ORISSA STATE WATER PLAN
2004

ORISSA WATER PLANNING ORGANISATION
DEPARTMENT OF WATER RESOURCES
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ACRONYMS

Am-N	Ammonical Nitrogen
BKVY	Biju Krushak Vikas Yojana
BPL	Below Poverty Line
BOD	Biochemical Oxygen Demand
BCM	Billion Cubic Meter (km^3)
CADA	Command Area Development Authority
CCA	Culturable Command Area
CEA	Central Electricity Authority
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
Cum	Cubic Meter
CWC	Central Water Commission
CWPRS	Central Water & Power Research Station
CE	Chief Engineer
DO	Dissolved Oxygen
DOWR	Department of Water Resources
DES	Department of Economics & Statistics
DL	Danger Level
DSL	Dead Storage Level
DP	Displaced Person
DI	Diversity Index
EIC	Engineer-in-Chief
EC	Electrical Conductivity
FC	Fecal Coliform
FRL	Full Reservoir Level
GWS&I	Groundwater Survey & Investigation
HYMOS	Hydrological Model Study
IMD	India Meteorological Department
INCID	Indian Congress of Irrigation and Drainage
ICMR	Indian Council of Medical Research
IWRM	Integrated Water Resources Management
JBIC	Japan Bank of International Co-operation
KBK	Kalahandi-Bolangir-Koraput
KLD	Kilo Litres Per Day
LPCD	Litre per capita per day
M & E	Monitoring & Evaluation
MINAR	Monitoring of National Aquatic Resources
MIS	Management Information System
MLD	Million Litres Per Day

MOWR	Ministry Of Water Resources
MWL	Maximum Water Level
MCM	Million Cubic Meter
NABARD	National Bank of Agriculture & Rural Development
NAC	Notified Area Council
NGO	Non Government Organisation
NWP	National Water Policy
NIH	National Institute of Hydrology
O&M	Operation and Maintenance
NPR	Nutritional per Capita Requirement
NSDP	Net State Domestic Product
OPGC	Orissa Power Generation Corporation
OHPC	Orissa Hydro Power Corporation
OLIC	Orissa Lift Irrigation Corporation
OMC	Orissa Mining Corporation
ORSAC	Orissa Remote Sensing Application Centre
OSDMA	Orissa State Disaster Mitigation Authority
OWPO	Orissa Water Planning Organisation
OWRCP	Orissa Water Resources Consolidation Project
PP	Pani Panchyat
PAP	Project Affected Person
PCCF	Principal Chief Conservator of Forest
PMF	Probable Maximum Flood
RIBASIM	River Basin Simulation
RSP	Rourkela Steel Plant
R & R	Resettlement & Rehabilitation
SAR	Sodium Adsorption Ratio
SWP	State Water Policy
SC	Schedule Caste
ST	Schedule Tribe
SI	Saprobic Index
SPCB	State Pollution Control Board
SRC	Special Relief Commissioner
TC	Total Coliform
TPA	Tons Per Annum
ULB	Urban Local Body
WHO	World Heath Organisation
WRB	Water Resources Board
WALMI	Water & Land Management Institution
WRCP	Water Resources Consolidation Project.

PREFACE

This document develops a plan for the effective management of Orissa's water resources with a view to enhancing the economic and social welfare of the State's population. It presents a concise description of state-wide relevant conditions by consolidating the knowledge gained by OWPO in elaborating the basin plans for the State's major rivers.

Responding to the expected provisions of the Orissa State Water Policy being developed, the document identifies the water-related issues that need to be addressed and proposes a coherent framework for the Government of Orissa to develop and undertake the interventions necessary to meet the needs of the water users while avoiding conflicts and maintaining the integrity of the environment.

The preparation of the document benefited from the input of the government departments and agencies concerned with water matters, with whom OWPO interacted in the course of developing the river basin plans and drafting this document.

The document has five parts.

Part A presents the salient features of Orissa by providing the basic information about the State's location, extent and population (Chapter 1), describing its administrative and governance setup (Chapter 2), and characterising its economy (Chapter 3) and socio-economic conditions (Chapter 4).

Part B defines the context for water management in Orissa by stating the objective to be pursued and principles to be followed in managing the State's water (Chapter 5), reviewing the relevant national and state policies (Chapter 6), identifying the applicable legal provisions (Chapter 7), taking stock of the institutions responsible for water management or having the capacity to provide relevant support (Chapter 8), and reporting on the status of water-management planning for the State (Chapter 9).

Part C describes in Chapters 10 through 16 the constituents of the State's resource base: human, land, mineral, water, forest, livestock, and fisheries resources.

Part D discusses the use and management of the State's water resources. It describes the water's use in the different sectors of social and economic activity – domestic, agriculture, energy, navigation, and recreation and tourism (Chapters 17 through 22) –, assesses the water quality of the State's rivers (Chapter 23), reviews the methods of estimating environmental flow (Chapter 24), establishes the state water balance for the present and the 2051 planning horizon (Chapter 25), brings out the critical aspects of managing the States water resources (Chapter 26), and characterises the challenge of dealing with natural hazards (Chapter 27).

Part E summarizes the principal issues and problems facing the management of Orissa's water resources (Chapter 28) and proposes a framework integrating the interventions of the State's concerned departments and agencies into a coherent plan to reach the goal of sustainable exploitation of Orissa's water and related resources (Chapter 29).

Data for this document has been collected from various sources, some of which have been mentioned in this report and reproduced as it appears in the respective documents. The correctness of data have not been independently verified.

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PART A

THE STATE OF ORISSA

1 LOCATION, SIZE AND POPULATION

Orissa is located on the eastern coast of India, between 17°31' and 22°31' N latitude and 81°31' and 87°31' E longitude. It 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, 15% of which lived in urban centres. It is currently growing at the annual rate of 1.59%. The average population density is 236 persons per km^2, compared to 312 for India.

2 ADMINISTRATION AND GOVERNANCE

2.1 Administrative Subdivision

The State is divided into 30 districts (Map 1), of which Mayurbhanj is the largest (1042km^2) and Jagatsinghpur the smallest (197km^2).

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

2.2 Governance

2.2.1 State Administration

The administration is run by a council of Minister headed by the Chief Minister. Ministers are in charge of one or more departments. There are about 35 departments in the State, each headed by a Secretary reporting to the Chief Secretary. Each department has a Chief Executive (Head of Department). Policy decisions regarding the Department are taken by the Cabinet, Minister in charge or the Secretary according to the power delegated to him. The HOD (Head of the Department) is responsible for executing the policy of the Government. There are various departments who have some functions related to the management and use of water resources. The details are shown in Table 1

2.2.2 District Administration

Orissa is divided into three ranges: Northern, Southern and Central Range under the administrative control of a Revenue Divisional Commissioner. The RDC is in charge of several districts under his control.

District Collector is the administrative head of each district. He has Sub-Divisional Officers, Tahasildars, Block Development Officers to look after Sub-Division, Tahasils and CD blocks respectively. The collector reports to the Revenue divisional Commissioner.

2.2.3 Local Self Government

In order to have the representation of the people, the district administration is now brought under an elected Zilla Parishad headed by a Chairman. Similarly,

development of CD blocks in charge of an elected Chairman and villages under a Sarapanch.

Urban local bodies, Notified Area Councils (NAC) and Municipalities are in charge of elected Chairman, where a Mayor is elected as the head of the corporation.

3 ECONOMY

3.1 Structure of the Economy

Table 50 shows the sectoral composition of the Net State Domestic Product (NSDP). It is seen that Agriculture and Animal Husbandry continues to be the economy's dominant sector. The 30.75% of total NSDP this sector 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%).

3.2 Per Capita State Income

NSDP per capita for the major states in India for 2000-01 is shown in Table 4, in both constant base 1993-94 and current prices. It is seen that only Bihar has a lower per capita state income than that of Orissa. Orissa's Rs 5663 NSDP per capita represents only 55% of the national income of Rs 10,254.

Orissa's per capita income is growing at a much slower rate than that of India as a whole. In 1994-95, Orissa's per capita income represented 63% of India's. By 2000-01 this ratio had dropped to 55%. A comparison with the other major states reveals that in the same year Orissa achieved only 36% of the per capita income of Punjab. The State is losing ground to Madhya Pradesh, Rajasthan and Uttarpradesh as well as states like Andhra Pradesh, West Bengal and Karnatak.

The long term growth rate of NSDP stands at 2.70% and growth of per capita NSDP is 0.67%. The major sector, Agriculture has not progressed well and the growth rate is only 2%.

3.3 STATE FINANCES

3.4 Budget

The State Budget for 2002-2003 (in Rs crore) was as follows:

	Receipts	Expenditure
Consolidated Fund	14981.4	15665.1
Public Account	6859.3	6175.6
Contingencies	150.0	150.0
Total	21990.7	21990.7

Sector-wise plan outlay and expenditure of the State from 2000-01 to 2003-04 is given in Table 2. Compared to other states the provision is rather poor.

3.5 Externally Aided Projects

The State receives financial assistance from external agencies like the World Bank, European Union, JBIC and other donor countries. It is proposed to allocate Rs 1102.92 crore for execution of EAPs out of State Plan outlay of Rs 3100 crore in

2002-03. There is an outlay of Rs 6181 crore in the 10th plan out of total Rs 19000 crore for execution of EAP.

3.6 Debt Burden

The debt burden of the State is increasing every year and stood at Rs 24,495.05 crore in 2001-02. The State has sought Central assistance for improvement of its economy.

3.7 Funding for DOWR

All the activities of Water Resources Department are covered under the Government of Orissa State Budget as well as from the grant and loan received from the Government of India and other external funding agencies. With limited resources, the State has to borrow from external and internal funding agencies to meet the developmental costs.

3.7.1 External Sources

(i) Orissa Water Resources Consolidation Project OWRCP - The Government of Orissa concluded a funding agreement for OWRCP with World Bank in 1996 for an amount of Rs 14,090 million and revised to Rs 15,395 million. The agreement has been extended up to 30th September 2004.

(ii) Hydrology Project - This is also a World Bank aided Project and designed to create a necessary institutional strengthening for hydrological observation and creation of database. The agreement expires on 31st March 2004 but a new Hydrology Project II will operate from 30 June 2004.

(iii) JBIC – Japan Bank of International Co-operation The Government of Orissa signed an agreement with OECF (Japan), now redesignated as JBIC for development of Rengali canal project. This funding is exclusively earmarked for execution of Rengali left canal from R.D 30 km to 71.3 km to be taken up in two phases.

(iv) European community funding - The European community credit is an externally funded scheme through which farmer's participation is encouraged for ayacut management. Selected minor Irrigation projects have been identified and the gradual transfer of ayacuts to water users is under process through above funding.

(v) KFW- Lift Irrigation Sector KFW - German Government funded schemes are implemented in lift Irrigation sector for sinking of tube wells in priority sector.

3.7.2 Internal Sources

NABARD – National Bank of Agriculture and Rural Development This bank is exclusively dedicated for funding in Rural Development as well as in the agricultural sector. DOWR receives loan for various Irrigation projects under RIDF (Rural Infrastructure Development Funding) in various phases and the funding is continuing.

4 SOCIO-ECONOMIC CONDITIONS

4.1 Employment

There is not enough employment opportunity in the State for the entire population. The situation gets worse every year with growth in population. According to 2001 census, the workers number 142.73 lakhs, or 38.88% of the State's population. Out of the working population Main Workers constitute 67.07%, Cultivators (29.69%) and Agricultural Labourers (35.04%) together constitute 64.73% of the total workforce. Thus agriculture is the largest employment-providing sector of the State.

Unemployment is one of the major problems of the State. It is estimated that number of unemployment persons has crossed one million mark. The State is urgently looking out for employment-generating and self-employment programs. Agriculture development appears to be the answer to this serious problem.

4.2 Income

Orissa is the poorest State in the country. Persons below poverty line (BPL) for major States in the country are shown in Table 3. From 1974 to 2000, 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. This is given in table 3(A). The below poverty level status of rural and urban population from 1973 – 1974 to 1999 – 2000 is given in Fig. 2 & Fig. 3. The per capita income distributed in various districts is shown in Map – 6.

4.3 Regional Disparity

Study of the district economy shows unevenness of development benefits and level of growth in the districts. DES has conducted a study of socio-economic condition of the districts and computed the Net District Domestic Product (NDDP) and per capita income of all the 30 districts of the State for 1993-1998 at constant prices. Study of the tables show that the district of Deogarh has the lowest NDDP (13,006) lakh Rs. and Ganjam has the highest (150,799) lakh Rs.. Nawarangpur has the lowest per capita income (Rs.3787) and Jharsuguda the highest (Rs.11,210). Number of BPL families (annual family income < Rs.11,000) in different districts of the State shows that poverty is very well spread in the rural area. Destitute (income < Rs.4000) and Very Poor (income Rs.4000 < Rs.6000) constitute more than 50% of rural families. The Planning Commission has developed an 'index of living condition' (Orissa Development Report, 2002) for ranking the districts. The district's value of the index and the rank are given in Table 5.

4.4 Culture

The State fosters old traditions and is very rich in culture. The people of the State speak a language called' Oriya' derived from ancient Sanskrit Oriya people have won national/international recognition in Arts and Literature. The State is rich in folk songs and dances.

The Scheduled Tribe 'Adivasi' have their separate culture, dance language and script. They lead a simple life and many of them are still untouched by modern civilisation.

The people of the State are peace loving and tolerant. Major disturbances are rare and short. Majority follow Hinduism, but Islam and Christianity is practiced with local pockets of concentration.

People of the State have a fond attitude towards water. The Hindus consider water a form of divine manifestation. Rivers are revered. People have the habit of taking bath once a day and sometimes twice. Lot of water is used for sanitation. To avoid heat people drink a lot of water and the food itself consists of plenty of water.

PART B

THE WATER MANAGEMENT CONTEXT

5 PLANNING OBJECTIVE AND PRINCIPLES

5.1 Planning Objective

The objective of planning the development and management of the State of Orissa's water resources is to define the optimal way in which these resources, in conjunction with the exploitation of the State's other resources, can contribute to attaining society's objectives of environmentally sustainable economic and social development.

5.1.1 India's Tenth Five-Year Plan

India's current development objectives, strategies and policies are embodied in the Tenth Five Year Development Plan (2002-2007), which, in addition to the traditional focus on economic growth, emphasises the importance of human and social development by also setting, for the first time in Indian planning history, corresponding quantitative targets[1]. The Five-Year Plan's strategies of particular relevance for water resources management concern the following sectors:

- Agriculture
- Rural Water Supply and Sanitation
- Urban Water Supply and Sanitation
- Forests and Environment

Agriculture

"Agricultural development must *be viewed as a core element of the Plan, since growth in this sector is likely to lead to the widest spread of benefits especially for the rural poor."* Agriculture *("in its extended sense")* is also considered as one of sectors having a large employment potential.

The appropriateness of the policies aiming at securing increased production through subsidies in inputs such as power, water and fertiliser is now being questioned. These subsidies have been provided at the expense of investment in rural infrastructure and of the maintenance of canals and roads. Moreover, subsidies like *"under-pricing of power and irrigation do not improve income distribution in rural areas and may also be environmentally harmful. … Excess use of water has produced water logging in many areas."*

"Both land and water will be crucial constraints on the efforts to expand production in agriculture" and the focus must be on raising the productivity of land and water in a manner that is sustainable over the longer term. The increasing strain on water resources represents the critical problem. *"The Tenth Plan must aim at a major revival of investment in irrigation capacity and water management. Greater attention will also have to be paid to rain water harvesting and increasing the irrigation potential through scientific watershed development and minor irrigation. There is*

[1] Planning Commission, Government of India, Tenth Five Year Plan 2002-2007

also considerable scope to improve the efficiency of the existing irrigation infrastructure through better and more participative management practices."

The rehabilitation and construction of minor irrigation schemes must be given priority, primarily because their short gestation period, as compared to major and medium schemes, will allow the rapid realisation of the important remaining potential for such schemes.

Crop diversification is expected to contribute significantly to making agriculture more profitable and increasing rural incomes. Growing pulses and oil seeds is not only comparatively labour intensive, but also contributes to the improvement of nutrition and of India's balance of payments.

Rural Water Supply and Sanitation

"In line with the National Agenda for Governance, safe drinking water is to be provided in accordance with the stipulated norms on a sustainable basis to all habitations by March 2004."

Although planning and financing of rural water supply is provided by *the "Central and State levels, responsibility for proper implementation has to be borne at the local level, by the Panchayati Raj Institutions (PRIs), with the help of organisations of the users… PRIs should be the key institutions for the convergence of drinking water supply programmes at the ground level. However, the financial and administrative authority has not been devolved to PRIs to the extent needed. Emphasis must be laid on the participation of stakeholders at all levels, from planning, design and location to implementation and management."*

"Rural sanitation is promoted as a total package consisting of safe handling of drinking water, scientific disposal of waste water, safe disposal of human excreta including child excreta, solid waste management, domestic sanitation and food hygiene, personal hygiene and village sanitation. However, there has hardly been any significant change in the sanitary conditions in the villages in India. The 54th round of National Sample Survey indicates that only 17.5 per cent of rural population were using latrines. There is a need to implement a revitalised programme for rural sanitation …"

Urban Water Supply and Sanitation

"As in the Eighth and Ninth Plans, in the Tenth Plan also the approach to the water supply and sanitation sector will take into account the guiding principles suggested in the New Delhi Declaration, which was adopted by the U.N. General Assembly in December 1990. These are:

(i) Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid waste;

(ii) Organisational reforms, promoting an integrated approach and including changes in procedures, attitudes, and behaviour, and the full participation of women at all levels;

(iii) Community management of services, backed by measures to strengthen the capacity of local institutions in implementing and sustaining water and sanitation programmes;

(iv) Sound financial practices, achieved through better management of existing assets and extensive use of appropriate technologies."

"Water supply and sanitation are the biggest challenges before Urban Local Bodies (ULBs)." Unfortunately, *"urban governance today is characterized by fragmentation of responsibility, incomplete devolution of functions and funds to the elected bodies and ULBs, unwillingness to progress towards municipal autonomy, adherence to outmoded methods of property tax and reluctance to levy user charges… Experience shows that functional autonomy becomes a reality only when it is accompanied by financial independence. State governments, therefore, need to strengthen the autonomous functioning of the ULBs through positive measures, and in particular, ensure their financial self-reliance."*

One of the causes *"of the fiscal imbalance of ULBs is the highly subsidised supply of services, in particular, water and sewerage. Insufficient revenue income prevents civic authorities from investing in services, leaving existing and future needs unfulfilled and this, in turn, hinders growth."*

"There is an urgent need to step up investment in this sector during the Tenth Plan. The tasks include efficiency improvement, better customer satisfaction, levy and collection of reasonable user charges, accessing institutional and market borrowings to provide sufficient investment funds, and institutional improvement at all levels."

"Supply of water to consumers should normally be based on the principle of effective demand that should broadly correspond to the standard of service which the users as a community are willing to maintain, operate and finance. At the same time, special provisions should be made to meet the needs of the poor who have less capacity to pay."

Forests and Environment

"Forests play an important role in environmental and economic sustainability. They provide numerous goods and services, and maintain life-support systems essential for life on earth." One of these is *"playing an integral part of the watershed to regulate the water regime, conserve soil, and control floods."*

"The National Forest Policy stipulates that one-third geographic area of the country should be brought under forest/tree cover… Successful models of watershed development have helped conserve soil and moisture, improve ground water recharge and the water regime and mitigated the adverse impacts of drought. The watershed approach should be universally adopted for the maintenance and development of forests."

As for the quality of the water, *"the major rivers of the country suffer from reduction in flow while entering the plains and passing through cities (because of water being drawn for irrigation and drinking water supply in cities). At the same time, they receive polluted discharge, the main pollutants being fertilisers and insecticides, untreated municipal sewage and industrial effluents… In areas of intensive industrial activity, there is high concentration of heavy/toxic metals in different proportions in ground water."*

"The sustainable use of bio-diversity is fundamental to ecologically sustainable development. India is one of the 12 mega diversity countries of the world. However, during the past few decades, industrialisation has put a strain on the eco-system, altering and even destroying it. The loss of bio-diversity stems from destruction of the habitat, extension of agriculture, filling up of wetlands, conversion of rich bio-diversity sites for human settlement and industrial development, destruction of coastal areas and uncontrolled commercial exploitation."

"The major instrument with the State to check environmental degradation is undoubtedly regulation. The country has adopted almost all environmental protection Acts and rules enforced in developed countries. But environmental degradation continues despite the existence of a longstanding policy, and legal-cum-institutional framework for environmental protection. The need for reducing the gap between principle and practice cannot be over-emphasised."

5.1.2 Objectives of Basin Planning in Orissa

While reflecting the prescriptions of India's Tenth Five-Year Plan, the State Water Plan will emphasise: the maintenance of good water quality to ensure public health and prevent damage to the environment; the availability of safe drinking water and water for sanitation for all; the attainment of food security; the growth of the State's economy and the creation of employment opportunities.

5.2 Planning Principles

The principles followed in planning for the optimal exploitation as spelled out in the draft for the Strategy Paper on River Basin Planning issued by OWPO in September 2002. Reflecting the concept of Integrated Water Resources Management (IWRM), they are grouped into:

- ***Institutional and Management Principles***, stressing the need for the clear definition of the roles of government and official bodies, the design of an effective structure and system of water resources management, the active participation of water users, and the establishment and maintenance of a comprehensive management information system.
- ***Environmental Management Principles***, which require balancing water-related activities with the needs of the environment to ensure sustainability, to conserve ecosystems, and to monitor environmental change.
- ***Social Principles***, calling for the provision of adequate water supply and sanitation facilities, the involvement of stakeholders and water users, and the consideration of gender implications in planning and implementation.
- ***Economic and Financial Principles***, requiring that water is considered as an economic good, that water tariffs be levied and that the demand and supply be managed so as to result in the rational allocation of the available water.
- ***Information, Education and Communications Principles***, underlining the importance of knowledge about water related activities, of pertinent education, and of appropriate communications and awareness building.
- ***Technological Principles***, calling for a balanced approach towards "hardware and software" components, and technology choices based on efficiency, appropriateness, cost, and suitability for local conditions.

6 POLICY FRAMEWORK

6.1 National Water Policy - 2002

The National Water Resources Council adopted the new National Water Policy (NWP) in its 5th meeting held on 01 April 2002. The policy provides the national perspective for the planning and management of water resources with a view to

ensuring their optimal, economical and equitable use. It recognizes that *"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 needs of the States."* It stipulates that *"State Water Policy backed with an operational action plan shall be formulated in a time bound manner say in two years."*

The NWP generally embodies the principles of IWRM. The following of the policy's provisions are of particular relevance:

- The development and management of water resources has to be planned for hydrological units. "All individual development projects and proposals should be formulated and considered within the framework of such an overall plan …"
- The effective application of the principles of IWRM requires the appropriate reorientation or reorganization of existing institutions and the creation of new ones where necessary.
- The institutional arrangements should allow giving the currently neglected maintenance of water resources schemes *"importance equal or even more than that of new construction."*
- River basin organisations should be established and "prepare comprehensive plans taking into account not only the needs of irrigation but also harmonising various other water uses … The scope and powers of the river basin organisations shall be decided by the basin states themselves."
- Subject to modification to suit local considerations, water allocation priorities should be as follows:

  Drinking Water

  Irrigation

  Hydro-power

  Ecology

  Agro-industries and non-agricultural industries

  Navigation and other uses
- "Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes."
- "Irrigation planning … should take into account the irrigability of land, cost-effective irrigation options possible from all available sources of water and appropriate irrigation techniques … Irrigation intensity should be such as to extend the benefits of irrigation to as large a number of farm families as possible."
- Concerning the resettlement and rehabilitation of people displaced by the construction of water management infrastructure, "a skeletal national policy … needs to be formulated … States should accordingly evolve their own detailed resettlement and rehabilitation policies."
- Planning, design, development and management of water resources schemes should involve "not only the various government agencies but also the users and other stakeholders. … Water Users' Associations and the local bodies such as municipalities and gram panchayats should particularly be involved in the operation, maintenance and management of water infrastructure."

