Integrated Water Resources Management: Lessons from Brantas River Basin in Indonesia

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Abstract

The development area of a river basin involves an ecosystem unit, an economic development area, and an administrative unit. Development of the river basin concerns not only the area based on a hydrological boundary, but also a surrounding area. This concept is needed because development of the river basin may affect the surrounding area. Optimum development in the river basin should be followed by development of the surrounding area; otherwise the optimum tends to decrease.

The Brantas River, in East Java Province, Indonesia, plays a vital role in the economic region, not only for East Java, but also nation-wide. The Government has created more than 20 projects that have brought great economic benefit to the Brantas river basin, concurrently with national economic development.

The President of the Republic of Indonesia on February 12, 1990, issued Government Regulation No. 5/1990 which established a State-Owned Company, namely Perusahaan Umum (PERUM) Jasa Tirta (PJT I: Jasa Tirta Public Corporation) to address water resources management, and facilitate operation and maintenance of finished structures on the Brantas river basin.

The mission of PJT I is to manage the water resources in the Brantas basin so that they can be optimised in order to promote regional development, to accumulate profits and to contribute to the development of the entire nation.

1. Introduction

Life on earth depends upon water, which maintains and correlates all ecosystems within the planet, continually moving on and in the ground surface. Water characterises the river resources on which mankind is largely dependent for livelihood. A steady increase in population and in both agricultural and industrial activities has shown that the idea that water has always been an unlimited commodity is erroneous. Excessive use of water resources, as a logical consequence of economic development, has induced a range of national problems. Not only has the shortage of clean water supply become an obstacle for economic development, but also an increase in waste discharges has polluted natural water bodies. This has worsened with the reduction of forested lands and conversion of agricultural areas to settlements that in turn have changed the hydrological cycle remarkably.

2. The Brantas river basin

Indonesia, straddling the equator, is an archipelago nation with over 17,000 islands, of which about 6,000 are inhabited. It covers an area of 1,940 million km^2. Much of the nation's population of about 220 million people (1997) lives in the four main islands, Java, Sumatra, Sulawesi and Bali. Although the average population density of Indonesia is currently about 104 per km^2, Java, the most densely populated island, in area only 6.9 percent of the country, had a population density of 926 per km^2, or 110 million in1997.

The Brantas river basin in East Java Province has been one of the most productive and advanced granaries in Indonesia, because of ample water resources, tropical climate and fertile soil. This basin holds possibilities for further agricultural development. Industry located in the lower reaches around Surabaya port is also promising for future growth.

The overall characteristics of the Brantas basin can be summarised as follows. The length of the river is about 320 km, and the catchment area about 12,000 km^2. Average annual rainfall is 2,000 mm, equivalent to a volume of surface water runoff of about 12 billion m^3. The basin's population is about 14 million (1997).

Brantas river basin development is carried out as an integrated development based on a master plan which is reviewed every 12 years, projecting future socio-economic conditions and based on the national guideline goals. The plan is based on the philosophy of one river, one plan, one co-ordinated management. Up to 1998, four Master Plans have been worked out. Facilities that already built are as follows:

MASTER PLAN	OBJECTIVES	STRUCTURES FINISHED
MASTER PLAN I	♦ Flood control	▪ Sutami Dam (1970)
(1961)	♦ Irrigation	▪ Selorejo Dam (1973)
	♦ Hydro-power development	▪ New Lengkong Dam (1973)
	♦ Water supply (domestic and industrial)	▪ Porong river improvement (1977) ▪ Lahor Dam (1977)
MASTER PLAN II (1973)	♦ Irrigation ♦ Flood Control	▪ Brantas middle reaches river improvement (1977)
	♦ Hydro-power development	▪ Wlingi Dam (1977)
	♦ Water supply (domestic and industrial)	▪ New Gunungsari Dam (1981) ▪ Bening Dam (1982)
		▪ Lodoyo Dam (1983) ▪ Tulungagung Drainage (1987) ▪ Sengguruh Dam (1989)

MASTER PLAN	OBJECTIVES	STRUCTURES FINISHED
MASTER PLAN III (1985)	♦ Water supply (domestic and industrial)	▪ Brantas middle reaches rehabilitation (1990)
	♦ Irrigation ♦ Hydro-power ♦ Flood control	▪ Tulungagung hydropower (1990) ▪ Jatimlerek rubber dam (1992) ▪ Wlingi dam rehabilitation (1993) ▪ Menturus rubber dam (1993) ▪ Porong river rehabilitation (1993) ▪ Surabaya flood control (1995) ▪ Wonorejo Dam (2000)
MASTER PLAN IV (1998)	♦ Water resources conservation and management	▪ Integrated Watershed Management

3. Benefits of the development

The benefits achieved due to water resources development in the Brantas basin include:

1. Protection against 50-year flood.
2. The 233 MW capacity of hydropower plants, producing around 1.0 billion kWh of energy per year.
3. Total area of paddy irrigated from the Brantas river system is around 345,000 ha. In the dry season irrigated agriculture consumes approximately 80 percent of the available water in the river. East Java, since 1989, can supply more than 30 percent of national food production.
4. Supply around 300 Mm^3 per year raw water for drinking and for industries.
5. Fresh water requirement for brackish aqua-culture was estimated at 13.5 m^3/s for 11,000 ha in the Brantas delta, but due to limitations of water, water supply of brackish aqua-culture depends on the return flow from irrigation water use.

