are demanding that the flow in the Joura should be stopped by constructing a bund over it. However, the people on the Joura riverbank oppose such a move. The flow of water from the Indravati into the Joura is the point of conflict. At times, people from Chhattisgarh enter Odisha and construct bunds on the Joura to stop the flow of water from the Indravati. During summers, when there is less water in the river, people construct bunds on the Joura more frequently. (Choudhury, et al., 2012)

2.7 The Vamsadhara

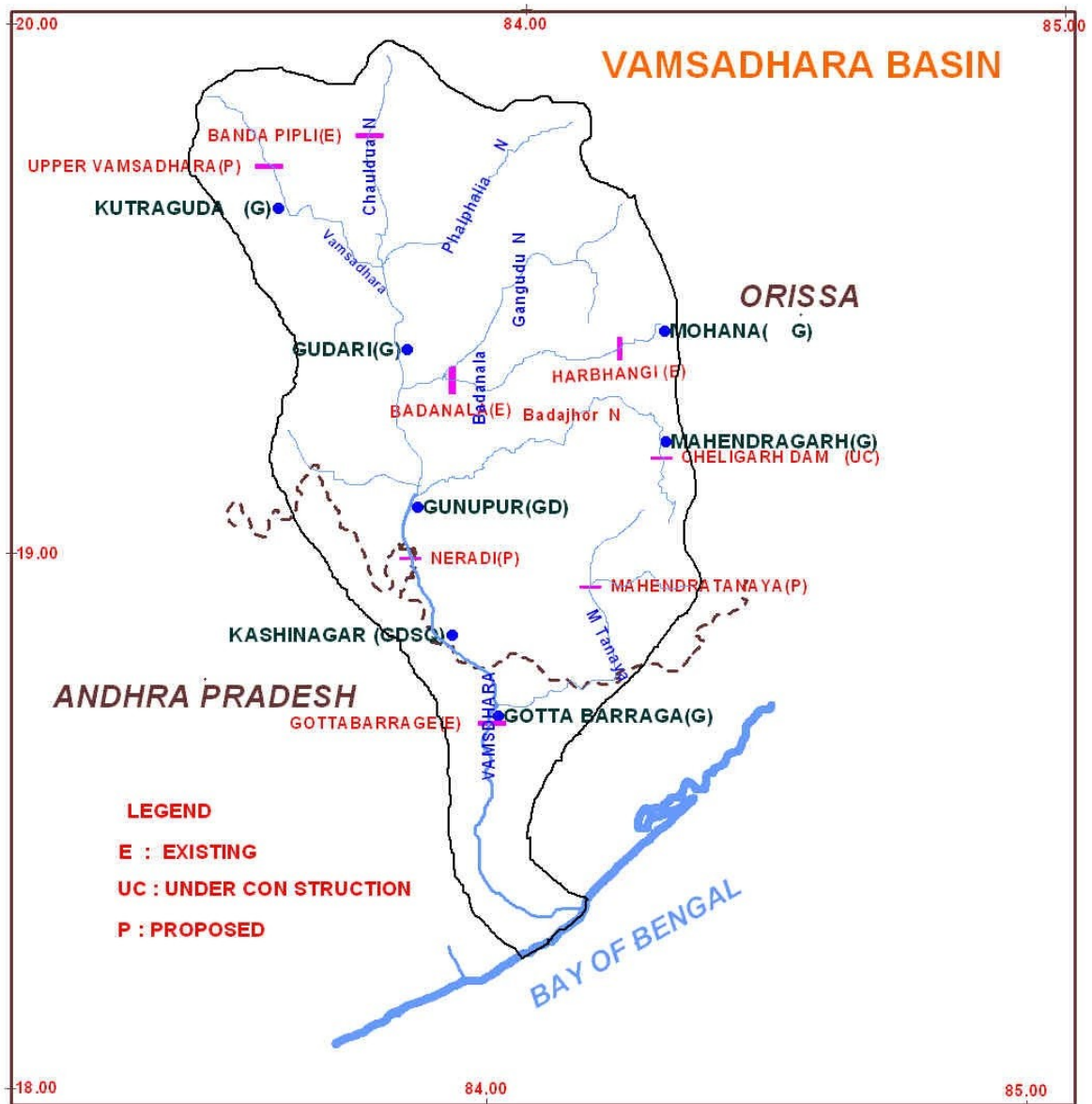


Figure 47 Vamsadhara Basin

2.7.1 Mythology/ Historical facts

The name of Vamsadhara/ Vansadhara River has been derived from the words “bansa” which means bamboo and “dhara” which means water flow. The river in fact originates from the forests covered with bamboo trees. Thus the river received the name of Bansadhara in Odia which was transliterated as Vamsadhara in Telugu. (Vamsadhara, 2016)

2.7.2 Tourist Places/ Religious Places

Maa Majhighariani Temple

Temple of Majhighariani, the presiding deity of the District, is located on the bank of the river Jhanjabati (tributary of Vamsadhara) at Rayagada. This tribal goddess has been assimilated into the Aryan-fold. Priests of the temple are non-Brahmins, and Paikas. Sometimes, “homa” or “fire sacrifice” is performed in Vedic way. A number of animals are sacrificed every day. People of Andhra Pradesh and Districts of Ganjam, Gajapati, Kandhamal, and undivided Koraput visit this place in large number every day. “Chaitra Parav” is performed every year in the month of “Chaitra” with pomp and ceremony.



Figure 48: Maa Majhighariani Temple

Minajhola

It is situated on the confluence of the Vamsadhara, the Phalaphalia and the Chauldhua. It has a temple dedicated to Lord Meenaketanswara which is one of the oldest temples of Rayagada. It is a Swayambhu Siva Linga and throughout the year it looks like a “Meena” or a fish except on Shivaratri. Large number of pilgrims from Andhra Pradesh and neighbouring Districts gather here on that day.

Kanak Durga Temple

Goddess Kanaka Durga (Mahisamardini Durga) was originally worshiped by rulers of Badakhemundi. Langula Biswambar Deva, the Raja of Gunupur (town on the bank of Vamsadhara) brought the idol when he was on hunting. This temple is inside the old Jagannath temple complex. Besides these main Sakti temples, Maa Brahmani Devi of Gumuda and Dakhina Kali temple at Gunupur are also famous Sakti temples. (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.7.3 Morphology

The natural beauty of Rayagada District fills one's heart with immense joy and thrills. The emerald valleys of the river Nagavali and the Vamsadhara, vast stretches of hills, evergreen forests, perennial streams, stiff and massive rocks and the rocky river beds. The Vanshadhara river originates from the Hills of Niyamagiri in Thuamul Rampur block in the Kalahandi district of Odisha at an elevation of 1300 meters. River Vamsadhara is an east flowing river and flows in southeast direction till it approaches Andhra border. River Vamsadhara forms common boundary between Odisha and Andhra Pradesh for 29 kilometres. There are 13 prominent tributaries of Vamsadhara of which 2 river join on right bank rest 11 join Vamsadhara on its left bank. River traverses a distance of 176 in Odisha and a total of 239 kilometers before finally meeting Bay of Bengal at Kalingapatnam, Andhra Pradesh.

Tributaries of Vamsadhara

The prominent tributaries of river Vamsadhara are Bhangi, Pedagoda on right side and Badanalla, Chauladhua, Pandaka Nalla, Badajhar, Harbhangi, Sananadi, Mahendratanya on left side.

Badajore-Badajore is a left tributary of Vamsadhara River. It originates near village Kokesingi and has a total length of 20 kms.

Pandaka Nallah- Pandaka Nallah is a left tributary of Vamsadhara River. The tributary has a catchment area of about 91 kms. It originates near the village Sunapur. It mainly flows in Rayagada district and has a total length of 36 kms.

Sana Nadi- Sana nadi is left tributary of Vamsadhara River. It originates near village Ramagiri. The total length of the stream from its origin to its confluence is 58 kms.

Harabhangi River- It is a left tributary of Vamsadhara River. It originates near the village Kerakhela and flows mainly through Gajapati district of Odisha. The length of the tributary is 81 kms.

Pedagoda River- It is right tributary of Vamsadhara. It originates near village Kailahkota. The total length of the river from its origin to its confluence is 48 kms.

Mahendra Tanaya- It is the left tributary of Vamsadhara River. It originates near village Badakua and flows mainly through Gajapati district of Odisha. The total length of the river is about 46 km.

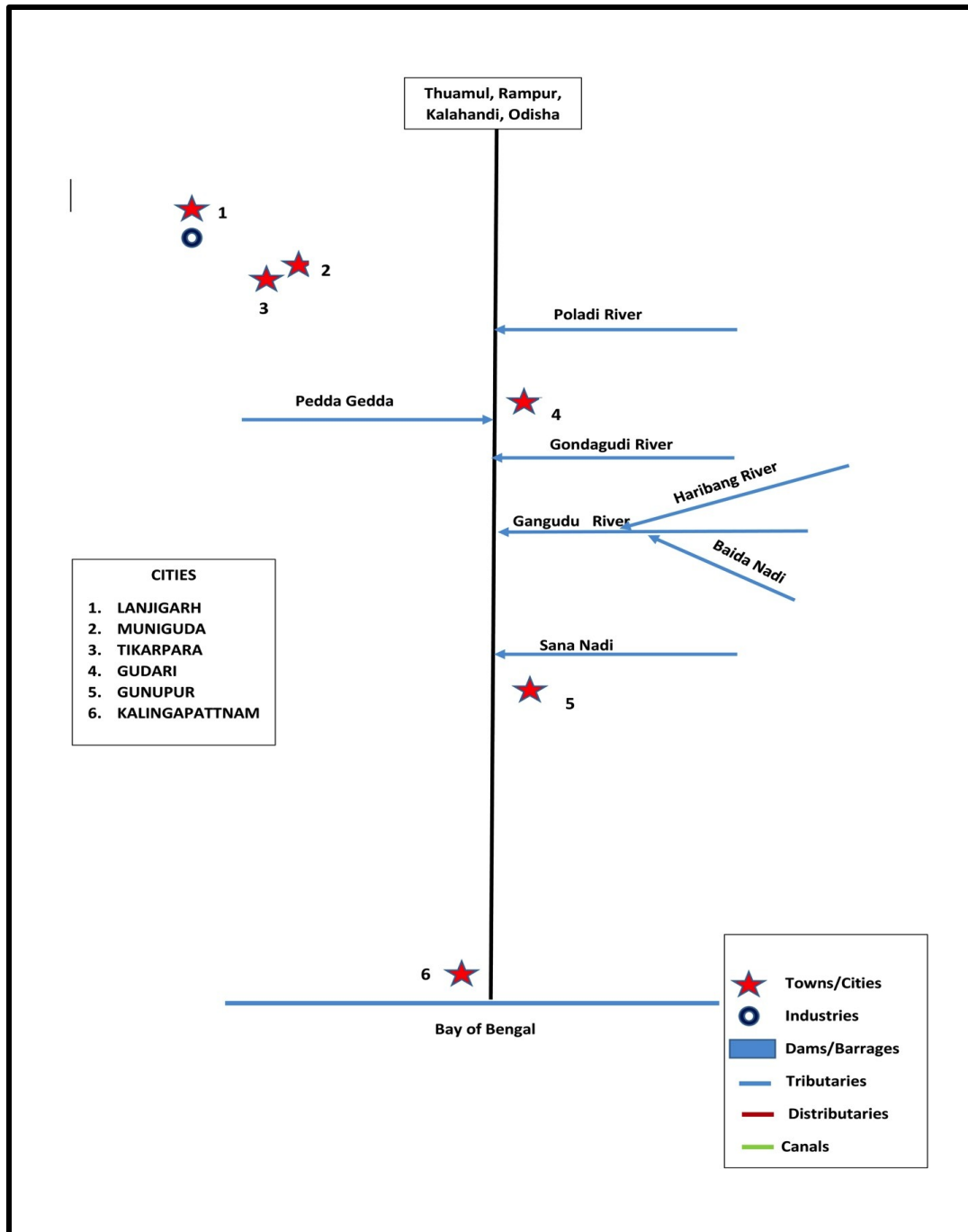


Figure 49 Vamsadhara Flow Diagram

Dams and Projects

SINo	Name of Dam	Year of Completion	River	Volume content of dam
1	Pratappur Dam	1983	Vamsadhara	172
2	Tangarakana Dam	1981	vamsadhara	52

Table 13: Dam on River Vamsadhara

2.7.4 Biodiversity

The river Vamsadhara and its tributaries in Muniguda and Gudari Ranges provide congenial aquatic wildlife habitat. Even, the Haribanga Dam in Gudari area besides confluence of the Vamsadhara river and its tributary Sana-nay, near village Chalkhamba in Gunupur Range are frequented by migratory birds providing the ideal habitat for the aquatic wildlife including the transitory home for migratory birds. Sub terrestrial habitat consists of burrows and natural crevices interspersed extensively with all the forest areas. Many burrows are even dug by the locals in the process of removal of roots and tubers. Besides, the accumulated rock pieces at the foothills and cracks in the rocky patches on the steep slopes also serve as a shelter for many reptiles like snakes, lizards etc. The vast stretch of forest cover of the Division, particularly in Muniguda.

Flora

Most of the forest blocks of the Division in the basin support almost dry miscellaneous types of forest though pure concentration of Sal also exist besides moist peninsular Sal forests in Kashipur/Tikiri/Muniguda Forest Ranges.

Fauna

The most striking and important animal encountered in the basin forest ranges is Elephant (*Elephas maximus*) and its habitat forms a major part of the proposed South Odisha Elephant Reserve under the project Elephant.

However the species structure of major communities is as follows:

Species found are Sambar, Cheetal, barking deer, Pangolin, Elephant, Wild boar, Mouse deer etc. Tiger, Leopard, Jungle cat, Civet cat, Leopard cat, Hyena, Jackal, Wild dog, Sloth bear, Mongoose, common Langur. Amongst the snakes are Python, Cobra, Viper and the Krait

The avifauna includes peafowl, red jungle fowl, common quail, green pigeon, the imperial pigeon. Doves, the hill mynas, the red-vented bulbuls, the golden back and the pied wood-peckers, thekoels, the crow pheasants, large Indian parakeets, the common king fisher, the common hombills, the common Indian night jar. The screech owl, the great horned owl, the swifts, pariah kite, the eagles, bush quail (*Perdicula asiatica*), the grey partridge, the cattle egret, storks, pond herons, the jungle crow, pipits and wagtails etc.

Fishery

Vamsadhara river supports fresh water, marine water and brakish water fishing activity. Total fish catch from Vamsadhara river basin in Odisha???? is 2086.32 MT, which is 0.80% of total fish catch

in Odisha. As there is no coastline in Odisha part therefore fresh water fish catch is only possible. (ORISSA STATE WATER PLAN, 2004)

2.7.5 Impact of Human Interventions

Rising population trend in basin will put tremendous pressure on basin resources. Projected population and industrialization will create deficit in food and water availability. Present water demand from all sources comes to 854 MCM which is expected to become 1777 MCM by 2051. Thus, there is need for harnessing the water resources by building adequate reservoirs to meet water and irrigation requirements. (ORISSA STATE WATER PLAN, 2004)

2.7.6 Conflicts in the basin

State Level

Transboundary water conflicts between Odisha and Andhar Pradesh over the construction of Vamsadhara-Rushikulya link by Odisha.

In many instances, the neighbouring states have taken steps without consulting the Central Water Commission, the Odisha government or the local community. There are several instances like, for example, the illegal construction of the canal near Katragadda by Andhra Pradesh government to divert the water of Vamsadhara River.

Construction of Spurs by Andhra Pradesh threatens Gunupur

The spur controversy began in the middle of June 2013 when, after getting information from local farmers, the district collector of Gajapati despatched an emergency letter to Orissa Chief Secretary P K Mohanty about Andhra Pradesh's decision to construct the spurs on river Vamsadhara violating a 1981 agreement between the neighbouring states. Both the farmers and Orissa government agree that construction of spurs on river Vamsadhara by Andhra Pradesh would lead to submergence of vast tracts in Kasinagar and Gunpur areas of tribal dominated Gajapati district. Following objections raised by the Orissa government, the state government has decided to stop further construction of spurs on the river and, if needed, they will be demolished. (Deccan Herald, 2003)

Diversion of water of Mahendratanya

Mahendratanya is a major tributary of Vamsadhara. Though four-fifth of the river flows in its state of origin, Odisha, and only one-fifth of it flows through Andhra Pradesh, both states share its waters according to a 1962 bilateral agreement. It was agreed then that any disputes between the states would be discussed and resolved through bilateral talks. However, the agreement was violated when the people of Gajapati district learnt about a project near Chapara in Andhra Pradesh to use the waters of the Mahendratanya through a canal to irrigate agricultural lands. (River Basin Transact,

2010)

People vs administration

Mining of Bauxite in Odisha is polluting the Vamsadhara River and its tributaries. In 2003, the Orissa government ordered the compulsory acquisition of farmlands to enable the construction of the Vedanta Aluminium Limited's alumina refinery at Lanjigarh. Since opening of refinery in 2006, it has led to water and air pollution, seriously undermining the quality of life and threatening the health of nearby communities. The refinery is built at a sensitive location, beside one of the main rivers in southern Orissa, the Vamsadhara. The river Vamsadhara is the main source of water for local people, as well as many villages downstream. People use it for drinking water, personal use, and irrigation and for their cattle. Recurrent instances of leakages of highly alkaline waste water into the Vamsadhara river was reported between 2006 and 2009. These instances had created considerable uncertainty and fear amongst local communities. (countercurrents.com, 2016)

