ANNEX – 4

WATER DEMAND FORECAST

ANNEX – 4 WATER DEMAND FORECAST

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

1 Component of Water Demand

Present major water users in the Brantas river basin are irrigation, brackish water fish pond, domestic water and, industrial water.

Irrigation is the largest water user in the basin. The irrigation area extends all over the basin. The total irrigation area which directly takes irrigation water from the Brantas river is about 83,000 ha and use 25 to 30 % of annual flow in the Brantas river. In dry season, it takes 70 to 80 % of river flow. As water demands increase in other sectors, the tremendous usage of water by irrigation becomes an issue. Efficient irrigation water management is being demanded though the agencies concerned have been making effort since the early 1980s. In this Study the irrigation water demand in future will be estimated taking into consideration the probable change of land use in the basin, the possible countermeasures to upgrade irrigation efficiency, etc.

Brackish water fish ponds are mainly located in the coastal area. Total brackish fish ponds is estimated to be 11,500 ha in the Brantas basin. The fresh water is taken from drainage canals in the irrigation area for the fish ponds. There is no water shortage in rainy season, but fresh water supply is very limited in the dry season resulting in low harvest. Land use in the coastal area has been changing in recent decades. A qualitative analysis will determine water requirement for brackish water fish culture.

Water for domestic purposes are provided by PDAMs in most urban areas and by other sources in rural areas. The present water supply service coverage in Surabaya municipality and Malang municipality is 35.4 % and 36.8 % respectively, while water consumption per capita in the same municipalities are 224 liter/day/capita and 147 liter/day/capita, respectively. Domestic water demand will be projected based on the present major water use indicators and population forecast for the year 2020.

Industrial water demand is estimated at about 250 million m^3/year at present. Out of the total supply, 131 m^3/year is taken from the Brantas river, and 80 % of this water is used for production of sugar (58 %) and paper (22 %).

River maintenance flow is incorporated in the Study as one of the water demand to maintain river condition at a certain level for several aspects such as water quality, recreation and ablution, preservation of biota, navigation, and so forth.

2 Irrigation Water Demand and Supply System

2.1 Existing Irrigation Area

(1) Irrigation Area In The Brantas River Basin

Irrigation area in the Brantas river basin was recorded at 309,000 ha in 1996 by Dinas Pekerjaan Umum Pengairan Daerah Propinsi Daerah Tingkat I Jawa Timur (Provincial Water Resources Services in East Java, hereinafter called as "Dinas Pengairan") as summarized in Table A4-1.[1] The irrigation area in the Brantas river basin is commanded by 13 Cabang Dinas PU Pengairan (Branch Water Resources Service, hereinafter called as "Cabang Dinas Pengairan") namely Malang, Kepanjen, Blitar, Tulungagung, Trenggalek, Kediri, Nganjuk, Pare, Mojoagung, Jombang, Mojokerto, Sidoarjo, and Surabaya. The commanding area of each Cabang Dinas Pengairan located in the Brantas basin are also summarized in Table A4-1.

(2) Irrigation Areas Irrigated By Brantas river

Many intakes were constructed on the Brantas river in the past centuries by farmers and rulers. Several medium and large scale irrigation development projects were commenced in 1970s as one of the component of Brantas River Basin Development Project launched by the Government of Indonesia at early 1960s. As a result, many irrigation intakes and canal systems have been rehabilitated and improved, and new irrigation systems have been developed. Further, some old run-of-river type intakes located in the middle reach of the Brantas main stream have been unified. Eventually, some 83,281 ha which consists of the following irrigation areas is irrigated by the Brantas main stream.

(i) Brantas Atas Irrigation Area

There are six intakes on the Brantas main stream and conjunctively irrigate Brantas Atas irrigation area (1,239 ha as of 1996). The intakes namely, Sarem, Watu Gedek, Prambatan, Gedang Klutuc, and Ngukir intakes are operated and maintained by Cabang Dinas Pengairan Malang.

(ii) Brantas Bawah Irrigation

There are two intakes further downstream of the Brantas river and irrigate Brantas Bawah irrigation area (1,407 ha). The intakes namely Sengkaling and Kadalpang intakes are operated and maintained by Cabang Dinas Pengairan Malang.

(iii) Molek Irrigation Area

Blobo dam and intake irrigate Molek irrigation area (3,984 ha) and are operated and maintain by Cabang Dinas Pengairan Kepanjen.

---

[1] Village Irrigation areas which are estimated some 60,160 ha in total in the entire East Java Province is not included since its breakdown is not available.

(iv) Lodoagung Irrigation Area

Wlingi dam and intake were constructed in 1977 and are operated by PJT to release irrigation water from Wlingi dam for Lodoagung irrigation area (12,321 ha) commanded by two Cabang Dinas Pengairan offices namely Blitar and Tulungagung.

(v) Mrican Kanan And Kiri Irrigation Areas

The Mrican barrage and intake were constructed in 1991 to replace and unify old intakes located near Kediri on the Brantas river. The intakes are operated by PJT to supply irrigation water for both Mrican Kanan area (16,334 ha) located right side of the Brantas river and Mrican Kiri area (Warujayeng-Kertosono, 12,570 ha) left side of the Brantas river.

The Mrican Kanan area is comprised with many irrigation areas such as:

- Pariterong area (675 ha) commanded by Cabang Dinas Pengairan Kediri,
- Papar-Peterongan area (3,147 ha) commanded by Cabang Dinas Pengairan Pare,
- Turi-Tunggorono area (5,475 ha) by Cabang Dinas Pengairan Jombang, and
- Sentul I and II, Melik and Kepuh areas (7,037 ha) in total commanded by Cabang Dinas Pengairan Mojoagung.

Those areas were individually irrigated by small tributaries before the completion of the Mrican Kanan main canal, and now mainly receive water from the Brantas river.

The Mrican Kiri commands Warujayeng-Kertosono areas in the Cabang Dinas Pengairan Nganjuk.

(vi) Brantas Kiri Kediri Irrigation Area

Three intakes namely Besuk, Kedung Kundi, and Pengkol irrigate some 534 ha commanded by Cabang Dinas Pengairan Nganjuk. Besuk intake which was used before does not function well now because of degradation of river bed and deterioration of the structure. Irrigation water is taken by pumps at Kedung Kundi and Pengkol intakes. These areas do not receive enough irrigation water by quantity and by time.

(vii) Jatimlerek Irrigation Area (Brantas Kiri Jombang Irrigation Area)

Jatimlerek rubber dam was constructed in 1991 to unify several irrigation schemes namely (from upstream), Jatimlerek, Gottan, Bebekan/Keboan, etc. The total irrigation area is estimated at about 2,050 ha and commanded by Cabang Dinas Pengairan Jombang. It is noted that Bunder I and II irrigation areas are included in the above command area. The Bunder I and II areas are located at just upstream of the rubber dam and irrigation water is taken by existing pumps.

The irrigation water taken at Jatimlerek rubber dam is also supplied to Wates-Pinggir area which is classified into the Brantas Kiri Mojokerto irrigation area as described thereunder.

(viii) Menturus Irrigation Area (Brantas Kiri Mojokerto Irrigation Area)

Menturus rubber dam was constructed to unify irrigation schemes such as (from upstream) Wates-Pinggir, Ngres, and Losari, etc. The total area is estimated at about 3,392 ha commanded by Cabang Dinas Pengairan Mojokerto.

(ix) Jatikulon Irrigation Area

Jatikulon free intake irrigates some 619 ha commanded by Cabang Dinas Pengairan Mojokerto. Irrigation water is taken by sluice gate located right side of the Brantas river.

(x) Brantas Delta Irrigation Area

There are two intakes, namely Voor Canal I and Voor Canal II at left side of the Brantas river just upstream of New Lengkong dam. These canals join at some 500 m downstream and is divided into two directions for irrigation in the Brantas delta, namely Mangetan irrigation canal and Porong irrigation canal. The total irrigation area of the Brantas delta is estimated at 27,362 ha and commanded by Cabang Dinas Sidoarjo.

(xi) Surabaya Irrigation Area

The Brantas river branches into two rivers namely Surabaya and Porong rivers at Mlirip gate. Some 1,469 ha is irrigated by the Surabaya river at the Gunungsari gate. Cabang Dinas Surabaya commands this irrigation area.

The location and configuration of these irrigation areas are indicated in Figure A4-1 and 2.

(3) Current Cropping Area And Pattern

Main crops in the irrigation area are rainy season paddy, dry season paddy, sugarcane, polowijo, vegetables, fruits, etc. Polowijo generally means second crop grown after rainy season paddy and is comprised with upland crops such as maize, soybean, peanuts, mungbeans, etc. The dry season paddy is further classified into two classifications namely, dry season paddy with permission and dry season paddy without permission. Irrigation water requirement of the dry season paddy with permission is calculated as paddy, while the water requirement of the latter one is limited to as Polowijo.

The cropping area and cropping pattern are recorded by each Cabang Dinas Pengairan. The records (so called Keadaan Irigasi) are collected from Cabang Dinas Pengairan and analyzed in the present study so as to get general idea on cropping area, period and cropping intensity. Averaged annual cropping intensity in the irrigation area by the Brantas river from 1994/95 to 1995/96 ranges from 1.5 to 2.6 as shown in Table A4-2. The cropping patterns in 1994/95 and 1995/96 are indicatory shown in Figure A4-3 by area.

(4) Current Irrigation Water Demand And Supply From The Brantas River

Each Cabang Dinas Pengairan calculates irrigation water requirement for his command area at beginning of rainy season cultivation and dry season cultivation. LPR (Polowijo Crop

Related Factor) method is commonly used in the calculation. Some water demand for factory and domestic uses are added to in case these water are supposed to be supplied by irrigation canal. As an example, for the Brantas delta area, an amount of 3.2 m^3/sec and 6.2 m^3/sec are added in rainy season and in dry season respectively. The results are presented to Dinas Pengairan. The Dinas Pengairan coordinates all calculations and presents to PJT, one of the member of Water Resources Management Committee (WMC, Panitia Tata Pengaturan Air). PJT prepares a water allocation plan in the coming season including reservoir operation plan in the Brantas river. After discussion with PJT and Dinas Pengairan, a draft final version of water allocation plan is discussed and approved by the WMC after revision if necessary. Based on the final water allocation plan approved by the WMC, Cabang Dinas Pengairan makes the irrigation plan for their commanding area. The LPR is utilized to make water distribution plan in the irrigation network.

Figure A4-4 shows recent irrigation water supply plan and actual discharge taken from the Brantas river from December 1994 to December 1996 as well as water demand requested by Dinas Pengairan. The total water taken at irrigation intakes is some 1.9 billion m^3 and 2.1 billion m^3 from October 1994 to September 1995 and October 1995 to September 1996 respectively. Each figure includes 150 million m^3 for industrial use in the Brantas delta as earlier mentioned.

The figure shows that the original water demand was reduced by some 30 to 50 percent. Further, the followings can be read from the figure;

- Actual water supply is close to the plan at Wlingi and Mrican Kanan and Kiri.
- Actual water supply is fairly close to the plan at Jatimlerek rubber dam.
- Actual water supply is close to the plan at Menturus rubber dam but extraordinary exceeded from December 1996 to June 1996. The reason is unknown.
- At Voor Canal I and II for Brantas delta area, actual water taken from the Brantas river always far exceeded from the plan. The reason may be assumed that when water was abundant in the river, gate operator tried to take water as much as possible and PJT did not strictly control the gate operation since the Brantas delta is the most downstream water user and overtaking water does not affect to others.