4. Post-construction problems

After construction, it is necessary to maintain the facilities in order to ensure maximum benefit and reach the planned technical life span. Adequate operation and maintenance (O&M) activities are necessary, but these activities encounter specific problems:

Institutions

To manage the basin, many institutions are concerned, and each has their sectoral responsibility. But co-ordination among sectors may be difficult in some situations, because each sector has previously had its own plan, strategies and objectives.

Management of water quantity and water quality

Water shortage occurs, if population growth and general economic development lead to an increased water demand (agricultural, domestic and industrial), while due to deteriorating water quality, the available water becomes unsafe to use. Effluent discharges of domestic as well as industrial wastewater have been increasing and hence, the pollution from wastewater is exceeding the assimilation capacity of the river.

Funding

The investment in new infrastructures, and the operation and maintenance cost are too huge to be covered by the government budget. It is necessary to increase participation of beneficiaries and the private sector in water resources investment and in the cost of operating and maintaining the infrastructures.

Conflict between water users and water usage

Water demands of beneficiaries have not been always fulfilled, especially in the dry season. On the other hand, some people use water in inappropriate ways. One of today's issues is that our life-styles tend to be wasteful of the available water resources. Often they use good quality water for other purposes, which actually need only lower quality.

Considering the limited amount of water, it is necessary to use available water resources wisely, avoiding conflict, and preserving the environmental capability to get sustainable benefits.

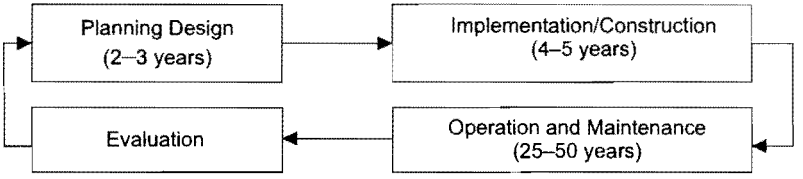
5. Perum Jasa Tirta (Jasa Tirta Public Corporation)

According to the laws and regulations, beneficiaries of water resources facilities are asked to contribute to the operation and maintenance of the facilities. Contributions from water users are not collected because projects are not authorised to collect these contributions. It is necessary to transfer the operation and maintenance of finished structures to a body that is duly authorised to collect contributions.

In Article 4 of Law No. 11 of 1974 on Water Resources, it is stated that the state's authority to manage water resources may be delegated to central or provincial governmental institutions or to definite corporate body where the requirements could be stated in Government Regulation. This is intended to give opportunity for public and private sectors to participate in developing the benefits of water resources.

After about 30 years of development, several river structures have been constructed along the Brantas River. The subsequent activities should be operation and maintenance (O&M). In the development cycle O&M is one of the main tasks for successful achievement of the objectives.

Development Cycle



The Jasa Tirta Public Corporation (PJT I) was established on February 12, 1990, by the government regulation No. 5/Th 1990. The main objective of establishing the corporation is to manage operation and maintenance of the facilities in the Brantas river basin.

The cost for operation and maintenance activities will be collected by PJT I from the beneficiaries. For the time being, the main source of funds will be from electricity, drinking water and industries. There is no obligation for farmers to pay water charges, although more than 80 percent of water in the Brantas River is for irrigation purposes. The government now is introducing a pilot project of Irrigation Service Fee in several provinces around Indonesia. The purpose of the pilot project is to show the farmers the importance of adequate budget to support the operation and maintenance of irrigation facilities.

6. Main tasks and working area of PJT I

Main tasks

Based on Ministry of Public Works Regulation No. 56/PRT/1991, Article 6, the main tasks of PJT I include:

a. Performing operation and maintenance of water resources infrastructure;

b. Water supply services;

c. Management of the river basin, including water resources conservation, development and utilisation;

d. Rehabilitation of water resources infrastructure.

Working area

PJT I conducts its activities, such as planning, construction, rehabilitation, operation and maintenance, supplying, conservation, supervision and control of water resources of 40 rivers in the Brantas basin.

Based on Article 8 clause (2), Government Regulation No. 5 of 1990, the management of other river basins by PJT I would be decided by the President upon the proposal of the Minister.

7. Integrated water resources management in the Brantas river basin

Integrated water resources management is taken to mean the process of formulating and implementing a course of action involving management of water and related resources for the purposes of achieving optimum allocation of water resources within a catchment area. With the Ministry of Settlement and Regional Development as the lead agency in this effort, this optimisation of water utilisation is meant to contribute to increase human welfare from improved agricultural, domestic and industrial use of water.

It is important to understand the need to intensify development efforts in upland areas. This is in response to a clear understanding, from experience with flooding, siltation and other downstream consequences of upstream activities, that a complex of inter-relationships links upland and lowland social and ecological systems. There is al[illegible] a clear sense that the past focus on the lowlands has been at the expense of upland areas, in terms of policy and programme attention. The consensus was, therefore, that a more balanced approach to the development of river basins should be adopted for the future.

