CHAPTER – V
WATER RESOURCES

5.1 Introduction

Water is an important and prime natural resource. Out of total precipitation including snowfall, about 4000 billions cubic meter is available for the country. From above, about 1869 billion cubic meter is available in shape of surface water and replenisable ground water. Out of above i.e. 690 billion cubic meter from surface water and 432 billion cubic meter from ground water can be put to beneficial use.

Orissa has a geographical area of 1,55,507 sq. km. which is 4.74% of land resources of India, but has share of 11% of water resources of the country. However the availability of this resource vary in space and time and calls for holistic approach for water resources development and management. With increase in population and improvement in living condition and to meet the nutritional requirement, a well-managed water resource development is highly essential.

5.2. Growth of Water Resource Related Sector

The Tenth Plan document lays focus on economic growth, emphasis on human and social development with special relevance on water resource management on following key sectors.

- Agriculture
- Water Supply
- Sanitation

5.2.1. Agriculture

Agricultural development is viewed as core element of the plan, as growth in this sector is likely to benefit the largest population and especially to the rural poor. However, this sector has maximum demand on water resources. Both land and water are the key ingredients and need careful management. The Government of India has set a priority action programme on an integrated management of water resources to meet present and future agricultural needs taking environmental considerations into account.

5.2.2. Water Supply and Sanitation

Rural Water Supply and Sanitation: As per National Agenda for Governance, safe drinking water was to be provided in accordance with stipulated norms on a sustainable basis to all habitations by March, 2004.

The National Health Policy-2002 also stipulates that steps has to be taken to reduce the spread of diseases including water borne infections such as Gastroenteritis, Cholera and Hepatitis. Further the policy sets the goal to reduce the mortality rate by 2010 to 50% on vector and other water borne diseases.

Rural sanitation is in neglected stage and caters only 17.5% of rural population and this is one of the key aspect of insanitation and spread of infections in water bodies

Urban Water Supply and Sanitation: The approach to water supply and sanitation will be as per the guiding principles suggested on the New Delhi declarations, which was adopted in the U.N. General Assembly during December, 1990. The main theme was protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid waste.

5.3. Principles and Priority of Water Allocations

The National Water council in its meeting held in August, 2002 adopted the National Water Policy, 2002. The policy emphasizes that the water is a scarce and precious national resource to be planned, developed, conserved and managed as such and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and need of the State. Effort is to be made to develop, conserve, utilize and manage this important resource in a sustainable manner and to be guided by the national perspectives.

As water resources is becoming scarce and there is competing multidisciplinary demand, the National Policy decided that in the National Planning and operations of system, water allocation priorities shall broadly be as follows: a) Drinking Water, b) Hydro Power, c) Ecology, d) Agro & Non-agro Industries & e) Navigation and other use

The Orissa State Water policy was formulated in 1994, consequent to National Water Policy, 1987. After revision of National Water Policy in 2002, the draft revised policy 2004 is ready to be approved and same priority as envisaged in National Policy has been adopted.

5.4. Water Utilisation in Dominant Sector

5.4.1. Agricultural Activities

Agriculture is the most dominant users of water resources. About 50 to 60% of the water resources is used for Irrigation purpose. This demand is required to be curtailed so as to accommodate other basic need. Besides, the advanced farm technology calls for optimal use of water. However,

irrigation requirement should be suitably planned to address the irrigation development of the state.

5.4.2 Agricultural Development

Out of total geographical area of 155.707 lakh ha the total cultivated / net sown area comes to 60 lakh ha. The cultivated area from 1990-01 to 2002-03 has been reduced from 63.04 lakh ha to 56.80 lakh ha. The break up of average cultivated land under different category is given below.

		(Lakh ha)
High land	-	26.94
Medium land	-	19.44
Low Land	-	15.57
		61.95

Earlier it was estimated that out of 65 lakh ha of cultivated land 59 lakh ha will be provided with irrigation. But recently while preparing the State Water Plan under OWPO, it was judiciously examined and found that only 49 lakh ha will be brought under irrigation which is considered as realistic and rational. The irrigation potential and present situation is given in ***Table 5.1***.

TABLE: 5.1
The irrigation Potential and present utilization

Type of Irrigation	Irrigation Potential (Lakh ha)	Present Utilities (Lakh ha)
Major and medium	28.8	12.21
Minor flow	9.7	4.64
Major river lift	2.0	
Minor lift	8.9	3.47
Creek Irrigation	0.5	
Other sources		5.22
Total	**49.9**	**25.54**

Source - DOWR

5.4.3 Basic Human Need

Domestic water requirement is the top priority. The urban and rural population besides drinking water requires satisfactory sanitary management. Proper water related sanitary waste disposal should be adequately handled. This area needs top priority and water from surface and ground water will be exclusively reserved for above purpose.

Domestic Use:

The citizens of Orissa have a right to access to fresh water in sufficient quantity with acceptable quality for drinking, cooking, cleaning and sanitation. The National and State Water Policies have accorded top priority to provide safe drinking water. Further the policy has specifically stressed that adequate safe drinking water facilities should be provided to the entire population both in urban and rural areas. Drinking water needs of human beings and animals should be the first priority on any available water. The guidelines for urban and rural water supply in Orissa is given in ***Table 5.2***.

TABLE: 5.2
Guidelines for Urban and Rural Water Supply

Urban water supply criteria

Classification of Towns	Population	Lpcd
Class-I	> 2,00,000	70
Class-II	> 50,000 and < 2,00,000	135
Class-III	< 60,000	150

Rural Water Supply Criteria

Big & Medium size village piped water supply	Population supplied with	40
Add 30% losses		
Small villages	-	100 Lpcd to be met from ground water

Abstract of Norms of water supply

Urban			Rural		Lpcd
Class-I	-	70* Lpcd	Big villages	-	40*
Class-II	-	135* Lpcd	Small villages	-	100
Class-III	-	150* Lpcd	Live stock	-	45
			Poultry	-	7

*Add 30% Extra

Source – State Water Plan (DOWR) Lpcd - Litre per capita per day

The Water utilization (2001-2051) for domestic purpose from both surface and ground water sources have been projected and presented in ***Table 5.3***.

TABLE: 5.3
Surface and Ground Water utilization during 2001 & 2051 (Estimated)

Unit- million cum

Surface Water		Ground Water	
2001	2051 (Estimated)	2001	2051 (Estimated)
798	1202	1198	1803

Source: DOWR

5.4.4 Industrial Development

Orissa is very rich in mineral deposits. Since last few years, rapid industrial activities have started. A number of Steel, Aluminum & Chromite related industries have come up and many are in pipeline. Government, in order to encourage the industrial growth has adequately earmarked sufficient quantity of water for the industrial purpose. In Orissa, the demand for water on industrial sector mainly relates to iron and steel industries, aluminum, fertilizer, ore processing, smelters, ferro-alloys, cement, sugar, pulp and paper, thermal power plants etc. However, the dominant users are steel, aluminum, thermal plants.

5.4.4.1 Iron and Steel Industries

In India during nineties the steel production works to 20 milion tons /year and likely to go upto 57 milion tons/year during 2010. In Orissa present production is of 3.33 million tons/year will go upto 25 milion tons/year by 2051. This projection may undergo change depending on the market demand. These industries are likely to be concentrated in Brahamani and Baitarani Basin where raw materials are located.

5.4.4.2 Aluminum Industries

This industry operates at three levels i.e. mining, refining and smelting. These industrial setup will come up in Koraput, Rayagada and Kalahandi Districts, where bauxite reserves are available. The necessary water requirement will be met from near by river sources in the area.

5.4.4.3 Cement, Sugar Industries

These industries are located where raw materials are available and for sugar there are concentrated pockets where sugar cane are grown by the farmers. The water demand will be met from nearby water sources.

