ORISSA STATE WATER PLAN

EXECUTIVE SUMMARY

ORISSA WATER PLANNING ORGANISATION
DEPARTMENT OF WATER RESOURCES
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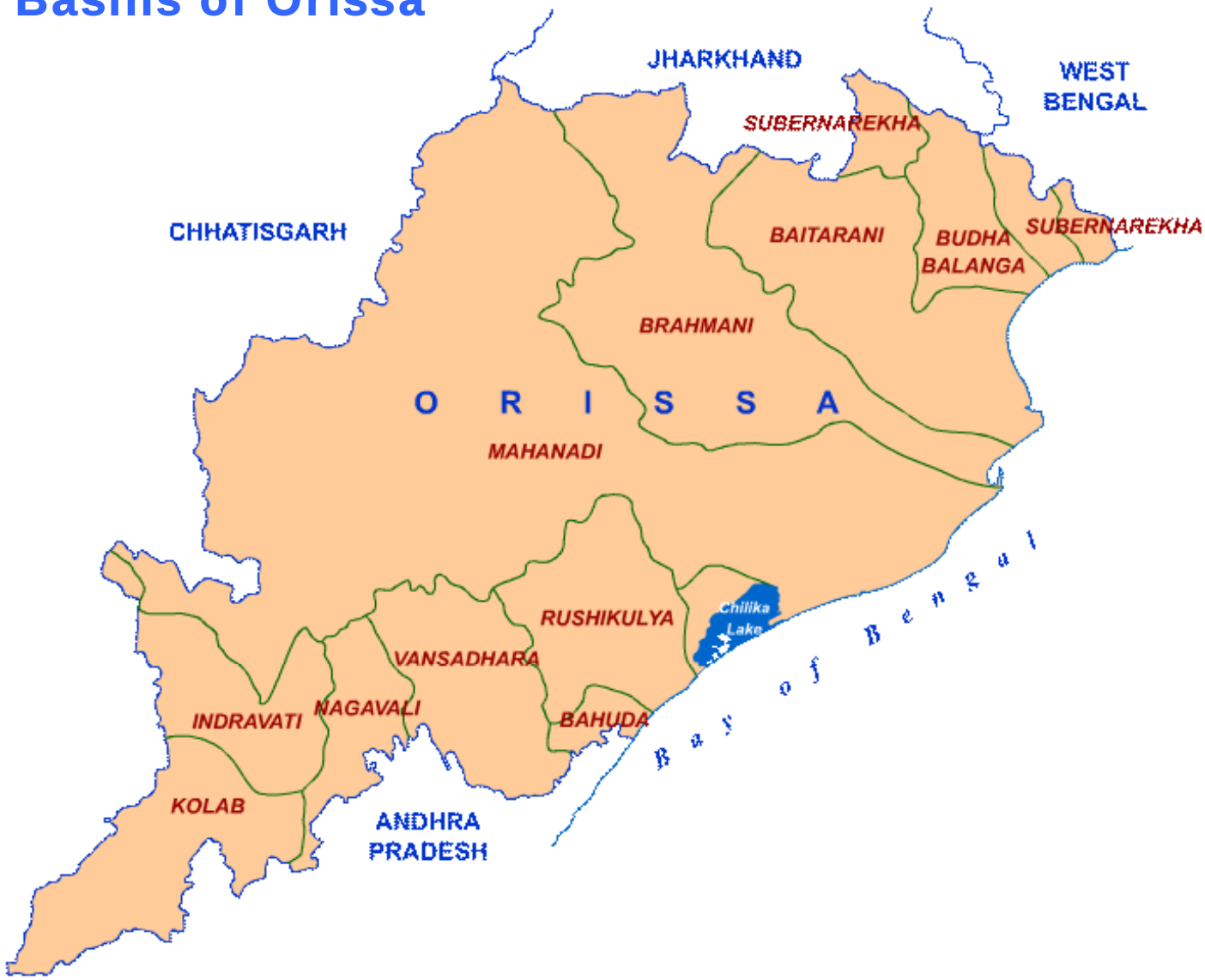
River Basins of Orissa



RIVER BASINS OF ORISSA

Sl, No.	Name of the Basin	Total catchment area in Km^2	Catchment area within Orissa in Km^2	Percentage of catchment area in Orissa to total geographical area of the state
1	Subernarekha	19227	2983	1.92
2	Burhabalanga &	4838	4838	3.11
	Jambhira	1853	1516	0.97
3	Baitarani	14218	13482	8.66
4	Brahmani	39116	22516	14.46
5	Mahanadi	141134	65628	42.15
6	Rshikulya	8963	8963	5.76
7	Bahuda	1118	890	0.57
8	Vansadhara	11377	8960	5.75
9	Nagavali	9275	4500	2.89
10	Kolab	20427	10300	6.61
11	Indravati	41700	7400	4.75
Sub Total:			151976	97.60
Area directly draining to sea			3731	2.4
Total:			155707	100.0

EXECUTIVE SUMMARY

1 THE STATE OF ORISSA

Orissa covers 155.707 km^2, which represents about 4.74% of the area of India. The 2001 Census established the State's population at 36.7 million. The average population density is 236 persons per km^2 compared to 312 for India. The composition of the Net State Domestic Product (NSDP) shows that Agriculture and Animal Husbandry continues to be the economy's dominant sector. The 30.75% of total NSDP this sector produces provides the bulk of what is produced by all primary sectors (39.23%) and outweighs by a factor of three the product of all secondary sectors (11.40%).

Orissa's Rs 5663 NSDP per capita represents only 55% of the national income of Rs. 10,254.

Unemployment is one of the major problems of the State. The State is urgently looking out for employment-generating and self-employment programs. Orissa is the poorest State in the country. The percentage of people living below the poverty line in all of India has been more than cut in half - from 55% to 26% - while in Orissa it decreased from 66% to 47%, still is the highest poverty rate for the States of the Union.