This attention to social equity relates to another point on which agreement was reached, namely, that answers to problems of river-basin development and water resources management cannot be found solely from a technical standpoint, but must be reached through close attention to social and economic factors affecting use of natural and human resources. Technical answers to most of the problems faced in the case study basins are already known. This technical knowledge can be made useful, however, only if it is combined with knowledge of social and economic systems to develop viable solutions to problems such as upland soil erosion, low incomes of many rural inhabitants, inefficiency in irrigation and other water applications, and so forth. It was agreed that such social and economic knowledge could only be obtained through active participation of local residents in activities of river-basin development and water resources management. Table 1 shows these activities, which are explained below.

Table 1: Integrated water resources management (scope of works)

- Basic concept: one river, one plan, one co-ordinated management
- Operated by permanent institution, not by project
- Professional staff
- Adequate budget

<u>Maintenance of Structures</u>
- Dam
- River
- Tunnel
- Etc.

<u>Upper watershed Management</u>
(Co-ordination among parties concerned)
- Reforestation
- Demplot of land use planning

<u>Water Quantity Management</u>
- Water allocation for beneficiaries
  - Agriculture
  - Raw water for drinking water and industry
  - Electricity
  - Tourism
  - Fishery
  - Transportation
- Flood management
  - Telemetering System (real time data)
  - Reservoir operation rule

<u>Water Quality Management</u>
- Source of pollutant
  - Industry
  - Domestic
  - Agriculture
- Pollution monitoring
  - Periodical monitoring (daily, weekly, monthly)
  - Data's evaluation
  - Recommendation (law enforcement)
- Public awareness
  - Clean river programme guide line
  - Public campaign
  - Continuous action

7.1 Maintenance of structures

Maintenance activity is primarily to protect water resources structures (dam, reservoir, weir, check-dam, dike, sluice, conduit, etc). PJT I implements the following categories of maintenance activities:

1 Preventive maintenance in the form of routine periodical maintenance and small repairs to prevent serious damage.

2 Corrective maintenance in the form of large-scale repairs, rehabilitation and rectification in order to restore or increase the functions of water resources infrastructure.

3 Emergency maintenance is a temporary repair that has to be done soon due to some emergency condition, such as flood.

The management of the Brantas river basin needs the participation of beneficiaries. For example, farmers play a role in operating and maintaining the irrigation infrastructure, including paying irrigation service fee (ISF), and other beneficiaries pay water abstraction fee. The fees are used to manage the river basin.

The management of the Brantas basin follows the concept of sustainability, meaning maintaining the resources. The concept of sustainability co-ordinates and integrates the river-basin activities and environment, and is applied to all phases of development, i.e. planning, design, construction, operation and maintenance.

7.2 Upper watershed management

The categories and percentages of land use in the whole basin as of 1990 were: farm land 57 percent, forest 26 percent, homestead area 14 percent, and others 3 percent, respectively. On the other hand, according to the land use map prepared by East Java Province, in the year 2008, farm land will have decreased and forest and homestead areas will have increased, compared with those in 1990, by 10.2 percent and 21.8 percent, respectively.

Sediment yield in the Mt. Kelud basin mainly results from eruption of a volcano, Mt. Kelud. Wlingi dam reservoir, located at the lower reaches of the basin, was damaged by sediment deposition coming from the southern slopes of Mt. Kelud after an eruption in 1990. In order to settle this problem, a sediment bypass channel in the Putih River and *sabo* (sediment retention) works are being constructed. *Sabo* works in the Konto and Lesti basins are also being rehabilitated or constructed, to trap sediment discharge.

Two dams (Sengguruh and Wlingi), out of six, suffered from sediment caused by volcanic eruptions (Mt. Semeru and Mt. Kelud). To overcome this problem, besides construction of check dams, periodical excavations (dredging) have been done by PJT I in both reservoirs. Reforestation works are also underway, led by PJT I.

7.3 Water quantity management

A Water Use Right is the right to obtain and use water for a certain necessity. Water use right is stipulated in the Indonesian Basic Constitution of 1945, Law No. 11 of 1974 on Water Resources, and Government Regulation No. 22 of 1982 on Water Resources Management. In principle, water resources are governed by the State and utilised as much as possible for the welfare of the people. Based on this principle, water use prioritisation is given in the Governor of East Java Decree No. 316 of 1988 as follows: (a) domestic water, (b) irrigation, (c) plantation, (d) fishery, (e) industry, (f) hydropower, (g) flushing, (h) swimming-pool. In particular, the Government Regulation 22 of 1982 on Water Resources Management, Article 2, states about the principle and basis of water rights, that in the water management regulations the principles of public utility, harmony and conservation shall be applied.

Particularly for groundwater, it is stated in Law No. 11 of 1974, Article 5, Paragraph 2, and the Government Regulation 22 of 1982, Article 6, that groundwater sources and hot springs such as power and mineral springs are not under the authority and responsibility of the Minister responsible for water resources, but they are under the Minister of Mines and Energy. However, this division between surface water and groundwater is considered inappropriate and will be re-aligned in the reformed policy for water resources development and management.

7.3.1 Licensing

Licences for water utilisation are issued by the Local Government, supported by technical recommendations from PJT I.