- Wherever feasible, "private sector participation should be encouraged in planning, development and management of water resources projects for diverse uses."
- "There should be a master plan for flood control and management for each flood prone basin. … Increased emphasis should be laid on non-structural measures such as flood forecasting and warning, flood plain zoning and flood proofing for the minimisation of losses and to reduce the recurring expenditure on flood relief."
- *"Drought-prone areas should be made less vulnerable to drought-associated problems"* through the application of appropriate measures and practices and relatively less water-demanding land use.
- "From the present emphasis on the creation and expansion of water resources infrastructure for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities."

6.2 State Water Policy of Orissa

Orissa formulated its first State Water Policy in 1994. Reflecting the provisions of the National Water Policy of 1987, its key objectives were [2]:

(i) *"Development of water resources available within the category of utilisable resource to the maximum possible extent for economic development, especially by efficient use of water for agriculture.*

(ii) *Maximum economic benefits through judicious conjunctive use of both surface and groundwater.*

(iii) *Judicious allocation of water resource to different sectors with drinking water occupying top priority in order to satisfy the basic need of the people.*

(iv) *Promotion of equity, social justice and balanced regional development. Special efforts should be made to extend the benefits of water use primarily by extending irrigation facilities to economically backward areas and chronically drought prone areas."*

The Policy mandated the DOWR to implement the policy provisions, under the guidance of the Water Resources Board (WRB), *"the highest co-ordinating body on water planning and allocation between sectors ..."* With a view to achieving effective management of the State's water resources, the Policy called for the establishment of: a framework of water resources plan based on basin studies; multipurpose river basin plans; a drought management plan; a computerised database and information system; an environmental management plan; and a flood and drainage management plan for each basin.

A new Orissa State Water Policy, drafted in conformity with the National Water Policy of 2002, is in the process of being approved.

[2] Government of Orissa, DOWR, State Water Policy of Orissa, 1994

6.3 Strategic Environmental Policy for Water Resources Planning and Development in Orissa – 2001

The Strategic Environmental Policy was issued by the Chief Engineer of the Orissa Water Planning Organisation In July 2001. The Policy's objective is *"to effectively integrate environment considerations in the development and implementation of the Integrated River Basin Plan … and operationalise the principles of sound environment planning in the water sector."*

The Policy groups the environmental issues into five categories: economic, physical, biological, social, and institutional. The principal provisions under each category are summarised below.

6.3.1 Environmental Economics

The application of the evolving principles and methodologies of environmental economics shall result in the feasibility studies of the Department's activities and projects fully reflecting *"their actual environmental cost, including both the ecological and social dimensions of 'environment'."*

6.3.2 Physical Aspects

Best available agricultural practices shall be adopted to avoid degradation of cropland in the basin's lower part. The loss of village forest due to the conversion of the land to paddy in ayacuts of irrigation projects shall be reversed and the deleterious effects mitigated; *"prospective village forest conversion within proposed ayacuts shall therefore be considered a project-induced environmental impact."* Up-basin catchments shall be *"protected to the maximum feasible degree from human activities inducing erosion"* and consequent deleterious effects on the hydrologic regime and water quality. The urbanisation of ayacuts is in principle to be opposed. The overexploitation of groundwater is to be avoided through implementation of effective control. *"Municipal waste water and industrial waste water shall be treated properly to keep the pollution load within permissible limit before discharging into natural water bodies."* The proliferation of aquatic weeds shall be controlled by appropriate measures *"to maintain the water quality within standard and to avoid eutrophication."*

Ecological Issues

"The significant loss of high quality forest and of habitat for fish and wildlife must be foreclosed or adequately mitigated;" the conservation of bio-diversity may necessitate the preservation of entire basins or sub-basins in their natural state. River fisheries shall be assisted through the provision of migratory pathways and the practice of appropriate reservoir-release regimes. The development of reservoir fisheries is a complex undertaking and, therefore, *"should incorporate from the outset expertise in reservoir fisheries ecology."* The Department shall *"preserve to the maximum feasible degree the proper ecological functioning of estuaries by assuring sufficient freshwater inflow: in terms of quality, quantity and timing."*

Social and Cultural Commitments

People displaced by projects shall figure among the project beneficiaries and find themselves in a post-project condition that is demonstrably better than their prior condition. All efforts shall be taken to conserve or relocate 'cultural properties' (temples, artefacts, sacred or historical sites, etc.) to the most feasible degree; where

this is impossible, such properties *"shall be documented and archived both textually and visually, so that their removal from the collective memory is neither absolute nor irretrievable."*

Institutional Aspects

The Department shall develop the institutional capacity to undertake environmental assessments and prepare environmental management plans and *"shall accept in principle that environmental documentation specifically, and environmental planning generally are field-based, experimental activities that cannot be executed entirely within an office armed with the most comprehensive checklist or sophisticated computer programs."*

6.4 Related Policies

6.4.1 National Health Policy – 2002

This policy proposes the implementation of a wide-ranging comprehensive set of measures necessary for accelerating the achievement of public health goals. Recognising the huge burden for society of the persistent high-level prevalence of communicable diseases (e.g., malaria, dengue, Japanese encephalitis, tuberculosis, HIV/AIDS, water-borne infections such as gastroenteritis, cholera and hepatitis), the policy sets the goal to reduce by the year 2010 the mortality on account of tuberculosis, malaria and other vector- and water-borne diseases by 50%. Of great significance for effective water resources development and management is the policy's emphasis upon the implementation of public health programs through local self-government institutions.

6.4.2 Orissa Industrial Policy – 2001

This policy was formulated with a view to exploiting fully the economic potential of Orissa's substantial natural resource endowment: abundance of mineral resources, long coast line, and plentiful freshwater and diverse forest wealth. It has as principal objectives: to create a business climate conducive to accelerating investment in industry and infrastructure projects; to raise income, employment and economic growth in the State; and to reduce regional disparities in economic development. To reach these objectives, the Government proposes, among other measures: to promote the image of Orissa as an attractive destination for investment and tourism; and to assume a proactive role in selected sectors such as mineral-based industries, craft-based products, and agro- and marine-based industries.

6.4.3 Orissa Agricultural Policy – 1996

This policy aims at doubling the production of foodgrains and oil seeds generating adequate employment opportunities in the rural sector, and eradicating rural poverty. Provisions of particular interest are: to enhance the status of agriculture from the present level of subsistence agriculture to a profitable and commercial venture; to adopt integrated programmes for problem soils such as water logged areas, areas with soil erosion, dry/rainfed areas, area under shifting cultivation, waste land, and saline and alkaline soils; and to provide irrigation facilities to 50% of cultivable land through completion of incomplete irrigation projects and promotion of individual and group enterprise.

6.4.4 State Reservoir Fishery Policy, Orissa – 2003

Issued in August 2003, this policy has as major objectives: to augment fish production from reservoirs through scientific management; to generate gainful rural employment with special reference to fishing communities and economic rehabilitation of displaced persons; to introduce systematic management strategies both for conservation and sustained fish production; to attract increasing investments from private sector; and to stimulate entrepreneurship for fishery sector with special reference to reservoir fishery. The policy prescribes the modalities of exploiting the fisheries of reservoirs leased out to fisheries cooperatives, individuals or companies, with the overall management provided by the Fisheries and Animal Resources Development Department in consultation with the Department of Water Resources.

6.4.5 Orissa Resettlement and Rehabilitation Policy – 1994

This policy was approved by the Government of Orissa in August 1994. It deals with the resettlement and rehabilitation of Displaced Persons (DP) and Project-affected persons (PAP) linked with the construction of Water Resources projects. This policy deals with the R&R packages to be given to the DP and PAP which include homestead land, house building assistance, agricultural land and maintenance grant for limited period of sustenance. The R&R policy of Orissa has uniform compensation provision for tribal and non-tribal population but the Ministry of Tribal Affairs (MTA) of the Government of India has stipulated certain extra facilities to tribal population and the same is also taken into consideration by the Government of Orissa.

6.4.6 Orissa Relief Code – 1980, amended in 1996

The Orissa Relief Code issued in March 1980 and amended in 1996 covers the extraordinary situations arising out of drought, flood, cyclone, earthquake, volcanic eruptions and other calamities. This code has specific provisions for food, shelter and other basic necessities for the affected people.

6.4.7 National Forest Policy – 1988

The National Forest policy was launched in the year 1988. It stipulates that, 33% of the geographical area should be under forest cover, with 60% coverage in hilly areas and 20% in plains.

7 LEGAL FRAMEWORK

7.1 Legislative Powers

Under article 246(3) of the constitution of India and entry 17 of list ii of the seventh schedule State Governments have the power to legislate in respect of ‘water’. Article 162 states ‘the executive power of a state shall extend to the matters with respect to which the legislature of the State has power to make laws.’ The powers of the State are subject to entry 56 of list I which gives power to the Union Government to legislate for regulation and development of inter-state rivers and river valleys. The Union is also empowered to provide for adjudication of any dispute or complaint of the States. Following these provisions, Union and State Governments have enacted several acts and rules.

7.2 Orissa Irrigation Act – 1959

The Orissa irrigation act came into force in 1959 and the Orissa Irrigation Rules in 1961. This act primarily covers the legal aspect related to construction and maintenance of irrigation works. It also prescribes the basic water rates to be made applicable to various class of irrigation system for which water is to be supplied by the Irrigation Department. The Orissa Irrigation Rules was amended in 2002 (Orissa Irrigation amended rules 2002) for revision of basic water rates for various class of irrigation system as well as for crops other than the basic cereal crops. Rates for water supplied for purposes other than irrigation works was also amended in 1998 to cover mainly the industrial and municipal water supply.

7.3 Orissa Pani Panchayat Act – 2002

The Orissa Pani Panchayat Act came into force in July 2002 and the Pani Panchayat Rules in April 2003. The Act's objectives are:

- To ensure optimum utilization of water by farmers for improvement of agricultural production.
- To encourage scientific and systematic development and maintenance of Irrigation infrastructure through farmers' participation.
- To involve farmers' organization in the management and maintenance of the Irrigation system for equitable and dependable supply and distribution of water.

The Pani Panchayat Act and Rules provide guidelines for formation, membership, duties and business of the Water Users' Association (Pani Panchayats).

7.4 Land Acquisition Act – 1894, amended from time to time

This is an act promulgated during the British Government period and deals with procedures and provisions of acquisition of Private Land for Government purpose. This is a prime act and through this provision Government handles acquisition of Land for the execution of Water Resource Projects.

7.5 Forest Conservation Act – 1980, amended up to 1992

This is the key act, which helps in protecting the Forest land and deals with procedures and provision for deserving the Forest land for Non- Forest use. One of the prime provisions of this act relates to compensatory afforestation by which equivalent forest area lost due to execution of new project is created.

7.6 Environment Protection Act – 1986, amended up to 1994

This is the principal act of Government of India, which has provisions to safeguard the environment. This act deals primarily with prevention, control and abetment of Environmental Pollution. All new major water resources projects to be implemented come under the provision of this act and procedure and guidelines outlined in this act are to be strictly and meticulously followed.

7.7 River Boards Act – 1956

Union Government has passed this act to advise the States on matters relating to regulation and development of waters of inter-state rivers. The Boards will have

members from Centre and co-basin States. This arrangement will avoid inter-state disputes.

7.8 Inter-state Water Disputes Act – 1956

Under this act enacted by the Union Government provides for adjudication of water disputes between two or more states. This act has been further revised to be more meaningful and useful in view of growing number of inter-state disputes. The details of interstate agreements with Orissa & other related matters are given in Annex.

7.9 Comments on Legal Framework

Water resources management in the State is mostly governed by the Orissa Irrigation Act – 1959 and the Orissa Pani Panchayat Act – 2002 and their Rules. Orissa Embankment Act and Orissa Navigation Act are also applicable but are not often taken into account. These acts are very old and need thorough modification to suit the present context.

8 INSTITUTIONAL FRAMEWORK

8.1 National Institutions

8.1.1 Ministry of Water Resources

The Ministry of Water Resources (MOWR) oversees the development scenario of water sector of the country, approves and funds key project schemes in flood control, major Irrigation, and other related activities. MOWR assists financially needy states for implementation of the projects, mediates in case of inter-state disputes, provides technical advice and arranges external funding for the states.

8.1.2 Central Water Commission

The Commission is the engineering organisation of MOWR. The Ministry handles the monitoring, implementation and evaluation of all projects and activities of the states through the Commission.

8.1.3 Other national Institutions guiding and governing the water development of the States

- Central Electricity Authority (CEA)
- Central Water and Power Research Station (CWPRS), Pune
- National Institute of Hydrology (NIH), Roorkee
- National Water Academy, Pune
- Central Board of Irrigation and Power (CBIP)
- Indian National Commission on Large Dams (INCOLD)
- Indian National Commission on Irrigation and Drainage (INCID)

8.2 State Institutions

8.2.1 State Planning Board

State planning Board is the key Organisation of Government of Orissa, who provides policy direction in formulating the plan scenario both for short term and long-term

developmental objectives. The Deputy chairman and members are nominated by the Government of Orissa. The Board has a member for Water Resources Development of the State.

8.2.2 Water Resources Board

The Government of Orissa constituted the Water Resources Board, the apex body in water sector with Chief Secretary of the State as Chairman, vide notification No Irr-I-IPL-22496 Dt 21/8/93. The Water Resources Board has ten departmental secretaries as members and EIC (P&D) as member-secretary. The Board has the following important functions.

(i) Formation of State Water Policy

(ii) Integrated planning of water Resources

(iii) Allocation of Water to various Water use sectors

(iv) Prioritisation of Water Resources Development

(v) Environmental management plan

The Board provides the highest forum for taking decisions regarding development of water resources of the State and, in particular, gives policy direction to the Water

8.2.3 Water Resources Department

The water related activities of the State are handled by the Department of Water Resources (DOWR) of the State headed by the Secretary DOWR is responsible for planning, developing and managing the State's Water Resources for irrigation, bulk water supply, drainage and flood control with direct responsibility for implementation of Major, Medium and Minor Irrigation projects and their operation and maintenance. The Secretary is supported by an Engineering Organisation and other, associated, organisations. The organisational structure of DOWR is given in Figure 17.

The information system plan for Department of Water Resources and State Institutions are given in Fig. 18 & Fig. 19

The Engineering Organization is headed by the EIC (Water Resources) and assisted by EIC (Planning & Design). Chief Engineer and Basin Managers are in charge of different river basins. Functional areas like Flood control, Drainage, Water Services and Designs are looked after by separate CEs. Water planning of the State is looked after by Orissa Water Planning Organisation (OWPO).

The associated organisations are the following:

- **Ground Water Survey & investigation (GWSI) Directorate.** This organisation is headed by a Director in the rank of Chief Engineer and is responsible for ground Water survey and Investigation of the State.
- **Orissa Lift Irrigation Corporation OLIC).** This is a State Government under taking and is responsible for installation, maintenance and operation of all lift irrigation works in the public sector and headed by an officer of the rank of Chief Engineer.
- **Orissa Construction Corporation (OCC).** This is a Government owned construction company and is entrusted with execution of major irrigation projects and is headed by the Managing Director in the rank of Chief Engineer.

- **Command Area Development. (CAD).** This Organization handles the command area activities in selected command area for optimal distribution of water below the outlet point and is headed by an officer of Chief Engineer rank.
- **Water and Land management Institute (WALMI).** The water and Land management Institute is a pioneer Organization responsible for training the Engineers on water and related agricultural development and imparts management techniques for handling water resource projects.

8.2.4 Other Departments and Agencies Concerned with Water Resources Management

Table 1 lists the departments other then that of Water Resources involved in the management of the State's water and indicates their corresponding functions.

8.3 Universities and Institutes

The following universities besides their usual academic functions also take large number of research projects under water and related socio-economic fields.

- Utkal University
- Orissa University of Agriculture & Technology (OUAT)
- Berhampur University
- Sambalpur University
- North Orissa University
- Fakir Mohan University
- Biju Patnaik University of Technology

The following leading institutes are also engaged in providing policy support to the Government through evaluation and other studies:

- Nabakrushna Choudhary Centre for developmental studies (NCDS).
- CINDRIT- an wing of XAVIER Institute of management.
- CYSD- Centre for Youth & Social Development.

8.4 Non Government Organisations

There are large numbers of voluntary organizations and Non-Government organizations working in the areas of rural development and poverty eradication while a few of them conduct survey evaluation, monitoring etc, and others are engaged in programme implementation.

9 STATUS OF WATER-MANAGEMENT PLANNING

DOWR has undertaken the study of the State's eleven major river basins under the World Bank-financed OWRCP since 1993. These studies have resulted in the quantification of the basin's human and natural resource base and the assessment of the resource base's capacity to satisfy the different water-use sectors up to 2051.

The eleven river basins for which studies have been prepared and complied are as below:

1. Mahanadi
2. Brahmni
3. Baitarani
4. Subarnarekha
5. Budhabalanga
6. Rusikulya
7. Bahuda
8. Vansadhara
9. Nagavali
10. Kolab
11. Indravati

PART C

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 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

10 HUMAN RESOURCES

10.1 Population Size and Distribution

The 2001 Census established the State's population at 36.707 million people. Their distribution among the 30 districts is given in Table 6.

According to the Census, 5.496 million of the State's population live in 138 towns including 10 Urban Agglomerations and 51,349 villages. The corresponding rate of urbanisation is 15%, compared to almost 30% for India as a whole.

Table 7 shows the distribution of the population by river basin, as determined on the basis of the portion of the district areas lying within the basin boundaries and the assumption that the district population is uniformly distributed over the district area.

In 2001, the State's average population density was 236 persons per km^2. As shown in Map 4 the density varies considerably from district to district. It is very high (>450) in the coastal region of the State consisting of the districts of Balasore, Bhadrak, Jagatsinghpur, Jajpur, Kendrapara, Khurda. The districts of Puri and Ganjam have marginally lower density. In the central region of the State the density of population was close to average (>150<300). The southern districts like Koraput, Malkangiri, Rayagada and western districts like Boudh, Deogarh, Kandhamal, Nuapara and Sambalpur show low population density (<150).

Population density is an indicator of degree of development. The coastal area is more developed and has a higher density of population. The inland Orissa or the central region is less developed and has a lower density of population. The lower density-areas of the State are least developed, but have a good potential for economic growth. They would absorb larger population provided their resource endowment, including human resources, is developed and efficiently utilized. The development should be planned judiciously so that population-resource balance is maintained

10.2 Gender Ratio

The total population of the State as per the Census of 2001 is 36.707 million out of which 50.83% are male and 49.17% female. Thus, the female population of Orissa is slightly lower than the male population.

The gender ratio of the State is 972, which is slightly more than the country as a whole (933). Gajapati, Ganjam, Kalahandi, Kandhamal, Kendrapara, Nuapada and Rayagada districts have female population slightly higher than the male population.

10.3 Literacy

The literacy rate overall is 63.61% which is slightly lower than the country average (65.38%). The male literacy rate is 75.95% whereas female literacy rate is 50.97%. Compared to more advanced states of the country the literacy rates needs improvement. Poor literacy areas are again the less developed south and west districts. Only a third (11 out of 30) districts have a literacy rate more than 70% most of which belong to the coastal area.

Improvement in literacy rate changes the outlook of the people and makes them more useful assets of the community. The spread of literacy and education among women are more fruitful for the society.

10.4 Education

The State has several schools and colleges to impart education to its people. The position of institutions and enrolment in the State is given below:

Type of Institution	Number	Enrolment (lakh students)
Primary School	42824	47.69
Secondary School	11510	10.55
Middle School	6282	11.34
General Colleges	1678	5.29

Besides, there are 35 engineering colleges, 3 medical colleges, 26 engineering schools and 24 ITIs to provide technical education. The major worry in the State is high drop out rate of students in the primary school level.

10.5 Health Services

As of 2001 there are 180 hospitals, 158 CHCs, 183 PHCs, 1166 new PHC (new) and 14 mobile health units. There are 13786 hospital beds in the State. There are 7560 people per doctor and 2663 people per hospital bed (India average 1361) in the State which is far from satisfactory. The State is well behind the aims of National Health Policy of providing universal health care and access to medical services. Life expectancy in the State has crawled to 57 years against national average of 61. The fact worrying the Government is the infant mortality rate (IMR) which is the highest (96 per thousand) in India.

Contaminated water contributes substantially to the ill heath of the society. Lack of sanitation is another factor which affects the rural people mostly. The habit of people to defecate in the open is one sure reason for spreading of water borne diseases. It is important to provide flush latrines in villages and motivate people to use them.

10.6 Backward Classes

Quite a large component of Orissa's population belongs to backward class consisting of Schedule Castes and Schedule Tribes. Population of SC and ST in the districts have been shown in Map 5

Among the backward population, level of literacy is very low. The incidence of poverty is much greater among them. It has been estimated in the year 1999-2000

that while 48.01% of the rural population remain below poverty line in Orissa, about 75% belong to backward in SC and ST classes.

10.7 Development of Women

It is encouraging to note that women in the State are coming forward to participate in the development works of the State. The literacy rate has increased to 51%now. Women employees in the organized sector have increased to 12.63% and 33.3% posts in Government are earmarked for women. But still a lot remains to be done to bring women to equal standard as men.

Women have a great role to play in management of water. Traditionally women of the State handle all the domestic use of water. In most of the districts of Orissa women also handle agricultural activities as labourers and cultivators. Education and participation of women in the management of water is essential.

10.8 Working and Non-working Class

Population consists of two groups: economically active group or workers and inactive group or non-workers. A Main Worker is one who gets employment for more than 6 months in a year or else he is a Marginal Worker. The different types of workers represent in all of India Orissa and the following percentages of the total population.

	Total population	Total workers	Main workers	Marginal workers	Non workers
India	100%	39.26	30.55	8.71	60.74
Orissa	100%	38.88	26.08	12.80	61.12

A worker may be a Cultivator, Agricultural Labourer, Household Industrial Worker or Other Worker. In India and Orissa, these groups represent the following percentages of all workers.

	Total Workers	Cultivators	Agricultural Labourers	Agricultural Workers	Workers in H.H.I.	Other Workers
India	100%	31.71	26.69	58.40	4.07	37.53
Orissa	100%	29.69	35.04	64.73	4.83	30.44

The Cultivators and Agricultural labourers together are designated as agricultural workers and constitute about 64.73% of working group in Orissa against 58.40 for India. This substantial group is the poorest class in the State. Unless agriculture is developed to such a degree that it brings profit to the cultivators and employment to the landless, Orissa will continue to languish as the poorest state in the country.

4.83% of the workers are engaged in household industries. The remaining 30.44% of the workers are engaged in miscellaneous types of activities.

10.9 Industrial Workers

In Orissa, growth of industries has not been as per expectation. Although vast potential lies in the industrial employment, the present status is negligible.

By 2050 it is expected that there will be substantial growth in industries in the State and as such the number of industrial workers will increase. In absence of firm information on industrial workers a likely projection of population of industrial workers is made. Basin wise present and future scenario is shown in Table 8.

10.10 The Problem of Unemployment

Along with the poor financial condition of the State the problem of unemployment is very severe. The unemployed are of two kinds: educated unemployed who seek a job in Government, or private sector and the uneducated unemployed who are mostly labourers. People in the second category are the most vulnerable and face hunger and malnutrition. In order to get some sort of employment many flee their home and become victim of social crimes. Enhanced agricultural activities hold promise for employment for these people.