The actual water supply seems to be strictly controlled or some time squeezed in the upstream intakes. The control, however, seems to be looser in the downstream. The downstream users can benefit the excess water, if any. Further, the surplus water frequently goes to sea without being utilized.

(5) Inventory Of Existing Irrigation Facilities

Table A4-3 summarizes inventory of existing irrigation facilities in the Brantas basin. On the Brantas river main stream, 12 intakes are operated by Cabang Dinas Pengairan namely, 8 intakes commanding Brantas Atas and Bawah irrigation areas in Cabang Dinas Pengairan Malang; Besuk, Kedung Kundi, and Pengkol for Brantas Kiri irrigation area in the Cabang

Dinas Pengairan Nganjuk, Jatikulon in Cabang Dinas Pengairan Mojokerto. The Besuk, Kedung Kundi, and Pengkol intakes do not function because of degradation of river bed, sediment in front of the intake, deterioration of structure, etc.

The following weirs and intakes are not included in the Table A4-3 since they are operated by PJT or PKB;

- Wlingi for Lodoagung, Mrican barrage for Mrican Kanan and Mrican Kiri, Menturus rubber dam are operated by PJT.
- Jatimlerek rubber dam is operated by PKB

Regarding the above intakes, PJT or PKB also take care of operation and maintenance work of main canal within 50 m downstream from the intake. The present condition of intakes in the Brantas river is presented in detail in Chapter III.5.

Table A4-3 shows density of irrigation canal ranges from 3 m per ha to 41 m per ha in the Brantas basin. Reason of such wide range and poor density is considered as:

- that most of the irrigation areas in the basin are irrigated by small tributaries and have small intake and poor canals.
- Most of the paddy field are irrigated by plot to plot irrigation method namely water flows from ridge of upstream field to downstream field without proper control.

On the other hand, canal density in large scale irrigation system is high. Canal density reaches some 80 m/ha in the Lodoagung irrigation area followed by 41 m/ha in the Brantas delta area. In the Lodoagung area and Brantas delta area, more than half of the side slope of secondary canals are lined by precast concrete blocks or wet stone masonry. In the commanded are by Cabang Dinas Pengairan Tulungagung some secondary canals are suffered from huge amount of sediment which is produced by recent eruption of Mt. Kelud.

Related structures in the Lodoagung area were constructed in early 1980s and are function well. In the Brantas delta area bifurcation structure to Mangetan and Porong canals function well. However, many small related structures in the area are, as similarly as those in the other irrigation areas, out of their ordinary lifetime and require replacement.

2.2 Present Operation and Maintenance

(1) Organization and Staff

Dinas Pengairan located in Surabaya takes a primary role in the operation and maintenance for Irrigation in East Java as a whole. Dinas Pengairan consists of Administration Division, five Sub Dinas, Functional position group, and Dinas Technical Execution Unit as shown in Figure A4-5. Total staff of Dinas Pengairan is of 647 including administrative staff and 275 staff dispatched to East Java Irrigation Project.

There are some 37 Cabang Dinas Pengairan in East Java. Of them, 13 Cabang Dinas

Pengairan are located in the Brantas river basin. Each Cabang Dinas Pengairan has sub offices in his command area namely Cabang Seksi Pengairan. There are some 76 Cabang Seksi Pengairan in the Brantas basin.. Total staff of 13 Cabang Dinas Pengairan is counted to 2,049 in 1996 including some 600 Juru Air[1] and administrative staff. The commanding area of one Cabang Dinas Pengairan generally corresponds with extent of irrigation system. Accordingly, it does not exactly correspond with boundary of Kabupaten. Some large scale irrigation systems extend to more than two Kabupatens such as Lodoagung area, Turi-Tunggorono area, etc. In such case, issues related to irrigation water is coordinated by Kordinator Wilayah (herein after called as Korwil). There are four Korwils in the Brantas basin namely Korwil Malang, Kediri, Jombang, and Mojokerto. Total staff of 4 Korwils is of some 229 in 1996. Accordingly, 2,925 staff are employed in Dinas Pengairan Daerah Propinsi Dati I Java Timur.

In addition, some 1,406 daily workers are employed by Cabang Dinas Pengairan in 1996 for operation and maintenance work in the Brantas basin.

(2) Irrigation Committee

Irrigation committees are established in each administrative level; i.e., Province, Kabupaten and Kecamatan. The administrative chiefs of those levels are appointed as chairmen of the committees of each level. The committee comprises basically the following members which are governmental agencies; PEMDA (Administrative Office of Kabupaten), Dinas PU Pengairan, Agricultural Service Office (DIPERTA), Rural Development Office (BANGDES), National Land Board (BPN), and Police Office. These membership differ between the committees more or less, and depend on the water user's sectors. For instance, the committee in Sidoarjo includes fishery office.

The irrigation committee decides the cropping and irrigation schedules in each season and coordinate between the offices related to the irrigation water. In addition, the committee has played an important role to make maximum utilization of limited water resources for irrigation with its effective use. The tasks of the committee are summarized as follows (extracted and translated from East Java Governor's Decree No. 111, 1994)

(a) To coordinate irrigation water usage in the Province,

(b) To coordinate in planning alternative land use of paddy and upland crops,

(c) To solve problems which could not be settled by lower level local government,

(d) To compile and process and prepare materials for Governor's consideration in making his policy on efficient irrigation water use,

(e) To advise Governor in relation to general instruction of guidance for Water User's Association,

[1] Juru Air: Field inspector responsible for water distribution to several tertiary units

(f) To coordinate concerned government office, agencies, and institutions in relating with irrigation water pollution,

(g) To give periodical report every April, October and whenever necessary to the Governor about task implementation of Irrigation Committee.

(3) O & M Works

The Dinas Pengairan is generally responsible for O & M works of irrigation system namely from intake, main and secondary canals and up to the first 50 m of a tertiary canal. O & M works are comprised with planning of the irrigation schedule, control of irrigation water delivery, and maintenance and repair of facilities.

The water management and operation plans are prepared for each irrigation block (Golongan) in accordance with the seasonal plan and water distribution plan for each intake. According to the operation plan, field personnel under Cabang Seksi Pengairan set irrigation facilities to control the water delivery. The opening of gate and amount of water at each regulating structures are recorded by Juru Air and his staff every day.

The irrigation water distribution and hydrological features are monitored by the field personnel and reported to Cabang Dinas through Cabang Seksi. The actual water distribution is compiled with cropping record. FPR is recalculated based on the actual discharge and is used for evaluation of water distribution activity in the past 10 days. The results are presented in a form of Keadaan Irigasi by each Cabang Dinas.

Irrigation water requirement is calculated by irrigation area and by 10 days. LPR (Polowijo Crop Related Factor) method is commonly used for irrigation water management in East Java including the Brantas River basin. This method contributes to simplify water demand calculation in field level. An irrigation area under cultivation is converted to LPR value (unit: Polowijo ha) multiplying the area by conversion factors which are decided to each crop and its growing stage. LPR represents a crop intensity in a sense.

LPR value (polowijo ha) = Cultivated area in ha x Weighted factor in polowijo

where, weighted factors;

- Nursery period of paddy = 20 pol.
- Land preparation period of paddy = 6 pol.
- Growing period of paddy = 4 pol.
- Young stage of sugarcane = 1.5 pol.
- Matured stage of sugarcane = 0 pol.
- Polowijo = 1 pol.
- Fallow = 0 pol.
- Unlicensed paddy (all stages) = 1 pol.

- Tobacco = 1 pol.

The LPR of the irrigation area at certain time is calculated as follows:

- Total irrigation area = 14,000 ha
- Growing stage of paddy = 10,000 ha,
- Growing stage of sugarcane = 3,000 ha,
- Growing stage of tobacco = 800 ha,
- Fallow = 200 ha
- LPR value = 10,000 x 4 pol. + 3,000 x 0 pol. + 800 x 1 pol. + 200 x 0 pol. = 40,000 + 800 = 40,800 pol.

In an actual operation, FLPR (Factor LPR)) which is a divided value of irrigation area by LPR, is utilized. For example, when the FLPR in certain irrigation area becomes lower than the standard FLPR, the area starts sever water management called "Giliran System" for water saving.

The following table presents the standard FLPR value which is decided as a result of field test conducted by the Research Institute of Bogor and Dinas Pengairan Jawa Timur.

Soil type	Standard FLPR (liter/sec/pol. ha)	Standard FLPR value converted to height of water for dry season in millimeter.
Sandy (Alluvial)	0.36	569
Medium (Latosol)	0.23	364
Glayey (Gromosols)	0.12	190

Source: Final Report on Special Assistance for Project Sustainability (SAPS-II) on Brantas river Basin Development Projects, Annex 6, March 1992

The standard FLPR value ranges from 0.23 to 0.36 in connection with the soil conditions in the Brantas basin. The FLPR adopted in each irrigation schemes are as follows;

Irrigation schemes	Soil type	Standard FLPR (liter/sec/pol. ha)	Adopted (liter/sec/pol. ha)
Lodoyo	Grey/Grayish brown alluvial	0.36 - 0.23	0.36
	Grayish brown regosols	0.36	
Mrican	Grey/Grayish brown alluvial	0.36	0.3
	Grayish dark alluvial	0.23	
Brantas Kiri Kediri	Grey/Grayish brown alluvial	0.36	0.36
Turi-Tunggorono	Grey/Grayish brown alluvial	0.36	0.36
Brantas Kiri Jombang (Jatimlerek)	Grey/Grayish brown alluvial	0.36	0.36
Brantas Kiri Mojokerto	Grey/Grayish brown alluvial	0.36	0.36
Jatikulon	Grey/Grayish brown alluvial	0.36	0.36
Delta Brantas	Grayish alluvial	0.36	0.36
Simowau	Grayish alluvial	0.36	0.36

Source: Final Report on Special Assistance for Project Sustainability (SAPS-II) on Brantas river Basin Development Projects, Annex 6, March 1992

Under the Giliran system, irrigation area irrigated by a main canal is divided into 2 to 3 rotation blocks. The rotation interval for one rotation block ranges from 3 to 5 days. So, a secondary canal can receive water only 3 to 5 days. Amount and duration of irrigation in the tertiary canals is determined in accordance with available water in the secondary canal and LPR (Polowijo Relative Areas) of each tertiary canal. In the extremely drought case, rotation in quaternary canals will be carried out if available water is extremely low.

(4) Operation And Maintenance Cost

The Government of Indonesia started EOM (Efficient Operation and Maintenance) in Java in 1987/88 as part of ISSP I, and continues under ISSP II and the ADB-supported Integrated Irrigation Sector Program (IISP). The EOM targets effective utilization of irrigation and drainage infrastructure to ensure adequate equitable water supply to all irrigation area as planned, and maintenance carried out so that the system perform as designed without further rehabilitation. The EOM is conducted on the Government owned irrigation system. The total target area of EOM in 1996/97 has been estimated at 111,500 ha by Dinas Pengairan. The cost for EOM is fully now borne by Indonesian budget. The Local Government has prepared annual budget of 3.5 billion Rp. from APBD for EOM scheme in the Brantas basin in the financial year 1996/97. Accordingly the average O&M cost for EOM area is of some 31,500 Rp/ha. Further, 2.9 billion Rp. has been prepared from APBD budget for small scale irrigation system which is less than 500 ha. The average budget for small scale irrigation system is calculated at some 15,400 Rp/ha.