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2.8 The Nagavalli

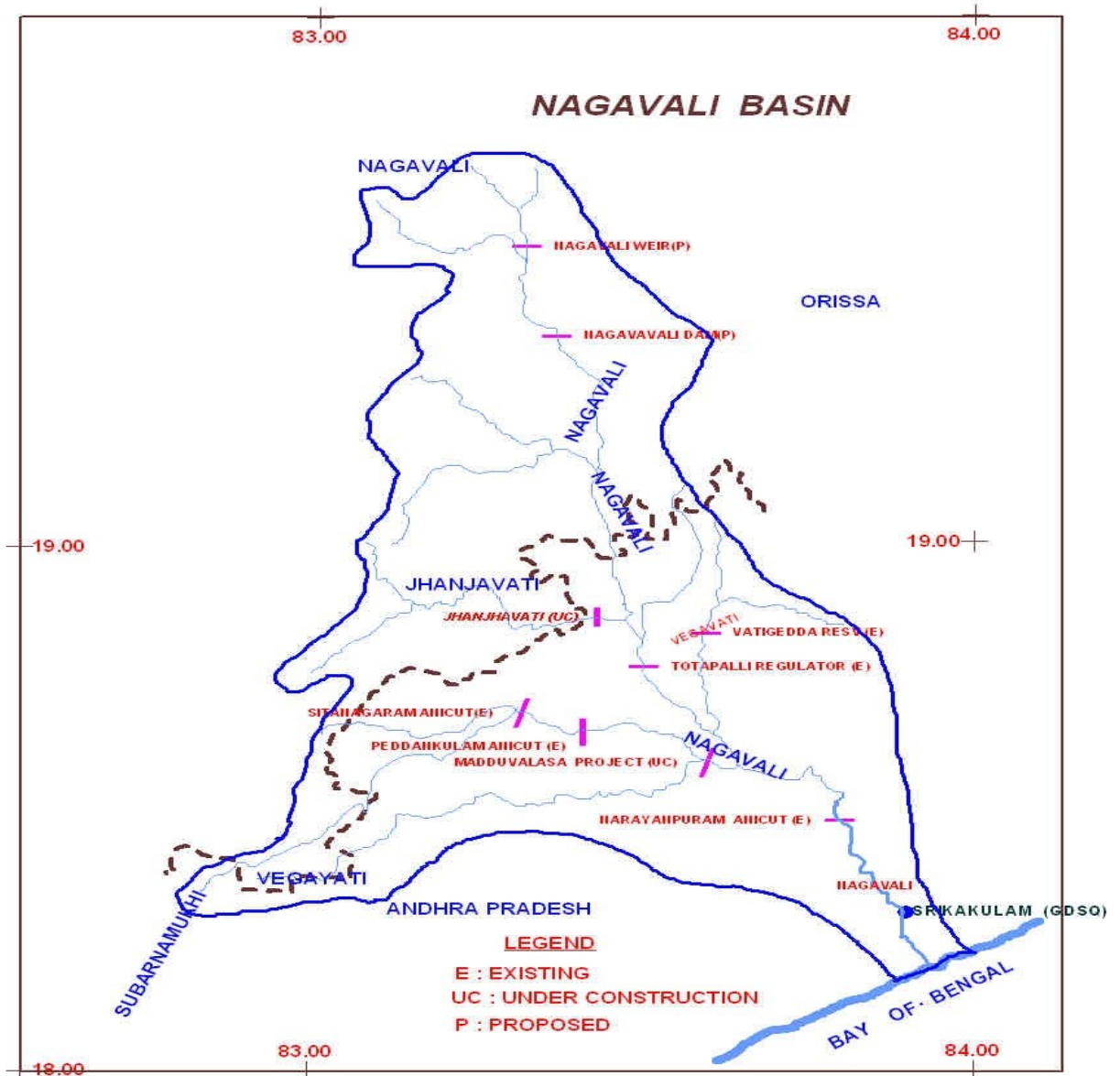


Figure 50 Nagavalli Basin

2.8.1 History/ Culture

Viswanatha Deo the middle of 14th century A.D chose Rayagada as his capital and shifted his headquarters to that new town. He built an enormous mud-fort at Rayagada, the ruins of which are still to be seen there. As a capital of the flourishing kingdom, Rayagada became during that time a centre of trade and commerce for the east coast of India. Viswanath Deo also constructed rows of temples along the river Nagavali and the ruined temple called Majhighariani near Rayagada is also attributed to him. He was a devout Vaishnava and during his rule Vaishnavism gained much popularity in the Nandapur kingdom. (ODISHA DISTRICT GAZETTEERS, 2014-16)

2.8.2 Morphology

Nagavali River forms a prime river of southern Odisha and north eastern Andhra Pradesh. The origin of Nagavali River lies in the eastern slopes of the Eastern Ghats near Lakhbahal, located at an altitude of 1,300 meters in the Kalahandi district of the Indian state Odisha. Langulya is another name for Nagavali River. Nagavali river basin hosts the Niyamgiri Hills. Nagavali moves through Hatipathar where it crisscrosses into a profound cut valley leaving colossal stones problematically roosted on rough couches. Nagavali River has a length of about 256 kilometers of which 161 kilometres lies in Odisha and the remaining in Andhra Pradesh. During its course, Nagavalli courses through the areas of Vizianagaram and Srikakulam and at last soaks into the Bay of Bengal close Mofaz Bandar. (Integrated Hydrological Data Book , 2006)

Tributaries of Nagavalli

The prominent tributaries are Pitadar Nallah, Datteibannda Nallah, Sananadi, Barha Nadi, Baldiya Nadi, Sat Nallha, Sitagura Nallha, Ghora Nalla, Sitaghera Nalla, Srikona Nadi, Bonamarha Nadi, Errigeda Nallha and Jhanjhabati river.

Pitadar Nallah- It is the upper portion of Nagavalli River before joining of Dateibanda Nallah on left and Sana Nadi on right side. The total length is about 14 kms and it mainly flows through Kalahandi district of Odisha.

Datteibanda Nallah- It is a left flowing tributary of River Nagavalli and originates near a village Lakjapadar in Rayagada district of Odisha. It flows through Kalahandi district and joins Pittadar Nallah before confluence of Sana Nadi in Rayada district. The total length is 12 kms.

Barha Nadi- It is a right tributary of Nagavalli River and it originates near the village Jatangaparha in Kalahandi district. The length of the river stream is 23 kms and it joins Nagavalli river at Kalyansinghpur in Rayagada district.

Baldiya Nadi- it is a right tributary of Nagavalli River and emerges after confluence of Bhatihat Nallah. The total length of the stream is 23 kms.

Jhanjavati River- It is a right flowing tributary of of Nagavalli originating near village Kalami. The

length of the river is 75 km of which 66 km flows in Odisha and rest 9 km lies in Andhra Pradesh. The portion of Odisha flows through Korapu district.

Sitaghera - It is a left flowing tributary of Nagavalli emerging after the confluence of Tayakarha Nallah and Sukulu Nallah originating near village Kaneli in Rayagada district and Nallah joins Nagavalli near village Garura in Rayagada district.

Srikona Nallah- it is a right tributary of Nagavalli emerging from the confluence of Dhalisghat Nadi originating near village Panabandha and Raniturga Nadi originating near village Bakomba near village Srikona in Rayagada district.

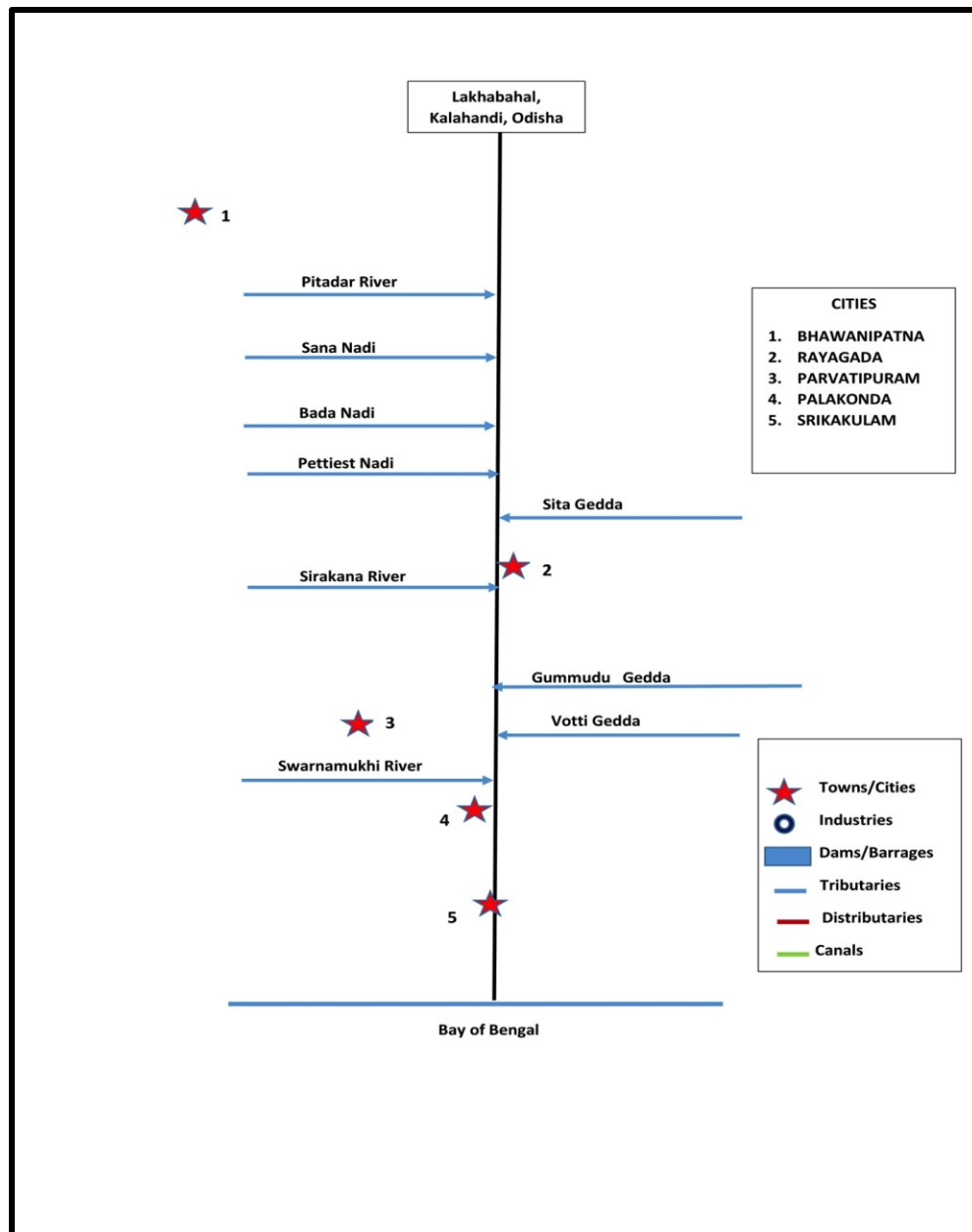


Figure 51 Flow Diagram of Nagavalli

Dam/ Project

Jhanjavati Project over Jhanjavati river (tributary of Nagavali) completed in 2006. It has 2919 TCM of volume content.

2.8.3 Biodiversity

Recent studies on the basin due to Niyamagiri issue in Odisha part have found the occurrence of more than 300 species of plant species which also includes medicinal, wild ornamental and wild crop species. Bamboo and Sal are predominantly found in the forest.

A number of wild animals like Leopard, Tiger, Elephant, Palm civet, Mouse Deer, Barking Deer, Sambar, Striped Hyena, Chital, Wild Dog, Sloth Bear, Bison, Nilgai, Giant Squirrels, Porcupine, Four horned antelope etc. There are about 67 species of birds reported in the basin.

Olive ridley turtles are found to be nesting on the beaches near the mouth of the river Nagavalli.

Tiger population in basin has reduced drastically and most of fauna are in the IUCN red list of endangered

Forest Reserves and Ranges

The course of Nagavalli River in Odisha has famous Niyamgiri range which was in International news regarding Mining and tribal conflict. Rayagada-Kashipur range and Rayagada range are also on its bank within the Odisha boundaries.

2.8.4 Tourist Places/ Religious Places

Hatipathar is a beautiful spot for picnic and one of the identified Tourist Centres (scenic spot) of Odisha located in Rayagada district.. The scenic spot with two water falls on the river Nagavali, is situated at a distance of 3 km from the town Rayagada. The two huge boulders on the hill top appear like massive elephants. The name Hatipathar (elephantstone) derives from the scene which looks like huge elephants. There is a very beautiful water fall in the spot which attracts tourist from all over the state.



Figure 52 Hati Pathar and Water fall

2.8.5 Conflicts over the basin

Inter state

A rubber dam was installed in river Jhanjabati, on a concrete plate in technical collaboration with Hydro-Construct of Austria. Its size could be raised or reduced by inflating or deflating the rubber balloon. It was planned to fix the rubber dam to a height of three meters to store water up to 125 meters (410 ft) msl in the reservoir without causing submergence in the Odisha side of the river. However, the prior agreement between Odisha and Andhra Pradesh on this project permits to raise the maximum reservoir level submerging Odisha area up to 480 ft msl. This dispute is not yet settled till date preventing use of the project's full irrigation potential for last 20 years as at present reservoir storage capacity is only 0.6 tmcft as against 4 tmcft planned storage.¹ Andhra Pradesh wants to resolve the issue by constituting **Nagavali water dispute tribunal** under the Interstate River Water Disputes Act as the dispute is not getting settled by negotiations between the two states. (Choudhury & Sathpathy, Researchgate, 2016)

Social and Environmental Movement

In the seventies, Basin under Rayagada districts of Odisha came under the influence of Naxal movement under the leadership of Nagbhusan Patnaik which was a kind of violent political protest against the landlords and Zamindars. Very recently this basin has also come under the influence of Maoist movement and there have been numerous incidents of killing by Maoists and counter killing by law enforcement agencies.(Gopabandhu Academy)

Similarly the Dongaria Kandhs are up in arms against the mining lease to Vedanta Alumina Ltd., in Niyamgiri Hills. The tribal people of this area have been opposing from the beginning under the banner "Niyamgiri Suraksha Samiti" since 2003. After several agitations, they have won the legal battle in Supreme Court in the year 2013 and it has attracted the attention of the country due to the involvement of social activists, NGOs and political parties.

2.9 The Budhabalanga

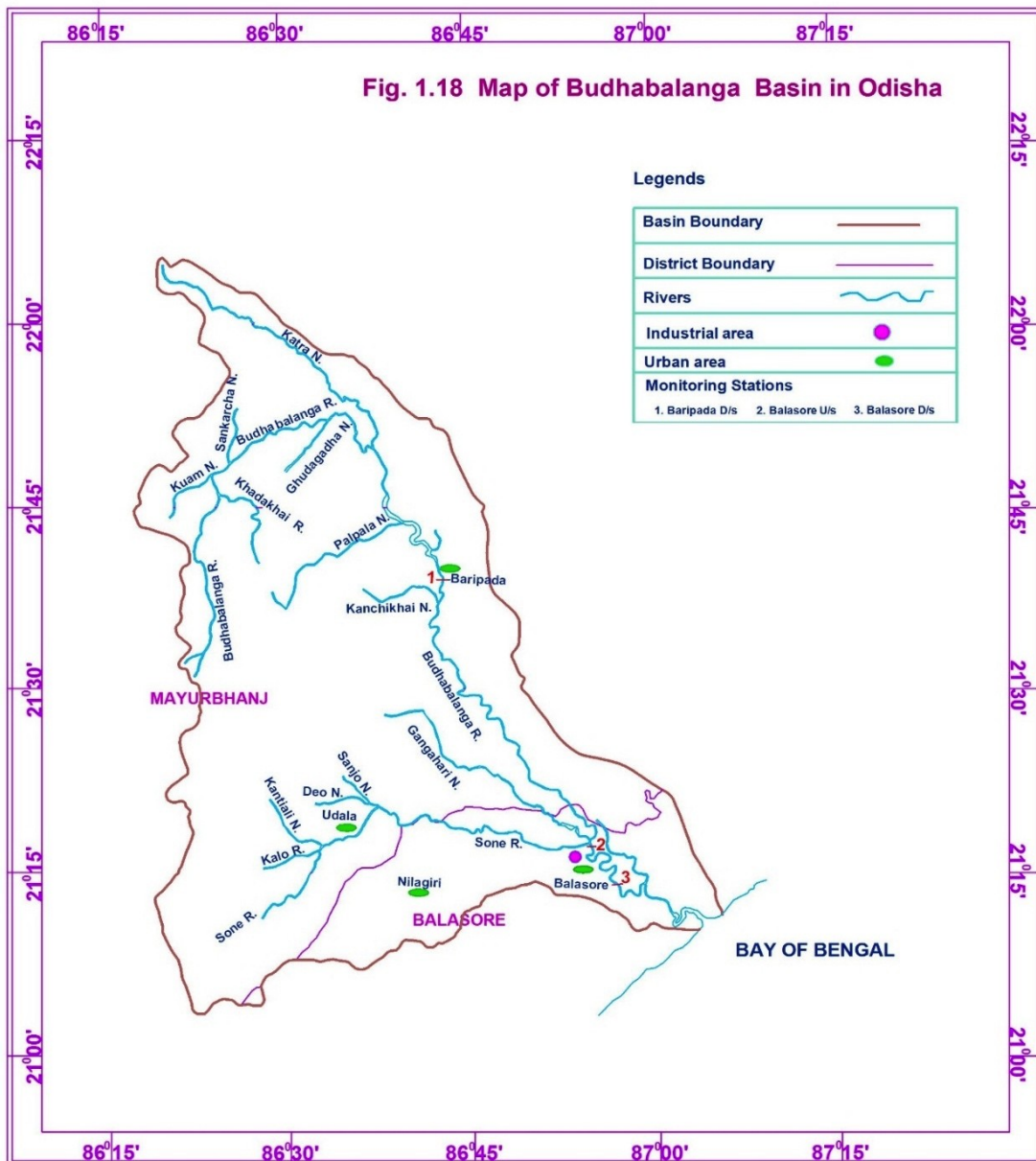


Figure 53 Budhabalanga Basin

2.9.1 Morphology

This river rises from the Similipal hills in double falls at Barehipani ($21^{\circ} 24'$ north and $86^{\circ} 36'$ east) and runs in northerly direction up to the village Karanjipal in Bangriposi police-station. It then runs to the north- east and passes almost parallel to the broad gauge Rupsa- Bangriposi Railway line upto the village Jhankapahadi. Then it changes its course to the south and meets the Katra nala which falls from the north-west. The other important tributaries are the Palpala and the Chipat both of which are hill streams rising from the Similipal hills. The river then passes through the town of Baripada, The ruins of Haripur, the old capital of Mayurbhanj are found on its right bank close to which there are palaeolithic and Neolithic sites laying in the valley of the river. The banks of this river are steep. After crossing the Mayurbhanj district border, it passes through Balasore district. The town of Balasore is located on its right bank. It ultimately falls into the Bay of Bengal.

Tributaries of Budhabalanga

The prominent tributaries of the Budhabalanga are Palapala, Sunei, Kalo, Sanjo, Deo, Gangahari and Katra.

Palapala River- Palapala river is a tributary of Budhabalanga river which originates from Kharimatia pahar. There is a weir at Baladiha with a canal systems to irrigate 3880 Ha. of land.

Sunei River- River flows from the right side of Budhabalnaga river. I originates from Gagua pahar at an elevation of 499m. There is a dam at Salchua. River Kalo, Sanjo and Gangahari and Targana are four tributaries of Sunei River

Kalo river- It originates in the Similipal Hills with a catchment area of 151 sq.km total length of river is 27 km and it has a dam constructed over it which irrigates 2400 Ha and 4800 Ha. in Rabi and Kharif respectively.

Sanjo River- It is a left tributary of Sunei River with a catchment area of 120 sq.km

Deo River- The river Deo emerges from similipal Hill range and flows in South ast direction. It is a tributary of Sanjo river. It drains a catchment area of 94 sq.km.

Katra River- Katra river originates from Bhimahanda at an elevation of 680 m. It drains a catchment area of 208 sq.km. And travels a length of 49 km.

Gangahari- It is left tributary of Sunei river originating from Gurusadar Pahar at an elevation of 897 m. in Similipal hills. It has a length of 61km.

2.9.2 Biodiversity

Aquatic Biodiversity

Most of the species recorded is widely distributed in the stream and river of Odisha. In Budhabalanga the fish like Labeo rohita, Cirrhinus mrigala, Catla catla, Labeo calbasu, Labeo bata,

Salmophasia bacaila, Garra mullya, Puntius ticto, Puntius conchoni, Crossocheilus latius, Amblypharyngodon mola, Puntius amphibius Puntius pulchellus, Puntius stigma, Barilius vagra groups more dominate. Therefore, the present investigation revealed that Cyprinidae fishes are found to be the more dominant group than others. It becomes evident that Budhabalanga River is rich in different varieties of ichthyofauna, i.e. 15 families, 31 genera and 45 species of fishes. The species diversity of fish values were ranging from 3.35 to 3.359. The species diversity of fish was at its peak in October ($H' = 3.345$) coinciding with the favourable after monsoon conditions such as sufficient water and ample food resources. The diversity was low in July with post monsoon ($H' = 3.262$) probably due to the over flow and speedy flow of water spread of the river. As per the IUCN (2010), the fish fauna of the Budhabalanga River the maximum (84.09%) species Least Concern, followed by Data Deficient (9.09%), Near to threatened (4.55%) and (2.27%) vulnerable species were recorded during the study period from June 2014 to November 2014. (D Samal, 2016)

Similipal

Similipal is the single largest compact sal bearing forest, a Tiger reserve, Sanctuary and a Biosphere Reserve. Home to largest potential breeding population of Tigers in Eastern Ghat. It is the only Tiger Reserve to have black (melanistic) tigers. Largest watershed for major rivers like Budhabalanga, Baitarani, Salandi and many perennial rivulets. It is a Hotspot of biodiversity with floral and faunal elements both from Western Ghats and Eastern Himalaya. It is home to diversified tribal communities like Ho, Santhal, Mankadia, Gond, Kol, Bhuyan in 65 villages within Similipal.