10.11 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. For this purpose, the actual average annual growth rate of population for the decades from 1971-81 to 1991-01 were taken into consideration. On the basis of this declining growth rate, the growth rate for subsequent decades up to the year 2051 is assumed zero after the year 2045. This projection, which also assumes that the degree of urbanisation will linearly increase from today's 15% to 32% in 2051, gives the following results. The population growth rate is shown in Fig. 4

	Population (millions)		
Year	Rural	Urban	Total
2001	31.211	5.496	36.707
2011	37.803	8.034	45.837
2021	38.716	9.965	46.681
2031	40.119	11.556	51.675
2041	40.928	12.546	53.474
2051	41.166	12.807	53.973

The population projection as detailed above is shown in Fig. 8

11 LAND RESOURCES

11.1 Physiography and Relief

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

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

The physiographic zones of Orissa are shown in Map no 2. The fertile plains of the coastal zone were formed by the sediments brought down by Mahanadi, Brahmani, Baitarani and Rushikulya. Inhabited by 44% of the State's population, they support intensive agriculture and produce a large share of State's food and income.

The other three zones combined can be called Orissa high lands. This part of the State has rugged, undulating topography and features mainly lateritic and red soils that are not very suitable for agriculture. It is, however, very rich in forest and mineral resources.

Its North and North Eastern part is an extension of Chhotanagpur plateau and lies west of Bengal basin. The southern parts of the State are the extension of Eastern Ghat Mountains. The ghats run into fragmentary spurs and ranges down the east side of peninsula receding inland and leaving broad planes between their base and east coast.

In the north of Mahanadi River there are several peaks above 1000 m and in the southwest of Mahanadi the ranges run parallel to the coast.

In between the Chhotanagpur plateau and its extension in North and North East and the Eastern ghats in the South and South West lies a vast stretch of table land i.e. the central table land. The table land has also small hills and hillocks. This covers the major portion of Mahanadi and Brahmani basins.

11.2 Drainage Pattern

As illustrated by Map 3, Orissa is drained by 11 major rivers and their tributaries, which are clearly separated by high ridges. The north of Mayurbhanj district is drained by Subarnarekha where as the south of the district and parts of Balasore district is drained by Budhabalang River. Districts of Kendujhar and Bhadrak drain into Baitarani. Sundargarh, Debgarh, Angul, Dhenkanal, Jajpur and Kendrapara drain into Brahmani river.Part of Sundargarh, Jharsuguda Sambalpur, Baragarh, Sonepur, Balangir, Nuapara, Cuttack, Jagatsinghpur, Khurda and Puri drain into

Mahanadi. Kolab and Indravati drain Nabarangpur, Malkangiri and Koraput districts and Vansadhara and Nagavali drain Rayagara and parts of Gajpati districts. Ganjam is drained by Rushikulya River. In the upper reach of the rivers the slope is steep and there is no problem of drainage. But once the rivers reach the coastal plains the slope flattens and velocity reduces and drainage congestion occurs. The drainage system in coastal areas of Orissa covers 17 doabs and shown in Map 17

11.3 Geological Features

Geological setting, climate and topography play an important role in occurrence and movement of water. The State is underlain by diverse rock types belonging to Achaeans to recent geological scale.

11.3.1 Rock Types

Major parts of Orissa State are underlain by hard rocks of pre-Cambrian age. The principal rock types are Granites and its variants, khondalites and associated rocks, basic meta-volcanic, Marble, Dolomite, Limestone, Pre-Cambrian Sand stone-shale sequence etc. Among all rock types, granitic rocks are the most extensive and show wide variation in mineralogical, textural and structural composition. Area with pre-Cambrian Consolidated formations are Sundargarh, Keonjhar, Maurbhanj, Sambalpur, Bolangir, Phulbani, Boudh, Gajapati, Nuapara, Kalahandi and parts of Nayagarh, Khurda, Balasore, Cuttack, Ganjam, Koraput, Kalahandi, Angul, Dhenkanal, Sambalpur and Baragarh district.

The Gondwanas include sandstones, shales, siltstones and conglomoratic beds, while the Baripada beds consists of fossil ferrous limestone, stratified semi consolidated sand beds with intercalated shale's. Parts of Sundargarh, Maurbhanj, Angul, Dhenkanal, Khurda, Sambalpur, Phulbani and Bolangir belong to the area with semi-consolidated formation.

The unconsolidated sediment include Pleistocene and recent alluvium. Older alluvium is generally overlain by Laterites. Coastal tracts of Puri, Khurda, Cuttack, Jajpur, Kendrapara, Balasore, Bhadrak, Ganjam Districts and inland river valleys belongs to the area with unconsolidated quaternary formation.

11.3.2 Plains

The coastal plain of Orissa extends from Subarnarekha River in the north to the Chilika Lake in south. It is widest about 75km. around Bhadrak and Cuttack. The coastal plains of Orissa extend over a distance of about 480km. It consists of a vast plain made up of Tertiary and quaternary sediments. The various features observed are wide extensive alluvial flood plains, natural-levees, paleo-channels, active channels, recent and Paleo-basin and beach ridges, tidal flats, mangrove and swamps, spits, bars and lakes. The general elevation of varies from 1 to 10m above mean sea level.

The erosional plains of Mahanadi and other river valleys lie between the northern uplands and southern hilly region of Eastern ghat. The tract covers major parts of undivided districts of Sambalpur, Bolangir, Dhenkanal and northern parts of Phulbani (Kandhamal) and western part of Puri distinct. The altitude of this tract lies between 150 to 300m above mean sea level (amsl). Major rivers like Mahanadi, Baitarani, Brahmani, Rushikulya, Nagavalli, Indravati, Vansadhara Bahuda etc. form valleys in

the erosional plain and alluvium occurs due to river action as discontinuous flood plain.

11.4 Soils

Geology provides an idea about the soil types in various physiographic units. The different soil types are related to the land forms as follows:

Land Form	Origin	Soil Types
Plateaus	In situ	Red and yellow soils including gravelly, sandy, loamy and lateritic soils
Up-land	In situ	Red soils with patches of red and black clay soils
Basins	Rivulinic deposits	Red loamy soil and alluvial soil
High Riverine Plains	Rivulinic deposits	Mainly red sandy and loamy soils with patches of red and black clay soils.
Low Riverine Plains	Rivulinic deposits	Deltaic and coastal alluvium both older and younger
Littoral Plains	Rivulinic deposits	Recent deltaic and coastal alluvium with patches of saline or saline alkaline soils.

As may be seen, most soils are reddish. The soils in the uplands basins and upper riverine plains are quite fertile and those in the lower reverie 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.

Map 7 shows the distribution of the different types of soil found in the State and Table 10 gives the area they cover in the districts. As seen from the table, 45% of the State has red loam and red sandy variety of soil and another 35% have mixed red and yellow soil. Only 4% of land is fertile alluvial soil. The characteristics of the different soil types are described below.

11.4.1 Soil Characteristics

Younger alluvial, coastal alluvial and coastal sandy soils

They are deficient in nitrogen, phosphoric acid, and humus but are not generally wanting in potash and calcium. Texturally these are sandy to loamy, pH values are on the alkaline side. These are most fertile soils and suitable for extensive cultivation of high water demanding crops like rice, jute and sugarcane. Because of high soil moisture these are prone to water logging and are also affected by flood incidence. These soils are found in the districts of Dhenkanal, Jajpur, Kendujhar and Kendrapara.

The deltaic alluvial soils

They are generally deficient in phosphorous and nitrogen, found only in Cuttack, Jajpur, Kendrapara, Jagatsinghpur and Khurda districts. The available potassium is fairly adequate and pH varies from 6.5 to 7.3. Generally paddy is grown on these soils.

Saline and saline alkali soils

They have developed along the coastal margin in Balasore, Bhadrak, Jagatsinghpur, Kendrapara and Jajpur districts. These are enriched by littoral deposits and blown sands and are rich in calcium, magnesium and also contain partly decomposed organic matter. These soils when reclaimed are rich in plant nutrients and can support good crop of rice.

Older alluvial soils

They are developed mainly in Sundargarh, Dhenkanal, Jajpur, Kendrapara districts. These are fairly mature soils with well-developed profiles.

Red loamy soils

They are poor in calcium, potash and low in phosphorus content. These soils are characterized by lighter texture, porous and friable structure, absence of lime and free carbonates and presence of soluble salts in small quantities. Mixed red and black soils, which are lighter, textured and usually devoid of lime concentrations and free carbonates are restricted to some parts of the basin. These soils differ greatly in depth and fertility. These are usually deficient in Nitrogen, Potassium and organic matter. This is found in Sundargarh, Sambalpur, Kendujhar, Mayurbhanj, Balangir, Kalahandi, Dhenkanal and Koraput.

Red and yellow soils, laterite soils and lateritic soils

These categories of land are available in certain parts of Sundargarh, Keonjhar and Dhenkanal, Cuttack and Puri districts. These soils are poor in calcium, phosphorous, nitrogen and humus. They may be either acidic or alkaline and pH ranges widely between 5.5 and 8.5.

Laterite soils are poor in N.P.K. and organic matter. They are generally acidic and the pH ranging between 4.5 and 6.0.

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 of the country 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.

11.4.2 Degraded Soils

There are different types of problem lands, where production is reduced either due to unfavourable physical-chemical properties of the soil or may be due to some inherent land feature and/or environmental conditions. Saline and acid lands, for example, require special treatment and improved agronomic measures for crop production. There are extensive areas of coastal saline lands in Orissa lying idle (waste) or producing very little Acid soils with limitation of crop output and poor response to chemical fertilizers specially the problem of "phosphate fixation" is wide spread over

vast and extensive areas of the State. 'Mine spoils' from mining operations of different mines such as coal, iron ore (hematite), chromites etc. are of particular importance and play a dominant role in land use management of the State where nature has bestowed upon bounty of different ores and minerals. Open cast mines and dumping of 'mine spoils' not only degrade the environment where it is dumped but also adjoining land becomes unproductive, as the washing are carried by rains to the nearby adjoining lands under cultivation.

Saline soils

Saline land is found along the coastal tract of Orissa. Due to cyclonic wave, the coast is more vulnerable to salinity. Nearly 5 km of estuarine river tract is susceptible to tidal ingress and due to heavy wind and soil erosion the saline waters enter into the field which after receding leave its salinity on the land. Saline land in the coastal area is often used for cultivation of salt resistant varieties of paddy. No other crop except fuel wood of mangrove species like Guan, Suam, Sundari and Bani etc. can grow in the area.

Saline soils of Orissa are of three categories according to the soil forming agents (a) Marine, (b) Estuarine and (c) Lacustrine soils. The marine and lacustrine soils are saline alkaline in nature, whereas the estuarine saline landscapes are of saline nature only (ORSAC, 1986)

Reclamation and management of saline lands differ according to nature and degree of salinity. The coastal saline soil requires preventive measures and construction of 'Polders' (embankment) not to allow tidal water inside the land. This is followed by use of Soil amendments like Gypsum, even paper mill sludge (in case of non-calcareous saline soils in the Orissa coast) and pyrites, sulphuric Acid wastes (alkali soils) etc, Tamarind wastes, Mango leaves, Argemone Mexicans and other acid forming organic wastes have been indigenously tried with success (Government of Orissa, 1971). Some times scrapping the surface soil, using irrigation to leach out salts followed by Gypsum and keeping soil in a better moisture regime by mulching have been successfully tried.

Acid Soils

Soils with pH less than 7 are acidic. Strongly acid soils with a pH less than 4.5 bring down the soil micro-flora activity and the availability of potash and some trace elements like copper and zinc. High rainfall with high temperature and heavy leaching is the main factor leading to formation of acid soils. It is estimated that there are about 48 lakhs ha of land which have acidity to some extent or other in Orissa. Out of this about 5 lakh ha suffer from high acidity. Amelioration of acid soils can be done by liming. The fineness (grade) of lime, the texture of the soil, the soil pH and crop to be grown decide the amount of lime required per hectare. Instead of lime, paper mill sludge can be applied in high rainfall area, as a liming material.

11.4.3 Soil Conservation

Soil erosion vis-à-vis formation of soil is a continuous natural process. Erosion, land degradation, water logging, ravine and gully formation are the normal problems in the water sheds of river valley projects. Increase of pressure on land with demographic growth and use of land for purpose other than field and forest crop in the catchment contribute to the soil erosion.

In the catchment on account of dendritic drainage pattern and undulating topography all types of erosion viz. sheet, rill, gully, land sliding and bank scouring prevail. The magnitude and intensity of the above type of soil erosion and salutation reduce the projected life span of the reservoirs of water resources project considerably. In order to check erosion and reduce degradation of soil various watershed management programmes are implemented through Government of Orissa funding or through assistance from Government of India.

The main objectives of the watershed management programmes:

- To reduce salutation of the reservoirs of water resource project.
- To prevent degradation of the catchment area and enhance its productivity through optimum land use management.
- To ensure adequate irrigation water to command area and thus increase production.
- To provide employment opportunities in rural areas to unemployed and under employed population.

Over all it will protect land degradation, promote and balance the eco-system and increase the fertility and productivity of the soil. The Directorate of Soil Conservation, under water shed mission programme is taking up soil conservation measures through water shed management schemes funded by Government of Orissa, Government of India and other External Funding Agencies. The primary funding agencies are Water Shed Development Project aided by World Bank, India-Danish Comprehensive Water shed Development Project, National Water Shed Development Project in rain fed areas and river valley schemes under central sector.

Soil conservation measures

Soil conservation measures were first initiated during the year 1956-57. During 2nd Plan period, measures were limited to bunding, plantation and gulley control works. In the 3rd Plan period emphasis was given on pasture development, stream bank erosion control, and water harvesting structures. The package of treatment includes bunding, terracing, plantation of cashew, sisal and miscellaneous species, pasture development, and construction of engineering structures for water harvesting schemes like gully control, silt retention structures etc. Up to 1994-95 the total soil conservation measures covered an area of 149,968 ha, out of which 63,624 ha have been treated with priority.

Land degradation and improvement measures

The total degraded land of Orissa stands as 61.21 lakh ha which works out to 40% of the total geographical area of the State. By 2001-02, 18.22 lakh ha of land have been treated with different anti-erosion measures with a view to enhancing the productivity of the soil for sustainable agriculture production.

Soil Conservation Measures for Orissa

The Government of Orissa established a Watershed Mission during 2001-02 with a view to ensuring soil and water conservation through effective co-ordination between watershed development programmes implemented in the State by way of adequate monitoring and supervision. In 2002-03, 1860 watershed development projects are in operation under different centrally sponsored schemes and through external aided projects (EAP). Out of above, 314 watershed projects in KBK districts have been

taken up for comprehensive treatment during 2001-02. Further, under the Drought Prone Area Programme (DPAP), 544 micro watershed projects are under implementation at a sanctioned project cost of Rs 140.58 crore to treat 2.61 lakh ha of land and the target for 2002-03 is to treat 11,000 ha.

11.5 Land Use

For agricultural development, water and land resources form the most essential input. The availability of land decides the potential and limitations of agricultural production.

Land use details are discussed in section 18.1 the land use pattern for the year 2001-02 given in fig - 9

11.6 Land Capability Features

Map 22 is based on the land capability map of the State developed by NATMO, Kolkata.

This gives the land capability of soil in the state showing its suitability for agricultural activity. Orissa is also sub divided into 10 zones, known as agro-climatic zones. The details of above have been shown in Map. 9

11.7 Water Logged Areas

Water-logged areas in the country has been classified on the basis of the water table between October and December (post monsoon).

- Fully waterlogged- with water table within 1.0 m below the ground surface.
- Water logged area- Water table within 2.0 m below ground surface.
- Potential water logged area- Water table between 2 to 3 m below ground surface.
- Safe area – Water table deeper than 3 m from the surface.

The depth to groundwater table both pre and post monsoon is shown in Map. 18(b) and Map. 18(c).

Water logging has become a serious problem in the coastal regions of the State. An area of 379 km^2 is water logged and details of the same are given in Table 11. This area relates to the undivided 13 districts in which the coastal districts have the maximum share of 94%.

Besides, the coastal districts also face the problem of salinity. An area of 1.493 lakh ha, in which salinity has an adverse effect on agricultural production, is distributed as shown below.

District	Area (lakh ha)
Balasore	0.549
Cuttack	0.489
Ganjam	0.121
Puri	0.334
Total	1.493

11.8 Wetlands

Wetlands are defined as the lands transitional between terrestrial and aquatic system, where the water table is usually at or near the surface or the land is covered by shallow water. The Ministry of Environment and Forest in 1992, decided that the wetland shall also include all deepwater habitats and the impoundments such as reservoirs, ash-ponds, cooling ponds and abandoned quarries.

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) Ahemadabad conducted a survey on the Status of wetlands of Orissa in 1996.

As per the survey, the total wetland area of Orissa was 3, 48,205.25 ha the break up of which is given below:

	Inland Wetland	Coastal Wetland (ha)
Natural	14001.75	1,83,144.75
Man-made	1,48,771.75	2287.00
Total	1,62,773.50	1,85,431.75

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

12 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 important.

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

(Source - Economic Survey 2002-03)
The location of Minerals in various parts of Orissa is shown in Map. 13

12.1 Present Status of Development

Table 13 indicates the production of minerals as a percentage of the total resource stock and the out put of the important minerals from 1991-99.

12.2 Output of Mineral Production

Orissa occupies a high rank in mineral output of India. Table 12 illustrates the rate of extraction of minerals in Orissa from 1977-2002.

12.3 Trend of Mineral Exploration

The production of mineral/ores from 1990-91 to 2001-02 is given in Table 14, which indicates that the value of production increases in the range of 5 to 20%.

12.4 Water Demand for Mine Development

The demand of water for mine development and ore extraction varies from mineral to mineral as well as exploitation category, i.e. opencast and underground.

Processing of Ore. Further where ore after extraction is washed for improvement of grade a lot of water is required and is to be met from nearby surface water and ground water sources.

Development of mine area and colony requirement. For sprinkling of mine area, dust suppression, colony requirement etc water should be drawn from the surface and groundwater source.

13 WATER RESOURCES

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

13.1 Surface Water

Every year, the State geographical area of 155.7 lakh ha receives plenty of rainfall, a part of which is lost by evaporation and transpiration. Another part is lost to deep percolation and a third part is stored as ground water reserve. The balance flows down to the sea as surface runoff. As the rainfall varies every year the surface runoff also varies.

There is no contribution from snow in the State.

13.1.1 Rainfall

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

Temporal distribution

Monthly normal rainfall in the State is shown below.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual	
14.0	25.9	21.4	35.3	70.8	213.2	351.6	335.6	236.5	131.6	39.9	6.4	1482.2	mm
1	2	1	2	5	14	24	23	16	9	3	0	100	%

It will be seen that 78% of annual rainfall is received from June to September and the balance 22% is available in eight months. This distribution strongly suggests that the State must store enough water available in these four months to use for the balance period. The entire rainfall is derived from tropical monsoon. Onset of monsoon every year (probable date 8-10 June) is uncertain, sometimes delayed till end of June. Some carry-over storage is necessary to take care of the June requirement.

The distribution of daily rainfall over the monsoon months is not even. There are very wet days and long dry spells: 300 to 500 mm rainfall may occur in 2 days and within the same year dry spells may extend up to 20-25 days. This distribution of daily rainfall calls for within the year storages. Again intense spell of rainfall is also commonly seen at frequent intervals. The details of storm events' showing heavy precipitation is given in table 49. The concentrated spells of intense rainfall cause heavy runoff resulting in floods. Floods are common place in the State and a medium flood occurs every alternate year. Drought is also a common phenomenon and sometimes both the extreme events happen in the same year.

Spatial variation

The rainfall pattern in the State is not uniform over space. The normal rainfall of the districts show wide variation from 1295 (Ganjam) mm to 1648mm. (Sundargarh).The wet districts are Sundargarh, Balasore and Bhadrak and the dry districts are Ganjam, Gajapati, Nuapada and Kalahandi. The annual normal isohyets are shown in Map 10.

13.1.2 The River System

There are 11 major rivers and streams flowing in the State. The longest and the largest is The Mahanadi and the smallest is the Bahuda. The rivers and their catchment area are shown in the table 18. The basin details are given in Table. 9

The Rushikulya and Budhabalanga entirely and the Baitarani mostly flows in the State and all others are inter-state rivers. There are inter-state agreements for sharing of water in most of the rivers.

The river Mahanadi alone covers about 41% of the State. The upstream catchment lies in Chhatisgarh State. Major tributaries of the river are Bheden, Ib on left and Tel Salki and Brutang on right. At Naraj, the river forms its delta. A number of branches take off from the river and the river finally joins the sea.

The Brahmani enters the State at Ved Vyas in Sundergarh district.Major tributaries are Tikra, Gohira, and Mankara Ramiala. The river enters the delta at Jenapur, branches further and joins the sea at Dhamra.

The Baitarani takes its origin in the State itself in Kendujhar district. Major tributaries are Kusei, Remal, and Salandi. Nearer to the sea, Brahmani and Baitarani join together.

Subarnarekha enters the State from the Jharkhand State. The river is common to the State of West Bengal. The water of the river has been distributed among the three states through a tripartite agreement. The river is known in the State for causing flood in the area.

Budhabalang is a small stream jacketed between Subarnarekha and Baitarani. The river serves Mayurbhanj and Balasore districts. Baripada and Balasore towns are situated on the bank of the river.

The entire catchment of Rushikulya lies inside the State. The prosperous Ganjam district is served by this river.

Vansadhara and Nagavalli rivers flow through Gajapati and Rayagada districts. The catchment area is mostly covered by thick growth of forests.

Kolab and Indravati are tributaries of Godavari. Kolab is called Sabari in the lower reach and joins Sileru at the southern tip of Orissa. The combined stream is taken as Kolab basin. Indravati flows in Orissa and later enters Chhatisgarh and finally joins Godavari in Andhra Pradesh.

The sediments brought down by Mahanadi, Brahmani, Baitarani and Rushikulya over the years has formed the coastal districts of the State which form the nerve centre of the State. The area is home to 16.12 million people amounting to 44% of the State's population.

13.1.3 Surface Water Resources

Water resources of the State are derived from the annual rainfall in the State. The State receives 230.76 BCM of rainfall in a normal year. An attempt has been made to estimate the amount of water available in the State.

OWPO uses a hydrology package HYMOS to estimate surface runoff from long-term rainfall series. The package mathematically models the natural hydrology cycle and computes runoff from a known value of rainfall. A number of parameters are used to compute the evapo-transpiration loss and loss due to percolation. Properly

calibrated, the model can fairly accurately generate overland flows from rainfall. The basin simulation model RIBASIM is used to allocate water at different withdrawal nodes. Each basin has several inflow nodes. Flow at these nodes are computed by the software HYMOS after proper validation of parameters using actual observed rainfall and flow data. There are about 250 inflow nodes distributed in 11 river basins.

A common time base from 1974 to 1994 has been selected for which concurrent data is available. Inflows at these nodes are computed using HYMOS and calibrated parameters. Now all the withdrawal nodes are switched off and RIBASIM is run for each basin. Annual flow computed at the lowermost node is estimated. The exercise is carried out for all the 11 basins. The flow for the State is computed by summing the 11 basin flows. Thus a runoff series for the entire State for 21 years is obtained and the statistical dependability is established.

A further check on the series is applied by comparing the annual rainfall with the annual flow thus obtained.

Using the above method the average runoff works out to 82.83 BCM annually and 75% dependability 69.70 BCM.