5.4.4.4 Thermal Power Plant

Thermal Power Plants are being located in coal deposit belts. The prominent areas are in Talcher-Angul of Angul district and in Ib valley area of Jharsuguda district. These locations are selected due to availability of coal and water from Brahmani and Mahanadi river. The Super Thermal Power plant at Kaniha is going to be largest thermal power plant of Asia with a generation capacity of 4000 MW. The Brahmani and Mahanadi rivers have adequate potentiality to set-up large thermal plants in future.

5.5. Water Resources and Its Availability

Orissa is fortunate to have abundant water resources both surface and ground water, compared to its size and population to national level. The water resource of Orissa is dependent on rainfall. Though, it is fairly adequate, it is unevenly distributed both spatially and temporally. The distribution of rain fall is shown as Annual Isohytes in **Map No-1.** The term average annual rainfall is 1482 mm. The monthly average rainfall distribution is shown in ***Table-5.4***.

TABLE: 5.4
Temporal Distribution Monthly Average Rainfall in the State

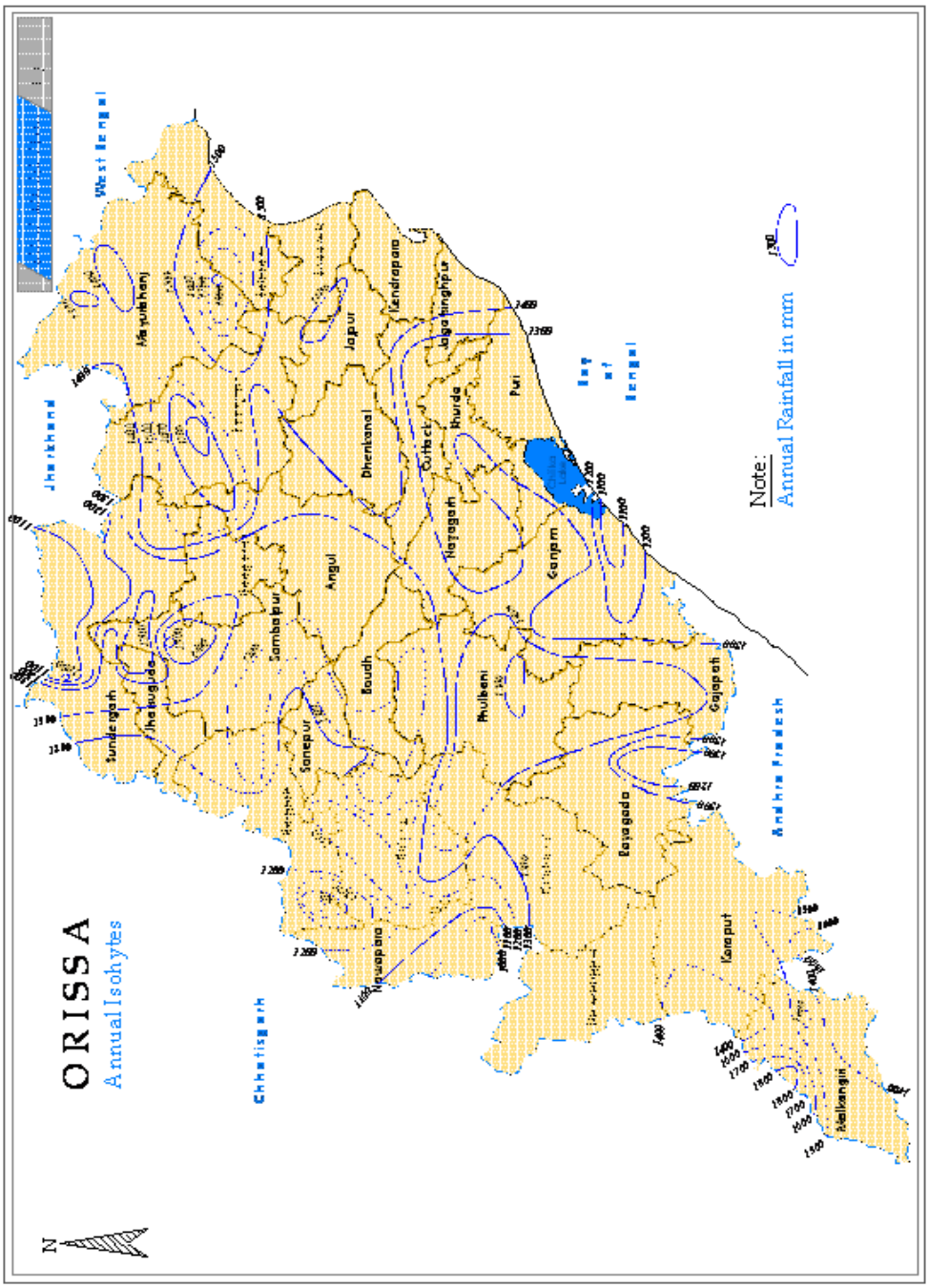
Month	Rainfall in mm.	Percentage
January	14.0	1
February	25.9	2
March	21.4	1
April	35.3	2
May	70.8	5
June	213.2	14
July	351.6	24
August	335.6	23
September	236.5	16
October	131.6	9
November	39.9	3
December	6.4	0
Annual	**1482.2**	**100**