Flora

The landscape supports 1076 plant species with 94 species of orchids of which three species are endemic-*Eria meghasaniensis*, *Tyna hookeriana* and *Bulbophyllum panigrahanum*. It is also the home of endemic cultivars like Paddy and aquatic grass. Sal, Bija, Sissoo, Asan, Ashoka, Champa are the main tree species. It houses 7% of the flowering plants and 8% orchids of India.

Fauna

The rich diversity of habitat and mosaic of landscapes with wide altitudinal and climatic variation of Similipal supports a fascinating faunal composition. There are 55 species of mammals, 304 species of birds, 62 species of reptiles, 20 species of amphibians and many species of insects and micro fauna.

Herbivores

Similipal harbours the largest population of elephants in Odisha. Indian Bison are found in a few

localized pockets in herds ranging from 8 to 20. The major deer species found in Similipal are Sambar, Chital, Barking deer and Mouse deer.

Carnivores

Similipal serves as a very good prey base for major carnivores like Tiger and Leopard. Other carnivores commonly found in Similipal are Leopard Cat, Fishing Cat, Jungle Cat, Wolf, Jackal and Hyaena. Other significant mammalian species of Similipal are Ratel, Civet, Giant Squirrel, Flying squirrel, Mongoose, Pangolin, Hare, Langur, Rhesus, and Macaque etc.

Reptiles

A significant population of Mugger Crocodile is present in river systems and perennial streams of Similipal. The snakes found in Similipal include Python, King Cobra, Common Cobra, Krait, Viper and many more.

Birds

With 304 species, Similipal is a Bird's paradise. Common birds are peafowl, Jungle Fowl, Partridge, Malabar Pied Hornbill, Grey Hornbill, Hill Myna, Parakeets, Crested Serpent Eagle, and Oriole.

2.9.3 Tourist Places/ Religious Places

Barehipani is the largest waterfall in Eastern Ghat and gorge formed by river Budhabalanga.



Similipal

The single largest compact sal bearing forest, a Tiger reserve, Sanctuary and a Biosphere Reserve.

Home to largest potential breeding population of Tigers in

Eastern Ghat. Only Tiger Reserve to have black (melanistic) tigers. Largest watershed for major rivers like Budhabalanga, Baitarani, Salandi and many perennial rivulets. Hotspot of biodiversity with floral and faunal elements both from Western Ghats and Eastern Himalaya. (ODISHA DISTRICT GAZETTEERS, 2014-16)

Figure 54: Barehipani Largest Waterfall



Figure 55 Simlipal National Park

2.9.4 Conflict over the basin

Social and Environmental Movement

The ‘**Save Budhabalanga river water**’ campaign has received a boost as eminent social and organic farming activist **Dr. Vandana Shiva** has extended her full support to the movement. Attending a meeting, she termed the use of river water for industrial purpose as ‘stealing’ and users as thieves.

Ms Shiva urged not to let the river water be used for industries and expose the thieves. He also said that people can’t allow parts of Odisha like Balaswar and Mayurbhanj to become Marathwada and Latur that faced earthquakes due to over drawing of river water. These areas of Odisha are vulnerable to earthquakes and landslides as the under earth plates are weak in the region,”

The campaign has been attended by eminent social and environmental activists like Medha Patekar, Rajinder Singh and Ranjan Panda. In order to save river Budhabalanga, activist called for rally from Simlipal (the emerging point of the river) to Balramgadi (the confluence point with sea).(MOHANTY, 2016)

2.10 Kolab & Bahuda Basin

Kolab River originates from the Sinkaran hills of the Eastern Ghats in Koraput districts and finally meets the Godavari in Andhra Pradesh. The prominent tributaries of Kolab are Karandi Nalla, Guradi Nalla, Kangar Nallah, Garia, Dharmageda Nallah, JamNadi, Malengar River, Mulervagu Nallah, Potteru Vagu Nallah, Machhakund River, Sileru River.

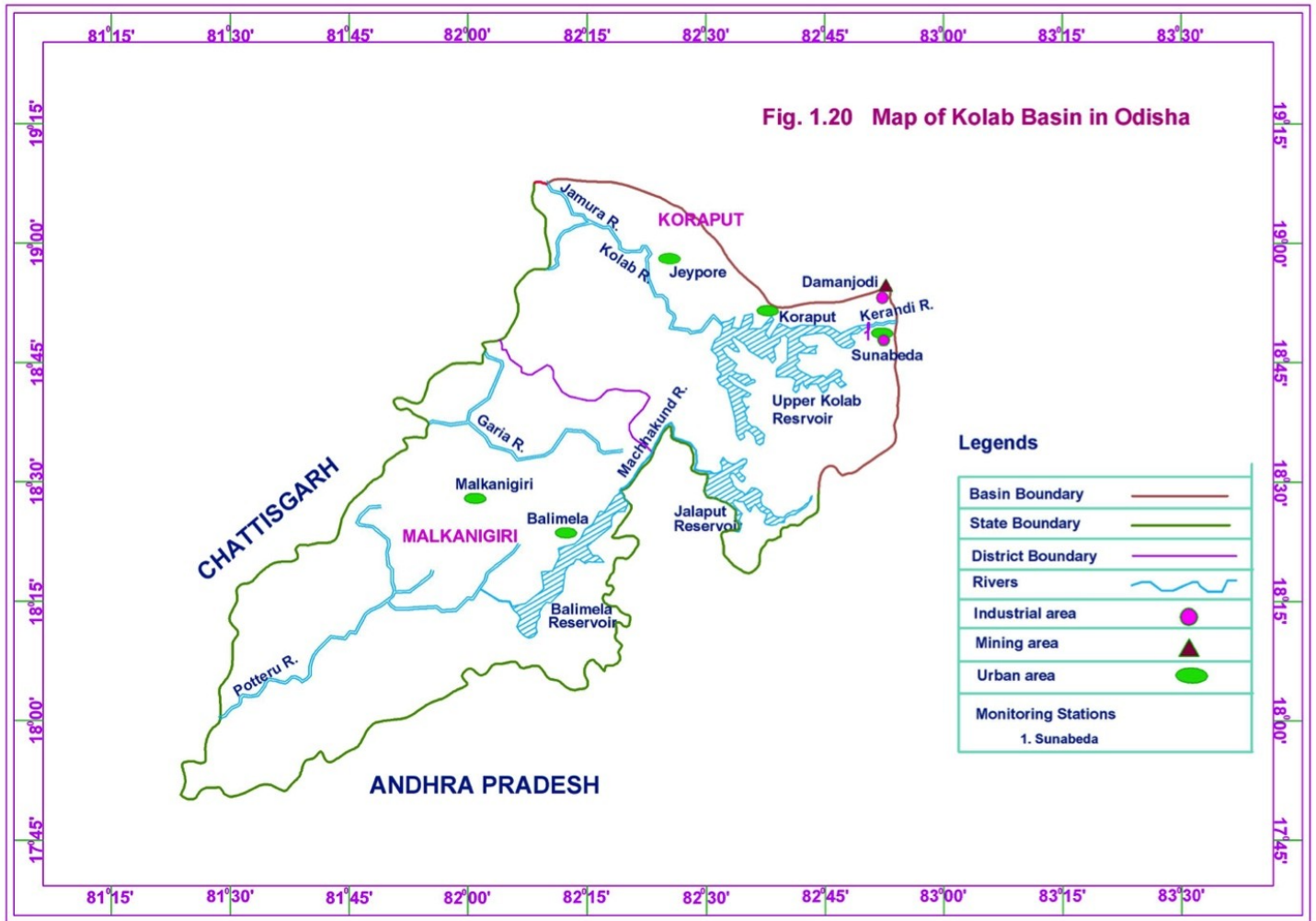


Figure 56 Kolab Basin Map

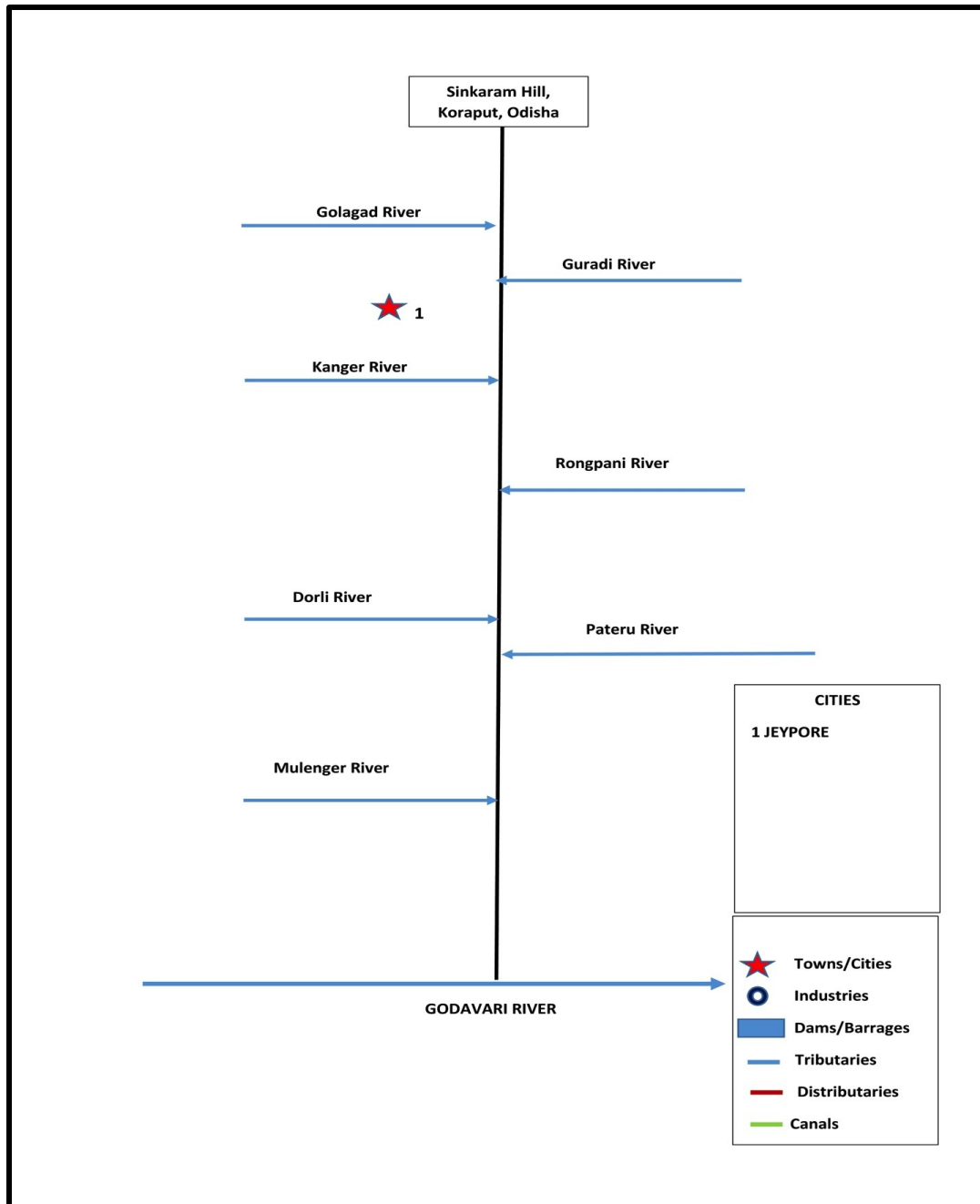


Figure 57 Flow Kolab Flow Diagram

Projects/Dams

SINo	Name of Dam	Year of completion	River	Volume content of dam in TCM
1	JALAPUT	2000	Sileru	286.18
2	BALIMELA	1988	Sileru	13856.00
3	SATIGUDA	1986	Satiguda nalla	1402.00
4	MALAKANGIRI	1959	Malkangiri nalla	46.29

Table 14 Projects/ Dams on Kolab (source: DOWR)

Bahuda River rises near village Luba from the Singharaj hills of the Eastern Ghats in Gajapati district. It flows in the north east direction up to 55 km, south east direction for 17 km in Odisha before entering Andhra Pradesh to flow for 18 km. Then it turns in Northeast direction for 6 km in Odisha before meeting the Bay of Bengal near the village Sunapurapeta, Odisha. The river traverses a total length of 96 km & the prominent tributaries are Poichandia, Bogiriadi, Batrada Nalla & Kantajura Nalla. (DOWR, ODISHA, 2016)



Figure 58 Bahuda Basin Map

3.0 Threat And Health Assessment

River	Inflow of Water in Basin inside Odisha (MCM)	Inflow of Water in Basin Outside Odisha (MCM)	Per capita Water resources in Basin (Cubic Mt)	Water Required for Total Urban population (2011) in MCM
Mahanadi	29,900	29,255	3,651	233
Brahmani	11,391	7,186	3,635	68
Baitrani	7,568		1,976	24
Rushikulya	3,949		1,342	36
Vamsadhara	5,083		4,967	7
Nagavali	2,853		5,195	7
Kolab	11,089		8,175	-
Indervati	6,265		4,922	11
Subernarekha	1,193	1,115	2,365	4
Budhabalang	3,111		2,264	19
Odisha	82,402	37,556	3,646	409

Table 15 Water Balance and Usage

Assessment of Population depending on the water resources of different River Basin for Agriculture and the Health of population residing in the basin.

River	Population Density per sq.km (2011)	% of Urban Population	% of Agriculture area	IMR
Mahanadi	282	17	42	61
Brahmani	256	16	34	56
Baitrani	324	8	47	53
Rushikulya	360	15	44	67
Vamsadhara	130	9	22	66
Nagavali	150	13	31	57
Kolab	128		41	51
Indervati	191	11	38	55
Subernarekha	338	5	62	49
Budhabalang	316	13	76	49

Table 16 Population, Agriculture and Health Distribution

Note- % of Agriculture area is found out by considering cultivable area in district and area of the basin in that particular district to maintain uniformity with non- identified basins.

Rushikulya River basin is the most densely populated river basin and Kolab being the least dense of all rivers. Considering the IMR among the different basins of Odisha, Rushikulya has highest IMR.

Rushikulya river has been in news for being extensively polluted and lack of required water to meet the population of the basin. Rushikulya River basin also has been under conflicts with regards to delay in various projects ment for irrigation and water storage.

3.1 Pollution

Surface Water Sources of Pollution

Industrial

Depends on industrial process. Mostly they are toxic and non-degradable. The industrial waste water constituents about 8 to 15% of total waste water which may go up to 33% due to rapid industrialisation.

The BOD (Biochemical Oxygen Demand) is a very important parameter for assessment of water quality related to industrial and domestic pollution.

Domestic

Mostly the pollutants are degradable. The domestic waste water comes in the range of about 80% of total waste water.

The total coliform and fecal coliform count in the sample are the indicators. Waste water from domestic sources contains many organic and fecal matters along with disease carrying coliforms.

Agricultural (Non point source)

The chemical fertilisers and pesticides are two important pollutants coming from the agricultural field to the river systems through drainage channels. Since in Odisha the use of fertilisers and pesticides are at low level compared to other states, it is not very alarming at the present stage. But due to conversion of large rain fed area to irrigated area the problem is likely to be encountered in future for agricultural pollution. Some research work is being conducted to replace chemical fertiliser with Bio fertilisers and pesticides with bio pesticides. (OSPCB, Water Quality Of Major Rivers of Odisha, 2007)

According to a CPCB report (River Stretches for Restoration of Water Quality, 2015)

The rivers in Odisha are monitored at 64 locations on 21 rivers. Among these 24 locations are not complying with Water Quality Criteria. These 24 locations are situated on 12 rivers viz. Brahmani, Budhalbhanga, Daya, Kathjodi, Koel, Kuakhai, Mahanadi, Nagavali, Rushikulya, Serua and Vanasdhara. The polluted rivers in Odisha are in 4 priority classes (Class- II, III, IV and V).

River	Stretch	Towns	Distance (Km)
Baitarani	Jajpur-Kuakhia Road to Dhamara	Jajpur	70
Brahmani	Rourkela to Biritol	Rourkela, Banki, Talcher Town, Biritol	250
Budhabalanga	Mahulia to Baripada	Baripada	5
Daya	Bhuabaneswar to Baragarh	Bhuabaneswar	15
Kathajodi	Cuttack to Urali	Cuttack, Urali	5
Koel	Dalki to Parlipos	Dalki	2
Kuakhai	Urali to Bhubaneswar	Bhuabaneswar	25
Mahanadi	Sambalpur to Paradeep	Sambalpur, Cuttack, Paradeep	250
Nagavalli	Jaykapur to Rayagada	Jaykapur, Rayagada	10
Rushikulya	Pratappur to Ganjam	Aska, Pittal, Purosottampur, Ganjam	15
Serua	Khandaetta to Sankhatrasa	Khandaetta	5
Vamsadhara	Gunupur to Bathili	Gunupur	5

Table 17 Pollution Stretches in Rivers of Odisha (CPCB)

3.2 Water Availability

Water Availability	Total Water Resource in 2001 in MCM	Per Capita Water resource in 2001 in (cu.mts)	Future Water Resource in 2051 in MCM	Per capita water resource in 2051 (cu.mts)
Mahanadi	59,155	3,651	50,939	2,434
Brahmani	18,577	3,635	14,509	1,928
Baitarani	7,568	1,976	7,568	1,348
Inderavati	6,265	4,922	6,265	3,433
Rushikulya	3,949	1,342	3,949	1,021
Vamsadhara	5,083	4,967	5,083	3,379
Nagavali	2,853	5,195	2,853	3,758
Budhabalanga	3,111	2,264	3,111	1,623
Subernarekha	2,308	2,365	2,308	1,766
Bahuda	438	1,616	438	1,412
Kolab	11,089	8,175	11,089	5,579
Total	1,20,396	3,646	1,08,112	2,516

Table 18 Water Availability Scenario

Source: DoWR, Odisha

Statistics of Water Scenario in Mahanadi

Water Balance Scenario in Mahanadi Reservoirs								
	Hirakud			Mundali				
	Inflow	Usage		Outflow	Inflow	Usage		Outflow
2001	33043	Agriculture	1753	30169	58087	Agriculture	6046	50681
		Public Water Usage	36			Public Water Usage	92	
		Industrial	30			Industrial	22	
2051	25282	Agriculture	5745	17225	49212	Agriculture	18080	27116
		Public Water Usage	292			Public Water Usage	443	
		Industrial	442			Industrial	101	