Technical recommendation from PJT I is important to ensure the balance of water supply and demand. Water in the Brantas River is used for various purposes. The main consumers are irrigation (80%), raw water for drinking, industries, fishponds, and urban flushing (20%) and electricity (which does not consume the water). Water allocation from PJT I to the users is on a contract basis. Users, except farmers, have to pay a fee to PJT I to cover operation and maintenance cost. The tariff is decided by the Government after discussion between PJT I and users.

7.3.2 Dry season operation rule

Water management in the Brantas River is co-ordinated by a body called Panitia Tata Pengaturan Air (East Java Provincial Water Board; EJPWB) headed by the Vice-Governor of East Java Province. The water allocation pattern consists of two kinds of Operation Rule (OR) that are for the dry season (June–November) and the rainy season (December–May).

The procedure of preparing the dry-season OR is as follows. In May users submit water demands to PJT I. By simulation and weather forecasting, PJT I prepares a draft dry-season OR. At the end of May the draft OR is discussed in the EJPWB and if all agree, it is then signed by the Vice-Governor. Implementation of the OR is done by PJT I with monitoring in 10-day periods. If there is deviation from predictions, or conflict of interest in the field, some members of EJPWB discuss and review the OR if needed.

7.3.3 Rainy season operation rule

Preparing the rainy season OR follows the same procedure as for the dry season. The important issue in the rainy season OR is flood management.

PJT I has prepared a Guideline for Flood Forecasting, Flood Warning and Flood Fighting on the Brantas River. Subjects of this book include critical locations along the river (levees), protection methods, materials and equipment available for flood fighting in warehouses along the river, names, addresses, and telephone numbers of staff involved, hierarchy of information to be submitted, etc.

To monitor rainfall intensity in the basin and discharge along the Brantas River, a tele-metering Flood Forecasting and Warning System (FFWS) has been installed, consisting of 26 rainfall stations and 31 water-level stations, covering 12,000 km^2 of catchment area, with the Master Station located on the main office of PJT I. Field data are transferred to the Master Station every 30 minutes in real time. The basic concept of flood control is one river, one plan, one co-ordinated management.

The purpose of establishing a flood forecasting and warning system is to prevent or mitigate damage and to ensure the safety of inhabitants. Flood-fighting activities are performed by flood defence teams. People living near the river are enabled to take necessary actions for flood protection, by giving them flood information with enough time allowance. Information on a coming flood such as scale, arrival time of peak, etc. is to be given to inhabitants well in advance, if occurrence of flood is judged to be inevitable.

7.3.4 Water quality management

Water quality control plays an important role for sustaining benefits in the Brantas River and its tributaries.

Legally, PJT I should have active participation in supervising and controlling the Brantas River water quality. The task of PJT I on water quality control is to support the Central and Provincial Governments. One continuous activity of PJT is water quality monitoring along the Brantas River at 50 sampling points and 41 sources of industrial pollution. The samples are tested by PJT I's Laboratory. These data can be used by the Local Government of East Java to control polluting activities. By using simulation computer programming, it can also develop a strategic action plan for pollution abatement in short, medium and long terms to achieve the river water quality objective.

The main pollutant sources in the Brantas River, based on a study in 1989, are industry, domestic users and agriculture.

To reduce pollutants from industries the Government issued a regulation that all industries have to install waste water treatment plants (WWTP). For small industries (home industries), it is difficult to follow the regulation. For some large industries the WWTP are not always operated.

More difficult to control is pollution coming from domestic waste. The people use the river water for many purposes. Because of low income and less awareness of environment protection it takes time to educate the people.

Pollution from agriculture is not a significant factor causing deterioration of water quality. Agricultural activity is done during the rainy season when the flow of water in the river is big enough to neutralise pollution.

Clean river programme

To minimise pollution discharge into the river, Government initiated a programme called the Clean River Programme (CRP) in 1989. PJT I and other parties promote the CRP through several activities. Pollution control is carried out by the Environment Pollution Control Committee (KPPLH) which is established by the Governor Decree, and consists of all agencies concerned. In KPPLH there are four Working Teams, for Clean River Programme, Clean Town, Domestic Waste Pollution Control and Industrial Waste Pollution Control respectively, PJT I sits as Vice Co-ordinator I of the Team for the Clean River Programme.

Effluent discharge standards are currently stated in the Governor Decree 136 of 1994, however, this is being updated involving all agencies concerned, co-ordinated by the Provincial Office of the Environmental Impact Management Agency or BAPEDALDA.

CRP Campaign

Public education is carried out in co-ordination with the Department of Home Affairs, Universities, Non-Governmental Organisations and Moslem traditional boarding schools, for the following groups of people: on land and water conservation, to people in villages and students of Moslem traditional boarding schools in the upper reaches; on water pollution control, to industry managers, high school teachers and students; on mining and land use in the river corridor, to the people and the village officials; on environment protection, to high school students.

The success of public education programmes is usually constrained by economic conditions. Although no specific assessment has been undertaken, the physical condition shows that so far public education has a good achievement proved by positive social control given by the public.

Law enforcement

Law enforcement is focussed on large industries. Many large industries do not operate their WWTP continuously. Difficulties of law enforcement include poor regulation, poor staff and difficulties of obtaining evidence. On the other hand, maybe, global co-operation is needed between developed and developing countries. Many large industries come from developed countries. What is their role to protect the environment?

