

The Basin Profile

China

Name of selected river basin : Fuyang river basin

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1. Country Overview

1.1 *Outline the salient features of the country with particular focus on the importance of irrigation in the economy.*

China is one of the most water-short countries in the world, and per capita water availability is only 1/4 of the world level. Irrigation has played a critical role in the growth of agricultural production. The proportion of cultivated area under irrigation has increased from 18 percent in 1952 to 54 percent in 1998. The growth in the area irrigated has resulted from the development of both surface water and groundwater resources. In the 1950s and 1960s, most of the growth came from the utilization of surface water resources suppressed from rivers. Since the 1970s, most of China's water resources for the new irrigation schemes have come from groundwater that has been heavily overabstracted recently. With population increase, urbanization and industrialization, the share of agricultural water use has declined from 97 percent in 1949 to 69 percent to 1998, and the share of industrial water use has reached 21 percent in 1998 while 10 percent of water was allocated to domestic and other uses in 1998. At the same time, more and more serious water pollution has not only jeopardized the environment but also worsened China's water shortage.

1.2 *Key national indicators*

Indicators	Units	
Total land area	Million km ²	9.6
Population (1998)	billion	1.25
Projected population for 2020	billion	1.52
Population growth rate (1997-1998)	%	0.96
Urban population (% of total,1998)	%	30.4
Urban population growth rate (1994-1998)	%	2.56
Rural population (% of total,1998)	%	69.6
GDP per capita (1998)	US\$	772
Contribution of agriculture to the GDP	%	18.4
Contribution of industry and manufacturing to the GDP	%	48.7
Contribution of services to the GDP	%	32.9
Average annual growth rate of agriculture (1994-1998)	%	11.5
Average annual growth rate of industry (1994-1998)	%	14.7
Average annual growth rate of services (1994-1998)	%	15.0
Total annual water resources (1998)	10 ⁸ m ³	34017
Per capita water availability	m ³	2200
Total water withdrawals (1998)	10 ⁸ m ³	5435
Per capita domestic withdrawal (1998)	m ³	44
Per capita industrial withdrawal (1998)	m ³	90
Per capita irrigation withdrawal (1998)	m ³	302
Gross irrigated area (1998)	million ha	52.2956
Population with access to safe water (1998)	%	98%

Note: Statistical data in 1999 have not been published.

2. Water Resources Policy

2.1 Describe the implicitly and explicitly stated national, federal/provincial or other subnational-level goals and policies for water resources development.

The following are national goals and policies for water resources development. Generally, goals and policies for water resources development at the provincial and sub-provincial level are the same as those at the national level.

1. *Strengthening flood control.* Flood control is given first priority for water management in China and a major part of central government investment funds are used in this effort. One of the major reasons is that there are many large and medium-sized cities along the large rivers, such as the Yellow and Yangtze rivers. Flood control actually focuses on the protection of urban areas of these cities.
2. *Promoting integrated water management.* In order to realize sustainable water development and strengthen government functions in water resources management, government agencies have put much hope on establishing an integrated water management system. In 1993, the State Council issued a regulation on water withdrawal permits and the implementation of the regulation was also issued by the Ministry of Water Resources (MWR) in 1996. Issuing a water use permit is the first important step for the government to realize integrated water management. Further, in order to strengthen integrated river basin management (IRBM), MWR is drafting a River Basin Management Law and considering to adjust and strengthen functions of the Seven River Basin Commission.
3. *Improving water use efficiency.* With increasing competition among various water use departments, improving water use efficiency, especially for agricultural water use efficiency, has been emphasized since the 1990s. Two main water policies have been adopted to improve agricultural water use efficiency. The first policy is aimed at creating a long-awaited upgrading program for aging irrigation projects in major irrigation areas. Investment has been focused on surface irrigation such as methods to channel lining or pipelines. Another policy is to establish 300 agricultural water-saving demonstration counties in order to extend more and more agricultural water-saving technologies to fields. Most funds for establishing 300 agricultural water-saving demonstration counties come from central and local governments. At the same time, the government hopes to improve water use efficiency through raising water price, conducting planned water use, strengthening integrated water management, adjusting cropping pattern and limiting high water consumption crops.
4. *Controlling water pollution.* Since the 1990s, the government has implemented several water pollution control projects for main rivers and has also modified the Water Pollution Law. The Environmental Protection Administration made a minimum standard for industrial wastewater drainage volume. If industry cannot control wastewater drainage according to the stipulated standard, the government will close the industry.
5. *Improving soil and water conservation.* In recent years, the Government of China has further realized the importance of reducing soil and water erosion, especially after the large flood of the Yangtze river in 1998. The government funding in water and soil conservation increased in the 1990s. In the meantime, the national water and soil erosion monitoring system was also established at the national level and a similar system is also to be established at each individual provincial level. The central government's goal is to bring an additional 650,000 square km of eroded area under control by 2010, and all treatable eroded areas can be basically under control in the near future. However, the measures to realize this aggressive goal are not clear.
6. *Developing irrigated area.* Though developing the irrigated area is always the goal of the government in realizing food security, the government funding spent on irrigation projects is relatively small and irrigation in the government priorities is ranked in the last position with regard to water issues. Back in the 1980s when the economic reforms started, the MWR was in charge of all large- and medium-size water investment, including irrigation projects. After reform, the budget and the use of the budget for irrigation were reallocated from the central to provincial governments. Thus, during the 1980s and early 1990s, no irrigation investments were made by the central government. With the deepening of the water crisis as well as the reemphasis on a grain self-sufficient agricultural policy in 1994, the central government, through MWR, started to allocate some fiscal funds to irrigation projects, especially water-efficient projects in the latter part of the 1990s.

3. Water Laws and Regulations

3.1 *List the existing laws and regulations concerning surface water and groundwater usage and pollution control.*

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Measures for the appraisal, collection and management of water fees for water project	1985/7	Principle of appraising water fee Water fee collection method Water fee management	Water Resources Agency, Price Management Agency, Financial Agency and other related Agencies.
Water Law	1988/1	Water property right Water utilization and development Water resources, water basin and water project protection Water use management Flood control	Water Resources Agency, State Council and other related Agencies.
Soil and Water Conservation Law	1991/6	Prevention control supervision	Water Resources Agency
Regulation for water withdraw permit system	1993/8	What kind of water use needs to apply for water withdrawal permit? Which agency has the right to issue a water withdrawal permit certification? How to apply for a water withdrawal permit?	Water Resources Agency, Urban Construction Agency, Geography and Mining Agency, River Basin Commission
Water Pollution and Prevention and Control Law	1996/5	Water environment quality standard and standard of sewage discharge. Monitoring management of water pollution control. How to prevent surface water pollution? How to prevent groundwater pollution?	Environmental Protection Administration and related Agencies such as Water Resources Agency, Urban Construction Agency, etc.
Flood Control Law	1997/8	Flood control plan Flood control and prevention Water project management in flood control area. Guarantee measures for flood control	Water Resources Agency
Regulation for Water Industry Policy	1997/9	Water project classification and fund collection Water price, collection and management Water saving, water resources protection and water resources technology Policy implementation	Planning and Development Commission, Government, Water Resources Agency
Regulation for Accountability Policy Plan (sanding fang'an)	1998/7	Principle for accountability policy plan. Procedure for implementing accountability policy plan. Work requirement for staff of administrative department of water resources	Water Resources Agency

Note: Include only some main laws and regulations.

4. Property Rights

4.1 *Outline the basis for general rights in agricultural land use, and surface water and groundwater use.*

According to the Land Management Law, there are two kinds of property rights of agricultural land: 1) *Collective property right*. Village collective owns ownership of collective land, farmers in the village have land use right. 2) *State property right*. Except for collective agricultural land, other lands belong to the state.

Nearly every farm household in China is endowed with land. Landownership rests with the village (or collective) and is contracted or otherwise allocated to households. Legal tenure security on contracted land was recently extended from 15 to 30 years, but village leaders frequently do not follow these policy directives. The dynamics of household and village demographics and other policy pressures often induce local authorities to reallocated land prior to contract expiration.

According to the Water Law, there are two kinds of water property rights of both surface water and groundwater:

- 1) *Collective property right*. If property right of a reservoir and water pocket belongs to a rural collective organization, property right of water stored in these reservoirs and water pockets will also belong to collective organization.
- 2) *State property right*. Except for the collective property right of water, other water including surface water and groundwater belongs to state.

According to the water withdrawal permit regulation, users (including individuals and institutions) cannot draw water from any river, lake or groundwater resources without obtaining a water use license. The water resources management agencies at each level have the right to issue a license to the water user. Different levels of water management agencies can permit the drawing of different volumes of water. The river basin commissions have the rights to permit drawing a large volume of water from the rivers or underground within the river basin. The water resources bureaus in the provincial governments have the right to permit the withdrawal of a relatively smaller volume of water. The much smaller volume of withdrawal, such as to dig a well, is approved by the local water resources bureau.

The water withdrawal permission policy has just been implemented in the last few years. Though officials from MWR believe that even though in some remote rural areas, there may be some wells drilled without a license, it is common in rural areas for farmers to drill wells without any permission or hard monitoring.

Except for obtaining a water use permit, water users also need to pay a water resources fee to the water resources agency. An agricultural water user is exempted from paying a water resources fee. With the decline in the groundwater table and the increase in water scarcity, the water resources agency is considering collecting an agricultural water resources fee from farmers. Since the urban or industrial sector that uses groundwater has to pay a water resource fee, besides the water delivery cost, the water resource fee can be used to cover expenditures of water management, through the management of the financial bureau in the same government level; and the water resources bureau has motivation to monitor the implementation of the regulation.

4.2 Land Laws and Regulations

List the existing laws and regulations concerning land use and land tenure.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Land Management Law	1986	<ul style="list-style-type: none"> • General principles • Landownership and use right • Land utilization and protection • State construction land use • Township and village construction land use • Legal responsibilities 	Land Management Authority
Notice on Strengthening Land Management, Preventing Unsuitable Land Use	1986	<ul style="list-style-type: none"> • Propagating land importance • Carefully checking nonagricultural land use • Taking comprehensive measures to strengthen land management • Establishing and perfecting land-management authorities 	Land Management Authority
Temporary regulation of occupying cultivated land tax	1987	<ul style="list-style-type: none"> • Definition of cultivated land • Charge rate and collecting method of occupying cultivated land tax • Management authority • Conflict management approaches 	Finance Authority
Regulation on Land Development Fund Management	1988	<ul style="list-style-type: none"> • Sources of land development fund • Major applications of land development fund • Land development fund and use principles • Land development fund management in financial system 	Agricultural, Forestry and Water Conservancy and other relevant authorities
Temporary regulation on city and township land use tax	1988	<ul style="list-style-type: none"> • Purpose of the regulation • Definition of tax payer • Charge rate and collecting approaches of land-use tax • Management authority 	Finance Authority
Regulation on land cultivation again	1988	<ul style="list-style-type: none"> • Definition of land cultivation again • Principles and standards of land cultivation again • Management authority • Compensating charge of land loss • Destroyed land management during construction • Punishment 	Land Management Authority
Temporary regulation of occupied land by construction	1988	<ul style="list-style-type: none"> • Suitable scope of the regulation • Procedure and approaches of applying for construction land use • Management authority • Punishment 	Land Management Authority
Notice on strengthening income management of selling state-owned land use right	1989	<ul style="list-style-type: none"> • Income turnover • Income division between central and local government • Application scope of income • Management authority 	Finance Authority
Several suggestions on defining landownership	1989	<ul style="list-style-type: none"> • State-vested landownership • Collective-vested landownership • State-owned land-use right • Use right of rural collective land used by construction 	Land Management Authority

4.3 Environmental Laws and Regulations

List the existing environmental laws and regulations.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Environmental Protection Law	1979	<ul style="list-style-type: none"> • General principle • Protecting natural environment • Preventing pollution and other public damages • Environmental Protection Authority and its responsibilities • Science and technological research, propagation and education • Reward and punishment 	State Environmental Protection Administration
Environmental Protection Management Approaches of Construction Projects	1998	<ul style="list-style-type: none"> • Management authority • Principles of construction regarding environmental protection • Environmental impacts report of construction projects • Supervision, reward and punishment 	Environmental Protection Authorities and Construction Institution and Its Management Authority
Several Stipulations Regarding Controlling Industrial Pollution Combined with Technological Innovation	1983	<ul style="list-style-type: none"> • Pollution-control requirement of enterprise's technological innovation • Integrated economic and environmental benefits principles of technological innovation • Reward and punishment policies of industry pollution • Key technologies of industry pollution control 	Industry Management Authorities and Economic Commission
Management Regulation on National Environmental Supervising	1983	<ul style="list-style-type: none"> • Environmental protection • General principle and major task • Environmental monitor authority • Responsibilities and functions • Management of environmental monitor station • Environmental monitor network • Report system 	Rural and Urban Construction Environmental Protection Department
Pollution control management regulation of drinking water source region	1989	<ul style="list-style-type: none"> • General principle • Division and protection of groundwater source; protection of region of drinking water • Supervision and management of pollution control in drinking water-source protection region • Reward and punishment 	Environmental Protection Authority, Water Resources Authority, Geological and Mining Authority, Sanitation Authority, Urban Construction Authority
Water Pollution Control Law	1996	<ul style="list-style-type: none"> • General principle • Formulating of water environmental quality standard and sewage discharge standard • Supervision and management of water pollution control • Surface water pollution control • Groundwater pollution control • Legal responsibilities 	Environmental Protection Authority

Temporary paid use approach of special fund for pollution source control	1988	<ul style="list-style-type: none"> • Source of special fund • Application scope of special fund • Management authority • Applying for special fund 	Environmental Protection Authority
Temporary method of collecting sewage discharge charge	1982	<ul style="list-style-type: none"> • Purpose of collecting sewage discharge charge • Requirement and procedures of paying sewage discharge fee for enterprises • Collecting method of sewage discharge fee • Management of sewage discharge • Application of sewage discharge 	Environmental Protection Authority

5. Water Allocation and Conflict Resolution

5.1 *Describe national policies for allocating water among competing uses and mechanisms for resolving conflicts among users.*

According to Provision 14 of the water law, water allocation should firstly ensure domestic water demand, then make unified planning with due consideration for agriculture, industry and shipping water demand. In the water-shortage area, urban scale, high water-consuming industry and agricultural development should be limited. In fact, water, especially surface water, will be firstly allocated to the domestic sector, then to ensure industrial development; agricultural water use will be considered the last. Generally, if agriculture cannot get enough surface water, it will turn to groundwater.

Generally, the higher level of Water Resources Agency will make the annual water-allocation plan among different water users, and then submit the allocation plan to the local government to get the approval. Before making the water allocation plan, the Water Resources Agency will solicit opinions on the water requirement from different water use departments. Opinions on water allocation from various water use departments will become the foundation of the water allocation plan and will also be adjusted and coordinated by the Water Resources Agency according to the overall water supply and demand situation. After the local government approves the water allocation plan, the administrative department of water resources will implement the water allocation plan. Last year's water supply and demand situations and the current year's water demand are bases for making the water allocation plan. Because water supply in the current year cannot be exactly predicted and perhaps some water use sectors do not satisfy the water allocation plan, the latter will be usually adjusted and difficult to implement; water conflicts among various water use departments will be still hard to avoid. The Water Resources Agency will try to solve any water conflict; if it still cannot be solved, the local government will intervene in it. The local court and even the higher court will help interested parties to solve water conflicts.

6. Indicate the main reasons for selecting the river basin for the case study.

There are several reasons for selecting the Fuyang river basin for our case study:

- It is an important agricultural production area in the Hebei Province and even in China.
- Irrigation has played a critical role in agricultural development and irrigation has developed faster than in Hebei and the state.
- It is also a very industrialized area and four important cities of the Hebei Province are concentrated here.
- It faces increasing water-shortage problems.
- Since the 1970s, groundwater has become more and more important as water sources for local agricultural and industrial development, and also for domestic water use. At the same time, overabstraction of groundwater and severe decline of the annual water table have occurred.
- With social and economic development, sharp competitions for water use among sectors has puzzled water-allocation mechanism and water policy.
- Urban and rural industrialization has resulted in growing water pollution that has worsened the water shortage.

6.1 Key Physical Features of the River Basin

6.1.1 Climate

Average annual rainfall (mm)	569.2
Annual average Eto (mm)	1,562
Maximum temperature (°C)	42.6
Minimum temperature (°C)	-20
Number of dry months (<5 mm rainfall)	4

List the major infrastructural facilities in the river basin (include only those facilities not already listed in the summary reports sent earlier).

Infrastructural facility	Number	Date of installation	Currently functional Yes/No
Large-scale reservoir	3	1 in 1960s 1 in 1970s 1 in the 1980s	Yes
Medium-scale reservoir	11	3 in the 1950s 1 in the 1960s 5 in the 1970s 1 in the 1980s 1 in the 1990s	Yes
Small-scale reservoir	212	During the 1950s-990s	Yes

6.1.2 River network

Length	km	403
Catchment area	km ²	22,814
Elevation (start)	M	107
Elevation (end)	M	9.6
Maximum flow (1998, main river)	m ³ /s	24.367
Minimum flow (1998, main river)	m ³ /s	1.367
Average annual discharge	10 ⁸ m ³	2.6871

6.1.3 How would you characterize the overall hydrology of the basin?

A water surplus basin	
Water resources are adequate at present	
Moderately water-scarce basin	
Seasonally water-scarce basin	
Water-scarce basin	Yes

7. Demographic Characteristics of the Basin

Total population (million persons)	15.64
Population density (persons/sq.km)	686
Number of urban centers	4
Number of villages	9092
Total urban population (million)	4.37
Total rural population (million)	11.27
Per capita availability of water (m ³)	868
Urban households having piped water (%)	97
Rural household having piped water (%)	77
% employed in agriculture	67
Proportion of population living below official poverty line (%)	6

8. Water Utilities

8.1 List the main types of water utilities in the river basin.

Type of utility	Number	Who owns utility	Who operates the utility	Legal status of operator
Surface irrigation systems	3	Government	Govt. agency	Govt. Department
Groundwater schemes	185,527	Village collective farmer; government	Village collective leader farmer; Govt. Agency	Local collective organization Informal and unrecognized by law Govt. Department
Domestic water supply schemes	41*	Government	Govt. Agency	Govt. Department
Hydropower plants	14	Government	Govt. Agency	Govt. Department
Wastewater treatment plants	3	Government	Govt. Agency	Govt. Department

*Cover only domestic water supply schemes in the urban sector (including city and town). There are no data for domestic water supply schemes in the rural area (village).

Provide information on the amount of water utilized in each sector (annual total and/or volume per second in comparable form) and the mean flow of the river (this information will help in understanding the pattern of sectoral water allocation and demand-supply condition in the basin).

In 1998 (dry year), the total available water in the Fuyang river basin was 1,141.16 million m³; among the total process depletion water use, 618.7 million m³ were allocated to irrigated crops, 219.6 million m³ to nonirrigated crops, 97.4 million m³ to orchards, 46.7 million m³ for industrial uses and 37.2 million m³ for domestic uses. Forest evapotranspiration was 95.6 million m³. Maximum flow of the main river in 1998 was 24.367 m³/s per second; the minimum flow of the main river in 1998 was 1.367 m³/s.

8.2 *Information Base of the River basin*

Describe the available system of monitoring rainfall, reservoir storage and river flows at key locations, water quality, groundwater level and quality, various environmental conditions, diversion by various users, etc., stating the agencies responsible for these monitoring tasks and the existing information-sharing arrangements.

There are 167 rain recording stations, 30 pan evaporation stations, and 12 hydrological stations in FRB. Most rain recording stations and pan evaporations are managed by the local Meteorological Bureau, a few rain recording stations and all hydrological stations are managed by the local Hydrological Bureau under the Water Resources Bureau, which monitors surface water and groundwater and reservoir storage change. Local Geological and Mining Bureau also monitors groundwater. Most of the water-quality information is collected by the Local Environmental Protection Bureau. The Local Water Resources Bureau also monitors surface water and groundwater quality.

9. **Water Administration**

9.1 *List the principal agencies involved in water management and indicate how they are spatially organized.*

Name of agency	Type of agency*	Area of jurisdiction**
Water Resources Agency	State/provincial/prefecture/county	Administrative region
Rural and Urban Construction Agency	State/provincial/prefecture/county	Administrative region
Environmental Protection Agency	State/provincial/prefecture/county	Administrative region
Geography and Mining Agency	State/provincial/prefecture/county	Administrative region
River Basin Commission	Main river basin/Branch river basin	River basin
Government	State/provincial/prefecture/county/town	Administrative region
Planning and Development Commission	State/provincial/prefecture/county	Administrative region
Forestry Agency	State/provincial/prefecture/county	Administrative region
Price Management Agency	State/provincial/prefecture/county	Administrative region
Agricultural Agency	State/provincial/prefecture/county	Administrative region

* National line agency/state/provincial/local government/other.

** Country/state/province/basin/water district/administrative region/village/scheme /other.

Add a brief note describing the basic roles and functions of the agencies specified.

1. Basic role and functions of water resources authorities (including provincial, prefecture and county water resources bureaus in Hebei, Handan, Shijiazhuang, Xingtai and Cangzhou):
 - Carry out Water Law, and organize making administrative regulations for water resources management.
 - Take charge of integrated regional water management and protection, promote comprehensive development and utilization of water resources and coordinate water conflicts among stakeholders.
 - Organize and draw up a long-term annual plan of water resources development, organize water conservancy construction.
 - Manage hydropower belonging to the Water Resources Bureau.
 - Responsible for flood control and drought fight.
 - Responsible for regional soil and water conservancy.
 - Organizing relevant departments to conduct water resources investigation and evaluation, responsible for national hydrological work management.
 - Responsible for reservoir resettlement management of hydropower and reservoir and fishery management.
 - Responsible for regional water science and technology, education and foreign exchange and cooperation of economic and technology.
 - Draw up a water-saving policy and program, formulate a relevant standard, guide national water saving work.
2. Basic role and functions of local environmental bureau (including Provincial, Prefecture and County Water Resources Bureaus in Hebei, Handa, Shijiazhuang, Xingtai and Cangzhou) are mainly for comprehensive management of water protection.
3. Basic role and functions of local Urban Construction Bureau (including Provincial, Prefecture and County Water Resources Bureaus in Hebei, Handan, Shijiazhuang, Xingtai and Cangzhou) are mainly for urban groundwater management and guiding urban water collection and water delivery by pipe network, household water saving and accepting supervision from the MWR.