A. ORISSA'S RESOURCE BASE

Orissa is a land of possibilities. The State is endowed with bountiful of resources, people, land, water, forest, minerals and other minor resources. These resources can't be exploited to meet the basic human need and enhancing the State's economic conditions. Water plays an important role in exploitation of these resources and hence it is important to make a detailed study about these resources before attempting any water plan.

2 HUMAN RESOURCES

2.1 Population Size and Distribution

With an overall population of 36.7 million people, 5.496 million of the State's population live in towns. The corresponding rate of urbanization is 15%, compared to almost 30% to India as a whole. In 2001, the State's average population density was 236 persons per km^2. The gender ratio of the State is 972, which is slightly more than the country as a whole (933). The literacy rate overall is 63.61 % which is slightly lower than the country average (65.25%). The male literacy rate is 75.95% whereas female literacy rate is 50.97%, Only a third (11 out of 30) districts have a literacy rate more than 70%, most of which belong to the coastal area.

2.2 Backward Classes

Quite a large component of Orissa's population belong to the so-called backward class consisting of Schedule Castes and Schedule Tribes. Among the backward population the level of literacy is very low. They have a much greater incidence of poverty It has been estimated in the year 1999-2000 that while 48.01% of the rural population remain below the poverty line in Orissa, about 90% belong to backward classes.

2.3 Population Projection for 2051.

The National Population Policy 2000 aims to stabilize population that is to achieve zero growth rate of population by the year 2045. On the basis of declining growth rate population is expected to stabiles at 53.973 millions. This projection also assumes that the degree of urbanization will in early increase from today's 15% to 32% in 2051.

3 LAND RESOURCES

3.1 Soils

As may be seen, most soils in the state are reddish. The soils in the uplands basins and upper reverine plains are quite fertile and those in the lower reverine and littoral plains, extremely fertile. But some saline or saline-alkaline patches are also seen close to the coastline. The soils in the various plateaus and hills have only low moderate fertility.

Soil Quality

Quality of soil in Orissa on average is not good in comparison to other states of India. Orissa comes *a* poor 14 out of 17 major states in terms of soil quality. Water holding capacity of the predominant soil types of Orissa is rather low. The soil is mostly light textured and has weak granular structure and hence can be eroded easily.

4 MINERAL RESOURCES

Orissa is one of the richest states in terms of mineral deposits and holds a key for *a* very bright prospect for establishing a big industrial growth.

According to the estimates of the mineral reserves made in 1991-92 for India and Orissa, the State's share of the national reserves is very significant

	India Reserve	Orissa Reserve	
Mineral	(Million tons)	(Million tons)	%
Chromite	186	183	98
Iron Ore	12745	3567	28
Coal	213905	51571	24
Buxite	2911	1733	60
Nickel	294	270	92

(Source - Economic Survey, 2002-03)

Orissa occupies a high rank in mineral output of India. The production of mineral/ores from 1990-91 to 1997-98 Indicates a production increase in the range of 5 to 15%.

5 WATER RESOURCES

Orissa has abundant water resources considering the volume available to the State. The State receives its annual supply of fresh water from two sources. Surface Water and Ground Water, both derived from annual precipitation.

5.1 Surface Water

Long-term average annual rainfall of the State is 1482 mm. The annual rainfall, though substantial in quantity, is unevenly distributed in space and time. 78% of annual rainfall is received from June to September and the balance 22% is available in eight months.

There are 11 major rivers (Map 1) and streams flowing in the State. The longest and the largest is the Mahanadi and the smallest is the Bahuda. The Rushikulya and Budhabalanga entirely and the Baitarani mostly flows in the State and all others are interstate rivers. There are inter-state agreements for sharing of water in most of the rivers.

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.

5.2 Ground Water

According to the latest assessment, Orissa has annually replenish able ground water resource of 2,101,128 Hectare-Metre (HM). out of which 112.272 HM is committed for the domestic and industrial requirements for coming 25 years.

The average stage of ground water development in the State is estimated to be 14.79%. However the ground water development in different parts of the State is not uniform.

Average surface and groundwater potential of the State is 141 BCM at present which is estimated to reduce to 129 BCM in 2050. Taking the growth of population into account the per capita availability works out to 3811 m^3 at present and will reduce to 2481 m^3 in 2050.

6. FOREST RESOURCES

6.1 Forest Area

In 2000-01, the forest areas administered by the two concerned departments were the following:

		(km^2)
Department of Forest & Environment	Reserve Forest	26,329
	Unclassified Forest	21
Revenue Department	Total	26, 350
	DPF	11, 686
	UDPF	3.839
	Other Forests	16.261
	Total	31.786
Orissa Forest Area		58.135

The forest survey of India (State Forest Report 1999) reports that the dense forest with crown density more than 40% is only 26,730 km^2 and forest with crown density between 10 to 40% is 20,745 km^2.

Forest area in the State is of the order of 37%, which is more or less satisfactory, But in reality, the forest cover is dwindling fast. Thus, closed forest area - a measure of effective forest cover - has become only about 17% of the geographical area.

6.2 Wildlife

Orissa has a fairly rich and varied fauna due to diversified topography and existence of natural habitat. There are one biosphere reserve, 18 sanctuaries, two National parks over an area of 6,677.50 km^2 of forest which is 10.30% of State forest area and 4.10% of total geographical area of the state. According to 1998 census of wild life, there are 84 types of reptiles, 446 types of birds and 65 types of mammals in Orissa forest.

7 FISHERIES RESOURCES

7.1 State's Resource Potential

Orissa's fish production comes mainly from two sources: inland fishing and marine fishing.