(5) Water User's Association (WUA)

Operation and maintenance of irrigation and drainage facilities in the tertiary block is carried out by WUA. WUA is generally established by Desa (village) or Kelurahan.[1] Its member is land owner, land worker, fish pond worker, corporation, etc. who use irrigation water in the Desa or Kelurahan. WUA has a chairman, deputy chairman, secretary, treasurer, technical organizer chief aide and leader of quaternary block those are elected from members. The member's general meeting is the highest authority in WUA. The organization of WUA is shown in Figure A4-6. WUA will do the following tasks;

- to manage water and irrigation network in tertiary irrigation system and block or pump irrigation area,
- to construct, rehabilitate and maintain tertiary irrigation network,
- to collect and manage Irrigation Service Fee,
- to supervise members carrying out government regulation regarding water use,
- to receive repaired small irrigation network and/or pump irrigation network given by government or institution related.

A WUA is established in accordance with administrative border of Desa or Kelurahan. If one tertiary block is wider than the border of Desa or Kelurahan, the boundary of the tertiary block is adopted to the boundary of the WUA. Some 2,718 WUAs have been established until 1996 in 8 Kabupatens including municipalities in the Brantas basin as shown in Table A4-4. Dinas Pengairan evaluated development level of those WUAs in accordance with his criteria. The assessment shows only 9 % of WUAs are well developed and 90 % of WUAs are under developing or not yet developed well as also shown in Table A4-4. The establishment and development of WUA are one of the key factor on efficient water management. Accordingly, acceleration of WUA establishment and development are expected.

(6) Irrigation Service Fees (ISF)

ISF have been introduced by the Government of Indonesia based on a "user-pays" basis to strengthen local government for irrigation management, increase beneficiary participation and ensure that adequate resources are provided for O & M on irrigation systems. In East Java, ISF have been applied to some 120,157 ha in eight Kabupatens by end of fiscal year of 1994/1995. Out of eight Kabupatens, ISF have been applied in five Kabupatens, namely Nganjuk, Jombang, Kediri, Tulungagung, and Blitar in the Brantas basin.[2] The total area is assumed more than 41,000 ha. Dinas Pengairan is implementing extension of ISF in 13 Kabupatens which cover irrigation area of some 405,000 ha in the Java Irrigation Improvement And Water Resources Management Project. Of them, four Kabupatens namely Malang, Mojokerto, Sidoarjo and Trenggalek are located in the Brantas basin. The total area

---

1 Kelurahan: Lowest level of government organization but has no autonomy.

2 Rencana Perluasan IPAIR Dalam Java Irrigation Improvement Project (JIWMP) Tahun 1995/1996 S/D 1997/1998 Di Java Timur

of four Kabupatens will be 72,000 ha.[1]

Tariff of ISF is a flexible rate which is calculated by each Kabupaten and irrigation system. The Government's basic concept for ISF is that ISF should be estimated according to the quality of services with necessity of repairing and maintenance budget by each system. The amount of ISF is calculated basically by the following formula.

ISF = (Total Maintenance Cost + Collecting Cost of ISF)/Total Irrigation Area

The tariff of ISF in the Brantas basin was set at Rp. 12,500 to 21,000 per ha per one year in 1993/1994.[2] ISF is used for repairing and maintenance of main and secondary canals.

Collection of ISF is implemented by WUA. Chairman of WUA who has been elected by the member of WUA is a collector. In addition, chairman of WUA's group (Gabungan HIPPA) coordinates fee collection between WUA's group. Collected fees are deposited to BRI Unit Desa (BRI at village level) within one day. The collector and chairman of WUA's group can receive 20 % of collected fees at maximum as a collecting fees. The balance (80% of collected fees) will be sent to BRI Cabang Office and be transferred to BPD (Bank Pembangunan Daerah)[3] which is a handling agency for tax, reeves, and other official revenue. The BPD keeps ISF, and it becomes local government budgets (APBD). BAMUS (Badan Musyawarah)[4] is responsible for management and operation of ISF. Should some repair work of irrigation facilities be requested by Cabang Dinas Pengairan, BAMUS meeting is held to assess its necessity and released its fund to the works.

2.3 Existing and On-going Irrigation Projects

Although East Java, including the Brantas river basin, is one of the best irrigation developed region in Indonesia, the Government of Indonesia continues the development to achieve equitable distribution of water, prosperity and stability of society, people's welfare, etc. The mainstay of irrigation development in Java has been shifted from large scale development to rehabilitation, development and turnover small scale irrigation to community, and EOM. In this connection, the following projects are operated in East Java.

(1) East Java Irrigation Project

The East Java Irrigation Project (herein after called as IRJAT) has implemented development of new irrigation system and rehabilitation of existing irrigation system in East Java as a whole. The present main task is rehabilitation which includes repairing canals and structures including lining, training of people, turnover program of the irrigation system which is less than 500 ha to the community, etc. The objective area has been recently concentrated into the Brantas basin and the Bungawan Solo basin. In 1997/98, IRJAT has nine sub projects in

[1] ditto

[2] Laporan Propil Jaringan Irigasi Program Iuran Pelayanan Irigasi (IPAIR) Realisasi Tahun 1993/1994 DI Jawa Timur Proyek Irigasi Jawa Timur

[3] BPD: Local Development Bank established in Kabupaten

[4] BAMUS: Discussion Committee, implementing agency for collection and management of ISF

total and of them three are located in the Brantas river basin namely Brantas Hulu, Brantas Hilir, and Sidoarjo. Total area commanded by the above three sub projects is estimated at some 32,800 ha. The major works of the above three sub projects are:

- Rehabilitation of main system
- Rehabilitation of small irrigation system
- Repair recent natural disaster,
- Improvement of Papar Irrigation system,
- Rehabilitation of village irrigation
- Development of village irrigation system
- Repair irrigation system in Brantas delta
- Optimization and turnover of small scale irrigation network
- Repair work in Lodoyo Irrigation system,
- Repair buildings and offices, etc.

The source of budget for IRJAT is divided into Indonesian own cash (66.7 %) and foreign loans (33.3 %). IBRD has been financing to IRJAT as part of ISSP I and II and will continue at least until 2000. In addition, OECF will start financing for development of village irrigation system through Project Type Sector Loan (PTSL) from 1997.[1]

(2) East Java Ground Water Development Project

The East Java Ground Water Development Project (hereinafter called as PAT) has developed more than 600 tube wells and irrigation systems in East Java under the finance of ISSP I and II of IBRD. The tube well irrigation systems are classified into two types by depth as follows:

Deep tube well irrigation system (DTW): Depth is some 100 m below ground surface; average production rate is more than 30 lit/sec,

Intermediate technology tube well irrigation system (ITW): Depth is some 60 m on average; average production rate is about 10 lit/sec,

The number of wells developed by PAT until 1996 in the Brantas basin are summarized as follows;

[1] Penjelasan Singkat Program Pelaksanaan Proyek Irigasi Jawa Timur Tahun Anggaran 1997/1998

Name of Zone	DTW (no)	ITW (no)
Kediri	129	
Nganjuk		46
Jombang		35
Mojokerto		49
Total	129	130

Source: PAT

Total irrigation area in the above system is assumed at about 6,000 ha. All facilities such as tube well, pumping equipment and irrigation pipes, etc. are handed over to WUA after two years transition period in which the operation and maintenance cost is borne by PAT; meanwhile, WUA collects fees from beneficiaries and deposits for fund in future operation by WUA. Farmers usually cultivate paddy in rainy season under nearly rained condition. In dry season Polowijo or other cash crops such as shallot, chili, groundnut, soybean, etc. are grown generally two times by irrigation. Dinas Pengairan informed that the tube well irrigation systems are not counted in the statistics (Baku Sawah) though the Dinas Pengairan supports operation and maintenance of the irrigation system.

It is informed by PAT to the Study Team that the annual potential of aquifer in the above zones is about 64 million m3 by DTW and ITW systems. Based on this, potential ground water irrigation system is estimated at 6,400 ha approximately. On the other hand, PAT has a plan to develop 17 DTWs in Jombang and Mojokerto in the fiscal year 1997/98.

It is also informed by PAT, that there are more than several hundred shallow wells developed by farmers in the Brantas basin especially in the zones above mentioned. Ground water is taken by centrifugal pump and production rate is assumed at 3 to 5 lit/sec. The PAT is not concerned with these shallow wells.

2.4 Summary of Current Problems Related to Irrigation

In this section, problems reported by agencies concerned, findings of the Study Team related to irrigation in the Brantas basin are summarized.

(i) Lodoagung irrigation area

Cabang Dinas Pengairan Tulungagung informed the Study Team that some secondary canals are suffered from huge amount of sediment which is produced by recent eruption of Mt. Kelud. Some drains are choked with sand and soil carried out by flood from adjacent hills. In this connection, some secondary and tertiary canals are washed away by the flood. This information was confirmed by site visit of the Study Team. Cabang Dinas Pengairan Tulungagung intends to construct small check dams and drainage improvement but they don't have enough budgets.

It is also reported that:

- irrigation water can not reach downstream in many tertiary canals. The reasons are assumed intentional or mistaken overtaking of water by upstream farmers, large seepage loss in the canal since it is constructed on the high embankment, etc.

- the water loss is higher than expected in some section in the main canal based on the actual flow measurement conducted by Cabang Dinas Pengairan Tulungagung.

(ii) Brantas delta irrigation area

As earlier mentioned, reduction of irrigation area is accelerated in the Brantas delta area. The urbanization and industrialization, however, are scattering in the irrigation area (sprawl) Buildings some time choke the tertiary canals so that the paddy field located downstream hardly receive water. On the other hand, when Giliran system is applied, some factories which originally took his water from canal can not take water for 3 to 5 days.

Many farmers have side job and employ agriculture labors from other area such as Nganjuk, Mojokerto, etc. So, planting and irrigation are carried out in accordance with availability of labors not with the planned schedule.

Overtaking water is observed in many irrigation blocks. The overtaking is frequently beyond control of Juru Air. Education is essential for efficient O&M.

(iii) Overall in the Brantas basin

Many old irrigation systems are not sufficiently equipped with water measurement structures. It is not sure that water is distributed as planned in the Giliran system without sufficient and precise measurement facilities. When Giliran system is applied, a secondary canal is kept dry 3 or 4 days until next turn comes. In the unlined canal, accordingly, initial loss of water in the canal is high to saturate the canal.

The intake discharge records show, though it is studied only two years, taking water from the Brantas river seems to be strictly controlled or some time squeezed in the upstream. On the other hand, in the downstream the control seems to be looser. The downstream user some time can benefit the excess water, if any. Further, the surplus water frequently goes to sea without being utilized. Should the available river flow be more than expected amount in the Brantas, water allocation plan has to be comprehensively revised without delay.