After several years of hard work, the people along the Brantas River have now come to the stage of understanding about environment protection, but not yet to do it. Some industries already applied to the court of justice. More time is needed, before environmental conditions will be completely protected. Public campaigns have to be continued.

8. Stakeholder identification and participation

8.1 Water resources stakeholders

Stakeholders in water resources can be classified into three main groups:

a. **Government** as the "owner and regulator" plays the role of controlling and policing water, and exercising public authority. It has the right to a part of the profit gained by the River Basin Management Agency while on the other hand it is obliged to contribute its funding for activities towards public safety and welfare.

b. **River Basin Management Agency** (RBMA) as the "operator" has the concession to manage water and its infrastructures, and develop its management system. It has the right to collect contributions from beneficiaries and receive contributions from the Government for public safety and welfare activities. It is also obliged to render prime services, promote public and private participation, give contribution to the owners, and to be accountable in performing tasks to shareholders and stakeholders.

c. **Society** as the "users" have the right to receive good services and participate in decision-making processes. They are expected to use water efficiently, take part in sustaining the environment, provide financial contributions for water resources management (WRM) and provide constructive social control.

The proportion of population below the poverty line (US$ 800/year) in the Brantas river basin after the economic crisis of 1998 is about 46.3 percent (1,193,075 households out of 2,578,139). Conflict of interest among stakeholders is still manageable, even though during the dry season the available water is not enough to cover all sector water demands. The irrigation water user, as the biggest water consumer (almost 80 percent of manageable water during the dry season), receives only 60 percent–80 percent of their water demand.

8.2 Organising stakeholders

Stakeholders are organised through the Water Resources Committee (WRC). The Vice-Governor is the chairman and Provincial WRM Office is the secretary. The WRC membership consists of high-level provincial officials from relevant sectors, RBMA and representatives of stakeholders i.e. Electricity State-Owned Company, Municipal Water Supply Corporation, industries (represented by Industry and Trade Provincial Office), farmers (represented by Irrigation Committee), universities, etc. The WRC is supported by some Technical Work Groups for specified fields, such as water conservation, water allocation, pollution control, flood control, sand mining, etc.

The role of the WRC is to assist the Governor in preparing the water resources management plan (policies, strategies, planning and programming) as well as to co-ordinate all regulatory aspects and to solve technical problems related to implementation of the plan. This WRC is responsible to accommodate various interests, and to govern the water management rules applied throughout the province.

8.3 Access to water for poorer people

Specific water users (for commercial uses: electricity, municipal water supply, industries, horticultural estate) should have water use permits from the Government. Once the permit is issued, the RBMA should secure the water allocation for their utilisation. The water users are obliged to pay water service tax and fee to the Government and the RBMA. Based on this permit, the RBMA and the user sign a Water Service Contract, which specifies the rights and obligations of each party.

On the other hand, social uses (irrigation water uses, human daily activities etc) and non-specific water users (municipalities), are not obliged by law to have water use permits. These users are not obliged to contribute water service tax and fee. Most of the non-licensed water users are poorer people in urban and rural areas.

In dry seasons when available water is not enough to cover all demands, irrigation users always have reduced water allocations. Irrigation Water User Associations distribute water among farmers under the guidance of District WRM Offices. The Municipal Water Supply Corporation supplies water for poorer urban people through public water-taps (10% of total distributed water). The RBMA supplies raw water to the sector users at their water intake based on an agreed allocation pattern.

Through the on-going national reform of water resources policies, it is intended to develop water use rights for irrigation and maintenance flow in order to have equitable access to water for the poorest people.

9. Institutional and policy issues

9.1 Institutional framework

One objective in the establishment of PJT I was to develop and implement the concept of an institutional framework for WRM, by establishing a permanent, neutral, professional and accountable institution to perform equally the principle of a healthy corporation and general utilisation of water resources, based on public, private and community participation.

The main strength is that WRM in the Brantas river basin performed by PJT I is a national pilot project for future WRM institutions in Indonesia. The weaknesses of the implementation of the system in other river basins in Indonesia are:

a. Limited capacity of the society to contribute to WRM cost;

b. Not all of the beneficiaries pay the cost borne for WRM;

c. Price of water does not encourage the private sector to participate in WRM.

d. Less awareness by the people means less social control on water resources issues.

After 10 years of the pilot WRM institution, the Government made the decision to implement the management system developed by PJT I in other strategic river basins.

9.2 Water rights

Based on the Indonesian Basic Law, the water right is in the hands of the State. The people have only water use right. Only specific beneficiaries have permits to use the water and permits to discharge their effluent to the river. For social use (farmers, etc) and non-specific beneficiaries (municipal) it is not necessary to have permits. In the near future, water use rights will be implemented for all water users. For the time being, the permit system does not allow tradable permits.

9.3 Water allocation mechanism

Stakeholders' participation in decision-making processes is conducted in the WRC. In water allocation, for example, the mechanism can be explained as follows:

a. The initial concept of water allocation is prepared by the RBMA with computer simulation based on water demand and water supply projection. The draft water allocation plan is discussed in the Technical Work Group and submitted to the WRC for approval.

b. The water allocation is then conducted by RBMA. If a significant deviation exists, RBMA makes a review and prepares the revised pattern, which will be discussed by the Technical Work Group and submitted, to WRC for approval.