Inland Fishing

	Water Area (ha)	Resource Potential (tons)	Level of Output (tons)	Output-Resource Stock Ratio
Fresh Water	706,222	307,282	130,401	42%
Brackish Water	417,537	65,935	13,601	21%
Total Inland	1123,759	373,217	127,046	39%

Marine Fishing

Orissa has a long coast line of 480 km. The area of continental shelf (0-200 m depth) amounts to 24,000 km^2, the largest in the country. Thus Orissa has a vast potential of marine fishing.

Fish Production

During 2001-02, out of the total fish production of 281,950 tons 120,050 tons were cultured and the balance of 161,900 tons was from captured fisheries.

The total value of fish production in the State increased from Rs 1045.81 crore during 2000-01 to Rs 1120.81 crore during 2001-02. Out of total value of fish and prawn production in the State during 2001-02, the value of marine fish stood at Rs 336.08 crore, fresh water fish at Rs 521.02 crore and brackish water fish at Rs 263.71 crore.

B. THE USE AND MANAGEMENT OF WATER

8. DOMESTIC USE

8.1 Water Demand

Daily Water requirement differs from person to person depending upon his habits and occupation. Depending on the standard norms of water supply for rural, urban population and livestock total water demand for the State has been estimated.

Domestic water demand in MLD (million liters per day) for the entire State has been computed as follows:

Year	Human	livestock/ Poultry	Total
Present Demand (2001)	1236	96	1332
Future Demand (2051)	1588	123	1711

Part of this demand will be supplied from surface water and the balance from ground water

sources.

Total future water demand (2051) for domestic water supply is 1146 million m^3 from surface water sources and 1718 m^3 from ground water sources.

The demand forms only 1.7% of surface water and 13.6% of ground water available in the State.

Although on an annual volume basis there seems to be no problem in supplying water to the entire population, the problem remains to make water available to all through out the year. In most cases surface water is available only for few days in a year and has to be stored in sufficient quantity to last for the year. Thus source, storage and distribution has to be analyzed case by case.

As an improvement over taking the State as a unit, individual river basins have been studied Water demand for the basin has been calculated at several locations and simulations run with a time step of a month, with an overall objective that water at these locations in all the basins is adequate for human needs.

9 AGRICULTURE

It will be noticed that net sown area of the State is about 60 lakh ha. Most of the land holdings in the State are less than 2 ha in size. As per 2001 census the marginal land holders (up to 1.0 ha) and small land holders (from 1.0 up to 2.0 he) constitute 53.61 % and 26.2% respectively of total land holdings and combined constitute about 80% of farm holders of Orissa. The marginal farmers, who constitute about 54% of the total landholders in Orissa possesses only 0.50 ha of land size on an average. The marginal and small farmers, who constitute about 80% of farming community, own only 50% of the land. Medium and large farmers, who constitute about 18% of the farming community. own the other 50 per cent.

9.1 Cropping Pattern and Cropping Intensity

Cropping Pattern

The principal crop grown in Orissa is rice. Rice is grown on $4/5^{th}$ land area. About 90% of total. cultivated area grows food grains.

In recent years, the rice dependent agriculture of the State has produced a glut in rice bringing down its price. The economic condition of the farmers has not improved over the years. A shift towards commercial crops appears essential.

Increase in irrigation coverage has induced some farmers to grow commercial crops like sugarcane, cotton, groundnut, potato, jute etc. Farmers of Kalahandi, Koraput, Bolangir, Nabarangpur and Rayagada have taken to cotton farming. The Government is encouraging farmers to grow sugarcane to feed the Sugar factories of the State. .

The State has vast potential for horticulture. The hill tracts of Kalahandi, Gajapati, Koraput, Kandhamala are suitable for horticulture. The state Government has taken steps to encourage these activities.

Area under fruit cultivation in 1999-2000 was 2.44 lakh ha. A number of fruits like mango, pineapple guava, sap etc, are grown in the State. Almost all the fruits like apples, oranges, grapes, and bananas are imported into the State.

Cropping intensity

The cultivated area of the state is 61.65 lakh ha and may be taken as provisional. In 2001-02 the Khariff area was 60.61 lakh ha. and Rabi area was 23.57 lakh ha. The total cropped area was 87.99 lakh ha. The crop intensity thus works out to be 144%. In general the cropping intensity varies from 110% to 150%.

Production and Productivity

Eyen though agriculture has remained the principal occupation of the people of the State, production has remained stagnant for several years. The crop productivity is among the lowest in the country.

Study of crop area, crop yield and production from 1970 through 2001 shows that the average crop yield works out to 918kg/ha with the following factors contributing to the State's low crop productivity:

- traditional farming practices
- low use of yield -stimulating Inputs like HYV seeds, chemical fertilizer etc,
- small size of operational holdings and tenancy
- low coverage of dependable irrigation
- low capital formation / investment
- incidence of natural calamities

Besides socio-economic condition of farmers lack of adequate extension, rural infrastructure and user involvement contributes in a big way towards low productivity of the State.

In order to meet future food demand improving crop productivity would be cost effective. Advancement of farm technology, assured supply of irrigation water and higher input of fertilizer and pesticides will improve the crop yield for future projects considerably. The crop yield in average for Khariff is assumed to grow linearly and reach 35 Qtl/ha. for irrigated and 20, Otl/ha. for rain fed paddy by the year 2051.

9.2 Irrigation

At huge public costal potential of 25.89 lakh ha. in Khariff and 11.17 lakh ha. in Rabi has been created. But hardly 70% of this potential area received irrigation. The actual figure of the potential utilized is under joint verification of Revenue Department and Department of Water Resources.

Major Irrigation

In the State major and medium projects potential has been created to provide irrigation to 12.21 lakh ha. in Khariff and 5.361akh ha. in Rabi. Evaluation studies carried out by several agencies, so that the potential created by these projects has not been fully utilized. The reasons are (i) non-completion of critical components (ii) system deficiency (iii)management inefficiency (iv) lack of maintenance and (v) lack of coordination 'among users.