9.2 List the main responsibilities of the specified agencies.

Tasks	Government	Water resources agency	Environmental protection administration	Urban construction agency	Geography and mining agency	Planning and Development Commission	Price management agency	Financial agency	Forestry agency	Agriculture agency	River Basin Commission
Governance	R	E	E	E	E	R	E	R	E	E	E
Water allocation for different uses	R	E	IP	E	E	R	IP	R	IP	IP	E
O&M of surface irrigation systems	R	E	IP	IP	IP	R	IP	R	IP	IP	E
Groundwater management	R	E	IP	E	E	R	IP	R	IP	IP	IP
Catchment area management	R	C	IP	IP	IP	R	IP	R	IP	IP	E
Domestic water supply	R	E	IP	E	IP	R	IP	R	IP	IP	E
Water quality management	R	C	E	C	C	R	IP	R	IP	IP	C
Salinity management	R	E	IP	IP	IP	R	IP	R	IP	E	IP
Drainage	R	E	E	E	E	R	IP	R	IP	IP	E
Flood protection	R	E	IP	IP	IP	R	IP	R	IP	IP	E
Wetland protection	R	C	IP	IP	IP	R	IP	R	E	IP	IP
Maintenance of infrastructure	R	E				R					
Master planning	R	E	E	E	E	R	R	R	C	C	E
Design and construction of new facilities	R	E	C	C	C	R	R	R	IP	IP	IP
Resource mobilization	R	E	E	E	E	R	R	E	IP	IP	E
Hydropower generation	R	E	IP	IP	IP	R	R	R	IP	IP	E
Impact assessment studies	R	E	E	E	E	R	C	R	IP	IP	E
Water pricing	R	E	E	E	E	R	E	R	IP	IP	IP

E - Executive responsibility; C - Consulted; R - Regulatory responsibility; IP - Interested party.

9.3 Describe the formal mechanisms for interagency coordination.

If several agencies take charge of the same water management issue, they will work together to make the work plan or regulations on water management. Finally, their work plan or regulations will be submitted to the central (local) government and the government will act as interagency coordinator. To coordinate interagency relations or conflict on water resources management, the government will hold a conference and each related agency will be required to attend it. At the conference, each agency will propose their suggestions on certain water management issues and their opinions on current institutional arrangement. Finally, the government will decide how to allocate rights and responsibilities among various agencies.

Currently, there is no Fuyang river basin (FRB) management organization and water resources are managed by the water resources authority of each Prefecture. The Provincial Water Resources Bureau will coordinate water resources management among various water resources management departments in the FRB.

9.4 Describe the mechanisms for the accountability of officials/water-service providers and users.

According to the Regulation for the Accountability Policy Plan (sanding fang'an) in 1998, the Administrative Department of Water Resources should adjust the internal structure of the organization based on the efficiency, simplicity and integration principle. Each staff member of the water resources administration should have a fixed position and clear responsibility. Requirements for fixed positions are work demand, water user participation, and comprehensive assessment decided by the agency. If the water providers belong to the staff of the Water Resources Administration, they will also comply with the regulation of the accountability policy plan.

10. Irrigated Agriculture

10.1 General

	Present (1998)	10 years ago (1985)
Cultivated area (1,000 ha)	1,239	1,284
Urban land area (1,990 km ²) *	87	-
Grassland/Savannah (1,990 km ²)*	78	-
Forest cover (1990 km ²)*	119	-
Area covered with water (1,990 km ²)*	2,238	-
Irrigated land area (1,000 ha)*	1,024	881
Irrigated area as a % of total arable area	83	69
Area under surface irrigation systems	150	210
Area under groundwater systems	874	671
Cropping intensity–surface systems	na	na
Cropping intensity–groundwater systems	na	na
Average cropping intensity of both surface water and groundwater systems	1.55	1.50

*Difficult to get data for 1998.

10.2 List the main crops grown under irrigation.

Name of crop	Present (sown area, 1,000 ha)	10 years ago (sown area, 1,000 ha)
Wheat	755	617
Corn	568	504
Cotton	79	131
Oil-bearing crops	105	72
Soybean	97	68

10.3 Indicate the current yield of major irrigated crops. How do current yields compare with yields obtained 10 years ago?

Name of crop	Yields 10 years ago			
	Amount (kg/ha)	Higher	About the same	Lower
Wheat	5,658	Yes		
Corn	6,438	Yes		
Cotton	879	Yes		
Oil-bearing crops	2,187	Yes		
Soybean	2,296	Yes		

10.4 Changes in Cropping Patterns and Yields

10.4.1 If changes in cropping patterns and yields have been noted, outline the main reasons for the changes with particular attention to impacts of the institutional environment.

According to our empirical research conducted in 30 villages in the Fuyang river basin, since the 1980s, sown area percentage of crops over total crop sown area has declined and sown area percentage of cash crops has increased. Research results show that property right innovation of the groundwater irrigation system is one important determinant of cropping patterns. Other determinants of cropping patterns are agricultural production price, grain procurement policy and opportunity cost of labor. Since the 1980s, the collectively owned groundwater irrigation system has been gradually substituted by a more market-oriented private or quasi-private irrigation system. In the early 1980s, the proportion of collective groundwater irrigation systems was 83 percent and the noncollective property right proportion were 17 percent; in 1998, the collective property right proportion declined to 31 percent, but the noncollective property right of the groundwater irrigation system increased to 69 percent. The results show that major determinants of the property right innovation in the irrigation system are the increasing water-shortage problems, stresses from local population growth with declining land endowment, weakening the village or community economic powder, improved human capital of the community, market development, and water finance and credit policies. Property right innovation of the groundwater irrigation system has impacts not only on cropping patterns but also on the technical efficiency of groundwater irrigation system, i.e., water supply efficiency. Results show that the noncollective property right is more beneficial for technical efficiency than the collective property right.

10.5 Outline mechanisms for beneficiary participation in O&M of irrigation systems.

For groundwater irrigation systems in the FRB, some water users who own the irrigation system will be directly responsible for O&M of the irrigation system; other water users who do not own the irrigation system usually do not participate in O&M of the irrigation system, but sometimes these water users will be hired by irrigation system owners to do some O&M work for the irrigation system.

For surface irrigation systems in the FRB, there are no water user associations (WUAs) but irrigation systems and local water resources bureaus are trying to develop WUAs. According to experiences from other irrigation systems in other river basins in China, WUAs can encourage farmers to take part in O&M of irrigation systems. Currently, village or town leaders will organize farmers to take part in O&M of irrigation systems through their administrative power, which always results in conflict between the village or town leader and farmers, and management efficiency is also low. Due to limited finances, funds for O&M of systems cannot always satisfy cost demand, and aging and low efficiency in irrigation systems are very common.

10.6 Multiple Use of Irrigation Water

10.6.1 List the various other uses of irrigation water at the level of the irrigation scheme.

Uses of water	Check X
Drinking water supply	X
Bathing/washing clothes	X
Watering home gardens	X
Animal husbandry	X
Cottage industry	X
Fishery/aquaculture	X
Electric plant	
Steam power plant	
Steel plant	
Fertilization plant	
Railway station	
Washing plant	
Other	

10.6.2 Describe the existing institutional arrangements to cope with the multiple uses of irrigation water.

The local government water resources bureau will be responsible for irrigation water allocation; the administrative power is the main measure for them to allocate irrigation water use. Basically, the government will allocate irrigation water based on economic value of various sectors. Drinking water will give priority in irrigation water allocation. Except for drinking, part of drinking water will be used for bathing and washing clothes, watering home gardens and animal husbandry water demand. These will all be controlled by households and the government cannot control it. Drinking water always accounts only for a small part of the irrigation water use; increasing large irrigation water use is industry, such as cottage, electricity, steel, fertilization, railway, washing plant and others. Though it is named as an irrigation system, irrigation water use is always considered last.

10.6.3 Describe how the multiple use of irrigation water is affecting the performance of irrigated agriculture.

If there is not enough groundwater to offset the declined surface water supply, precipitation is also very low and yields of crops will decrease. If such a trend continues, cropping pattern will be changed and some drought-resistant varieties will be substituted for normal varieties. Further, various kinds of water conservancy measures will be adopted by farmers. If agriculture cannot get a sufficient water supply, fertilizer input may be reduced, but variety and farm chemicals will be increased. If there is abundant groundwater, farmers will exploit groundwater for irrigation. Because groundwater supply is more flexible than surface water and more reliable for water supply, the share of the area of cash crops will be increased.

11. Competition for Water in the Basin

11.1 Enter relevant code: 1=no competition, 2=moderate competition, 3=severe competition, 4=complementary use.

	Irrigation	Domestic water	Industry	Hydropower	Navigation	Fisheries	Waste disposal	Recreation	Water quality control	Aesthetic/environment use	Other
Irrigation	3	3	3	1	-	2	4	2	4	2	-
Domestic water supply	3	3	3	1	-	2	4	2	4	2	-
Industry	3	3	3	1	-	2	4	2	4	2	-
Hydropower	1	3	2	1	-	2	4	2	4	2	-
Navigation	-	-	-	-	-	-	-	-	-	-	-
Fisheries	2	3	2	1	-	2	4	2	4	2	-
Waste disposal	4	4	4	4	-	2	1	2	1	2	-
Recreation	2	3	2	1	-	2	4	2	4	2	-
Water quality protection	4	4	4	4	-	2	1	2	1	2	-
Aesthetic environmental use	2	3	2	1	-	2	4	2	4	2	-

11.2 Describe how the competition of water at the basin level is affecting agricultural water use.

With increasing sharp competition for water use among various sectors at the basin level, agricultural water use has presented several obvious characteristics:

1. Because more and more water has been allocated to the nonagriculture sector, agriculture has to depend on groundwater, which has played a key role in agricultural development.
2. With the groundwater table dropping, shallow water cannot satisfy agricultural water demand and farmers have to explore deep water.
3. More and more farmers have realized severe water-shortage problems; for the future development trend of local water resources, it has been easy for farmers to adopt water-saving technology.

12. Outline Briefly the Emerging Trends in the Scarcity of Water.

Rank in order of importance:

1. *Overexploitation of groundwater.* The groundwater table has declined faster; some aquifers have become dry resulting in soil consolidation and plant wilting, and damage to the ecological system. Due to the overexploitation of groundwater, several cones of depressions of groundwater exist in the FRB. The overdraft of groundwater also accelerates the infiltration of surface water; the pollutants contained in surface water have also entered groundwater resulting in groundwater pollution. Severe water pollution has put much pressure on water shortage.
2. *Serious water pollution.* Due to industrialization, urbanization and chemical agricultural input increase, serious water pollution has put increasing stress on water scarcity.
3. *Growing surface water scarcity.* Continued dry years and increasing water demand made Fuyang River dry and the storage in reservoirs has also declined much. Many people believe that the water-saving potential of the Fuyang river basin is not large; most important way to resolve water scarcity is to transfer water from the south (such as Yangtze river) to North (such as the Hebei Province).
4. *Inter-sectoral competition for water.* To ensure industry and urban water demand under limited available water, water resources allocated to agriculture will decrease much and, at the same time, improving water use efficiency through adopting various water saving technologies has become urgent.

13. Outline Briefly the Emerging Trends in the Inter-Sectoral Competition for Water.

With sharper competition among various sectors, high-value sectors, such as industry, and the politically important sector, such as the domestic-water sector and the environmental water demand will be given priority in water allocation; but low-value product and the low political position sector, such as agriculture will get less and less water resources compared with other sectors. How to decrease agricultural water demand and improve agricultural water use efficiency have become hot points in the future for policymakers and academics.

14. Outline Briefly the Emerging Trends in the Water Quality and Environmental-Related Problems.

Industry, agriculture and population growth lead to more and more serious water pollution of both surface water and groundwater. Water pollution has not only put much pressure on water shortage, but also resulted in many environmental problems. However, with the growing sewage emission, limited sewage disposal ability is hard to meet the disposal demand. In recent years, water pollution has been noticed by central and local governments, and the government has decided to control water pollution through investing large amounts of money into the water pollution control projects. However, most water pollution control measures have focused on surface water pollution; groundwater pollution has still not been emphasized and how to deal with groundwater pollution is an important problem to be solved in the future.

15. In the Light of the Emerging Trends in Water Resources in the Basin, Assess the Future of Irrigated Agriculture in the Basin.

With the groundwater table dropping, the irrigation cost will increase. Furthermore, the water price will be raised and an agricultural water resources fee will be collected in order to protect scarce water resources according to the water policy development trend. At the same time, grain price cannot rise and other agricultural input prices also showed an increase trend. In order to earn some profits and avoid a large economic loss, farmers will try to adjust cropping patterns. In the future, grain crops will be gradually substituted by high-value crops (cash crops, such as vegetables). In addition, dryland agriculture will also be adopted by more and more farmers and drought-resistant new varieties will become popular.

16. Summarize the Key Institutional Arrangements that should be in Place to Enhance the Productivity and Sustainability of Irrigated Agriculture in the Basin.

Note: Ongoing.

The Basin Profile

Indonesia

Name of selected river basin : Ombilin river subbasin of the Inderagiri river basin,
West Sumatra, Indonesia.

Document prepared by : The Center for Irrigation, Land and Water Resources, and
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1. Country Overview

1.1 *Outline the salient features of the country with particular focus on the importance of irrigation in the economy.*

Rice is the main staple food for almost the whole Indonesian population, which is now more than 200 millions. Of the total arable area of land some 7.1 million hectares (or 83.5%) of wetland area are irrigated land. In 1998, agriculture contributed 17.20 percent to the Indonesian GDP, second only to industry and mining with the contribution of 25.30 percent.

1.2 *Key national indicators*

Indicators	Units	
Total land area	km ²	1,937,179*
Population (most recent figure)	million	204.392
Projected population for 2020	million	na
Population growth rate	%	1.6
Urban population (% of total)	%	32
Rural population (% of total)	%	68
GNP per capita (1998)	US\$	na
Contribution of agriculture to the GDP	%	17.20
Contribution of industry and manufacturing to the GDP	%	25.30
Contribution of services to the GDP	%	9.57
Average annual growth rate of agriculture (last 5 years)	%	1.72
Average annual growth rate of industry (last 5 years)	%	5.62
Average annual growth rate of services (last 5 years)	%	1.56
Total annual water resources (latest year for which data are available)	km ³	na
Per capita water availability	m ³	14,000
Total water withdrawals (latest year for which data are available)	km ³	na
Per capita domestic withdrawal (latest year for which data are available)	m ³	na
Per capita industrial withdrawal (latest year for which data are available)	m ³	na
Per capita irrigation withdrawal (latest year for which data are available)	m ³	na
Gross irrigated area (latest year for which data are available)	ha	7,100,000
Percentage of population with access to safe water	%	51

*Including East Timor of 14,609 sq. km.

na = Data not available.

2. Water Resources Policy

2.1 Describe the implicitly and explicitly stated national, federal/provincial or other subnational-level goals and policies for water-resources development.

Objective 1: Improve the national institutional framework for Water Resource Development and Management by the

- 1.1. Establishment of a national water resource management coordination framework
- 1.2. Involvement of the private sector in development and stakeholders in basin-management policy and decision making
- 1.3. Improve national water resource information and decision-support systems
- 1.4. Improve national hydrological and water-quality data collection and management system

Objective 2: Improve the organizational and financial framework for river-basin management by

- 2.1. Improving the provincial regulatory management of river basins and aquifers
- 2.2. Developing a sustainable corporate framework for management of a strategic river basin

Objective 3: Improve regional water quality management institutions by

- 3.1. Establishing an effective and enforceable national regulatory framework for water pollution control
- 3.2. Integrating water quality management implemented in six developed river basins

Objective 4: Improve irrigation management policy, institution and regulation by

- 4.1. Improving irrigation governance, transparency, and accountability through farmer empowerment and management transfer
- 4.2. Improving regional government irrigation service
- 4.3. Ensuring fiscal sustainability and efficiency of O&M and rehabilitation of irrigation schemes

3. Water Laws and Regulations

3.1 *List the existing laws and regulations concerning surface water and groundwater usage and pollution control.*

Enactment	Date	Key provisions	Agency/agencies responsible for implementing legal provisions
UUD 1945	1945	Basic concepts and ideas of all aspects of the national society's life	
Agrarian Law		Basic concepts and principles on management and development of land, water and air	
Water Law		Basic guidance on water management and development; elaboration of provision in agrarian law	
Government Regulation (GR) on water system; GR on irrigation; etc.		Elaboration of Water Law	
Ministerial Regulation (MR) on basin management; MR on water licensing; etc.		Elaboration of Water law and GRs	
Provincial Regulation (PR) on WUA; etc.		Adoption and adaptation of Laws, GRs, and MRs to provincial conditions	
District Regulation (DR) on WUA; etc.		Adoption and adaptation of PRs to district conditions	

4. Property Rights

4.1 *Outline the basis for general rights in agricultural land use, and surface water and groundwater use.*

According to the Indonesian constitution, water is a god-granted resource and should be used for the highest level of welfare of the people. Water is therefore owned communally by all citizenry; no individual ownership can be claimed over water. The idea also provides the basis for the state right to control—but not to own—water. This state right to control water is exercised by the government, which is pertinent in three areas: legislation, operational and regulatory.

5. Water Allocation and Conflict Resolution

5.1 Describe national policies for allocating water among competing uses and mechanisms for resolving conflicts among users.

Since the mid-1990s, recognizing the increasingly relative scarcity of water, the government policies on water have been oriented toward the attainment of greater efficiency and productivity of water use and allocation. Water Law No. 11/1974 prioritizes the need of people to water for drinking, domestic, national defense and security, religious purposes, agriculture, animal husbandry, plantation, fishery, amenities, mining, navigation and recreation. There is, however, no legal provision on conflict resolution in Water Resources Development. It is understood, however, that all coordination committees are supposedly functioning as interagency and interregional conflict-resolution bodies. A higher committee is supposed to resolve lower interregional conflicts.

6. Indicate the main reasons for selecting the river basin for the case study.

The subbasin chosen for study is the upper-part of the Kuantan/Inderagiri river basin, which is one of the six basins found in West Sumatra Province. Prior to the construction of the Singkarak Hydroelectric Power Plant (HEPP) in 1997, water in the basin had been used for irrigation, domestic water supply, thermal power plant, coal washing, fishing activities, and washing and bathing. The operation of the Singkarak HEPP has, however, reduced the discharge in the Ombilin river significantly, and drained water from the studied basin to other basins. The reduction in the discharge has affected other users along the river and increased competition and conflicts among users, particularly between the management of Singkarak HEPP and other water users.

6.1 Key Physical Features of the River Basin

6.1.1 Climate

Average annual rainfall (mm)	2,025.91
Annual average Eto	1,947.4
Maximum temperature (°C)	28
Minimum temperature (°C)	19
Number of dry months (<5 mm rainfall)	0

6.1.2 River Network

Length	km	72*
Catchment area	km ²	120,421
Elevation (start)	m	na
Elevation (end)	m	na
Maximum flow	m ³ /s	185*
Minimum flow	m ³ /s	7.2*
Av. Annual discharge	mcm	62.3*

*For the Ombilin river only over which water accounting was done.

6.1.3 *How would you characterize the overall hydrology of the basin?*

A water surplus basin	
Water resources are adequate at present	X
Moderately water-scarce basin	
Seasonally water-scarce basin	
Water-scarce basin	

7. Demographic Characteristics of the Basin

Total population	690,159
Population density	395.98
Number of urban centers	4
Number of villages	400
Total urban population	na
Total rural population	na
Per capita availability of water (m ³)	na
Household having piped water (%)	12.56
% employed in agriculture	58.84
Proportion of population living below official poverty line	na

8. Water Utilities

8.1 *List the main types of water utilities in the river basin.*

Type of utility	Number	Who owns the utility	Who operates the utility	Legal status of operator
Surface irrigation systems	0	na	na	na
Water wheel irrigation systems	184	Farmer	Farmer	Owner and operator
Pump irrigation systems	14	Farmers' groups	WUAs	Local NGO recognized by special law
Groundwater schemes	0	na	na	na
Domestic water supply schemes	2	Government-owned water supply enterprises =2		
Hydropower plants	1	State-Owned Electric Company (SEC)		Semi-government enterprise
Thermal power plants	2	SEC=1, Coal Mining Company=1		Semi-government enterprise = 1; Private sector = 1
Coal-washing plants	1	Coal Mining Company	Coal Mining Company	Private sector
Wastewater treatment plants	0	na	na	na

Note: For the Ombilin river only, over which the study is concentrated.

9. Water Administration

9.1 List the principal agencies involved with water management and indicate how they are spatially organized.

Name of agency	Type of agency*	Area of jurisdiction**
Provincial Development Planning Board (PDPB)	Provincial	Province
Provincial Water Service (PWS)	Provincial	Province
Provincial Environmental Controlling Board (PECB)	Provincial	Province
Provincial Mining & Energy Service (PMES)	Provincial	Province
Provincial Agricultural Service (PAS)	Provincial	Province
Provincial Transportation Office (PTO)	Provincial	Province
Provincial Settlement Service (PSS)	Provincial	Province
Provincial Land Agency (PLA)	Provincial	Province
Domestic Water Supply Enterprise (DWSE)	District	District
State Electric Company	Regional	Regional

* National line agency/state/provincial/local government/other.