Another check on the results is exercised by obtaining the dependable flows using runoff factors. The State is divided into several regions, the bigger basins subdivided into more sub basins. Dependable flows obtained for existing and ongoing projects after detailed analysis are taken as the representative runoff for the sub-basin. The dependable flows are computed by summing up the sub basin runoff values.

Developed annual flow thus computed contains a component of flow that comes from outside the State mainly from Chhatisgarh in Mahanadi and from Jharkhand in Brahmani. This component of flow is obtained as the flow at the closest inflow node inside the State. The flow from Orissa catchment is obtained after separating this component from the total flow.

In future the upstream states will increase their exploitation of water for development of their own State. These developments will cause reduction of flow into the State. There may not be any appreciable flow during non monsoon months but there will be surplus flow during the monsoon period. Considering full planned development in the States of Chhatisgarh and Jharkhand, Orissa can still hope to get about 20 BCM of water from these States. Developed annual flow series are given in Table 19.

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. This is shown in Table 20 & 21.

BOX-1

WATER RESOURCES : ORISSA
SURFACE WATER
(includes resources from outside State)

	2001 (BCM)	2050 (BCM)
Average	120.397	108.113
75% dependable	95.540	85.891

13.1.4 Storage Schemes

Mere availability of water on an annual basis conveys no meaning about usability part of it. The temporal variability is such that this water is available in nature for about 100 days in a year. The surface water must be stored in sufficient quantity to last for rest of the year.

The State has developed 44 storage schemes in major and medium scheme sector and 2713 storage schemes in minor irrigation sector. The total live storage developed is 16.70 BCM and shown in Fig - 6.

BOX-2

WATER STORAGE : INDIA AND ORISSA

	Storage in BCM	
	India	Orissa
Storage Developed	174	16.70
Under construction	75	3.30
Future	132	21.86
Total	381	41.86
Potential	1869	120
Live Storage per Million people	0.291	0.556

The storage position in the last 5 years is shown in the Fig. 6

13.1.5 Inter-State Agreements

Orissa has many inter state rivers. According to the Indian constitution the states are the owners of water and as such each state has to enter into an agreement with co-basin states for sharing water of the rivers.

Orissa has four neighbouring States:

- West Bengal
- Jharkhand
- Chhatisgarh
- Andhra Pradesh

River basins common to one of these States and Orissa are the following:

State	Rivers
West Bengal	Subarnarekha
Jharkhand	Brahmani Subarnarekha Baitarani
Chhatisgarh	Mahanadi Indravati
Andhra Pradesh	Vansadhara Nagavalli Kolab Bahuda

In Mahanadi basin inter-state agreement between Chhatisgarh (formerly Madhya Pradesh) and Orissa covers the water shares of its tributaries like Ong, Jonk, and Udanti very well. But there is no clear agreement regarding water shares in the main stem of Mahanadi but the riparian rights of Hirakud dam has been discussed in the inter-state meetings (Panchamarhi and Bhubaneswar). There is a need to have an agreement in this regard so that developments in up stream of Hirakud dam pay due regard to Hirakud. Advance warning before release of water from dams up stream Hirakud during flood has also been discussed.

There does not exist any inter-state agreement between Jharkhand (Bihar) and Orissa regarding share of water of Brahmani River. The riparian use of Rengali Project should be protected with an agreement.

Water shares of Subarnarekha, Vansadhara, Nagavali, Kolab (Sabari and Sileru), Bahuda, Jhanjavati and Indravati have been well covered in inter-state agreements.

Recently there had been some dispute with Chhatisgarh over diversion of Indravati water to river Kolab in Jaura Nala. Matters regarding power from Hirakud (5 MW), and irrigation for Jonk Dam need be discussed and settled.

There exists an inter-state joint control board for Subarnarekha and Balimela. It is necessary to have RBOs for all the inter-state rivers to discuss and settle developments in these basins. The details regarding interstate agreements are given in Annex-B.

13.2 Ground Water

Assessment of ground water potential of the State has been finalised by the Study Group formed for the purpose.

13.2.1 Hydrogeological Situation

The geological formations of the area govern the occurrence and movement of ground water. Diverse rock types, ranging in age from Aarchaean to recent origin underlie the State. Hydro-geologically the State can be divided into 3 distinct units, consolidated, semi consolidated and unconsolidated formations. The hydro geological scenario of Orissa related to groundwater is shown in Map. 18(a)

Consolidated formation

The consolidated rock occupies 80% of the total area of the State, which include the hard crystalline and compact metamorphic rock formations belonging to the Archaean and Pre-Cambrian age. The rock types are mainly granites, khondalite, chanockite, granite gneisses, schistose rocks, quartzites, calsilicates, shale, phyllite, marble, lime stone, sandstone etc. These rocks are hard and compact and lack in primary porosity. The ground water occurs in secondary porosity resulting from weathering; fracturing and jointing, Ground water occurs under water table condition and circulates through underlying fractures and fissures and from a dependable source of ground water in hard rock formation. In general the average thickness of weathered residium varies from 5 m to 15 m and deeper water bearing fracture zones mostly occur within a depth of 120 m. But deeper potential fractures have been encountered (down to a depth of 200 m) in Koraput, Kalahandi, Bolangir, and

Baragarh. Keonjhar and Mayurbhanja districts and with cumulative discharge up to 25 lps. Ground water occurs in semi-confined condition in fissured and fractured zone of these formations but yield range in pre-Cambrian fractured shale from 5 to 15 lps have been noticed in localised pockets confined to western part of the State bordering the Chattisgarh State. The development of ground water in this tract is feasible through open wells and bore wells. Weathered and fractured granites and granite gneisses form productive zones and yield varies between 3 to 10 lps. The yield characteristics in shales, schist, quartzites Khondalite, Charnockites etc. is ranging from 1 to 5 lps.

Semi-consolidated formation

This includes Gondwana sedimentaries and Baripada beds. The Gondwanas include sandstone, shales, siltstones and conglomoratic beds. The Baripada beds consists of fossliferrous Limestone, stratified semi-consolidated sand beds with inter calated shales. In the semi consolidated sedimentary rocks the most promising rocks found are sandstone. Ground water occurs in these formations under unconfined to confined condition. The yield from wells in lower Gondwanas (Dhenkanal) is up to 21m^3/hr but yield from, wells in Upper Gondwanas particularly Bhubaneswar city recorded 1/5 m^3/hr. In the Lower Gondwana basin in and around Talcher, auto flowing wells are seen.

Unconsolidated formation

The unconsolidated formations include alluvial deposits along the principal rivers and coastal tract. The unconsolidated sediments include pleistocene and recent alluvium. The older alluvium is generally overlain by laterites. Laterites form good acquitter when are fractured. Maximum development of alluvial formations occurs along the coastal tract with a maximum thickness of about 600 m. Alluvium also occurs as discontinuous patches adjoining the river courses, where the thickness is limited to 45 m. The sand and gravel forms good aquifer with yield ranging from 10 to 30 l/s the river valley deposits comprises sand, clay, pebbles and calcareous concretions of varying thickness varying from 15 to 300 m.

The coastal alluvium is represented by vast stretch of alluvial flat covering an area of about 15,500 km^2 of the coastal districts. The width of the coastal alluvium ranges from 15 km to 70 km. the area is marked by outfall of the rivers like Mahanadi, Baitarani, Brahmani, Budhabalang and Suharnarekha, which combinedly form the compound delta. The coastal alluvium ranging in age from late tertiary to quaternary forms most productive aquifer. The ground water occurs both in unconfined and confined condition. Fresh water aquifer occurs up to a depth of 300 m.

A considerable area of about 5.93 lakh ha on the coastal alluvial front comprising 42 blocks of 7 districts is beset with salinity. The ground water structures like dug well and tube well (shallow and Medium) are feasible in this tract. Depending upon the occurrence of freshwater, deep tubewells may be feasible in the coastal saline tract. Fresh water aquifer tapping a saturated granular zone (15-30 m) yields from 174 to 276 m^3/hr with a drawdown of 3 to 24 m.

13.2.2 State Ground Water Resource

According to the latest assessment, Orissa has annually replenishable ground water resource of 2,101,128 Hectare-Metre (ham), out of which 112,272 ham is committed for the domestic and industrial requirements for coming 25 years.

Ground water draft

The ground water draft is the quantity of ground water withdrawn from the ground water reservoirs. The total quantity withdrawn is termed as gross draft. The annual ground water draft of a structure is computed by multiplying its average discharge and annual working hours, the number of working hours can be calculated by the hourly consumption of electrical or diesel energy. As per current utilization in this State the gross annual draft for dug well without pump set is 0.33 ham, for dug well with pump set 0.96 ham. For bore well, filter point tube well 3 ham, shallow tube well 10 ham and for medium deep tube well 15 ham. The Minor Irrigation Census 1986-87 has brought out the existing ground water structures and these are taken as base figures to work out ground water draft and to project future ground water development.

The ground water development in Orissa is restricted to the shallow aquifer zone, within 50m depth and is mostly through institutional finance both in public and private sectors. The shallow ground water structures include dug wells and bore wells in the hard rock areas and dug wells, shallow tubewells, filter point tube wells, in the alluvial terrain. The medium deep tubewells are also constructed in alluvial areas down to an average depth of 100-150 m. Restricting the stage of ground water development in the State to the safe limit of 60%, there is a further scope for future irrigation use.

The average stage of ground water development in the State is estimated to be 14.79% as per the latest assessment. However the ground water development in different parts of the State is not uniform. Based on the hydro-geologic, agro-climatic and socio-economic status, the ground water development in some parts has been rather intensive. But so far the development of ground water has not reached the stage of over exploitation in any block of the State. The district-wise ground water resource status and irrigation potential of the existing ground structures is furnished.

Stage of ground water development

The stage of ground water development in an area is to be taken as the ratio of gross annual draft for all uses to the total utilisable ground water resource. It is normally expressed in percentages.

For the purpose of clearance of schemes by financial institutions, categorization of areas based on stage of ground water developments has been recommended as follows subject to the various conditions of pre monsoon and post monsoon water table trends.

Category of Area	Stage of Groundwater Development
Safe	less than 70%
Semi-critical	70 to 90%
Critical	90 to 100%
Over-exploited	greater than 100%

In over exploited areas, micro-level surveys are required to evaluate the ground water resource more precisely for taking up further ground water development. As per National Water Policy, ground water development is limited to annual replenish able ground water resources; hence ground water exploitation is not permitted in over exploited areas. The pre monsoon and post monsoon water table trends and their levels are the ultimate indicators of the extent of ground water development

taking place in an area. Hence, the behaviour of ground water level should be deciding factor to indicate the possibilities of future ground water development. The GEC norms recommend that in the areas where, falling trend of ground water levels is witnessed both in pre and post monsoon seasons, even if stage of ground water development is 70% or less, the area may not be categorised as safe. The resource assessment may have to be made at a frequently interval before taking up additional ground water abstraction structures in that region. It is therefore, to be in a safer position; the stage of ground water development has been limited to 60% for planning of further ground water development in this report. Also the areas of blocks having poor ground water quality have not been recommended for further development without area-specific field studies.

13.2.3 Ground Water Resource of Districts

The Study Group has approved the block-wise ground water resource assessment based on the GEC norms 1997 for 314 blocks of 30 districts in Orissa. Ground water resource has been estimated for fresh water only. Depending upon the varied hydro geological situations the ground water development potentials of the State also vary widely in different districts. Even though rainfall is the principal source of recharge the recharge due to canal seepage and return flow from irrigation has also been significant in the irrigation commands of many districts. Ground water resources of the districts and the State are given in the Table 22.

Coastal saline area

A considerable area of about 5.39 lakh ha in the coastal alluvial tract is beset with salinity hazard. All the coastal districts suffer from salinity problem in different magnitudes. In a narrow tract it starts from Chandaneswar in Balasore district in the northeast and extends up to Brahmagiri in Puri district in the southwest. The saline aquifers occur at different depths. The salinity hazards are not uniform through out the coastal tract. All precautions should be taken not to disturb the existing fragile ground water gradient further. The maximum width (55 km) of this tract is in the Mahanadi delta. In Brahmani-Mahanadi delta region over a large area the top aquifers down to a depth of 60 to 320 m are saline to brackish in nature and fresh water aquifers occur below this depth. In the eastern part of Puri, around Nimapara, Kakatpur and Gop, fresh water aquifers occur down to a depth of 70 to 110 m, below which the formation water is brackish to saline in nature. In Puri-Balighai-Ramchandi tract a second group of fresh water aquifers occurs in the depth range of 135 to 290 m. In the area, west of Puri town, aquifers are generally brackish to saline, except in local pockets.

The ground water resource of the poor ground water quality areas of 42 blocks of 7 coastal districts have been assessed separately as per the GEC norms 1997. Further development of ground water in these areas can only be taken up after extensive monitoring of its behaviour in the region.

	Affected Blocks	
District	Full	Part
Balasore		Bahanaga, Balasore,Baliapal, Basta, Bhograi, Remuna
Bhadrak	Chandbali	Basudevpur,Tihidi, Dhamnagar

Ganjam		Chatrapur, Chikiti, Ganjam, Khalikote, Rangeilunda
Jagatsinghpur	Ersama	Balikuda, Kujang, Nuagaon
Jajpur		Bari, Binjharpur, Dashrathpur
Kendrapara	Mahakalpara, Marshaghai, Rajkanika, Rajnagar	Aul, Derabish, Kendrapara, Pattamundai
Puri		Astarang, Brahmagiri, Delang, Gop, Kakatpur, Kanas, Krushna Prasad, Nimapara, Pipli, Puri, Satyabadi
Total	6 Blocks	36 Blocks

A number of districts present complex salinity profiles as follows:

Pattern of Salinity	District
Saline water overlying fresh water	Conspicuously occurs in Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Jajpur Districts
Fresh water overlying saline water	Prominent in Puri, parts of Jagatsinghpur, Kendrapara Districts
Alternating fresh water zones	Prominent in parts of Kendrapara District
Saline water at all depths unto 600m	Conspicuous in Puri, parts of Jagatsinghpur, Kendrapara Districts.

BOX-3

WATER RESOURCES: ORISSA
GROUND WATER

	Resources in BCM
Total Annual Available Replenishable	21.011
Safe Usable (60%)	12.607

13.3 Total Water Resources of Orissa

The total water resources of the State have been estimated as 141 BCM at present which also includes resources available from outside State. A comparison of water resources of Orissa and India is shown in Box-4.

BOX-4

WATER RESOURCES :ORISSA AND INDIA

Unit = BCM

	INDIA	ORISSA
Rainfall	4000	231
Usable Surface Water	690	70*
Ground Water	432	21
Total	1122	91

*does not include resource available from outside State

13.3.1 Per Capita Water Availability

Average surface and ground water 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 m3 in 2050. The average per capita water availability in the country is 1820 m^3 in2001, which will reduce to 1200 m^3 in 2050. If the water availability falls below 1000 m^3 per capita it is generally considered a scarcity condition. Based on this criterion the water availability position of the State is comfortable in the State even in 2050.

Water availability in the basins will give an idea about the regional disparity if any. Table 23 shows the per capita water availability in the basins. The per capita availability of surface water in future scenario by 2051 is shown in Map. 19

14 FOREST RESOURCES

14.1 Forest Area

The State has a total forest area of 58,135 km^2, which is about 37% of its geographical area. The Department of Forest and Environment manages 26,350 km^2 of Reserve Forests area (RFs) under various working plans and schemes while 31,786 km^2 are Demarcated Protected Forests (DPFs) and Undemarcated Protected Forests (UDPFs) and other forests. The later category of forests is under the administrative control of Revenue Department. However, Department of Forest and Environment looks into the protection of these forests and proposes that for better protection and management the revenue forests be declared Reserve Forests.

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

		(km^2)
Department of Forest and Environment	Reserve Forest	26,329
	Unclassified Forest	21
	Total	26,350
Revenue Department	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 cover with crown density more than 40% is only 260,730 km^2 and forest with crown density between 10 to 40% is 20,745 km^2. The actual forest cover based on satellite data is given in Table. 15. The forest map also shows the forest cover distributed in Orissa and is shown in Map. 21

14.2 Forest Products

Forestry sector contributes a meagre 0.27% to the NSDP but its contribution to the society is immense. It provides livelihood support to many poor tribal people in terms of fuel wood, housing materials, fodder, small timber etc.

Timber was earlier the revenue earner for the Forest Department. But timber felling has been banned following large scale cutting of forests. In Orissa, Non timber forest produces (NTFP) are very valuable. Important among NTFP are fuel wood, gum, resins, siali leaves, kendo leaf, Sal seeds, and bamboo.

However the role of two important forest products and their earnings got reversed. Timber earning was reduced from 42.49 crore in 85-86 to 10.31 crore in 2001-02 and kendo leaf earning increased from 26.8 crore to 85.10 crore during the same period.

Kendo leaf is used in manufacture of bidis and the State produces 15% of the total produce of the country. Picking of kendo leaves is a labour intensive activity and provides employment opportunity to the rural poor.

In 1997-98, the following volume of Forest Produce was harvested:

Product	Volume	Units
Timber	20,205.292	m^3
Fire wood	35,445.244	Tons
Bamboo	2,06,182	SU
Kendo leaves	4.956	lakh Qntls.
Sal seeds	9011.139	Tons

14.3 Requirement of Forest Produce

People of the State need forest products mostly for food, fuel wood, construction material and for industrial use. The volumes required in 2001 were estimated as follows:

Fuel for domestic use	1,38,87,000	tons
Firewood grade material for Industries	2,40,000	tons
Total Fuel wood	1,41,27,600	Tons
Bamboo for domestic use	2,48,842	tons
Bamboo for paper pulp	2,60,000	tons
Total Bamboo	5,08,842	Tons
Timber for domestic use	3,50,000	m^3
Timber for Industrial use	17,000	m^3
Total timber	3,67,000	m^3
Fodder	3,43,66,400	Tons

Source: PCCF, Orissa

Actual production in that year was far from adequate, which resulted in the following shortfall in meeting the demand.

	Requirement	Production	Shortfall	
Fuel Wood	1,41,28,000	1,35,000	1,39,93,000	tons
Bamboo	5,08,842	2,50,000	2,58,842	tons
Timber	3,67,000	1,00,000	2,67,000	m^3
Fodder	3,43,66,400	N.A.	N.A.	tons

Source: PCCF, Orissa

14.4 Degradation of Forests

Due to human interference, forests now have very little forest cover. So closed forest area (CFA) is the real measure of forest cover in the State.

Looking at the individual districts, we find some inter-district variations. Taking the districts with more than 30% of area under forest, we find that the extent of degradation is relatively more in the districts (Koraput, Ganjam, Phulbani,

Kendujhar), compared to the State as a whole and is relatively much less in Mayurbhanj and Sundargarh. Effective forest cover (closed forest area, as percentage of total geographical area) has thus become particularly low for certain districts with large portion of geographical area under forest: Koraput (12.27%); Kalahandi (13.52%); Ganjam (15.08%). On the other hand, in the case of Mayurbhanj and Phulbani district, effective forest cover has remained close to one-third of geographical area.

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. Table 15 will give a real picture of the state of affairs in the State.

It is interesting to note from the relevant data on the extent and status of forest in Orissa that the area under forest as such has remained around 30% between 1972 and 1997, which is close to the recommended norm. However, this is misleading, as it does not say anything regarding the extent of degradation of forest resources and hence the extent of effective forest cover. These are provided by satellite data. As per the extent of degradation, this is captured by closed forest area as percentage of total forest area: we find that this has come down to 55.43% in 1997 from 77.13% during 1972-75. In other words, nearly half the forest area is degraded. Thus, closed forest area - a measure of effective forest cover - has become only about 17% of the geographical area. The detail of forest area as described above is given in Fig. 5

14.5 Forest Area Put to Non Forest Use

For various developmental activities, forest area has to be diverted for other non forest use. Table 16 lists out the amount of forest land diverted for different purposes. Till 2002 an area of 27,055 ha has been diverted for 237 projects.

But following the forest conservation act an equal amount of non forest land has to be handed over to the Forest Department for a forestation.

14.6 Medicinal Plants

Orissa is very rich in bio-diversity. Varieties of plants with medicinal properties are found in the forests of Orissa. Medicinal plants, by and large, are available in hill peaks and mountains like Meghasan, Gandhamardan, Malyagiri, Nimagiri, Bankashen and Mahedragiri in the districts of Mayurbhanj, Kendujhar, Koraput, Kalahandi and Ganjam respectively.

14.7 Wildlife

14.7.1 Status of Wild Life

Orissa has a fairly rich and varied fauna due to diversified topography and existence of natural habitat. It is to mention that for protection of crocodiles, sea turtles, white deer and wild bear several projects have been launched in the State by creating many sanctuaries and national parks. On the whole one biosphere reserve, 18 sanctuaries, two National parks have been created 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 species of mammals in Orissa forest. The tiger population was reduced by 12.10% while population of Chitas was increased by 5.90%. The number of elephants, which was 2003 during 1993, has been decreasing.

The diversity of the State's fauna is characterized by number of species representing each of the principal groups:

	(Number of species)
Mammals	65
Birds	445
Reptiles	84
Fishes	several

14.7.2 Protected Fauna

Birds and animals which are rare or vanishing require special protection. This has been ensured by inclusion of this species in Schedule I of the Wild Life Protection Act, 1972, Animals, birds and reptiles listed under this schedule are permanently protected from hunting and shooting.

Mammals	Black buck (Antilerer cerviespia) Cheetah (Felis viverrina) Golden Cat (Felis temmincki) Indian Wolf (Canis lupus) Tiger (Panthera tigris) Elephant (Elephas maximus)
Reptiles	Crocodiles (including Estuarine or salt water crocodiles – Crocodilus perosus or crocodiles pallustris, gravialis gangeticus)
Birds	Peafowl (pavo cristatus) White winged wood duck (Cairira scutulate)

14.7.3 Census of Wild Life Population

In order to help wild life management and planning census of wild life population is carried out every few years. Population of elephants, tigers and leopards in 2002 is given in Table 17.

15 LIVESTOCK RESOURCES

Rural Orissa has animal husbandry as the second source of income next to agriculture. About 80% of rural households have livestock of at least one species. The 2000 livestock census recorded the following numbers (in thousands) of the different species present in the State[3].

Buffalo	Cattle	Sheep	Goat	Poultry	Pig
1,388	13,768	1,779	5,880	18,438	602

Assuming a rural household to be composed of five members, the 80% of households keeping livestock (about 5 million) hold on average the following numbers of animals and poultry.

Buffalo	Cattle	Sheep	Goat	Poultry	Pig
0.28	2.76	0.36	1.18	3.69	0.12

The productivity of livestock is very low. The State's annual production of milk, meat and eggs in recent years amounted to the following.

Milk * (tons)	Meat ** (tons)	Eggs * (million)
894,000	42,638	1088

* 2002-03 ** 2001-02

This output corresponds to the following annual per capita availability for the State's population of 36.7 million.

Milk * (kg)	Meat ** (kg)	Eggs * (number)
24.4	1.2	29.6

The State has ambitious plans to enhance the animal products. The plan is to increase the number of improved breed in the State and increase productivity.

[3] State's Economy in Figures: Orissa 2002, Directorate of Economics and Statistics

16 FISHERIES RESOURCES

16.1 State's Resource Potential

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

Inland Fishing

Inland fisheries related to culture and capture fisheries. Culture fisheries are carried out in tanks and ponds whereas Capture fisheries are confined to reservoirs, canals and rivers. Brackish water fisheries, which are related to the fisheries activities in the brackish water lagoon (namely-Chilika), tanks, ponds and estuaries and restricted only in the coastal districts of the State. The annual inland fisheries potential of the State and its exploitation (annual average output from 1995 through 2000) has been estimated as follows:

	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 shown in Table 25.