Minor (Flow) Projects

In this sector alone irrigation to 4.64 lakh ha. in Khariff and 0.71 lakh ha. in Rabi has been provided. There are several partially and completely derelict (PDCD) projects-which are unable to provide irrigation, The status of these projects should be properly studied and PDCD projects fit to be rehabilitated should be brought back to operational condition.

Minor (Lift) Projects

Potential created in this sector is, 3.471akh ha, (as of June 2003). Authentic evaluation of performance of these projects has not been made. Rehabilitation of the defunct projects has now been taken up by the Pani Panchayats.

As more than 70% of the population of the sate are directly dependent on agriculture, Improved agriculture will bring in food and prosperity to a majority of people of the state.

The ultimate irrigation potential of the state is now estimated as follows

(Lakh ha)

Major and Medium	28.8
Minor (Flow)	9.7
Major River(Lift)	2.0
Creek Irrigation	0.5
Minor (Lift)	8.9
Total	49.9

9.3 Food Security

Estimation of Food Requirement

On the basis of the nutritional requirements and the present and ultimate population of the river basins, the demand for food grains in the individual basins in the years 2001 and 2051 is estimated. For paddy, the basin requirements as up to 93 lakh tons in 2001 & 1361akh tons in 2051.

It is estimated that irrigation facilities covering some 32 lakh ha would be required to achieve full food security.

To achieve this potential irrigation from different sources would be distributed as follows:

(Lakh ha.)

Major/Medium flow schemes	18.00
Major River Lifts	1.00
Minor Flow	7.00
Minor Lift	6.00
Total	32.00

The existing schemes, together with the completion of the ongoing schemes would be sufficient to provide the required irrigation potential

10 INDUSTRY AND MINES

Despite high potentials. Orissa ranks one of the least industrialized states in India contributing about 2% of the country's industrial output. A comparison of state-wise industrialization level shows that Orissa has consistently been among the least industrialized states far the last 40 years.

Natural resources based industries constitute a major share of Orissa's industries. It is to be noted that though Agriculture contributes significantly to NSDP there are hardly any agro industries in

the state. Likewise there is hardly any value addition to the natural resources industries. The ores are exported in raw form without converting them to more profitable products. engineering goods and chemicals have a low share in industries.

10.1 Water Requirements

Steel Industry

Steel production in Orissa is assumed to increase from 5 million tons per year in 2001 t0 15 in 2010 and 25MT in 2050. The increase is expected to be the result of additional capacity installed, in the Brahmani, Baitarani and Rushikulya basins. The future water demand from these rivers produces the following annual water requirement in million m^3

Yar	Brahmani	Baitarani	Rushikulya
2001	180	45	-
2010	200	60	40
2050	300	100	100

Aluminum Industry

The Aluminum Industries at present are operating at three levels i.e. mining, refining and smelting. For mining and refining local river and stream water are used and for smelting power intensive input is required far which captive power plants are installed. The sources of water far the present and proposed projects t1ave been identified.

The water demand far each project is being worked out.

Cement Industry

The cement industry in Orissa has been developed in Sundargarh, Jaharsuguda and Bargarh district due to availability of abundance of lime stone, clay and coal. The location of cement plants and water sources have been identified.

Thermal Power Plants

Orissa has vast deposits of coal which induces in setting up a large number of Thermal Power Plants. Additional thermal plants are being considered in the State. Assuming that 1 MW of installed capacity requires 80 m^3 of water per day, the water requirement of the proposed thermal plants has been estimated.

Industrial water requirement has now been computed based an industrial workers population and on probable growth of industry and pro-rata consumption for unit of industrial production. These figures would be revised in future when full information is available.

Basin-wise Industrial Water Demand

In the absence of number and location of industrial units in the state, it is not possible to make a realistic projection of industrial water demand. Industrial water requirement can be worked out in an indirect manner based on number of industrial workers. A relation has been developed between rural labour force and industrial workers. Industrial water requirement has been considered as 900 liters per capita per day (Lpcd) for each industrial worker and the requirement has been reduced to 650 Lpcd by 2051 due to assumed technological advance. For the Brahmani, Mahanadi, Baitarani and Rushikulya basins, a more detailed estimate based on the expected growth of industrial output has been worked out.

Reservation of Water for Industrial Use

With its notable concentration of natural resources Orissa's industrial development seems inevitable. In the absence of relevant information. It is not possible to project when, where and what type of industrial growth will take place. However, water can be reserved as proposed in the State Water Plan.

11. ENERGY

Hydro Power

There are 6 hydropower stations in the state namely Hlrakud, Balimela, Rengali, Upper Kolab, Upper Indravati and Machhakund Power stations, The Installed capacity of these Power stations is 1976.25 MW and the state's share is 1918.5 MW. The power annually generated from these stations is about 750 MW.

The total share of the state is 3477.50 MW out of which thermal power is 880 MW and from Central sector is 679 MW. Thus hydropower has got a share of 55% in the State's generating capacity.

The present power demand of the state is 1600 MW and the peak demand is 2000 MW. The State has to buy some 50 MW of power from the captive power plants in the State. There is still much potential for hydro power generation in the state.

The hydro power stations alter the flow regime in the downstream. A study by experts is necessary to check that the alteration of flow does not affect the sensitive species down stream.

12 NAVIGATION

It was planned by the British Government in the 19th century to use the rivers of Orissa to provide a water way from Cuttack to Calcutta. A number of structures like weirs, navigation locks,

channels were constructed, The transport worked for some time but was soon replaced by the railways first and then by road transport. A part of the system is still functional and is used for transport of goods. No big scale navigation proposal is planned as cheaper and safer transport alternatives are now available.

13 RECREATION AND TOURISM

River Sports

River Sports are now gaining popularity as adventure sports. Vast potential lies in reaches of Mahanadi, Brahmani and Baitarani.