2.5 Current Agriculture Production

Table A4-5 shows annual harvested area, unit yield and production of major food crops produced in the Brantas river basin. As shown in the table, harvested area of wetland paddy has decreased from 416,900 ha to 386,300 ha from 1985 to 1995. On the other hand, it has increased from 1,493,000 ha to 1,533,000 ha in East Java during the same period. The share of the Brantas river basin in East Java has decreased from 27.9% to 25.2% accordingly. The total production of wetland paddy has increased from 2,160,000 ton to 2,230,000 ton in the Brantas river basin and 7,440,000 ton to 8,580,000 in East Java respectively. The share of the Brantas river basin has also decreased from 29.1% to 26.0%. This phenomenon is observed in other food crops such as maize, peanuts, soybean, etc. The total annual harvested area has decreased from 874,700 ha to 803,700 ha in the Brantas basin. On the other hand, however, it has increased from 3,530,000 ha to 3,754,000 ha in East Java.

Eventually, the role of the Brantas river basin is decreasing in agriculture in East Java. The reason of the decrease might be caused from reduction of agriculture land in the basin, irrigation development in East Java, etc.

2.6 Irrigation Area in 2020

(1) Estimation based on the past trend

The Brantas river basin has been already reclaimed at the maximum possible extent from the viewpoint of land resources. It may fairly be said that the reclamation in hilly and mountainous areas should be prohibited to maintain these areas as water conservation and breeding area. While, the low alluvial plain is main active area in agriculture commerce, industry and settlement area of inhabitants. In future, it is forecasted to be more and more difficult to maintain the agricultural area because the commercial and industrial activities increase in the basin.

The irrigation area in the basin has reduced by some 8,500 ha from 1985 to 1996 though it has increased in three Cabang Dinas as shown in Table A4-6. The reduction of irrigation area is mainly observed in Surabaya and its suburbs due to the rapid urbanization and industrialization. The irrigation area under the Cabang Dinas Pengairan Surabaya is reduced from 4,900 ha to 1,500 ha from 1980 to 1996 and that in the Cabang Dinas Pengairan Sidoarjo from 32,600 ha to 28,400 ha.

As shown in the table, annual reduction rate of irrigation area is estimated at some 0.04% on average from 1985 to 1990 in the Brantas basin and at some 0.38% from 1990 to 1996 respectively. This means the conversion of irrigation area to other uses has been sharply accelerated from early 1990s except for Surabaya. Should the conversion of irrigation area continue with same decrease rate (0.38%), some 37,100 ha will be converted from irrigation area to other uses by 2020. Accordingly, some 272,000 ha irrigation area will remain in the basin as shown in the table.

(2) East Java Development Plan for 2008

In 1994 the East Java provincial government prepared development plan for 2008 namely Rencana Tata Ruan Wilayah Propinsi Daerah Tingkat I Jawa Timur 2008 (herein after called as the Plan 2008). The Plan 2008 estimated the irrigation area in East Java and Brantas river basin will increase by 36,700 ha and by 10,300 ha by 2008. Accordingly, total irrigation area will reach to 933,000 ha in East Java and to 318,900 ha in the Brantas basin respectively. This increase will be achieved by irrigation development in the existing rainfed area and converted from other land use as shown in Table A4-7.

This plan, however, is hardly to be examined how many irrigation areas will be converted to other land uses.

(3) The Study for Formulation of Irrigation Development Program in the Republic of Indonesia (FIDP)

The Study for Formulation of Irrigation Development Program in the Republic of Indonesia (herein after called as FIDP) was conducted by JICA in 1992 and 1993. One of the major objective of the FIDP Study was to formulate an irrigation development program, in a long term range, which provides current and future Repelita with rationale and guideline of irrigation development plans having regional priority, in line with overall food production increase program, thus, contributing to the sustenance of self-sufficiency in rice. The target year of the FIDP was 2020. The FIDP estimated irrigation area in East Java as follows:

- There is no further irrigation development potential in East Java from 1990 to 2020,
- The existing irrigation area of 897,300 ha in 1990 will be reduced by 265,000 ha by conversion to other uses by 2020,
- The total irrigation area will accordingly be 632,300 ha in 2020, 70.5% of the existing irrigation area,
- The irrigation development in East Java is supposed to be concentrated into rehabilitation and groundwater development/small scale irrigation in some 222,900 ha of the above.
- Accordingly, the reduction rate of irrigation area is figured out some 1.16% per annum.

(3) Comparison of the studies

The above three estimation are summarized as follows:

Name of Study	Total reduction up to 2020 (ha)		Irrigation area in 2020 (ha)	
	East Java	Brantas basin	East Java	Brantas basin
Present JICA Study	-99,700	-37,100	808,000	272,000
East Java Plan 2008	36,800	+10,305	933,000	318,800
FIDP	-265,000	Not estimated	632,300	Not estimated

In the above table figure estimated by the Present JICA Study shows medium value between other two studies/plans and is applied to the present study.

2.7 Cropping Intensity and Patterns in Future

As earlier mentioned, a typical cropping pattern in the Brantas river basin is classified into three basic patterns such as paddy - paddy - polowijo, paddy - polowijo - polowijo and sugarcane. The average cropping intensity is figured out some 210% in a year. The intensity of each crop, however, varies from area to area. As an example, rainy season paddy varies from 90% in Jatikulon area and 20% in the Brantas Atas area. The dry season paddy varies from 50% to 10%. This relatively low intensity of paddy seems to be caused by:

- the Government of Indonesia has been promoting crop diversification from mono-culture of paddy,
- the market trend has been changing due to improvement of living standard and urbanization in and around the Brantas basin, etc.

In future, water demands will remarkably increase in the industrial and domestic sectors resulting in a severe stress to irrigation water saving; based on this assumption the present Study presumes the future cropping pattern in the basin as stated below.

(i) High yielding varieties (HYV) will be cultivated in all paddy field for water saving; the growing period of HYVs is assumed as 90 days after transplanting and is shorter than local varieties.

(ii) At present in some areas, a fallow of some one month is observed between rainy season paddy and dry season paddy. Dry season paddy, however, should follow soon after rainy season paddy so as to reduce the dry season water requirement. In the target year the cropping area will decrease, on the contrary, population will increase. So there may be no difficulty of agricultural labor forces.

(iii) The present irrigation records (Keadaan Irigasi) show some 8,000 ha of unauthorized paddy in dry season. These areas are provided minimum demand of water (equivalent to LPR=1.0) when irrigation eater is sufficient and will be abandoned in the drought period. However, the farmers in the unauthorized paddy field may abstract water more than their allowed amount from irrigation canals or river illegally. The unauthorized area should be controlled strictly by authority concerned getting understanding from farmers for the effective use of limited water resources. The previous report (Final Report on Special Assistance for Project Sustainability (SAPS-II) on Brantas River Basin Development Projects reported that the unauthorized paddy cropping has remarkably reduced where a cooperative society of farmer's organizations is established and the necessary arrangement for water management is decided. The present Study expects the unauthorized paddy will be disappeared and the area will be cultivated by polowijo.

(iv) Extent of sugarcane may not drastically change in future, since cultivation of sugarcane is generally reflected with capacity of sugar factory.

Eventually the present Study estimates the cropping intensity in the Brantas basin may not significantly change from the existing intensity. Table A4-8 shows assumed cropping intensity and cultivated area in future applied for calculation of irrigation water demand in future. Figure A4-7 shows future cropping patterns in each area.

2.8 Irrigation Water Requirements

(1) Calculation Method and Criteria of Irrigation Water Requirement

The irrigation water requirement such as potential present water requirement and future irrigation requirement at the target year of areas irrigated by the Brantas river main stream are calculated in the present study. The following two publication are used in the calculation:

- Irrigation Design Standards Design Criteria Volume Irrigation System Design KP-01 1st Edition December 1986 published by DGWRD (herein after called as KP-01),
- FAO Irrigation and Drainage Paper 24, Crop Water Requirements published by FAO in 1977 (herein after called as FAO #24)

The most of the records regarding to the irrigation water management such as intake discharge records, irrigation water distribution records, etc. are recorded by 10 days. Taking this fact into account, the irrigation water requirement is calculated for 10 days in the present study.

(i) Net Field Irrigation Requirement

General

Net field irrigation requirement is calculated by the following equation.

$$NI = IR + CU + P + NR + WL - ER$$

Where;

NI:	net field water requirement
IR:	irrigation requirements during land preparation
CU:	crop consumptive use of water
P :	percolation rate
NR :	nursery requirement
WL :	water layer replacement
ER :	effective rainfall

Crop Consumptive Use of Water (CU)

CU can be given by multiplying Reference Crop Evapotranspiration (ETo) and crop coefficient (Kc).

The ETo is calculated for each 10 stations by the modified Penman method established by FAO #24 as recommended in KP-01. The climate data used in the calculation such as temperature, humidity, wind velocity and sunshine hours are summarized in Table A4-9. The calculation results of ETo are tabulated in Table A4-10.

Crop coefficients (Kc) of both traditional and high yielding varieties of paddy are recommended in KP-01. The Kc values are shown in Table A4-11. In the calculation of potential present water requirements calculation, Kc value either for traditional variety or high yielding variety is used depending on growing period shown in the record (Keadaan Irigasi). On the contrary, for calculation of future water requirements, the crop coefficient of HYV is applied.

Crop coefficients of polowijo, namely maize, soybeans, peanuts, onions, green beans are taken from KP-01. Polowijo is a general term of these crops; extent of each crop and growing stage are hardly counted. Accordingly, average crop coefficient of 0.73 is simply taken for the estimate of the water requirement as shown in Table A4-11.

Crop coefficient of sugarcane is also taken from KP-01. There are two series of crop coefficient of sugarcane cane namely, for new plant (24 months) and for ratoon (12 months). The present study assumes two times of ratoons after new plant. Accordingly, 4 cropping patterns are considered and average of them is applied in the calculation as shown in Table A4-12.

Crop coefficient of tree crops such as citrus and apple are taken from the FAO #24 as shown in Table A4-13.

Crop coefficients of all crops related to the present study are interpolated to each 10 days. Further, we stagger the crop coefficients in accordance with the cropping patterns applied in the study and calculate average coefficient for every 10-day.

Percolation (P)

Referring to the previous study, percolation rate in the paddy field is assumed from 2.0 to 4.4 mm/day. The percolation rate applied by the present study is shown in Table A4-14 by irrigation area.

Irrigation requirements during land preparation (IR)

For the calculation of the irrigation requirements during land preparation the method developed by Van de Goor and Zijlstra (1968) is used as recommended by KP-01 as shown below.

$$IR = M \times e^k / (e^k - 1)$$

Where;

IR: irrigation requirement at field level in mm/day

M: water requirement to compensate for evaporation and percolation of the fields already saturated $M = Eo + P$ in mm/day; Eo is open water evaporation taken at 1.1 x ETo during land preparation in mm/day, P is percolation mm/day

k: $M \times T / S$; T is land preparation period in days (20 days in the present study), S is pre-saturation requirement (200 mm) added with 50 mm water layer in mm, e.g. S = 200 + 50 = 250 mm.

As explained above, IP is a function of percolation, ETo and T which vary from place to place and time to time. As a result of calculation, the irrigation requirement during the land preparation varies from 16 mm/day to 20 mm/day as shown in Table A4-15.

Nursery Requirement (NR)

Water requirements for nurseries are included in the land preparation water values mentioned above.

Water Layer Replacement (WL)

As suggested by KP-01, 2 water layer replacements are taken into account; each of 50 mm at about 1 month and 2 months after transplanting.