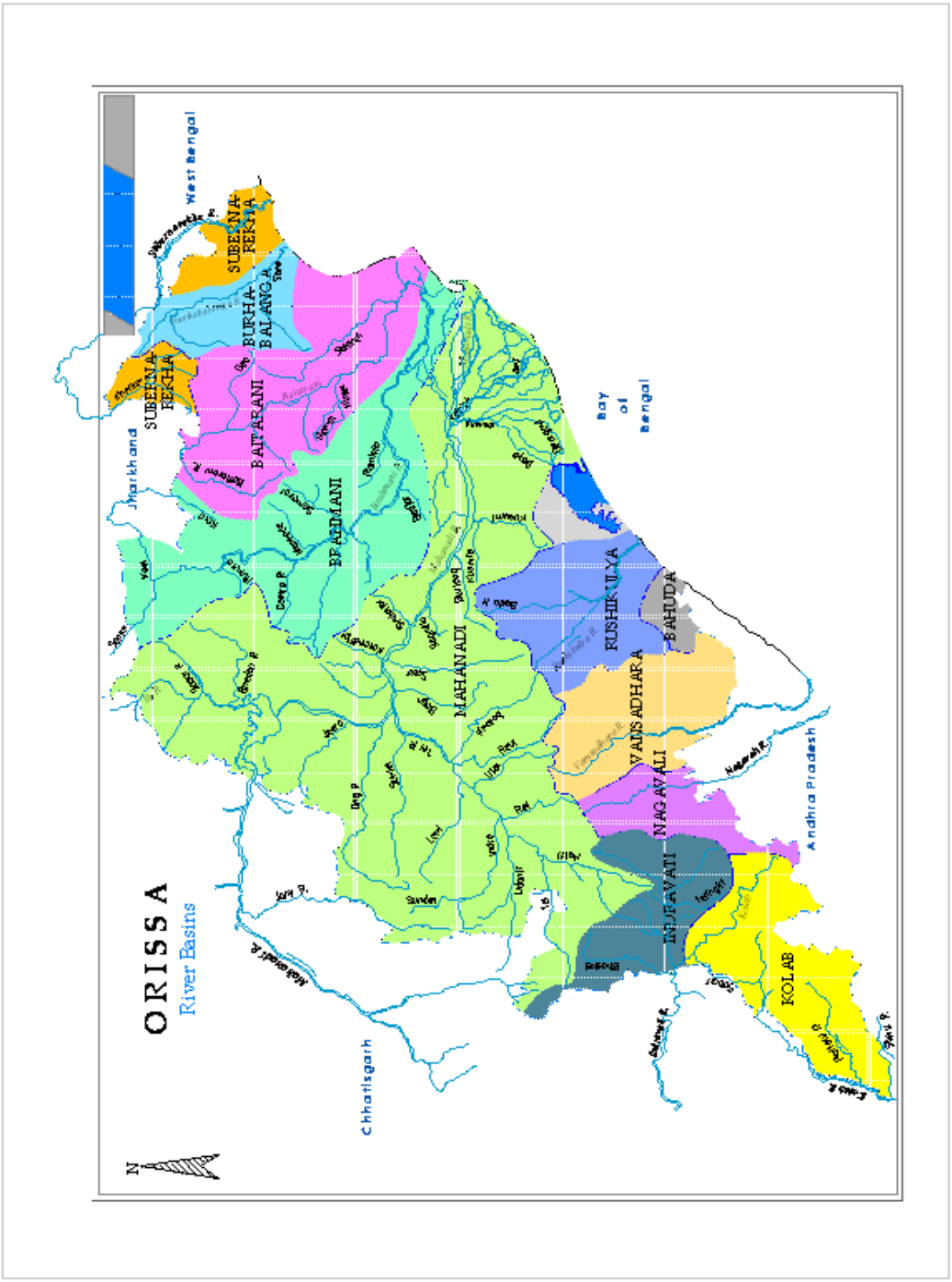
Source: DOWR

The major part of rainfall i.e. about 80% is received from southwest monsoon from June to September and balance 20% in rest eight months. After the rainfall, a part is lost by evaporation, transpiration and deep percolation. Some part is stored as ground water resource and balance flow down to sea as surface runoff. During monsoon, there are very wet days and also long dry spells. In some years both the extreme events like flood and drought occur. However flood has became recurring phenomenon and almost occurs in every third year.

5.5.1. Surface water resource and River Basins:

The entire Orissa is drained by eleven river basins. The river basins are shown in **Map No - 2.** The rivers are mostly inter state rivers but few of


ORISSA
Annual Isohytes
Note:
Annual Rainfall in mm
N
West Bengal
Jharkhand
Chhattisgarh
Andhra Pradesh
Bay of Bengal
Mayurbhanj
Jajpur
Kendrapara
Jagatsinghpur
Dhenkanal
Cuttack
Khurda
Puri
Nayagarh
Ganjam
Angul
Sambalpur
Sundergarh
Jharsuguda
Sonepur
Boudh
Phulbani
Gajapati
Rayagada
Koraput
Malkangiri


ORISSA
River Basins
West Bengal
Jharkhand
Chhattisgarh
Andhra Pradesh
Bay of Bengal
SUBERNA-REKHA
BURHA-BALANG
BAITARANI
BRAHMANI
MAHANADI
RUSHIKULYA
BAHUDA
VAMSADHARA
NAGAVALI
INDRAVATI
KOLAB
N

them are also state rivers originating and draining within the state. The basin area, catchment area and features of the river system are presented in ***Table 5.5, 5.6, 5.7 and 5.8***.

TABLE: 5.5
Basin Area in Km^2

Basin	Basin Area	Percentage
Mahanadi	65628	42.15
Brahmani	22516	14.46
Baltarani	13482	8.66
Rushikulya	8963	5.76
Indrvati	7400	4.75
Kolab	10300	6.61
Vansadhara	8960	5.75
Nagavali	4500	2.89
Budhabalang	6354	4.08
Bahuda	890	0.57
Subemarekha	2983	1.92
Area directly draining to sea	3731	2.40
Total	**155707**	**100.00**

Source: DOWR

TABLE: 5.6
Orissa: River length and Catchment Area in Km^2

Rivers	Total Catchment (Km^2)	C.A. Inside Orissa (Km^2)	Total Length (Km)	Length inside Orissa (Km)
Mahanadi	141134	65628	851	494
Brahmani	39116	22516	765	461
Baitarani	14218	13482	440	360
Rushikulya	8963	8963	175	175
Vansadhara	11377	8960	239	176
Nagavali	9275	4500	217	125
Kolab	20427	10300	343	270
Indravati	41700	7400	530	167
Bahuda	1118	890	96	74
Subarnarekha	19277	2983	446	81
Burhabaianga	4838	4838	199	199

Bramhani starts at Panposh in Orissa
Source: DOWR

TABLE: 5.7
Inflow of Individual Basins (Present Scenario 2001) Unit: million m^3

Basin name	75% Dependable			Average		
	Own	Outside	Total	Own	Outside	Total
Mahanadi	25508	23225	48732	29900	29255	59155
Brahmani	8489	5521	14011	11391	7186	18577
Baitarani	5434		5434	7568		7568
Rushikulya	2782		2782	3949		3949
Vansadhara	3881		3881	5083		5083
Budhabalang	2521		2521	3111		3111
Kolab	8885		8885	11089		11089
Indravati	4451		4451	6265		6265
Bahuda	213		213	438		438
Nagavali	2322		2322	2853		2853
Subarnarekha	1193	1115	2308	1193	1115	2308
Total	65679	29861	95540	82841	37556	120397

Source: DOWR

TABLE: 5.8
Inflow of Individual Basins (Future Scenario 2051) Unit: million m^3

Basin name	Dependable flow			Average flow		
	Own	Outside	Total	Own	Outside	Total
Mahanadi	25508	16702	42210	29900	21039	50939
Brahmani	8489	2395	10884	11391	3118	14509
Baitarani	5434		5434	7568		7568
Rushikulya	2782		2782	3949		3949
Vansadhara	3881		3881	5083		5083
Budhabalang	2521		2521	3111		3111
Kolab	8885		8885	11089		11089
Indravati	4451		4451	6265		6265
Bahuda	213		213	438		438
Nagavali	2322		2322	2853		2853
Subarnarekha	1193	1115	2308	1193	1115	2308
	65679	20212	85891	82841	25272	108113

Source: DOWR

5.5.2 Surface Water Assessment

The eleven river basins have been described in brief in previous chapter. It may be seen that some of the rivers are interstate rivers and some are confined to Orissa. The interstate rivers carry the discharge to Orissa

from the neighbouring states. Though surface water resources have been assessed earlier but an attempts has now been made by the Orissa water planning organization of Water Resources Department to scientifically asses the resources through a hydrology package hymos and based on above long hydrological series have been developed from 1974-75 to till recent year.

The inflow series for Orissa are given in ***Table – 5.9 and 5.10 (A)*** for Year 2001 and in ***Table – 5.10 (B)*** for Year 2051.

TABLE: 5.9
Summary of Inflow Assessment

It depicts the series both for inside and outside Orissa. From the series it is assessed as below.		
Dependable flow Orissa portion Orissa (68502) + Subarnrekha (1193)	-	69,695 MM^3
Average flow Orissa portion Orissa (81634) + Subarnrekha (1193)	-	82,827 MM^3
Average flow including outside Orissa (118075) + Subarnrekha (2308)	-	1,20,383 MM^3

TABLE: 5.10 (A)

It depicts a scenario in 2001 for individual basins		
75% dependable flow Orissa portion	-	65,679 MM^3
Average flow Orissa portion	-	82,841 MM^3
Average flow including outside Orissa	-	1,20,391 MM^3

TABLE: 5.10 (B)

It depicts a scenario for – 2051		
Average flow including outside Orissa	-	1,08,113 MM^3
The reduction in flow in year 2051 is due to increase in utilisation of resources in neighbouring states.		