Lakes and Reservoirs

Orissa boasts of Asia's largest brackish water lake, Chilika which has immense tourism potential. Besides, the man made reservoir are scenic places and attracts tourists. Properly exploited these sites will be money grosser for the Government

Water Wild Life

Birds and dolphins in Chilika are tremendous tourist attractions during winter. Similarly crocodiles in Bhitarkanika and Satkosia are also crowd pullers.

Sea beaches

There are beautiful beaches like Puri, Gopalpur, Chandbali and lesser known Konark, Chandrabhaga and other virgin beaches which can be developed as tourists' attractions.

14 WATER QUALITY

Water Quality of Major Rivers of Orissa: Summary

Mahanadi

In spite of many towns in upstream, the Hirakud reservoir water almost conforms to Class-B (outdoor bathing), except for sporadic increase in the Total Coli form (TC) values.

There is deterioration in the water quality at Sambalpur downstream (D/S) which continues approximately up to a distance of 2.5-3.0 km. From this point to Sonepur (about 60 km along the river course), the river travels through a region with no major urban settlement or waste water outfall. Thus the water quality at Sonepur upstream (U/S), which is immediately downstream of Ong confluence, is quite satisfactory. The 100km stretch of the river from Sonepur to Tikarpara does not have any industry or urban settlement on its banks and there is no major wastewater outfall. From Tikarpara to Narsinghpur (about 40km), river flows almost completely undisturbed.

Hence relatively clean, unpolluted water is expected at Tikarpara and without much change in quality at Narsinghpur.

During its course from Narsinghpur to Cuttack (about 50 km), the river conform is to Class-C (drinking water source with conventional treatment followed by disinfections). Within the city the river receives considerable untreated wastewater and the water quality get further deteriorated up to a distance of about 2.0 km.

Brahmani

From the water quality monitoring data, it is seen that there is a general deterioration of water quality at Panposh *(D/S),* Rourkela *(D/S)* and Talcher *(D/S).* This is an expected observation, since a number of large and medium industries and mines are operating at Rourkela and Angul Talcher industrial complex and the industrial and domestic waste water generated in these two areas ultimately find their way to Brahmani.

The water quality status remains more or less the same up to Talcher (U/S) through Bonaigarh. Rengali and Samal, since there are no major urban settlements or wastewater outfalls in this stretch. This stretch conforms to Class-C quality criteria, There is a decline in the water quality at Talcher D/*S.* However, after a distance of about 3-4 km, there is sufficient restoration to conform to Class-C, which continues up to Pattamundai through Bhuban and Dharmasala (about 170 km). The magnitude of improvement in the water quality in this stretch is, however, not the same as that in the Bonaigarah-Rengali-Samal stretch, since there is increase in the population density and intensity in agricultural activities as the river enters into the deltaic region.

Subarnarekha

The river conforms to Class-C inland surface water.

Nagavali

In the Orissa portion of the basin there is only one major town, Raygada where, two major industries are presently operating. 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 water quality should normally be fit for all beneficial uses.

Rusikulya

Industrial activities are confined to three locations namely, Aska (sugar and distillery), Ganjam (caustic soda, chlorine and hydrochloric acid), Chhatrapur (rare earths). The amount of domestic wastewater generated from the 18 urban centers in the basin is about 29.000 m^3/day. The water is expected to be of fairly acceptable quality in the major stretch of the river.

15 ENVIRONMENTAL FLOW

15.1 The Concept of Environmental Flow

There is now an increasing recognition that modification to river flows need to be balanced with maintenance of essential water dependent ecological systems. The flows needed to maintain these services are termed "environmental flows" and the process for determining these flows is termed "environmental flow assessment" or EFA.

In the instant case, the basin has two distinct seasons, wet or monsoon season and dry or non-monsoon season. Instead of using average annual flow (MF), the concept of average seasonal flow (ASF) is used. The proportion of ASF to be prescribed as EF should be decided in consultation with some local reputed experts on the subjects. The following proportion of ASF has been taken for deciding EF for the basin.

Monsoon	Non-monsoon
40%	50% Outstanding
30%	45% Excellent
20%	30% Good
10%	20% Poor
<10%	<20% Severe Degradation

16 STATE WATER BALANCE

Overall water balance for the state is presented in Table 1.

17 WATER MANAGEMENT: CRITICAL FACTORS

17.1 Water Conservation

Water is becoming increasingly scarce resource day by day. Even water rich area need to conserve water for two simple reasons. (1) Increasing demand from population alone will force us to conserve the scarce resource (2) new development is financially and environmentally getting more and more expensive. Wiser use of water will eventually become more economical as its scarcity value increases.

The principal users of water are agriculture, domestic consumers and industry.

Water Conservation in Agriculture

Even though any regular measurement of irrigation efficiency has not been made in the State, it is generally observed that over all efficiency is of the order of about 40%. There are several water

conservation technique that can be applied to improve efficiency.

Unlined earthen canal convey water to the field and it is largest source of loss of water and amounts to as high as 45 to 50%.

It is advisable to line the canal at least in permeable reaches using cost effective and durable lining materials.

Field level Conservation

Field application efficiency can be improved using agronomic methods like use of short duration crops, improved crop varieties, Some crops like rice have shown that up to 20 -25% reduction in theoretical crop demand during the crop period does snot affect the Crop yield very much if water is delivered at critical growth periods. The method of supplying less than theoretical requirement during non-critical period of growth is called 'deficit' irrigation and should be applied to conserve water.

Water Conservation in Domestic Water Supply

The loss in urban water supply arises from (i) delivery loss and (ii) end use loss. Delivery loss is generally termed as un-accounted for water (UFW). UFW in Orissa could be in the order of 50 to 60%. The physical component of UFW arises out of leaks in pipes ad over flows in over head tanks. The administrative component is the amount used but not paid for (unauthorized connections). Even though urban water supply and loss form a small fraction of water resources of the State, the lost water is treated potable water and hence expensive. It is advisable to detect, and plug the leaks in the delivery system early.