Table 19 Water Statistics in Mahanadi Reservoirs

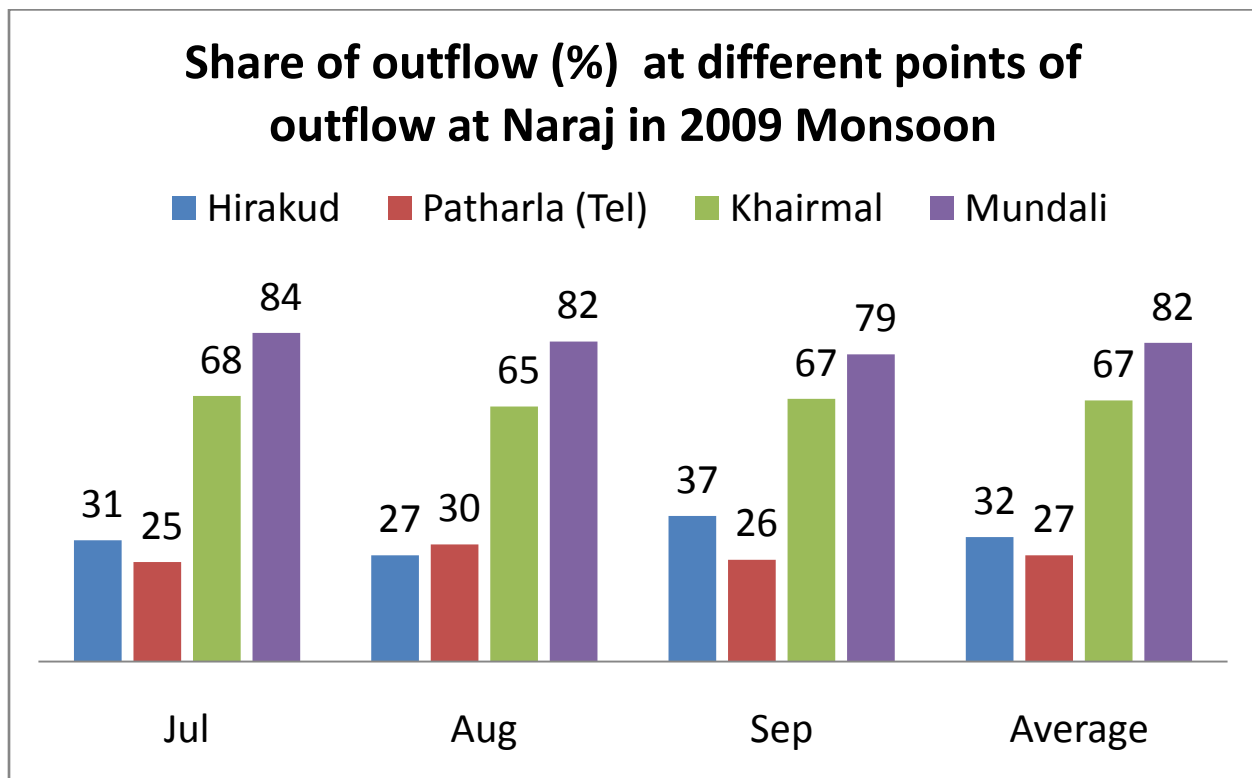


Figure 59 Mahanadi Outflow at different Points

3.3 Climate Change

Climate change refers to the change in the statistical distribution of weather patterns when that change lasts for an extended period of time. Climate change may refer to a change in average weather conditions, or in the time variation of weather around longer-term average conditions. Climate change

generally is the change in weather for a longer period of time. The impact of climate change on river basins is increasing day by day in the recent times due to the rise in temperature and changes in the precipitation level. These changes affect the river basins also adversely, sometimes reducing the water level of rivers or increasing the water level resulting in floods etc. Moreover, climate change effects like the variation in flash flood peaks taking place in the river basins are an important aspect of climate change. Simultaneously it also affects the nearby areas of the rivers and also the water quality and further changes in the streamflow of the rivers. (Between 1990 to 2008), Odisha has experienced 12 years of flood, 5 years of drought, one Super Cyclone and many depressions and cyclones. Years with both flood and drought are becoming more pronounced. Not only in scale, disasters are spreading to newer territories too. When flood was common in coastal plain, drought was in upper terrain. But with the changing climate, both drought and flood are becoming common in almost all parts of the state. 10 districts of Odisha had experienced flood up to 1991 and after 1994 more and more districts figured in the list. The height is that, in the year 2006, 27 districts out of 30 in Odisha experienced the flood.

Climate change impact on Mahanadi

Impacts of climate change on hydrology are assessed by downscaling large scale general circulation model (GCM) outputs of climate variables to local scale hydrologic variables. Here, this modelling approach is characterized by uncertainties resulting from the use of different models, different scenarios, etc. Modelling uncertainty in climate change impact assessment includes assigning weights to GCMs and scenarios, based on their performances, and providing weighted mean projection for the future. Here using this model the impact on Mahanadi river basin is shown.

The study shows that there is a decreasing trend in the monsoon flows of Mahanadi river at Hirakud dam. An earlier study on Mahanadi River also observed a decrease in monsoon stream flow for the historic period. One possible reason for such a decreasing trend is the significant increase in temperature due to climate warming. An analysis of instrumental climate data has revealed that the mean surface temperature over India has increased at a rate of about 0.4°C per century¹⁰, which is statistically significant. The increasing trend of temperature in Mahanadi river basin due to climate change is even more severe. The surface air temperature over this basin is increasing at a rate of 1.1°C per century, which is more than double the rate of increase for entire India. Increase of temperature at such a high rate may increase the evaporation and thus reduce the effective rainfall which is reflected in the stream flow predictions. An increase in trend of extreme drought is also observed by Ghosh and Mujumdar, due to high surface warming which is consistent with the predictions of Mahanadi stream flow obtained by Mujumdar and Ghosh. Although the future predictions present a favorable condition in Hirakud dam for flood control operation, simultaneous occurrence of

reduction in Mahanadi stream flow and increase in extreme drought is likely to pose a major challenge for water resources engineers in meeting water demands in future.

Kathajodi and Kuakhai tributaries of Mahanadi are constantly expanding and changing their course, nearly 10,000 people living in a cluster of villages under Cuttack Sadar Assembly constituency are living in perpetual fear of being washed away by the surging waters of the three rivers. Erosion of the Mahanadi embankment has assumed alarming proportions and is giving nightmares to people in scores of villages in Jagatsinghpur district. With river Bhargavi changing course all too often in the recent past, vast areas in Puri district are facing a constant threat of submergence. Mostly erosion is occurring due to change in climate which results in abnormal precipitation over the basin.

Hirakud: Changing Rainfall & Runoff

Rainfall	Original	Revised(1958-2009)
Mean Annual	1381.25mm	1120mm
Max. Annual	1808.73mm	1928mm(1961)
Min. Annual	940.31mm	691mm(1979)
Runoff	Pre construction period	Post construction period
Average Annual	4.85M.Hect.M/ 39.32M.Ac.Ft	3.313M.He.M/ 26.589MAcft. (58-09)
Max. Annual	8.62M.Hect.M/ 69.822MAcFt (1919)	9.09M.Hect.M/ 73.629M.Ac.ft.(1961)
Min. Annual	2.54M.Hect.M/ 20.574MAcFt(1902)	1.133M.Hect.M/ 9.183M.Ac.ft.(2000)

Table 20: Rainfall Variation

Climate Change Impact may force Olive Ridley Turtle to leave Rushikulya river mouth for mass nesting

As per experts and volunteers working in areas of safety and conservation of the sea turtles it is that higher degree of erosion at many points of the coastline poses serious threat to the marine species and raises doubts about the continuity of the tradition of mass nesting by the Olive Ridley marine turtles called 'Arribada'. The doubts seem to be logical because the nesting grounds are being squeezed alarmingly and the coastal vegetation that plays a vital role in providing food to lakhs of mother turtles and their hatchlings is vanishing rapidly because of coastal erosion.

While the rise in sea level resulted by the phenomenon of global warming and climate change there of is believed to be the primary reason of the erosion at Rushikulya. Erosion of beaches has resulted in less space for the turtles to do their activities and destruction of the mangrove and coastal vegetation that acts as the source of food for the visiting marine turtles.

The vulnerability of the particular coast to climate change impact has increased to an alarming

degree and the unique beach is losing its area into the sea because of erosion, Odisha government's plan for a minor port on Devi River Mouth is just adding further risks to the beach that has been a popular rookery for the Olive Ridley Sea turtles since many years. If the coastal erosion continues across the coastline of Odisha at the current pace, the marine turtles would find it difficult to make pace for their nesting activity. (Hotnews, 2016)

Baitarani River changes in Basin

The impact of climate change on the water balance components of a data-starved Upper Baitarani River basin of Eastern India using Arc SWAT model of 12 Climatic scenarios indicated a reduction in the surface runoff ranging from 2.5 to 11% by changing the temperature from 1 to 5°C, whereas the increase in rain fall by 2.5 to 15% suggested an increase in surface runoff by 6.67 to 43.42 % from the baseline condition.

The Impacts of Climate Change on Runoff in Baitarani River Basin

Human settlements, deforestation, mining and faulty agricultural practices coupled with high intensity monsoon rain fall have been continuously degrading the catchment of the study area. These factors along with the regular flood pose a threat to life and property of the inhabitants in the lower catchment of the river. The impacts of climate change on surface runoff in the eastern part of India using Soil and Water Assessment Tool (SWAT). The analysis indicates the increase of temperature by 1, 2 and 3 °C. On the contrary, the increase in precipitation by 5 and 10% (scenarios 6 and 7) indicates a significant increase in surface runoff in the study area. From this comparison it is clear that the area is more sensitive to change in precipitation than causes an insignificant decrease in mean annual surface runoff in the studied area. On the contrary, the increase in precipitation by 5 and 10% (scenarios 6 and 7) indicates a significant increase in surface runoff in the study area. From this comparison it is clear that the area is more sensitive to change in precipitation than temperature change.

Impact of climate change on Brahmani – Baitarani Delta

The delta of the Brahmani-Baitarani river basin, located in the eastern part of India, frequently experiences severe floods. The climate change analysis performed for the Brahmani- Baitarani river basin indicates the main changes—likely increases in monsoon rain fall especially in the Mountainous region and a likely increase of the number of heavy rain days. The Habeleswari village of Anandapur block is in danger due to the flood of the river Baitarani. Most of its agricultural lands are facing threat of getting submerged.

Modeling Impact of Climate change on Hydrology of the Brahmani River Basin

Distributive parametric modelling approach to reflect spatial heterogeneities—using Precipitation Runoff Modeling System indicates

Stream flow sensitivity – 4 C rise in temperature resulted in 11.4% decrease in annual stream flow, with maximum decrease (12%) during monsoon and minimum (2.7%) during pre-monsoon season. 10% increase in rainfall resulted in 22.9% decrease in annual stream flow, with maximum decrease (25%) in monsoon followed by post monsoon and pre monsoon season.

Combined effect of rainfall and Temperature changes- Temperature rise of 4 C and a 10% decrease in rainfall resulted in 32.90% decrease of annual stream flow, with maximum reduction (35%) in monsoon and minimum in pre-monsoon. 4C rise of temperature and 30% increase in rainfall resulted in 62.2% increase in annual stream flow, with maximum increase (72.5%) in monsoon and minimum in winter. Maximum absolute changes in stream flow during the month of July- stream flow almost doubled with 30% increase in rain fall and minimum absolute change (32.90%) in the month of January. With 30% increase in rainfall and 4C increase in temperature, the magnitude of changes in mean monthly stream flow ranged from 83.40% (July) to 26.90% (January). A Maximum decrease of 37% (July) was simulated with 4 C increase in temperature together with 10% decrease in rainfall.

Impact on Subarnarekha River due to Climate Change

The declining water levels in major rivers of Jharkhand State much ahead of the dry season is lowering the underground water levels and also affecting cultivation in State. Environmentalists fear negative changes in overall climate will make the region more prone to calamities. The adverse impacts of global climate changes (CC) have forced the Subarnarekha River to dry up abnormally much ahead of the dry season now like every year in recent times. Reduced run-off is increasing the pressure on freshwater resources in much of the state, especially with more demand for water as population increases. Freshwater being a vital resource, the downward trends are a great concern.

The study on hydrological condition for baseline period and future period of 2015-2030 revealed decrease of rainfall and corresponding decrease of stream flow in the June-September (JJAS) period for almost half of the future years. Increase of potential evapotranspiration for the months of February to June, increase of annual 24-h maximum rainfall and associated increase in the annual flood maxima with time of occurrence of peak rainfall and peak flow shifting from monsoon period to the month of May were also noted. The majority of river basins have shown increasing trends both in annual rainfall and relative humidity. The magnitude of increase in rainfall for considered river basins varied from 2 –19% of mean per 100 years. (Google scholar, 2016)

Impact of climate change on Budhabalanga and Subarnarekha

Impact of climate change on the Budhabalanga River and its nearby areas results in heavy rainfall in the region over a period of time. Heavy rain in the upper catchment areas of Budhabalanga River

triggered the possibility of floods in rivers. Frequent low pressure formed off Odisha coast triggers heavy rains. Officials of the Irrigation department said over 100 villages close to Subarnarekha, Budhabalanga and Jalaka rivers in Bhogarai, Jaleswar, Basta, Baliapal and Sadar blocks are now in danger. These river-side villages are facing havoc from erosion and are slowly but steadily losing their land. The villages face the threat of getting washed away completely if no protective measure is taken urgently. (The New Indian Express, 2013) In fact, the Subarnarekha has already swallowed about 75 per cent of Badakhanpur village and its neighboring Sankarpur under Baliapal block. Both the rivers have posed danger to 13 panchayats in Bhogarai block, followed by eight in Baliapal, five in Jaleswar, four in Remuna and five in Sadar blocks. And the latest victim is Old Balasore area. Subarnarekha has been a serious threat for Bhogarai, Baliapal and Jaleswar for the last 15 years. Heavy sand deposits at the Subarnarekha confluence have forced the river to change its course. (Merinews, 2009)

3.3 Quality of River

The water quality management in India is performed under the provision of Water (Prevention and Control of Pollution) Act, 1974. The basic objective of this Act is to maintain and restore the wholesomeness of national aquatic resources by prevention and control of pollution. The Act does not define the level of wholesomeness to be maintained or restored in different water bodies of the country. The Central Pollution Control Board (CPCB) has tried to define the wholesomeness in terms of protection of human uses, and thus, taken human uses of water as base for identification of water quality objectives for different water bodies in the country. Categorization of water classes as per CPCB is as follows:

Designated-Best-Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	<ol style="list-style-type: none"> 1. Total Coliforms OrganismMPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 2mg/l or less

Outdoor bathing (Organised)	B	<ol style="list-style-type: none"> 1. Total Coliforms Organism MPN/100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20^oC 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	<ol style="list-style-type: none"> 1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20^oC 3mg/l or less
Propagation of Wild life and Fisheries	D	<ol style="list-style-type: none"> 1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	<ol style="list-style-type: none"> 1. pH between 6.0 to 8.5 2. Electrical Conductivity at 25^oC micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

Table 21: Water Qualities

3.3.1 Mahanadi Quality

About 86% of the catchment (72,691 km² out of a total of 84,372 km²) and major tributaries of Mahanadi (Seonath, Jonk, Hosdeo and Mond) above the Hirakud dam are in Madhya Pradesh/Chhatisgarh. Since several large towns and industries (Rajnandagaon, Bhillai, Durg, Shimoga, Raipur, Bilasplur, Korba etc.) are located on the banks of these tributaries, they carry considerable pollution load to the reservoir. In Odisha the river Ib with its share of pollutants drains into the reservoir. The River water is categorized to Class-C category. However, recent monitoring stations assessments make it fall in Class D.

SI No	Monitoring Stations	Quality
1	Hirakud	B/D/E
2	Sambalpur U/S	D/E
3	Sambalpur D/S	D/E
4	Sonepur U/S	C/D/E
5	Sonepur D/S	D/E
6	Tikarapara	C/D/E
7	Narsinghpur	C/D/E
8	Cuttack U/S	C/E
9	Cuttack D/S	D/E
Overall Quality		D

Table 22 Quality of Mahanadi River Water

Trend of Water Quality of Mahanadi

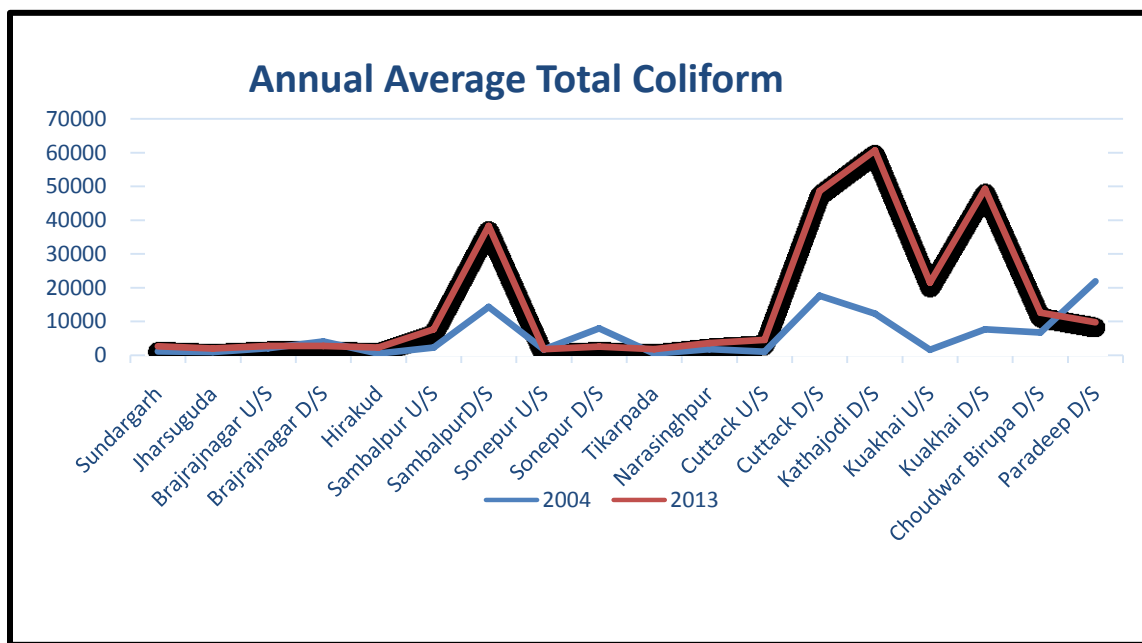


Figure 60: Trend of Total Coliform

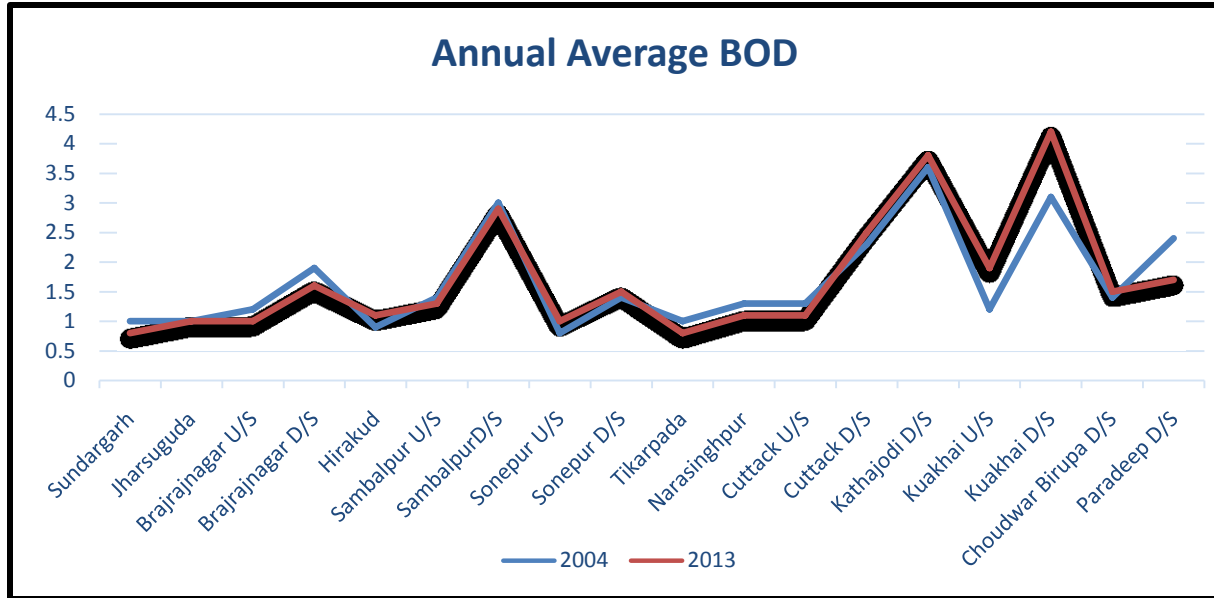


Figure 61: Trend of BOD

Mahanadi water quality exceeded in tolerance limit for DO and BOD during recent years. Causes include Industrial chemicals and hazardous effluents coming from industry, raw domestic sewage and biomedical waste coming from the growing healthcare facilities (Jena, 2008).