According to fishery survey of India maximum sustainable yield up to 200 m depth zone is 125,600 M.Tons and has now revised to 160,910 M.Tons.

As can be seen from Table 25 that with the resource potential at 3 lakh tons, Orissa occupies the third position behind Gujarat and Kerala. In relation to continental shelf area Orissa has the second highest resource potential per km^2 of continental shelf area, next to the South Western Coastal region.

16.2 Consumption and Production of Fish

16.2.1 Consumption

Orissa is a leading state in consumption of fish in India. Per capita annual consumption of fish for Orissa for the year 96-97, 97-98, 98-99, 99-00, 00-01, 01-02 and 02-03 is 7.78, 8.60, 8.23, 7.33, 7.71, 8.14 & 8.28kg respectively. Comparison of monthly per capita consumption of fish in major states of the country is shown in Table 24.

16.2.2 Fish Production

The Fish Production in the State by the end of Eighth Plan (1996-97) was 276,950 tons, which increased marginally to 281,950 tons by the end of Ninth Plan (2001-02) showing an increase of 1.8% only. During 2002-03, the inland fish production increased by 3.65% over the inland fish production of 2001-02 while the marine fish

production has increased by 0.98%. Out of the total fish production of 289.21Tmt during 2002-03, 126.97 Tmt was cultured source and the balance of 162.24 was from capture sources.

The total value of fish production in the State increased from Rs 1120.81 crore during 2001-02 to Rs 1264.10 crore during 2002-03 registering an increase of 12.78%. Out of total value of fish and prawn production in the State during 2002-03, the value of marine fish stood at Rs 395.46 crore, fresh water fish at Rs 636.42 crore and Brackish water fish at Rs 232.22 crore.

16.3 Development Programme

The inland fisheries development programme in the State is undertaken mainly by the Centrally Sponsored Scheme called FFDA (Fish Farmer's Development Agency). Each District of the State has a FFDA, where District Collector is the Chairman of the Managing Committee. In this scheme, there is credit facility for area development in private sector. The feasibility report is prepared by the District Fisheries Office and sent to Banks for financing. There is also subsidy assistance to encourage the fish farmers of the State with a repayment period of seven years with one-year moratorium.

16.3.1 Pond/Tank Fisheries

It is estimated that there are 2, 21,171 tanks/ponds spread in the 30 districts. The total water spread area of these tanks amount to about 1.17 lakh ha. Fish production from the tanks in 2002-03 was 1, 19,795 tons.

Renovation/excavation of new tanks is done mostly under FFDA in each district. The extension wing of the Fisheries Department guides fish-farmers in the districts for scientific fish culture with proper training programme at GP, block level of the Districts. Some tanks are also developed under SGSY (Swarna Jayanti Grama Swarojgar Yojana) scheme since 1st April 1999. Under the above schemes the beneficiary avails loan from the financing banks and then repays the same after production from their tanks in period of seven years from development of the new tanks. The district office prepares the scheme, feasibility report and sends it to the financing bank. The beneficiary also avails the subsidy due in the above schemes as per the scheme.

16.3.2 Reservoirs

The total available reservoir water are in the state is around 2, 56,000 hectares out of which 1, 97,200 ha are suitable for fisheries. The production from reservoir was 8504 MT during 2002-2003. In Orissa the average fish production from reservoirs is around 9.3 kg per ha per year which can be enhanced by scientific managements practices. Accordingly the state has promulgated "State Reservoir Fishery Policy" during 2003.

As per the said policy fishing rights of 138 reservoirs having Mean Water Spread Area (MWSA) of 40 hectares and above have been vested with the Fisheries & ARD Department and the following action plan have been chalked out to augment fish production i.e. at least 100 kg/ha./year.

Action is being taken to formulate Primary Fishermen Cooperative Society(s)/ Self Help Group(s) in each reservoir. As such, 93 PFCSs and 34 SHGs have been constituted for intervention in the reservoirs to enhance fish production.

Due to shortage of rearing space stocking of reservoirs is invariably done with 40-60 mm size early fingerlings that result in less annual production due to predation. To enhance fish production, bigger size fingerlings are required to be stocked fro which captive nurseries are required to be excavated. Till date, 16 reservoirs have been provided with such captive nurseries. The nurseries will be managed by PFCSs/SHGs to rear fingerlings.

To acquaint the fishermen with the techniques of reservoir management 14 nos. of sensitization workshops have been organised at the District Head Quarters with the participation of stake holders and key players.

As per the provision of the policy, both lease value and royalty in respect of 100 reservoirs have been collected from PFCSs/SHGs till date and leasing procedure is being finalised.

During monsoon, ban on catching of brood stock from the reservoirs have been imposed from 15th June to 31st August to allow every fish to breed at least once in its life time to enhance auto recruitment in these water bodies.

Action is being taken to provide net and boat to the fishermen to catch fish from the reservoirs. 72 numbers of boats and 1440 kgs. Of nets have already been supplied to fishermen of KBK districts under RLTAP. Besides, nets and boats will be made available to the fishermen under Centrally Sponsored Plan Scheme after imparting training to fishermen through DRDA funding.

16.3.3 Prawn Culture

Fresh water prawn culture is being encouraged in the private sector. The field extension staffs assist the fish farmers in supplying prawn seed from natural seed collection centres and prawn hatcheries.

The estuarine area offers very good ground beyond the CRZ for brackish water prawn culture. Especially the species P. mondon is cultured in the state and the Department of Fisheries monitors the programme.

There is also good scope for setting up of fresh water prawn hatchery in the state. The giant freshwater prawn M. rosenabergii hatchery can be setup in the coastal Districts as there is need of saline water for management of giant freshwater prawn.

To augment IMC (Indian Major Carp) seed production, modern carp hatcheries have been established in the departmental farm. Encouragement is also made for setting up of hatcheries in private sector.

16.4 Fish Migration

Mass movement of fish is associated with either feeding or breeding, which are important functions of fish life. This movement takes place at different stages of fish life under certain physico-chemical and biological conditions that occur regularly, cyclically and naturally in the water environment. Indian major carps, which grow in the rivers, undertake breeding movement during monsoon when the rivers are in spate. Brood fishes during that time move in mass upstream to the shallow reaches for breeding.

The freshwater prawn, M. rosenbergii, is known to breed in the freshwater in the river but they undertake larval development in the estuary and the larvae migrate from the estuary to the rivers upstream to their natural habitat in the river. They breed in the

river and the fertilized eggs and hatched larvae are washed out in the monsoon flood to the estuary for larval development. It is reported that M. rosenbergii larvae undertake migration up to 100 km upstream to their natural habitat.

The flow pattern in the river should be so regulated that the prawn/fish finds sufficient water to move at least during breeding season, i.e. June-August, so as to multiply their race and have a sustainable fisheries development in the river basin. During the dry season the fishes/prawn accommodate themselves in the river pools/deep gorges, which exist in the river bed.

The riverine resources are renewable. Every year there is breeding and every year there is recruitment of new seed in the river and they grow and breed again after attaining maturity. The fish/prawn multiply in great numbers. The other species possess enormous power of multiplication with a fecundity of 0.5 – 1.5 lakhs depending upon the size of the mother fish/prawn.

Generally the maturity of gonads coincides with the monsoon flood as gifted by nature. And the fish/prawns in the river do not breed unless there is a “fluviating current” in the river.

Where possible an artificial flooding should be created through barrages in the upstream of the river to keep moving water current in the river.

Due to construction of Dam in the Major river system of Orissa the migration of some fishes like Hilsha ilisha and Mohaseer have been adversely affected. An in-depth study is essential to address the problem for these straddling species. Fish ladder may be constructed to facilitate migration of fish in river system. The premier National Institute like Central Inland Capture Fisheries Research Institute (CIFRI), Barrackpore, (ICAR) and West Bengal can undertake such studies if funds will be made available from out sources. Such study can enable the state to estimate the minimum water flow required to sustain the ecosystem.

With the existing trend of inland fisheries (Culture) growth rate of 6.16, the quantum of fresh water indicated at Table-25A will be indispensable for inland pisciculture and inland fish seeds hatcheries till end of 2010.

PART D

THE USE AND MANAGEMENT OF ORISSA'S WATER RESOURCES

17 DOMESTIC USE

The citizens of Orissa have a right to access to fresh water in sufficient quantity with acceptable quality. Water is required for sustaining human life. Water is required for drinking and cooking food. A lot of water is also required for cleaning and sanitation.

Orissa does not have a health policy of its own. The National Health Policy (NHP) 2002 stipulates to reduce mortality by 50% on account of water borne and other vector related diseases by 2010. The above stipulations have direct bearing on assurance of supply of safe drinking water to the urban and rural population.

The National Water Policy and State Water Policy have accorded top priority to allocation of drinking water in the planning and operation of systems. Further the policy has specifically stressed that adequate safe drinking water facilities should be provided to the entire population both in urban and in rural areas. Irrigation and multipurpose projects should invariably include a drinking water component, where there is no alternative source of drinking water. Drinking water needs of human beings and animals should be the first priority on any available water.

17.1 Per Capita Water Requirement

Daily Water requirement differs from person to person depending upon his habits and occupation.

17.1.1 Urban Water Supply Criteria

The following standards are currently applied in the State to assess the domestic water requirements of urban centres:

Classification of Towns/Cities	Population	Lpcd
1. Towns provided with piped water supply but without sewage system	<50,000	70
2. Cities provided with proper water supply where sewage system is existing / contemplated	>50,000 <200,000	135
3. Metropolitan and mega cities provided with proper water supply whenever sewage system is existing / contemplated	>200,000	150

To reflect real-life conditions, the consumption rates in Litres per capita per day (lpcd) is increased by 30%, accounting for unaccounted water use (15%) and service loss (15%). Where water is provided through public stand points, a rate of 40 lpcd is assumed. The detail of water supply to various urban agglomerations is given in Table. 27

17.1.2 Rural Water Supply Criteria

Block headquarters and big villages do not qualify as urban centres but the presence of sizable, concentrated populations justifies providing them with piped water supply systems. The standard applied for these systems is 40 lpcd, plus 30% to account for losses. Other miscellaneous need like washing, bathing etc from Groundwater.

For small villages the standard is 100 lpcd, to be met from groundwater.

17.1.3 Water Supply for Animals

Next to agriculture animal rearing holds promises for employment and income generation for the rural folk. Water requirement for livestock and poultry is discussed here.

Livestock

It is difficult to assess the exact livestock population though some figures are available in statistical Hand Books. However some sort of statistical relation exists between human and livestock population and the live stock population is considered as 90% of rural population.

Water requirement has been considered as 45 lpcd per head of livestock.

Poultry

Water requirement has been considered as 7 lpcd per head of poultry.

Water demand for livestock and poultry is considered as domestic water demand and has been worked out separately and included in the total water demand at a location.

ORISSA: NORMS FOR WATER SUPPLY

Urban		Rural	
Class 1	70 Lpcd	Big villages	40* Lpcd
Class 2	135 Lpcd*	Small villages	100 Lpcd
Class 3	150 lpcd*		

Livestock	45 lpcd
Poultry	7 lpcd

* Add 30% extra

Population

The break up rural and urban population for present and ultimate for all the 11 basins are given in Table 6.

Livestock and poultry population

Population of livestock and poultry for all the basins has been estimated and tabulated in Table. 15.

17.2 Water Demand

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

17.2.1 Urban Water Demand

Present Demand (2001) 927 MLD
Future Demand (2051) 2216 MLD

This amount will be supplied from surface water sources wherever possible.

17.2.2 Rural Water Demand

Big Villages

Present Demand (2001) 611 MLD
Future Demand (2051) 1568 MLD

Small Villages

Present Demand (2001) 2442 MLD
Future Demand (2051) 2352 MLD

Rural water supply will be mostly from ground water. But wherever possible, surface water may be used.

Livestock and Poultry

	Livestock	Poultry	Total
Present Demand (2001)	1236	96	1332 MLD
Future Demand (2051)	1588	123	1711 MLD

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 million m^3 from ground water sources.

17.2.3 Resource availability

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, it may be difficult to make water available to all throughout 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 analysed case by case

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

17.3 Water Supply Facilities

According to 2001 census the State has 138 towns including 10 urban agglomerations, and 51,349 villages. Water supply to UA has been discussed in some detail.

17.3.1 Water Supply to Urban Agglomerations

List of the UA along with the present and future population and water demand is given in Table 27.

17.3.2 Cities and Towns

There are 138 towns (population more than 5000) in the State at present. Population and demand for water supply to these cities and towns is shown in Table 28.

17.3.3 Small Villages

It is proposed to provide one well for every 100 persons for their drinking water needs. The villagers can fulfil their other domestic needs from the village pond. At least one pond for each village has to be provided and size of the pond will depend on the population using the pond.

18 AGRICULTURE

Orissa has a bad reputation for starvation deaths, hunger and poverty. The first priority with the State is to produce enough food and make it available to its people. Food of the people consists of animal and agricultural product. Rice, wheat and other cereal products, pulses, oilseeds derived from agriculture and milk, eggs, fish and meat derived from animals form the principal food of the people.

18.1 Present Land Use

Land Use Pattern of the State is presented in Table 30. The table supplies information on area of the State put to different use from 1990-91 to 2002-03. It will be noticed that net sown area of the State is in the average about 60 lakh ha.

18.2 Farm size

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 (up to 1-2 ha) constitute 53.61% and 26.2% respectively of total land holdings and combined constitute about 80% of farm holders of Orissa. The details of land holding are given in Table 31.

The marginal farmers, who constitute about 54% of the total landholders in Orissa possess only 0.50 ha of land size on an average. These farmers would be non-viable farmers, even if all types of government and community support would be provided to them. The small farmers, who constitute about 28 percent of the total land-holders of the State possess on an average 1.37 ha of land. These farmers are potentially viable farmers and would be viable (i.e. self supporting), if irrigation, credit and other supporting services would be made available to them. The marginal and small farmers, who constitute about 82% 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.

18.3 Farming practice

The farming practice has been handed down from generation to generation. The change towards modern farming is very slow. The use of tractors and other modern implements are still very limited. The use of fertilizers and pesticides is still very low.

The consumption of fertilisers in the State is only 3.45 lakh tons (2001-02). Per hectare consumption has increased over the past 30 years as follows:

Year	Consumption (kg/ha)
1975-76	6.7
1980-81	8.7
1985-86	15.2
1990-91	20.1
1993-94	21.3
1998-99	36.0
2001-02	41.0

In 2000-01 sale of agricultural implements in the State was of Rs 3.80 crore

18.4 Natural Calamities and their Effect on Agricultural Production

Orissa is a state where natural calamities like flood, cyclone and drought visit the State almost every alternate year. Occurrence of any of these natural calamities affects agricultural production seriously. A study of meteorological scenario and corresponding food production from 1964 to 2004 show that there are only 13 normal years out of 40(roughly 1/3). Thus natural calamities have serious bearings on agriculture of the State and the sector needs protection from the calamities.

18.5 Cropping Pattern and Cropping Intensity

18.5.1 Cropping Pattern

The principal crop grown in Orissa is rice. People grow rice in almost all the fields under rain-fed condition. In irrigated area the crop is predominantly rice except few farmers who grow non-rice crops like vegetable, oilseeds and pulses. During Rabi no crop is grown in rain-fed areas. Wherever possible, people grow pulse like mung and biri which thrive on residual moisture of monsoon period. Besides rice, a variety of non-rice crops are grown in irrigated area in Rabi. The district wise irrigation coverage is shown in Map. 11

The above statistics show that rice is grown in 4/5th land area. About 90% of total land area grows food grains. In some districts the cultivable lands are limited and the distribution of cultivable area to geographical area is shown in Map. 8

In recent years, 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.

The cropping pattern practiced in the State reveals that paddy is the single-most dominant crop that is grown in the State. In the recent years paddy has lost its market and the paddy growers face a lot of difficulty to sell their produce. Increase in irrigation coverage has induced farmers to go for commercial crops like sugarcane, cotton, groundnut, potato, jute etc. Farmers of Kalahandi, Koraput, Bolangir, Nabarangpur, Rayagada have taken to cotton farming. Government is encouraging farmers to grow sugarcane to feed the Sugar factories of the State.

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

A number of fruits like mango, pine apple, guava, sapeta etc are grown in the State. Area under fruit cultivation in 1999-2000 was 2.44 lakh ha, but almost all the fruits like apple, orange, grapes and banana are imported into the State.

18.5.2 Cropping Intensity

The cultivated area of the State is 61.65 lakh ha. In 2001-02 the Kharif 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%. The cropping intensity from 1997-98 to 2002-03 is shown in Fig 11. Ministry of Agriculture, GOI has suggested not to increase the cropping intensity more than 140% as it will lead to rise of groundwater table and other consequential problems.

18.6 Production and Productivity

Even though agriculture has remained the principal occupation of the people of the State, the production has remained stagnant for several years. The crop productivity is among the lowest in the country. The yield and production of food grain is given in Table 32 and Fig. 15. The production of rice and food grain from 1997-98 to 2002-03 is shown in Fig. 16. The district wise yield rate of paddy is shown in Map. 12

Table 32 presents crop area, crop yield and production from 1970 through 2001. The average crop yield works out to 918 kg/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 rural infrastructure and user involvement, contributes in a big way towards low productivity of the State.

Analysis of Orissa's food grain production over the 1970-2000 period shows that the growth rate is about 1% in 30 years which means the production has remained practically stagnant. Comparative figures for major states show that agriculturally advanced states are way ahead of Orissa.

In order to meet the food demand option of bringing in improvement in crop productivity can be considered. 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 consumption of fertiliser in Orissa is at much lower level and a comparison to all India level from 1996-97 to 2000-01 is shown in Fig. 14. The crop yield in average for Kharif is assumed to grow linearly and reach 35 Qtl/ha for irrigated and 20 Qtl/ha for rainfed paddy by the year 2051.

	Paddy Yield (Qtl/ha)	
Year	Irrigated	Rain-fed
2001	22.44	15.00
2051	35.00	20.00

18.7 Irrigation

Table 33 shows the irrigation potential created in each district up to June 2003 by Major and Medium, Minor (Flow) and Minor (Lift) schemes. The table does not include the area reported by the agricultural statistics as being irrigated from 'Other Sources'.

18.7.1 Consolidation of Existing Irrigation Potential

At huge public cost a potential of 25.89 lakh ha in Kharif and 11.17 lakh ha in Rabi has been created. But according to the statistics of Department of Agriculture in a good year like 2001-02 irrigation could be provided to an area of 17.52 lakh ha in Kharif and 7.93 lakh ha in rabi (Table 34) .Thus there is a big gap between potential

created and actually utilised. The irrigation coverage in 2001-02 for Kharif and Rabi are shown in Fig. 13(A) & 13(B).

Major irrigation

In the State major and medium projects provide irrigation to 12.21 lakh ha in Kharif and 5.36 lakh ha in Rabi. Evaluation studies carried out by several agencies show that the potential developed has not been fully utilised. 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.

Incomplete projects

Huge investment lies locked in Rengali, Subarnarekha projects. After a very long gestation period, Rengali has started showing results. There are several medium projects lying incomplete due to various reasons.

Minor (Flow) projects

In this sector alone irrigation to 4.64 lakh ha in Kharif and 0.71 lakh ha in Rabi has been provided. Proper evaluation as to what percentage of this potential is fully utilised has not been made. There are several partially derelict and completely derelict (PDCD) projects which are unable to provide irrigations. The status of these projects should be properly studied and PDCD projects fit to be rehabilitated should be brought back to operational condition. Government has launched a new Biju-krushak Vikas Yojana (BKVY) which may take up such projects.

Directorate of Economics and Statistics (DES) on behalf of Government of India has conducted a census of MI schemes in 1993-94 and 2002.According to the report on MI flow schemes 61.8% of the potential created was covered and 11.13% area could not be covered due to lack of storage in that year. Thus 73% area could be covered in a good year. Out of the balance 27% only 5.98% area could not be covered due to poor condition of canals

Minor (Lift) Projects

Potential created in this sector is 3.47 lakh ha (June 2003). Authentic evaluation of performance of these projects has not been made. According to the DES study of 2002 69% of surface lift schemes, 68.5% of deep tube wells, 75% of dug wells and 62.5% of shallow tube wells were working.

System deficiencies

Many projects/project components are not able to render proper service due to fault in the head works or canal system. Proper technical examination should be conducted and fault repaired.

Rehabilitation – the cheapest option

Even though any recent evaluation study is not available, it appears that about 25 to 30% of the potential created is not functioning properly. It is necessary to conduct a performance survey, identify the problem and take corrective measures urgently.

18.7.2 New Development

Need

As more than 70% of the population of the state are dependent on agriculture, improved agriculture will bring in food and prosperity to majority of people of the

state. The strategy of improving agriculture is to raise the productivity level to 3.5 ton/ha in at least a part of the total cultivated area. System consolidation discussed in the previous paragraph can restore full potential development of 25.89 lakh ha of irrigation. Assuming high yield rate of 3.5 tons/ha, the present development can produce about 89 lakh tons of food grains. This amount will not satisfy the requirement of 2051. New development of water resources is necessary.

Major/Medium Schemes

Orissa has got vast scope for large and medium sized irrigation projects. The Decade of Destiny formulated by the Engineer Statesman Dr. A.N.Khosla is the first serious attempt in the state to plan and execute large irrigation schemes after construction of Hirakud and Salandi projects. The draft Master Plan in 1982 listed major and medium projects of the state and many projects were executed following the plan. Over the years the state has completed construction of eight major projects and 50 medium projects. At present seven major and 12 medium projects are under construction. The total irrigation potential created so far is 12 lakh ha. The state has taken up survey and investigation of several projects. These 'pipeline'projects number 48 out of which 16 are major and 32 are medium projects. OWPO has already completed planning for all the major 11 basins of the state. The basin studies have identified 168 major/medium schemes, which are found to be feasible on a very preliminary analysis. These projects together will create a potential of 28.82 lakh ha as follows:

Status	Type	Number of Projects	Potential (lakh ha)
Completed	Major	8	9.485
	Medium	50	3.103
Ongoing	Major	7	4.917
	Medium	12 + 16 *	0.956
Pipeline	Major	16	4.191
	Medium	32	1.750
Identified	Major and Medium	43	4.414
	Total	168 + 16 *	28.816

* creek projects

Complete list of projects is annexed "D"

Inter Basin Transfer

The basin study of individual basins has worked out in-basin availability and demand of water in 2001 and in 2051. Simulation studies with in-basin resources show that in some basins the requirement cannot be satisfied over time and space (ex. Rushikulya) and some of the basins have surplus water (ex. Vansadhara, Nagavalli). It is therefore necessary to carry water from surplus area to deficit area after satisfying all demands including environmental low-flow requirements. The inter-basin transfer will also help the state to even out difference in spatial distribution of rain fall. The feasible inter-basin transfer links inside the State have been discussed in annexure C. .

Minor (Flow) Schemes

Irrigation projects with potential not exceeding 2000 ha are termed minor projects. Projects with more than 40 ha potential are under the control of the DOWR (MI wing) and projects with less potential are with Panchayat Raj Department

The MI wing has so far constructed 4777 MI projects with irrigation potential of 5.400 lakh ha.

MI Organisation has identified 1154 schemes to irrigate further an area of 4.228 lakh ha thus increasing the ultimate potential to 9.628 lakh ha.

Major River Lift Schemes

Unlike states like A.P, Maharastra, Orissa has so far not executed a single major river lift scheme. There is vast potential of such schemes in Mahanadi, Brahmani, Indravati, Subarnarekha, Vansadhara basins. Some proposals have been prepared in Banapur-Baideswar stretch on right of Mahanadi and Baramba-Athagada area on left of Mahanadi. There is scope to lift water from tail race pond of Indravati project to irrigate about 26,000 ha. Similarly about 20,000 ha of area can be irrigated by lifting water from Rengali right and left main canal. There is potential of lifting water from Tel and irrigate areas near and Tarabha. These schemes together can generate a potential of 2 lakh ha.