End use loss arises out of over designed fittings and plumbing. Low flush toilets and low flow shower-heads can reduce water use by 20 to 30%. If pipe pressure is reduced same service can be obtained by spending less water. The water saving fixtures may be encouraged for installation.

Water Conservation in Industry

Industry uses water for cooling, cleaning, processing and removing wastes. Orissa has steel, aluminum, fertilizer, chemical, paper industries and some thermal power plants. Thermal Power Plants use large amount of water for cooling. Large percentage of water used for industry is returned to the water cycle but with altered temperature and chemical properties. Most industries now recycle used water and only take in 'make up' water.

Waste-water reuse

As a technique of water conservation, wastewater from industrial and municipal use can be treated to required standards and then used directly or indirectly after mixing with fresh water. In addition

to serving the purpose of water conservation waste-water reuse will reduce pollution of fresh water.

17.2 Participatory Irrigation Management

Public controlled irrigation systems have not performed well. User-Manager interface in these systems has always been weak and the user is never satisfied with the services. User has a direct interest in the operation and efficiency of the system as he has his investment in farming at stake. Experiments in participatory irrigation management (PIM) in India and abroad in the last decade had been a success. PIM has been introduced in Orissa after careful planning. The water user associations in the State are called Pani Panchayat (PP). ani Panchayat Act and Rule provide the required legal back bone to the process.

Users participation in irrigation was introduced in the State under World Bank assisted Orissa Water Resources Consolidation Project (OWRCP).It was proposed to form 698 Pani Panchayats in 33 Projects covering an area of about 332,079 ha in two phases. But as per revised programme, basing on ground condition 692 Pani Panchayats will be formed for 320,084 ha in two phases.

Thus, 668 Pani Panchayats out of the proposed 692 have been registered and 576 have signed agreements to take over 0&M of canals under their jurisdiction.

Being encouraged by the progress of Pani Panchayat Programme under OWRCP, the management of DOWR have decided to extend the Pani Panchayat programme to all the remaining command area of 14.51 lakh ha covered by Major, Medium, Minor (flow) and Lift irrigation Projects. Out of 14.51 Lakh ha it has been programmed to form Pani Panchayats in 7.63 Lakh ha in the first phase (starting from 3/02). The balance area of 4.60 Lakh ha under Major & Medium Irrigation Projects will be completed by end of 2005.

In Major and Medium, 42 projects covering an area of 4.10 Lakh ha 937 Pani Panchayats have been programmed in the first phase and 430 have been registered covering an area of 1.84 lakh ha so far. .

17.3 Pricing of Water

The Second Irrigation Commission (1972) carefully examined the matter of water pricing and suggested that water rates should cover the working expenses and interest on capital. The fifth Finance Commission recommended a return of 2.5% of capital investment over and above the O&M costs. The 6th and 7th Commission recommended to recover at least the cost of maintenance. The 10th Finance Commission again recommended O & M costs plus 1 % on capital investment.

Looking at the benefits, water rates should be proportional to the incremental benefits from irrigation. It is a general principle to fix water rates at 3 to 5% of value of produce. In Orissa, the differential production with irrigation is about 2 tons of paddy costing about Rs. 10,000/-. *So a* water rate of Rs. 300 to *500/* ha is appropriate.

The water rates should also take into the ability of farmers to pay. This criterion is very relevant to Orissa as about 80% of its farmers are marginal and small farmers. A concession rate (say 50%) may be applied to a farmer whose land holding is less than 1 ha. Further, Orissa is subject to disasters and water fees may be waived under certain circumstances in a given year.

Area based tariff is considered easy for operation but as the collections show it is rather more complicated and difficult to apply. The area based rate structure is an adhoc system and has no relation with supply or service. This structure encourages water waste and reduces water productivity. This leads to adoption of high water consuming cropping pattern and results in uneven distribution of water in the command area.

In order to address these problems, volumetric pricing of water has to be introduced. Orissa Irrigation system is not equipped at present to switch over to a volumetric basis of water rate. A gradual change over is recommended - the sooner, the better.

Immediately the micro systems may be converted to the volumetric system. Supply to Pani Panchayats (PP) may be made on volumetric basis. The responsibility of charging and collecting from individual farmers may be left to the PPs.

17.4 Cost Recovery

DOWR plans to recover the O&M costs in full by realizing it from the agriculture and Industrial consumers.

The present O&M cost for Major, Medium and Minor Irrigation Sector is about Rs 60 crores (Major & Medium - 52 crores and Minor - 08 Crores), The Government of Orissa has increased the water rate far Industrial and Commercial Water use in 1994 and both agricultural and industrial

water rates in 1998. The present estimated potential revenue (water rate) is about Rs 60 crores as per DOWR records and would be generated in he different sectors as follows:

(Rs. crore)

Urban & Municipalities	2.00
Power Plants	20.28
Industries	10.00
Agriculture	30.13
Total:	62.41

17.5 **Private Participation**

Water Resources development and management in the State is mostly run by the government. The Government of Orissa, in particular, has very limited budgetary resources and cannot find money for new development. There are not even any funds for maintenance of already existing works. Thus the water service sector is in an unsatisfactory state. Poor people of the state have no access to clean fresh water and the public system may not be able to find a solution in near future.

The answer appears to lie in seeking private participation in development and management; but obviously the private entrepreneur will not be interested unless it is commercially profitable. There is always the danger of over commercialism and losing sight people's right to access to clean water.

Water is fast becoming the 'blue gold' of the 21st century. The gap between increasing demand and shrinking supply of water is attracting commercial organizations to invest in water. Elsewhere in the world, the experience has not been very happy. It is therefore not wise to open the flood gates to private participation in all spheres of water; but a cautious approach should be employed. Only surplus water should be allowed to be exploited commercially and only for production of commercial goods. Industrial and agricultural uses can have private participation. Water for basic and domestic needs should be under Government control but management may be left to user organizations or suitable social organization.