3.3.2 Brahmani Quality

Brahmani River which provides water to the heavily industrial corridors of India is the most polluted river in Odisha. Industrial complexes of Rourkela, Talcher-Dhenkanal and Sukinda are situated on the banks of Brahmani. Thus major source of pollution to river Brahmani are from Industries, agricultural runoff, domestic waste from rapidly growing urban population and mining activity. The State Pollution Control Board officials maintain that the Brahmani has been designated as a class C river. However, the water quality data shows that except at a few places, the river is largely of D category.

Monitoring Station	Quality Class
Panposh U/S	C/D/E
Panposh D/S	E
Rourkela D/S	D
Bonaigarh	C/D/E
Rengali	C/D/E
Samal	C/D/E
Talcher (U/S)	C/D/E

Talcher (D/S)	E
Bhuban	C/D/E
Dharmasala	C/D/E
Pattamundai	C/D/E
Over all	D

Table 23 Quality of Brahmani River Water

(ORISSA STATE WATER PLAN, 2004)

As per CPCB study a stretch of 250km of Brahmani River is identified as polluted stretch extending from Rourkela to Britol town which also includes Banki and Talcher town. (CPCB, 2015)

3.3.3 Baitarani Quality

Baitarani river bank is devoid of large towns or highly water polluting industries. However, catchment areas of Baitarani River is densely populated with high mining activities. Joda (population about 39,000) is the centre of major iron ore mining activities. Anandpur and Jajpur are sub-division and district headquarters respectively. The quality of water at these three places very nearly conform to class-B. With the inclusion of TC, the water quality can be said to conform to class-C. As the river enters its tidal zone at Chandbali and Dhamra, there is significant deterioration in the water quality, both on account of tidal effect (higher Electrical Conductivity-EC and Chlorides) and pollution generating activities like fishing and preliminary fish processing (higher BOD and TC) and the water becomes unsuitable for almost all beneficial uses of inland surface water. (State Water Plan, 2004)

Biological monitoring of the entire stretch of river shows the river is in a state of slight to moderate pollution. Considering pH, DO, BOD, EC and N values, the present wholesomeness of the water may be considered as “Excellent”. Taking into consideration the TSS values, the water quality at Jajpur is downgraded to “Desirable” level. TSS observed at Chandballi is quite high. However, FC value taken into consideration except few occasions the river water quality is not acceptable. (OSPCB, Water Quality Of Major Rivers of Odisha, 2007)

Threats to River

Low volume of water, low flow condition, densely populated catchment areas and flowing of streams in the close proximity of various iron and manganese mines have resulted the water to be acidic especially during the post-monsoon period and alkaline in most of the places during the monsoon and pre-monsoon period. Water from Baitarani is subjected to exploitation by the densely industrialized area in the catchment area. Water from Baitarani River turns red in colour due to release of industrial waste and open cast mining which contaminates river water.

3.3.4 Subarnarekha Quality

Subarnarekha is an interstate river (total length 395 km) with catchment areas in Jharkhand, West Bengal and Odisha. Only a small stretch (86 km, about 22%) of its total length flows through Odisha, before falling into the Bay of Bengal at Bhograi Block of Balasore district. In the Odisha portion of the basin, industrial and mining activities are almost nonexistent. There is only one Class-II town in the basin (Jaleswar, population about 22,000). Except Jaleswar, which is on its bank, the wastewater generated in other smaller towns and villages would not have any significant impact on the water quality of the river.

In spite of industrial, mining and urban activities in Jharkhand and West Bengal, the river seems to have considerable regenerative capacity, with regard to degradable pollutants like BOD, Chemical Oxygen Demand (COD) etc. The concentrations of the metals expected from the mining activities at Jharkhand and West Bengal (e.g. iron, chromium, copper etc) are also found to be quite low to be of any environmental significance and the water quality determination at Rajghat (About 05 km downstream to Jaleswar and 60 km upstream to the confluence with sea), conforms to Class-C inland surface water.

3.3.5 Rushikulya Quality

Heavy siltation of the Rushikulya river has led to increased conductivity of the water and the river bed has risen up to the land level making it unfit for consumption and even cultivation. Around 60 per cent of arable land in Ganjam district receives water from this river.

According to a report by Central Pollution Control Board (CPCB), the ability to conduct electricity (conductivity) of Rushikulya is 20 times more than the ideal 2,250 micro mhos/cm, which is highest in the State. The high electrical conductivity may adversely affect the yield per hectare in the district. The river is considered lifeline of the farmers in Ganjam. Conductivity not only affects the harvest but also the quality of the soil. Worse still, water availability for the crop would reduce greatly. (Indian Express, 2012)

Domestic sewage and more importantly, effluent discharged by the chloralkali industries situated at the estuary, leading to Hg contamination

The impact of the effluent discharged from a chloralkali factory, on the water quality of the Rushikulya river estuary, was studied. The effluent was found to be significantly deteriorating the physio-chemical status and aesthetic characteristics of the estuarine water. Out of the several characteristics studied, the levels of BOD, COD and mercury, and to some extent the nutrients, were found to be alarming warranting immediate attention. The effluent was not fit for being discharged as such. The estuarine water was completely unfit for supporting aquatic life. (BP Shaw, 1991)

Downstream and upstream of Ganjam District, the river belongs to Class D, indicating that it is

highly polluted.(River Basin Rushikulya, 2016)

3.3.6 Inderavati Quality

Principal sources of water pollution in Indervati River is from waste generated from urban settlement, agriculture, industries, and mining activities. Since industrialization, agriculture and urbanization has not taken place to a great extent water quality in the Odisha part has not been effected to a noticeable degree. Water quality of the river is found to be between class B and class C depending upon the nearness to urban settlement.

3.3.7 Vamsadhara Quality

Water quality, Gauge discharge and sediment observations are done at Kashinagar station. Gauge discharge observation is also made at Gunupur.

Water samples from 113 wells in the lower Vamsadhara (Spreading over an area of 817 sq.km in northern Andhra Pradesh) were analysed for Ca, Mg, Na, K, Cl, SO₄, HCO₃, F, NO₃ and PO₄. The results indicate the presence of phosphate in the groundwater ranged from 0.72 to 7.07 mg/l, which is beyond the limits recommended for domestic and water treatment purposes.

Presence of nitrate in groundwater is also detected.The major sources of pollution detected are mining and allied activities, agricultural runoffs and domestic sewage.

(INTEGRATED HYDROLOGICAL DATA BOOK, 2012)

3.3.8 Nagavalli Quality

Water quality is monitored at J.K pur D/s and Rayagada D/s. In Odisha portion of the basin there is only one major town, Rayagada from where the waste water generation at Rayagada may have some direct impact on the river water quality. Except around Rayagada, the river from its origin in the hill ranges of the Eastern Ghats near village Bijapur in Kalahandi district, to its exit from Odisha at Karada village of Rayagada, it flows mostly through sparsely populated areas with almost no industrial and mining activities.

At Rayagada, two major industries are presently operating, namely J. K. Paper Mills, a large pulp and paper mill and IMFA Ferro Alloys Plant at Therubali, of which the discharge of effluent from the paper mill will have any significant impact on the river water quality if not taken care of. The monitoring results have thus confirmed that water quality of river (Odisha portion), except in about the 15 km stretch, from the D/S of the wastewater discharge point of the J. K .Paper Mill to a little further D/S of Raygada, should normally be fit for all beneficial uses. According to 2001 Water in Rayagada had pH of 7.80. Thus, State pollution control board of Odisha have marked river in Class

C category. (OSPCB, Water Quality of Major Rivers of Odisha, 2007)

3.3.9 Budhabalanga Quality

River Budhabalanga is deteriorated due to the immersion of idols. The concentration of cadmium has increased significantly in the river water after the idol immersion and becomes normal after one to two month of the idol immersion. However, it was below the permissible limits. Magnesium, Chromium, Cadmium, Lead and Arsenic concentration has also increased significantly in the river water ten days after the idol immersion. Magnesium is non-poisons, though it increases the hardness of water.

Over the years the concentration of heavy metals, especially manganese, lead and mercury has also increased considerably in the river water compared to the specifications of highest desirable limits as set by BIS and ICMR. The concentration of cadmium, mercury and lead, the potentially obnoxious heavy metals had increased many folds in the water due to idol immersion compared to highest desirable limits of BIS and ICMR standard. The heavy metal especially manganese, lead and mercury excess in water cause skin diseases.

The chromium concentration in the river water did not change much and was below the limits of standards. After the immersion of the idols, its concentration increased further and after about 45 days of immersion its concentration slightly decreases still it higher than before idol immersion. The heavy metals are known to be persistent and gradually accumulate and magnify through the process known as bioaccumulation and bio magnifications, while they move up in the food chain. Thus load Cadmium and Mercury may magnify in their concentrations at different tropic levels in the river ecosystem and finally reach the humans through food chain. Organic compounds of Mercury, for example Methyl Mercury when it enters the human body, concentrates in the brain and destroy the brain cells, damaging the central nervous system and also cause Ulceration of the digestive facts. Therefore, it is suggested that the authorities looking into the environmental protection of the river need to take necessary steps.(Kausik Kumar Das, 2012).

Threats to River

The Budhabalanga river flows from an elevation of about 1,100 meters. The river passes through very stiff slopes. The river has high eroding capacity. The high velocity of its stream flow erodes the soil. The river covers two revenue districts of Mayurbhanja and Baleswar. It also covers the coastal planes. The gradual destruction of the forest cover in the Similipal hills has rendered this mighty river flood-prone. During the monsoon period, the river creates havoc in Mayurbhanj and Baleswar districts and causes colossal damages.(The Pioneer, 2016)

3.4 Ranking of Rivers

Using the Falkenmark Water Stress Indicators and taking the scenario (Table 14) of average flow of the rivers and 75% dependability for the year 2001 and 2051 the following scenario of per capita availability of water the following situation can be foreseen, where 0 is more critical/ stressed and 5 is least critical/stressed.

3.4.1 Per Capita Availability of Water

River Basin Priority	Average Flow		Dependable flow (75%)	
	2001	2051	2001	2051
Mahanadi	5	4	5	3
Brahmani	5	3	4	2
Baitarani	3	2	2	1
Inderavati	5	5	5	4
Rushikulya	2	1	0	0
Vamsadhara	5	2	5	4
Nagavali	5	5	5	4
Budhabalanga	4	2	3	2
Subernarekha	4	3	4	3
Bahuda	3	2	0	0
Kolab	5	5	5	5

Table 24 Priority on Water Availability

Based on the per capita water availability (75% dependability) in 2001 itself Rushikulya was a water scarce basin along with Bahuda as the water availability was less than 1000 m³ perperson per year. Though as per average flow the situation of these rivers is little better as “water shortage basins”. Other basins close to scarcity condition are Baitarani (water shortage basin in 2001). But by 2051 based on the dependable flow projectios Rushikulay, Bahuda and Baitarani will be water scarcity basins while Budhabalanga and Brahmani rivers will be water shortage basins. Subarnarakha will be very close to being a water stressed basin. Water stress mapping of the rivers has been done bellow (5 most stressed to 0 least stressed)

3.4.2 Industrial use of Water

Basin	Supply to Industry in MCM	Industrail Water Supply as % of average flow
Mahanadi	268	

		0.55
Brahmani	84	0.60
Baitarani	63	1.16
Inderavati	21	0.47
Rushikulya	49	1.76
Vamsadhara	17	0.44
Nagavali	9	0.39
Budhabalanga	23	0.91
Subernarekha	7	0.30
Bahuda	5	2.35
Kolab	22	0.25

Table 25: Industrial use of Water Quantity

With respect to industrial use of water Mahanadi and Brahmani contribute 268 and 84 MCM of water annually followed by Baitarani 63 MCM and Rushikulya ((49 MCM). But looking at the amount of water being diverted for the industries as percentage of the average flow of the river, Mahanadi and Brahmani contribute between 0.5% to 0.6% of the annual flow for the use by the industries. On the other hand Baitarani contributes 1.76% and Bahuda 2.35% of its water. Industrial water use accounts for 0.91% of the annual flow of Budhabalanga. Based on the stress due to industrial water use the rivers have been ranked in column 3 of the table above. .

Water Quality of the Rivers

With respect to the pollution of the rivers, it has been looked into in two ways – the length of the rivers that has been polluted and the BoD value for eh river at different stretches. Both Mahanadi and Brahmani rivers have the about 250 kms of their stretches which has been identified as highly polluted. 54% of the length of river Mahanadi and 51% of river Brahmani are polluted. Another river that has a long stretch of 70 kms (about20%) polluted is Baitarani. Based on the river stretches polluted the rivers have been ranked (least polluted 0 to highest polluted 5) has been provided in column 4.

Similarly the water quality of the rivers based on the assessment done by CPCB for different stages has been used to rank the rivers in column 5.

3.4.3 Health of the Rivers of Odisha

River Basin Ranking	Water stress	Industrial use	Length of the river polluted	Pollution Based on the BoD (0 least polluted)	Cumulative Rank (Scores of prev parameters added and ranked)
Mahanadi	1	1	5	4	5
Brahmani	2	1	5	4	4
Baitarani	4	2	3	5	3
Inderavati	0	0	0	1	10
Rushikulya	5	3	2	5	1
Vamsadhara	1	0	1	5	6
Nagavali	1	0	1	3	9
Budhabalanga	3	1	1	2	7
Subernarekha	2	0	1	1	8
Bahuda	5	4	1	4	2
Kolab	0	0	0	1	10

Table 26 Overall Ranking of Rivers

To come out with an overall statement on the health of the rivers the scores of the rivers have been added together and the rivers have been ranked. Rushikulya comes out as the most distressed river. It already is water scarce and also has a heavy pollution load though in a relatively lesser stretch. Rushikulya is followed by Bahuda, another comparatively smaller river. And the list of the stressed rivers with the most stressed river on the top is like this. And this list confirms to the overall understanding of the health of the rivers.

1. **Rushikulya**
2. **Bahuda**
3. **Baitarani**
4. **Brahmani**
5. **Mahanadi**
6. **Vamsadhara**
7. **Budhabalanga**
8. **Subernarekha**
9. **Nagavali**
10. **Inderavati & Kolab**

4.0 Fact Sheet of River Basin of Odisha

4.1 Fact Sheet of Mahanadi River

Geography	Common name	Great river
	Origin	Nagri town, Chhattisgarh
	Longitude	80°28' - 86°43' E
	Lattitude	19°8' - 23°32' N
	Catchment Area(sq.km) C.G & Odisha	141589
	Shape and Size(basin)	Upper basin-saucer shaped (chhattisgarh), basin-cercular with 400km dia,exit passage-160km length & 60 km breadth
	Elevation(m) at Drainage basin	Avg-426, Max-877, Min-193
	Total length(km)	851(357km in Chhattisgarh & 494 km in Odisha)
	Cities cover	Sambalpur, Sonepur, Cuttack,Bhubaneswar, Subalaya,kantilo, Boudh, Banki
	States cover	Odisha,Chhattisgarh
	% cover with respect to area(odisha basin)	42.15
Agroecology	Basin climate(North part of mahanadi)	Sub-tropical, Summer temp-29°C, Winter temp-21°C, onset of monsoon-1st week of june,precipitation 800-over 1600mm(july-Sept),less than 50mm(jan-feb),Relative humidity-88%
	Soil types at basin (up to Mahanadi-Manibhdra dam ite)	Main type-Red & yellow soils, mixed black and red soil. Laterite (lower part of Odisha),deltaic soil(coastal part of Mahanadi), black & sandy soil (part of Chhattisgarh)
	Mineral wealth (up to Mahanadi-Manibhdra dam site)	Coal, Manganese, Bauxite, Gold, Pyrite, Iron ore, Galena, Graphite , Lead, Zinc, Iron, Soap-stone, Limestone, lead, Mica, Dolomite, Fireclay, China Clay, Copper,
	Avg annual rainfall (mm) at basin	1463
	Agricultural land Total	54.27%
	Forest coverage	26.72%
	Avg cropping pattern at bain(up to Mahanadi- Manibhdra dam ite)	Main crops-Paddy, kodan-kutki,Mung, Biri, cereals,pulses
Problems	Issues	Severe flooding
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011 census)	185,37,378
	Population density / Sq.km	282
Development	Irrigation Project on River	76
	Hydroelectric project	4 (Gangrel,Hasdeo bango,Hirakud,Sikaser
	Power houses	6(Gangrel,hasdeo,hirakud-I,hirakud-ii,sikaser,upper indravati)
	Lift stations	2
Quality	Ph at basin(cuttack site)	6.97-7.95
	Class	D

Hydrological Aspects	Dams inside Odisha	32
	Other Name involved	Sorrow of Orissa
	No. of tributaries(Major)	9
	Distributaries(Major)	7
	Hydropower potential(MW)	627
	Surface Water potential(KM3)	66.88
	Grund Water potential(KM3)	16.46
	Flowing direction	East-West
	Out Falling	the Bay of Bengal
	Average Water Resource Potential (MCM) in Odisha and C.G	66880
	Total Utilizable Surface Water Resource (MCM) in Odisha & C.G	50000
	Live Storage Capacity of Completed Projects (MCM)	12799
	Live Storage Capacity of Projects Under Construction (MCM)	1465
	Total Live Storage Capacity of Projects (MCM)	14244
	No. of Hydrological Observation Stations (CWC)	39
No. of Flood Forecasting Stations (CWC)	4	

Table 27: Fact Sheet of Mahanadi River

4.2 Fact Sheet of Brahmani River

Geography	Origin	Vedvyas, Rourkela, Odisha
	Longitude	83° -52' - 87°-03 E
	Latitude	20° -28' - 23° - 35' N
	Total Catchment Area(sq.km)	39269
	Elevation(m)	600(Rising point)
	Total length(km)	799
	Districts covered	Sundergarh, Sambalpur, Angul, Dhenkanal, Deogarh,Keonjhar,Jajpur,Kendrapara
	States cover	Orissa, Jharkhand and Chhatisgarh
	% cover with respect to river basin in Odisha	14.46
Agroecology	Basin climate	Max-47° C, Min- 4°C.
	Soil types at basin	Yellow soils, red sandy and loamy soils, mixed red and black soils and coastal alluvium
	Mineral wealth	Coal, iron ore, copper, bauxite, chromites, limestone, manganese, dolomites, lead, fire-clay and china clay, etc
	Annual rainfall (mm) at basin	Max:2654 mm, Min:380.4 mm
	Coverage % of Agricultural land in Odisha	34

	Forest coverage %	38
Problems	Issues	Pollution
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011)	57,53,307
	Population density / Sq.km	256
Development	Irrigation Project on River	Jokadia and the Jenapur anicuts
	Hydroelectric project	Rengali hydroelectric project
	Power houses	Rengali power house
Water quality	Ph at basin	Max-8.1, Min-6.9, Avg-7.5-7.8
	Class	D
Hydrological Aspects	Dams (Including tributaries) in Odisha	12
	No. of tributaries(Major)	6
	Hydropower potential(MW)	250
	Surface Water potential(MCM)	18,577
	Flowing direction	East flowing
	Out Falling	Bay of Bengal
	Average Water Resource Potential (MCM) in Odisha	18577
	Industrial Water Demand (MCM)	84
	Live Storage Capacity of Completed Projects (C.C.A in Ha)	37574
	Live Storage Capacity of Ongoing Projects (C.C.A in Ha)	2,58,175
	No. of Hydrological Observation Stations (CWC)	31
	No. of Flood Forecasting Stations (CWC)	1