Water distribution among sectors is done by the RBMA, while water distribution in irrigation areas is done by Water Users' Associations under guidance of District Water Resources Technical Management Units.

10. Water accounting

Land utilisation differs in each part of the basin, especially affected by topography. Most of the arable land is utilised for productive farming (38%) and the rest of is used for forest, settlement and non-agriculture activities. Critical land that is subject to erosion is estimated 17 percent of the Lesti Catchment and 18 percent of the total Brantas upper reach. Features of the Brantas river basin are shown in Tables 2 to 5.

Table 2: Main features of the Brantas river basin

Main river		Kali Brantas (320 km)
Geographical co-ordinates		110°30' – 112°55' E and 7°31' – 8°15' S
Average temperature		25.5° C
Relative humidity		82%
a)	Total catchment area	11,800 km² (25% of East Java)
b)	Total reservoir capacity	
	• Gross storage (initial/present)	525 / 297 million m³
	• Effective storage (initial/present)	378 / 245 million m³
c)	Water availability	
	• Average precipitation	2,000 mm/year
	• Run-off coefficient	about 0.50
	• Potential flow	11,800 million m³/y
d)	Water utilisation	
	• Irrigation	2,400 million m³ (79.9 %)
	• Domestic	225 million m³ (7.5 %)
	• Industry bulk supply	133 million m³ (4.4 %)
	• Maintenance flow	204 million m³ (6.8 %)
	• Fisheries (irrigation return flow)	41 million m³ (1.4 %)
	Total	3,003 million m³ (100.0 %)

Table 3: Precipitation in the Brantas river basin (1995–1999)

Units: mm

Month	Average	Maximum	Minimum	Season
January	343.83	566.72	181.90	Rainy season
February	306.62	554.03	193.25	Rainy season
March	297.33	512.51	88.75	Rainy season
April	203.00	389.57	49.31	Rainy season
May	110.55	324.65	12.14	Dry season
June	61.23	224.64	0.11	Dry season
July	40.54	271.81	0.00	Dry season
August	19.79	96.47	0.00	Dry season
September	28.46	152.33	0.00	Dry season
October	81.45	353.43	1.65	Dry season
November	176.33	393.66	25.12	Rainy season
December	278.93	473.35	124.25	Rainy season
Total	1,948.06	3,434.26	1,228.05	

Source: PJT I (2000)

Table 4: Population

Description	Java Island	East Java Province	Brantas River Basin
Area (km^2)	132,206	47,938	11,800
Population:			
• 1980	91,269,528	29,188,852	11,996,000
• 1990	107,581,306	32,503,991	13,004,000
• 1995	114,733,486	33,844,002	13,534,000
• 2000 (projected)	122,811,842	35,570,386	14,224,370
Density (person/ km^2)	929	742	1,205
Percent to East Java	125.2	100.0	162.4

Source: Indonesian Statistical Office (2000)

Table 5: Growth of Gross Regional Domestic Product in the Brantas basin

Units: %/year

Sector	1984–1985	1985–1992	1993–1995	1996–1998
Agriculture	3.1	3.2	0.5	11.6
Industry	4.7	10.7	12.2	15.4
Services	7.3	7.3	7.9	13.5
Gross Domestic Product	5.5	6.7	7.7	9.8

Source: Final report of Master Plan IV (1998), Indonesian Statistic Office (1999)

The Gross Regional Domestic Product (GRDP) of the basin amounted to 39,018 billion Rupiah in 1995 (note: US$1=Rp 2,250 at bank exchange rate during 1995), which was 58.9 percent of the GRDP of East Java and 9.4 percent of Indonesia's Gross Domestic Product (GDP). GRDP per capita of the basin was US$1,269 in 1995, which was 46 percent and 44 percent, respectively higher than the rates for East Java (US$872) and all Indonesia (US$880). After the economic crisis in 1997, the GRDP of the basin was estimated 45,428 billion Rupiah in 1998 (US$405). The basin's economic growth was led mainly by the industry sector after the mid-1980s.

10.1 Water resources utilisation

Sources and uses of water in Surabaya Metropolitan Area (SMA: Gresik, Bangkalan, Mojokerto, Surabaya and Sidoarjo) in 1998, and estimates of future demand, are shown in Tables 6 and 7.

Table 6: Sources of water

Units : m^3/second

Brantas River	47.84
Treated surface water	1.43
Spring/well	0.53
Other surface water	0.12
Total existing supply	49.92

Source: East Java Water Balance Team (1998)

Table 7: Water use in SMA

Units: (m^3/second)

	1998	2000	2005	2010	2020
Industry	3.96	4.53	11.58	27.30	90.04
Irrigation	41.41	41.41	33.28	29.17	20.58
Domestic	10.69	13.35	19.33	25.74	41.93
River maintenance	7.50	8.64	11.49	14.34	20.00
Total demand	63.56	67.93	75.68	96.55	172.55

Source: East Java Water Balance Team (1998)

Table 8: Overall demand and supply in SMA

Units: m^3/second

Year	1998	2000	2005	2010	2020
Demand	63.56	67.93	75.68	96.55	172.55
Supply capacity (1998)	49.92	49.92	49.92	49.92	49.92
Deficiency (without action)	(13.64)	(18.01)	(25.76)	(46.63)	(122.63)

Source: East Java Water Balance Team (1998)

Note: The balance does not include brackish water fisheries

11. Major Issues and Strategies

11.1 Major issues

Water resources will be the limiting factor in development of the region. The water demand is estimated to be tripled in the next 20 years, while water resources development is already limited. Wonorejo Dam, which will be in operation in 2001, is the last favourable dam site in the basin.