18 NATURAL HAZARD DAMAGE MITIGATION

Orissa is frequently visited by natural hazards like floods, cyclones and droughts.

18.1 Floods

Major east flowing rivers like Mahanadi, Brahmani, Baitarani, Subarnarekha and Rushikulya fall into the Bay of Bengal in Orissa, They form their delta in the State where the land is very flat. During monsoons, they carry enormous amount of water which overflow the banks and cause flood. Besides these rivers, Vansadhara also causes floods in Gunupur - Kashinagar area.

The flood problem of the state is generally more pronounced in the Mahanadi-Brahmani-Bataranl delta. The three rivers form several branches in the delta and get intermingled among themselves Mahanadi floods are the most severe and if they are contained most of Orissa's flood problem will be solved.

18.2 Cyclones

The Bay of Bengal is a breeding ground of cyclones. Generally a cyclone originates as a low pressure in the Bay, becomes a depression and then gets converted into a "cyclone". Depending upon the associated wind speed, the cyclone may be a severe one or a very severe. When traveling over the Bay, the cyclone collects water particles and after crossing the coast causes wide spread rain. A cyclone has three devastation causing factors (i) high speed wind (ii) heavy rain and (iii) surge. In general, the Orissa coast receives 2 to 3 cyclones every year, the most severe one was the super cyclone of 1999, wind speed >300 kmph. rainfall >500 mm, tidal wave 3-6 m]. which left more than 12000 dead.

Cyclones generally bring with them strong winds, extensive and heavy rainfall, costal inundation, and/storm surge. Frequency studies of cyclones show that major cyclones have a return period of about 10 years.

18.3 Drought

Like floods and cyclones droughts are also regular visitors to the State. The basin studies have analyzed frequency of droughts. A drought prone map has been prepared by extending the basin maps to the State level.

Drought proofing

As a drought proofing measure, water available in the basin may be harnessed/stored in reservoirs.

Sometimes even though the total rainfall in a year is adequate to sustain crops, due to long dry spells the crops may fall. In such situations, small within-the-year storages may suffice. This storage can be achieved by

(i) Small within-the-bank storages by a series of check dams.
(ii) A series of small command area reservoirs connected to a major stream at diversion point. Connecting existing irrigation channels to existing or new ponds/tanks.
(iii) Transferring water from water surplus basins to deficient basins.

A liberal evaluation and cost-benefit analysis may be adopted for such cases.

C. STATE WATER PLAN

19 ISSUES, PROBLEMS AND ACTION PLAN

The issues and problems Identified are described under the following headings:

- Laws and Institutions .
- Environment
- Basic Human Needs
- Food Security
- Economic Development
- Poverty Reduction
- Disaster Management
- Hydraulic Infrastructure

The State Action Plan embodies the actions necessary to respond to the issues and problems identified above. The Plan is expected to guide the interventions required for the rational and effective management of Orissa's water resources, with a view to contributing to the realization the State's potentialities.

19.1 Indicative Actions

Appropriate actions to be undertaken in the various programme areas are identified below. They will need to be operationalised in the form of projects.

The projects are the responsibility of the line agencies, local governments and others, and are to be developed and implemented by them within the framework of the State Action Plan and in accordance with the Government's procedures.

Component / programme	Indicative Actions
Laws and Institutions	
State Water Policy:	State Water Policy to be approved by Water Resources Board and promulgated by the Government of Orissa.
Laws and Regulations:	Review existing laws and regulations governing water management at all levels and assess with respect to the new State Water Policy, the State Water Plan and. the Basin Plans. Identify laws and regulations that need to be modified or added . . I o the existing legal framework to ensure that water-related matters are appropriately dealt with in a context of Integrated Water Resources Management. Develop required texts and submit 'for promulgation by the competent authorities
Institutional Framework:	Implement the reform of the institutional framework for water resources management in accordance with the revised legal framework. Provide all stakeholder departments with the human and material means necessary to deal effectively with their water related responsibilities
Knowledge Base & Research	Implement an internet based system allowing the sharing of water related data and information by stakeholder departments. Undertake studies to fill knowledge gaps in the database, as required for effective water resources management. Undertake research on critical water-management issues such as water-use efficiency and the pricing of water for domestic, agricultural and industrial use
Local Government Capacity.	Strengthen the capacity of local governments (both urban and rural) to perform functions of effective water management.
W**ater User Groups**	Continue supporting the creation of water user groups across the State, giving priority to public schemes being rehabilitated and strengthen their capacity to effectively assume their responsibilities, including the efficient use and conservation of

	including the efficient use and conservation of irrigation water.
Participatory Mechanisms	Establish River Basin Organisation (RBO) in pilot basin. Conduct public awareness campaign in pilot basin. Extend RBO concept to additional basins.
River Basin Planning	Bring all river basin plans to the fourth spiral level. Periodically update river basin plans.
State Water Plan Implementation	Each stakeholder department to develop detailed plan for implementing Programmes in its area of responsibility, including cost estimates and scheduling of required activities or projects. Consolidate stakeholder plans into a comprehensive executable State Action Plan.
Environment	
Upper Watersheds	Assess extent and degree of degradation of upper watersheds and status ongoing restoration and protection work. Apply community-forestry approach to the restoration of forest Cover.
Mining & Industrial Pollution:	Enforce clean-up of excessive pollution from existing industrial and mining operations.
Water Quality Monitoring:	Strengthen monitoring network and improve dissemination of data and information to stakeholder departments and the public.
Wetlands	Develop approach to the integrated management of the coastal wetlands' land and water resources, with a view to preserving their bio-diversity and developing tourism. Apply the approach to the most seriously threatened wetlands.
Aquatic Ecosystems	Undertake the study of threatened aquatic ecosystems, as required to estimate environmental flow.