Government of Orissa has approved a policy to set up new mega lift schemes. According to the policy, Government will fund, own and maintain the schemes. The farmers will have to pay a compulsory basic water rate like flow schemes. Separate tariff will be applicable for Rabi irrigation.

Minor (Lift) Schemes

Minor (Lift) schemes are looked after by the Orissa Lift Irrigation Corporation (OLIC) and Ground Water Survey and Investigation. Resource assessment and ground water development planning is done by GWS&I whereas Lift Schemes under Government, sector is taken up by OLIC. Individual/ group of farmers take up lift schemes in private sector.

River Lift Schemes

OLIC have so far completed 10,205 RL schemes with a total potential of 2.62 lakh (3/2004) ha. The rivers and streams of the state offer further scope for RL schemes. It is planned to create potential of 80,000 ha through small RL schemes spread throughout the state.

Groundwater Lift Schemes

The ground water potential of the state is 21 BCM. At 60% exploitation the usable ground water is about 12.6 BCM. This resource is planned to be used for industrial, domestic and agricultural use. Keeping about 3 BCM for industrial & domestic use balance 9.6 BCM can be used for providing irrigation. Thus there is enough water for agriculture use for more than 9 lakh ha.

Use of ground water in the state is very low and has been estimated as 14.79% in the private sector so far irrigation potential of 2.20 lakh ha has been created through 3,00,467 dug wells, 11,598 filter point tube wells and 153 bore wells. In the Government sector irrigation has been provided to 95,400 ha through MI (ground water lift) schemes. This sector has not been given its due importance as is seen from the fact that about 3.47 lakh ha has been irrigated in about 50 years. It is

important to make a regular study based on actual field surveys and finalise the structures required for ground water exploitation. The proposed potential of 3.44 lakh ha through lift is achievable. This can be achieved through 40,000 tube wells, 4 lakh dug wells.

Other sources

The potential created through other sources has been reported as 5.52 lakh ha. There is no way to check the performance. Since the source of such irrigation is from small tanks and wells in an unorganised sector without providing assured irrigation, this potential is not considered for planning purposes.

18.7.3 Total Potential

It has been reported since long that the ultimate irrigation potential of the State is 59 lakh ha. The source wise allocation is reported as follows:

	(lakh ha)
Major and Medium	39.49
Minor (Flow)	9.70
Minor (Lift	8.87
Other Sources	0.94
Total:	59.00

Although the arable area of the state has been reported as 65 lakh ha, about 62 lakh ha of area will be available for cultivation as per the following break up.

	(lakh ha)
High Land	26.94
Medium Land	19.14
Low Land	15.57
Total	61.65

It is not possible to get 59 lakh CCA out of 62 lakh ha of arable land.

The ultimate potential of 59 lakh ha was earlier estimated without sufficient data and analysis. Some details have now been worked out in the individual basin studies. As per the basin study the ultimate potential for major and medium projects works out as 28.8 lakh ha. Similar studies have not been done for minor irrigation but a rough study suggests that the proposed potential is achievable. The ultimate potential 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

The District wise irrigation coverage for completed, ongoing and proposed projects for major & medium, minor flow, minor lift as per above have been prepared in detail. The list is attached in Annexure D.

18.8 Food Security

For the purpose of planning, it is generally confirmed that 75% of cereal requirement of the state is produced in the state and distribution.

18.8.1 Estimation of Food Requirement

Nutritional Per Capita Requirement (NPR)

Food intake of a person depends on his occupational engagement - sedentary work, moderate work and heavy work, sex – male and female, food habit - vegetarian and non-vegetarian, age: child or adult. Based on these considerations, recommended intake of food per day in grams has been prescribed by several institutes like the National Institute of Nutrition (NIN), Hyderabad National Nutrients Monitoring Bureau (NNMB). Indian Council of Medical Research (ICMR) had conducted extensive diet surveys in different parts of country both in rural and urban areas & has prescribed balanced diet for all categories of people.

The following composition of daily food intake (in grams) has been considered a balanced diet meeting the needs of Orissa population:

Cereal	390
Pulses	66
Vegetables	192
Oil and Fat	37

Taking oil to oil seed ratio as 30% per capita requirement works out as (in kg/yr)

Cereal (Rice)	142
Pulses	24
Vegetables	70
Oil and Fat	45

Taking an average paddy to rice ratio of 0.60 and losses as 6.5% (drying, wastage, transit - 4.5% and fodder 2%) total paddy requirement works out to 252kg/yr.

BOX-5

ORISSA : NPR

	NPR in kg/year
Paddy	252
Pulses	24
Oilseeds	45
Vegetables	70

Demand for food grains

On the basis of the nutritional requirements shown above and the present and ultimate population of the river basins (Table 7), the demand for food grains in the

individual basins in the years 2001 and 2051 is estimated as shown in Table 29. For paddy, the basin requirements add up to 93 lakh tons in 2001 and 136 lakh tons in 2051.

18.8.2 Required Irrigation Coverage

The irrigation coverage has to be so designed that the state should be able to provide food security to its people and to provide means to enhance economic status by growing high value crops. It may be assumed that to secure food for all, the state should be able to grow 75% of its cereal (Mainly Paddy) requirement from irrigated agriculture. Although there is enough water to achieve the ultimate potential of 49.9 lakh ha, for food security purpose about 32 lakh ha, of land as below can be irrigated.

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

Assuming that during a drought year a) minor projects will go dry, b) medium projects will fulfil 50% of their capacity, and c) major projects and lift schemes operate at full capacity, only about 70% of the irrigation potential would be realised.

Therefore, irrigation facilities covering some 32 lakh ha would achieve full irrigation of 22 lakh ha. The irrigated 22 lakh ha would then produce 77 lakh tons of paddy, and 10 lakh ha under stressed irrigation would produce 20 lakh tons totalling 97 tons of paddy. Balance amount of paddy would be imported.

The existing major and medium flow schemes, together with the completion of the ongoing schemes would be sufficient to provide the expected irrigation potential of 18 lakh ha.

	(lakh ha)
Potential already created	12.59
Potential from ongoing schemes	5.87
Total	18.46

Similarly irrigation from other sources can be provided by completion of ongoing and identified schemes.

Once the goal of food security is achieved land and water i.e available in the state in sufficient quantity can be used to enhance the economic condition of the people. For this purpose, the full irrigation potential of 49.9 lakh ha can be exploited. Thus the balance 17.9 lakh ha of land can be provided with irrigation for commercial agriculture. To achieve this objective the state may encourage a) corporate farming, b) private participation, c) farmer group participation with Government help.

19 INDUSTRY AND MINES

19.1 Industrialisation in Orissa

Despite high potentials, Orissa ranks one of the least industrialised states in India contributing about 2% of the country's industrial output. A comparison of state-wise industrialization level is shown in Table 35. As the table shows, Orissa has consistently been among the least industrialised states for the last 40 years.

Table 36 illustrates the relative importance of each of the State's industrial sectors by presenting the distribution among the sectors of the employment offered and net value added by all sectors. From the table it is clear that natural resource based industries constitute a major share of Orissa's industries. It is to be noticed that though Agriculture contributes largely to NSDP there is hardly any agro industries in the state. Again there is hardly any value addition to the natural resources industries. The ores are exported in raw form without converting it to more profitable products. The share of Orissa in All India resource stock and out put from 1991-92 to 1999-2000 is shown in Table 13. The engineering goods and chemicals have a low share in industries. The rate of extraction of important minerals is given in table 12.

19.2 Industrial Centres

Major industries in the state have grown in clusters. Major industrial centres of Orissa are shown in Map 14.

19.2.1 Iron Ore and Steel Industries

The World consumption of steel is recorded as 615.36 million tons in 1993 and 748.00 million tons in 2000. This is likely to go up steeply in coming decade. In India the per capita consumption of steel is 26 kg where as it is 400 kg in developed countries. During Nineties the steel production in India was 20 million tons/year and is likely to go up to 57 million tons/year during 2010.

In Orissa Rourkela Steel Plant is the only integrated Steel Plan with installed capacity of 1.5 million tons/year and is likely to be expanded up to 2.5 million tons/year. The first phase of Second Steel Plant i.e. Neelachal Ispat Nigam has been commissioned near Dhuburi in Jajpur District and has capacity of 1.1 million tons/year.

The following, smaller, steel plants are also operating in Orissa:

Plant	Location	Product	Capacity (million tons/year)
Ipit-Tata	Joda, Keonjhar	Sponge Iron	0.12
Orissa Sponge Iron Ltd	Palasponga, Keonjhar	Sponge Iron	0.10
Kalinga Iron Works	Barbil, Keonjhar	Pig Iron	0.14

Construction of the following potential plants would increase production capacity by 7.7 tons/year.

Plant	Capacity (million tons/year)
Brahmani Iron and Steel	1.0
Orissa Steel Ltd	0.5
Bhusan Steel	1.2
Zindal Steel	1.0
Arats Steel	1.5
Mesco Kalinga	1.5
Ganapati	1.0

19.2.2 Ferro Alloy Industries

The rich deposits of chromites are conducive to setting up large number of ferro chrome plants in Orissa. The increasing steel making capacity in the State, gears up setting in more numbers of ferro alloys projects. This will have tremendous effect on water sources and pollution load coming in the water body. The following plants are presently operating in Orissa:

Plant	Location	Products	Water Source
Ferro Alloys Plant (FACOR)	Bhadrak	Ferro Chrome	Salandi
Ispat Alloys	Balasore	Ferro Silicon	Burhabalanga
Indian Charge Chrome Ltd. (ICCL)	Choudwar	Charge Chrome	Mahanadi
Indian Metals & Ferro Alloys (IMFA)	Thiruvali	Ferro chrome, Ferro Silicon	Nagavalli
Ferro Manganese Plant	Joda	Ferro Manganese	Baitarani
Ferro Chrome Plant	Jajpur Road	Ferro Chrome	Brahmani
Jeypore Sugar	Rayagada	Ferro Manganese	Nagavalli
Ferro Alloy Plant	Banaripali	Ferro Chrome	Kusei
Nav Bharat Ferro Alloys	Meramundali	Ferro Alloys	Brahmani

An additional steel alloys plant is proposed by Arati Steel to be located in Ghantikhal, Athagarh, it would draw water from the Mahanadi for the production of charge chrome.

Projections

It is expected that by 2015 the State's steel production capacity may go up to 15 million tons/year and by 2050 to 25 million tons/year. The iron ore extraction of 16 tons/year at present may go up to 40 million tons/year and by which the Iron ore may be exhausted in coming 150 years.

19.2.3 Iron Ore Mines

The Iron ore mines are mostly located in Sundergarh, Mayurbhanj, Keonjhar and Jajpur Districts (Table 41) having total resource of 3567 million tons which is 28% of the all India reserve. The rate of extraction is 14 to 16 million tons which is 0.33% of annual extraction of total resource but this is likely to be doubled in coming decades.

A significant increase of production and export of iron was observed in the five-year period from 1997 to 2002:

Year	Production (lakh tons)	Exported (lakh tons)	Value of export (Rs crore)
1997-98	123.6	9.54	61.39
1998-99	116.7	6.68	45.68
1999-00	120.5	9.96	78.68
2000-01	143.5	28.25	222.88
2001-02	167.9	35.46	272.33

In last two years the export quantity has increased to 20% of production of ore. The important iron ore mines are shown in Table 37. And the distribution of mines for whole of Orissa as located in river basins are shown in Table 42.

19.2.4 Aluminium Industry

As a metal Aluminium has inherent advantages like light weight, high strength, good thermal and electrical conducting, corrosion resistance and non-toxicity. It has wide range of application from kitchen wares to space crafts. Because of its wider utility, the present global growth rate is around 4 to 5% per annum but in India it is expected to be of the order of 6 to 8%, the per capita consumption of aluminium in the country being less than 1 kg as against 25 kg in the developed countries. During the 1990's the consumption rate in India was 0.5 million tonne which was to be increased to 1.0 million tons by year 2000.

In Orissa there is huge reserve of bauxite which is the ore for Aluminium. The main reserve lies in the eastern ghats in the southern Orissa i.e. in Koraput and Rayagada districts. The bauxite reserve of Orissa is estimated as 1733 million tons compared to 2911 million tons of India which accounts for 59.53% of the Indian reserve. The extraction of bauxite is in the range of 30 to 36 lakh tons and during 2001-02 it is around 36.1 lakh tons which is about 0.21% of the reserve available and 97% of extraction came from Koraput district and rest 3% from Sundergarh district. The bauxite production in the state is likely to increase from current level of 3 tons to 20 tons in coming years.

The principal characteristics of existing and proposed units of Orissa's aluminium industry are summarized in Table 39.

19.3 Water Requirements

19.3.1 Steel Industry

The water consumption per tone of steel produced varies between 15 to 45 m^3/ton in India. In Rourkela Steel Plant this is as high as 45 m^3/ton, including power plant and domestic requirements. However, as per the water (Prevention and Control of Pollution) Cess Act' 1976, the norms of water use in Steel Plants in India is 20 m/ton.

The water use is much less in developed countries. The water use in Japan has come down to 4m^3/ton and in some European countries it is 3 m^3/ton of steel.

Present use in Rourkela Steel Plant:

Capacity	Total water consumption	Water consumption per ton of steel	As per MINARS
1.8 tons/year i.e. 4931.5 tons/day	265580 m^3/day	53.85 m^3/ton	16 m^3/ton

Steel production in Orissa is assumed to increase from 5 million tons per year in 2001 to 15 in 2010 and 25 in 2050. The increase is expected to be the result of additional capacity installed in the Brahmani, Baitarani and Rushikulya basins. The estimate in Table 38 of the corresponding water demand from these rivers produces the following annual water requirement in million m^3:

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

19.3.2 Aluminium Industry

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

	Mining	Refining	Smelting
Existing			
Nalco	Panchptmali Local stream	Damanjodi Local stream	Angul Captive Plant Brahmani River
Indal			Hirakud Reservoir
Proposed			
Utkal Alumina	Baphilimali Local stream	Kashipur Indravati Reservoir	No smelting. Alumina to be exported
L & T	Sijimali, Kuturmali Local stream	Kasipur Nagavali River	-do-
Sterlite	Lanjigarh	Nagavali River	-do-

The water demand for each project is being worked out.

19.3.3 Cement Industry

The cement industry in Orissa has been developed in Sundergarh, Jharsuguda and Bargarh districts due to available in abundance of lime stone, clay and coal. Subsequently the clinker and gypsum are being partially replaced by the industrial solid waste like the basic slag of Iron and steel industry (Slag cement) or fly ash of

thermal plants (puzzolona cement). Due to available of slag from the Rourkela Steel Plant a large number of mini steel plants have come up in and around the Rourkela industrial area. Earlier the clinkers are produced in wet process which has become out dated and the wet process have been replaced in favour of dry process technology. The location of cement plants and its details are given below.

Name of Industry	Location	Production Capacity (tons/day)	Water Source
Orissa Cement	Rajgangpur	1800	Tributary of Brahmani
IDCOL Cement	Bargarh	2630	Tributary of Mahanadi
L & T Ltd.	Jharsuguda	2000	Ib
Chariot Cement	Rourkela	600	Brahmani
Mini Cement Plants	19 No. in Sundergarh 3 Nos. in Bolangir 3 Nos. in Koraput 1 No. in Ganjam		50% of mini cement plants have since been closed

19.3.4 Thermal Power Plants

Orissa has vast deposits of coal which induces in setting up a large number of thermal power plants. The total coal reserve in Orissa accounts to 51571 million tons out of 213,903 million tons reserve in India which is 24.11% of India's reserve. The coal reserves located in Angul and Jharsuguda districts are being exploited by the Mahanadi Coal Field Ltd a Government of India undertaking. During 2001-02, about 478 lakh tonne coal was produced out of which Talcher zone and Ib valley produced 331.00 and 147.00 lakh tons respectively. It is estimated that if 500 lakh tons are exploited annually which account to 0.096% of Orissa' the coal reserve will last for 1040 years for total exhaustion. Table 40 lists the thermal plants in operation.

Additional thermal plants being considered are listed in Table 41. Assuming that a MW of installed capacity requires 80 m^3 of water per day, the water requirement of the proposed thermal plants is estimated as follows:

Basin	Location	Capacity (MW)	Water requirement.
Mahanadi Basin	Ib River and Hirakud Reservoir	8200	656,000 m^3/day i.e. 239.44 million m^3/year
Mahanadi Basin	Naraj	1000	80,000 m^3/day 29.2 million m^3/year

19.3.5 Basin-wise Industrial Water Demand

In 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 lpcd for each industrial worker and the requirement has been reduced to 650 lpcd by 2051. Applying this approach in the river basin studies produced the result shown in Table 43.

For the Brahmani, Mahanadi, Baitarani and Rushikulya basins, a more detailed estimate based on the expected growth of industrial output resulted in the following annual water requirements:

Basin	Industry		Water Demand (million m^3/year)
Brahmani	Iron and Steel Industry		300 .00
	Aluminium Smelter		3.10
	Thermal Power Plant		208.12
	Total		511.22
	Add 10% for other industries		51.00
	Total Brahmani Basin		562.22
Mahanadi	Iron and Steel Industry		
	Aluminium Smelter		1.00
	Thermal Power Plants	Existing	35.09
		Future	268.64
	Total		304.73
	Add 10% for other industries		30.47
	Total Mahanadi Basin		335.20
Baitarani	Iron and Steel Industry		100.00
	20% for other industries (mostly Ferro alloys)		20.00
	Total Baitarani Basin		120.00
Rushikulya	Iron and Steel Industry		100.00
	20% for other industries (e.g. rare earths)		20.00
	Total Rushikulya Basin		120.00

Table 42 groups Orissa's mines located in River Basin of Orissa.

19.3.6 Reservation of water for industrial use

With such concentration of natural resources Orissa's industrial development seems inevitable. In 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 Table 43 and the required reserve better estimated as more information becomes available.

20 ENERGY

Hydro Power

Status of Development

There are 6 hydropower stations in the state namely Hirakud, Balimela, Rengali, Upper Kolab, Upper Indravati and Machhakund power stations. The state has full share of power except in Machhkund where the state's share is 30%. The installed capacity of these power stations is 1976.25 MW and the state's share is 1918.5 MW. The energy 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.

Potential

There are still a lot of potential of hydropower generation in the state.

Environmental Safeguards

The hydropower 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 downstream.

21 NAVIGATION

History

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.

22 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 reservoirs 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.

23 WATER QUALITY

Water is one of the essential ingredients of life on planet earth. With the growth in world population and rapidly increasing economic activities, water demand has already outstripped supply in many regions with competing demands leading to critical water management problems.

Fresh water is a finite resource and in many parts of the world is becoming increasingly scarce. Water is being polluted at a rapid rate and it is estimated that 80% of all diseases in developing countries and one third of the deaths are related to contaminated water.

23.1 Surface Water

23.1.1 Sources of Pollution

Industrial

Depends on industrial process

Mostly they are toxic and non-degradable.

The industrial waste water constituents about 8 to 15% of total waste water which may go up to 33% due to rapid industrialisation.

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

Domestic

Mostly the pollutants are degradable.

The domestic waste water comes in the range of about 80% of total waste water.

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

Agricultural (Non point source)

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

23.1.2 Consequences of water pollution

Water pollution affects the life in two ways (I) toxic chemicals and harmful microbes in waste water are health hazards (ii) Nature's response to pollution by aerobic digestion of the pollutants causes decrease in oxygen concentration in water which is detrimental to aquatic life.

The non-degradable pollutants in water like heavy metals, pesticides residues enter the food chain through planktons to fishes into human body and also through food materials to the body. In the process the concentration of a pollutant in the tissue of

organism increases which is called Bio-magnification. Man being at the top of food chain accumulates such pollutants the most.

The degradable category of pollutants is attacked by aerobic bacteria (oxygen demanding) with the help of dissolved oxygen. By the process the oxygen level is depleted and anaerobic bacteria takes over. The decomposition and sludge is produced due to above process. This results in death of living organisms and is known as "Eutrophication".

23.1.3 Water Quality Standards

The Central Pollution Control Board has classified the water of major rivers of India on the basis of their designated best use.

The water quality parameters relevant to the above cases are described in IS 2296/1982.

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.

In this connection, classification of river water is discussed in respect of those parameters, considered to be of primary concern for the designated best use. These primary water quality criteria (Table 44) 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).

Annex F introduces more sophisticated quality measures and describes the status of water quality in the State's major rivers. The pollution stretch in Brahmani & Mahanadi river which is the critical areas in river system is shown in Map 20. A summary of the water quality assessment of the Mahanadi, Brahmani, Baitarani, Subarnarekha, Nagavali and Rushikulya rivers follows.

23.1.4 Water Quality of Major Rivers Of Orissa: Summary

Mahanadi

About 86% of the catchment (72,691 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 Madhyapradesh/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 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 agriculture activities. Hence there is some deterioration in the quality of water entering into Cuttack (Cuttack U/S), particularly in respect of 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 untreated wastewater and the water quality gets further deteriorated up to a distance of about 2.0 km further down stream, after which it starts showing improvement. The water quality of river Mahanadi as described above is shown in Table 45.

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 even 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 ofahbout3-4 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 generation 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 perhaps making a greater contribution to downgrade the water quality, than the industrial effluents. As regards the biological parameters like Saprobic (SI) and Diversity (DI) index are shown in Table 46. The violation of Fecal coliform is shown in Table 47 and the summary of water quality results is given in Table 48.

Baitarani

There are no large tows or highly water polluting industries on the banks of Baitarani. Joda (population about 39,000) is the centre of major iron ore mining activities. Anandpur and Jajpur are sub-division and district headquarters respectively. Jajpur is also an important religious place for Hindus .Nevertheless, all the three towns are small in terms of population (less than 40,000) and as such the pollution load is not very high. This is reflected in the quality of water at these three places, particularly during recent years. But for a higher Coliform level, the water qualities very nearly conform to class-B. With the inclusion of TC, the water quality can be said to conform to class-C. As the river enters its tidal zone at Chandbali and Dhamra, there is significant deterioration in the water quality, both on account of tidal effect (higher Electrical Conductivity-EC and Chlorides) and pollution generating activities like fishing and preliminary fish processing (higher BOD and TC) and the waster becomes unsuitable for almost all beneficial uses of inland surface water.

Subarnarekha

Subarnarekha is an interstate river (total length 395 km) with catchment areas in Jharkhand, West Bengal and Orissa. Only a small stretch (86 km, about 22%) of its total length flows through Orissa, before falling into the Bay of Bengal at Bhograi Block of Balasore district.

In the Orissa portion of the basin, industrial and mining activities are almost non-existent. There is only one Class-II town in the basin (Jaleswar, population about 22,000). Except Jaleswar, which is on its bank, the wastewater generated in other smaller towns and villages would not have any significant impact on the water quality of the river.

In spite of industrial, mining and urban activities in Jharkhand and West Bengal, the river seems to have considerable regenerative capacity, with regard to degradable pollutants like BOD, Chemical Oxygen Demand (COD) etc. The concentrations of the metals expected from the mining activities at Jharkhand and West Bengal (e.g. iron, chromium, copper etc) are also found to be quite low to be of any environmental significance and the water quality determination at Rajghat (about 05 km downstream to Jaleswar and60 km upstream to the confluence with sea), conforms to Class-C inland surface water.

Nagavali

Nagavali is an interstate river about 217 km length flowing through Orissa and Andhra Pradesh . In Orissa the length of the river is about 125 km.