** Country/state/province/basin/water district/administrative region/village/scheme/other.

9.2 List the main responsibilities of the specified agencies.

Tasks	PDPB	PFPS	PLA	PWS	PECB	PMES	PAS	PTO	PSS	PHS	PIS	DWSE	SEC
Governance	E	C	C	C	C	C	C	C	C	C	C		
Water allocation for different uses													
O&M of surface irrigation systems				E			C		C				
Groundwater management				C		E							
Catchment area management		E	C	C	C								
Domestic water supply				C								IP	
Water quality and salinity management			E	C	C			R	C	C			
Drainage				E					R				
Flood protection				E					R				
Wetland protection							E						
Maintenance of infrastructure				E									
Master planning		E											
Design and construction of new facilities				E					C				
Resource mobilization													
Hydropower generation					C		E						IP
Impact assessment studies		E			R								

E-Executive responsibility; C-Consulted; R-Regulatory responsibility; IP-Interested party.

9.3 Describe the formal mechanisms for interagency coordination.

Investigation and analyses on this topic are ongoing.

9.4 Describe the mechanisms for the accountability of officials/water-service providers and users.

Investigation and analyses on this topic are ongoing.

10. Irrigated Agriculture

10.1 General

	Present	10 years ago
Cultivated area (ha)	130,291	
Grassland/Savannah (ha)	11,234	
Forest cover (ha)	45,498	
Area covered with water (ha)	1,956	
Irrigated land area (ha)	32,180	
Irrigated area as a proportion of total arable area (ha)	24.70	
Area under surface irrigation systems (ha)	32,180	
Area under groundwater systems (ha)	0	
Cropping intensity – surface systems	Twice a year	
Cropping intensity – groundwater systems	na	na

10.2 List the main crops grown under irrigation.

Name of crop	Present	10 years ago
Rice	X	X
Mung bean	X	
Groundnut	X	X
Red pepper	X	
Vegetables	X	

10.3 Indicate the current yield of major irrigated crops. How do current yields compare with yields obtained 10 years ago?

Name of crop	Present yield			Yields 10 years ago	
	Amount	Unit	Higher	About the same	Lower
Rice	4.20	t/ha		X	
Mung bean	0.95	t/ha		X	
Groundnut	0.95	t/ha		X	

10.4 *Changes in Cropping Patterns and Yields*

10.4.1 *If changes in cropping patterns and yields have been noted, outline the main reasons for the changes with particular attention to impacts of the institutional environment.*

10.5 *Outline mechanisms for beneficiary participation in O&M of irrigation systems.*

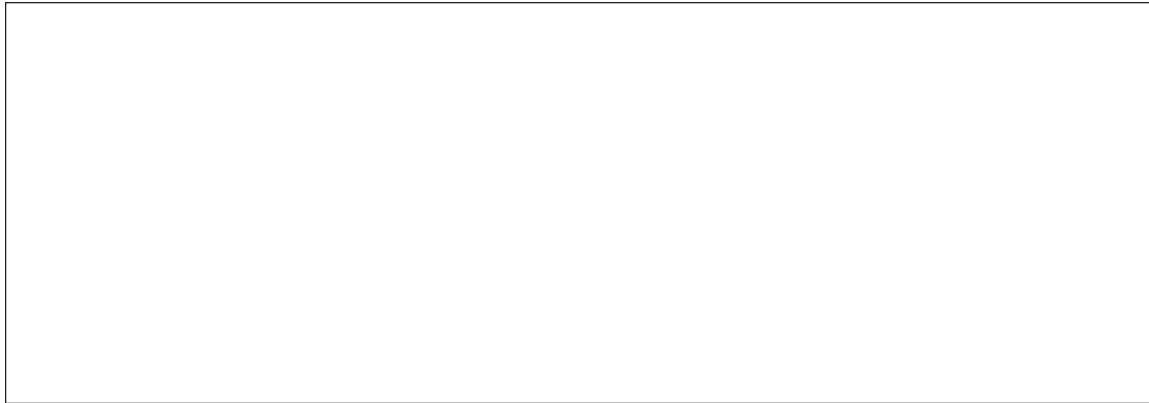
Regulation on ISF for the surface irrigation system requires that ISF is implemented with farmers' participation, represented by WUA officials, in assessing the O&M costs of certain irrigation system. The district water service then decides the proportion of the cost to be paid by the farmers by considering the farmers' ability to pay and the different quality of water service at different areas within a system. The tariffs of ISF, therefore, vary across systems and across areas within a (large) system. WUAs collect the fee and give it to the government, through District Income Service, which is authorized to use the fee for O&M. Although the principle is that the fee collected in certain systems is for the O&M of the system, no mechanism exists to ensure this, since the discretion for budgeting for irrigation O&M is only in the hands of the government. In general, however, implementation of ISF cannot be considered as a success. In most FMIS, the ISF is not collected and farmer participation is required in the form of labor. In the case of the waterwheel irrigation system, O&M of the system is the full responsibility of the owner. The amount of fee to be paid by farmers and the use of the collected fee are in the hands of the owner. Generally, farmers have to pay the water fee (i.e., 10% of the production) to the waterwheel owners.

10.6 *Multiple Use of Irrigation Water*

10.6.1 *List the various other uses of irrigation water at the irrigation-scheme level.*

Uses of water	Check X
Drinking water supply	
Bathing/washing clothes	X
Watering home gardens	
Animal husbandry	X
Cottage industry	
Fishery/aquaculture	X
Other	

10.6.2 Describe the existing institutional arrangements to cope with the multiple uses of irrigation water.



10.6.3 Describe how the multiple uses of irrigation water are affecting the performance of irrigated agriculture.

As mentioned above, in some cases the irrigation water is also used for fish culture, animal husbandry and domestic use (particularly for washing and bathing). It should be noted, however, that fish culture is found only in the systems with adequate water supply; and not all farmers in those systems can practice fish culture owing to the same reason. Generally, fish culture is limited to the upstream areas only, over which water supply is adequate. As a result, downstream areas are often affected by the intensive use of water in the upstream.

11. Competition for Water in the Basin

11.1 Enter relevant code: 1=no competition, 2=moderate competition, 3=severe competition, 4=complementary use.

	Irrigation	Domestic water	Industry	Hydro-power	Navigation	Fisheries	Waste disposal control	Recreation	Water quality	Aesthetic/Environment use	Other
Irrigation	2	2	2	3	1	1	2	4	4	1	
Domestic water supply	2	1	2	3	1	1	2	1	4	1	
Industry	2	2	1	2	2	2	2	2	3	2	
Hydropower	3	3	2	1	1	2	2	1	2	2	
Navigation	1	1	2	1	1	1	1	4	1	1	
Fisheries	1	1	2	2	1	1	2	1	4	1	
Waste disposal	2	2	2	1	2	2	1	2	2	2	
Recreation	4	1	2	1	4	4	2	1	4	4	
Water-quality protection	4	4	3	2	1	4	3	4	1	4	
Aesthetic environmental use	1	1	2	2	1	1	2	4	4	1	

11.2 Describe how the competition of water at the basin level affects agricultural water use.

The multiple uses of water at the basin level (refer to Ombilin river only) as described above have reduced water available for irrigated agriculture. Consequently, the number of waterwheels decreased from 366 in 1996 to 184 in 2000, and the serviced area dropped from 549 hectares in 1996 to 333 hectares in 2000.

12. Outline briefly the emerging trends in the scarcity of water.

13. Outline briefly the emerging trends in the inter-sectoral competition of water.

As mentioned above, inter-sectoral competition for water use becomes intenser as the new users come up. Since there is no legal provision for inter-sectoral water allocation, the interest of the traditional and less-powerful users tends to be bypassed by bigger and more powerful users. The lack of clear institutions managing water at the basin level causes an unequal distribution and allocation of water among users.

14. Outline briefly the emerging trends in the water quality and environmental-related problems.

Decreased discharge of the Ombilin river has also lowered the quality of water because river discharge is now dominated by the inflow from the Selo river with a very low quality. Downstream of the river, the problem was exacerbated by waste disposed from the coal mining company. The domestic water supply enterprises reported that the costs of water treatment increased by almost double due to the decline in the quality of raw water to be processed. People estimate that a number of fish varieties have disappeared from the river.

15. In the light of the emerging trends in water resources in the basin assess the future of irrigated agriculture in the basin.

One major point raised from the above discussion is that irrigation water use has not been given an equal share in water allocation. As a result, we have seen that the total irrigated land and, in some cases, cropping intensity and yield of irrigated agriculture have declined markedly.

16. Summarize the key institutional arrangements that should be in place to enhance the productivity and sustainability of irrigated agriculture in the basin.

Investigation and discussion over this subject are still underway and we have yet to come out with a set of conclusions and/or recommendations.



The Basin Profile

Nepal

Name of selected river basin : East Rapti river basin

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International Water Management Institute
Kathmandu, Nepal

03 November 2000



1. Country Overview

1.1 *Outline the salient features of the country with particular focus on the importance of irrigation in the economy.*

Nepal is an agrarian country. About 81 percent of the total population in Nepal is involved in the agriculture sector and it contributes around 40 percent to the Gross Domestic Product. By 1997, some form of irrigation was available only in 48.5 percent of the potentially irrigable area of 2,178,000 hectares. With time, the total area under irrigation increased from 849,216 hectares in 1992 to 1,055,617 hectares in 1997. The trend is expected to continue until the saturation point is achieved as the current policies immensely emphasize on the development of irrigated agriculture in the country.

1.2 *Key national indicators*

Indicators	Units	
Total land area	km ²	147,181
Population (most recent figure) 1997	million	21.081503
Projected Population for 2020	million	36.049392
Population growth rate	%	2.36
Urban population (% of total) – based on 1991 population distribution	%	9.2
Urban population growth rate (last 5 years)	%	na
Rural population (% of total) – based on 1991 population distribution	%	90.8
GNP per capita (1999)	US\$	222
Contribution of agriculture to the GDP ¹ (1998/99)	%	40.1
Contribution of industry and manufacturing to the GDP (1998/99)	%	33.0
Contribution of services to GDP (1998/99)	%	26.9
Average annual growth rate of agriculture (1994/95 – 1998/99)	%	2.3
Average annual growth rate of industry (1994/95 – 1998/99)	%	5.3
Average annual growth rate of services (1994/95 – 1998/99)	%	5.8
Total annual water resources (latest year for which data are available)	km ³	20,000
Per capita water availability	m ³	10,000
Total water withdrawals (latest year for which data are available)	km ³	na
Per capita domestic withdrawal (latest year for which data are available)	m ³	na
Per capita industrial withdrawal (latest year for which data are available)	m ³	na
Per capita irrigation withdrawal (latest year for which data are available)	m ³	na
Gross irrigated area (IWMI 1998; Irrigation Service Fees in Nepal)	ha	1,091,000
Percentage of population with access to safe water (1997)	%	61

¹Reclassified based on GDP reported by Central Bureau of Statistics 1999; Statistical Year Book of Nepal 1999, tables 16.6 and 16.7.

2. Water Resources Policy

2.1 Describe the implicitly and explicitly stated national, federal/provincial or other subnational-level goals and policies for water resources development.

The goal of water resources development in the country is to tap and utilize water resources for gaining social benefits by ensuring the participation of the private sector. It is believed that developing huge water resources potentials of the country will not only meet the country's energy demand but also greatly help develop agricultural and industrial sectors, facilitate socioeconomic development, and contribute to poverty alleviation.

Currently, efforts to formulate an overall water resources development and management strategy are underway with the vision that efficient and judicious harnessing of the water resources can accelerate the economy to a "high growth path" on a sustainable basis as water is Nepal's key strategic national resource with a potential to be the catalyst for the all-round development and economic growth of the country. Water resources development so far, especially in such areas as irrigation, hydropower generation, drinking water supply and sanitation, is far below its potential.

3. Water Laws and Regulations

3.1 List the existing laws and regulations concerning surface water and groundwater usage and pollution control.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Irrigation Act 2018	1963	Provides legal provisions concerning water use, construction and maintenance of canals, distribution of water, collection of water charges, sewerage, etc.	The Ministry of Water Resources
National Code 1963 (Muluki Ain 2019)	1963	<ul style="list-style-type: none">Establishes the general code of conduct while exercising the right of the public to use water to satisfy its various domestic and industrial needs.Prohibits any form of contamination to the water body limiting the access of others to use the same body of water.Prohibits the discharge of water and sewage into groundwater aquifers.	The Government of Nepal
Irrigation, Electricity and Related Water Resources Act, 2024	1968	Provides legal provisions related to irrigation, production of electricity and other matters concerning water resources.	The Ministry of Water Resources
Canal Operation Regulation	1974	Governs water use for irrigation.	The Ministry of Water Resources
Irrigation Regulation, 2045	1988	Provides legal provisions for formation of water users' group, water distribution, realization of water charge, etc.	The Ministry of Water Resources
Irrigation Policy, 2049	1992	Clarifies the government's policy in the field of irrigation.	The Ministry of Water Resources
Water Resources Act, 2049	1993	<ul style="list-style-type: none">Vests the ownership of all the country's water resources in the state.	The Ministry of Water Resources

Water Resources Regulation, 2050	1993	<ul style="list-style-type: none"> • Establishes a hierarchy of need for water utilization and set up the state as the licensor of water use. • Allows water user groups to be formally registered under it. • Makes provisions for a charge or annual fee to the licensee for utilizing water resources and related terms and conditions. • Lists the government’s ability to make rules on matters relating to fee, charges, etc. payable to the HMG for the utilization of any service related to water resources. • Stipulates that water must be used without causing damage to others (also supported by Nepal’s constitution 1990). • Provides a basis for utilization and allocation of water based on the national preference and priorities. First priority goes to drinking water and domestic use followed by irrigation, fisheries, hydropower generation, cottage industry, industrial enterprises and mining, navigation, recreation, and other uses. 	The Ministry of Water Resources
		<ul style="list-style-type: none"> • Provides the implementation procedures of the Water Resources Act, 2049. • Assigns the power to the district level to recognize licensed users and resolve water disputes. • Makes the provision of one “District Water Resources Committee” in each district, under the chairmanship of Chief District Officer (CDO), and comprising district-level representatives from Agriculture Development Office, Forest Office, Drinking Water Office, Irrigation Office, Electricity Project, Office of HMG, Offices related to utilization of water resources, District Development Committee, and Local Development Officer. • Stipulates that any individual or group that obtained the license for a certain water use has to pay to the HMG an annual water license fee. • Where HMG has developed the water resources, a committee will be formed for the determination of the rate Service Fee and the extra charge for those who do not pay in time. The committee will consist of a person assigned by HMG– Chair, a person among the water users assigned by HMG-Member, and a person assigned by HMG-Member. 	
		<p>The committee will fix the service fee considering the following criteria:</p>	
		<ol style="list-style-type: none"> 1. Capital investment depreciation rate or amortization. 2. Net benefit received by the users. 3. Canal O&M expenditure. 4. Changes in consumers’ price index. 	

		<ul style="list-style-type: none"> • Makes DWRCs responsible for monitoring of water resources in each district. • Makes provision for the turnover of publicly managed irrigation systems. 	
Environmental Action Plan	1994	<ul style="list-style-type: none"> • Gives some guidelines for integrated river-basin wide management. • Lays down a few guidelines for maintaining the water quality. 	The Ministry of Environment and Population
Amended Irrigation Policy, 2049.	1997	<ul style="list-style-type: none"> • Gives some guidelines on monitoring of water resources. • Expects the creation of detailed geographical and management information systems, which will be updated and institutionalized for monitoring purposes. • Provides guidelines related to irrigation system turnover. 	The Ministry of Water Resources

Others

- Nepal Water Supply Corporation Act, 1992
- Industrial Enterprises Act, 1992
- Electricity Act, 1992
- Electricity Rules, 1988
- Fixation of Electricity Tariffs Rules, 1993
- Vehicle and Transport Management Act, 1992
- Aquatic Animals Protection Act, 1960
- Forest Act, 1992
- Trekking and River Rafting Act, 1984
- Solid Waste Management and Resource Mobilization Act, 1987
- Decentralization Act 1982 and Bylaws, 1982
- Act on Utilization of Public Goods, 1991

4. Property Rights

4.1 *Outline the basis for general rights in agricultural land use, and surface water and groundwater use.*

Agricultural Land Use:

- Legally recognized landownership.
- Formal tenancy rights (50% ownership).
- Formal leasing.
- Informal leasing, tenancy and sharecropping.

Surface Water:

- Customary use right as dictated by the national code of conduct.
- Recently, licensing and pricing regulations have been introduced.

Groundwater:

- Related policies and regulation are still under discussion.

4.2 Land Laws and Regulations

List the existing laws and regulations concerning land use and tenure.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Land Reform Act	1964	<ul style="list-style-type: none">• The state owns all natural resources including land and water.• Every family can legally keep and use the land up to 16.9, 4.7 and 1.28 hectares in Terai, Hills and Kathmandu Valley, respectively.	Ministry of Land Reform, HMG Nepal

4.3 Environmental Laws and Regulations

List the existing environmental laws and regulations.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Environment Protection Act	1997	Legal provisions to maintain clean and healthy environment by minimizing adverse impacts from environmental degradation on human beings, wildlife, plants, nature and physical objects; and to protect the environment with proper use and management of natural resources. Also considers that sustainable development could be achieved from the inseparable interrelationship between the economic development and environment protection.	Ministry of Population and Environment, HMG Nepal
Environment Protection Rules	1997	Details process for enforcing the abovementioned Act.	Ministry of Population and Environment, HMG Nepal

5. Water Allocation and Conflict Resolution

5.1 Describe national policies for allocating water among competing uses and mechanisms for resolving conflicts among users.

There is a mechanism of sectoral prioritization of water. The priority order is given below:

- i. Drinking and domestic use
- ii. Irrigation
- iii. Agricultural uses (animal husbandry)
- iv. Hydropower
- v. Cottage industry, industrial enterprises, mining
- vi. Navigation
- vii. Recreational use

6. Indicate the main reasons for selecting the river basin for the case study.

- Presence of varied water uses
- Evidence of competition for water within a sector or between sectors
- Existence of irrigated agricultural practices
- Availability of data

6.1 Key Physical Features of the River Basin

6.1.1 Climate

Average annual rainfall (mm)	2003
Annual average Eto (mm/day)	4.01
Maximum temperature (°C)	30.7
Minimum temperature (°C)	4.7
Number of dry months (<5 mm rainfall)	2.3

6.1.2 River network

Length	km	399
Catchment area	km ²	3,222
Elevation (start)	m	1,500
Elevation (end)	m	135
Maximum flow	m ³ /s	500
Minimum flow	m ³ /s	40
Average annual discharge (outflow)	mcm	3,576

6.1.3 How would you characterize the overall hydrology of the basin?

A water surplus basin	
Water resources are adequate at present	
Moderately water-scarce basin	
Seasonally water-scarce basin	X
Water-scarce basin	

7. Demographic Characteristics of the Basin

Total population (estimated in 1998)	663,465
Population density (persons/km ²)	212
Number of urban centers	3
Number of villages	na
Total urban population	163,647
Total rural population	499,818
Per capita availability of water (m ³)	9,034
Urban households having piped water (%)	35.54
Rural household having piped water (%)	79.2
Proportion employed in agriculture (%)	42

8. Water Utilities

8.1 List the main types of water utilities in the river basin.

Type of utility	Number	Who owns the utility	Who operates the utility	Legal status of operator
Surface irrigation systems	214	Government and farmers both collectively and individually	WUAs = 208 Jointly by the government and farmers - 6	Govt. Department Local WUAs – Some recognized by law and some informal
Groundwater schemes	STW = 589 Dug wells = 1,809 Treadle pumps = 47	Mostly by individual farmers and some in groups	Mostly by individual farmers and some in groups	Some recognized by law and some informal
Domestic water supply schemes	45	Municipal-level schemes (3 schemes) by the government and village-level schemes by user groups	Municipal-level schemes by Water Supply Corporation and village-level schemes by user groups	Majority of user groups are legally recognized
Hydropower plants	None	Not applicable	Not applicable	Not applicable
Wastewater treatment plants	None	Not applicable	Not applicable	Not applicable
Wetlands and other water bodies	Numerous—exact number yet to be ascertained	Royal Chitwan National Park	Park officials and local people in the buffer zone	Buffer zone peoples' committees are legally recognized
Hand pumps	Numerous—exact number not available	Individual farmers	Individual farmers	Informal and private
Industries	126	Public and private	Government and private sectors	Legally recognized

Water Account Result for the above (Normal) Year (1978).

Study Year: Above Normal Year, 1978		Previous Year: Normal Year		
No.	Component	Subcomponent	Volume in (m ³ x 10 ⁶)	% of Net flow
1	Gross inflow	a) Rainfall	7,141.27	na
		b) Kulekhani	103.69	na
		c) Narayani	52.80	na
2	Storage changes	a) Surface storage	-0.74	na
		b) Ground storage	-126.03	na
3	Net inflow		7,170.99	na
4	Process depletion	ET of paddy	144.68	2.02
		ET of paddy (spring)	20.60	0.29
		ET of maize (winter)	22.89	0.32
		ET of maize (summer)	42.95	0.60
		ET of wheat	11.59	0.16
		ET of potato	5.16	0.07
		ET of pulses	3.53	0.05
		ET of vegetables	4.81	0.07
		ET of oil seeds	18.85	0.26
		Domestic uses	5.90	0.08
		Animal uses	2.99	0.04
		Industrial uses	0.18	0.00
		Subtotal	284.13	3.96
5	Non-process depletion (beneficial)	a) ET of forest (dense)	823.24	11.48
		b) ET of forest (sparse)	959.20	13.38
		c) ET of grazing land	112.24	1.57
		d) ET of homestead	38.81	0.54
		Subtotal	1,933.49	26.96
6	Non-process depletion (non-beneficial)	ET of barren land, flood plain and water body	242.15	3.38
7	Outflow	Runoff	3,847.87	53.66
	Sum of depletion and surface runoff		6,307.64	na
	Sum of net inflow		7170.99	na
	Difference in estimation ²		863.36	na

²The difference in estimation may be due to the use of some hypothetical figures in the calculation.