Storage Potential and Development:

The availability of surface water in Orissa is fully dependent on south west monsoon. Due to temporal variability, the water availability in nature is for about 100 days only in a year. Therefore, the surface water must be stored in sufficient quantity so as to last for the rest of the year.

The state has developed 44 storage schemes on major and medium projects and 713 schemes in minor irrigation sector. The total live storage developed so far is 16.70 BCM. The storage position of India and Orissa is given below. (***Table 5.11***)

TABLE: 5.11
Water Storage Scenario – India and Orissa (BCM)

Water Storage	India	Orissa
Developed	174	16.70
Under construction	75	3.30
Future	132	21.86
Total	381	41.86
Potential	690	120

5.5.3 Ground Water Scenario

A comprehensive understanding of the groundwater regime, its recharge and discharge characteristics are very important to evolve a strategy for its optimal utilization. Hence precise assessment of quantity and quality of ground water resource is a pre requisite for planning its development.

From the history of development of ground water, it is seen that during 1992 a modest estimation of ground water resources was made as per guidelines of the Ground Water Estimation Committees (GEC) of 1984. Subsequently the Govt. of India revised the GEC norms in 1997. Consequent to above, the Govt. of Orissa re-constituted the study Group for Orissa in 1999 to revise the ground water assessment based on GEC norms of 1997.

In Orissa, the hydrological parameters are conducive for steady replenishment of ground water. The diverse rock types, ranging from Archean to recent origin under lies the Orissa topography. The Archean occupies about 80% of total geographical area of the state. The geological setting primarily controls the occurrence and movement of ground water. The composition and structure of the geological formation influence certain inherent properties like porosity, permeability and hence water holding and water yielding capacity of aquifers, thereby playing a vital role in the hydrological regime.

Ground Water Assessment

The assessment of ground water resource has been done taking the blocks as the assessment units. According to the latest assessment, Orissa has an annually replenishable ground water resource of 21,01,128 hect-metre (HM) and 60 % of it is considered as safe use. About 1,22,272 HM is committed for domestic and industrial requirement for coming 25 years. The ***Table-5.12*** shows the utilisable ground water resources.

TABLE: 5.12
Ground Water Resources of Orissa

District	Ground water resource assessed (HM)	Utilisable resource for domestic and Indstrial use (HM)	Annual draft for Irrigation use (HM)	Gross annual draft for all uses (HM)	Stage of GW development
Angul	86673	3935	9338	11968	13.81
Balasore	99888	5556	38410	41804	41.85
Bargarh	56073	3687	2060	4548	8.11
Bhadrak	51209	2928	17480	19854	38.77
Bolangir	71349	4051	3421	6231	8.73
Boudh	36977	1359	4938	5775	15.62
Cuttack	105367	6747	10755	14886	14.13
Deogarh	21225	786	1340	1853	8.73
Dhenkanal	65195	3479	6571	8840	13.56
Gajapati	27754	1202	3085	3966	14.29
Ganjam	113804	9098	18828	24431	21.47
Jagatsinghpur	139699	2765	11423	13646	9.77
Jajpur	58997	4848	14059	17104	28.99
Jharsuguda	17267	1849	2304	3381	19.58
Kalahandi	89520	6911	7832	11483	12.83
Kandhamal	62396	2170	4278	5548	8.89
Kendrapara	32344	782	6852	7550	23.34
Keonjhar	132291	4954	12713	16042	12.13
Khurda	90183	8542	4455	10017	11.11
Koraput	82136	4033	1358	4685	5.70
Malkangiri	32880	1281	781	1725	5.25
Mayurbhanj	152064	6640	22798	27362	17.99
Nawapara	36729	1528	3139	4318	11.76
Nawarangpur	48103	3809	1372	3353	6.97
Nayagarh	51429	2418	4270	6077	11.82
Puri	88348	3187	4431	6470	7.32
Rayagada	62882	3389	3807	7038	11.19
Sambalpur	66332	2921	3304	5214	7.86
Subarnapur	29940	1827	1951	3092	10.33
Sundergarh	92074	5590	8691	12427	13.50
State Total	**2101128**	**112272**	**236044**	**310689**	**14.79**

Source: G.W.S.I. Directorate

The table shows that ground water utilisation in Orissa is in the range of 14.79% and the utilization in Bhadrak and Balasore districts are in the high range of 40%. The low range utilization districts like Koraput,

Malkangiri and Nabarangpur are in the range of 5 to 6%. The utilizable ground water resource is presented in ***Table 5.13***.

TABLE: 5.13
Utilisable Ground Water Resources

	Unit BCM
Total annual Resources	21.011
Safe use (60%)	12.607

5.5.4. Costal Saline Area and Effect on Ground Water:

A considerable area of about 5.39 lakh hectares of the coastal alluvial tract is beset with salinity hazard. In a narrow tract it starts from Chandereswar in Balasore district in the north east and extends upto Brahmagiri in Puri district in the south west. The Saline aquifers occur in different depth. The salinity zone and pattern of occurrence of fresh and saline aquifers are presented in ***Table 5.14 and 5.15***.

TABLE: 5.14
The Pattern of Occurrence of Saline Aquifers in Orissa

District	Blocks	
	Full	**Part**
Balasore		Bahanaga, Balasore, Baliapal, Basta, Bhograi, Remuna
Bhadrak	Chandbali	Basudevpur, Tihidi, Dhamnagar
Ganjam		Chatrapur, Chikiti, Ganjam, Khalikote, Rangeilunda
Jagatsinghpur	Ersama	Balikuda, Kujanga, Nuagaon
Jajpur		Bari, Binharpur, Dashrathpur
Kendrapara	Mahakalpara Marshaghai, Rajkanika, Rajnagar	Aul, Derabish, Kendrapara, Pattamundai
Puri		Astarng, Brahmagiri, Delang, Gop, Kakatpur, Kanas, Krushna Prasad, Nimapara, Pipli, Puri, Satyabadi
Total	**6 Blocks**	**35 Blocks**
A number of district present complex salinity profiles as follows:		
Pattern of Salinity		**District**
Saline water overlying fresh water		Conspicuously occurs in Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Jajpur District
Fresh water overlying saline water		Prominent in Puri, parts of Jagatsinghpur, Kendrapara District.
Alternating fresh water zones		Prominent in parts of Kendrapara District
Saline water at all depths unto 600m		Conspicuous in Puri, parts of Jagatsinghpur, Kendrapara District.

Source: G.W.S & I Directorate

TABLE: 5.15
Surface and Ground Water Resources of Orissa and India

Unit- BCM

	India	Orissa	With outside Orissa
Rainfall	4000	231	
Usable surface water	690	70 *	120
Ground Water	432	21	21
Total	**1122**	**91**	**141**

**Does not include resources available from outside state.*

5.5.5 Per-capita Water Availability and Water Stress Basins

Average surface and ground potential of the state is 141 BCM at present and is estimated to reduce to 129 BCM in 2051. However considering the growth of population with criteria of national population policy, the per capita availability in Orissa which, works out to 3359 m^3 at present will reduce to 2218m^3 in 2051. This is in comparison to national scenario of per capita availability of 1820 m^3 in 2001 and 1200m^3 in 2051. As per international standard an area is considered as stressed if the per capita availability falls below 1000 m^3.

Table – 5.16 (A) shows the per capita availability of surface water in river basins of Orissa, ***Table 5.16 (B)*** projects the situation in 2051. From the above it will be seen that Rushikulya, Baitarani and Bahuda will tend to water stress basins by 2051.