Basic Human Needs	
Urban Water Supply, Sanitation & Storm-Water Drainage.	Develop concept integrating the management of water supply, Sanitation, solid waste disposal and storm-water drainage in urban agglomerations Apply concept to a pilot agglomeration, focusing on the creation of a competent local organisation to operate and maintain the required facilities, to recover costs and to provide adequate services to the poor Apply lessons learned at pilot agglomeration to other agglomerations. Develop zoning by-laws for Urban Local Bodies, taking into account the need for effective water supply and sanitation facilities and for unimpeded drainage of rain water.
Rural Water Supply and Sanitation	Develop concept for community management of water points (dug wells, tube wells, springs), including the training of the community's management and supervision committees. Apply concept to the villages of pilot development blocks, where each block is representative of its region's hydro-geologic and socio-economic conditions. Develop state-wide approach integrating public health and technical considerations to dealing with the threat of excessive levels of harmful substances found in the groundwater of certain areas. Identify water bodies polluted by human waste beyond acceptable limits Conduct public awareness campaign at identified sites and assist population in installing adequate individual sanitation facilities

Food Security	
Surface-Water Irrigation Schemes.	Raise output from existing major, medium and minor (flow) irrigation projects by: a) executing works to effectively deliver water to the schemes' entire command area, and b) increasing the land's productivity through increased water-use efficiency and use of modem inputs.

	Complete on-going major and medium projects and ensure achieving rapidly full utilization and high productivity through providing timely appropriate support to water users groups. Implement new minor (flow) irrigation projects, giving priority to areas where the irrigation coverage is below the state average
Ground Water Irrigation	Identify areas where groundwater is available in sufficient quantity to be used for irrigation after having satisfied domestic demand. In tile identified areas, provide support to farmers or farmer groups in getting equipped for irrigation from groundwater, giving priority to areas where the irrigation coverage is below the state average. Accelerate the transfer to farmers of all but the largest public groundwater irrigation schemes. Promote conjunctive use (by the farmers) of groundwater in parts of gravity irrigation schemes threatened by water logging.
Soil & Water Conservation	Promote and support soil and water conservation practices in agricultural watersheds, including rain water harvesting and recharging ground water.
Economic Development ***Farm Incomes*** ***Agro Industries***	 Intensify agricultural extension support to improving the land's productivity, as required to raise farm incomes. Provide agricultural extension support to converting from paddy to cash crop production in areas where the market for such crops is economically accessible. Promote establishment of industries processing cash crops.
Poverty Reduction Small-Scale Irrigation	 Assist marginal farmers without access to the command area of a formal irrigation scheme in exploiting the full potential of the land available to them through rain water harvesting and groundwater irrigation.
Disaster Management Flood & Cyclones	Undertake flood and cyclone hazard mapping and develop land use zoning and regulations. Design and implement for each threatened area a comprehensive set of emergency preparedness and response measures, including, for example, flood forecasting and warning, and construction of public shelters, as well as rules of effective coordination of the efforts of local governments and concerned state agencies.

Drought	Carry out public awareness campaigns and assist threatened populations in flood proofing their houses where feasible. Promote, in rural areas not served by formal irrigation systems, techniques of water harvesting and conservation. Assist population in developing groundwater resources where necessary & feasible.
Hydraulic Infrastructure	
Water Allocation and Transfer	Assess Orissa's overall resource base with a view to identifying areas where water represents or will represent a serious constraint on socio-economic development in the medium term. Undertake pre-feasibility studies of the most promising possibilities of transferring water from a water-rich to a water poor basin.
Inter-Seasonal Water Storage	Carry out feasibility studies *of* the transfer schemes passing the pre-feasibility assessment Based on the results of the river basin studies, identify the most promising reservoir sites and undertake their pre-feasibility study, followed by the feasibility study of the sites passing the pre-feasibility test.

19.2 Priority Areas of Intervention

The State Water Plan provides a framework that brings out the interventions inter relatedness and importance for the optimal, sustainable exploitation of Orissa's water resources and to ensure that these interventions are complementary rather than conflicting and receive the political support necessary for their timely realisation.

While all interventions *are* necessary, some must be undertaken with a higher degree of urgency than others. They *are* in the areas of:

- ***Laws and Institutions***
- ***Environment***
- ***Basic Human Needs***
- ***Food Security / Economic Development / Poverty Reduction.***

A coherent appropriate set of-laws and the corresponding institutions are an obvious prerequisite for the effective development and management of the State's water and related resources. Figure 2 illustrates the steps to be taken to *create* the required legal and institutional setup. While the yet to be finalized and promulgated new State Water Policy will provide the formal backdrop for the

design of this setup, there is nothing that should prevent the Government of Orissa's departments and agencies to start acting in the spirit of the proposed State Water Plan once it has been accepted by the Water Resources Council.

Postponing the clean-up of excessive mining and industrial pollution and the improvement of living conditions in towns and cities will perpetuate the current conditions, threat to public health and cause the cost of the necessary corrective measures to rise exponentially. In certain situations, to neglect dealing with these problems in a timely manner may lead to irreversible negative environmental consequences.

Increasing output from existing major, medium and minor (flow) irrigation projects by rehabilitating such schemes and raising the land's productivity through increased water use efficiency and the use of modern inputs and farming practices is essential to meet the State's food requirements in the medium and long term. Moreover, the improved conditions will raise farm income already in the short term, thereby contributing to economic development and poverty reduction, particularly if accompanied by a shift from growing paddy into the production of higher-value crops.

STATE WATER BALANCE

Demand	Surface Water		Ground Water	
	2001	2050	2001	2050
Domestic	776	1144	1163	1718
Agriculture	18000	40000	4688	9408
Industry	568	1158	100	200
Environment	21000	21000	8400	8400
Others	100	200	100	200
Total	40444	63502	14451	19926
Water available	70000	70000	21000	21000
Note:- Water Demand is approximate. Environment demand has been taken as 30% for surface water and 40% ground water.				