Water Account Result for Normal Year

Year of Interest: Normal Year, 1979

Previous Year: Above Normal Year

No.	Component	Subcomponent	Volume in (m ³ x 10 ⁶)	% of Net flow
1	Gross inflow	a) Rainfall	5,853.98	na
		b) Kulekhani	86.87	na
		c) Narayani	52.80	na
2	Storage changes	a) Surface storage	0.74	na
		b) Ground storage	126.03	na
3	Net inflow		6,120.42	na
4	Process depletion	ET of paddy	148.61	2.43
		ET of paddy (spring)	13.23	0.22
		ET of maize (winter)	20.53	0.34
		ET of maize (summer)	27.73	0.45
		ET of wheat	5.98	0.10
		ET of potato	1.94	0.03
		ET of pulses	5.18	0.08
		ET of vegetables	5.47	0.09
		ET of oil seeds	11.72	0.19
		Domestic uses	5.90	0.10
		Animal uses	2.99	0.05
		Industrial uses	0.18	0.00
		Subtotal	249.46	4.08
5	Non-process depletion (beneficial)	a) ET of forest (dense)	669.45	10.94
		b) ET of forest (sparse)	769.33	12.57
		c) ET of grazing land	90.37	1.48
		d) ET of homestead	31.72	0.52
		Subtotal	1,560.87	25.5
6	Non-process depletion (non-beneficial)	ET of barren land, flood plain and water body	197.50	3.23
7	Outflow	Runoff	3,575.76	58.42
	Sum of depletion and surface runoff		5583.59	na
	Sum of net inflow		6120.42	na
	Difference in estimation		536.83	na

Water Account Result for Dry Year

Year of Interest: Dry Year, 1992

Previous Year: Normal Year

No.	Component	Subcomponent	Volume in (m ³ x 10 ⁶)	% of Net flow
1	Gross inflow	a) Rainfall	4,433.10	na
		b) Kulekhani	78.09	na
		c) Narayani	52.80	na
2	Storage changes	a) Surface storage	0.00	na
		b) Ground storage	0.00	na
3	Net Inflow		4,564.00	na
4	Process depletion	ET of paddy	150.27	3.29
		ET of paddy (spring)	13.61	0.30
		ET of maize (winter)	11.22	0.25
		ET of maize (summer)	29.44	0.65
		ET of wheat	3.68	0.08
		ET of potato	2.25	0.05
		ET of pulses	2.90	0.06
		ET of vegetables	5.14	0.11
		ET of oil seeds	6.53	0.14
		Domestic uses	5.90	0.13
		Animal uses	2.99	0.07
		Industrial uses	0.18	0.00
		Subtotal	234.12	5.13
5	Non-process depletion (beneficial)	a) ET of forest (dense)	647.35	14.18
		b) ET of forest (sparse)	764.08	16.74
		c) ET of grazing land	90.74	1.99
		d) ET of homestead	31.04	0.68
		Subtotal	1,533.21	33.59
6	Non-process depletion (non-beneficial)	ET of barren land, flood plain and water body	195.72	4.29
7	Outflow	Runoff	2,200.54	48.22
	Sum of depletion and surface runoff		4,163.59	na
	Sum of net inflow		4,564.00	na
	Difference in estimation		400.41	na

Mean Monthly Discharge at Rajaiya Station

Name of station: Rajaiya Lat. 27 26 30; Long. 84 58 15; Elevation: 332; Drainage area: 579 sq. km.

Name of river: Rapti Station number : 60

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1976	8.01	6.69	5.39	5.43	8.8	19.3	53.3	52.4	48.8	24.1	13.4	9.36	21.3
1977	7.38	6.18	4.87	7.49	8.65	14.4	48	63	45.5	29.9	20.6	13	22.6
1978	9.92	8.08	7.45	14.5	12.2	48.5	62.25	72.15	40.6	27.55	17.5	12.05	27.73
1979	8.08	8.1	5.86	5.25	4.56	11.8	76.5	81.3	35.7	25.2	14.4	11.1	23.99
1980	8.38	7.23	6.29	4.7	6.88	24.3	47.3	66.1	60.2	29.7	16.5	11.5	24.09
1981	9.57	6.98	5.55	6.72	9.67	14.8	61.9	82.9	74	40.9	19.5	13.3	28.82
1982	10.7	9.34	9.76	11.8	10.64	12.8	54.55	59.5	88.7	30.7	16.7	12.5	27.31
1983	11.5	10.4	9.25	9.09	11.6	10.8	47.2	46	51.4	30.2	15.9	13.1	22.20
1984	12.2	10.6	8.9	8.18	8.58	28.1	55.8	60.4	95.2	26.2	17.9	13.7	28.81
1985	12.2	10.9	9.19	9.58	12.3	22.2	53	51	91.4	50.7	24.7	16.6	30.31
1986	12.8	11.8	10.2	9	9.66	24	57.8	86.6	88.9	35.8	20.2	15.1	31.82
1987	15.5	10.6	8.73	9.09	8.5	10.8	63.6	73.9	43.3	27.9	16.9	13.4	25.19
1988	11.7	10.4	10.2	10	12.2	21.1	55.8	87.4	60.2	20.5	15.3	14.9	27.48
1989	14.8	13.2	11.2	12.1	11.6	18.1	61.6	41.2	99.3	29.5	16.6	14.6	28.65
1990	9.20	8.86	7.45	9.16	11.53	17.82	55.40	81.44	79.58	37.24	9.33	7.47	27.87
1991	8.12	7.62	9.33	9.00	10.28	21.90	56.51	66.80	73.43	28.75	9.1	9.5	25.87
1992	8.74	8.27	9.29	9.43	9.83	17.17	56.01	67.34	63.49	36.41	8.9	9.2	25.34
1993	8.14	8.14	7.57	8.73	9.73	18.45	63.66	84.58	61.89	29.34	8.8	9.6	26.55
1994	7.55	7.85	7.49	7.87	9.82	29.57	53.86	68.21	62.68	26.78	7.5	9.6	24.90
1995	8.73	8.83	7.84	8.01	11.63	31.38	56.02	80.68	55.90	27.76	9.33	9.47	26.30
1996	9.34	9.06	9.40	8.27	9.81	18.86	57.21	77.28	66.05	34.72	8.66	8.50	26.43

Computation of Discharge at Confluence Point

$Q_c = Q_r \cdot (A_c/A_r) \cdot (R_c/R_r) \cdot (S_c^{1/2}/S^{1/2})$; $S_c = 0.013772$; $S_r = 0.032657$; Drainage area = 2,993 sq.km;
 Length of the basin = 98.75 km; Length up to Rajaiya = 35 km;
 Main stream = 122 km; tributaries = 277 km.

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1976	40.05	46.08	35.68	22.32	18.98	62.69	168.53	133.60	174.23	60.90	50.21	39.52	63.82
1977	28.83	25.29	21.10	18.46	35.66	23.55	166.47	175.85	154.23	148.05	70.07	41.17	64.75
1978	112.70	60.96	21.24	44.28	40.13	132.16	154.45	274.96	145.20	69.81	300.97	105.76	81.72
1979	131.47	26.73	5.11	10.80	27.59	61.69	235.68	271.67	105.69	259.21	46.35	162.89	84.43
1980	7.80	22.43	54.12	8.76	33.17	79.65	174.21	324.05	209.38	188.74	107.66	20.41	94.42
1981	71.74	6.50	15.23	51.43	45.33	68.47	263.50	423.17	345.45	26.57	71.34	8.64	131.49
1982	38.40	26.29	52.25	78.60	35.89	47.62	193.29	301.17	367.59	103.53	39.47	43.76	112.53
1983	34.56	11.47	53.29	21.69	46.72	26.52	185.21	162.69	167.26	110.39	178.20	77.29	78.18
1984	71.30	22.50	23.21	27.21	32.30	79.86	249.27	205.25	334.73	246.00	11.63	111.77	103.53
1985	41.89	232.32	62.54	18.20	47.46	53.84	245.57	196.47	240.03	228.37	40.27	52.13	103.70
1986	44.32	36.51	60.14	47.82	35.63	73.48	220.47	268.70	303.55	180.16	214.39	58.30	111.07
1987	65.37	55.18	30.13	33.20	32.93	45.51	250.91	187.71	90.15	102.02	11.19	37.47	82.68
1988	7.66	31.63	32.66	39.81	42.15	66.80	205.97	239.91	161.49	34.54	69.53	46.15	85.43
1989	150.17	41.27	54.06	57.37	28.32	56.71	169.44	124.58	221.13	70.25	91.24	38.18	78.35
1990	30.91	23.64	25.81	20.64	36.83	59.67	172.47	199.47	196.85	76.61	69.84	69.43	76.05
1991	15.42	94.54	30.02	42.94	23.06	58.01	164.03	185.88	167.61	63.07	73.26	34.09	69.18
1992	32.90	21.43	39.48	39.33	23.37	39.88	170.82	197.54	151.50	83.44	16.77	15.18	67.96
1993	14.58	57.54	23.66	25.69	39.50	50.09	130.66	217.99	166.87	99.93	43.22	31.05	68.04
1994	18.89	45.92	24.62	20.39	35.34	78.47	198.46	212.71	330.65	61.63	45.09	39.96	86.91
1995	34.83	33.26	17.57	98.66	26.16	83.71	176.38	194.58	184.24	200.37	21.99	15.65	72.82
1996	35.82	25.40	23.02	11.73	22.68	57.23	152.71	189.70	173.50	104.33	39.96	39.22	70.39
Average	49.03	45.09	33.57	35.21	33.77	62.17	192.79	223.22	209.11	119.90	76.79	51.81	85.12

Note: Some undefined values of runoff at the confluence were predicted because of rainfall ratio with zero value either in the Rajaiya basin or in the whole basin. Such values are replaced by taking the average of the preceding and the following month.

8.2 Information Base of the River Basin

Describe the available system of monitoring rainfall, reservoir storage and river flows at key locations, water quality, groundwater level and quality, various environmental conditions, diversion by various users, etc., stating the agencies responsible for these monitoring tasks and the existing information-sharing arrangements.

Department of Hydrology and Meteorology (DIHM) collects rainfall, humidity, sunshine hour, evaporation, wind speed, and temperature data by means of a network of several hydrological and meteorological stations located throughout the country. The collected data are published regularly and are also available from the Department's database. In addition, various agricultural research stations also collect agro-meteorological data. There are also some special data collection points that are administered through several research projects by TU, NARC, RONAST, RECAST, ICIMOD, etc. DIHM also collects river discharge data of the main rivers in the country. Besides, concerned specific projects (such as irrigation, drinking water, and hydropower projects) collect and maintain data of the related water sources. The groundwater level and quality data are to be collected by the Groundwater Division of the Department of Irrigation (on verification it was found that the data are inadequately kept). There is no clear mechanism for sharing the data or maintaining a national database. DIHM is making some efforts to address this gap. No agency has been given specific responsibility for monitoring and/or maintaining records of water diversions along a stream by various water user systems.

9. Water Administration

9.1 List the principal agencies involved in water management and indicate how they are spatially organized.

Name of agency	Type of agency*	Area of jurisdiction**
National Water Resources Committee	Government	Country
National Planning Commission	Government	Country
Water and Energy Commission Secretariat	Government	Country
Ministry of Water Resources	Government	Country
Groundwater Resources Development Board	Government	Country
Department of Hydrology and Meteorology	Government	Country
District Water Resources Committee	Local government	District (province)
WUAs and WUA Federation	Irrigation beneficiary groups	Schemes and district

Note: Spatial linkages of these agencies will be dealt in-depth in the subsequent institutional studies.

* National line agency/state/provincial/local government/other.

** Country/state/province/basin/water district/administrative region/village/scheme /other.

9.2 List the main responsibilities of the specified agencies.

Responsibility Matrix: Agencies responsible for identified tasks

Tasks	National Water Resources Council	National Planning Commission	Ministry of Water Resources	Water and Energy Commission Secretariat	Ministry of Population and Environment	Groundwater Resources Development Board	Department of Hydrology and Meteorology	Nepal Electricity Authority	Department of Irrigation	Department of Water Supply and Sewerage	Nepal Water Supply Corp.	WUAs and Federation	I/NGOs	Remarks
Governance	C	C	R	C	C	C	C	R	R	R	C	IP	IP	
Water allocations for different uses	C	C	R	C	C	C	C	R	C	C	IP	IP	IP	
Water distribution	C	C	C	C	C	R	C	R	R	R	C	IP	IP	
Water quality protection and salinity management	C	C	C	C	R	C	C	C	C	R	C	IP	IP	IP
Flood protection	C	C	C	C	C	IP	C	C	E	R	IP	IP	IP	
Wetland protection	C	C	C	C	E	C	C	C	C	C	IP	IP	IP	
Maintenance of infrastructure	C	C	C	C	C	C	C	R	R	R	R	IP	IP	IP
Master planning	E	R	R	R	C	C	C	C	R	R	C	IP	IP	
Design and construction of new facilities	C	C	C	C	C	C	C	E	E	E	E	C	IP	
Resource mobilization	E	E	C	C	C	C	C	C	C	C	C	IP	IP	
Impact assessment studies	C	E	E	E	E	E	C	C	C	C	C	C	C	

E-Executive responsibility; C-Consulted; R-Regulatory responsibility; IP-Interested party.

9.3 Describe the formal mechanisms for interagency coordination.

There are various bodies for coordinating various agencies involved in the water-resources associated programs. Water Resources Development Council, National Planning Commission and District Water Resources Committees are the main agencies associated with the interagency coordination. Subsequent elaborate studies on institutional aspects would provide in-depth understanding of the prevailing mechanism of the coordination. It will be better dealt in the ongoing study on institutional aspects.

9.4 Describe the mechanisms for the accountability of officials/water service providers and users.

Will be better understood and reported during the subsequent institutional studies.

10. Irrigated Agriculture

10.1 General

	Present	20 years ago
Cultivated area (ha)	85,578	83,448
Urban land area (ha)	1,607	na
Grassland/Savannah (ha)	10,581	22,734
Forest cover (ha)	120,959	194,214
Area covered with water (ha)	17,275	na
Irrigated land area (ha)	32,267	na
Irrigated area as a proportion of total arable area (%)	42.73	na
Area under surface irrigation systems (ha)	32,388	na
Area under ground water systems (ha)	7,743	na
Cropping intensity – surface systems	na	na
Cropping intensity – groundwater systems	na	na

10.2 List the main crops grown under irrigation.

Name of crop	Present	10 years ago
Paddy	Paddy	Paddy
Maize	Maize	Maize
Early paddy	Early paddy	-
Wheat	Wheat	Wheat

10.3 Indicate the current yield of major irrigated crops. How do current yields compare with those obtained 10 years ago?

Name of crop (irrigated area)	Present yield		Yields 10 years ago		
	Amount	Unit	Higher	About same	Lower
Paddy	3.4	t/ha		X	
Maize	1.2	t/ha		X	
Early paddy	4.2	t/ha		na	
Wheat	2.1	t/ha		X	

10.4 Changes in Cropping Patterns and Yield

10.4.1 *If changes in cropping patterns and yields have been noted, outline the main reasons for the changes with particular attention to impacts of the institutional environment.*

This will be dealt with in the forthcoming performance assessment of irrigated agriculture exercise.

10.5 Outline mechanisms for beneficiary participation in O&M of irrigation systems.

Entire O&M and other irrigation management responsibilities in case of farmer-managed irrigation systems (FMIS) and fully turned over systems lie with the WUAs. Formal or informal WUAs already exist in the case of FMIS.

In case of jointly managed systems, such responsibilities are mutually agreed upon and tasks are carried out accordingly. As per the Irrigation Policy there will be no fully agency-managed systems. WUAs will be formed in the systems where they do not exist and the irrigation management responsibilities will be shared. Several WUAs have been formed or are in the process of being formed.

In order to receive the agency's support of various kinds in the irrigation systems the formation of water user groups is mandatory.

Formation of a national-level WUA Federation is also in the process.

10.6 Multiple Use of Irrigation Water

10.6.1 *List the various other uses of irrigation water at the irrigation-scheme level.*

Uses of water	Check X
Drinking water supply	X
Bathing/washing clothes	X
Watering home gardens	X
Animal husbandry	X
Cottage industry	X
Fishery/aquaculture	X
Other	

10.6.2 Describe the existing institutional arrangements to cope with the multiple uses of irrigation water.

No precise policies exist with respect to inter-sectoral water transfers or interbasin transfers of water. The natural resources in the country are owned by the state and only use rights are given out. The central government-level agencies have the sole decision-making authority and accordingly command influence. Recently, there were some initiatives for delegating some related authority over to the district-level water resources committees. Subsequently, these committees are expected to be primarily involved in river water management tasks at the district level. Only informal inter-sectoral water allocation arrangements exist, for example, between water mills and irrigation. There exist informal intra-sectoral water allocation and distribution arrangements, for example, in-between turns of irrigation. Spatial water administration is based on administrative boundaries of districts that do not follow the basin's hydrological boundaries. There are various bodies for coordinating various agencies involved in the associated water resources programs. Water Resources Development Council, National Planning Commission and District Water Resources Committees are the main agencies associated with the interagency coordination. Subsequent elaborate studies on institutional aspects would provide in-depth understanding of the prevailing mechanism of the coordination. There are no established procedures for the involvement of private sectors in irrigation activities; licensing and pricing arrangements are still under discussion.

10.6.3 Describe how the multiple use of irrigation water affects the performance of irrigated agriculture.

This will be dealt with in the forthcoming irrigated agriculture performance assessment report.

11. Competition for Water in the Basin

11.1 Enter relevant code: 1=no competition, 2=moderate competition, 3=severe competition, 4=complementary use.

	Irrigation	Domestic water	Industry	Hydro-power	Navigation	Fisheries	Waste disposal	Recreation	Water quality control	Aesthetic/Environmental use
Irrigation	2	1	1	1	1	2	1	2	1	2
Domestic water supply	1	2	2	1	1	1	2	2	2	1
Industry	1	2	2	1	1	2	1	1	2	2
Hydropower	1	1	1	1	1	1	1	1	1	1
Navigation	1	1	1	1	1	1	1	1	2	1
Fisheries	2	1	2	1	1	1	2	1	2	1
Waste disposal	1	2	1	1	1	2	1	2	2	1
Recreation	2	2	1	1	1	1	2	1	1	1
Water quality protection	1	2	2	1	1	2	2	1	1	1
Aesthetic and environmental use	2	1	2	1	1	1	1	1	1	1

11.2 Describe how the competition for water at the basin level affects agricultural water use.

This will be dealt with in the forthcoming performance assessment report.

12. Outline briefly the emerging trends in the scarcity of water.

- Seasonal water scarcity
- Surface irrigation systems are getting stressed for required water supplies during the dry season.
- Quests by WUAs for augmenting water supplies from alternative surface sources and groundwater.
- Catchment degradation and growing water demands.

13. Outline briefly the emerging trends in the inter-sectoral competition of water.

- Competition for water uses and related inter-sectoral conflicts with increasing water demands leaving less and less water for irrigation purposes.
- Policies of securing water rights are getting refined. Water licensing, pricing, surface water and groundwater use and water quality regulations are emerging.

14. Outline briefly the emerging trends in the water quality and environmental related problems.

- Conflicts between the buffer-zone settlers, irrigation systems and the national park people are becoming more vivid and arrangements are being mutually discussed to resolve mutually affecting water use practices.
- Silt-laden flows due to the degradation of catchment and industrial affluent causing problems for irrigated agriculture.
- Growing concerns about river diversion on the environment, especially on terrestrial and aquatic life.

15. In light of the emerging trends in water resources in the basin, assess the future of irrigated agriculture in the basin.

This will be dealt with in the ongoing irrigated agricultural performance assessment studies.

16. Summarize the key institutional arrangements that should be in place to enhance the productivity and sustainability of irrigated agriculture in the basin.

A set of recommendations will be made after the planned in-depth institutional studies.

The Basin Profile

Philippines

Name of selected river basin : Upper Pampanga river basin

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1. Country Overview

1.1 *Salient features of the country with particular focus on the importance of irrigation in the economy*

- The Philippine economy remains agriculture-based, yet agriculture's share of total output has fallen from over a third to barely a fifth in the last 50 years.
- Area devoted to agriculture (11,664,600 ha) represents 39 percent of the total land area (30,000,000 ha).
- GVA in agriculture, fishery and forestry in 1996 was P470, 341 million pesos, and a growth rate of 3.07 percent; crops contribute 60 percent.
- Yields in traditional grain like rice and corn improved steadily from 1946-50 (1.11 tons/ha for rice and 0.61 tons/ha for corn) to 1991-96 (2.85 for rice and 1.46 for corn), albeit not very dramatically.
- Sixty three percent of the population in 1997 were dependent on agriculture as a source of livelihood.
- The country's population of 74.7 million in 1998 is projected to increase to 107.2 million in 2020 as the country's population increases at the rate of 2.32 percent per annum.
- With the rapid increase in population and urbanization, there is an apparent need to increase food production.
- Population growth rate (2.32) has been outpacing growth rate in agriculture (0.72) from 1994-1998.
- Area devoted to agriculture is decreasing due to the pressures of urbanization and industrialization, which continue to hamper production efforts; hence, the need to optimize available land for agriculture is imperative, which is only possible if water is available.