TABLE: 5.16 (A)
Per Capita Water Resources in Basins of Orissa Present Scenario

Basin name	Dependable		Average	
	Total	Per Capita (m^3)	Total	Per Capita (m^3)
Mahanadi	48732	3007.75	59155	3651.06
Brahmani	14011	2741.52	18577	3634.95
Baitarani	5434	1418.82	7568	1976.01
Rushikulya	2782	945.33	3949	1341.87
Vansadhara	3881	3792.49	5083	4967.08
Budhabalang	2521	1834.35	3111	2263.65
Kolab	8885	6550.15	11089	8174.97
Indravati	4451	3496.78	6265	4921.89
Bahuda	213	786.16	438	1616.61
Nagavali	2322	4227.89	2853	5194.73
Subarnarekha	2308	2365.24	2308	2365.24
Total	**95540**	**2665.64**	**120397**	**3359.17**

TABLE: 5.16 (B)
Per Capita Water Resources in Basins of Orissa Future Scenario
(million m^3)

Basin	Dependable		Average	
	Total	Per Capita (m^3)	Total	Per Capita (m^3)
Mahanadi	42210	2017	50939	2434
Brahmani	10884	1446	14509	1928
Baitarani	5434	9678	7568	1348
Rushikulya	2782	719	3949	1021
Vansadhara	3881	2580	5083	3379
Budhabalang	2521	1315	3111	1623
Kolab	8885	4471	11089	5579
Indravati	4451	2439	6265	3433
Bahuda	213	687	438	1412
Nagavali	2322	3059	2853	3758
Subernarekha	2308	1766	2308	1766
Total	**85891**	**1762**	**108113**	**2218**

The table shows that Rushikulya will reach the scarcity condition in future in about 50 years. Other basins close to scarcity condition will be Baitarani and Bahuda basins.
Source: DOWR

5.5.6. Wet Lands

Wetlands have assumed a considerable significance in recent years with growing interest in them for supplementing human dietary requirements, supply for domestic use and their ecological significance in terms of flood control, water purification, aquatic productivity and micro climatic regulation and as habitats of fish and other aquatic forms.

The wetlands consist of two categories:

- Inland wetland — Natural and man made
- Coastal wetland — Natural and man made

The Orissa Remote Sensing Application Centre (ORSAC) and Space Application Centre (ISRO) Ahmedabad conducted a survey on the Status of wetlands of Orissa in 1996. The detail break-up of wet lands in the districts of Orissa is presented in ***Table No. 5.17***.

TABLE: 5.17
District Wise Breakup of Wetlands

Sl. No.	Name of District	Area in Hect.
1.	Angul	25175.50
2.	Balasore	16809.75
3.	Bhadrak	8629.75

Sl. No.	Name of District	Area in Hect.
4.	Bargarh	794.00
5.	Balangir	826.00
6.	Boudh	63.00
7.	Cuttack	2889.25
8.	Deogarh	1062.00
9.	Dhenkanal	506.25
10.	Gajapati	694.25
11.	Ganjam	12779.75
12.	Jagatsinghpur	10440.00
13.	Jajpur	1407.50
14.	Kalahandi	194.00
15.	Kendrapara	30748.25
16.	Keonjhar	3777.00
17.	Khurda	3872.25
18.	Koraput	17400.00
19.	Malkangiri	16869.00
20.	Mayurbhanj	2671.25
21.	Nuapada	1626.00
22.	Nabarangpur	744.00
23.	Nayagarh	594.25
24.	Phulbani	428.75
25.	Puri	117523.75
26.	Rayagada	294.00
27.	Sambalpur	62794.000
28.	Sundargarh	6265.00

As per the survey, the total wetland area of Orissa was 3,48,205,25 ha. The category-wise inland and coastal wetlands in Orissa is presented in ***Table 5.18***.

TABLE: 5.18
Inland and Coastal Wetlands in Orissa

Category	Inland Wetland		Coastal Wetland (ha)	
	Numbers	Area in ha.	Numbers	Area in ha.
Natural	100	14001.75	104	183144.75
Man-made	134	148771.75	7	2287.00
Total	**234**	**162773.50**	**111**	**185431.75**

Source: ORSAC

The coast includes two wetland sites declared to be of international importance under the Ramsar convention, namely Lake Chilika, since 1981, and Bhitar Kanika since 2002.

5.5.7. Water Balance of Orissa State

The water budgeting relating to the availability of surface and ground water resources and the potential demand by various disciplines have been meticulously assessed both for the present (Year 2001) and for future (Year 2051). This exercise have been conducted after due interaction made with stakeholders department. The ***Table-5.19*** shows the summary of above exercise.

TABLE 5.19
Water Balance of Surface & Ground water during 2001 and 2051 (Estimated)

Unit-million cum

Demand	Surface Water		Ground Water	
	2001	2051 (Estimated)	2001	2051 (Estimated)
Domestic	798	1202	1198	1803
Agriculture	18000	40000	4688	9408
Industry	606	1750	100	200
Environment	21000	21000	8400	8400
Others	100	200	100	200
Total	40504	64152	14486	20011
Water available	70000	70000	21000	21000

Source: DOWR

Note: Water demand under various discipline is approximate and environment demand has been taken as 30% for surface water and 40% of ground water.

The above table showing the water balance has been extracted from the State Water Plan prepared by the **Orissa Water Planning Organisation (OWPO)** of the **Department of Water Resources (DOWR)**. This document has been prepared based on certain assumptions and may under go change in different scenario related to developmental options of various organizations.

5.6 Impacts Due to Water Related Activities

The Developmental activities like irrigated agriculture along with occurrence of natural hazards like flood, cyclone and drought used to have its impacts on Orissa. These are described below:

5.6.1. Water logging

Water logging occurs due to steady rise of ground water table after introduction of irrigated agriculture without adequate drainage. There are different criteria used for delineation of waterlogged areas. However it has been established that if the ground water table lies upto 1m to 1.2mt below ground surface, the area comes under potential waterlogged areas. In Orissa the waterlogged areas have been estimated by various agencies from time to time. (***Table No 5.20***)

TABLE: 5.20
Water Logged Area in Orissa

			Area-Thousand Hect.
National Commission on Irrigation 1972	**National Commission on Agriculture 1976**	**Ministry of Agriculture**	**Orissa Remote Sensing Application Centre (ORSAC) 1993**
Not reported	60	60	84.80
	District Wise Break up of Waterlogged Area Units – Thousand Hect.		
	Balasore	-	6.3
	Bolongir	-	3.4
	Cuttack	-	31.4
	Dhenkanal	-	0.9
	Ganjam	-	5.9
	Kalahanadi	-	6.3
	Keonjhar	-	1.0
	Koraput	-	3.8
	Mayurbhanje	-	1.2
	Phulbani	-	1.1
	Puri	-	14.0
	Sambalpur	-	7.7
	Sundergarh	-	1.8
	Total		**84.8**

Source: ORSAC

The worst effect of water logging is the development of salinity. Salinity arises because of upward movement of soluble salts in the soil. This is caused due to concentration of chlorides and sulphates of sodium, calcium and magnesium in soil at a level that would affect the plant growth.

One of the worst affected area due to drainage congestion and resulting loss of agricultural command is in the Mahanadi Delta. It is estimated that out of 3.03 lakh ha irrigated area in Mahanadi delta, about 1.00 lakh ha is out of command due to drainage congestion.

5.6.2. Floods

Orissa is one of the most chronically flood affected State in the country. The east flowing rivers like Mahanadi, Brahmani, Baitarani, Subarnarekha and Rushikulya causes flood from June to October when monsoon become active and this is caused with depression in Bay of Bengal with heavy precipitation occurring almost every third years.