Effective Rainfall

The KP-01 recommends the following equation to calculate effective rainfall for paddy cultivation;

$Re = f \times 1/15 \times R(\text{half month})_5$

Where;

f:	effective rainfall rate, 70% recommended in KP-01
Re:	effective rainfall in mm/day
$R(\text{half month})_5$:	minimum half monthly rainfall with return period of 5 years in mm

The Widas Part I Study checked actual effective rainfall rate by using daily simulation method in the field. The study revealed that the efficiency of rainfall is to be 0.48 to 0.55 in the plot to plot irrigation system which is predominant in the Brantas basin as follows:

	Case 1 (4 plots)	Case 2 (3 plots)	Case 3 (2 plots)
Average effective rainfall rate (%)	48%	51%	55%

Taking into this result, the present study assumes the effective rainfall rate at 50 %.

In the present study, effective rainfall is estimated for 10 days as earlier mentioned. Accordingly, $R(10\text{-day})_5$ substitutes for $R(\text{half month})_5$ in the above equation.

In the present study, 10 rainfall stations are selected to cover all irrigation area in the basin. A water year starts from October taking into consideration the rainfall pattern in the study. Annual rainfall of each water year is summarized in Table A4-

16 for selected 10 rainfall stations.

The frequency analysis of annual rainfall is carried by using Gumbel method. Probable rainfalls for return period in 2 years, 5 years and 10 years are figured out. The results are shown in Table A4-17.

The above 80% dependable rainfall is distributed to every 10-day of the year based on the average distribution pattern of some years of which annual rainfall correspond to the 80 % dependable rainfall. The R(10-day) $_5$ rainfall of each station are tabulated in Table A4-18.

The following table shows irrigation area and his representative rainfall station selected by the present study taking into consideration their location.

Irrigation area	Rainfall station	Irrigation area	Rainfall station
Brantas Atas	Malang (Kayutangan)	Brantas Bawah	Malang (Kayutangan)
Molek	Kepanjen	Lodoagung	Blitar (Lodoyo) x 0.23 + T' agung (Kali dawir) x 0.87
Mrican Kanan	Kediri x 0.23 + Kertosono x 0.33 + Jombang x 0.44	Warujayen-Kertosono	Kertosono
Brantas Kiri Kederi	Kertosono	Jatimlerek	Tapen
Menturus	Tapen x 0.5 + Mojokerto x 0.5	Jatikulon	Mojokerto
Delta	Mojokerto x 0.5 + Juanda x 0.5		

The effective rainfall for upland crops such as polowijo, sugarcane, etc. is calculated by the USDA Soil Conservation Service method as shown in KP-01. In the calculation, storage factor is assumed at 1.0.

(ii) Diversion Water Requirement

The diversion water requirements are figured out by the following equation.

GI = A. NI/Ei

Where,

- GI : diversion water requirement
- A : irrigation area
- NI : unit water requirement
- Ei : irrigation efficiency

Efficiency

The irrigation efficiency depends on irrigation method, material and condition of irrigation facilities, operation and maintenance works, water management on the field including field soil texture, etc.

The measured data of irrigation efficiency are hardly provided by Cabang Dinas to the JICA Study Team. During the discussion with Cabang Dinas Tulungagung, however, some information were given; In Lodoagung area, some 10% is disappeared from main canal even all turnouts are closed as shown below.

Section of main canal	length (km)	loss (%)
BLT I - BLT II	5.1	12.9
BLT II - BLT III	13.7	8.02
BLT III - BLT IV	5.3	10.8
BLT IV - BLT V	5.9	9.69

Further, Cabang Dinas Tulungagung gave the overall irrigation efficiency to be 50 to 60 %.

The KP-01 recommends irrigation efficiency as follows:

	Initially	Possible improvement
Main irrigation system	0.75	0.80
Tertiary unit	0.65	0.75
Overall	0.50	0.60

Based on these, irrigation efficiency is simply assumed at 0.50.

(2) Potential Irrigation Water Requirements at Present Condition

Present cropping patterns in each area irrigated by the main Brantas river are illustrated in the series of Figure A4-3. The potential irrigation water requirement at present condition is conducted for the period form October 1994 to September 1996. The detail of the calculation is attached in Appendix IR. The results are summarized below and in Table A4-19 together with Dinas Pengairan's estimate, PJT's plan and actual intake discharge record for comparison.

In Lodoagung, request by Dinas Pengairan and JICA's estimate are similar. The PJT's plan and actual supply are short. In Mrican Kanan Dinas's estimate and PJT plan are short. In Delta Brantas, Dinas's estimate, though it may includes water supply to the fish ponds in the Sidoarjo region, is larger than JICA's estimate,

Name of irrigation area	Annual mean and max. irrigation water requirements (m3/sec)					
	Dinas's estimate		PJT plan		JICA's estimate	
	Average	Max.	Average	Max.	Average	Max.
Lodoagung	9.6	21.0	7.6	14.5	9.9	17.4
Mrican Kanan	10.7	20.4	7.7	12.9	13.9	35.6
Mrican Kiri	9.6	18.1	7.4	12.5	9.5	22.6
Brantas Kiri Kediri	0.6	1.0	0.6	0.9	0.3	1.3
Jatimlerek	1.1	2.0	1.0	2.2	0.9	5.1
Menturus	3.4	5.0	1.7	2.8	1.7	3.6
Jatikulon	0.5	1.8	0.6	0.8	0.5	1.7
Delta Brantas	29.5	46.0	21.7	34.1	18.1	35.2
Basin total	64.9	103.0	48.3	75.2	58.8	86.6

(3) Future Irrigation Water Requirements

The Widas Flood Control and Drainage Project Part I Study March 1986 (herein after called as Widas Part I Study) studied relation between starting time of rainy season paddy cropping and average water demand in the dry season paddy. The optimum starting period in each area recommended in the study are summarized as follows:

Area	Optimum starting period of rainy season paddy
Molek	Middle to late October
Lodoagung, Warujayeng-Kertosono	Late to early November
Turi-Tunggorono	Early November
Jatimlerek	Early November
Jatikulon	Early November
Delta Brantas	Middle November to early December

The river flow in the Brantas river, however, is generally lowest in November and starts increasing from middle December. On the other hand, the above cropping pattern may require large amount of water from the river in November for irrigation. The present Study considers two types of cropping calendar to find out optimum water management plan as follows:

Case 1 Land preparation for rainy season paddy cultivation starts early October in some area so as to start dry season paddy in the middle of rainy season.

Case 2 The cropping starts one month later of Case 1, namely at November.

The calculation results are summarized in Table A4-20 and breakdown of the calculation is compiled in Appendix IR. Annual water requirements in all areas are figured out at 1,452 million m3 for Case 1 and 1,404 million m3 for Case 2. The maximum values, however, largely decrease from 92.3 m3/sec for Case 1 to 67.2 m3/sec for Case 2. This reveals that Case 2 has a great advantage for water saving provided that sufficient irrigation water is timely supplied without fail especially from July to November.

2.9 Countermeasures for Water Saving

(1) Canal lining and rehabilitation works in Lodoagung

As earlier mentioned, 10 % of water is uncontrollably in the main canal in Lodoagung. This might be seepage loss because of soil characteristics in the area. Study team makes short estimate of possible water saving by concrete lining. referring to FAO Irrigation and Drainage Paper 2, Canal Lining published by FAO (herein after called as FAO #2). The estimation shows seepage loss will decrease from 10.0% to 3.3% in the main canal, 7 secondary canals and 1 suplesi canal as a whole.

Canal lining is proposed to save above seepage loss in the main canal and secondary canals. This Study assumes some 6.5% of water can be saved by lining. Concrete block lining with 7 cm thickness is tentatively proposed since maintenance work is easier than plain concrete lining. Hydraulic design is tentatively made to figure out required work quantity. Selected earth material has to be filled to narrow the canal bottom. Work volumes calculated are shown in Table A4-21 and summarized as follows:

Concrete lining works	735,200 m2
Earthfill works	385,900 m3

The Cabang Dinas Pengairan Tulungagung has a plan to rehabilitate some irrigation areas so as to recover the original function (refer to paragraph 2.4). The rehabilitation includes construction of check dam on Kali Timo, sediment removal in drainage canal Rowo Ubang and secondary canal Rawaremang, by pass to Kali Pangang Ploso, etc.

It is noteworthy that detailed design is required to make proper design of the canals and to estimate precise cost.

The construction cost for above canal lining and rehabilitation works is tentatively estimated at some million Rp. 28,585 as shown in Table A4-22. In the table canal lining cost solely figured out at million Rp. 27,343 for some 10,000 ha. Accordingly, unit cost of canal lining is calculated at Rp. 2,735,000 per ha.

(2) Canal lining works in other areas

In the Brantas basin, most of irrigation canals are constructed by earth on the similar soil type as Lodoagung. Therefore, the present study estimates that seepage is one of the main factor of irrigation water loss in the canal. The concrete lining can save some 6.7 % of water in the canal. Though field measurements in the long period are indispensable to estimate accurate seepage loss in the canals, this Study tentatively assumes that 3.5% can be saved in Delta Brantas area, 5% in other areas except for Lodoagung taking into consideration the topography and soil type in the existing canal route, etc. It is expected some 130 million m3 will be saved by concrete lining of main and secondary canals in the basin as a whole

Inventory and topographic survey of the existing canals are necessary to make a adequate design and cost estimate. An unofficial information is given to the Study team by IRJAT that they have executed concrete lining in the Brantas Delta and it has cost around Rp. 1,200,000 per ha. The condition of the existing lining work is checked by the study team. The field visit revealed that the most of the lining works have been done only side slopes. In the Brantas basin as well as entire Indonesia, a ratio of water depth to canal bed width is varies from 3 to 5 with side slop to vertical 1 to 1.25 or 1 to 2. Accordingly, canal bed width may be around 2 times of side slopes. Based on this, the study team assumes that the canal lining for three dimensions will cost two times of 2 dimensions. The unit price of Rp. 2,735,000 per ha is tentatively applied in the study.

Area-wise implementation is proposed. A priority ranking is made for the concrete lining works based on the following conditions;

- The area from which return flow from irrigation goes outside of the Brantas basin is given the first priority,
- The area which is suffered from shortage of irrigation water has a high priority

Based on the above, Lodoagung area is given the first priority followed by Delta Brantas, Mrican Kanan, Warujayeng-Kertosono, etc. The objective area of canal lining works is tentatively assumed a medium between 1996's irrigation area and that in 2020.

A detailed design will be executed for the respective area followed by tender, contract, and construction. The detailed design for Lodoagung will start early 1999 after arrangement of fund and will last around 1 year. The detailed design will include field investigations, justification study, inventory survey, topographic survey, detailed design and cost estimate, preparation of tender documents and prequalification of tenderers. The justification study is essential to make a precise quantitative analysis of effect by concrete lining for water saving.

The procurement of contractor will take some 6 months including tender and tender evaluation. Accordingly, construction works will start middle of 2000 and will last 2 and half years.

The above process will be repeatedly executed for other areas. The construction schedule is summarized in Figure A4-8.

The canal lining costs are estimated at some million Rp. 236,581 as shown in Table A4-23.

The main objective of the canal lining projects is to save irrigation water for other use. It, however, will produce other benefit such as alleviation of maintenance cost. Therefore, the above cost will be allocated to both to irrigation/agriculture and other sectors which will get benefit from the saved water from the viewpoint of project economic evaluation and financial justification.

(3) Other measures to be conducted for water saving

Efficient water saving can be achieved with irrigation system adequately designed, proper irrigation method and human resources.