1.2 Key national indicators

	Unit	Quantity	Source
1. Total land area	km ²	300,000	PSY
2. Population (1998)	million	74.723373	PSY
3. Projected population for 2020	million	107.240,000	Computed
4. Population growth rate (1990 - 1995)	%	2.32	PSY
5. Urban population as % of total	%	47.56	PSY
6. Urban population growth rate	%	na	na
7. Rural population as % of total	%	52.43	PSY
8. GNP per capita, 1998 at current prices	US\$	914	MTPDP
9. Contribution to the GDP of ff. sectors (1993-1998)			
a. Agriculture	%	21.3	MTPDP
b. Industry and manufacturing	%	35.2	MTPDP
c. Services	%	43.5	MTPDP
10. Average annual growth rate of (1994-1998):			
a. Agriculture	%	0.72	MTPDP
b. Industry and manufacturing	%	4.62	MTPDP
c. Services	%	4.9	MTPDP
11. Total annual water resources (1976)			
a. Mean rainfall	km ³	708	1/
b. Mean runoff	km ³	479	1/
c. 90% probability runoff	km ³	257	1/
d. Total = a + c	km ³	965	Computed
12. Per capita water availability	m ³	12,900	Computed
13. Total water withdrawals	km ³	220	Computed
14. Per capital withdrawal of ff. sectors:(1983)			
a. Domestic	m ³	31	2/
b. Industrial	m ³	1.2	2/
c. Agriculture (mainly irrigation)	m ³	2,885	2/
15. Gross irrigated area (1998)	ha	1,475,484	MTPDP
16. Percentage of population with access safe water	%	78.29	MTPDP

PSY = Philippine Statistical Yearbook, 1999.

MTPDP = Medium-Term Philippine Development Plan, 1999-2004.

1/ = NWRC as summarized in World Bank, Philippine Irrigated Agriculture Sector Review, 1992.

2/ = National Water Resources Council, 1983, Agno River Basin Framework Plan.

2. Water Resources Policy

2.1 Describe the implicitly and explicitly stated national, federal/provincial or other subnational-level goals and policies for water resources development.

The bases of the Philippines' policies on water resources development and management are the Constitution and the 1976 Water Code (P D 1067). The agency mandated to enforce the provisions of these basic laws is the National Water Resources Board (NWRB), formerly the National Water Resources Council (NWRC). Important provisions of these laws are:

1. *All waters belong to the state.* These include rivers and their natural beds, springs and brooks including their natural beds, natural lakes and lagoons, all other categories of surface water, atmospheric water, groundwater and seawater. Water inside private lands also belong to the State.
2. *Appropriation of waters.* Each user of water is required to secure a water permit from the NWRB to obtain a Water Right for the use of the water. Only qualified citizens of the Philippines may apply for water permits. Water appropriation honors the priority in time, (first come, first served) except during times of emergency where the use of water for domestic and municipal purposes shall have a better right over all other uses.
3. *Utilization of water.* This defines the preferences in the development of water resources that include security of the state, multiple uses, beneficial effects, adverse effects and costs of development. Further provisions define the utilization of groundwater, watercourses for conveyance, water reuse, construction of storage dams and other structures, drainage systems and cloud seeding.
4. *Other provisions of the Code.* This includes control of floodwater, flood plain management, navigation and well drilling. Conservation and protection of water and watersheds are also promulgated including protection of wildlife sanctuaries and protection of water bodies from pollution. The latter part of the Code established the penal provisions for violations and the administrative requirements for its implementation.

Development Objectives

The Medium-Term Philippine Development Plan (MTPDP) for 1999-2004 explicitly stated that the objective of the water-resources sector is to provide improved services to the communities through efficient conservation, utilization and planning of the country's water resources. Planning is based on the following:

- a. Water is a limited resource that must be conserved and managed efficiently.
- b. Water shall be treated as an economic good such that capacity and willingness-to-pay should be considered in water pricing.

The formulated principal objective supports the following:

- a. The creation of an independent authority that will formulate national policies on resource management, regulation, utilization, planning and conservation. The authority shall pursue sustainable development, promote an integrated development approach, implement policies on decentralized operations and support the activation of river-basin authorities to effect IWRM.
- b. The participation of the private sector to promote market-based incentives in water conservation and provision of incentive programs on water resources development initiatives.
- c. Irrigation development anchored on food security.
- d. Strong community-based forest protection and reforestation activities.
- e. Pricing mechanism that balances cost recovery and externalities with the capacity and willingness-to-pay of beneficiaries.
- f. Intensified campaign to raise public awareness that water is a limited resource and an economic good.
- g. A rational and coordinated basic water data collection system with efficient and effective information flow to facilitate water resources assessments.
- h. Strict enforcement of water-related laws, rules and regulations as deterrent to overexploitation of the groundwater resources.
- i. Harvesting and impounding of rainwater as an alternative to groundwater utilization.
- j. Participation of women in water supply and irrigation development.
- k. Conducting priority research for water conservation, sanitation and pollution control.

The statement of the above objectives is an implicit recognition of the prevailing sad state of water resources development and management in the Philippines as given below:

- a. Proliferation of water sector agencies. There are at least 30 government agencies dealing with water.
- b. Inability of the NWRB to effectively enforce the provisions of the Water Code. NWRB is confined to the headquarters in Metro Manila.
- c. The need to structure and strengthen the NWRB.
- d. The sorry state of the basic water data collection that hampers the assessment of water resources for development planning. For example, data series of rainfall and stream flow are short and discontinuous.

- e. The impact of the Local Government Code on decentralization and devolution of some of the functions of national agencies. For example, the communal irrigation development that has been devolved from the National Irrigation Administration to the local government units.
- f. The propensity of many Filipinos to use rivers, creeks and other watercourses as dumping sites of waste without regard to quality deterioration and destruction of the ecosystem.
- g. The overlapping functions of many water agencies. For example, NIA, BSWM, and LGU currently undertake irrigation development.
- h. The reluctance of water project beneficiaries to shoulder O&M cost. For example, the very low collection efficiency of irrigation service fee and the ever-increasing ISF collectibles of NIA.
- i. The continuing deterioration and degradation of the watersheds because of the combined impact of logging operations and slash-and-burn agriculture.
- j. The urgent need to synchronize water resources development efforts for better efficiency and effectiveness of scarce investment funds.

3. Water Laws and Regulations

3.1 *Laws and regulations concerning surface water and groundwater usage and pollution control.*

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Philippine Constitution	1987	All water and other natural resources are owned by the state.	DENR, NWRB, PNP
PD 1067	1976	Quantitative regulation, appropriation, utilization, development and conservation of water resources.	NWRB
RA 3601	1964	Creation of the National Irrigation Administration for development of water resources for irrigation, particularly NIS.	NIA, DPWH
PD 552	Sept. 11, 1974	Expansion of the powers of NIA to include both NIS and CIS, authority to delegate partial or full management of NIS to IAs and to undertake multipurpose water resources projects designed primarily for irrigation.	NIA
PD 1702	July 18, 1980	Further amendments to RA 3601 increasing NIA capitalization from P2 billion to P10 billion and authorizing NIA to collect 5 percent of project cost as administrative and engineering overhead charges on projects it implements.	NIA
RA 6978	Jan. 24, 1991	Promote rural development by providing for accelerated programs for construction of irrigation projects. Mandated NIA to complete construction of irrigation projects in 1.5-million hectares of nonirrigated but irrigable area within 10 years.	NIA

RA 8435	1997	Known as Agriculture and Fisheries Modernization Act (AFMA). High priority to rehabilitation and small-scale community-based irrigation projects. Recognizes IAs as partners in irrigation development and watershed conservation and rehabilitation. Promotes collaboration among NIA, DENR, NPC, LGU and IA for watershed rehabilitation and protection. Reiterates devolution of CIS to LGU and management turnover of NIS to IAs.	NIA, DA, DENR, NPC, LGU
E.O. No. 374– Creating the Presidential Task Force on Water Resource Development and Management	Oct. 15, 1996	The Task Force shall serve as an oversight body for ensuring the efficient sourcing and use of water resources, in particular the provision of policy and program recommendations on the following: a. Water supply planning and coordination, including the efficient allocation of water resources. b. Prioritization of programs and projects critical for ensuring sustainable, adequate, safe and affordable water supply. c. Coordination and monitoring of water policies and programs. d. Pricing policies on water resources.	DENR, NWRB, DOE, DOH, DA, DILG, MWSS
RA 8041 (National Water Crisis Act of 1995)	1995	<ul style="list-style-type: none"> • Authorized the organization of the Joint Executive Legislative Water Crisis Commission, which shall, among others, recommend measures that will ensure continuous and effective monitoring of the entire water supply and distribution system in the country. • Sections 8, 9 and 10 specify the circumstances under which a person may be charged and penalized for theft, pilferage or any unlawful acts against any water utility, whether public or private. 	
RA 6978	Jan. 24, 1991	Promote rural development by providing for an accelerated program for construction of irrigation projects. Mandated NIA to complete construction of irrigation projects in 1.5 million hectares of nonirrigated but irrigable area within 10 years.	NIA
DENR Administrative Order No. 34 s. 1990	1990	Specifies the revised water usage and classification for fresh surface water (lakes, reservoirs) and coastal and marine water.	
Philippine Constitution	1987	<ul style="list-style-type: none"> • All water and other natural resources are owned by the state. • The state shall allow the use or development of water by administrative concessions through the issuance of water right to users. The water right is the privilege to appropriate and use water granted by the government through the NWRB. • The measure and limit of appropriation of water are beneficial use, and the utilization of the right amount during the period that the water is needed for producing the benefits. 	DENR, NWRB, PNP

		<ul style="list-style-type: none"> • Priorities in appropriation of water follow the priority in time principle except in times of emergency when the use of water for domestic purposes has greater right over all other uses. 	
PD 1702	July 18, 1980	Further amendments to RA 3601 increasing NIA capitalization from P2 billion to P10 billion and authorizing NIA to collect 5 percent of project cost as administrative and engineering overhead charges on projects it implements.	NIA
PD 1067	1976	Quantitative regulation, appropriation, utilization, development and conservation of water resources.	NWRB
PD 552	Sept. 11, 1974	Expansion of the powers of NIA to include both NIS and CIS, authority to delegate partial or full management of NIS to IAs and to undertake multipurpose water resources project designed primarily for irrigation.	NIA
RA 3601	1964	Creation of the National Irrigation Administration for development of water resources for irrigation, particularly NIS.	NIA, DPWH

4. Property Rights

4.1 *Outline the basis for general rights in agricultural land use, and surface water and groundwater use.*

The agencies responsible in the appropriation of land to agricultural use are the following:

- a. The Department of Environment and Natural Resources (DENR). It is responsible for the delineation of public land for conversion to Alienable and Disposable Land. No public land may be acquired for titling unless declared by DENR as A&D lands.
- b. The Department of Agrarian Reform (DAR). Lands that are currently under agriculture are banned for conversion to other land uses. Also, DAR is responsible for the acquisition of agricultural lands for distribution to landless farmers. Agricultural lands that are subject of agrarian reform are subdivided to a maximum of 3-hectare farm lots and distributed to actual tillers. A landowner is entitled to retention of, at the most, 7 hectares for each of his/her heirs.

The utilization of surface water and groundwater is governed by the Philippine Water Code through the National Water Resources Board (NWRB):

- a. All water belong to the state and are not subject to any acquisitive prescription.
- b. The state may allow the use or development of water by administrative concession through the issuance of a Water Right to the user. The Water Right is the privilege to appropriate and use water granted by the government through the NWRB.

- c. The measure and limit of appropriation of water are beneficial use and the utilization of the right amount during the period that the water is needed for producing the benefits.
- d. Priorities in appropriation of water follow the priority in time principle except in times of emergency when the use of water for domestic purposes has greater right over all other uses.

4.2 Land Laws and Regulations

List of existing laws and regulations concerning land use and tenure.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Administrative Order No. 37, s. 1999	1999	Specifies revised guidelines on the certification of eligibility for reclassification of agricultural lands and provides mechanisms for the implementation thereof.	DA, DAR
Republic Act No. 8435 (Agriculture and Fisheries Modernization Act)	1997	Provides the delineation of Strategic Agriculture and Fisheries Development Zone (SAFDZ) within the network of Protected Areas for Agriculture and Agro-Industrial Development (NPAAD) to ensure that lands are efficiently and sustainably utilized for food and nonfood production and agro-industrialization.	DAR
Republic Act No. 7279 (Urban Development Housing Act of 1992)	1992	Provides for the rational use and development of urban land to bring about: (1) equitable utilization of residential lands in urban and urbanizable areas; (2) optimization of the use and productivity of land and urban resources; (3) development of urban areas conducive to commercial and industrial activities; (4) reduction in urban dysfunctions, particularly those that adversely affect public health, safety and ecology; and (5) access to land and housing by the underprivileged and homeless citizens.	HLURB (Housing and Land Use Regulatory Board)
Republic Act No. 7160 (Local Government Code)	1991	Mandates cities and municipalities to prepare and update their respective comprehensive land-use plans enacted through zoning ordinances which shall serve as a basis for use of their resources and reclassification of agricultural lands.	DILG, DAR
Republic Act No. 6657 (Comprehensive Agrarian Reform Law)	1988	The Department of Agrarian Reform may authorize the reclassification or conversion and deposition of the land after a lapse of 5 years from its award, if it ceases to be economically feasible and sound for agricultural purposes or when the locality has become urbanized and will have greater economic value for residential, commercial or industrial purposes.	DAR

P.D. 1067 (Water Code of the Philippines)	1976	Any watershed or any area of land adjacent toNWRB any surface water or overlying any groundwater may be declared as a protected area. Rules and regulations may be promulgated to prohibit or control such activities by the owners or occupants thereof within the protected area, which may damage or cause the deterioration of the surface water or groundwater or interfere with the investigation, use, control, protection, management or administration of such waters.
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4.3. List of existing laws and regulations concerning environment management

Environmental laws and regulations

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
Republic Act No. 8749 (Philippine Clean Air Act of 1999)	1999	The state shall promote and protect the global environment to attain sustainable development while recognizing (1) the primary responsibility of local government units to deal with environmental problems and (2) the principle that “pollutants must pay.”	DENR
Republic Act No. 8371 (Indigenous People’s Right Act of 1997)	1997	Provides the indigenous peoples (IPs) with a freer reign on the management of their ancestral domains and promotes partnership between the government and the IPs in protecting the forests.	DENR/ DAR
R.A. No. 8041 (National Water Crises Act of 1995)	1995	Seeks to address the issues relevant to the water crises including, but not limited to, supply, distribution, finance, privatization of state-run water facilities that include the protection and conservation of watersheds.	DENR, NWRB, MWSS, LWUA
Republic Act No. 7279 (Urban Development Housing Act of 1992)	1992	Provides for the rational use and development of urban land to bring about (1) equitable utilization of residential lands in urban and urbanizable areas, (2) optimization of the use and productivity of land and urban resources, (3) development of urban areas conducive to commercial and industrial activities, (4) reduction in urban dysfunctions, particularly those that adversely affect public health, safety and ecology, and (5) access to land and housing by the underprivileged and homeless citizens.	
Republic Act No. 7586 (National Integrated Protected Areas System Act of 1992)	1992	Underscores the critical importance of protecting and maintaining the natural biological and physical diversities of the environment, notably in areas with biologically unique features to sustain human life and development, as well as plant and animal life. Imposes a ban on logs and lumber exports as well as on logging in old-growth forests.	DENR

Presidential Decree No. 1160	1977	Vested authority in the Barangay (Village) Captains to enforce pollution and environmental control laws.	National Environmental Protection Council
Presidential Decree No. 1152		Section 14 of the Code provides management guidelines aimed to protect and improve the quality of Philippine Water Resources through classification and standards, and surveillance and mitigation of pollution incidents.	National Pollution Control Commission

Water Rights Regulations – PD No. 1067 (Adopted from Philippines Water Supply Sector Reform Study, 1993)

A water right is the privilege granted by the government to the appropriate use of water. A water right is evidenced by a document called the water permit. The Water Code prescribes the requisites for application and grant of water permits.

The following may apply for water permits:

- Citizens of the Philippines.
- Associations, cooperatives and corporations duly organized and registered under Philippine laws with at least 60 percent of its capital owned by Filipino citizens.
- Government entities and instrumentalities including government-owned and controlled corporations.

Water permits may be applied for and granted by the NWRB in the following instances:

- Appropriation of water for domestic, irrigation, power generation, fisheries, livestock-raising, industrial, recreational and other purposes.
- Changes in the purpose of appropriation.
- Amendment to an existing permit, such as change in joint or nature of diversion, amount of appropriation, period of use, etc.
- Transfer or lease of water right.
- Temporary appropriation and use of water.
- Developing a stream, lake or spring for recreational purposes.
- Lowering or raising the level of water of a lake, river or marsh or draining the same.
- Trans-basin diversion.
- Dumping of mine tailings or waste into a river or a waterway.

In certain instances, the NWRB may delegate authority to grant water permits to other government agencies, to wit:

- The Department of Energy (DOE) for excavation for the emission of a hot spring.
- The Weather Bureau (PAGASA) for cloud seeding to induce rainfall.
- The National Pollution Control Commission (NPCC) for recharging groundwater supplies.

Whenever necessary, however, the Board may exercise any of the above-cited delegated authorities.

The instances where a water permit is not necessary are:

- When the owner of the land where the water is found uses the water only for domestic purposes, provided that such use shall be registered when required by the NWRB. The NWRB may, however, regulate such use when there is wastage or in times of emergency.
- When natural bodies of water are appropriated to be used under any of the following conditions:
 - Water is appropriated by means of hand-carried receptacles.
 - Washing or bathing, watering or dipping of domestic or farm animals.
 - Navigation of water rafts or transportation of logs and other objects by floatation.

The right to use water is deemed acquired as of the date of filing of the application for a water permit in the case of approved permits, or as of the date of actual use in cases where no permit is required.

Water permits granted shall be subject to conditions of beneficial use, adequate standards of design and construction, and other conditions that the NWRB may impose. Beneficial use is the utilization of water in the right amount during the period that the water is needed for producing the benefits for which the water is appropriated.

5. Water Allocation and Conflict Resolution

The Philippine Water Code of 1976 established the basis for water allocation as follows:

Water appropriation follows the order of preference for the following purposes:

- a. Domestic – utilization of water for drinking, washing, bathing, cooking or other household needs, home gardens and watering domestic animals.
- b. Municipal – utilization of water for supplying water requirements of the community.
- c. Irrigation – utilization of water for producing agricultural crops.
- d. Power generation – utilization of water for producing electrical or mechanical power.

- e. Fisheries – utilization of water for propagation and culture of fish as a commercial enterprise.
- f. Livestock-raising – utilization of water for large herds or flocks of animals rose as a commercial enterprise.
- g. Industrial – utilization of water in factories, industrial plants and mines, including the use of water as an ingredient of a finished product.
- h. Recreational – utilization of water for swimming pools, bath houses, boating, water skiing, golf courses, and other similar facilities in resorts and other places of recreation.

Conflict resolution on Water Rights is based on the principle of priority in time, i.e., between two or more appropriations of water from the same supply source, the earlier water permit has a greater priority. In the case where this is not resolved by the priority in time, the order of preference enumerated above for the use of water is applied. Conflict resolution involving the use of water is one of the major functions of the NWRB. The Board also organizes Special Committees for conflict resolution for persistent conflict cases similar to the competition of NIA, MWSS and NPC on the water stored in the Angat dam. The Water Crisis Committee for this case remains active since its creation because of the insufficient supply to satisfy both the water requirements for Metro Manila and the irrigation areas in Angat RIS. In this case, the Committee appropriates the water for the different uses every dry season, based on stored water volume in the reservoir as at the end of October. On very acute supply situations, however, the water requirements for Metro Manila for domestic use get the highest priority, as what happened in 1997-1998 when the irrigation service in Angat RIS was totally suspended. Nonetheless, the issue of the compensation of the farmers on their foregone economic benefits in rice production remains unresolved.

6. Indicate the main reasons for selecting the river basin for the case study.

- a. It is considered a major rice producing area, supplying the staple food requirement of 25-30 percent of the total population of the Philippines.
- b. There is a felt need to make sure the available water resource is appropriated wisely to the different water users consistent with the national policy on food security, environment and economic development.

6.1 Climate

Average annual rainfall (mm)	1,994
Annual average Eto	1,907
Maximum temperature (°C)	32.84
Minimum temperature (°C)	20.84
Number of dry months (<5 mm rainfall)	2

6.2 River Network

Length	km	530
Catchment area	km ²	3,742
Elevation (start)	m	122
Elevation (end)	m	11
Maximum flow	m ³ /s	366
Minimum flow	m ³ /s	115
Average annual discharge	mcm	231

6.3 How would you characterize the overall hydrology of the basin?

A water surplus basin	
Water resources are adequate at present	X
Moderately water-scarce basin	
Seasonally water-scarce basin	
Water-scarce basin	

7. Demographic Characteristics of the Basin

Total population (1995)	1,482,580
Population density (1995)	450/km ²
Number of urban centers	3
Number of villages	325
Total urban population (1990)	457,647
Total rural population (1990)	829,868
Per capita availability of water (m ³ /day)	100-150
Households having piped water (%)	27.29
% employed in agriculture (Nueva Ecija, 1990)	22.40
Proportion of population living below official poverty line (Central Luzon, 1997)	33.80

8. Water Utilities

8.1 Main types of water utilities in the river basin

Type of utility	No.	Who owns the utility utility	Who operates the utility	Legal status of operator
Surface irrigation systems	27	Government/ communal	IA	Local NGO-Formal
1. Communal				
rivers and creeks				
small reservoir	7	Government/ communal	IA	Local NGO-Formal
2. National				
surface	3	Government	IA	Government
groundwater schemes				
1. Communal	9	Government	IA	Local NGO-Informal
2. National	0	0	0	0
Domestic water supply schemes	17	Government	Government	Local NGO
Hydropower plants	2	Government	Government	Government
Wastewater treatment plants	0	0	0	0
Wetlands and other water bodies	0	0	0	0

Sector	Annual total demand in MCM
<i>Beneficial use</i>	
Rice and other crops	2,526
Domestic use	68
Industrial, commercial, and recreational	5
<i>Non-beneficial use</i>	
Surface water evaporation	185
ET weeds and brushes	2,206
<i>Outflow</i>	
Drainage outflow in Pampanga river	3,358

9. Water Administration

Institutions relating to water resources/irrigation systems development in the Philippines

National Water Resources Board (NWRB) formerly known as National Water Resource Council

Mandate

Coordinate and integrate water resources development and management throughout the country. In addition, the NWRB also:

- Coordinates and formulates the framework policies concerning water supply and water resources.
- Grants water permit for the appropriation and utilization of water resources.
- Formulates and promulgates rules and regulations for the optimum utilization of water resources.