Floods in Mahanadi have been moderated to great extent by the Hirakud dam, but floods of 1980, 1982, 1991, 2001 & 2003 have demonstrated that a second dam in Mahanadi may be the answer to the problem. Rengali Dam across river Brahmani is able to moderate flood at its delta head upto 4 lakhs cusecs but the confluencing of Baitarani, Brahmani & Mahanadi in the costal delta causes heavy damages which is almost recurring. The floods in 1980 in Vamsadhara river caused severe damage in Gunpur town and surrounding area. The flood in November 1990 in Ganjam district caused severe damages in the Rusikulya catchment. The unprecedented rainfall in1991 in Thuamul-Rampur caused severe flooding in Indravati river and caused disaster in Upper Indravati Project.

Flood is a curse for the people of coastal Orissa and the economy is severely strained due to this event year after year.

5.6.3. Cyclones

The Bay of Bengal is the breeding ground of cyclones. A cyclone originates as low pressure becomes depression and converted into cyclone. A cyclone has three devastating factors (i) high wind speed (ii) heavy rain and (iii) surge. In general, Orissa coast receives 2 to 3 cyclone every year and the most severe one was the super cyclone of 1999. This has resulted wind speed of >300 Kmph, rainfall >500mm tidal wave of 3-6mt height and caused death of 12,000 persons besides huge loss of cattles. The super cyclone caused wide spread flooding in coastal belt of Orissa with severe damages in Baitarani & Salandi basin.

5.6.4. Droughts

Though Orissa comes under good rainfall zone, but wide spread temporal and spatial variation results drought conditions. Very often late arrival of monsoon and its early retreat causes water stress during crucial stage of plant growth. Some of the recent severe drought years of Orissa are given in ***Table 5.21***.

TABLE: 5.21
Severe Droughts in Orissa

Year	Deviation from normal rainfall	
	mm	Percentage
1965	505.4	33.6
1972	325.4	21.7
1974	551.3	36.7
1976	490.0	32.6
1979	551.8	36.7
1981	315.1	21.0
1987	461.9	30.7
1996	460.1	30.6
2000 & 2003	N.A.	35.0

5.7 Water Quality

5.7.1 Use Based Water Quality Standards

Meaningful evaluation of water quality status requires that the quality be viewed in the context of the uses which the society wishes to make of the stream, each of which requires special characteristics. In India, water quality is usually assessed in respect of the following five broad categories.

Class Use

A. Drinking water source without conventional treatment, but after disinfections.

B. Organised outdoor bathing.

C. Drinking water source with conventional treatment followed by disinfections.

D. Fish culture and Wildlife propagation.

E. Irrigation, Industrial cooling or Controlled Waste Disposal

Water quality parameters relevant to the above uses, are described in IS 2296/1982. These primary water quality criteria for the above used classes are given in **Table-5.22**. They are derived from the criteria developed in other parts of the world, namely USA, UK, Germany and Japan (CPCB: ADSORBS/3/78-79, ADSORBS/2/80-81).

TABLE: 5.22
Water Quality Criteria

Parameter	Quality criteria				
	Class - A	Class - B	Class -C	Class -D	Class - E
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-8.5
DO (mg/l) Minimum	6.0	5.0	4.0	4.0	-
BOD (mg/l) Max.	2.0	3.0	3.0	-	-
TC (MPN/100ml) Max.	50	500	5000	-	-
Am-N (mg/l) Max	-	-	-	1.2	-
EC (mirco mhos/cm)	-	-	-	1000	2250
SAR Max	-	-	-	-	26
Boron (mg/l) Max	-	-	-	-	2.0

Source: State Pollution Control Board
DO - Dissolved Oxygen, BOD-Biochemical Oxygen Demand, TC - Total Coliform
EC-Electrical Conductivity, SAR-Sodium Absorption Ratio

5.5.7.2 Biological Assessment of Water Quality

Biological assessment is based on the fact that pollution of water bodies will cause changes in the physical and chemical environment of water, which in turn, will disrupt the ecological balance of the ecosystem. Through bio-monitoring, the cumulative effects of all the pollutants can be determined and the overall health of the ecosystem can be properly assessed. Bio-monitoring results are generally expressed in terms of two indices, namely the Saprobic Index (SI) and the Diversity Index (DI). Water quality criteria in terms of SI and DI are given in ***Table-5.23***.

TABLE: 5.23
Biological Indicators

Monitoring Station	Water Quality
High Biodiversity DI ≥ 0.6 SI = 6-10 BOD ≤ 3 mg/l	Clean
Moderate Biodiversity DI = 0.2 – 0.6 SI = 2 to 6 BOD = 3 – 6 mg/l	Slight to Moderate Pollution
Poor Biodiversity DI ≤ 0.2 SI ≤ 2 BOD ≥ 6 mg/l	Heavy to Severe Pollution

5.7.3 Water Quality in Terms of Wholesomeness

The basic objective of the Water (Prevention and control of pollution), Act, 1974 which governs the water quality management in the country, is "to provide for the prevention and control of water pollution and maintaining or restoring the wholesomeness of water". Over the years it was felt that the designated use concept with the objective of protecting the direct beneficial used to humans and classifying water quality accordingly, needs to be reviewed and 'wholesomeness' should incorporate an overall integrated view of the water ecosystem. The first priority in water quality assessment and management should be maintain and restore a desirable level of its environmental quality. Accordingly specific requirements for 'Acceptable', 'Desirable' and 'Excellent' levels of wholesomeness with short, medium and long term goals have been laid down (Water Quality – Criteria and Goals, CPCB, MINARS/17/2001/2002) (**Table – 5.24**).

TABLE: 5.24
Standard for Regular Monitoring Parameters

Sl.	Parameter	Requirements		
		Excellent	Desirable	Acceptable
1.	pH	7.0 – 8.6	6.5 – 9.0	6.5 – 9.0
2.	DO (% saturation)	90 – 110	80 – 120	60 – 140
3.	BOD (mg/l)	Below 2	Below 5	Below 8
4.	EC (micromhos/cm)	< 1000	< 2250	< 4000
5.	(Nitrate + Nitrate) N (mg/l)	< 5	< 10	< 15
6.	Suspended Solids (mg/l)	< 25	< 50	< 100
7.	*FC (MPN/100 ml)	< 20	< 200	< 2000
8.	Bio assay (Zebra fish)	No death in 5 days	No death in 3 days	No death in 2 days
*FC Values should meet for 90% of samples				FC: Fecal Coliform

5.7.4 Water Quality of Major Rivers Of Orissa: Summary

The water quality of two major rivers i.e. Mahanadi and Brahmini are described below.

5.7.4.1 Mahanadi

About 86% of the catchment (72560 km^2 out of a total of 84,372 km^2) 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 Orissa the river Ib with its share of pollutants drains into the reservoir. But in spite of this, the reservoir water almost conforms to Class-B (outdoor bathing), except for sporadic increases in the Total Coliform (TC) values.

Sambalpur is the major urban area (population about 1.6 lakhs, district and division headquarters) immediately downstream of Hirakud reservoir (about 5 km). Apart from being a source of water supply, Mahanadi at Sambalpur is used for bathing and waste water (untreated) disposal. Hence 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 wastewater outfall.

Sonepur is the confluence point of Mahanadi with two of its important right bank tributaries, namely Ong and Tel. Thus the water quality at Sonepur upstream (U/S), which is immediately downstream of Ong confluence, is quite satisfactory. Though Sonepur is the district headquarters with all consequent activities, the deterioration in the water quality at Sonepur (S/S) is not as much as expected. This is primarily because Sonepur (D/S) on Mahanadi is actually the downstream of its confluence with Tel, which has a significant annual average flow with a small pollution load.

Moreover, in spite of being the district headquarters, Sonepur is still a small town (population: about 20,000) with no noticeable growth in urban and industrial activities.

The 100 km stretch of the river from Sonepur to Tikarpara does not have any industry or urban settlement on its banks (except two small sub-divisional towns- Boudh and Athamallick, population less than 20,000) and there is no major wastewater outfall.