Table 28: Fact Sheet of Brahmani River

4.3 Fact Sheet of Baitrani River

Geography	Orgin	Gonasika/Guptaganga (Cow Nose Shaped) hills
	Longitude	85 ⁰ 10' - 87 ⁰ 03' E
	Lattitude	20°35' - 22°15' N
	Catchment Area(sq.km)	14,218 Odisha(13,482), Jharkhand(736)
	Elevation(m) at Drainage basin	900
	Total length(km) in Odisha	360
	Major Cities cover	6
	States cover	Odisha, Jharkhand
	% cover with respect to basin area(Odisha)	8.66
Agroecology	Basin climate(Keonjhar)	Maximum(48.5°C) and minimum (6° C)
	Soil types at basin	Yellow soils, red sandy and loamy soils, mixed red and black soils and coastal alluvium
	Mineral wealth	Iron ore, copper, chromite, asbestos, manganese, atomic minerals, china clay and soap stone
	Average annual rainfall (mm) at basin	1450
	Agricultural land in Odisha	47%

	Forest coverage	30%
Problems	Issues	Massive floods during monsoon, Illegal and unplanned land use of the upper reaches of the river and river breaching.
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011)	43,63,092
	Population density / Sq.km	324
Development	Irrigation Project on River	18
	Hydroelectric project	0
	Power houses	0
Water quality	Ph at basin	6.06 - 7.43
	Class	C
Hydrological Aspects	Dams in Odisha	8
	No. of tributaries(Major)	22
	Hydropower potential(MW)	0
	Flowing direction	Flows in a northerly direction, then it changes its path suddenly by 90 degrees and flows eastward
	Out Falling	Bay of Bengal
	Per Capita Water Resource Potential (MCM)	1976.01
	Industrial Water Demand (MCM)	63.20
	Live Storage Capacity of Completed Projects (C.C.A in Ha)	To be included
	Live Storage Capacity of Ongoing Projects (C.C.A in Ha)	To be included
	No. of Hydrological Observation Stations (CWC)	12
	No. of Flood Forecasting Stations (CWC)	-

Table 29: Fact Sheet of Baitrani River

4.4 Fact Sheet of Rushikulya River

Geography	Orgin	Matarbarhi village of Kandhamal district, Odisha
	Longitude	84° 01' - 85° 06' E
	Lattitude	19° 7' - 20° 19' N
	Catchment Area(sq.km)	8,963
	Shape and Size(basin)	Leaf shaped
	Elevation(m)	1000(Rising point)
	Total length(km)	165
	Cities cover	Berhampur, Chhatrapur, Ganjam, Aska, Bhajanagar and Sarada.
	States cover	Odisha
	% cover with respect to river basin in Odisha	5.76
Agroecology	Basin climate	Mean annual rainfall- 1260 mm, Mean Max Temp- 39.1°C, Mean Min Temp- 8.7°C, Relative maximum humidity(%)-85.4, Relative minimum humidity-35.5
	Soil types at basin	Na

	Rock type (Basin)	Na
	Mineral wealth	Clay, lime stone, manganese, sand talc, black sand and grinding materials
	Annual rainfall (mm) at basin	Max:2553 mm, Min:257 mm
	Coverage % of Agricultural land	44
	Forest coverage	349 ThHa
	cropping pattern at basin	The main forest products are timber, bamboo, myrabalam, tamarind, sal, mahua, resin, kendu leaf, siali leaf, sal leaf & neem & karanj seeds. Major crops are paddy, ragi, moong, biri, til , groundnut , horse gram, sugarcane and chilly.
Problems	Issues	Flood, Pollution of the Rushikulya river due to industrial effluents containing harmful elements like Mercury Protest against Pipalpanka Dam in the Gnajam District for TISCO.
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011)	32,29,060
	Population density / Sq.km	360
Development	Irrigation Project on River	The Rushikulya Irrigation System is the only Major Irrigation Project and another 11 Medium Irrigation Projects
	Hydroelectric project	0
	Power houses	0
Water quality	Ph at basin(2011)	7.22 - 8.47, Avg-8.1 near Rushikulya river mouth (long 84°91' - 85°13' N and lat 19°24' - 19°44' E),Gopalpur
	Biologica oxygen demand(BOD) mg/l (2011)	0.83 to 3.80, Avg- 1.79. near Rushikulya river mouth (long 84°91' - 85°13' N and lat 19°24' - 19°44' E),Gopalpur
Hydrological Aspects	Dams	13
	No. of tributaries	Major- Badanadi, Dhanei,Ghodahado,Padma,Baghua
	Hydropower potential(MW)	0
	Flowing diretion	East flowing
	Out Falling	Bay of Bengal
	Average Water Resource Potential (MCM)	3949
	Live Storage Capacity of Completed Projects (CCA in Ha)	96810
	Live Storage Capacity of Projects Under Construction (CCA in Ha)	12310
	Total Live Storage Capacity of Projects(CCA in Ha)	109120
	No. of Hydrological Observation Stations (CWC)	23

Table 30: Fact Sheet of Rushikulya River

4.5 Fact sheet for Subarnarekha

Geography	Orgin	Nagri Village, Ranchi, Jharkhand
	Longitude	85° 8' to 87° 32'E
	Lattitude	21° 15' to 23° 34' N
	Catchment Area(sq.km)	19277
	Elevation(m)	600
	Total length(km)	395
	Districts cover in Odisha	Mayurbhaj, Balasore
	States cover	Odisha, Jharkhand, West Bengal
	% cover with respect to river bain area(Odisha)	1.92
Agroecology	Basin climate	Southwest monsoon
	Annual rainfall (mm) at basin	Max:3846 mm, Min:577 mm
	Coverage % of Agricultural land	62
Problems	Forest coverage	20.86 ThHa
	Issues	Pollution and Water Scarcity
Demography	Conflict/Dispute involved (Yes/no)	Yes
	Population (2011)	10,07,992
Development	Population density / Sq.km	338
	Irrigation Project on River(Major)	5
Water quality	Hydroelectric project(MW) in Odisha	2
	pH at basin	6.5-8.5
Hydrological Aspects	Class	C
	Dams	5
	No. of tributaries (Major)	15
	Hydropower potential(MW)	2
	Flowing direction	South-East
	Out Falling	Bay of Bengal
	Average Water Resource Potential (MCM)	2303
	Industrial Water Demand (MCM) in 2001	7.03
	No. of Hydrological Observation Stations (CWC)	12
No. of Flood Forecasting Stations (CWC)	2	

Table 31: Fact sheet for Subarnarekha

4.6 Fact Sheet of Inderavati River

Geography	Orgin	Ghats of Dandakaranya range, Kalahandi, Odisha,
	Longitude	83°07'10"E at Risisng point
	Lattitude	19°26'46"N at Risisng point
	Catchment Area(sq.km)	41,700
	Elevation(m)	914(rising point)

	Total length(km)	530 (167 in Odisha)
	Cities cover	Kalahandi,Nabarangapur
	States cover	Odisha,Chhattisgarh
Agroecology	Basin climate	Tropical Monsoon
	Soil types at basin	Red Sandy and red loamy soil
	Rock type (Basin)	Limetone,quartzite,conglomerate
	Mineral wealth	Iron, Mica, Clay, Bauxite, Dolomite
	Annual rainfall (mm) at basin	Max-4427.6 mm, Min-562.3 mm
	Coverage % of Agricultural land in Odisha	38
	Forest coverage	242.72 ThHa
Problems	Issues	Projects and Displacement
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011) in Odisha	14,11,838
	Population density / Sq.km in Odisha	191
Development	Irrigation Project on River	17
	Hydroelectric project	5
Water quality	Ph at basin	-
	Class	C
Hydrological Aspects	Dams (Major)	1
	Annual Flow	6265
	Barrages/weirs	17
	No. of tributaries	14 major
	Hydropower potential(MW)	600
	Flowing diretion	west-ward then outh ward and joined godavari river
	Out Falling	the Bay of Bengal
	Average Water Resource Potential (MCM)	6,265
	Utilizable Surface Water Resource (MCM)	1442
	Live Storage Capacity of Completed Projects (CCA in Ha)	132250
	Live Storage Capacity of Projects Under Construction (CCA in Ha)	61856
	Total Live Storage Capacity of Projects(CCA in Ha)	194115
	No. of Hydrological Observation Stations (CWC)	13

Table 32: Fact Sheet of Inderavati River

4.7 Fact Sheet of Vamsadhara River

Geography	Origin	Thuamul Rampur in the Kalahandi district, Odisha
	Longitude	83° 20' - 84° 20' E
	Latitude	18° 15' - 19° 55' N
	Catchment Area(sq.km)	11,377
	Elevation(m)	less than 10 mts. above MSL in south (Kalingapatnam) to 1545 mts. on the northwest hills (Near Bissam Cuttack)
	Total length(km)	239, (179 in Odisha)
	Cities cover	Srikakulam, Narasannapeta, Patapatnam, Tekkali, Palasa, Sompeta, Parlakhemundi, Gunupur, Kashinagar, Bissam Cuttack
	States cover	Odisha, Andhra Pradesh
	% cover with respect to Odisha river basin area	5.75
Agroecology	Basin climate	10° C to 43° C
	Soil types at basin	Mixed red, black soils, red sandy soils, yellow soils, coastal sands and forest soils
	Mineral wealth	Manganese, graphite, quartz, limestone, mica and bauxite.
	Annual rainfall (mm) at basin	Max:2591 mm, Min:410 mm and avg-1400
	Coverage % of Agricultural land in Basin in Odisha	38
	Forest coverage	50.48
Problems	Issues	Prone to frequent floods with an aerial extent of 10,601.5 sq. km
	Conflict/Dispute involved (Yes/no)	yes
Demography	Population (2011)	10,23,338
	Population density / Sq.km	130
Development	Irrigation Project on River	2
	Hydroelectric project	0
	Power houses	0
Water quality	pH at basin	7-8.5
	Class	C
Hydrological Aspects	Dams	1
	Discharge (m ³ /sec) at mouth	Avg-25
	No. of tributaries	13
	Hydropower potential(MW)	600
	Average Water Resource potential(MCM) in Odisha	6265

Table 33: Fact Sheet of Vamsadhara River

4.8 Fact Sheet of Nagavalli River

Geography	Orgin	Eastern slopes of the Eastern Ghats,Lakhabahal, Kalahandi district of Orissa
	Longitude	82° 53' - 84° 05' E
	Lattitude	18° 10' - 19° 44' N
	Catchment Area(sq.km)	9275
	Elevation(m)	1300(Rising point)
	Total length(km)	256 (125 in Odisha)
	Districts cover	Kalahandi, Koraput, Srikakulam, Vizayanagaram, Visakhapatnam
	States cover	Odisha,Andhrapradesh
	% cover with respect to river Odisha bain area	2.89
Agroecology	Basin climate	Mean annual Rain fall- 1185 mm, Mean Max Temp-33.9°C, Mean Min Temp- 17.6°C,Relative maximum humidity(%)-84, Relative minimum humidity-66
	Soil types at basin	Red type,ocassionally interlayered by with gravel and kankar,on the southern side of the area sand is underlined by clay
	Rock type (Basin)	Khondalites and unclassified crystallines.
	Mineral wealth	Manganese, quartz, mica, graphite, limestone, bauxite and construction materials
	Annual rainfall (mm) at basin	Max:1973 mm,Min:1077 mm
	Coverage % of Agricultural land in Odisha	31
	Forest coverage	29.7 Th. Ha
	Cropping pattern at basin	Paddy, sugarcane, wheat, potato,cotton in the district of Koraput, Rayagada and paddy, ground nut and sugarcane in the district of Srikakulam
Problems	Issues	flood
	Conflict/Dispute involved (Yes/no)	Yes
Demography	Population (2011)	6,76,678
	Population density / Sq.km	150
Development	Irrigation Project on River	Thotapally, Narayanpuram and Jaiyavathi are the major projects besides another one medium irrigation projects in the catchment areas of the river basin.
	Hydroelectric project	0
	Power houses	0
Water quality	Ph at basin	7.7(2014-15), 7.5(2013-14)
	Class	C
Hydrological Aspects	Dams	0
	Discharge (m ³ /sec) at mouth	24

	Barrages/weirs	Thotapalli Barrage is located at village Thotapalli in Vizianagaram district and presently being upgraded as barrage.
	Tributaries	Barha, Baldiya, Satnala, Sitagurha, Srikona, Janjavati, Gumudugedda, Vottigedda, Suvarnamukhi, Vonigedda, Relligedda and Vagavati.
	Hydropower potential(MW)	0
	Flowing direction	East flowing
	Out Falling	Bay of Bengal
	Average Water Resource Potential (MCM) in Odisha	2853
	Utilizable Surface Water Resource (MCM) in Odisha	178..65
	Live Storage Capacity of Completed Projects (MCM)	170.89
	No. of Hydrological Observation Stations (CWC)	10

Table 34: Fact Sheet of Nagavalli River

4.9 Fact Sheet for Budhabalang River

Geography	Orgin	Similipal hills, Mayurbhanj, Odisha
	Longitude	86° 20' to 87° 05'E
	Latitude	21° 22' - 22° 20' N
	Catchment Area(sq.km)	4838
	Elevation(m)	800 (At source)
	Total length(km)	199
	Districts cover	Mayurbhanj and Balasore
	States cover	Odisha
Agroecology	% cover with respect to river basin area(Odisha)	4.08
	Basin climate	Southwest monsoon
	Mineral wealth	Iron ore, china clay, quartz, soap stone and Limestone
	Annual rainfall (mm) at basin	Max:3295 mm, Min:544 mm :(including jambhira basin)
	Coverage % of Agricultural land	76
Problems	Forest coverage	190 ThHa(including Jambhira basin)
	Issues	Pollution and Water Scarcity
Demography	Conflict/Dispute involved (Yes/no)	Yes
	Population (2011)	20,08,156(including Jambhira basin)
	Population density / Sq.km	316(including Jambhira basin)
Development	Irrigation Project on River(Major)	4
	Hydroelectric project(MW)	2
	Power houses	1
Water quality	pH at basin	6.5-8.5
	Class	C

Hydrological Aspects	Dams	4
	No. of tributaries	Prime tributaries include the Gangadhar, Catra and Sone.
	Hydropower potential(MW)	0
	Surface Water potential(MCM)	3111
	Flowing direction	South-East
	Out Falling	Bay of Bengal
	Per Capita Water Resource Potential (MCM)	2263
	Present Demand (MCM)	735
	Industrial Water Demand (MCM) in 2001	22.70
	Live Storage Capacity of Completed Projects (C.C.A in Ha)	16060
	Live Storage Capacity of Ongoing Projects (C.C.A in Ha)	31156
	No. of Hydrological Observation Stations (CWC)	22
	No. of Flood Forecasting Stations (CWC)	0

Table 35: Fact Sheet for Budhabalang River

5.0 Other Related Informations

5.1 Mahanadi

5.1.1 Land use land cover

Majority of the land under the Mahanadi Basin is covered with agricultural activity with net showing of 4834526 ha which is about 38 % of total area under the basin followed by forest land of 3362125 ha of land. 774862 ha of land is under non-agriculture use. A total of 3039622 ha of land is waste, fallow and barren land.

Demography

The population of Mahanadi basin as per 2011 census was computed on proportionate are basis from the district figures work out to 230.95 lakhs of which the rural population was 176.90 lakh and urban population was 54.05 lakh. The state wise population falling in the basin is computed as 128.78 Lakh in Chhattisgarh, 0.88 lakh in Madhya Pradesh, 0.10 Lakh on Maharashtra, 0.14 lakh in Jharkhand and 101.85 lakh in Odisha. Population of Mahanadi basin in the year 2001 was 16,202,133 of which 3,177,223 was rural and 13,024,910 was urban population.(Census , 2001)

5.1.2 Livelihood

Agriculture

Mahanadi valley is best known for its fertile soil and flourishing agriculture which is the principle occupation of the basin supporting livelihood in basin. Before the Hirakud dam was built, the river carried a huge amount of silt and its delta had one of the highest yield per acre in the whole of India. At present, agriculture primarily depends on a network of canals that arise from the river. Rice, oilseeds and sugarcane are the principal crops in the river basin. Few districts in western Odisha like Sambalpur and Bargarh practise agriculture twice a year due to irrigation provided by Hirakud Dam. As per 1991 census 4204039 were reported to be the main workers whereas 618570 were reported marginal workers.

Fishery

Fishery is one of the major source of livelihood among the people residing on the bank of the river Mahanadi. Fish catch in the basin can be divided into Fresh water, brackish water and marine water fish. Fish production from Mahanadi was recorded to be 147818 MT. Fresh water catch was 70315 MT whereas Brackish and Marine Water fish catch was 8511 MT and 68992 MT respectively.(Economic Survey, 1999) The average income of a fisher family of studied stretches is found to vary between Rs.1000 and Rs.3200 per month depending upon the season of catch.(Singh, 2014)

Industrial sector

In addition to abundant agriculture produce, the basin has high deposit of raw materials for industrialization. There are many industries both large and small scale industries in the basin. Which includes aggro-based industries as well as mineral based industries. Many thermal power plants can also be found which recruits about 814157 industrial workers.

5.1.3 Urbanization and Industrialization

Urbanization

Three important urban centres in the basin are Raipur, Durg and Cuttack. In Odisha part Urbanization can be divided into four sub basin parts. The upper Mahanadi, the middle Mahanadi, the lower Mahanadi and delta Mahanadi. Upper Mahanadi basin has 7 municipality and 15 NACs' Sundargarh, Jharsuguda, Belpahar being the important towns.

Middle Mahanadi basin consists of 1 Municipality and 3 NACs' Sambalpur being the important one and is also among the big cities of Odisha.

Lower Mahanadi has 4 NACs, Athagarh and Nayagarh town being the important ones.