Water quality degradation is a problem especially in the down stream area: Surabaya River and Porong River. The total pollution load in the basin has increased almost threefold during the last 10 years: 125 ton BOD/day in 1989 became 330 ton BOD/day in 1998, of which 62 percent is from domestic users and 38 percent from industries.

Watershed degradation promotes erosion and sedimentation. The sediment load in Sutami catchment area is estimated about 3.2 million m^3/y in 1998, meaning an increase by almost threefold during the last 30 years.

11.2 Strategic plan

The main strategies for addressing these major issues are:

- Promote stakeholders' participation in the decision-making process to get their commitments in the implementation of a WRM plan.
- Public education to promote positive social control from the public.
- Implement economic and other instruments to promote efficient use of water, abate pollution load and develop sources of funds for WRM budget.
- Develop and implement consistently Land and Water Conservation Plan.

Projections of future water quantity and water quality under this plan are shown in Tables 9 and 10.

Table 9: Water quantity

Units: m^3/second

Year	1998	2000	2005	2010	2020
Deficiency (without actions)	(13.64)	(18.01)	(25.76)	(46.63)	(122.63)
Action plan:					
• Demand efficiency	6.21	7.10	10.22	18.35	58.51
• Supply efficiency	3.60	3.60	3.20	3.20	2.80
• WR development					
- Wonorejo Dam		8.02	8.02	8.02	8.02
- Umbulan Spring			4.45	4.45	4.45
- Beng Dam *)				9.50	9.50
- Kd. Warak Dam					3.50
• Final balance	(3.83)	(2.86)	0.13	(3.11)	(35.85)

Source: Surabaya Development Programme (1998)

*) Pumping scheme: Brantas river will be pumped to the reservoir during rainy season.

Table 10: Water quality

Units: ton BOD/day

Year	1998	2005	2010	2020
Projected load without actions	330	395	442	565
Domestic load	205	224	234	257
Industrial load	125	171	208	308
Maintenance flow (m^3/sec)	7.5	7.5	7.5	7.5
Projected load with actions *	330	208	177	118
Domestic load	205	182	151	92
Industrial load	125	26	26	26
Maintenance flow (m^3/sec)	7.5	11.5	14.5	20.0

Source: Pollution Control Master Plan (1998)

*The water quality objective will be achieved in 2020 if targeted pollution load abatement can be realised.

12. Financial aspects

12.1 Sources of funds

In order to achieve sustainable WRM, budget availability for river basin management needs to be secured. This requires that beneficiaries gradually bear costs for river basin management through the application of the principles of Users Pay, Polluters Pay, as well as Government Obligation (for funding social services and public safety and welfare measures, such as flood control, water pollution control, land and water conservation, and irrigation).

Funds obtained from beneficiaries are used for operation and maintenance activities. Investment budget may be obtained from: 1) Corporate internal funds, 2) Government Budget, 3) Local or foreign loans, and 4) Other reliable sources (Joint ventures, Municipal Bonds, etc.). The major cost components are indicated in Table 11.

Table 11: Components of cost

Direct Costs	Indirect Costs
• Operation and Maintenance	• Personnel expenses (for Head Office)
• Watershed conservation	• General expenses (for Head Office)
• Personnel expenses (for WSD Offices)	• Travel expenses (for Head Office)
• General expenses (for WSD Offices)	• Depreciation
• Travel expenses (for WSD Offices)	• Marketing expenses
	• HRD expenses
	• Public Education cost

Note: WSD Offices: Water Services Division Offices

12.2 Fund-collection process

In principle, PJT I should negotiate the fee tariff with the sector users. Then the agreed tariff is proposed by PJT I's Board of Directors to the Ministry of Settlement and Regional Development (MSRD). After getting recommendation from the Ministry of Finance and the Governor, the Ministry approves the fee tariff.

The fee paid by the users is collected by PJT I in collaboration with Provincial Tax and Retribution Offices which already have a well-established collection system. The non-fee payer (social and non-specific users) pays to the government in other forms of tax (land and building tax etc). The government then gives subsidy to finance activities relating to social services and public safety and welfare.

12.3 Methods of assessment of water service fee

Based on the Government Regulation No. 6/1981 the fee should be calculated to cover: 1) operation and maintenance; 2) depreciation; 3) interest; and 4) fund for further development. Considering the capability to pay, the fee is calculated only for operation and maintenance cost recovery.

The water service fee is calculated by the RBMA based on the following methodology:

(a) Listing of all major water resources infrastructures.

(b) Identification and calculation of operation and maintenance activities of each infrastructure.

(c) Distribution of cost among functions for multipurpose facilities (separable or joint cost).

(d) Derivation of proportions for allocating operation and maintenance cost for each sector user (based on the gross benefits received by sector users).

(e) Derivation of operation and maintenance costs for respective function for all facilities.

(f) Derivation of amounts of power generation (kWh/year) for electricity, water used (m^3/year) by other sector users (municipal water supply, industries).