From Tikarpara to Narsinghpur (about 40 km), river flows almost completely undisturbed. The Tikarpara-Narsinghpur sub-basin is neither agriculturally nor is industrially prosperous and human activities on its banks scarce. 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 enters into its deltaic region, characterized by high population density and intense agricultural activities. Hence there is some deterioration in the quality of water entering into Cuttack (Cuttack U/S), particularly in respect of Total Coliform (TC), but still conforming to Class-C (drinking water source with conventional treatment followed by disinfections). Within the city (population: about 5.5 lakhs), the river receives

considerable quantity of untreated wastewater and the water quality gets deteriorated up to a distance of about 2.0 km down stream of Cuttack, after which it starts showing improvement.

Taking into consideration the biological indices and the BOD values, the entire river stretch is in a state of slight to moderate pollution as per the criteria given in **Table – 5.23.**

5.7.4.2 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 wastewater generated in these two areas ultimately find their way to Brahmani. The spatial variation of water quality is in a predictable way. Occasional monitoring results indicate that the water quality starts showing significant improvement after about5-6 km from Rourkela (D/S) and the BOD conforms to the stipulations for Class-B inland surface water. 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 about3-4 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 Bonaigarh-Rengali-Samal stretch, since there is increase in the population density and intensity in agricultural activities as the river enters into the deltaic region.

During the eighties and early nineties, the water quality of the river at Rourkela and Angul-Talcher caused much concern. Presently, however, there is no indication of any severe industrial pollution in these two stretches. This could be because of some effective pollution control measures taken by the industries and mines, over the years. A significant step in this direction is recycling / reusing of waste water by some of the major polluting units and reduction in the quantity of effluent by some large industries. The major problem constituents for the water quality at all stretches seem to be of organic (BOD) and bacteriological (TC and Fecal Coliform) nature. Even at Panposh (D/S) and Talcher (D/S), the decline in water quality is more pronounced in terms of BOD, TC and FC, indicating that the domestic and municipal wastes are making a greater contribution to downgrade the water quality, than the industrial

effluents. Summary of the water quality assessment results are given in **Table – 25.**

TABLE: 5.25
Brahmani River: Summary of Water Quality Assessment Results

Monitoring Station	Use based		Biological		Degree of Wholesomeness	
	Class	Parameter (s) responsible for down grading the water quality	Status of Pollution	Parameter (s) responsible for down grading the water quality	Level	Parameter (s) responsible for down grading the water quality
Panposh (U/S)	C/D/E	TC	Slight to Moderate	Sl, Dl and BOD	Below Acceptable	FC
Panposh (D/S)	E	BOD, TC Amm- N	Slight to Moderate Pollution	Sl. Dl and BOD	Below Acceptable	FC
Rourkela (D/S)	D	BOD, TC	Slight to Moderate Pollution	Sl. Dl and BOD	Below Acceptable	FC
Bonaigarh	C/D/E	TC	Slight to Moderate	Sl, Dl and BOD	Acceptable	FC
Rengali	C/E/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Acceptable	FC
Samal	C/D/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Acceptable	FC
Talcher (U/S)	C/D/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Acceptable	FC
Talcher (D/S)	E	BOD, TC, Amm- N	Slight to Moderate Pollution	Sl, Dl and BOD	Below Acceptable	FC
Bhuban	C/D/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Below Acceptable	FC
Dharmasala	C/D/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Acceptable	FC
Pattamundai	C/D/E	TC	Slight to Moderate Pollution	Sl, Dl and BOD	Below Acceptable	FC

Source: State Pollution Control Board, Orissa

5.7.5 Ground Water Quality

The ground water in the State is generally slightly alkaline. In the consolidated and semi consolidated formations, the quality of ground water is generally fresh and is suitable for all types of uses including drinking. However the ground water in shallow aquifers in general is suitable for irrigation and other purposes. In coastal tracks, sea water ingress and tidal incursions have contaminated the ground water. In this

tracks the ground water quality varies widely from calcium bicarbonate in inland areas to sodium chloride near the sea. The depth wise hydro chemical quality profile is also non-uniform. This is due to a variety of situations that has evolved depending upon the nature of sediments, aquifer properties, fresh water head and hydrology of the basin. Complexity of situation arises due to non homogeneity of aquifer resulting in penetration of sea water wedge into the coastal track. However in the inland, the ground water from deeper aquifers has pH value from 6.62 to 8.2, Total Dissolved Solids (TDS) from 265-134 ppm, hardness as CaCO3 from 21 to 263 ppm. and Chloride from 14 to 307 ppm. The Sodium Adsorption Ratio (SAR) varies from 0.54 to 8.2.

5.7.6 Fluoride Contamination

There are reports of fluoride contamination in ground water in Boden block of Nuapada district, Bhapur and Sarankul block of Nayagarh district, Bolagarh block of Khurda district and part of Bolangir district. This has resulted in severe health hazard in above areas. The State government is taking steps to identify the chronically affected areas to provide piped water supply. Inspite of adequate measures by NALCO to reduce fluoride emission, fluoride pollution of water and its adverse effect in human health have been observed. Steps have been taken to provide piped water supply in vulnerable areas in villages around its smelter unit.

5.8 Water Resources Management

5.8.1. State Water Policy

Water is scarce but sustains all life form. Considering its increasing scarcity, the planning and management of this resource and its optimal economical and equitable use has become absolutely necessary. The Government of Orissa first prepared its State Water Policy in1994 and based on the revised National Water Policy 2002, prepared a new revised State Water Policy 2004 and expected to be released soon. This is a vital document and covers comprehensively all situations in areas related to development and management of water resources with due consideration of ecological balance and sustainability of this important natural resource. There is emphasis on conjunctive use to relieve the water logging situation.

5.8.1.1 Participatory Irrigation Management

There has been a paradigm shift in the Water Resources Planning from mere harnessing of water resources to ensuring sustainable water resources management with active participation of local people. The concept of Participatory Irrigation Management (PIM), which is termed as Pani Panchayat was introduced in Orissa as Pani Panchayat Act 2002 and

Pani Panchayat Rule 2003. Initially, it is programmed to form 698 Pani Panchayats in 33 projects covering an area of 3.32 lakh Ha. It is targeted to cover an area of 14.50 lakh Ha in two phases subsequently.

5.8.2. Disaster Management Policy

The Orissa famine code 1913 had provisions to meet situation arising out of famine and was revised to cover flood during 1930. The relief code of Orissa took shape after the cyclone of 1971 and the first print of Orissa Relief Code was released in March 1980. The Govt. of Orissa again amended the Relief Code in 1996. Consequent to above, the National Disaster Management Cell started functioning at Bhubaneswar since 1996. The Orissa State Disaster Mitigation Authority (OSDMA) came into existence immediately after the super cyclone in 1999. It is registered under society registration act of 1860 to operate as an autonomous organization. OSDMA is entrusted with the task of restoring livelihood, reconstructing damaged infrastructure and enhancing preparedness measures of the state to face calamities like flood, cyclone drought and other natural hazards.

5.8.3. Food Security

The irrigation coverage has to be designed in such a manner that during stressed monsoon condition, the state should be able to grow 75% of cereal crop. The balance 25% can be met from Govt. of India godowns to meet the emergency. Accordingly out of total potential of 49.9 lakh Ha of irrigation potential, 32.0 lakh Ha will be brought under irrigation coverage at the minimum, to meet 75% cereal production for food security. After the area of irrigation coverage for food security is achieved, the remaining area will help to enhance the economic condition of farming community by adopting cash crops and other financially sustainable crops.