Some criticism have been raised to Indonesian system design criteria. For example, a combination of undershot gates at cross-regulators and adjustable Romijn weirs at canal intakes is the worst combination of control structures with regards to hydraulic stability.[1] Review of system design criteria, however, is outside of the scope of work in the present study and is expected to be conducted by other study/project.

Based on the information given by Dinas Pengairan to the Study team, farmer's consciousness for water saving is under development in the basin. Establishment and development of WUA are one of the key factor regarding human resources. The present study considers that consciousness and incentive are very important for water saving. All farmers in the basin have to be informed and convinced that they have to save water to meet increase of other uses. The consciousness must be raised by interaction between agencies such as Dinas Pengairan and PJT, and WUA. It is noteworthy that viability of WUAs, and their ability to perform their functions, depend upon in large part on the reliability of water delivery to individual farmers which in turn depends on reliable supply from level to level in the system. [2]

2.10 Prospective Agricultural Development in Future

(1) Potential Irrigation Development Projects

Several irrigation development projects were planned in the Widas Part I Study. Of them have Gottan-Losari Project has been implemented as Munturs Rubber dam irrigation area, Papar-Petrongan Irrigation Project in the Mrican Kanan irrigation area. The others are as follows:

- Lesti Left Irrigation Project
- Widas Extension Project
- Widas South Project
- Beng Irrigation Project

The detailed information are tabulated in Table A4-24.

These projects require new storage dam and/or intake or pumping station. The water resources developments are substantial issue to achieve the objectives of the project. These projects, however, will contribute to correct disparity in economic development in the basin, if implemented.

---

[1] Modern Water Control in Irrigation, World Bank Technical Paper Number 246 Irrigation and Drainage Series

[2] above stated

(2) Prospective Agricultural Development

(i) Future food consumption trend

In the present study, the GRDP of the Brantas basin is expected to be on the same level as upper middle income country as described in Chapter 2 in this report. Table A4-25 shows Development Index of representative five Asian countries, namely Indonesia, Philippines, Thai, Malaysia, and Japan extracted from World Development Report 1996, IBRD. In the Report, Indonesia, as a whole, is classified into lower middle income country together with Philippines and Thai. Malaysia is classified into upper middle income country. Table A4-26 shows summary of per capita food supply in the above five countries extracted from Food Balance Sheets 1992-1994, FAO. From this table food supply situation in Indonesia can be concluded as follows:

- Per capita supply of total cereals and rice are top of the four countries,
- Calorie supply is third but is close to the second country (Malaysia),
- Vegetables and other foods except vegetable oils are the lowest.

Although people's taste for food is different from country to country, and each country has his food policy, the consumption of vegetables and other foods in Indonesia may increase in future as the living standard improves. The FIDP estimated per capita consumption of paddy in East Java will increase from 120.5 kg/year in 1990 to 127.5 in 2003 and then gradually decrease to 124.0 kg/year by 2020. Although paddy (rice) will be main food crop in Indonesia as well as in the Brantas basin, the consumption of rice will decrease as living standard improves. The crop diversification have to be promoted so as to meet probable increase of vegetables and fruit, meat, etc.

The Brantas basin has much advantage for promotion of horticulture such as;

- The basin has very large urban areas in which marketability of horticultural crops are large,
- It extends wide range of elevation from more than 2,000 m to sea level. This enables to develop various horticulture,
- Farmers in the basin has a long experience of irrigation farming

(ii) Increase of Agricultural Productivity

Measures are to be taken by the Government and farmers to increase agricultural productivity in the Brantas basin. The mainstay of agriculture is to be shifted from paddy cultivation to horticulture. This movement has been already observed from cropping pattern. In order to achieve the crop diversification successfully, the government should take an important role to motivate, guide and support farmers taking into consideration the national food security policy. Food self-sufficiency is one of the most important issue of any country. Further, the Government should motivate farmers to participate not only in production but also in the market.

A master plan for modernizing agriculture and irrigation water management systems is substantial to achieve high productive agriculture and water saving agriculture. The master plan should includes the following development plan.

- Modernizing plan of irrigation and drainage facilities not only to supply sufficient water but to save water,
- Modernizing irrigation water management systems plan,
- Paddy cropping improvement plan concerning variety, scheduling, farming practices and management system from the view point of water saving and marketability
- Horticulture and industrial cropping development plan
- Agricultural supporting plan, concerning farmers organization (revitalization of cooperatives), financing, research, training and extension, etc.

Further, it is desirable to make a feasibility study in some selected areas. The feasibility study should include the following issues;

- Paddy cropping improvement plan concerning variety, scheduling, farming practices and management system from the view point of water saving and marketability,
- Horticulture and industrial cropping development plan,
- Irrigation improvement plan for more adequate, reliable, timely, equity water distribution including possible development of large-sized paddy field for more labor productivity by efficient labor operation and mechanized farming,
- Preliminary design of improvement structures,
- Irrigation water management plan,
- Operation and maintenance plan,
- Proposed organization of irrigation areas in terms of organizational structure,
- Proposed action plan to accelerate WUA development,
- Environmental conservation plan,
- Estimation of project cost and benefit,
- Implementation program and schedule,
- Evaluation of the project, and
- Recommendations.

3 Brackish Water Fishery

3.1 Existing Fishery Area

The brackish water fishponds (tambak) for fish and shrimp cultivation in East Java are centuries old. They were first developed along the North coast of East Java where majority of them are still located.

The existing total area of brackish water fishery in East Java for 1997 is approximately 60,000 ha., out of which 54,000 ha. is under extensive culture, and only 6,000 ha. under intensive culture (which were introduced here in1985). The total present brackish water fishery area in the Brantas delta is approximately 15,730 ha., it mostly is based on the extensive method of cultivation.

There are about 318,812 people employed by inland fishery in East Java. There are about 4,000 brackish water fishpond owners in the Brantas delta. The owners employ more than 3,000 tenant farmers. The total inland fishery production for East Java, in 1995, was 122,573 tons. For the year 1996 brackish water fishery yield was 23,744 tons in the Brantas delta.

(1) Irrigation System

The brackish water fishery irrigation system comprises of the Primary Channels (built by the provincial E.J. Fishery Service), the Secondary Channels (built by the local Regional Fishery Service) and the Tertiary Channels (built by the fishpond owners). In reality, this irrigation system is quite complex. It is not uniform in its operating state, and the conditions of channel's infrastructure vary from area to area. In the field, in many place, there is no clear differentiation between primary, secondary and tertiary channels. The maintenance of all the three types of irrigation channels and the system's repairs is the sole responsibility of fishpond owners.

In the Brantas delta two irrigation canals, namely Mangetan and Porong provide water to a paddy irrigation area of 27,362 ha. The paddy irrigation area in Sidoarjo has been reduced due to the other land use pressures, between 1980 to 1997 it has been reduced from 32,600 ha. to 27,362 ha. In the future, further reduction in the acreage of paddy agriculture is anticipated.

The return flow from this operation is available for the irrigation channels of brackish water fishery. It is extremely difficult to measure this water amount accurately. Most of the estimates available are based on subjective judgments. If the water for paddy agriculture decreases the return flow as a result, also decreases. Moreover, there is no return flow in the dry season.

Recently, the newly organized Forum Kommunikasi Masyarakat Tambak (FKMT), Fishpond Owners Association, Sidoarjo Regency, have developed irrigation facilities including the deepening of tertiary channels. The channel deepening activities were funded by the farmers organized in FKMT and the Regional Government on a 50-50 cost sharing basis. In Sedati 72 km. of channels were created (at a cost of Rp. 192 million), in Buduran 24.5 km. (at a cost of Rp. 137.5 million) and Obarir about 14.5 acres (at a cost of Rp. 184 million).

After the necessary investments in the upgrade of channels to maintain the irrigation system in good working condition, it would be justifiable to charge the fishpond owners a fee for water at the fishpond gate. The fishpond owners have reported their willingness to pay for clean water to the Study team. At present, all secondary channels are not operational, and there is no efficient operation system for their regulation. The services provided by the EJFS, and the Local Fishery Bureau (LFB), Sidoarjo, are not very effective and consistent.

(2) Cropping Pattern

The extensive fishponds (more than 90% of the total in E. Java) have one cropping cycle which is 8 months long. It relies on tidal water and irrigation water return flow exchange and its production is approximately around 500 kg./ ha./year.

In the intensive fishponds (less than 10% of total in E. Java) the cropping cycle is only 5 month long, with 2 annual periods of harvest in March - April and November - December. In this method of cultivation, it is possible to have a production of 14 - 16 tons/ha./year. However, since 1992, this method has been abandoned by fishpond owners in the Brantas delta. The reason has reportedly been a virus infection and water pollution in the return flow.

Since 1992 - 93, the cropping pattern in the Brantas delta has been changing, the milkfish production has been increasing and the production of all types of shrimps has been decreasing. As a consequent, presently, about 60% of all shrimp production in East Java province are produced using extensive method.

Fishpond Production in Brantas Delta for 1996

Type of Shrimp & Fish	Production in Tons
White Shrimp	1,290
Tiger Shrimp	5,090
Mixed Shrimp	2,270
Milk Fish	7,239
Tawes	1,376
Others	1,170
Sidorajo Total Production	17,197
Surabaya Total Production	6,547
(Type Breakdown for Surabaya)	(Not Available)
Brantas Delta Total	23,744

(3) Water Demand Under Present Condition

The water demand at present in the Brantas delta is calculated to be 1.29 m^3/sec.The brackish water fishpond's requirements of fresh water are calculated by multiplying the total fishpond area by the water consumption rate. In addition, it includes 3000 m^3 / ha. of water at the start of every cropping season for the extensive fish ponds, and the flushing water is required every alternate days. The flushing water is calculated to be approximately 3 % of the 3000 m^3 / ha. The formula used to derive the water demand is presented below.

$$Q(FP) = 365 \times (q(f) / 1000) \times A(FP) + q(ft)$$

Where: Q(FP) = Fishpond Water Demand (m^3 / year)

q(f) = Flushing Water Requirement 90 (m^3/alternate day)

A(FP) = Fishpond Area (ha.) (15,730)

q(ft) = Fishpond Water at the start 3,000 (m^3/ha./year)

Mean monthly precipitation in the Brantas delta is 12.56 mm

Fishpond Water Demand

Unit:(m^3/sec.)

Month	Irrigation Water Return Flow	Water Demand in the Fishpond	Net Water Demand (Un-met)
Jan.	3.7	1.29	0.0
Feb.	0.6	1.29	-0.69
Mar.	3.1	1.29	0.0
Apr.	4.9	1.29	0.0
May	2.6	1.29	0.0
June	0.5	1.29	-0.79
July	0.0	1.29	-1.29
Aug.	0.0	1.29	-1.29
Sept.	0.0	1.29	-1.29
Oct.	0.27	1.29	-1.02
Nov.	3.8	1.29	0.0
Dec.	6.8	1.29	0.0
Average/Year		1.29	

(4) Water Consumption

The extensive method of fishpond cultivation requires the freshwater to be mixed with sea-water in the beginning of each cropping. The freshwater requirements at the start of cultivation to fill-up an empty and cleaned out fishpond is 3000 m^3/ha., and the total requirement of freshwater, i.e. initial tank fill-up and alternate day flushing is 1.29 m^3/second. The average depth of the fishpond ranges between 70 cm. to 1 meter. The freshwater is mixed with sea-water in a separate reservoir before filling in the fishpond.