Reviews and approves water resources development plans and programs.

- Undertakes river-basin survey and appraisal of water and related resources.

The NWRB is an interagency body composed of the following:

Secretary of Public Works and Highways, Chairman
Director General of National Economics and Development Authority, Member
Secretary of the Department of Agriculture, Member
Secretary of Department of Trade and Industry, Member
Secretary of the Department of Environment and Natural Resources, Member
Secretary of the Department of Health, Member
Administration, Metropolitan Waterworks and Sewerage System, Member
Administration, National Irrigation Administration, Member
President, National Power Corporation, Member

National Irrigation Administration (NIA) created by virtue of Republic Act No. 3601 in June 1964

Mandate

Develop, improve, operate and maintain irrigation systems throughout the country. By virtue of Presidential Decree No. 552, NIA assumes the following powers and objectives: (NIA, 1990):

- Plan, design, construct and/or improve all types of irrigation projects and appurtenant structures.

- Supervise the operation, maintenance and repair or otherwise administer temporarily all communal and pump irrigation systems constructed.
- Charge and collect from the beneficiaries of the water, from all irrigation systems constructed by, or under, its administration, such fees or administrative fees or administrative charges as may be necessary to cover the cost of O&M and to recover the costs of construction within a reasonable period of time.
- Construct multipurpose water resources projects designed primarily for irrigation and secondarily for hydraulic power development and other uses as flood control drainage, land reclamation, domestic water supply among others.
- Plan, design and construct drainage facilities and protective works for agricultural purposes to increase or maximize their production yield.

NIA's policymaking body is the Board of Directors composed of six members, to wit:

Secretary of Agriculture, Chairman
 Administrator, National Irrigation Administration, Vice-Chairman
 Director General, National Economic and Development Authority, Member
 Secretary of Public Works and Highways, Member
 President, National Power Corporation, Member
 A member appointed by the President of the Philippines from the private sector representing the rice and corn industry.

Offices and Functions

Central Office

The NIA Administrator is the chief executive officer. He is supported by a Deputy Administrator and four Assistant Administrators for the following sectors: Project Development and Implementation (PDI); Systems Operation and Equipment Management (SOEM); Finance and Management; and Administrative Services.

Directly under the NIA Administrator/Deputy Administrator are 12 departments and two staff offices, namely:

Departments

- Project Development Department
- Construction Management Department
- Design and Specifications Department
- Institutional Development Department
- Systems Management Department

- Equipment Management Department
- Controllership Department
- Treasury Department
- Management Services Department
- Personnel and Records Management Department
- Legal Department
- Procurement and Physical Resources Department

Staff Offices

- Corporate Planning Staff
- Publication and Information Staff

The Central Office is responsible for the issuance of guidelines and policies regarding the field operations of the agency.

Regional and Provincial Offices

There are 13 Regional Irrigation Offices (RIO), each headed by a Regional Irrigation Manager (RIM). At the provincial level, there are 67 Provincial Irrigation Offices (PIOs) each headed by a Provincial Irrigation Officer (PIO).

The RIOs oversee the PIOs and Irrigation Systems Offices (ISO) aside from implementing locally funded national irrigation projects. Meanwhile, the PIOs are responsible for the identification, survey, planning and implementation of Communal Irrigation Projects (CIPs), organization and training of Irrigators' Associations (IAs) and provision of services to the communal systems. The PIOs also assist private individuals or groups of farmers desiring to put up their own irrigation systems. The CIS and PIOs were legally devolved to LGUs by virtue of the Local Government Code of 1991.

The ISOs are headed by irrigation superintendents. They are responsible for the O&M of the national irrigation systems. The Project Management Offices (PMOs), which are headed by project managers, implement foreign-assisted national and communal irrigation systems.

Local Water Utilities Administration (LWUA), created by virtue of Presidential Degree No. 198, as amended.

Mandate

To serve as a specialized lending institution for the promotion, development and financing of Local Water Districts (LWD) and Rural Water Works and Sanitation Associations (RWSA). LWUA is required to assist in the development of pipeline systems serving individual household connections (Level 3) and communal faucets systems (Level 2) in provinces, cities and municipalities with duly organized Water Districts (WDs) and RWSAs.

Section 50 of PD 198 provides that LWUA shall perform the following functions, among others:

- Prescribe minimum standards and regulations for construction materials and supplies, maintenance, operation, personnel training, accounting, and fiscal practices for local water utilities.
- Furnish technical assistance and personnel training programs for local water utilities.
- Monitor and evaluate local water standards.
- Effect system integration and deannexation whenever economically warranted.

Bureau of Soil and Water Management (BSWM)

Mandate

- Render assistance on matters relative to the utilization and management of soil and water as vital agricultural resources.
- Formulate measures and guidelines for effective soil, land and water resources.
- Undertake research on soil conservation and fertility management in agricultural areas.
- Engage in rainmaking projects to solve the impact of prolonged drought and thereby minimize their effects in standing agricultural crops.

The BSWM is headed by a Director who is assisted by an Assistance Director. Directly under the Director/Assistant Director are eight (8) divisions, each headed by a division chief. These divisions are:

Agricultural Land Management and Evaluation
Soil Conservation Management
Water Resources Management
Soil Survey
Soil and Water Resources Research
Laboratory Services
Cartographic Operations
National Soil and Water Resources Research Center

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

Roles and Functions

- Obtain agromet data for farm weather forecasting.
- Observe and record synoptic data for weather forecasting.
- Disseminate severe weather bulletin and farm weather forecast.

Bureau of Fisheries and Aquatic Resources (BFAR)

Mandate

- Conserve, protect and sustain the management of the country's fishery and aquatic resources.
- Alleviate poverty and provide supplementary livelihood among municipal fisherfolk.
- Improve productivity of aquaculture within ecological limits.
- Utilize optimally the offshore and deep sea resources.
- Upgrade postharvest technology.

The NAMRIA is headed by an administrator who is assisted by three deputy administrators. Directly under the office of the administrator/deputy administrators are four divisions (namely: the Administrative, Financial Management, Plans and Operations, and Security and Intelligence divisions) and five departments (namely: the Coast and Geodetic, Surveys, Engineering Services, Mapping and Reprography, Remote Sensing and Resource Data Analysis and Information Management).

Information on the country's land and water resources vital in the implementation of plans geared towards economic progress are made possible through the conduct of integrated and periodic surveys. In addition, NAMRIA classifies for the DENR the remaining unclassified public forests to segregate and demarcate forestlands from nonforest lands. Lands found suitable for agricultural purposes and declared as Alienable and Disposable (A&D) are then slated for distribution to settlers and landless qualified beneficiaries of the comprehensive Agrarian Reform Program.

The agency also conducts land-use assessment/evaluation and land classification and certification of land classification status (NAMRIA, undated).

9.1 Principal agencies involved in water management; indicate how they are spatially organized.

Name of agency	Type of agency	Area of jurisdiction
National Irrigation Administration (NIA)	National government corporation	Country
National Power Corporation (NPC)	National government corporation	Country
Department of Public Works and Highways (DPWH)	National line agency	Country
Department of Environment and Natural Resources (DENR)	National line agency	Country
Bureau of Soils and Water Management (BSWM)	National line agency under the Dept of Agriculture	Country
Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA)	National line agency under the Department of Science and Technology	Country
Local Water Utilities Administration (LWUA)	National line agency	Country thru Water Districts
National Electrification Administration (NEA)	National line agency	Country thru Electric Cooperatives
Bureau of Fisheries and Aquatic Resources (BFAR)	National line agency under the Department of Agriculture	Country
National Mapping and Resources Information Authority (NAMRIA)	National line agency	Country

9.2 Main responsibilities of the specified agencies.

Tasks	DENR	DPWH	DILG	DOST	DA	DOH	LGU	NWRB	NEDA	DBM	DOF	LWUA
Governance	R	R	IP	IP	E	IP	E	R	C	R	C	C
Water allocation for different uses	C	C	C	IP	R	IP	E	R	C	C	IP	R
O&M of surface irrigation systems	IP	IP	C	IP	E	IP	IP	R	C	IP	IP	IP
Groundwater management	IP	R	C	C	E	C	IP	R	C	IP	IP	E
Catchment area management	C	C	C	IP	E	C	IP	R	IP	IP	IP	C
Domestic water supply	C	C	C	IP	C	E	E	R	C	IP	IP	E
Water quality and salinity management	R	R	C	IP	C	C	IP	R	C	C	IP	E
Drainage	R	R	C	IP	E	C	C	R	IP	C	IP	R
Flood protection	R	E	C	IP	C	C	C	R	IP	IP	IP	C
Wetland protection	E	IP	IP	IP	C	IP	C	R	IP	IP	IP	C
Maintenance of infrastructure	R	E	IP	IP	C	IP	IP	R	R	IP	C	R
Master planning	C	C	C	IP	C	IP	E	R	C	C	IP	C
Design and construction of new facilities	C	R	IP	IP	E	IP	IP	R	R	C	C	R
Resource mobilization	C	IP	C	IP	E	IP	IP	R	C	C	IP	R
Hydropower generation	R	R	C	IP	E	IP	IP	R	R	C	C	C
Impact assessment studies	E	IP	C	IP	IP	IP	IP	R	C	C	C	C

E = Executive responsibility; C = Consulted; R = Regulatory responsibility; IP = Interested party.

9.3 *Formal mechanisms for interagency coordination*

Generally, all major government institutions are now present in the basin. What is lacking is an effective mechanism for interagency cooperation and coordination. This is particularly affected by the implementation of the devolution of the extension function of the DA to the LGUs. The presence of the DA is now up to the regional level and the provision of extension services to the farmers is through the Provincial Agriculturist and Municipal Agriculturists who are under the administrative supervision of the Governor and Mayors, respectively. There is no focused, coordinated and packaged program specific for irrigated agriculture.

The enactment of R.A. 8435 otherwise known as the Agriculture and Fisheries Modernization Act of 1997 on December 23, 1997 may pave the way for the development of a better mechanism for interagency coordination. The AFMA underscores the Philippine government's efforts to modernize the agriculture and fisheries sectors of the country. Such legislation spells "the urgent related measures to modernize the two sectors to enhance their profitability and to prepare for the challenges of globalization through an adequately focused and rational delivery of necessary support services."

To strengthen the coordination and management of the agricultural and fisheries modernization process, the Intersectoral Committee on Agriculture and Fisheries Modernization (ICAFM) was created.

The committee is chaired by the Secretary of Agriculture and the DA "Undersecretary for Field Operations shall serve as the Deputy Chairperson. The members of the ICAFM include the Undersecretaries or Commissioners for Policy and Planning of Government Departments, Commissions, Authorities, Agencies and entities including representatives of key national association of farmers, farm women, fisherfolk, rural workers, private agribusiness, rural youth and indigenous people.

The committee serves as a standing committee for interagency and inter-sectoral consultation and coordination on the implementation of R.A. 8435. The ICAFM meets at least once each quarter or more often at the behest of the Secretary.

Inter-sectoral committees at the regional/provincial levels that will ensure coordination at the local levels may likewise be created.

At present, there is an existing Interagency Committee on Water Crisis Management composed of the following:

Chairman	-	MWSS
Members	-	NWRB, DPWH, NIA, PAGASA, NPC, LWNA, BSWM

This committee meets regularly to discuss the different aspects relating to water resources management.

Also, there is an ongoing water resources development project with the different components being implemented by the different agencies concerned such as the following:

A. Water Resources Planning and Management

Chairman	-	NWRB
Members	-	NEDA, DPWH, DENR, DILG, DA, MWSS, LWNA, NIA, NPC

- B. Watershed Management
 - Chairman - DENR
 - Members - NEDA, DA, DAR, DILG, NIA, PNOC, LGU, NGO
- C. System Improvement and Repair –NIA
- D. Institutional Strengthening of NIA and IAs – NIA
- E. Environmental Improvement – NIA and DOH

9.4 Mechanisms for the accountability of officials/water-service providers and users

Water Supply Sector

The provision of water supply in the Philippines is organized through four key agencies:

- Metro Manila and surrounding urban centers and rural areas where water and sewerage services are supplied by the Metropolitan Waterworks and Sewerage System (MWSS).
- Large provincial urban communities, where these responsibilities are provided by the Local Water Utilities Administration (LWUA).
- Provincial rural areas and small urban communities, where responsibility is shared by the Department of Public Works and Highways (DPWH) and the Department of Interior and Local Government (DILG)

Irrigation Sector

- National Systems - National Irrigation Administration
- Communal Irrigation Systems - LGUs/Provincial Irrigation Offices

Other key national government agencies providing planning, funding and support programs

- The Department of the Budget and Management (DBM) is tasked with determining the budgetary allocation for capital outlays for government agencies and government equity contributions, grants and subsidies to government-owned or controlled corporations. The DBM develops the overall budgetary expenditures of the National Government and ensures that budget releases conform to approved annual plans and programs.
- The Department of Environment and Natural Resources (DENR) is responsible for the formulation of policies and guidelines for the enforcement of environmental protection and pollution control regulations. It is primarily responsible for the preservation of watershed areas and the rational and efficient management of water resources.
- The Government Corporate Monitoring and Coordinating Committee (GCMCC), as an interdepartmental oversight committee, is responsible for monitoring and evaluating the performance of government corporations, providing guidelines for preparing corporate

plans, and recommending sanctions and incentives to the President, based on performance. It is also responsible for coordinating and reviewing all proposals and studies on the government corporate sector, including the creation of new state enterprises.

- The Department of Finance (DOF) is responsible for the generation and management of the financial resources of the government. It reviews and approves all public-sector debts, oversees the fiscal soundness of public investments based on objectives of equity, cost recovery and economic growth, and sets the fiscal deficit of major government corporations, as part of the public-sector borrowing program.
- The Department of Health (DOH) is responsible for environmental and water quality regulation, and supervision of general sanitation activities. Locally, it presides over the installation of toilets and wastewater disposal systems, and monitors the quality and safety of water supplies for drinking purposes.
- The Department of the Interior and Local Government (DILG) has a responsibility to develop the capability and competency of local government units (LGUs) to provide, manage, operate and maintain water supply projects and to assist LGUs in organizing barangay waterworks and sanitation associations (BWSAs).
- Local Government Units, such as City and Municipal Governments, provide, manage and operate local water supply systems in communities under their respective jurisdiction.
- The Local Water Utilities Administration (LWUA) was established as a specialized lending institution, tasked with the provision of financial and technical assistance to Water Districts (WDs) and Rural Waterworks and Sanitation Associations (RWSAs). LWUA is required to assist in the development of pipeline systems serving individual household connections (Level 3) and communal faucets systems (Level 2) in provincial cities and municipalities with duly organized WUs and RWSAs.
- The Metropolitan Waterworks and Sewerage System (MWSS) is charged with the provision of Level 3 water systems, together with sewerage services in Metro Manila and surrounding areas.
- The National Economic and Development Authority (NEDA) acts as the central planning agency, coordinating with other government agencies, in the national plan formulation process. It gathers inputs from all vital sectors, including the water sector. NEDA synthesizes and integrates all inputs to develop policy guidelines and a national plan, which conforms to the goals of the National Government. Local and regional development plans typically constitute the major inputs to the national plan.
- The National Water Resources Board (NWRB) is responsible for the overall planning, coordination and formulation of framework policies concerning water supply and water resources. The NWRB is also responsible for issues related to water rights.
- The Department of Public Works and Highways (DPWH) also has responsibility for development of integrated national plans and programs for water supply, in accordance with the National Government's development thrusts and policies.

10. Irrigated Agriculture

10.1 General

	Present	10 years ago
Cultivated area (1,000 ha)	254.490	203.592
Urban land area (1,000 ha)	67.365	66.115
Grassland/Savannah (1,000 ha)	4.117	4.940
Forest cover (1,000 ha)	37.425	39.296
Area covered with water (1,000 ha)	9.600	9.120
Irrigated land area (1,000 ha)	123.357	124.259
Irrigated area as a % of total arable area	48.5	48.80
Area under surface irrigation systems (1,000 ha)	98.222	96.174
Area under groundwater systems (1,000 ha)	25.135	28.085
Cropping intensity-surface systems (%)	154	156
Cropping intensity-groundwater systems (%)	200	200

10.2 Main crops grown under irrigation*

Name of crop	Area (ha)		
	10 years ago	Present	% Change
Rice WS	22,721	22,522	(0.09)
DS	21,821	19,099	(12.47)
Vegetables			
Corn			
Onion			

* Represents only irrigated area of UPRIIS.

10.3 Current yield of major irrigated crops. Current yields compared with yields obtained 10 years ago.

Name of crop	Unit	Yield			
		10 years ago (1990)	Present (1999)	Higher	Lower
Rice					
Wet season	cav/ha	63.58	54.85		14.00 %
Dry season	cav/ha	90.74	71.63		21.00 %
Onion					
Corn					
Vegetables					

10.4 *Changes in Cropping Patterns and Yields*

10.4.1 *Main reasons for the changes with particular attention to impacts to the institutional environment (if changes in cropping patterns and yields have been noted).*

- Yield declined, attributed to the El Niño phenomenon that damaged the crop in the first half of 1998 and a strong typhoon in the second half.
- Localized incidence of pest infestation also reduced yield of palay.

10.5. *Mechanisms for beneficiary participation in O&M of irrigation systems*

The NIA is among the first irrigation agency in Asia that adopted a participatory approach in irrigation management. The participatory process in irrigation development has evolved since the mid-seventies and jibe with the project development cycle. NIA has practiced two separate but complementary schemes in its participatory development, one for CIS and the other for NIS.

For CIS, the process involves the following:

1. *During the feasibility study* – IAs or farmers initiate the investigation of the project by submitting a formal request to the Office of the President or NIA through their local government.
2. *Organization/strengthening of IAs* – Upon the initiation of the project investigation, NIA deploys the Institutional Development Officer (IDO) to mobilize users and commence organization/strengthening of IAs. The objective is to facilitate farmer participation in detailed engineering design.
3. *Detailed engineering design* – The IDO facilitates the participation of farmers in collective decision making, particularly regarding the type of structures and location of tertiary turnouts and alignment of the conveyance system.
4. *Formation of legal entity* – The IA is formally convened and registered with the Securities and Exchange Commission after ratification of the Constitution and bylaws by the general assembly.
5. *Construction of the main system* – NIA manages the construction using labor and some local materials provided by the IA. The IA members are paid for their labor but a portion of this is contributed as IA equity on the project cost. Equity contribution is 10-30 percent of recoverable cost. Usually, the costs of roads and flood protection structures are deducted from the project cost. IA also monitors expenses and deliveries of construction materials and safeguards these at the site. Cost reconciliation is undertaken periodically and members are informed during regular meetings.
6. *Design and development of terminal facilities* – The users undertake the survey and construction through their turnout service area group (TSAG) leaders following training provided by NIA. NIA provides technical supervision.

7. *System management phase* – The completed communal irrigation system is turned over to IA management when the IA has full responsibility and authority for operating and maintaining the system. The turnover procedure includes cost reconciliation, agreed amortization fee and assessment of training needs on financial and system management. NIA provides the needed formal training and technical advice on the first 2 years after project completion.

For the NIS, the current NIA program is as follows:

1. *Project development phase* – The involvement of the users is generally limited to information sharing and consultation. The IA has little influence on the design of the system or management of construction. This evolved because users are not required to contribute to the capital cost of constructing the NIS, unlike in CIS. Also in NIS, right-of-way for canals and roads is paid to the affected farmers/landowners whereas in CIS the farmers are required to contribute this as a component of their equity in construction cost. This is now being rectified in the rehabilitation projects of NIA where the IAs are actively involved in the construction of farm-level facilities.
2. *System management phase* – NIA retains full management authority and ownership of NIS. Delegation of maintenance and ISF collection is implemented through Type I (maintenance) and Type II (collection) contracts. IAs are trained formally to execute their duties under these contracts. This is now being rectified in the rehabilitation of existing systems where a NIA-IA joint system management is proposed. Under this scheme the NIA is responsible for the O&M of the headworks and main canals while the IA is given full management authority and responsibility for the entire lateral canals. The IA remuneration is a percentage share on collected ISF that is agreed upon prior to management transfer. The most common sharing arrangement is 60 percent to the IA and 40 percent to the NIA.