Mahanadi Delta the lowest part of the basin is highly urbanized area in the basin. It has 5 municipalities and 10 NACs' Cuttack, Bhubaneswar, Paradeep, Kendrapara, and Puri are big towns/cities in Odisha. It is observed that Mahanadi basin requires 63,89,11,400 lpcd of water for its urban population whereas waste water generated calculated is 41,83,42,867 lpcd. (Overall water requirement and waste water generated per person/day is 200 lpcd and 131 lpcd). (Kamyotra & Bhardwaj, 2011)

URBAN POPULATION OF MAHANADI BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Sundargarh Town	Municipality	Sundargarh	30,352	38,421	45,036	9.0072	5.899716
Belpahar	Municipality	Jharsuguda	24,607	32,826	38,993	7.7986	5.108083
Brajrajnagar	Municipality	Jharsuguda	69,667	76,959	80,403	16.0806	10.532793
Jharsuguda town	Municipality	Jharsuguda	65,054	76,100	97,730	19.546	12.80263
bargarh	Municipality	Bargarh	51,205	63,678	80,625	16.125	10.561875
Barapalli	Notified Area Committee/Council	Bargarh	16,371	19,157	20,850	4.17	2.73135
Padampur	Notified Area Committee/Council	Bargarh	...	15,442	17,625	3.525	2.308875
Hirakud	Notified Area Committee/Council	Sambalpur	23,833	26,394	30,207	6.0414	3.957117

Burla	Notified Area Committee/Council	Sambalpur	34,640	39,204	46,698	9.3396	6.117438
Binika	Notified Area Committee/Council	Subarnapur	12,955	14,539	15,765	3.153	2.065215
sonpur	Municipality	Subarnapur	14,409	17,540	20,770	4.154	2.72087
Khariar road	Notified Area Committee/Council	Nuapada	14,027	16,629	18,967	3.7934	2.484677
Khariar	Notified Area Committee/Council	Nuapada	11,738	13,409	15,087	3.0174	1.976397
Junagarh	Notified Area Committee/Council	Kalahandi	12,974	15,759	19,656	3.9312	2.574936
Bhawanipatna	Municipality	Kalahandi	51,062	60,787	69,045	13.809	9.044895
Kesinga Town	Notified Area Committee/Council	Kalahandi	14,127	16,917	19,239	3.8478	2.520309
Kantabanjhi	Notified Area Committee/Council	Balangir	17,535	20,095	21,819	4.3638	2.858289
Titlagarh	Notified Area Committee/Council	Balangir	25,719	27,904	31,258	6.2516	4.094798
DAV college area	Outgrowth Ward of Titlagarh	Balangir	...	2,369	2,809	0.5618	0.367979
Patnagarh	Notified Area Committee/Council	Balangir	16,246	18,694	21,024	4.2048	2.754144
Bolangir	Municipality	Balangir	69,920	85,261	98,238	19.6476	12.869178
Sambalpur	Municipality	Sambalpur	1,31,138	1,53,643	1,84,000	36.8	24.104
Boudh town	Notified Area Committee/Council	Baudh	...	18,025	20,424	4.0848	2.675544
Phulbani	Municipality	Kandhamal	27,154	33,890	37,371	7.4742	4.895601
Udaigiri	Notified Area Committee/Council	Kandhamal	8,508	10,204	11,302	2.2604	1.480562
Banki	Notified Area Committee/Council	Cuttack	14,350	15,989	17,521	3.5042	2.295251
Nuapatana	Notified Area Committee/Council	Cuttack	14,350	15,989	17,521	3.5042	2.295251
Athagarh	Notified Area Committee/Council	Cuttack	13,661	15,848	17,304	3.4608	2.266824
Khandapara	Notified Area Committee/Council	Nayagarh	7,522	8,757	9,038	1.8076	1.183978
Kantilo	Census Town	Nayagarh	8,258	8,735	9,181	1.8362	1.202711
Nayagarh	Notified Area Committee/Council	Nayagarh	10,464	14,314	17,030	3.406	2.23093
Choudwar	Municipality	Cuttack	36,877	42,622	42,784	8.5568	5.604704
Charbatia	Census Town	Cuttack	5,965	5,234	4,016	0.8032	0.526096
cuttack	Municipal Corporation	Cuttack	4,03,418	5,34,654	6,10,189	122.0378	79.934759
Jagatsinghpur	Municipality	Jagatsinghapur	25,016	30,824	33,631	6.7262	4.405661
Paradeep	Municipality	Jagatsinghapur	48,104	73,625	68,585	13.717	8.984635
Kendrapara	Municipality	Kendrapara	35,015	41,407	47,006	9.4012	6.157786

Bhubaneswar	Municipal Corporation	Khordha	4,11,542	6,48,032	8,43,402	168.6804	110.485662
pipili	Notified Area Committee/Council	Puri	11,649	14,263	17,623	3.5246	2.308613
Nimapara	Notified Area Committee/Council	Puri	13,658	16,915	19,289	3.8578	2.526859
Konark	Notified Area Committee/Council	Puri	10,899	15,013	16,779	3.3558	2.198049
Puri town	Municipality	Puri	1,25,199	1,57,837	2,00,564	40.1128	26.273884
Khurda town	Municipality	Khordha	30,591	39,054	46,205	9.241	6.052855
Jatani town	Municipality	Khordha	50,116	53,251	55,925	11.185	7.326175
banpur	Notified Area Committee/Council	Khordha	13,702	16,474	17,278	3.4556	2.263418
Balugaon	Notified Area Committee/Council	Khordha	12,404	15,823	17,645	3.529	2.311495
Total			20,46,001	26,98,506	31,93,457	638.6914	418.342867

Table 36 Urban Population of Mahanadi

Source: City Population de

Industrialization

Mahanadi basin, because of its rich mineral resource and adequate power resource, has a favourable industrial climate. The Important industries presently existing in the basin are the aluminium factories at Hirakud and Korba, thermal plants of Orissa Power Generation Corporation (OPGC) at Banharpalli (near Brajrajnagar), Indian Aluminium Co.Ltd., Smelter and Captive Power Plant at Hirakud, Tata Refractories at Brajrajnagar, L & T Cement at Jharsuguda, ACC Cement, Bargarh, Shakti Sugar at Baramba, Indian Chargechrome Ltd. (ICCL), Choudwar, CPP of ICCL at Chaudwar, Paradeep Phosphates Ltd. (PPL), Paradeep, Oswal Ltd. at Paradeep and East Coast Breweries and Distilleries, Paradeep, Paper mill near Cuttack and cement factory at Sundargarh. Other industries based primarily on agricultural produce are sugar, textile and oil mills. Mining of coal, iron and manganese are other industrial activities.

Power Projects

There are at present two hydroelectric projects on river Mahanadi Burla Hydroelectric project having a capacity of 235.5 M.W and Chiplima Hydro-electric project of 72 M.W capacity.

5.2 Brahmani

5.2.1 Land use land cover

The basin is rich in forests that occupy 15,101 sq.km and Net shown area occupies 12,432 sq.km of the total basin area, which is about 38% and 31% of total area respectively. Permanent pastures, waste and fallow land constitute occupy rest of the basin area.

Demography

As per 2001 census data total population of the basin was 5,110,660 of which 1,027,359 was urban and 4,083,301 was rural. By 2025, the population of the basin is projected to go up to 7,526,383 million, of which 2,394,961 will be urban and 5,131,422 will be rural population.

5.2.2 Livelihood

Fishing

Fishing is one of the main occupations along the river Brahmani. The fishermen are their own masters, utilising their skills and the bounties of nature to make a living however, this activity has reduced drastically in recent years due to enormous reasons. The predominant species found in Brahmani River are Carps, Catfishes, Feather-backs, Forage fishes, Prawns and Hilsa. Total annual fish catch estimated at 24,000 MT. (Jain, Agarwal, & Singh, 2007)

Agriculture

Nearly 80 % of the basin population depend on agriculture for their livelihood (Jain, Agarwal, & Singh, 2007) . The Brahmani river basin falls from 5 to 9 agroclimatic zones for producing different crops. Zone 5-6 cover the entire of Brahmani basin and is the hub for extensive pulses cultivation. In addition to this Sugarcane, jute, oil seeds and other cereals are widely grown. Eastern embankment of Brahmani river fall under zone 7 which is solely dominated by oilseeds. 8-9 zones are on the middle and lower valley of Brahmani valley, this area is extensively cultivated with cotton and sugarcane.

Other than this paddy is the principal crop in Odisha, which it is grown in large number whole throughout the basin. (Know India, 2016)

5.2.3 Urbanization and Industrialization

Urbanisation

The basin has witnessed rapid growth in the number of towns and total urban population and this could be attributed to the large mineral wealth and consequent industrial growth. A number of towns including Rourkela Steel city, Rourkela Municipality and its suburbs, Talcher Thermal complex and its nearby urban areas like FCI Township, Rengali Dam Township, Dera Colliery Township did not even exist in 1951. Urban population of 9, 29,555 was measured from the existing towns and urban settlements in the year 2011. (City Population, 2016).

URBAN POPULATION OF BRAHMANI BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Birmitrapur	Municipality	Sundargarh	33,556	29,447	33,442	6.6884	4.380902
Rourkela Town ship	Industrial Township	Sundargarh	1,42,408	2,06,693	2,10,317	42.0634	27.551527
Rourkela	Municipality	Sundargarh	2,15,509	2,24,987	2,72,721	54.5442	35.726451
Kuanrunda	Census Town	Sundargarh	9,043	1.8086	1.184633
Kulunga Industrial Estate	Outgrowth Ward of Raurkela	Sundargarh		34,566	47,319	9.4638	6.198789
OCIL township	Industrial Township	Sundargarh		2,196	2,397	0.4794	0.314007
Rajgangpur	Municipality	Sundargarh	39,549	43,594	51,362	10.2724	6.728422
Jalda	Census Town	Sundargarh	13,116	11,961	15,789	3.1578	2.068359
Bonaigarh	Census Town	Sundargarh	7,080	1.416	0.92748
Rengali Project township	Census Town	Anugul	10,855	8,115	6,345	1.269	0.831195
Deracolliery Township	Census Town	Anugul	13,096	18,592	15,787	3.1574	2.068097
Talcher town	Municipality	Anugul	26,806	34,998	40,841	8.1682	5.350171
Nalco Township	Census Town	Anugul	8,102	18,045	19,644	3.9288	2.573364
Angu town	Municipality	Anugul	24,772	38,018	43,795	8.759	5.737145
Kamakhya Nagar	Notified Area Committee/Council	Dhenkanal	12,832	15,003	16,810	3.362	2.20211
Dhenkanal	Municipality	Dhenkanal	46,314	57,677	67,414	13.4828	8.831234
Bhuban	Notified Area Committee/Council	Dhenkanal	18,966	20,234	22,200	4.44	2.9082
Brahmarada	Census Town	Jajapur	...	8,515	10,721	2.1442	1.404451
Pattamundai	Notified Area Committee/Council	Kendrapara	28,220	32,730	36,528	7.3056	4.785168
Total Population			6,34,101	8,05,371	9,29,555	185.911	121.771705

Table 37 Urban Populatio of Brahmani Basin

Source: City population de

Industrialization

The Brahmani river basin with its rich minerals and cheap labour offered an ideal ground for establishment of industrial units. Sundergarh, Angul and Dhenkanal have a major share of industries and have a reasonably well-diversified industrial pattern. Jute, textile and paper units that are located at Dhenkanal and the entire Angul-Talcher Industrial Complex have significant large scale mineral processing industries. As per 2001 census Brahmani river basin has 2,56,811 industrial workers. (ORISSA STATE WATER PLAN, 2004).

Power Projects

The hydropower potential of the basin is assessed as 548 MW at 17 identified location in the basin. However, present installed capacity is of 250 MW and only 135 MW in operation. Thus there is lot more to potential for hydro power. (India-WRIS, 2016).

5.3 Baitarani

5.3.1 Land use land cover

The basin is rich in forests which occupy about 31% of the area. Agriculture with net shown area occupies about 43% of total basin area constituting the main source of rural livelihood and incomes. 3.4 % of land is culturable waste. Nearly 14 % of basin area is waste land and 6 % of land is put for non-agriculture purpose. (Choudhury P. R., Baitarani Initiative, 2016)

Demography

Baitarani river basin has a population of 43, 63,092 and density of 324 person per km² as per 2011 census. In 2001 population of basin was reported to be 3,829,931 which included 3,496,088 rural and 333,343 urban population. Looking at the growing trends of population it is estimated that population of basin would become 5,614,349.(State Water Plan, 2004)

5.3.2 Livelihood

Majority of the population is engaged in agriculture for their livelihood. However, due to existence mineral wealth in the basin sizeable population is also engaged in industrial sector and trade and commerce. Livestock and poultry raising is another important sources of livelihood in the basin. In addition to the above, forest produce brings significant income for the traditional forest dwellers and tribal of basin. Total worker population reported is 35 % of total basin population and Non- worker population accounts for 65% of total population.

Agriculture workers

72% of the total workers are main workers and 28 % of the total workers are categorized in other workers. 47% of the main worker population is engaged as agricultural labour and 45% of main

worker are cultivators. Rest 8 % of main workers are engaged in household industrial activity.

Industrial workers

As basin is rich in minerals, Industrial setup has engaged 38.7% of total worker population in the basin.

Fishery and livestock

Baitrani river basin nearly produces 35,000 MT of milk from its cattle. Meat production was reported to be about 5 MT per 1000 goats in the basin. Basin has a potential of 26000MT fish catch annually.(Choudhury P. R., 2016)

5.3.3 Urbanization and Industrialization

Urbanization:

Urban Centres in the basin include towns of Joda, Champua, Karanjia, Keonjhar, Anandpur and Jaipur. Population of the urban centre according to 2011 census inside the river basin was reported to be 3,32,237.

URBAN POPULATION OF BAITRANI BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Jumpura	Census Town	Kendujhar	...	5,265	6,064	1.2128	0.794384
Jajanga	Census Town	Kendujhar	...	5,799	7,482	1.4964	0.980142
Joda	Municipality	Kendujhar	31,069	38,689	46,631	9.3262	6.108661
Barbil	Municipality	Kendujhar	42,032	52,627	66,540	13.308	8.71674
Bolani	Census Town	Kendujhar	...	11,833	11,708	2.3416	1.533748
Champua	Census Town	Kendujhar	5,746	8,309	10,394	2.0788	1.361614
Karanjia	Notified Area Committee/Council	Mayurbhanj	17,623	21,441	22,865	4.573	2.995315
Keonjhar	Municipality	Kendujhar	41,945	51,845	60,590	12.118	7.93729
Anandpur	Municipality	Kendujhar	30,278	35,048	39,585	7.917	5.185635
Jajpur	Municipality	Jajapur	26,119	32,239	37,458	7.4916	4.906998
Dhamnagar	Notified Area Committee/Council	Bhadrak	...	18,550	22,920	4.584	3.00252
							0
Total Population			194812	2,81,645	3,32,237	66.4474	43.523047

Table 38 Baitarani Urban Population

Source: City population de

Industrialization

The basin is backward from the industrial point of view. There are three medium scale industries in the basin viz. (i) Ferro-Manganese Plant (ii) The sponge Iron Plant at Joda and (iii) The Orissa Sponge Iron Plant. There are few small scale industries also in the basin.

Minerals: The basin is rich in mineral wealth. Iron ore, copper, chromites, asbestos, manganese, atomic minerals, china clay and soap stone are available in Cuttack, Keonjhar and Mayurbhanj districts of Orissa and in Singhbhum district of Bihar.

According to Department of water resource Odisha, Annual requirement of water from Baitarani for industrial usage is 120 million m³/year. Out of which 100 million m³ is used by Iron and steel industry and rest 20 million m³ is used by other Ferro-alloy industries. A population of 192454 is engaged in industrial sector in Baitrani River basin.

5.4 Rushikulya

5.4.1 Land use land cover

Land use pattern of Rushikulya is similar to rest of the river basin in Odisha. Out of total 896.31 Ha geographical area 349.11 Ha of land is covered with forest which is 39.94 % of the total basin area. Net sown area under the basin is 371.56 Ha. Waste land which includes permanent pasture, cultivable waste, trees and grooves, barren and fallow land cover an area of 133.09 Ha. Land put to non-agriculture use is 42.53 Ha. (Land Statistics, 1999)

Demography

According to 2011 census Rushikulya river has a population of 32, 29,060 and has density of 360/sq. km. Basin population was 29, 42,901 and density of 328 /sq.km as per 2001 census.

5.4.2 Livelihood

Agriculture

Agriculture is the primary occupation in the basin. There are 321568 cultivators and 273662 agricultural labour in the basin. Flat topography of the basin is very rich in cultivation of paddy which contributes to 66 % of the total crops grown in the basin. Under the command Area Development project, the cultivable command area for Rushikulya is 61300 Hectares.

Others means of livelihood: Population engaged in Livestock and orchard plantation are 18892. The main forest products are timber, bamboo, myrabalam, tamarind, sal, mahua, resin, kendu leaf, siali leaf, sal leaf & neem & karanj seeds. Commonly raised livestock includes sheeps, goats, poultry and cattle. Production of 1156 MT meat and 26730 MT of milk was reported by livestock department. (Livestock Census, 1999)

Trade

Population of 31513 are engaged in trade and commerce. Berhampur is the leading business centre in the basin.

Fishery in Basin

Rushikulya River contributes good amount of fish production. Three types of fishing activities can be found in the basin namely Freshwater fishes all along the river, Brackish water fish near to mouth of River and Marine fish on the mouth to sea waters of Bengal Bay.

Inland fishery activity widely practised in the basin. There are two breeding centres at Humari(Ganjam) and Dighapahandi. Prawn seeds are also grown at Hinjlacut and Bhanjanagar area. The total fresh water catch in the basin is 13983.54 MT. Total brakish water fishery catch is 1772.67 MT and marine fish catch is 6973 MT. There are two fishery jetties at Pathera and Sabilia and one fishing Harbour near Gopalpur.

5.4.3 Urbanization and Industrialization

Urbanization

There is only one big city Berhampur in the river basin which has municipality and is among the big cities of Odisha. However, Rushikulya basin has 16 existing NACs since 1991. Important towns in the basin includes Chatrapur, Bhanjanagar, Aska, Saroda, Gopalpur, khalikot and Ganjam. The urban population recorded din the year 1998 was 4, 83,000. (Census of India, 1998-99)

URBAN POPULATION OF RUSHIKULYA BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Daringbadi	Census Town	Kandhamal	...	5,513	6,995	1.399	0.916345
Suruda	Notified Area Committee/Council	Ganjam	13,268	14,648	14,867	2.9734	1.947577
Mundamarei	Census Town	Ganjam	...	4,205	4,253	0.8506	0.557143
Aska	Notified Area Committee/Council	Ganjam	19,363	20,739	21,428	4.2856	2.807068
Badagada	Census Town	Ganjam	...	6,755	6,982	1.3964	0.914642
Pitala	Census Town	Ganjam	...	4,393	4,458	0.8916	0.583998
Hinjlicut	Notified Area Committee/Council	Ganjam	17,676	21,347	24,671	4.9342	3.231901

Purusottampur	Notified Area Committee/Council	Ganjam	12,904	14,249	15,366	3.0732	2.012946
Behrampur	Municipal Corporation	Ganjam	2,10,418	3,07,792	3,56,598	71.3196	46.714338
Ganjam Town	Notified Area Committee/Council	Ganjam	10,847	11,317	11,747	2.3494	1.538857
Chatrapur	Notified Area Committee/Council	Ganjam	17,952	20,289	22,027	4.4054	2.885537
Gopalpur	Notified Area Committee/Council	Ganjam	...	6,663	7,221	1.4442	0.945951
Total Population			3,02,428	4,37,910	4,96,613	99.3226	65.056303

Table 39 Rushikulya Urban Population

Source: City Population de

Industrialization

A number of large scale industries have been set up in the basin. Among them are M/s Jayashree Chemical Industries. Aska Co-operative Sugar Industries Ltd. Nuagam, Aska Spinning Mills, Monorama Chemical Works Ltd., Orissa Tubes Pvt. Ltd., etc. There are about 3360 numbers of small scale industries of different categories mainly food and allied, forest & wood based, rubber and plastic products and glass and ceramics. There is enough scope for setting up forest based industries. The basin is rich in mineral wealth. The major economic minerals are clay, lime stone, manganese, sand talc, black sand and grinding materials.(Rushikulya, 2016)

5.5 Subarnarekha

5.5.1 Land use land cover

The major part of basin (according to 2005-06 survey) is covered with agricultural land accounting to 53.76% of the total area and 2.39% of the basin is covered by water bodies. Agricultural land has maximum land cover over the basin with about 15696 km² area followed by forest cover of 8394km² area in the basin. Total built up area over the basin is 2429.14 km² which is 8.32 percent of total basin area. Wasteland and grassland together have area of 1980 km², which is 6.78 percent of the total area.(River Basin Atlas of India, 2012)

Demography

According to 2001 census Subarnarekha river basin had a population of 1457560 where 1427594 was rural and 29966 was urban population respectively. Density of population was calculated to be 390 person/sq.km. According the growing trends of population water resource department have projected a total of 2434991 population by 2051. (Orissa State Water Plan, 2004)

5.5.2 Livelihood

Agriculture

The SMP has two dams (Chandil and Icha), two barrages (Kharki and Galudih) and a network of canals from these reservoirs, a canal from Gauldih barrage carries water to the agriculture rich land of Odisha.(Archives, 2016) These SMP provide reliable water for about 900 km² agriculture fields in Odisha. Thus, enriching the livelihood in the agriculture sector. According to district statistical hand book of Balasore and Mayurbhanj 130070 people depend on agriculture which includes both cultivators and agricultural labourers.