The intensive farms are now only spread in the north of East Java, while the extensive farms are the norm in the Brantas delta. In the more productive intensive cultivation freshwater for flushing is required everyday. The very few remaining intensive fishpond operations in the Brantas delta also use ground water (average depth in Sidoarjo: 30 m). For the purpose of the water demand calculations in this study, intensive fishponds are not treated separately, for the present water requirements. The intensive fishponds in the Brantas delta are very few and do not allow easy access to their operations. They are at present reported to be less than 5% of the total in the Brantas delta.

The return flow water available in 1997 in the Brantas delta has been of bad quality, and in many cases it has to be treated before releasing it to the fishponds in Sidoarjo and other areas in the Brantas delta. The growing Chemical industry discharges and untreated waste-water from Mojokerto has reportedly been impacting negatively in the Brantas delta.

(5) Proposed Water Saving Plans

There is a water shortage in Sidoarjo during the dry months, i.e. from June to October, and no organized conservation or storage of return flow water has been undertaken by the fishpond farmers. In addition, the freshwater supply is limited during the month of February due to low paddy requirements also. The fishpond owners receive freshwater free of charge. The supply of water is not uniform for all the fishponds in the area, it varies widely from one area to another. There is a need to map and understand how the entire area is supplied with the irrigation return flow. The irrigation return flow and drainage that provides most of the freshwater has an approximate efficiency of 50 %, plus a drought year dependability of 80%. The extensive cultivation requires the freshwater in the beginning, at the start of cultivation, when the fishpond has to be filled up with a mixture of sea-water and freshwater. The intensive cultivation requires in-take of freshwater everyday and extensive cultivation requires freshwater for flushing every alternate day.

There is a licensing fee paid by extensive and intensive fishpond owners depending on the hectare area of the fishpond. It is based on a federal government regulation, where by the license for extensive fishpond is given by the Bupati (Chief) of the district and for intensive fishpond cultivation the license is issued by the EJFS. To start water conservation practices, a water demand management program to institute efficiency and conservation should be made a part of the licensing process.

During the field investigations, it was found that the water saving has not been carried out in any systematic or planned way. There is a shortage of return flow water during the dry season (June to October), and in February when the demand for water is low in the paddy fields. Advanced engineering technology should be introduced with re-circulation systems and water reservoir storage system for the future operations of the area's brackish water fishponds.

3.2 Salinity of Brackish Water Culture

(1) Fishery Production and Salinity

There is roughly a curvilinear relationship between the brackish water fishery yield and salinity. The practiced range of salinity for the extensive method has been observed between 15 to 35 p.p.t. The maximum yields of around 500 kg. per ha. have been obtained at around 20 to 25 p.p.t. for various types of shrimps. The milk fish has tolerance for a larger range, for example, in the rainy season it is cultivated between 0 to 5 p.p.t. salinity, and in the dry season it has been cultivated at 40+ p.p.t. salinity.

(2) Appropriate Salinity

According to the East Java Fishery Service (EJFS), the average range of salinity during rainy season is considered to be 15 to 20 p.p.t., while the range for dry season is around 30 to 35 p.p.t. The production for both shrimp and milk fish increases in the rainy season. At higher salinity and in the dry season production is reduced. Also, closer to the sea production is higher than inland.

The pond salinity for the intensive method of fishpond cultivation ranges between 18 to 35 p.p.t.

(3) Water Demand

The water demand is calculated to be $\underline{1.29\ m^3/sec}$. In agriculture, the overall efficiency of irrigation canals is 50 %, and there is an additional water loss. The losses accrue at many levels, due to operations, conveyance and field applications. The amount of water reaching the drainage canal is only 30 % during the best periods of return flow. There is also a 80% dependability for drought year in the Brantas delta. The return flow from irrigation has an un-met net demand of water in February, and between June to October.

Summary of Return Flow Water Demand

Unit: m^3/sec.

Return Flow Water Demand	1996	2020
Extensive	1.29	0.86
Intensive	-	1.68
Total	1.29	2.54

3.3 Development Plans

(1) Economic Development Plans

The province of East Java contributes approximately 15 % to the Indonesian economy whereas 17 % of the national population (33 million) lives in the province. Fishery (inland and marine) is important to the economic well being of the people. The inland fishery contribution to the gross regional domestic product (GRDP) for 1995 was US $ 312.76 million (constant market price) and 1.21% of total GRDP. The shrimps are mostly exported to Japan, USA and in the region, and provides about US $200 million in export earnings. The gross value of farm produced shrimp in all of Indonesia for 1995 was US $2.3 billion.

The brackish water fishery production of East Java for 1995 has been 66,950 tons approximately. The fishpond production of shrimps peaked in 1992, since then there has been a production decline reportedly because of virus infections and bad quality of water. The smaller rate of growth in the recent years has been was due the deterioration of water quality. In 1995, fish and shrimp production decreased by around 0.76 %. The inland fishery yield has had the following yield for the period 1970-95.

Inland Fishery Yield (1970 - 1995)

Year	Yield / Ton
1970	29,018
1980	50,110
1990	144,314
1995	126,635

In Surabaya and Sidoarjo, the industrial sector growth, urbanization and human settlement is increasing and is rapidly increasing gradually replacing the fishpond area which is located close to Surabaya. For example, in Sidoarjo out of 17,000 ha. of brackish and freshwater fishponds 2,000 would be reclaimed for a Marina development project. According to the " Spatial Planning and Zoning in East Java up to 2011" the urban development and human settlement would further encroach upon decreasing fishponds. According to the provincial land use data, in the next 20 years the fishponds would be reduced to approximately 11,500 ha.

(2) Project Features

In the Brantas delta, Sedati, Probolingo, Pangan and Gresik still have good extensive fishpond cultivation with a good mangrove cover. The mangroves play an important role in the ecological balance of the fishpond area, they help in improving the sea-water quality. In many of the fishpond areas of the Brantas delta the mangroves are dying. As a result the fishpond farmers are relocating to locations where healthy mangroves are still present.

The right side of Kali Porong has had a problem with the fishponds near Bangil, here the fishponds are inundated with excessive water during the rainy season. This results in the farmers abandoning fishponds. In addition, there are other problems in extensive fishponds most notably due to the virus affecting the shrimp cultivation. It was reported by LFS that the presence of iron (Fe +ve ions) and mercury (Hg) in the fishponds has also been a problem.

In general, there is no clear differentiation between primary, secondary, and tertiary channels. This has resulted in the share of responsibility between the government and fishpond farmers not being carried out. The government is responsible for primary and secondary channels and the water users in the fishponds for tertiary channel, however, the entire maintenance is carried out by the water users. There is supposed to be a special officer for taking care of the field irrigation, who is not available.

The water users organization like "HIPPA" for paddy irrigation cannot be established due to different conditions prevailing in the fishpond area. The FKMT (Fishpond Owners Association) has just started operations to improve the conditions, regional and local government authorities have proposed channel development and rehabilitation projects. A spatial plan of the shrimp field area is also being prepared in cooperation with Brawijaya University.

(3) Cost Estimate(1995)

Production costs of Milkfish	US $ 1,304 / ton
Production costs of Shrimp (Tiger)	US $ 4,348 / ton
Production costs of Shrimp (White)	US $ 4,348 / ton
Production costs of Milkfish & Shrimp (Mixed)	US $ 1,739 / ton
Average per capita income of owners ....Rp. 3.0 mill.......	US $ 1,300 / year
Average per capita income of employees.. Rp. 1.3 mill........	US $ 565 / year

3.4 Operation and Maintenance under Present Condition

(1) Operation Rule and Actual Operation Record

The EJFS, Surabaya's primary function is to solve problems of the entire brackish water fishery business. The main tasks of Local Fishery Bureau (LFB), Sidoarjo's include the improvement of fishery business, fishpond owner's welfare, natural resource preservation especially fishery, and licensing of extensive fishponds. The LFB is divided into the Production (fish catch, cultivation and the environment), and the Farming and Fishing Business Section (licensing, quality control and marketing).

The LFB, Sidoarjo has no budget for primary O/M it only provides policy recommendations. The O/M is considered to be the sole responsibility of fishpond owners. In 1997, in Sidoarjo, the Fishpond Owners and Fisheries Association (FKMT) on a 50/50 cost sharing basis has formed an association to carry out O/M activities in extensive, and intensive fishponds. The key problem of fishpond owners and tenant farmers is their having low level of education, experience in modern technical cultivation method. Technical training and bringing educated people into the fishpond business enterprise would be necessary for the growth in the future.

At present, modern technology is not utilized by extensive fishpond owners in the Brantas delta. The EJFS has made assessments and recommended modifications for fishpond operations. It also has introduced the fishpond farmers to modern water quality improvement technology.

In 1997, the local government collects no revenues from the brackish water fishponds. There is no duty or tax on the export of fish or shrimp. The regional government, however, provides part of the budget for FKMT in Sidoarjo

(2) Management Organization and Staffing

The LFB, Sidoarjo in mid-1997 had a total staff of 54. In Sidoarjo office 28 staff members were based, while 26 staff members were based in the field.

(3) Annual O/M Cost

The national and provincial budget provides support for the entire fiscal year.
For 1995 - 96 the National Budget provided........Rp. 59 mil......US $ 25,650
For 1995 - 96 the Provincial Budget provided......Rp.145 mil.....US $ 63,000
The Local Presidential Directive provided..........Rp. 45 mil..... US $19,565

The budget breakdown is as follows:
Staff Salary..Rp.167.8 mil....US $ 73,000
Running Cost..Rp.21.7 mil....US $ 9,435
Development Costs...Rp.7.5 mil....US $ 16,300
The Local Field Budget.....................................Rp. 21.7 mil.....US $ 9,435

3.5 Reorganization at Present

(1) Required Activities

Since the fishpond crisis of 1992, when a drastic reduction in shrimp production occurred, a salient reorganization of the existing fishponds has taken place. This has coincided with the urbanization which is on-going in the Brantas delta around Surabaya metropolitan area. The Sidoarjo regency which is in the delta of Brantas river, is between 0 - 25 m. above the sea water surface, the brackish water fishponds here are located at 0 - 3 m. The monthly mean rainfall in the Brantas delta is 12.56 mm. At present, there are about 3 districts where conditions in extensive fishponds are quite good. The EJFS, Surabaya and LFB, Sidoarjo should make plans to retain the healthy and profitable fishponds as profit making enterprises. These fishponds should not draw any freshwater during the dry season. To mitigate the water shortage during dry months reservoirs need to be built for storing excess water available during the rainy months, and re-circulation systems as utilized in OECD countries need to be introduced. In addition vaccination and medicines for shrimp diseases, and the use of decomposing bacteria to improve the water quality should be investigated.

(2) Organization and Staffing

The emphasis should be put on scientific and modern business organizations. More responsibility of organizing production should be with the modern private sector enterprises. Once the size and scope of the future fishpond business has been determined, its organization and staffing should be set-up in partnership with modern agro-business customized to those requirements.

(3) Annual O/M Cost

The cost should be competitive and reflect the proposed changes. Budget should be allocated for investigation, research and human resource development and upgrade of fishpond farmer's skills. The current annual budget of US$ 108,000 for the LFS, Sidoarjo is inadequate and needs to be revised, after considering the future needs.