In the Orissa portion of the basin there is only one major town, Raygada (district head quarters, population about 58,000). The wastewater generation at Raygada may have some direct impact on the river water quality. Except around Raygada, the river from its origin in the hill ranges of the Eastern Ghats near village Bijapur in Kalahandi district, to its exit from Orissa at Karada village of Raygada, it flows mostly through sparsely populated areas with almost no industrial and mining activities. At Raygada, two majuor industries are presently opera ting, namely J. K. Paper Mills, a large pulp and paper mill and IMFA Ferro Alloys Plant at Therubali, of which the discharge of effluent from the paper mill will have any significant impact on the river water quality. This is confirmed from the monitoring results. It is thus clear that the water quality of river (Orissa portion), except in about the 15 km stretch, from the D/S of the wastewater discharge point of the J. K .Paper Mill to a little further D/S of Raygada, should normally be fit for all beneficial uses.

Rushikulya

Rushikulya is a small river of about 165 km length. It flows almost entirely through the Ganjam district of Orissa and falls into the Bay of Bengal at Ganjam town. The basin however includes parts of Phulbani district. Industrial activities are confined to three locations, namely, Aska (Sugar and Distillery), Ganjam (Caustic Soda, Chlorine and Hydrochloric Acid), Chhatrapur (Rare Earths), the effluents from which will have a direct bearing on the water quality of the river. The sugar mill and distillery effluents from the Aska Cooperative Sugar Mills carry very high BOD and COD load. The industry has an ETP, but is of low efficiency to meet the required standards. The major pollutant from the caustic soda plant at Ganjam (Jayshree Chemicals) which is of serious concern is mercury. However, because of the steps taken by the industry for mercury removal from the effluent, its concentration in the river water at the downstream of the effluent discharge point generally remain within the permissible limits. In the Rushikulya basin, there are no major mines. Some small stone quarries operate in the basin, which have very marginal impact on the water quality.

Amount of domestic wastewater generated from the 18 urban centres in the basin (one Municipality-Berhampur with population of about 2.9 lakhs, three NAC's with population more than 20,000 and 14 with population less than 20,000) is about 29,000 M^3/day. Except a few of the urban centres like Aska, Hinjilikat, Purusottampur and Ganjam, the impact of the wastewater discharged at other places is not expected to be significant. Even in the above mentioned three towns, there is no organized discharge into the river. Hence the water is expected to be of fairly acceptable quality in the major stretch of the river, except may be a marginal increase in BOD and higher coliform levels due to the practice of open defecation.

Water quality monitoring at Madhopur and Pottagarh (U/S and D/S to the discharge of Jayshree Chemicals located at about 10 km and one km from the confluence of the river with the sea) indicate perceptible tidal effect up to Madhopur.

The water quality for the river system is more critical for river Brahmani and river Mahanadi. The detail study for above two rivers is given in Annex – F.

23.2 Ground water Quality.

The ground water in the State is 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 acquifiers in general is suitable for irrigation and other purposes. In coastal tracks the 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. Further 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 in to the coastal track.

However in the inland the ground water from deeper aquifers has Ph value from 6.62 to 8.2, 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. In general the quality of ground water can be used for drinking purpose and is also suitable for irrigation uses and suitable for most of the crops grown in Orissa.

24 ENVIRONMENTAL FLOW

24.1 The Concept of Environmental Flow

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, drainage 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 the size and frequency of floods. In many cases, these modifications have adversely affected the ecological and hydrological services provided by water ecosystems, which in turn has increased the vulnerability of people-especially the poor-who depend on such services. 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," or EFA

The method for 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. Sometimes this flow is dependent on the amount (quantity) and sometimes the depth in the stream.

Flow regime in the rivers of the State shows that in the monsoon season (June-October) there may be one or two large floods some small intensity floods and the base flow during non-monsoon season (November-March).

Different component of the flow regime maintain different types of aquatic eco-system.

Base (low) flow. These flows determine whether the river is perennial or flows only during the monsoon season. The amount of flow available supports different species.

Small floods: size, number per year, and timing. Small floods stimulate spawning in fish, flush out poor-quality water, cleanse the riverbed, and sort the river stones by size, thereby creating different kinds of habitat. They trigger and synchronize activities as varied as upstream, migrations of fish and germination of seedlings on riverbanks.

Large floods: size and timing. Large floods trigger the same in-river responses as small ones, but also provide scouring flows that shape the channel. They move and cleanse cobbles and boulders on the riverbed, and deposit silt, nutrients, eggs, and seeds on floodplains. They re-charge soil moisture levels in the banks, enabling seedlings of riparian trees to grow, and maintain links with the sea by scouring estuaries. These floods inundate backwaters, secondary channels, and floodplains. They trigger bursts of growth in many floodplain species, including water birds such as ibis.

24.2 Impact of flow modification

In course of time the eco system gets accustomed to the regular flow pattern and an equilibrium state persists. Any modification of the in-stream flow will disturb the equilibrium condition and will affect the downstream ecosystem.

24.2.1 Effects of Development

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

Flows in a River

Management Actions	Example of the impact on flow	Examples of ecosystem consequences
Irrigation flow (using the river as a conduit)	Dry-season low flows increased, and seasonal variability reduced.	Can result in higher flows in the dry than in the wet season. Hydraulic and thermal conditions, in particular, can become mismatched with life-cycle requirements, causing species to decrease in numbers and abundance. Pests are often able to take advantages of such environmental conditions and increase in abundance.
Run-of-river diversion	Wet and dry season low flows reduced.	Reduces habitat availability and restricts movement of aquatic animals, thus increasing competition for space and vulnerability to predation. Increases diurnal temperature fluctuations, concentrates effluents and can lead to toxic algal blooms.
Large dams	Frequency and duration of floods reduced.	Flood cues that trigger fish spawning or seed germination may occur at the wrong time of the year or not at all, resulting in a failure to produce new generations of individuals. Reduced wetting of banks stresses riparian vegetation and reduces establishment of seedlings. Bank stability is weakened and soil erosion increases. Reduced lows into estuaries reduce access for marine fish using estuaries as nursery areas. Reduced flooding of riparian wetlands and floodplains causes loss of fisheries and other attributes.
Hydropower stations	Timing and distribution of flows altered. Rate of change between high and low flows decreased.	Mismatched flows and abnormal flow fluctuations impact life-cycle stages of many animals and plants.
A forestation of catchments	Wet and dry season low flows reduced and small floods attenuated.	Reduces flood cues that trigger fish spawning or seed germination, and decreases wetted habitat through the year.
Deforestation of catchment	Energy of medium large floods increased dry season flows increased.	Increases bank and bed erosion, which alters the available habitat for aquatic species. Reduces habitat availability in the dry season. Increases the risk of animals being washed away.

24.2.2 Sustainable Use

Development of water resources is inevitable and is essential for survival of human beings in the basin. If exploitation of the river system is studied with respect to the benefits, it is seen that water use remains sustainable to a point. Over exploitation beyond this point makes the use non-sustainable and also the benefits reduce. It is therefore necessary to strike a balance between the exploitation and benefits. Such a study with help quantifying the environment flows.

24.3 Methods for Computing Environmental Flow

Awareness about environmental flow is of recent origin. Methods for quantifying such flows have not been fully stabilized. There are several such methods in use in the last 20 years. These methods can be classified into two categories: Prescriptive and Interactive. The features of the two categories are compared below.

Prescriptive	Interactive
Often provide a single flow regime to maintain a single objective (river condition)	Provide a range of flow regimes, each linked to a different river condition.
Motivate for the inclusion of specific parts of the flow regime	Explain the consequences of flow manipulations
Not conductive to exploring options.	Conducive to exploring options.
Suited for application where objectives are clear and the chance of conflict is small	Suited for application where the eventual environmental flow is an outcome of negotiations with other users.

24.3.1 Prescriptive Methods

These are four broad approaches.

The Tennant Method: - The approach is based on hydrological index and does not take into account the specific nature of the stream. Past flow records are examined and a certain percentage of the average annual flow (AAF) is described as the environmental flow (EF).

The hydraulic rating methods use the relationship between the stream flow and hydraulic characteristics like water depth, wetted perimeter, velocity etc. it is assumed that a certain set of hydraulic characteristics is favourable to the desired eco-system and the appropriate flow to maintain the hydraulic characteristic is prescribed as the Environmental flow.

Expert Panel Method: An expert panel examines the impact of different flows on the existing aquatic biota and recommends certain flow as EF.

Holistic approach consists of collection of a large amount of river-specific data and study of flow needs of desired biotic group. The flow need is examined in relation to flow characteristics of the stream and the EF is prescribed.

24.3.2 Interactive Methods

There are two approaches:

The In-stream flow incremental method (IFIM) use habitat simulation methodology, which examines the effect of incremental discharges on channel structure, water

quality and availability of a suitable micro-habitat. Flow found most suitable in different studies is taken as EF.

Downstream Response to imposed Flow Transformations (DRIFT) a number of biophysical and socio-economic scenarios are examined and flow requirement for each scenario is established using different models. Finally all the scenarios and corresponding flow requirements are examined and the most suitable flow is agreed upon.

24.3.3 Comparison of Methods

All the methods discussed above have their own merits. A desktop method like the Tennant method does not require lot of field data where as holistic prescriptive methods and interactive methods require a large amount of field data and expert input. The later mentioned methods consume time and are not suitable for a rapid assessment. When a macro study is undertaken and field information is not available, a desktop method is suitable and for specific projects involving sensitive biota, more sophisticated methods will be useful.

In a basin study, which takes a macro view of the basin and involves many prospective projects and where the feasibility is the only interest, Tennant method can be used. When a specific project comes to the implementation stage, more project specific data should be collected and EF reviewed using suitable approach and employing subject matter specialists. The Tennant method has two drawbacks: (i) it does not take river characteristics; nature of downstream biota into account (ii) assumes that the river under study is hydro logically/ hydraulically similar to the stream for which it was developed. The above two drawbacks can be upset by making a rapid study of the river and taking experts' opinion when deciding the proportion of AAF to be taken as EF.

In the instant case, the basin has two distinct seasons, act or monsoon season and dry or non-monsoon season. Instead of using 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 exports on the subjects. The following proportion of ASE 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

24.3.4 Working Methodology

A number of strategic locations are selected like just downstream of major withdrawal points, sensitive biota locations, locations of large community etc. Low flow nodes at these locations are included in the basin schematic diagram. RIBASIM simulation is run for the entire simulation period by switching off the withdrawal points and flow at these points is noted and ASF is computed for each node. Switching on all the point's, runs another simulation. The resultant flows are noted and examined according to the above table. All such flows should have a rating 'good' or above.

25 STATE WATER BALANCE

WATER BALANCE Unit – million cum

DEMAND	SURFACE WATER 2001	SURFACE WATER 2051	GROUND WATER 2001	GROUND WATER 2051
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

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

26 WATER MANAGEMENT: CRITICAL FACTORS

26.1 Irrigation Water Supply

26.1.1 Legal Provisions

Water resources management of the State is mostly governed by the following acts: Orissa Irrigation Act 1959 and Orissa Pani Panchayat Act 2002 along with their rules. Orissa Embankment Act and Orissa Navigation Act are also applicable. All these acts except the PP Act are very old and need thorough modification in the present context.

26.1.2 Certification of Ayacut

Government of Orissa follows a procedure of verification of ayacut through a joint inspection by DOWR and Revenue officers. The entire reported potential has not yet been certified. The present position of verification is as follows:

	Potential created ('000 ha)	Certified ('000 ha)
Major/Medium Projects	1220.71	1063.83
Minor (Flow)	558.51	394.79
Total	1779.22	1458.62

As will be seen that 18% of potential created has not been certified yet. DOWR should take a special drive to get this ayacut certified.

26.1.3 Procedure for Irrigation Supply

No systematic procedure is followed in the State for irrigation water supply. Orissa Irrigation Act/ Rules provide the following procedures for irrigation water supply.

Irrigation works is classified as Class I, II, III and IV depending upon depth of water to be supplied to the staple cereal crop.

For non-cereal crops the command is divided into blocks according to the crops grown.

The Irrigation Officer prepares a draft irrigation chart for both cereal and non-cereal crops. The chart gives the quantity of water to be supplied and time schedule.

Each block has a three year rotation period.

Water is supplied as per the final chart notified to the farmers.

The farmers do the water distribution from the water course among themselves within a block.

Farmers have to apply in Form G2 months in advance for supply of water for crops other than staple cereal crop.

After satisfying himself the Irrigation officer issues a permit in Form H or refuses supply in Form-I.

The present practice is to supply water for Kharif crops continuously for the entire base period. Major/Medium project commands receive Class I (28") irrigation and M. I. commands receive Class II (23") irrigation. L.I. commands are not covered under this classification.

A rabi strategy meeting under each Collector is held which is attended by DOWR and DOA officers and target for rabi irrigation is set. No farmers are contacted. No application as stipulated in the Acts/ Rules is collected and no permits issued.

The present system followed is very adhoc and no wonder, the irrigation supply is very irregular.

26.1.4 O&M

O&M of irrigation system is highly unsatisfactory. The general criticism is put on (i) lack of funds (ii) small fraction available to works. The working expenses for the system have to be realized from the water rates to make the system sustainable.

Structures in the system should follow a maintenance schedule. An asset list be prepared and regular maintenance done.

Annual maintenance of canals under taken. It is worth while to handover the maintenance to Pani Panchyats on an Annual Maintenance Contracts basis.

Technical problems like grade, location of CD, location and design of outlets, should be referred to a technical group under CE (D&R) and got corrected.

Operation of canals/ works should be in consultation with the concerned Pani Panchyats.

Coverage under different crops should be planned in consultation with Pani Panchyats.

26.1.5 Conjunctive Use of Water

Surface and ground water is managed separately through independent organisations although both are now brought under DOWR. Conjunctive use of water has not been planned or practiced in a big way in the state. There is ample scope for making use of this technique.

Near the canals where the ground water table is close to the NSL water can be lifted and put into the canal to augment its capacity and command additional areas.

Canal irrigation may be periodically stopped and farmers may be encouraged to lift water from the dug wells in their farm for irrigation.

26.2 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.

The principal users of water are agriculture, domestic and industrial use. World wide these uses are in the ratio of 69, 23 and 8. In a State like Orissa where industry has not picked up well, agriculture account for about 80% of use. In future, it is expected that agriculture, industry and house hold use will stabilize in the ratio 70, 20 and 10. Increase in efficiency in use of all these 3 sectors is vital.

26.2.1 Water Conservation in Agriculture

In an irrigation system, there are three distinct phases of movement of water.

(i) Conveyance of water, movement of water from the source through main and secondary canals to tertiary canals.

(ii) Distribution: Movement of water through tertiary canal to the field.

(iii) Field application: Movement of water in the field to the crop.

The over all efficiency is the combination of the efficiency in three stages. 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 techniques that can be applied to improve efficiency.

Reservoir

Loss from reservoir took place through evaporation from the surface and through seepage at bottom. In shallow reservoirs evaporation loss is substantial in summer months. However, spreading chemical or barriers is very expensive and not very effective.

Canal

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

Canal seepage water finds its way to the ground water aquifer which eventually joins the stream as return flow. The seepage loss may not be considered as a loss to the water resources but is an irrigation loss nevertheless. The seepage loss can be arrested effectively by lining of the canal. Lining has additional benefits like control of weed growth, reduction of water logging, prevention of bank erosion etc. It is advisable to line the canals at least in permeable reaches using cost effective and durable lining materials.

Field level conservation

Normally in Orissa, the basin irrigation method is used as major crop grown is the rice. The method consists of creating pool for water in the field and compensating evaporation and percolation loss by irrigation. Application efficiency is about 60% in

unlined canals and 70% in lined canal. Efficiency in piped irrigation system with sprinklers/micro-irrigation is 70 to 90%.

Approximate application efficiency of various on-farm irrigation system and methods:

System/ method	Application efficiency (%)
Earth Canal network; Surface methods	40-50
Lined Canal network; Surface methods	50-60
Pressure pipe network; Surface methods	65-75
Hose Irrigation systems	70-80
Low -medium pressure Sprinkler systems	75
Micro sprinklers, Micro jet Mini sprinklers	75-85
Drip Irrigation	80-90

Pressurised irrigation systems are expensive to install and require periodic maintenance. Small farmers may not afford the system but in big farmers and commercial agriculture the system should be introduced.

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 not 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.

26.2.2 Water Conservation in Domestic Water Supply

Rural Water supply is mostly from ground water sources and through shallow tube wells. It is observed that people use the tube well water for washing, bathing and even for bathing cattle. This has resulted in many tube wells going out of use. The policy is to provide a tube well for drinking water purpose only (one tube well for100 people) and a pond for other domestic purposes including washing of cattle. Ponds of adequate capacity should be provided in all villages through renovation of old ones or construction of new ones.

The urban water supply is mostly through pipes. 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 Andover 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.

26.2.3 Water Conservation in Industry

Industry uses water for cooling, cleaning, processing and removing wastes. Orissa has steel, aluminium, 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.

In general waste-water reuse succeeds in areas where the demand outstrips the supply by a good margin. Such a situation has not developed in the state and also the State does not generate large volume of industrial waste. But there are pockets where the reuse process will certainly be beneficial like Angul-Talcher area and area close to large urban centres. The State should develop guidelines for re-use and set standards for the purpose.

26.2.4 Policy Tools

Water management with only physical water conservation measure will not be effective unless planned in conjunction with institutional and policy tools. The following reforms may be considered.

(i) Volumetric water pricing

(ii) Participatory Irrigation Management

(iii) Water Rationing

(iv) Awareness and Education

(v) Improvement in Water services

Water Rationing

Estimated crop requirement is mostly theoretically or based on experience of similar crops. Irrigation supply may be deliberately reduced and its effect on crop yield observed. It is generally observed that reduced supply does not reduce crop yield appreciably. The minimal optimal requirement should be used.

Water Service

Operation of irrigation systems plays an important role on water consumption. Water delivery schedules should not be rigid and binding. It must be demand driven and should be able to respond to the needs of the farmers. The Canal and control system should also be accordingly designed. The user confidence is important. The farmers should be satisfied that whenever they request for an increase/decrease in supply, it will be carried out within a reasonable time. This will discourage the tendency of farmers to grab water whenever available and will improve equity.

26.3 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). Pani Panchayat Act and Rule (2002) 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 O&M of canals under their jurisdiction.

PANI PANCHAYAT IN ORISSA (NON-WRCP)

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 as detailed below.

	(lakh ha)
Major & Medium (Flow)	11.90
Minor Irrigation (Flow)	3.64
Minor Irrigation (Lift)	2.17
Total	17.71
Area under OWRCP	3.20
Balance	14.51

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) as follows.

	(lakh ha)	Achievement (lakh ha)
Major & Medium (Flow)	4.10	1.84
Minor Irrigation (Flow)	2.76	1.97
Minor Irrigation (Lift)	0.78	2.00
Total	7.63	5.81

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.

26.4 Pricing of Water

Many economists have suggested considering water as an economic goods. Others consider water as God's gift and so should not be priced. Water itself does not cost money, but to keep water in pure form, conserve and convey to the place of need

and treat waste water require a lot of money. Secondly, water like any other natural resources is available to a State. If the State finds that it is endowed with more water than its people need, it has the right to harness and sell. It is therefore logical that water be priced to defray development costs.

Irrigation in India started as a commercial venture during the colonial rule. Such projects were taken up which yielded more revenue than the operation cost and recovery towards investment. After 1880, some drought relief schemes were taken up which were unproductive. After independence, the commercial approach was abandoned with food self sufficiency, food security and general agricultural development in mind. A social benefit cost ratio criteria was applied for selection of irrigation projects. Projects with BCR 1 in drought prone areas and 1.5 elsewhere were selected. Public irrigation systems gradually came to be considered as free and negligible revenue came from these systems. The effect was disastrous. No money was available for maintenance and up keep, not to speak of new investment.

The Second Irrigation Commission (1972) carefully examined the matter 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.

26.4.1 Recovery of O&M Costs

O & M of irrigation canals consist of (i) maintenance and repair (ii) improvement and extension, (iii) Machinery & Equipments, (iv) Establishment & Administration. Analysis of these components of O&M cost shows that in Orissa, the establishment cost consumes about 60% of O & M grant and only 40% is available for maintenance and repair. Improvement and extension is taken up by separate funds.

Finance Commissions and working group on Major and Medium Irrigation have conducted detailed studies in this aspect. The 10th Finance Commission had adopted a norm of Rs. 300/- for each ha of utilized potential and Rs.100 for unutilized potential.

Gross receipts from irrigation never quite covered the working expenses on irrigation. A study on irrigation projects in India shows that while in mid-seventies the gross receipts accounted for about 90% of working expenses in late eighties it fell to less than30%. The situation in Orissa is no different.

If we consider the interest on capital investment the situation is still worse (about 15%). In Orissa gross receipts from irrigation is low but O & M expenses are still lower. So Orissa was able to recover the working expenses in 1984-86. In 1987-88 the recovery fell to about 46%.

Water being a State subject different States charge different rates for irrigation supply. States like A. P., Karnataka, Tamil Nadu do not charge water rates separately but the land revenue is charged at higher rates. States like Kerala charge only for gross area irrespective of crops and season.

26.4.2 What Is The Right Price?

According to the 11th Finance Commission the O & M costs of irrigation system is about Rs. 360/- per ha. Investment cost of irrigation schemes is about Rs. 1 lakh/ ha, 1% of which works out to Rs. 1000/-.

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 water rate of 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 concessional rate (say 50%) may be applied to a farmer whose land holding is less than 1 ha.

26.4.3 Basis of Water Rate

Traditionally irrigation water rates are area based .In States like Orissa the tariff is crop wise and season wise. Orissa uses two types of water rates.

Compulsory basic water rates for entire command area growing staple cereal crop.

Water rates for crops other than staple cereal crops (crop wise)

(Orissa Irrigation Rules 1961)

Zone wise water rates have been dispensed with.

Area based tariff is considered easy for operation but as the collections show 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 structure encourages farmers to maximize output per unit of irrigated land rather than per unit of water. 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 supply 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 Pani Panchayats.

At present the tariff (revised 2002) are as follows:

(i) Compulsory basic water rate Rs 250 per ha

(ii) Water rates vary from Rs 930/- to Rs 28/- per ha depending on the type of crop.

The present system is to send demand notes to individual farmers and collect water rate as applicable. With the introduction of Pani Panchayats, eligible Pani Panchayats receive a grant of Rs.100/- from the compulsory basic water rate of Rs. 250/- per ha. Gradually the Pani Panchayats will levy and collect water rates from individual farmers. At this stage it is appropriate to charge the Pani Panchayats on volumetric basis. The recommended rate is

Rs 20 per million litres – for individual farmers.
Rs12 per million litres – for public supply to Pani Panchayats.

Compared to this, industrial water supply is Rs 500 per million litres.

26.5 Sale of Surplus Water

The simulation studies show that about 50% of available water will ultimately flow to the sea during monsoon months. Even after taking care of the environmental and low flow requirement (taking a high 50% of surplus) about 30% of water can be diverted to other deficit States. In an average year the surplus will work out to about 36 BCM. Taking the present rate of Re 0.50 per m^3 average income per year will come to Rs 18000 million.

26.6 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 for 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 the different sectors as follows:

	(Rs. crore)
Urban & Municipalities	2.00
Power Plants	20.28
Industries	10.00
Agriculture	30.13

The revenue from Agriculture and Industrial Sector has shown an increasing trend as it increased from 08.07 Crores in the year 1997-98 to 14.87 Crores in the year 1998-99 and 17.59 Crores in the year 2000-2001. During the year 1999-2000, due to exemption of Agriculture taxes in14 districts, which have been affected by Super Cyclone, collection of revenue fell to about Rs.8.40 Crores. The rising trend of water tax collection can be seen from the following table, which shows the year wise collection of agricultural and industrial water rate in million Rupees.