10.6. Multiple Use of Irrigation Water

10.6.1 Various uses of irrigation water (at irrigation-scheme level)

<u>Uses of water</u>	
Drinking water supply	
Bathing/washing clothes	X
Watering home gardens	X
Animal husbandry	X
Cottage industry	
Fishery/aquaculture	X

10.6.2 Institutional arrangement to cope with the multiple use of irrigation water

None at present

10.6.3 Effects of multiple uses of irrigation water on the performance of irrigated agriculture

The performance of irrigated agriculture is not unduly affected by the multiple use of irrigation water mainly because such uses do not significantly reduce the available water. In two districts (III and IV) of UPRIS, 24 and 28 percent, respectively, reported the presence of establishments that destroy laterals. These establishments are livestock and duck farms, manufacturing of rubber slippers, and a number of illegal housing by some squatters. Animals are a hazard to the NIS because they ditch on the canals that cause damage to the embankments. On the other hand, squatters throw household wastes into the canal, which destroys water quality, hampers the flow of water and causes siltation. Similar effects could be cited among those areas in District IV where manufacturing of rubber slippers is found nearby. Byproducts are thrown into the canals that result in an environmental hazard. Yield performance in irrigated agriculture is not unduly affected, although data are needed to support this.

11. Competition for Water in the Basin

	Irrigation	Domestic water	Industry	Hydro-power	Navigation	Fisheries	Waste disposal	Recreation	Water quality control	Aesthetic/Environmental use
Irrigation	-	2	1	2	1	2	1	2	4	4
Domestic water supply	3	-	2	1	1	2	2	2	4	4
Industry	2	2	-	1	1	2	2	2	4	4
Hydropower	2	1	1	-	2	2	2	2	4	4
Navigation	2	2	1	2	-	4	1	2	4	4
Fisheries	2	2	1	2	2	-	4	4	4	4
Waste disposal	1	1	1	1	1	1	-	2	4	4
Recreation	2	2	2	1	1	1	1	-	4	4
Water quality protection	4	4	4	4	1	4	1	4	-	4
Aesthetic/environmental use	2	2	2	2	2	2	1	4	4	-

11.2 Effects of the competition of water at the basin level in agricultural water use

Water for domestic, industrial and recreational uses is mainly drawn from the groundwater; these uses compete with irrigation use. At this stage, however, considering the vast reserve of groundwater in the basin, which is being replenished by rainfall every year, this competition of other users with irrigation does not affect agricultural water use. Moreover, the results of the field-level study show that in the UPRIS area, except for fishponds, other establishments like duck

and poultry farms compete with irrigation water use that, nevertheless, consume a very minimal amount of water.

12. Emerging Trends in the Scarcity of Water

1. There is a scarcity of irrigation water at the tail end of irrigation systems.
2. Water supplies for domestic uses are dwindling, particularly in areas where the water sources are springs.
3. In populated areas where water for domestic and industrial uses is drawn from groundwater aquifers, the resulting drawdown is felt in nearby farming communities where water yield in wells tends to decrease.

13. Emerging Trends in the Inter-Sectoral Competition of Water

The ever-increasing demand of water for domestic use due to the increase in the population in urban areas results in a keen competition among water users, particularly in irrigation. Water for hydroelectric plants and cooling water for fossil and coal-fed power plants are also increasing, and their water demand to support this sector is also putting a strain on the available water supplies. Food-manufacturing and beverage industries will soon demand for more water as these sectors are beginning to grow.

14. Emerging Trends in the Water Quality and Environmental-Related Problems

1. Due to the increasing intensity of farming activities, surface water quality in terms of physical, chemical and biological characteristics is beginning to deteriorate.
2. Solid wastes, particularly polyethylene plastic materials and rubber from cottage industries, are clogging waterways and irrigation canals.
3. There are no sewage treatment plants in cities and municipalities where wastewater together with raw sewage is drained into rivers and creeks.

15. The Future of Irrigated Agriculture in the Basin in the Light of the Emerging Trends in Water Resources

Expansion of Irrigation Area – When the Casecnan Multi-Purpose Irrigation and Power Project is completed the area provided with irrigation facilities will be about 140,000 hectares. This brings the irrigation development in the basin to about 92 percent of the total basin area of about 152,000

hectares. The remaining 12,000 hectares are mostly the upland areas that are not suitable for irrigation development except for pockets of flat areas that could be covered by small pump schemes. These areas are the flat but high-elevation areas north of the UPRIIS service area in San Jose City, Lupao, Rizal and Bongabon Nueva Ecija; and those that are located east of the main canal of District III in Cabanatuan City and Sta. Rosa Nueva Ecija. Further expansion of irrigation area in the basin would be limited in the future. The expansion may even be offset by a reduction in cultivated area due to urbanization, infrastructural expansion and land use conversion.

Improved Irrigation Performance of UPRIIS – The service area of UPRIIS is about 102,500 hectares. The historical record of operations reveals that the average areas irrigated in the wet season and the dry season are 83,620 hectares and 70,300 hectares, respectively.. The average cropping intensity is only about 150 percent. This is far below the expected performance of UPRIIS as a storage-supported scheme. The main reason for below-par performance of UPRIIS is related to water shortages and inequitable distribution, particularly in the dry season. The additional water from Casecnan, estimated at about 800 MCM/year is expected to increase the cropping intensity in the service area of UPRIIS to 180 percent and provide irrigation to 35,000 hectares of previously nonirrigated farmlands in Muñoz, Guimba, Talugtog and Nampicuan, all in the province of Nueva Ecija. Better reliability of irrigation resulting from the additional supply is also expected to motivate the farmers to increase their investment on farming inputs thereby increasing their yield.

Agricultural Production – The total yearly rice production in the basin is expected to increase by at least 700 tons resulting from the additional production due to improved cropping intensity in UPRIIS and the irrigation of rain-fed areas of 35,000 hectares under Casecnan.

Future Investment in Irrigation – It is anticipated that future irrigation investments in the basin will focus on rehabilitation of existing schemes. The maintenance capacity of NIA, limited as it is, is mainly due to inadequate O&M funds that will further decrease. This is the combined impact of the reduced collectibles as a consequence of the “Socialized ISF rates” and the low collection efficiency. The NIA effort of transferring the O&M responsibility to IAs may somehow alleviate the situation but the overall scenario in the basin is that this alternative may work on a limited scale only. UPRIIS is such a large system that the personnel streamlining after the turnover to IA requires a substantial amount of funds. NIA’s effort in irrigation management transfer is already hampered by lack of funds to support separation pay for systems under 3,000-hectares.

Water Resources in the Basin - The water accounting did not detect any water deficits based on the annual totals. The temporal and spatial variability of water availability, however, connotes that a major portion of the water coming into the basin simply passes downstream unutilized. A major portion of the rainfall received in the basin below the Pantabangan reservoir is presumably measured as runoff downstream. Improved utilization of the rainfall during the wet season could probably save some of the water releases from the reservoir that could be allocated for the dry-season cropping. The completion of the Casecnan Project will, of course, remove any fear of water deficit in the basin in the future as this will satisfy the current water requirements for agriculture. Since the expansion of the irrigated area will be limited in the future, as discussed above, the requirements for other uses are within the capacity of the basin resources.

16. Key Institutional Arrangements to Enhance the Productivity and Sustainability of Irrigated Agriculture in the Basin

Interagency Cooperation and Coordination. As mentioned in the earlier section, all major government institutions are now present in the basin but apparently what is wanting is a focused, coordinated program for irrigated agriculture.

Provision of Support Services Based on Farmers' Needs – Among the important issues that need to be addressed to enhance the productivity and sustainability of irrigated agriculture are:

- a) costs of inputs, such as fertilizer, pesticides, and labor;
- b) farm-gate prices of paddy;
- c) credit availability;
- d) variability in performance of agricultural extension workers;
- e) strengthening of cooperatives;
- f) access to postharvest facilities;
- g) marketing of paddy; and
- h) production and marketing of non-rice crops like onion and garlic.

The Basin Profile

Sri Lanka

Name of selected river basin : Deduru Oya river basin

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1. Country Overview

1.1 *Outline the salient features of the country with particular focus on the importance of irrigation in the economy.*

During the last two decades, the economy of Sri Lanka has been radically transformed from a predominantly agricultural economy to one where the industrial and services sectors play vital roles. Agriculture continues to be the vital sector and is the main source of livelihood of a substantial proportion of the rural population.

The development of irrigation has been a major component of the development policies followed by successive governments. In the early 1950s, investments in irrigation accounted for about one-third of the total public investments. It declined to 15 percent in the mid-1960s and then rose to as high as 25 percent in the 1980s. From the mid-1960s to the mid-1980s, the area irrigated grew from about 300,000 to 500,000 hectares. Most of the growth was in major irrigation schemes in the dry zone, principally under the multipurpose Mahaweli Development Program initiated in the early 1970s, which developed over 100,000 hectares of improved irrigation.

Irrigation development, coupled with the introduction of new technology, played a pivotal role in increasing rice production in the country and in realizing the national policy objective of self-sufficiency in rice. At present, about half the national rice output is produced in the irrigation schemes in the dry zone where high levels of solar energy have permitted a faster growth in yields.

The benefits of irrigation investments include more than the value of the physical commodities produced. It also led to a major population resettlement and employment creation. Between 1946 and 1981, the population in the dry zone, which accounts for 62 percent of the country's land area, increased from 12 to 26 percent of the total population of Sri Lanka. The majority of the new settlers were landless persons from the wet zone who were resettled in the irrigation schemes and were provided with employment opportunities in farming. Investments in irrigation and the development of the dry zone discouraged rural-urban migration and reduced the social costs associated with overpopulation in the cities. Also overlooked in benefit-cost calculations, are the many other uses of water in irrigation systems, such as fish, livestock and garden production as well as domestic use.

1.2 Key national indicators

Indicators	Units	
Total land area	km ²	65,600
Population (most recent figure)	million	18
Projected population for 2020	million	22
Population growth rate	%	1.1
Urban population (% of total)	%	21
Urban population growth rate (last 5 years)	%	4.78
Rural population (% of total)	%	79
GNP per capita (1999)	US\$	775
Contribution of agriculture to the GDP	%	24
Contribution of industry and manufacturing to the GDP	%	40
Contribution of services to the GDP	%	52
Average annual growth rate of agriculture (last 5 years)	%	4.9
Average annual growth rate of industry (last 5 years)	%	11.9
Average annual growth rate of services (last 5 years)	%	12.0
Total annual water resources (latest year for which data are available)	km ³	22.99
Per capita water availability	m ³	2,390
Total water withdrawals (latest year for which data are available)	km ³	9.77
Per capita domestic withdrawal (latest year for which data are available)	m ³	11.3
Per capita industrial withdrawal (latest year for which data are available)	m ³	11.3
Per capita irrigation withdrawal (latest year for which data are available)	m ³	542
Gross irrigated area (latest year for which data are available)	ha	642,000
Percentage of population with access to safe water ¹	%	69.9

¹Source: Executive Summary report, Rural Water Supply & Sanitation Project, NWSDB.

2. Water Resources Policy

2.1 Describe the implicitly and explicitly stated national, federal/provincial or other subnational-level goals and policies for water resources development.

Water resources in Sri Lanka are traditionally considered as state property. Water resources development is a national subject. In recent years, some aspects of water resources development have been devolved to provincial government and local-level administrations, especially irrigation and domestic water supply. A national policy on water resources was formulated recently on the initiative of the newly established Water Resources Council but it is yet to be formally approved by the government. The policy emphasizes the sustainability of water resources with due consideration to economic, financial, environmental, social and other factors. The policy also recommends the adoption of a participatory and gender-sensitive approach for water resources development and management; sharing of the cost of water resources management with beneficiaries; and the development of a master plan for water usage. Steps are also being taken to develop a water allocation policy to make the optimum use of available water resources to cater to competing demands of different sectors like irrigation and power generation.

Provision of irrigation for rice production has been a major plank of the government policy for water resources development. Irrigation development has been linked with national food security, land settlement, employment creation and improving farm incomes. The government has traditionally subsidized the irrigation water. Since 1990, it has partially transferred O&M functions to farmer associations. The government is committed to transfer full responsibility for O&M to farmer groups.

3. Water Laws and Regulations

3.1 *List the existing laws and regulations concerning surface water and groundwater usage and pollution control.*

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
The Irrigation Ordinance No.32	1946	The Irrigation Ordinance provides for the regulations for the Divisional Secretaries (DSs) to prepare plans for new minor irrigation schemes or introducing changes to the existing ones. The approval of the Minister is required to prepare plans for the major irrigation schemes in terms of this ordinance. The ordinance also provides for the regulation for holding cultivation meetings in major irrigation schemes. There are provisions to take seasonal cultivation decisions at a special meeting of an IMD Project Committee attended by the DS.	Minister of Irrigation, DS, IMD PC
The State Land Ordinance	1947	The right to use, flow, management and control of any public lake is vested in the state under this ordinance. It makes a distinction between public water and private water. Part IX of the ordinance provides for the regulation and control of public water and streams through a system of permits. Water for irrigation is exempted from license requirements.	DS
The Electricity Act No.19 (as amended)	1950	This Act provides for the licensing or installation for the generation of electricity. These licenses confer all rights necessary for the purpose of electricity generation, including rights to use water.	Ministry of Irrigation and Power
The Soil and Water Conservation Act	1951	This Act empowers the Minister of Agriculture to declare areas subjected to soil erosion as erodible areas. The Minister may make regulations applicable to these areas requiring the owners of land to take measures to afforest the banks or watercourses or to maintain a strip of land along the banks of watercourses free from cultivation.	The Minister of Agriculture
The Agrarian Service Act (an amendment and continuation of the Paddy Land Act No.1 of 1958)	1979	Provides provision for tenure security in irrigated lands and sound management of agricultural activities and water in small tank systems through Agrarian Service Committees and Farmer Organization, etc.	Commissioner of Agrarian Services
The Mahaweli Authority of Sri Lanka Act, No. 23 (as amended)	1979	This Act empowers the Mahaweli Authority to use and develop the water resources of the Mahaweli river.	The Mahaweli Authority
The National Water Supply and Drainage Board Act No.2 (as amended)	1974	This act empowers the National Water Supply and Drainage Board (NWS&DB) to direct and use water to provide water supply for public, domestic and industrial purposes without other approval.	The NWS&DB
The National Environment Act (as amended)	1988	Provides provisions for environmental pollution control including the pollution of water and protection of sensitive habitats like lagoons and lakes, etc.	The National Environmental Authority (authority over some activities has been delegated to the Provincial Environmental Authority)
Agrarian Services (Amendment) Act No. 4	1991	Provides direction for handing over of full responsibilities over O&M and resource mobilization below distributary canals to farmer organizations.	Irrigation Management Division and Irrigation Department

4. Property Rights

4.1 *Outline the basis for general rights in agricultural land use, and surface water and groundwater use, water allocation and conflict resolution.*

Different rights are attached to lands under different ownership categories like *sinnakkara* (freehold), *paraweni lands* (inherited), *swarna bhumi* and *jayabhumi*, lands with LDO permits and encroached lands. Owners of freehold and paraweni lands have the right to sell their land while those in irrigation settlement schemes (those with LDO permits) and also those occupying encroached lands cannot sell their lands in the open market. Those with LDO permits hold the land on a long lease from the government. The lease confers on the owner most of the advantages of ownership, but gives the state the power to remove unsatisfactory cultivators. The land cannot be alienated without permission, or sold to redeem debts. The land can be passed to one heir only.

The Agrarian Service Act has provisions for the Agrarian Service Committee to acquire cultivable but uncultivated lands in a given Agrarian Service Center area on a temporary basis if such lands have not been put to proper use by the owners. The Act also provides provisions over tenure rights in irrigated lands to secure the rights of the tenants as well as of the landlords.

In old irrigation schemes like small tanks in old villages in Sri Lanka water rights are defined traditionally. However, the tank, irrigation canal system and the catchment area are entirely government property. In new schemes, the allottees have equal rights over water. However, under water-scarcity conditions, at a cultivation meeting held for that purpose, the proprietors can take decisions on the part of the irrigation system that is entitled for water in a given season

The Crown Lands Ordinance of 1949 gives a person who occupies the land on the bank of any public lake or stream the right to use water in that lake or stream for domestic use, livestock or agricultural purposes provided that it is extracted by manual means. The owners of private lands can extract groundwater in their lands without any restrictions. There are no rules or regulations to control their water use.

4.2 *Land Laws and Regulations*

List the existing laws and regulations concerning land use and tenure.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
State Land Ordinance Act No.13	1949	Makes provision for the grant and disposition of state lands in Sri Lanka: for the management and control of such lands and the foreshore: for the regulation of the water in the lakes and public streams.	Government Agent (District Secretary-GA) Divisional Secretaries (DS)
State Land Encroachment Ordinance No. 8	1954	Makes provisions for the prevention of encroachments on state lands.	GA, DS
Land Acquisition Act No. 8 as amended in 1979	1979	Makes provisions for acquisition of lands and servitudes for public purposes.	Ministry of Lands
Land Settlement Act No. 22	1955	Makes provisions to amend and consolidate the law relating to land settlement.	Settlement Officers appointed for the purpose (Asst. Commissioner of Land)
Land Development Ordinance No. 43	1973	Provides for systematic development and alienation of state lands.	Land Commissioner

Soil Conservation Act No. 25 and No. 29	1951 1953	Makes provisions for the conservation of soil resources, for the prevention and mitigation of soil erosion and for the protection of the land against the damages by flood and drought. The Act empowers the Minister to make regulations to arrest soil erosion in all kinds of lands and acquisition of such lands in case of necessity.	Ministry of Agriculture
Agrarian Service Act No. 58	1979	Provides security of tenure to tenant cultivators, specifies the rent payable by tenants to cultivators to provide for maximum productivity of paddy and other agricultural lands through the proper use and management of agricultural crops and livestock.	Commissioner of Agrarian Service Department
Mahaweli Authority Act No. 23	1979	Makes provisions to improve, farm, cultivate, maintain, lease, purchase, sell or otherwise deal with all or every part of lands in an area declared by the Minister as a special area of the Mahaweli Authority.	Director, Mahaweli Authority

4.3 Environmental Laws and Regulations

List the existing environmental laws and regulations.

Enactment	Date	Key provisions	Agency/Agencies responsible for implementing legal provisions
The National Environmental Act No. 56	1988	Makes provisions with respect to the powers, functions and duties of the Authority for the protection, management, enhancement of the environment, regulation, maintenance and control of the quality of the environment, for the prevention, abatement and control of pollution.	Central Environment Authority
Forest Ordinance	1907	Makes provisions for the state ownership and management of forest resources.	Forest Department
Plant Protection Ordinance	1924	Makes provisions against the introduction into Sri Lanka and against the spread therein of weeds, pests and diseases injurious to or destructive of plants, and for the sanitation of plants in Sri Lanka.	Department of Wild Life Conservation
Soil Conservation Act No. 25 and 29	1951 1953	Makes provisions for the conservation of soil resources, for the prevention and mitigation of soil erosion and for the protection of the land against damages by floods and droughts. The Act empowers the Minister to make regulation to arrest soil erosion in all kinds of lands and acquisition of such lands in case of necessity.	Ministry of Agriculture
Fauna and Flora Protection Ordinance 1937	Amended in 1970	Seeks to control the areas designated by the Ordinance by a series of permitted and prohibited acts.	Department of Wild Life Conservation
Mines and Mineral Act No. 33 of 1973	Amended in 1992	Makes provision to check the degradation of the environment resulting from the mining industry.	Geological Surveys and Mines Bureau

5. Water Allocation and Conflict Resolution

5.1 Describe national policies for allocating water among competing uses and mechanisms for resolving conflicts among users.

It is only at this stage that the policies for allocating water among competing uses are being prepared at the national level. The sectors that have received priority are the irrigation sector (agriculture), power generation and domestic water supply. There are competing demands from sectors like power generation (electricity) against the demands of the irrigation sector. Decisions over water allocation between irrigation and power generation sectors are taken at the Mahaweli Water Allocation Panel (in case of power stations at Mahaweli). The general principle adopted is to issue water for irrigation after using water for power generation.

In the context of the Deduru Oya and many other river basins, there is not much demand from the industrial sector and other sectors due to the slow tempo of the growth of these sectors.

When there are conflicts they are resolved through the existing coordinating mechanism like the Divisional- and District-level agricultural committees or National-level coordinating mechanisms using the provisions in the existing ordinances like the Land Development Ordinance, Irrigation Ordinance, etc.

6. Indicate the main reasons for the selection of the river basin for the case study.

1. Though this river basin is not a water-scarce basin, it experiences temporal and seasonal water scarcity problems and, hence, the study can investigate into the possibilities available for efficient water use through improved institutional mechanisms.
2. The government has an interest in developing the water resources in the basin for agriculture and has encouraged IWMI to select this basin to obtain information and data required for development activities.
3. Under given resources and time constraints of the study, the Deduru Oya is a manageable river basin for the study team.
4. Under the ADB funding and also under the initiation of the Water Resources Development project of the North Western province a study had already been undertaken to prepare a river basin profile. The Ministry of Water Resources Development wanted to continue this study further to gain a better understanding on the institutional and socioeconomic aspects, but the basin profile did not throw much light on these aspects.