Industry/ mining Sector

The Subarnarekha passes through areas with extensive mining of copper and uranium ores and is said that river flows through one of the heavily mineral deposits in India. Leading Industrial complex like TISCO, Tata Motors, Tatanagar Foundry, TCIL, Indian Steel Works etc. engages a majority of the population in the basin into industrial and mining activity. A population of 57833 is dependent on industries for their livelihood in the basin. (Orissa State Water Plan, 2004)

Fishery

Fishery is one of the important means of livelihood in the basin. Total basin produces nearly 900 MT of fish every year which includes 800 MT of fresh water and remaining 100 MT of brackish water fish catch. (Orissa State Water Plan, 2004)

5.5.3 Urbanization and Industrialization

Urbanization

Rairangpur and Jaleswar are the two urban centres in Subarnarekha river basin (Odisha part). Both the two centres have been designated as Notified Area Committee/Council areas. Population of these two urban centres was 51,263 as per 2011 census against a population of 43,283 in 2001. (City Population, 2016).

URBAN POPULATION OF SUBARNAREKHA BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Jaleswar	Notified Area Committee/Council	Baleswar	16,786	21,387	25,747	5.1494	3.372857
Rairangpur	Notified Area Committee/Council	Mayurbhanj	18,097	21,896	25,516	5.1032	3.342596
Total			34,883	43,283	51,263	10.2526	6.715453

Table 40 Subarnarekha Urban Population

Source: City Population de

Industrialization

There are not much industries in Odisha basin part. However, the neighbouring states of Jharkhand and West Bengal have engaged majority of the basin population in the industrial sector. Tata group being the major industries in the basin.

5.6 Inderavati

5.6.1 Land Use Pattern

Major portion of the basin passes through the densest forest of Bastar and Nabarnpur districts of Chattisgarh and Odisha respectively. Relatively small portion is covered with scrubs and central part of the basin has cultivable area for Rice and millet. Land use pattern of Inderavati basin in Odisha has 32.80 % of forest area, net area shown covers an area of 36.61 %, land put to non-agriculture use constitutes 6.82%, Miscellaneous tree and grooves, fallow land and waste land constitutes 23.77 % of the basin area. (ORISSA STATE WATER PLAN, 2004)

Demography

Total population of Inderavati River as per 2001 census was 1,191,460 out of which rural and urban population was 1,084,131 and 107,329 respectively. Density of population inside the basin was reported to be 161 persons per km²(ORISSA STATE WATER PLAN, 2004). According to decadal growth over 1991-2001, population of Inderavati basin is projected to be 1420073.

5.6.2 Livelihood

Agriculture

Majority of the population depend primarily in agriculture. As per statistical report (2001) the total workers in the basin are 581113 of which 329433 are main workers and 251680 are marginal workers. Out of the total worker population are 31% are cultivators and 48% are agriculture labours.

Fishery

Fishery is another means of livelihood for the people in basin. Total fish production as per statistic of 2004 reported as 2811 MT. Only fresh water fish catch is available from Odisha part and no marine or brackish water fish is found in Odisha from Indervati River. Fish catch from Indervati constitutes nearly 22 % of total fish catch in Odisha.

Industrial sector

There is no big industry in the basin but population depend on allied activities including forest produce including cottage industries to supplement their income. Industrial workers in population in the basin as per 2001 census is reported to be 59871.

5.6.3 Urbanization and Industrialization

Urbanization

There are no big cities in basin. However, there are few towns and district headquarters which have urban population of 1, 54,438 as per 2011 census data as compared to urban population of 1, 35,435 in 2001 (City Population, 2016). Urban centres in the basin include towns/NACs of Koraput, Kotpad, Nawarangpur, Umerkote, Mukhiguda, Kathiguda, Papadahandi and Boriguma.(City Population, 2016)

Industrialization

Inderavati River basin is an underdeveloped region where agriculture is the most important means of livelihood. Industries are limited to agro-based and forest based industries which also include cottage industries. However, basin is rich in raw materials for industrialization. Available raw materials include ores and minerals of iron, manganese, coal, lime stone, bauxite, graphite, chromite and dolomite. Industrial workers in population in the basin as per 2001 census is reported nearly 5.02 % of total basin population.

Power Projects

The Upper Inderavati Hydroelectric Projects consisting of Inderavati, Kapur, Muran and Padagada dam generates 600 MW of power.

5.7 Vamsadhara

5.7.1 Land use land cover

Basin area in Odisha is 8960 sq.km, 4523 sq.km of the basin area is covered with forest which is nearly half of basin area. Total cultivable area available is 2411 sq.km which is 29.61% of total basin area. Cultivable area includes culturable waste, current fallow, other fallow and net shown area. Net shown area in basin was measured to be 1921 sq.km which is 21.44 % of basin area. Waste land and land put to non-agriculture use covers 22.53% of basin area.(INTEGRATED HYDROLOGICAL DATA BOOK, 2012)

Demography

As per 2001 census total population reported in Vamsadhara River basin was 1,023,338 which includes a rural population of 944, 259 and urban population of 79,079. Population in 2011 became 1,088,946 with a density of 130 person/sq.km. (ORISSA STATE WATER PLAN, 2004)

5.7.2 Livelihood

Agriculture is primary occupation of the inhabitants of Vamsadhara basin. Basin valley is a region dominated by sugarcane cultivation. Oilseeds are also widely cultivated to the east of the Vamsadhara and thus a separate region is formed As per the National Water Development Agency,

the cropping pattern suggested for streams in between Rushiklya and Vamsadhara is 45% paddy, 15% pulses, 15% oilseed, 15% fodder (Kharif). In the coastal region of Vamsadhara, there are plantations of jackfruit, cashew, coconut, mango and almond contribute to income generation of basin population.

Due to less industrial area people engaged in industrial activity are very less. A population of 51423 is reported to be engaged as industrial workers in nearly 900 small scale industries.

5.7.3 Urbanization and Industrialization

Urban Centres

Parlakhemundi, Gunupur, Kashinagar, Bissam Cuttack are the important towns of Odisha. Whereas Srikakulam, Narasannapeta, Patapatnam, tekkali, Palasa, Sompeta, are the important towns in Andhra Pradesh state. Population of urban centres within Odisha have been found out to be 1,01,991 as per 2011 census.

URBAN POPULATION OF VAMSADHARA BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Kashinagar	Notified Area Committee/Council	Gajapati	10,102	9,791	9,684	1.9368	1.268604
Paralehkamundi	Municipality	Gajapati	36,667	43,097	44,469	8.8938	5.825439
gunupur	Notified Area Committee/Council	Rayagada	18,317	21,198	24,162	4.8324	3.165222
Gudari	Notified Area Committee/Council	Rayagada	6,611	6,849	6,931	1.3862	0.907961
Tikarpada	Census Town	Rayagada	...	6,183	8,346	1.6692	1.093326
Bissam katak	Census Town	Rayagada	...	7,408	8,399	1.6798	1.100269
Total Poulation			71,697	94,526	1,01,991	20.3982	13.36082

Table 41 Vamsadhara Urban Population

Source: (City Population , 2016)

Industries

There is no large scale industry in the basin but there are a number of agro and forest based small scale industries in Srikakulam district of Andhra Pradesh and Koraput & Kalahandi district of Orissa. Nearly 900 small scale industries have been operational in forest produce and mineral

processing. The important minerals found in the Vamsadhara basin are manganese, graphite, quartz, limestone, mica and bauxite besides building materials. Manganese ore is available extensively in Srikakulam and Koraput districts.

Alumina refinery owned by Vedanta Resources is located in the Lanjigarh town which is in the Vamsadhara river basin area.(INTEGRATED HYDROLOGICAL DATA BOOK, 2012)

Projects: Irrigation, Power etc.

Irrigation

There are only three irrigation projects over the Vamsadhara River. Two have been completed and one is ongoing project. All the three projects are reservoirs of which reservoir at Badanallaha has live storage capacity of 6714 Ham and irrigates an area of 8750 Ha whereas another reservoir is at Upper Harbhangi river with a live storage capacity of 8625 Ham and irrigates an area of 9150 Ha.

Power

There are no hydroelectric projects or power houses in Vamsadhara River in Odisha. However, two potential locations have been identified to cater the power needs of the basin population.(ORISSA STATE WATER PLAN, 2004)

5.8 Nagavalli

5.8.1 Land Use Land Cover

Nagavalli being an interstate river has 4500 sq.km of area in Odisha part. Majority of the area is under rich forest cover of basin. Forest cover accounts for 32.12% of the total basin area. A total cultivable area of 1741.71 sq.km lies in basin out of which only 1282.33 sq.km is only shown. Waste land accounts for 23.29% of total area. Land put to non-agriculture use is only 5% of total basin area. Rest of the lands is under miscellaneous trees and grooves. (Land Statistics, 2001)

Demography

The whole Population near Nagavali river basin as per 2011 census was found to be 6, 76,678 with density 150 / Sq.km. whereas the total population of the basin as per 2001 census was 5,78,143 and density of 128/ Sq.km. The uplands of Nagavali River basin having hilly topography are mainly inhabited by tribal population. (Census of India, 2011).

5.8.2 Livelihood:

Forest Products:

The forest rich basin especially on the upper basin areas of Odisha are rich with natural resources. Tribal and traditional forest dwellers highly depend on the forest goods as a means and source of livelihood in the area. Nearly 32% of river basin is covered with dense forest which supports the livelihood of people over the basin.

Agriculture

Majority of the population in the basin in Odisha part come under main workers which include cultivators and agricultural labourers. Major crops grown in the area are paddy, oil seeds, cotton and vegetables. The basin is surplus in cereal crops but deficit in cash crops like oil seeds and pulses.

In the recent years cotton and maize are being taken up as a commercial crop in a big way. As these crops fetch good price the local farmers have started cultivating these crop as a replacement of the minor millets, pulses etc. In an earlier phase of crop diversification or substitution the farmers has taken to eucalyptus, jatropha and lemon grass. But these crops proved to be non-remunerative for the farmers in the long run.

Industrial workers

Minor population comes under the marginal worker categories in the basin who work in the industries. According to the district administration of Rayagada (town on the bank of Nagavalli River) a population of 29052 of the total workforce of the basin are engaged as Industrial workers. (Orissa State Water Plan, 2004)

Fishing

Fishing is one more predominant activity in the river basin. There is enough potential for inland fishery inside the Odisha boundary. Net fish production of the basin is 1153.67 MT (2002-2003) which is about 0.4% of Odisha's fish production. Nearly 55 fishing villages in along the river and the mouth of Nagavalli River. (Orissa State Water Plan, 2004)

5.8.3 Urbanization and Industrialization**Urbanization**

The important towns in the basin are Lanjigarh, Amadalavalasa, Rayagada, Parvatipuram, Palkonda, Veeragattam, Srikakulam and Bobbili. Nagavalli River flows in the outskirts of Rayagada, a town and district headquarters of Rayagada in Odisha. Rayagada Municipality had a population of 57,732 as per 2001 census which is now 71,208 as per 2011 census. It also flows through Srikakulam town, the district headquarters in Andhra Pradesh, and finally joins the sea at Kallepalli village, located at a distance of 5 kilometres from Srikakulam town. (Census of India, 2011)

URBAN POPULATION OF NAGAVALLI BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Rayagada	Municipality	Rayagada	48,247	57,759	71,208	14.2416	9.328248
Chandili	Census Town	Rayagada	16,151	18,685	18,552	3.7104	2.430312
Total Population			64,398	76,444	89,760	17.952	11.75856

Table 42 Nagavalli Urban Population

Source: City population de

Industrialization

The basin does not have much large industries. The existing small scale industries are mostly oriented to forest and agricultural produce and are located in the Srikakulam Regional Economy. Manganese, quartz, mica, graphite, limestone, bauxite and construction materials are found in abundance in the Basin. JK Paper mills Rayagada situated on the bank of river Nagavali is one of the large scale paper mills producing high grade papers. The effluent generated in this paper mill is subjected to various treatments by activated sludge process and discharged into river Nagavali. However, the water quality of Nagavalli has remained a cause of concern. The river water influences the inhabitants of this area in many ways.

Projects: Irrigation, Power etc

Nagavali River and its tributaries host a number of irrigation projects.

Jhanjavati Project/ Rubber Dam is located on a tributary of Nagavali River called Jhanjavati, at Rajyalaxmipuram village in Komarada mandal of Vizianagaram district. It is the first rubber dam of the country and is the biggest of this kind in Asia. It is aimed to utilize 4 TMC of available water and to irrigate / stabilize a total ayacut of 24,640 acres in Vizianagaram District.

Thotapalli Barrage is located at village Thotapalli in Vizianagaram district and presently being upgraded as barrage.

Madduvalasa Reservoir is located at Madduvalasa village in Vangara mandal of Srikakulam district. It is built across Vegavati and Suvarnamukhi tributaries. The project is started in 1977 and provides water for 24500 acres of land for cultivation.

Narayanapuram Project is located in Burja mandal in Srikakulam district. It was constructed to support the irrigation to the agriculture fields in Andhra Pradesh. (Nagavalli, 2016)

5.9 Budhabalang

5.9.1 Land use land cover

Forest cover over Budhabalang basin is 175.83 Ha which is 36.34% of the total area under the basin. Whereas net sown area of the basin is 210.05 Ha which is 43.42% of the total basin area. Other waste land which includes barren land, fallow land, cultivable waste and permanent pasture in the basin have an area of 57.71 Ha. 28.656 Ha of land in the basin is put to non-agriculture use.(District at a Glance, 2004)

Demography

Including Budhabalanga and Jambhira basin, The Population was found to be 20, 08,156 in 2011, with a density of 316 / Sq.km(Department of Water Resources, Odisha, 2016) which was reported to be 1432618 in Budhabalang basin in 2001 with a rural and urban population of 1190748 and 241870 respectively as per census of India.

5.9.2 Livelihood

Primarily most of the people in the basin depend on agriculture. Total cultivable area in Budhabalang basin is 252581 Ha. It is interesting to see that basin receives fair amount of rainfall which is favourable for paddy crop. However, most of population own small land holdings and are subjected to uneven rainfall which results in poor yields over the basin. A population of 160959 are cultivators whereas 180226 are engaged as agricultural labours. 15861 population of the basin is engaged in trade and commerce as well as other services sector.(District Statistical Hand Book, 2004)

Animal Husbandry:

Forest rich Budhabalanga basin supports raising of animal husbandry. Farmers take animal husbandry as an added supplementary income and also as means of sustainable livelihood. Farmers raise cattle, sheep, goat, poultry etc for milk and meat. Basin had reported 525642 indigenous and 20144 cross breed cattle. Livestock census also reported 1086792 sheep and goat population. Poultry has been seen as most increasing trend over in the basin and has turned out to be great business for the farmers.(District at a Glance, 2004)

Fishery:

Budhabalanga supports both fresh water and marine fishery. Mouth of the Budhabalang is in Balasore districts of Odisha. Fish catch of 7039 MT marine, 478 MT Brakish and 1709 MT fresh water was reported in Balasore district. Upper river which flows mostly in Mayurbhanj districts had reported fresh water fish catch of 3696 MT. Thus river has been giving livelihood to population of basin and has been source of income for many.(District at a Glance, 2004)

5.9.3 Urbanization and Industrialization:

Urbanization:

The two important towns of Odisha are located along the river Budhabalang namely Baripada and Balasore. These have their own municipalities besides these there are also two NACs which come under the basin. These urban centres are thickly populated and much of the population is engaged in government sector services and trade.

URBAN POPULATION OF BUDHBALANG BASIN							
Town	Status	District	1991	2001	2011	Water Required Per capita/day (2011) in million lpd	Waste water generated per capita/day (2011) in million lpd
Baripada	Municipality	Mayurbhanj	49,619	95,004	1,09,743	21.9486	14.376333
Remuna	Notified Area Committee/Council	Baleswar	...	29,072	33,378	6.6756	4.372518
Baleswar	Municipality	Baleswar	85,442	1,06,082	1,18,162	23.6324	15.479222
						0	0
Total Poulation			1,35,061	2,30,158	2,61,283	52.2566	34.228073

Table 43 Budhabalang Urban Population

Source: City Population de

Industrialization

There are no big industries found in the basin. However medium and small scale industries are found in the vicinity of Baripada and Balasore. Among the two towns, Balasore is more industrialized which has Birla tyres and Oriplast pipes like medium scale industries. Whereas, Baripada hosts agriculture processing units like rice and oil mills besides this it also has textile mills in its industrial corridor.

Projects: Irrigation, Power etc.

There are at present four projects over the Budhabalang river basin which are used mainly for irrigation and flood monitoring purpose through various canal systems. The storage structures includes the following projects:

Sunei dam: It is situated across river Sunei, in Bhudhabalanga basin in the Kaptipada Sub-Division of District Mayurbhanj. The maximum height of the dam is 30 m. Length of earth dam is 1789 m and spillway length is 84.5 m. Catchment area at Dam site is 227 sq.km .The project irrigates 5200 Ha in Rabi and 10,000 Ha in Khariff.

The problems are: The hydrology needs review as the inflow recorded in 1999 was 2918 m³ /sec against PMF of 2874 m³ /sec. There is settlement on the crest of the dam. The relief wells need reactivation. Heavy erosion in the spill channel. Appreciable seepage at junction of earth dam and the ridge.

Kalo dam: The dam is located in the district of Mayurbhanj. It intercepts a catchment of 153 sq.km for providing irrigation to 4800 ha in khariff and 1920 ha in Rabi. An earth dam, partly zoned and partly homogeneous section of 2388 m length and 70m long spillway have been constructed across river Kalo in Budhabalanga basin.

The major dam safety problems are: There are cavities at the lower nappe of ogee spillway and longitudinal cracks at dam crest.

Arikul dam: A 16.74m high earth dam has been constructed across the stream near village Kamtamara within Khunta Block and Udala Tahsil of Mayurbhanj District. The project envisaged the construction of surplus Escape which is centrally located, a little away from the deep channel to the left. The head regulator was constructed to the left of surplus Escape. The designed ayacut of the project was 1052 ha in Kharif and 202 ha in Rabi. The dam was completed in 1980.

The dam safety problems are: The dam crest is uneven. U/s pitching has been disturbed. Depression of rip rap at three locations. D/s apron has cracked. Retrogression reached the dam toe

Badajore Dam: This is a zoned earth fill dam constructed in the year 1974 across Badajore nalla in Budhabalanga Basin and located near village Badajore in the district of Mayurbhanja. The length and height of the dam are 1621m and 12.00m respectively. Gross storage capacity at FRL is 3.55 Mm³. Khariff ayacut is 1184.40 Ha and Rabi Ayacut is 86.85 Ha. Catchment area is 43.70 km².

Problems identified: Longitudinal cracks are seen at many places. There is leakage of water through abutment wall. Ogee surface concrete has been damaged. All six Falls in the spill channel are damaged.

(State Dam Safety Organization, 2007)

Hydroelectric projects:

Only one mini hydroelectric plant of 2 MW is set in the right canal of Sunei irrigation project. Otherwise there are no big Hydro-electric projects over Budhabalang River.

Future Projects:

In upcoming to harness the water potential four more irrigational projects are proposed which includes Katra, Budhabalang, Sajo and Deokund irrigation projects.

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