(g) Calculation of water service fee for each sector user to recover operation and maintenance costs.

It is very difficult for the RBMA to make a tariff agreement. There is no guideline issued by the Government in calculating fee. Through the on-going National Reform of Water Resources Policies, it is intended to issue a Government Regulation on the guideline for calculating water service fee and waste water discharge fee.

12.4 Budget approval process

(a) Four months before effectiveness of the following fiscal year, the Board of Directors prepares the next Yearly Corporate Budget and Work Plan, based on the operation and maintenance work plans proposed by each Water Services Division, by considering the recommendation of RBWRC and PWRC.

(b) Before submitting the Yearly Corporate Budget and Work Plan to the MSRD and Minister of Finance, it is discussed and approved in principle by the Supervisory Board. The Board of Directors and Supervisory Board hold several meetings to discuss both the technical and financial matters.

(c) Approval of the Yearly Corporate Budget and Work Plan is obtained from the Minister of Finance after recommendation from the MSRD.

12.5 Effects of the financing system

During the last 10 years, the tariff level of water service fee has increased as shown in Table 12. The progressive tariff and increasing tariff level stimulate the application of recycling technologies for major industrial water users, such as sugar-cane factories. For the time being, it is difficult to have equity and adequate access for poor people. The Government Obligation Principle cannot be implemented due to the Government's budget limitation. Equitable access to water could be improved after the implementation of water use rights for irrigation and for environment (maintenance flow) and commitment of Government in realising Government Obligation Principle.

Table 12: Tariff level

Unit: Rupiah

Water Users	Units	1990	2000
Electricity State Owned Company	Rp/kWh	6.00	13.61
Municipal Water Supply Corporation	Rp/m^3	16.00	35.00
Industries	Rp/m^3	16.00	52.00*

*Basic tariff level for progressive tariff system

Note: In mid-2000, 1 Rupiah = 0.0115 US cent at nominal exchange rate

13. Present condition of PJT I

The following is a summary of the main features of PJT I at present.

Beneficiaries' contribution for operation and maintenance

Beneficiaries' contribution in 1999 reached Rp 27 billion (US$ 4 million). Even though this does not cover normal operation and maintenance budget requirements, it leads to these results:

- Increasing regional revenue as the result of orderliness in water allocation and tariff determination in Brantas river basin;
- Cost burden from government budget allocation for Brantas river basin could be minimised and allocated for other basins.

Improvement of water resources infrastructure functions

Improvement of operation and maintenance has resulted in improved functioning of water resources infrastructure, which directly contributes to management improvement.

Company performance in 1991–1999

The company's audit up to the fiscal year 1999 is considered excellent, proving satisfactory results from application of the cost recovery principle.

Public/Private and community participation in water resources management

Water resources management operated by PJT I makes it possible for public as well as private sectors to participate in water resources development and management in the basin.

ISO 9001 Certification

Certification of ISO 9001 for Design, Operation and Maintenance of Water Resources Infrastructures in the Brantas river basin issued by SGS International Certification Services, has proven professional water resources management practices by PJT I.

14. Conclusion

14.1 General view of the Corporation

The Brantas river basin has been a valuable natural resource for many years. It was essential for food production; to support national economic development, water is considered as a strategic commodity.

- The development of the Brantas river basin has been carried out since 1961 as an integrated development through a series of Master Plans with the basic concept of one river, one plan, one co-ordinated management. The benefits of development include flood control, food production, drinking water, industrial water, electricity production.
- In order to overcome the post construction problems, the Government of Indonesia established the state-owned corporation PJT I on May 12, 1990.
- The management of water resources in the Brantas river basin is carried out as an integrated management operated by PJT I. The scope of activities of PJT I are: water quantity management, water quality management, maintenance of water resources infrastructure. PJT I has implemented Quality Assurance System ISO-9001, issued by Yarsley International Certification Services Limited, London, No. Q.9755 on May 12, 1997.
- To operate these activities, PJT I collaborates with related agencies, such as: East Java Provincial Water Resources Committee (Panitia Tata Pengaturan Air) for water allocation, Commission for Environmental Pollution Control and Abatement (KPPLH) for pollution control.
- The funding for operation and maintenance of water resources in the Brantas river basin mainly comes from the contributions of beneficiaries: State Electric Power Company, Regional Drinking Water Supply Company and Industries.
- In the future, PJT I will be extended to cover other rivers in Indonesia.

14.2 Management problems

- The formula to compute the unit water rate is not established yet. This is needed, from the point of view that water revenue should be reliable and stable for the long-term sustainability of the corporation.
- The operation and maintenance contribution from beneficiaries excludes depreciation. In the future it may be necessary to establish a water rate formula including depreciation and other factors.
- Up to now farmers do not pay operation and maintenance contribution. Most of the irrigation water users still keep the old perception that the charge for water used is included in the tax they pay.
- Due to lack of awareness, water taken by the farmers is not efficiently utilised. Some farmers take more water than their actual needs. As a result, farmers downstream face water shortage problems in the dry season.
- River water quality has seriously deteriorated throughout all the Brantas River. The reason is untreated wastewater from industry, domestic users, agriculture and livestock breeding which has been drained into the river.

- At present, the upstream area of the basin has been considerably devastated and existing reservoirs have suffered from sedimentation.