6.1 Key Physical Features of the River Basin

6.1.1 Climate

Average annual rainfall (mm)	1,609
Annual average Eto	1,649
Maximum temperature (°C)	30.0 (Kurunegala)
Minimum temperature (°C)	25.5 (Kurunegala)
Number of dry months (< 5 mm rainfall)	65 mm min: rainfall in August

6.1.2. *List the major infrastructural facilities in the river basin (include only those facilities not already listed in the Summary Reports sent earlier).*

Infrastructural facility	Unit	Total number	Remarks
Urban centers	Number	12	01 – Provincial capital 01 – Main town 10 – Urban centers
Roads			
Highways	km	155	03 – Highways
Main roads		370	Class B roads
Village roads		2,500	Class C roads
Railway	km	47	02 – Main lines 06 – Railway stations
Public transport	Number	6	06 – Bus depot with 350 buses and staff
Electricity (National grid supply)	-	-	Covers all highways and main roads; 40 percent of the villages has access to electricity
Hospitals and health care	Number	28	01 – Teaching hospital 08 – District hospitals 11 – Base hospitals 08 MOH offices handling 65 maternity and child care clinics
Police stations	Number	1 12	01 – Deputy Inspector General's office 12 – Stations under 3 Divisions of Senior Superintendents of Police
Schools	Number	9 21 186	National schools Secondary-level colleges Primary-level schools
Forest office	Number	1 3	01 – DFO division offices 03 – RFO range offices
Veterinary service	Number	11 26	11 – Veterinary Surgeons' offices 26 – Livestock Development Offices
Agricultural service	Number	3 15 124	03 – Deputy Director's office 15 – Assistant Directors' offices 124 – Agricultural Instructors' offices
Agrarian service	Number	01 16 16	01 – Deputy Commissioner's office 16 – Divisional offices 16 – Agrarian Service Centers
Irrigation service	Number	01 04 04	01 – Deputy Director's office 04 – Irrigation Engineers' offices (04 – Divisional Assistant and Technical staff attached to these offices)

6.1.3 River network

Length	km	115
Catchment area	km ²	2,622.5
Elevation (start)	m	750
Elevation (end)	m	0
Maximum flow	m ³ /s	1,645
Minimum flow	m ³ /s	02
Av. Annual discharge	mcm	1,610

6.1.4 How would you characterize the overall hydrology of the basin?

A water surplus basin	
Water resources are adequate at present	
Moderately water-scarce basin	
Seasonally water-scarce basin	X
Water-scarce basin	

7. Demographic Characteristics of the Basin

Total population	1,044,558
Population density	378
Number of urban centers	22
Number of villages	2,807
Total urban population	103,212
Total rural population	941,346
Per capita availability of water (m ³)	1,046
Urban households having piped water (%)	21
Rural household having piped water (%)	9
Proportion employed in agriculture (%)	40
Proportion of population living below official poverty line (%)	61.45

8. Water Utilities

8.1 List the main types of water utilities in the river basin.

Type of utility	Number	Who owns the utility	Who operates the utility	Legal status of operator
Surface irrigation systems	Major - 03 Medium - 04 Minor - 3596	Government	Major - Govt. Agency and WUAs Medium - Govt. Agency and WUAs Minor – WUAs	Major Govt. Department and WUAs (Registered under the Govt. Departments as legal bodies) Medium – Govt. Department WUAS Minor - WUAs
Groundwater schemes	Agricultural shallow wells - 465	Individual landowners	Individual landowners	Individual landowners
Domestic water supply schemes	Pipe-borne 37 tube wells – 1199	Local Government body, Government Organization and users alone	Local Government body NWS&DB WUAs	Local Government body or Government Organization
Hydropower plants	na			
Wastewater Treatment plants	na– No significant industries or enterprises requiring wastewater treatment plants.			
Wetlands and other water bodies	Water bodies comprise 11,410 ha =4.4 percent of the total land area in the basin, 140 ha of wetlands comprising mangroves and marshes=0.05 percent of total land area	Government	Government (Mainly the Department of Coastal Conservation)	Government

8.2 *Provide information on the amount of water utilized in each sector (annual total and/or volume per second in comparable form) and the mean flow of the river (this information will help in understanding the pattern of sectoral water allocation and demand-supply condition in the basin).*

Description	Total amount (mcm/year)	Discharge (cumecs)
Inflow	3,893.02	123.4
Agricultural sector water use	1,837.00	58.3
Domestic sector water use	7.21	0.23
Animal use	0.07	0.002
Industrial use	2.85	0.09
Environmental use	1,131.90	35.90
River outflow	914.0	28.29

8.3 *Information base of the river basin*

Describe the available system of monitoring rainfall, reservoir storage and river flows at key locations, water quality, groundwater level and quality, various environmental conditions, diversion by various users, etc., stating the agencies responsible for these monitoring tasks and the existing information-sharing arrangements.

Activity	Functions and agencies responsible
Monitoring rainfall	Meteorological Department
Reservoir storage and river flows	Irrigation Department
Water quality and various environmental conditions, monitoring	Central Environmental Authority
Groundwater level and quality	Water Resources Board
Diversion by various users	If it is an illegal diversion from an existing irrigation canal or a system, Irrigation Department is responsible for monitoring and legal action. If it is a natural watercourse or body, Divisional Secretary is the person responsible for monitoring and taking action.
Existing information sharing arrangements	Data can be obtained for the relevant department. Departments like Census and Statistics publish some data and information on various aspects such as climate and rainfall.

Information	Data	Agency responsible for monitoring	Data maintaining (performance)	Remarks
Meteorological data	All meteorological data	1. Dept. of Meteorology	Satisfactory	Meteorology station, Kurunegala
		2. Rice Research Institute	Satisfactory	Rice Research Institute, Batalagoda
	Rainfall	3. Department of Irrigation	Unsatisfactory	Major irrigation systems – 4 in the Deduru Oya basin
Hydrological data	Pan evaporation	4. Measuring agents	Satisfactory	6 rainfall measuring agents functioning in the basin.
	Rainfall	for Met. Dept.		
	River flow	1. Irrigation Department	Unsatisfactory	3 locations
	River diversions	2. Central Environmental Authority	Unsatisfactory	2 locations
	Tank water levels			7 locations
	Water issues			7 locations
Crop production data	Water quality			
	Extent of cultivation	1. Dept. of Agriculture	Unsatisfactory	124 Agricultural Instructors' units to collect data
	Total production	2. Dept of Export Agriculture	Satisfactory	
Land use data	All related data	3. Coconut Cultivation Board	Satisfactory	
	Land use maps	Department of Land Use and Policy Planning	Unsatisfactory (last update 1986)	2 Area offices are involved
Demographic data	Population data	Divisional Secretary offices	Satisfactory	26 DS divisional offices are involved
Animal production data	Data on types of animal	Department of Animal Health & Production	Satisfactory	9 Basin-level divisional offices are available
	Number of animals			
Industrial production data	Production-related data			
	Data on type of industries	1. Industrial Service Bureau	Satisfactory	Keep records only on registered industries.
	Annual production data	2. DS office	Unsatisfactory	

9. Water Administration

9.1 Add a brief note describing the basic roles and functions of the agencies specified.

Name of agency	Basic roles and function
Irrigation Department (ID)	Investigation, planning, designing and construction of major reservoirs; acquisition, allocation and distribution of water up to the tertiary system (distributary level); maintenance of the main and secondary systems of the irrigation schemes.
Irrigation Management Division (IMD)	Coordination of activities related to planning, implementation and monitoring of agricultural plans in major irrigation systems through a project management committee established for the purpose; enhancement of farmer participation to take over O&M and other management responsibility at tertiary-system level; establishment and strengthening of farmer organizations for joint management of the irrigation schemes.
Agrarian Service Department	Assures tenure security to tenant cultivators; specifies the rent payable by tenants to cultivators; establishes FOs in small tank systems; registers FOs so that they gain legal recognition; holds cultivation meetings in minor tank systems; implements regulations in the Agrarian Service Act.
National Water Supply and Drainage Board (NWS&DB)	NWS&DB is responsible for the development, operation and control of water supply and sewerage systems and for the distribution of water for public, domestic and industrial purposes.
Central Environmental Authority (CEA)	Carries out functions such as making recommendations to the ministry for development of the national environmental policy; coordination and implementation of long-term environmental protection plans; coordination of all regulatory activities relating to the discharge of waste and pollutants; carries out surveys aiming at environmental pollution control, establishment of quality standards and methods for collecting and testing samples and other environmental pollution-control activities under the Environmental Act; the CEA is also responsible for approving Environmental Impact Assessments in development projects.
Water Resource Board	Works as an advisory body on groundwater; carries out hydrological investigation and the development of groundwater resources; identifies groundwater potential sites.
Coast Conservation Department Pradesheeya Sabha (PS)	Deals with the conservation of natural resources in coastal areas. Issues environmental permits to small-scale industries in the PS areas; takes legal action against environmental pollution.

9.2 List the principal agencies involved in water management and indicate how they are spatially organized.

Name of agency	Type of agency*	Area of jurisdiction**
Irrigation Department	National	Irrigation Engineer's (IE) division
Irrigation Management Division	National	Irrigation scheme
Agrarian Service Department (administrative division)	National	Divisional Officer's divisions (Administrative division)
National Water Supply and Drainage Board	National	District level
Environmental Authority	National and provincial	National and provincial levels
Water Resources Board	National	National
Coastal Conservation Department	National	National
Pradesheeya Sabha	Local government body	Provincial

* National line agency/state/provincial/local government/other.

** Country/state/province/basin/water district/administrative region/village/scheme/other.

9.3 List the main responsibilities of the specified agencies.

Tasks	ID	IMD	ASD	NWS&DB	EA	WRB	GA/DS	WUAs	CCD
Governance									
Water allocation for different uses	E,R						R		
O&M of surface irrigation systems	E	IP	E,R					C, E	
Ground water management						E,R			
Catchment area management	R	IP	R			E	R		
Domestic water supply				E		R			
Water quality and salinity management *									
Drainage	E,R			E,R					
Flood protection	E,R								
Wetland protection					R				E,R
Maintenance of infrastructure	E,R		E,R	E,R					
Master planning*									
Design and construction of new facilities	E,R			E,R					E,R
Resource mobilization	E,R		E,R	E,R				E,R	E,R
Hydropower generation**									
Impact assessment studies	E,R		E,R	E,R	R	R			

E- Executive responsibility

C – Consulted

R - Regulatory responsibility

IP - Interested party

* No responsible agency.

** No hydropower generation in

9.4 *Describe the formal mechanisms for interagency coordination.*

Hierarchical Committee system established at different levels as follows:

Level 1

Agrarian Service Committees (ASC) and AMA Committees at Agrarian Service Center Level. These committees attended by field-level officials of line agencies like the Agrarian Service Department (ASD), Department of Agriculture, Coconut Cultivation Board, etc., and the representatives of FOs are supposed achieve interagency coordination at ASC level. This provides a forum for the officials to do joint planning, implementation and monitoring. Issues and problems that the committee cannot solve at this level are presented to the Divisional Level Agricultural Committee. Divisional Officer of the ASD is the coordinator of these committees at the ASC.

Level 2

The Agricultural Committee at Divisional Secretariat level (DS level) attended by line agency officials working at DS level and a limited number of farmer representatives in the forum for interagency coordination for agriculture-related activities at also DS level. The DS presides over this meeting. The problems that cannot be solved at this level are presented to the District Agricultural Committee. The Divisional-level environment committee, which is the coordinating body for environmental-related activities and issues, is represented by the same officials and farmer representatives attending the DS-level agricultural committee. This coordinating meeting is held after the monthly Divisional-Level Agricultural meeting. In addition, there is an electorate coordinating committee chaired by the Member of Parliament and attended by the officials, local level politicians, etc. The activities related to infrastructural development are mainly attended to at this committee meeting.

Level 3

The District Agricultural Committee chaired by the Government Agent and attended by the district-level officers of the agencies working in the area and a limited number of farmer representatives constitute the coordinating mechanism for agricultural plan implementation at the district level. The most important agriculture-related issues as well as policy-related matters are discussed and attended to at this committee. In addition, there is a Development Committee, which coordinates the development activities implemented within the district. This is attended by the district-level officers working in the district and political leaders in the electorates in the district. The Chief Minister of the province presides over this meeting.

Level 4

The National Water Supply and Drainage Board has recently established a coordinating committee at provincial level bringing together the district-level officers in Puttlam and Kurunagala districts coming under the North Western Province to effectively implement the projects for drinking water supply. But this arrangement is limited to the domestic water supply sector.

9.5 *Describe the mechanisms currently in place for interagency coordination in water resource planning, water resources management including water-quality management, environment and watershed management, and coordination of water use at low flows.*

There are no coordinating arrangements at present for water resources planning, management, water-quality management, environment and watershed management and coordination of water use at low flows. A National Water Resources Authority, Water Resources Council and Water Resources Tribunals have been proposed in the National Water Resources Management Policy to address some of these issues. The Environment Authority is responsible for water quality and environment management, for which environmental committees have been established at different levels. For example, an Environment Officer has been appointed to each and every DS office to form and strengthen environmental committees at DS level. Accordingly, the Environment Committees at the DS and district level have been established in almost all the divisions and districts.

9.6 Describe the mechanisms for the accountability of officials/water service providers and users.

There is no mechanism for holding different stakeholders accountable to the parties concerned over service delivery in irrigation projects or schemes. In major irrigation systems, the government officials provide irrigation water if water is available in the tanks or reservoirs. Since they provide a free service to the users, accountability is not a concern. Also accountability has not been built into the service delivery system of the state bureaucracy. Users of irrigation water are supposed to attend to some O&M activities; however, the present service delivery system does not make them accountable for it.

10. Irrigated Agriculture

10.1 General

	Present (last update)	10 years ago
Cultivated area (ha)	201,585	
Urban land area (ha)	520	
Grassland/Savannah (ha)	55	
Forest cover (ha)	8,035	
Area covered with water (ha)	11,410	
Irrigated land area (ha)	48,655	
Irrigated area as a proportion of total arable area (%)	24	
Area under surface irrigation systems (ha)	47,150	
Area with groundwater systems (ha)	1,515	
Cropping intensity – surface water systems	1.33 - 1.65	
Cropping intensity – groundwater systems	1.8 – 3.0	

* Data on land use changes in recent years are not available but there is considerable change in cultivated lands and forest. A significant extent of coconut lands has been converted to residential lands. These changes can be better explained once we complete the data analysis on household survey.

10.2 List the main crops grown under irrigation.

Name of crop	Present	10 years ago
Paddy	Yes	Yes
Vegetable	Yes	No
Chili	Yes	Yes

Due to the high returns and water scarcity in *yala* (dry seasons) some farmers have shifted from paddy to vegetables and chili crops.

10.3 Indicate the current yield of major irrigated crops. How do current yields compare with those obtained 10 years ago?

Name of crop	Present yield		Yields 10 years ago		
	Unit	Amount	Higher	About the same	Lower
Paddy	kg/ha/season	4,404			✓
Vegetables	-				✓
Chili (dry)	kg/ha/season	800			✓

* Considerable change has taken place in using improved seeds and application of input in agriculture. Some changes on market prices have also taken places on both inputs and agricultural products. Therefore, yield increases have been reported.

10.4 Changes in Cropping Patterns and Yields

10.4.1 If changes in cropping patterns and yields have been noted, outline the main reasons for these changes with particular attention to impacts of the institutional environment.

Some significant changes have taken place in the cropping pattern. Farmers have a tendency for growing more other field crops. Some considerable changes have taken place on yields too. This is due to application of improved seeds and other inputs. Significant changes have not been reported in the cropping intensity. However, these observations can be better explained once we complete the analysis on the recently completed farmer survey in the basin.

10.5 Outline mechanisms for beneficiary participation in O&M of irrigation systems.

In major and medium-scale irrigation systems responsibilities over the O&M at the distributary canal level and below it have been handed over to the water user associations (WUAs) initiated by the Project Managers attached to those projects. In major schemes, which are under the INMAS program, coordination required for O&M of the system is achieved at a project committee attended by farmers representing the irrigation system and officials of ID and other agencies. In the medium-scale irrigation project, coordination is achieved through a similar committee system operating under the MANIS system. In major schemes, Project Managers are from the Irrigation Management Division of the Ministry of Irrigation while in the MANIS projects Technical Assistants (TAs) of ID hold the position of Project Manager (PM). In both systems, WUAs are still paid some financial incentives for O&M of the system in their charge.

In minor tank systems, the Agrarian Service Department has established WUAs, which are supposed to take over O&M responsibilities. Though operation and pre-seasonal maintenance activities are done by WUAs, major physical improvements are still attended to by the government, with funds from donor agencies.

10.6 Multiple Use of Irrigation Water

10.6.1 List the various other uses of irrigation water at the irrigation-scheme level.

Uses of water	Check X
Drinking water supply	X (Negligible)
Bathing/washing clothes	X
Watering home gardens	X
Animal husbandry	X
Cottage industry	X
Fishery/aquaculture	X
Other	

10.6.2 Describe the existing institutional arrangements to cope with the multiple use of irrigation water.

The National Water Supply and Drainage Board and the Irrigation Department work together informally to resolve conflicts emerging in the two sectors: irrigation and drinking water. In small tanks, farmers and other water users such as fishermen and livestock keepers interact with each other and decide arrangements for water use in a given season. Irrigation agencies interact with water users and provide facilities for using water for washing and bathing (in water delivery canals, tanks and reservoirs).

10.6.3 Describe how the multiple use of irrigation water affects the performance of irrigated agriculture.

This is not a significant issue at present. It is only in one major irrigation system, Magalla, that irrigation water is tapped for providing domestic water supply but priority is always given to irrigated agriculture. As explained in table 10.6.2 farmers in small-scale irrigation systems mutually decide how to share water for agriculture and other uses always giving priority to agriculture. Due to this reason there is no significant negative impact on agriculture as a result of multiple uses (current situation).

11. Competition for Water in the Basin

11.1 Enter relevant code: 1=no competition, 2=moderate competition, 3=severe competition, 4=complementary use.

	Irrigation	Domestic water	Industry	Hydro-power	Navigation	Fisheries	Waste disposal	Recreation	Water quality control	Aesthetic/ Environmental use	Others
Irrigation	-	2	1	-	-	1	2	1	2	1	-
Domestic water supply	2	-	2	-	-	1	3	1	3	1	-
Industry	1	2	-	-	-	1	2	1	3	2	-
Hydropower*											
Navigation*											
Fisheries	1	1	1	-	-	1	3	2	3	3	-
Waste disposal	2	3	2	-	-	3	3	2	3	3	-
Recreation	1	1	1	-	-	2	2	1	1	1	-
Water quality protection	2	3	3	-	-	3	3	2	3	1	-
Aesthetic/ Environmental use	1	1	2	-	-	3	3	1	1	1	-

*Not relevant.

11.2 Describe how the competition for water at the basin level affects agricultural water use.

At present, there is no competition for water at the basin level to have a significant negative impact on agriculture. This is mainly due to the slow growth and development of industrial and other sectors.

12. Outline briefly the emerging trends in the scarcity of water.

There is no scarcity at present due to lack of competition from multiple users of water. However, with the development and growth of industrial and domestic water-supply sectors due to the government interventions for the development and expansion of those sectors, there is a possibility for water scarcity both in the surface water and groundwater resources. There is a tendency for soil moisture depletion due to soil erosion, reduction of shade and ground cover as a result of deforestation, etc., which too would have an impact on groundwater resources.

Since groundwater extraction is not guided by a clear policy and technical guidelines, there is a tendency for the increase of agro-wells, which would create negative impact on groundwater resources.

Unregulated sand mining in Deduru Oya has already caused deepening of the riverbed causing groundwater depletion.

13. Outline briefly the emerging trends in the inter-sectoral competition for water.

There is a possibility for competition among the irrigation sector, especially among those using Deduru Oya water for irrigation, if major irrigation schemes depending on the river are constructed. Rehabilitation of small irrigation systems in such a way as to store more water would also have negative impacts on water users in downstream reservoirs and small tank systems.

Under the government's industrial development programs, industrial villages are to be established in the basin area. This would lead to competition among the industries for water.

Under the government programs for the use of groundwater and water in streams for the development and expansion of domestic water supply (drinking, bathing and washing, etc.) for the growing urban and rural population would lead to competition and water scarcity within the domestic water sector.

14. Outline briefly the emerging trends in the water quality and environmental-related problems.

Due to the unregulated sand mining, the Deduru Oya riverbed has sunk low causing groundwater depletion in many areas in the basin. In the tail-end parts of the basin, excessive sand mining has caused seawater intrusion damaging the whole ecosystem and livelihood of agricultural communities in those areas.

Unregulated shrimp farming in coastal areas of the basin has caused water pollution in lakes, ponds and other watercourses.

Due to lack of a systematic waste disposal system both groundwater and surface water resources get polluted, especially in urban areas of the basin. Contaminated water from hospitals, hotels and industries has polluted streams in some areas of the project making it difficult for authorities to find freshwater resources for development of domestic water supply schemes.

14.1 *In the light of the emerging trends in water resources in the basin, assess the future of irrigated agriculture in the basin.*

The construction of a new reservoir in the Deduru Oya basin to provide supplementary irrigation to water-short small tank systems in the basin would help increase cropping intensity and productivity in those systems. However, this would demand rigorous water management efforts in the existing irrigation systems like Ridibendi ela and Batalagoda feeding direct from the Deduru Oya.

Unregulated groundwater tapping by constructing agro-wells without assessing groundwater potential would cause severe groundwater depletion in the future. However, the number of wells in the basin is not significant enough to have a negative impact. The development of salinity in agro-wells was reported from the Chilaw area where groundwater has been extracted for an urban domestic water supply scheme. However, there is a tendency for emerging negative impacts on agriculture under groundwater if unregulated groundwater development in the basin continues.

15. **Summarize the key institutional arrangements that should be in place to enhance the productivity and sustainability of irrigated agriculture in the basin.**

The present institutional arrangements available at various line departments like the Department of Irrigation, the Department of Agriculture, Agrarian Services, etc., and coordinating arrangements at ASC, DS and District levels are sufficient to achieve productivity and sustainability of the irrigated agriculture if they are made to function effectively and efficiently. The major problem associated with them is that they do not function well due to various socioeconomic and institutional constraints. There is a necessity to strengthen these institutions and coordinating mechanisms by giving them more authority and power to attend to resource management tasks effectively. A system of monitoring, feedback and evaluation needs to be built into the organization culture and the parties concerned must be made accountable to the coordinating committees over their tasks. Strengthening of existing mechanisms like DS-level and District-level agricultural committees as effective bodies, with power and authority for planning and implementation of agricultural activities, is more likely to achieve productivity and sustainability. An institutional mechanism is necessary to attend to some critical issues relevant to the whole river basin.

Also, there is a need for introducing changes and modifications to the existing rules and regulations and also by introducing new rules, regulation and policy measures where there are no such arrangements for use of water resources like groundwater.