5.8.4. Industrial Water Reservation

The Water Resources Department, while preparing a State Water Plan with an objective to cater to the future development up to year 2051 has kept adequate provision of water for industrial growth. The rivers, which have the potential to support industrial growth like Mahanadi, Baitarani, Brahmani and Rushikulya have been specifically considered for reservation of water for industrial purpose. A sudden spurt of industrial activities has started in Orissa. The prominent industries in the pipeline are steel and ferro alloys, aluminium and chromite based industries. The DOWR has worked out a water balance for 2001 and for 2051 where provision for industrial water has adequately been considered. This may undergo substantial revision as per market demand and consequent setting up of industries.

5.8.5. Flood Management

Floods in Mahanadi, Brahmani and Baitarani bring perpetual problems to the state. A serious consideration for a second dam in Mahanadi has engaged the mind of planners and engineers of Orissa. Government of Orissa is considering for preparation of a revised Flood Master Plan to provide adequate safety for protection of vulnerable areas from flooding. It has been estimated that out of total geographical area of 1,55,707 Sqkm, 41,000 Sqkm area is flood prone and an area of 25,000 Sqkm. has been brought under protection. Flood protection is also ensured by constructing embankments in river course like capital embankments, test relief embankments, saline embankments and other embankments which runs in Orissa for a total length of 5869 Km. These embankments needs to be strengthened considering the new flood recurrence and encroachments coming into flooded zones.

Flood management can be addressed by two approaches i.e. (i) structural (ii) non-structural. Structural method calls for physical construction of structures like dams and dykes with provision of spill channels where as non-structural methods envisages methods like flood plain zoning, water shed management, flood forecasting and flood warning.

5.8.6. Drought Management

Drought is a recurrent occurrence in Orissa. In order to handle the drought situation, necessary storage has to be created to store the run-off coming in the river system during the weak monsoon period. DOWR has undertaken a detailed study taking into consideration the potentials available in major and minor river systems as well as in ground water system.

Besides, the drought situation can also be handled with the following methodology;

i) Providing series of small command area reservoirs connected to major stream at diversion point.
ii) Connecting existing irrigation channel to the existing or new ponds / tanks.
iii) Transferring water from surplus basins to deficient basins.

5.8.7. Water Quality Monitoring and Management

The State Pollution Control Board is monitoring the quality parameter for 5 river systems out of 11 river systems. Steps have been taken to ensure that the industries discharge their effluent after suitable treatment. The Water Resources Department is working out the modalities to monitor the

remaining 6 river systems so that quality parameters of all the river systems of Orissa are monitored properly.

5.8.8. Environmental Flow

In Order to sustain the eco-system and to have overall balance in nature, an adequate flow in river system has to be maintained for flushing industrial waste, to reduce salinity in the coast and to dilute the toxic disposal. Some wetlands and sanctuary are located down stream and also need sufficient water for its management. Accordingly sufficient water has to be reserved for the above purpose.

5.8.9 Environmental Flow (EF) Assessment

The flows of the world's rivers are increasingly being modified through impoundments such as dams and weirs, abstractions for agriculture and urban supply, maintenance of flows for navigation, drain return flows, and structures for flood control. These interventions have had significant impacts reducing the total flow of many rivers and affecting both the seasonality of flows and size and frequency of floods. In many cases, these modifications have adversely affected the ecological and hydrological services provided by water eco systems, which in turn has increased the vulnerability of people-especially the poor, who depend on such services.

Development in the basin will affect one or more components of in-stream flow. It may reduce the frequency of large floods, may wipe out small and low floods altogether, may rearrange timing of floods, may even increase flow in the stream. The consequence of such modification will be degradation of downstream ecosystem.

There is now an increasing recognition that modification to river flows need to be balanced with maintenance of essential water-dependent ecological services. The flows needed to maintain these services are termed "environmental flows" and the process for determining these flows is termed "Environmental Flow Assessment(EFA)".

The method of determination of environmental flow is rather complicated as it is not quite easy to determine exactly what amount of flow will prevent riverine, floodplain estuarine degradation.

Awareness about environmental flow is of recent origin. Methods to quantify such flows have not been fully stabilized. There are several methods in use. These methods can be classified into two categories i.e. Prescriptive and interactive.

In the Orissa scenario, the basin has two distinct seasons, wet or monsoon season and dry or non-monsoon season. Instead of using Average Annual Flow (AAF), concept of Average Seasonal Flow (ASF) may be 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. (***Table 5.26***)

TABLE: 5.26
Rating of Environment Flow Based on Seasonal Abstraction

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

Source: Env. Department- World Bank

In order to match the above requirements, Orissa proposes to reserve the following quantity for environmental purpose. The seasonal distribution of flow will require a meticulous planning with multi disciplinary inputs from experts. The reservation of environmental flow in 2001 and 2051 is presented in ***Table 5.27***.

TABLE: 5.27
Reservation of Environmental Flow in 2001 & 2051

Unit- Million Cub Mt

Year	Total resources (Annual)	Environmental flow availability	% of total flow
2001	70,000	42,000	60
2051	70,000	21,000	30

Source: DOWR

In view of the above, the environmental flow may be considered in category of good to excellent. The environmental flow assessment for two important wet lands i.e. Chilika and Bhitar Kanika is very important and due reservation has to be made for sustenance of above two Ramsar wetlands.

Chilika Lake:

The detail of environmental flow for Chilika lake from Mahanadi river system is being worked out under WRCP with the guidance of

International experts and the quantum of flow required will be regulated from the new Naraj Barrage which is to be made operational shortly.

Bhitar Kanika Sanctuary:

This sanctuary is located at the mouth of Brahmani River and the environment flow to sustain the eco system is required to be assessed through wild life and other experts.

5.8.10 Integrated Water Resource Management (IWRM)

The Department of Water Resources have undertaken an exercise under the World Bank aided project i.e. WRCP in which the State Water Plan for Orissa has been prepared. The above has considered the Integrated Water Resources Management, which is the latest prescription on the subject. The challenges faced by the countries in their struggle for economic and social development are increasingly related to water. Water shortages, quality deterioration, flood impacts and food security are the main problems faced by the nation. The concept of I.W.R.M. has attracted particular attention following the International Conference at Dublin and Rio-de-janerio in 1992. As per Global Water Partnership irrigation (GWP) water resource management is to be handled, integrated with following sectors.

i) Water supply and sanitation
ii) Drainage
iii) Energy
iv) Environmental situation
v) Other uses like industry

Taking the above concept, the Department of Water Resources, Government of Orissa took the task of coordinating the various requirement related to water sector with the stake holder departments and other water users organizations. Consequent to above, the State Water Plan has recently been prepared. This has been approved by the State Water Resources Board, the apex body of Govt. of Orissa. The above achievement will be a milestone in the development of the Integrated Water Resources Management, which will ensure sustainable and equitable supply of water to all sectors including ensuring ecological balance of the hydrological system. However the Integrated Water Resources Management will involve primarily the institutional strengthening and other managerial re-structuring which is a pre-requisite for achieving the sustainable management of the important natural resource. The estimated industrial water demand is presented in ***Table 5.28***.

TABLE: 5.28
Estimated Industrial Water Demand

Basin	Demand in million m3	
	Demand (2001)	Demand (2051)
Mahanadi	267.50	521.40
Brahmani	84.40	187.50*
Baitarani	63.20	139.90
Rushikulya	48.60	96.40
Vansadhara	16.90	37.50
Nagavali	9.15	18.92
Kolab	22.40	49.50
Indravati	21.00	45.50
Bahuda	4.70	9.40
Subarnarekha	7.03	14.69
Budhabalang & Jambhira	22.70	47.70
Total	**568**	**1168**

** Likely to Grow to 562 millon m^3*

Source: DOWR