Year	Agricultural Sector	Industrial Sector	Total Amount
1996-97	33.999	36.282	70.281
1997-98	44.664	36.134	80.798
1998-99	95.074	53.688	148.762
1999-2000	59.386	24.648	84.034
2000-2001	109.857	88.806	198.663
2001-2002	123.871	48.531	172.402

The collection of dues falls far short of estimation for various reasons like

(i) Ambiguous legislation

(ii) Inadequate collection system

(iii) Lack of monitoring/supervision

To increase the cost recovery from Industrial Sector, adequate steps are being taken for metering the industrial water use. 43 Nos. of Major industries out of 92 Nos. of identified industries have already installed flow meters.

Water rates have been revised and the revised agricultural water rate has been notified by the Revenue Department on 5th April 2002 and published in the Extraordinary Orissa Gazette vide No.494 dated 5th April 2002 enhancing the Kharif rate to Rs 250 per ha and Rabi rate to Rs 450 per ha.

26.7 Private Participation

Water Resources development and management in the State is mostly run by government. Government of Orissa, in particular is strapped in cash crunch and cannot find money for new development. Even there is no fund for maintenance of already existing works. Thus 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 of people's right to access to clean water.

Is water a commodity?

Unless water is defined as a saleable 'commodity' public participation looks a distant possibility. The answer to this question has been in affirmative and negative, by Government and non-government agencies. But the real answer is 'Yes' and 'No'. 'Yes' when used to produce commercial goods and 'No' when used as a life support. Life support needs, no doubt, has overriding priority over other uses but it is not wise to blot out commercial value of water completely. It may be wise to divide available water into two parts: reserve a part for life support needs and use the surplus part commercially. The proceeds may be used to develop system for life-support needs.

Water is fast becoming the 'blue gold' of the 21st century. Gap between increasing demand and shrinking supply of water is attracting commercial organisations 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 organisation.

27 NATURAL HAZARD DAMAGE MITIGATION

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

27.1 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 total flood prone map of Orissa is given in the Map No. 15.

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

A detailed study on historical floods of Mahanadi with proposed intervention have been discussed and attached in Annex – G.

27.2 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 travelling 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 > 12000 dead.

Category of cyclones

Cyclones have been classified into the following categories:

	Maximum Wind Speed	
	(knots)	(km/h)
Super Cyclone	>120	>221
Very Severe Cyclonic Storm	64 to 119	119 to 221
Severe Cyclonic Storm	48 to63	88 to118
Cyclonic Storm	34 to 47	63 to 87
Deep Depression	28 to 33	51 to 62
Depression	17 to 27	31 to 50

Historical Cyclones

Cyclones occur very frequently in Orissa. The following very severe and stronger cyclones have struck the Orissa coast since 1942.

		Maximum Wind Speed	
		(knots)	(km/h)
9th Nov.1973	VSCS	113	209
30th Oct.1971	VSCS	101	187
31st Oct. 1972	VSCS	100	185

9th Nov.1995	VSCS	Nr	Nr
22nd Sept. 1972	VSCS	100	185
10th Sept. 1972	VSCS	95	176
12th May 1979	VSCS	92	170
16th Nov. 1942	VSCS	91	168
17th Oct. 1999 (Gopalpur)	VSCS	100	185
29th Oct.1999 (Paradeep)	Super Cyclone	178	329

VSCS Very Severe Cyclonic Storm

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.

The Super Cyclone of 1999 is described in Annex H.

27.3 Drought

Like floods and cyclones droughts are also regular visitors to the State. The basin studies have analysed frequency of droughts. A drought prone map has been prepared & shown in Map No. 16.

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 ca 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 a diversion point.

(iii) Connecting existing irrigation channels to existing or new ponds/tanks.

(iv) Transferring water from water surplus basins to deficient basins.

The following links may be explored in more detail.

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

27.4 Bank Erosion

Orissa's rivers are notorious for bank erosion. This activity is more pronounced in Mahanadi, Subarnarekha and Vansadhara. Although the delta area is more prone to bank erosion, this activity is not uncommon in the upper reaches. A map showing areas with severe problems is annexed.

Several protection measures are taken by the Department of Water Resources to save the banks where habitation is threatened. Generally the protection works are taken up through providing spurs and groynes or through stone pitching and revetment.

DOWR is unable to tackle the problem fully due to shortage of funds. It is only able to perform on a crisis management basis. It is necessary that a survey of threatened areas be taken up and a well designed action plan prepared. The works may be prioritized and taken up as per availability of funds.

PART E

STATE WATER PLAN OBJECTIVES AND STRUCTURE

28 ISSUES AND PROBLEMS

This chapter summarises the principal issues and problems related to the management of Orissa's water resources, as brought to the fore by the study of the water's availability and its exploitation in the various social and economic sectors. The discussion of lacunae is not meant to imply that no progress has been made in water development and management but rather to focus on key areas of needed improvement.

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

28.1 Laws and Institutions

Inadequacy of legal and institutional framework for multi-sectoral water resources planning

Orissa lacks the coherent legal and institutional framework necessary for the effective management of the State's water resources with a view to achieving social and economic development objectives in a context of increasing water stress.

Apart from the Environmental Protection Act, the current National and State laws governing conditions in the different social and economic sectors do not pay sufficient attention to water and the critical role it plays in most human activities. Moreover, certain laws dealing explicitly with water are very old, going in some cases back as far as the 19th Century.

The State's institutions responsible for water-related matters (stakeholder institutions) are not yet adequately equipped to deal with the effects of increasing water stress. In particular, there is no effective mechanism to ensure the institutions' concerted actions in line with the principles of Integrated Water Resources Management (IWRM), today's universally accepted approach to dealing with the complexities of water issues.

Approval of the new State Water Policy being developed is a crucial first step towards elaborating a consistent set of laws for the different sectors concerned with water and the necessary institutional reform.

Need for a comprehensive knowledge base and research capacity

The hydrologic processes governing the availability of water in Orissa's river basins are relatively well understood and the related available data sufficient for engineering studies. Data and Information about the water's quality, its use, and the various

impacts of this use, are very limited. They are generally inadequate to allow the informed planning of water-related matters by the stakeholder institutions and, particularly, the thorough cooperation of these institutions necessary to minimise conflicts at the level of the water users.

The provision of adequate professional and material resources for the interpretation of the accumulated data and the appropriate presentation of the results is essential for this cooperation to become reality. So is the facility to undertake research about critical issues facing water management, such as, for example, the pricing of water for agricultural, industrial and domestic use, the willingness and capacity to pay of the water users, and the contribution of irrigation to the income of farms of different types and sizes.

DOWR has identified the information needs and is proposing an internet-based information system to facilitate the sharing of data and information.

Responsibility of local government

A key tenet of IWRM is that the use of water be managed at the lowest possible level. The limited resources and governance capacity of most local level administrative entities represent a serious impediment to the successful application of this principle.

The State has recognised the need for strong local bodies to adequately manage local affairs, and the practice of irrigation by farmer groups in particular.

The necessary local-level institutions have been created and are increasingly becoming operational. Water-management interventions should systematically incorporate the strengthening of local governance, not only to ensure the sustainability of these interventions as such but also to contribute to the State's decentralisation objective in general.

Capacity building of water user groups

The efficient use of water at the farm level is of crucial importance in two ways. First, it is essential for raising the land's productivity to the level necessary to feed the State's growing population. Second, it allows minimising the water withdrawn from the source and conveyed in the distribution system, the obvious effects of which are: the larger volume of water conserved for the environment, the lesser need for maintenance of the distribution system, the avoidance of water logging, and the reduction of return flow polluting the receiving waters with sediments and agro-chemicals.

The Pani Panchayats being created in the State hold the key for attaining water-use efficiency at the farm level. They deserve the highest possible level of support to enable them to practice effective water use and to assume their other responsibilities as soon as possible.

Participatory water planning

The concept of participatory water planning is central to the idea of IWRM. It must involve both the water users and the State's stakeholder departments.

The basic instrument to operationalise this concept is the River Basin Organization (RBO). Creation of this type of agency is being considered by the State. The river basin plans currently being finalised by the DOWR will provide the foundation for the work of Orissa's River Basin Organisations, which will include the updating of these

plans as necessary to reflect the ever evolving conditions. A draft report on Institutional Reforms have been prepared and attached in Annex – A, which needs a thorough deliberation on the subject.

28.2 Environment

Degraded forest cover of upper watersheds

Shifting cultivation and logging have a serious deleterious effect on Orissa's upper watersheds. Destruction of the vegetative cover results in rapid runoff and erosion, which contributes to flooding and the sedimentation of surface water bodies.

Corrective measures are being implemented, but the information available about the extent and degree of the degradation and the status of the ongoing work is limited. It is generally recognised that without the proper involvement of the local population in the restoration work and subsequent management of the regenerated forest resources, the result of the intervention will not be sustainable.

Degradation of water quality

Orissa's waters are polluted by waste from settlements, mines, industry and agriculture, reducing the water's suitability for human use and for supporting healthy aquatic ecosystems.

Good progress has been made at some industrial sites in reducing the discharge of pollutants to acceptable levels. All mines and industries releasing pollutants in excess of emission standards should be required to conform to these standards as soon as possible.

To be effective, the measures to reduce pollution from human settlements, both rural and urban, must be part of an integrated approach to water supply and sanitation.

Inadequate water-quality monitoring

In-stream water quality monitoring is adequate on the Mahanadi and Brahmani Rivers. On the additional four rivers for which water quality data are collected, the sampling networks are very inadequate. On the five remaining major rivers, water quality is not monitored at all.

Effective water resources management is impossible without adequate, reliable water-quality data. All the State's rivers, lakes and reservoirs should be provided with appropriate sampling networks and the collected data disseminated to the stakeholder departments and the public.

Threatened wetlands

The State's wetlands, particularly those located along the coast, are of great importance for the conservation of bio-diversity. At least two of them, the Ramsar sites of Chilika and Bhitarkanika, have significant tourism potential, the realisation of which would be a boon to the local economy.

To preserve their character and capacity to support the ecosystem as well as the influx of visitors, these wetlands must be very rigorously managed, with water and land considered in an integrated fashion and the local population actively participating.

Little-known aquatic ecosystems

Very little is known about the State's aquatic ecosystems. Reliable data and information about them is a fundamental prerequisite for estimating a waterway's environmental flow – the minimum flow required to sustain the ecosystems.

If the human use of a given river's water is to be maximised without damaging, possibly irreversibly, the ecosystem, the environmental flow must be known as accurately as possible. For the State's most intensively exploited water bodies, appropriate studies to generate the required data and information should start immediately.

28.3 Basic Human Needs

Unsatisfactory water supply and sanitation conditions in cities and towns

The State's urban centres are presently not capable of providing clean water for domestic use to all, and of disposing appropriately of human and solid waste. Moreover, their storm-water drainage facilities are generally unable to handle the flows resulting from heavy rainfall.

These conditions not only diminish the quality of life but also represent a serious threat to public health and lead to the pollution of the receiving waters.

In light of the problem's magnitude and Orissa's rapid urbanisation, this issue needs to be addressed with great urgency. Given the interdependence of water supply, sanitation and solid waste management, they must be treated in an integrated manner, bearing in mind the importance of cost recovery for sustainability and the requirement of providing the services also to the poor unable to pay for them.

Unsatisfactory rural water supply and sanitation

According to the statistics, the State's rural population is well served with facilities providing clean water for domestic use. The statistics, however, are limited to reporting on the number of facilities installed. The question of water quality is not considered, although the presence of excessive levels of substances like arsenic and iron in the groundwater is not infrequent. Hand pumps installed on tubewells are often in disrepair and the people have to walk long distances to fetch clean water or resort to using nearby surface water.

Sanitation facilities in rural areas are virtually non-existent, which leads to high levels of fecal pollution of surface waters, including even major rivers like the Brahmani.

To eliminate the threat to public health of these conditions, a vast effort of promoting rural sanitation and of securing potable water of acceptable quality is required. While the sanitation facilities will in most cases be owned and maintained by individual households, wells and tubewells will be public facilities, the equitable operation and maintenance of which depends on a good measure of communal cooperation. The communities should be provided with the minimum of technical and accounting skills necessary to ensure the sustainability of the rural water points.

28.4 Food Security

Orissa's natural resources can feed its growing population

Orissa's land and water resources are sufficient to meet the food requirements of the state population once it has stabilised at its maximum expected level four or five decades hence. This can in a large measure be achieved thanks to the (potentially)

significant increase of the land's productivity the application of irrigation water makes possible.

The required investments in irrigation facilities are large and followed by substantial recurrent costs. To minimise the impact on the state budget it is imperative to pursue a strategy that maximises the results of the money spent. Such a strategy includes not only giving high priority to the rehabilitation of existing and completion of ongoing projects but also putting in place effective organisational structures to operate the schemes in an optimal fashion and the agricultural extension support necessary to realise rapidly the expected productivity gains.

On the other hand, rainfed crops, notably paddy, will continue to satisfy an important part of the State's demand for food. Increasing the productivity of these crops will reduce the need for irrigation.

Realisation of potential offered by existing irrigation infrastructure

The State contains a large number of irrigation schemes that are not fully exploited. While the existing irrigation infrastructure was designed and built to serve a total of close to 26 lakh ha of land in Kharif and about 11 lakh ha in Rabi, the areas irrigated in 2001-02 were only 18 lakh ha in Kharif and 8 lakh ha in Rabi, representing a capacity utilisation of 70% for Kharif and 73% for Rabi.

Identifying the causes of this unsatisfactory situation and taking the measures necessary to fully use the infrastructure already in place should happen at the earliest and the lessons learned considered in the creation of additional infrastructure.

Completion of ongoing surface-water irrigation projects

Construction of seven major and 12 medium irrigation projects covering a total of 4.8 lakh ha is in progress. To this total, the Rengali project alone will contribute 2.3 lakh ha. Several medium projects are lying incomplete due to various reasons.

It is estimated that the exploitation of the full capacity of the existing irrigation facilities and of the major and medium projects yet to be completed will allow the production of 107 lakh tons of paddy. This production, together with at least 20 lakh tons of rainfed paddies produced in a normal year, will meet the state population's cereal needs for several decades. This estimate does not include the additional production that would result from the realisation of 4.2 lakh ha under 1154 identified minor irrigation schemes.

Since medium and minor irrigation projects produce results more quickly than major projects, both in terms of producing food and raising the farmer's income, the completion of such projects should receive priority. The emphasis on medium and minor projects should be maintained for the creation of irrigation facilities following completion of the ongoing major and medium projects.

Expansion of groundwater irrigation

The State has significant, albeit unevenly distributed, groundwater resources. While they provide the bulk of water for domestic use in rural areas and will continue to do so with priority in the future, in many parts of the State the groundwater could be developed for irrigation to a considerably higher degree than is currently the case.

Irrigation from groundwater, especially in the dry season, provides a solid basis for crop diversification. In gravity scheme command areas, the conjunctive use of groundwater reduces the tendency for water logging.

When practised by individual farmers or small groups of farmers from their own dug or drilled wells, groundwater irrigation minimises operational difficulties and has the effect of internalising the capital and recurring costs of lifting and distributing the water in the cost of production.

Soil and water conservation in agricultural watersheds

Cultivated watersheds offer attractive opportunities to grow crops other than rice, including fruit, but they are also prone to erosion and represent, therefore, a source of sedimentation of the State's waterways. Appropriate soil and water conservation practises will both increase the land's productivity and reduce the rate of erosion.

Such practices, including rain water harvesting and recharging groundwater, should be actively promoted.

28.5 Economic Development

Increase farm incomes

Given the large part farmers represent of the State's population, the increase in their income and purchasing power will have a significant widespread effect on the local economy and contribute to the economic development of India as a whole.

The increase in farm income is primarily the consequence of improved productivity and the production of higher-value crops. With appropriate extension measures productivity gains can be achieved under both rainfed and irrigated conditions. The production of higher-value crops, however, will essentially depend on irrigation, which limits the risk to the farmer of investing in the inputs required to grow such crops.

Provide off-farm employment

Considering the weight of agriculture in the State's economy, the establishment of agro-industries (of which there are few at present) would seem to be a logical approach to creating off-farm employment. Orissa has the land base and climate necessary to produce a great variety of crops that could be processed as well as the water required to operate the processing pants.

Off-farm employment will be provided by the expansion of Orissa's industry based on the State's important mineral resource base. The industrial plants, along with the mines producing the raw material, withdraw significant amounts of water and generally return much of it to the receiving waters in a polluted state. These factors need to be considered in choosing the sites of new plants.

Fishing is a traditional off-farm activity. To ensure the fisheries' sustainability, preserving the water's quality is of fundamental importance.

28.6 Poverty Reduction

Small-scale irrigation to reduce poverty

The great majority of Orissa's farmers (80%) cultivate less than 2.0 ha of land. Among these, those cultivating less than 1.0 ha represent over half of the State's farmers and are considered marginal land holders. The marginal land holders must

account for a large part of the close to one half of the State's population living below the poverty line.

The possibility to reduce the poverty of marginal farmers is location specific. Improving the productivity is limited by the quality of the land and the availability of water. Cultivating higher value crops is worthwhile only if the market for such crops is not too distant.

Small-scale irrigation from groundwater or water harvesting can make an important contribution to raising the standard of living in many situations, particularly those of the disadvantaged classes of society.

28.7 Disaster Management

Mitigating the effects of floods and cyclones

Severe floods and cyclones are common in Orissa. While flooding occurs on many reaches of the State's rivers, their effect is concentrated in the coastal plains, which are also affected by the violent winds, heavy rainfall and storm surges caused by cyclones. These disasters often have a significant cost, in terms of: a) loss of human lives, houses, animals and belongings, b) crop losses, and c) damage to infrastructure (mostly road, railroad and canal embankments).

Appropriate structural and non-structural measures designed to limit these costs must be implemented.

Drought Proofing

Despite the relatively important rainfall the State receives in the average year, the more pronounced negative departures from this average result in droughts. They regularly occur in the drought-prone areas and sometimes over most if not all of the state.

The formal irrigation schemes, particularly those drawing water from reservoirs, provide a considerable degree of drought proofing in that they allow achieving acceptable crop yields in spite of insufficient rainfall. Particular attention must therefore be paid to areas lacking such infrastructure, where measures such as rain water harvesting and ground water development need to be taken to make the vital minimum of water available for consumption by humans and livestock and, where possible, the growing of crops.

28.8 Hydraulic Infrastructure

Water Allocation and Transfer

Orissa's river basins are not equally endowed with land, water and mineral resources. While land and minerals are static, water is moving and can to some degree be manipulated. To realise the State's socio-economic development potential, it might be advantageous to transfer water from water-rich basins to basins where the existing water resource is inadequate to fully develop the complementary resources.

Inter-Seasonal Water Storage

The obvious way to drought-proof Orissa is to conserve some of the abundant water of the monsoon season for use in the dry season. A considerable water storage infrastructure is already in place, but there is great potential for enhancing it. Where economically justified and feasible from a social and ecological point of view,

multipurpose reservoirs should continue to be built. They not only allow storing water for irrigation, producing hydro power and augmenting the river's dry-season flow, but also create fisheries potential and slow down the flood waters.

29 THE STATE ACTION PLAN

The State Action Plan embodies the actions necessary to respond to the issues and problems identified in the previous chapter. 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 realisation the State's potentialities.

This chapter describes the structure of the proposed Action Plan, presents an indicative list of actions to be undertaken, and identifies the areas of intervention that should be given high priority.

29.1 Action Plan Structure

The top two levels of the Action Plan's structure (Figure 12 & 13) can be termed components and programmes, with a given component being made up of programmes contributing to the attainment of the same goal. A given programme, in turn, is constituted of projects designed to help meet the programme's objectives.

The components and the goal they are intended to attain are the following:

Plan Component	Component Goal
1. Laws and Institutions	Rational and effective management and equitable use of Orissa's water resources
2. Environment	Clean water in sufficient and timely quantities for multipurpose use and preservation of the aquatic and water-dependent ecosystems
3. Basic Human Needs	People's quality of life improved by the equitable, safe and reliable access to water for health and hygiene and by the effective disposal of waste and of surplus water
4. Food Security	Water related constraints on agricultural production minimized
5. Economic Development	Orissa's economy expanded
6. Poverty Reduction	Reduced number of people living below the poverty line
7. Disaster Management	Climatic and water-related threats to life and livelihood mitigated by structural and non-structural measures
8. Hydraulic Infrastructure	Orissa's rivers equipped with the hydraulic infrastructure necessary for the optimal use of the state's water

The Plan Components' goals can be achieved by implementing programmes in the areas identified below:

Plan Component	Programme Areas
1. Laws and Institutions	State Water Policy
	Laws and Regulations
	Institutional Framework
	Knowledge Base and Research
	Local Government Capacity
	Water User Groups
	Participatory Mechanisms
	River Basin Planning
	State Water Plan Implementation
2. Environment	Upper Watersheds
	Mining and Industrial Pollution
	Water Quality Monitoring
	Wetlands
	Aquatic Ecosystems
3. Basic Human Needs	Urban Water Supply, Sanitation and Storm-Water Drainage
	Rural Water Supply and Sanitation
4. Food Security	Surface-Water Irrigation Schemes
	Groundwater Irrigation
	Soil and Water Conservation
5. Economic Development	Farm Incomes
	Agro-Industries
6. Poverty Reduction	Small-Scale Irrigation
7. Disaster Management	Floods and Cyclones
	Drought
8. Hydraulic Infrastructure	Water Allocation and Transfer
	Inter-Seasonal Water Storage

29.2 Indicative Actions

Appropriate actions to be undertaken in the various programme areas are identified below. They will need to be operationalise 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 to 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 and 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
Water 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

Component / Programme	Indicative Actions
	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 of ongoing restoration and protection work
	Apply community-forestry approach to the restoration of the forest cover
Mining and 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, and 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

Component / Programme	Indicative Actions
	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, tubewells, 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 modern inputs
	Complete on-going major and medium projects and ensure achieving rapidly full utilisation 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
Groundwater Irrigation	Identify areas where groundwater is available in sufficient quantity to be used for irrigation after having satisfied domestic demand
	In the 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

Component / Programme	Indicative Actions
	groundwater irrigation schemes
	Promote conjunctive use (by the farmers) of groundwater in parts of gravity irrigation schemes threatened by water logging
Soil and 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	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
Agro-Industries	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	
Floods and 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
	Carry out public awareness campaigns and assist threatened populations in flood proofing their houses where feasible
Drought	Promote, in rural areas not served by formal irrigation systems, techniques of water harvesting and conservation.
	Assist population in developing groundwater resources where necessary and feasible
Hydraulic Infrastructure	
Water Allocation and	Assess Orissa's overall resource base with a view to

Component / Programme	Indicative Actions
Transfer	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
	Carry out feasibility studies of the transfer schemes passing the pre-feasibility assessment
Inter-Seasonal Water Storage	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

29.3 Priority Areas of Intervention

None of the interventions proposed above represents a revolutionary new idea. Many are in fact already being implemented or are considered to be undertaken in the near future. All the State Water Plan does is to provide a framework that brings out the interventions' interrelatedness 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***
  - Mining and Industrial Pollution
- ***Basic Human Needs***
  - Urban Water Supply, Sanitation, and Storm-Water Drainage
- ***Food Security / Economic Development / Poverty Reduction***
  - Raise output from existing irrigation schemes

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 finalised 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 propose State Water Plan once it has been accepted by the Water Resources Board.

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.