3.6 Proposed Organization (2020)

From an overall and long-term strategic planning perspective the brackish water fishery is profitable with high rates of return on the investment. There has been a lack of capital spent on infrastructure in the past, which would have to be overcome. The brackish water fishery in the Brantas delta is centuries old and provides employment to more than 7,000 farmers. In the future, better business management and the motivation of fishpond farmers for ownership should make it into a more viable enterprise.

Given the spatial plan to reduce the fishponds area to 11,500 ha., and the average availability of return flow water estimated at a monthly average of 2.2 m^3/second. Selected extensive fishponds should modernized and converted for intensive cultivation. This should be undertaken after all the necessary precautions have been taken. It is estimated that it would be feasible to convert 1,000 ha. to the intensive cultivation. The water demand for the intensive conversion will be based upon the daily flushing rate of 30% of 3,000 m^3/ha. The estimated demand for water will be 1.68 m3/second. The remaining 10,500 ha. extensive fishponds will have a water requirement of 0.86 m^3/second. If there will be no conservation or no re-circulation system will be installed there will be a net un-met requirement of 0.34 m^3/second in the year 2020.

In addition, prevention of disease by building separate reservoirs and periodic water quality monitoring should be required for all the future activity. Given the attractive economics of shrimp and milkfish farming, modern private sector should be involved in an environmentally sound manner. More value added products like crabs, rock lobster and finfish like red snapper could also be cultivated in the fishponds in the future. Agro-business would need to work together with extensive and intensive fishpond farmers who still want to stay in business. In the future, the provision of return flow water should be a priced input to the fishpond farmers. The water must be provided for an agreed price to the fishpond farmers and could be managed by a Water Supply Company.

In Sidoarjo, there are still a few selected districts quite suitable for the future shrimp and milkfish production. The seawater conditions have potential for fishery development beyond 2020. It would have to be taken up as a modern business enterprise, which would be managed as an efficient business.

Furthermore, a water shortage in the Brantas delta is anticipated after 2020. The freshwater demand would need to be curtailed, and utilized by storing excess water during the rainy season. Alternatively, there are also plans for the fishponds to be relocated. According to EJFS, the future growth of the brackish water fishponds will be located the South side of East Java, down from Malang.

(1) Required Activities

An action plan for the future development of brackish water fishery will have to be undertaken. It will build upon the potential of viable existing fishponds and upgrade it to higher productive capacity, in addition to the prospective new area being brought under cultivation in the South of East Java. The plan should make recommendation for better water resource management in the existing fishpond area which would be retained in the future. The past lack of investment in the fishpond infrastructure channels would need to be taken on a priority basis. To realize the full potential of the brackish water fishery independent and collaborative research and investigation would have to be accelerated. To increase the human resource potential incentives to the farmers must be provided. The tenant farmers who comprise about 70 % of the fishpond farmers should be given an option for ownership.

(2) Organization and Staffing

A proposed action plan should be undertaken which will provide a tentative and workable organization and staffing plan. This plan must consider a detailed human resources plan and mechanisms to upgrade the skills of more than 7,000 fishpond farmers (owners and tenants)

(3) Annual O/M Cost

The proposed plan would require more resources than the existing budget of US $ 108,000. The amount of resources would be based upon an appraisal of needs between the LFS and the fishpond business enterprise.

References:

1. East Java Fishery Service, "East Java Figure Fisheries: 1995, Surabaya, East Java

2. Local Fishery Bureau, "Annual Report: 1995", Sidoarjo Municipality, East Java

3. Hariati, A. M. et. al., "The Impact of Penaeus Monodon Fabricius Postlarvae Stocking Density on Production in Traditional Tambak Systems in East Java, Indonesia", Aquaculture Research 1997, 28.

4. Hariati, A. M.. et. al., "Penaeus Monodon (Fabricius) Production Related to Water Quality in East Java, Indonesia", Aquaculture Research 1996 27.

5. Hariati, A. M. et. al., "Recent Developments of Shrimp, Penaeus (Fabricius) and Penaeus Merguiensis (de Man), Culture in East Java", Aquaculture Research, 1995, 26.

6. East Java Statistics Office and the Government of East Java, "East Java in Figures 1995", November 1996.

7. Nippon Koei Co. & JICA, " the Study for Formulation of Irrigation Development Program in Indonesia", Final Report, Volume 3, November 1993.

4 Domestic Water Demand

4.1 Present Domestic Water Supply

(1) Public Water Supply System by PDAM

Public water supply systems are operated by water supply organizations called Perusahan Daerah Air Minum (Regional Water Supply Company, or " PDAM " hereafter). There are altogether 14 PDAMs in the Brantas River Basin area, one PDAM in each regency and municipality. PDAMs' service is provided mostly in urban areas by pipe water supply system as a major service as well as through water supply by deep and shallow wells and water tank trucks for rural area and fringe areas. Piped water supply systems include both house connections and pubic hydrants. The major customers of PDAM are households, business and commercial institutions, various government and social organizations and industries.

Table A4-26 presents an outline of the services for households provided by 14 PDAMs in the Brantas River Basin area.

Table A4-27 presents sources of water which the 14 PDAMs depend on.

(2) Domestic Water Supply by Other Source

Population in rural areas and urban fringe areas get water for domestic use from such sources as river, shallow wells, irrigation and drainage canals, PDAM's water tank trucks and rain water. The consumption of 50 to 60 liter per day per capita is the generally recognized amount of water used in areas where no pipe water supply system is available, both in urban and rural areas.

4.2 Projection of Domestic Water Demand

(1) Methodology

Projection of domestic water demand is made for urban population to be served by pipe water supply system of PDAMs and rural population to be served by various means such as wells, water tank trucks and direct use of river and canal water. The following steps are taken for the projection.

- Estimate of present population broken down into urban and rural
- Projection of urban and rural population
- Preparation of key water supply indicators :
- service coverage ratio
- water consumption per capita
- ratio of un-accounted-for water
- Projection of total domestic water demand

- Projection of domestic water demand for the main stream of the Brantas River

(2) Population Projection

Total population in 1996

The population presented in Table A17-1 in Annex 17 is the basis for the population projection. For the purpose of domestic water demand projection, the total population in 1994 was adjusted to that in 1996 by applying the growth rates between 1988 and 1994 for each regency and municipality to make them consistent with the data on domestic water use as shown in Table A4-28.

Urban and rural population

Data on urban population were obtained from Cipta Karya, which has been planning a World Bank funded project entitled " Second East Java Urban Development Project (hereafter the WB project)". The WB project aims to develop urban infrastructure systems including water supply systems in the urban areas in East Java with the target year 2005. As part of the plan, the WB project gives urban population figures for each regency in East Java. These data are used to estimate urban population in each regency in addition to the five municipalities whose population is regarded 100% urban. Urban and rural population in 1996 thus estimated for Brantas are as follows.

- Total population : 13,808 thousand
- Urban population *: 6,545 thousand (47%)
- Rural population : 7,263 thousand (53%)

* total of population in municipalities and urban areas in regencies

Projection of urban and rural population

Urban population is projected for each regency and municipality. For urban areas in regencies, annual growth rates were set based on the growth rates of the total population in the regency and coefficient of 1.5. This coefficient is the ratio of the growth rate of urban population to that of total population growth experienced by the upper middle income countries.

Rural population is derived as the differences between the projected total population and urban population. Urban and rural population thus projected for 2020 are presented in Table A4-28 and summarized as follows.

- Total population : 17,697 thousand
- Urban population : 9,312 thousand (51 %)
- Rural population : 7,263 thousand (49%)

(3) Key Water Supply Indicators

The key water supply indicators for the urban areas in each regency and municipality are shown in Table A4-28.

Service coverage ratio

The WB project aims to expand the service area of PDAMs to a range of 60 to 90% of all the urban areas in East Java by 2005. In Surabaya, service coverage is planned to reach 90% by the end of 1998 with an aid from the World Bank under the " Surabaya Urban Development Project ". Considering these developments, it would be reasonable to assume that 100% area of all the municipalities and urban areas in Brantas be covered by PDAM's pipe water supply service by 2020.

Water consumption rate per capita

Average water consumption per capita of all the PDAM customers in Brantas was 175 liter per capita per day (lcd) with a range of the lowest at 70 lcd in Kediri to the highest of 224 lcd in Surabaya. In accordance with income increase, these rates are anticipated to increase in the future under the present tariff level. Water consumption rates per capita for 2020 are set at four levels at 120 lcd, 150 lcd, 200 lcd and 250 lcd considering the rates applied in the WB project and the present rates recorded at PDAM.

Ratio of un-accounted-for-water

The ratios of un-accounted-for-water ranged between 19% in Nganjuk and 54% in Kediri. The target ratio is set at 20% for all the areas except in Nganjuk where the present level is already below 20%. The target for Nganjuk is set at 15%.

Domestic water demand in rural area

Domestic water demand in rural area is projected based on water consumption rate at 60 lcd and the projected rural population.

(4) Domestic Water Demand Projected for 2020

Domestic water demand thus projected for 2020 for the Brantas Basin is presented in Table A4-28 and summarized as follows.

Total water demand :	1,003 million m^3 per year
Urban area :	819 million m^3 per year *
Rural area :	184 million m^3 per year

* including un-accounted-for water

Out of the demand above, domestic water demand for the water of the mainstream of the

Brantas River is those in Surabaya and Sidoarjo. The water sources of these PDAMs at present are as follows.

(unit : liter per second)

	Brantas River	Other	Total
Sidoarjo	555	302	857
Surabaya	5,100	330	5,430

Excluding the water to be supplied by other source, the demand for the Brantas River in 2020 is estimated as follows.

Sidoarjo : 82 million m^3 per year

Surabaya : 373 million m^3 per year

Total : 455 million m^3 per year

5 Projection of Industrial Water Demand

5.1 Objective

Industrial water demand is projected for the year 2020. The projected industrial water demand will be inputted into a water balance analysis. Industrial water demand is projected in the following steps.

- estimate of present industrial water use by source, area and type of product
- establishment of a socio-economic framework with a focus on industrial development
- estimate of growth rates in water use by type of industry
- estimate of gross industrial water demand
- establishment of efficiency improvement targets
- estimate of gross and net industrial water demand for the water to be taken from the main stream of the Brantas River

5.2 Present Industrial Water Use

The present amount of water used for industrial production is estimated by source of water as shown in Table A4-29 through A4-31 and summarized as follows.

	(million m^3/year)	(%)
- direct abstraction from the Brantas River :	131	60.9
- abstraction of ground water :	67	31.2
- supply by PDAMs :	5	2.3
- other source :	12	5.6
- total :	215	100.0

The Brantas River above includes the main stream, tributaries and canals. The data are obtained from PJT for the year 1996. There were altogether 95 industries directly taking water from the Brantas River. As Table A4-29 shows, sugar industry and paper industry are the largest water users, each accounting for 58% (76 million m3 per year) and 22% (29 million m^3 per year) of the total amount.

The data on ground water use are obtained from East Java Mining Service. These data are the amount of ground water licensed to be abstracted. The data from DIPENDA were sought to obtain data on the actual amount of water abstracted. It was found, however, that the DIPENDA data do not classify the purpose of water use (industrial, commercial, domestic etc.) For the present study, therefore, the data on licensed amount were used. Concerning the distribution of ground water among type of industries, sugar and paper industries are also the largest consumers of ground water, each accounting for 51% (34 million m^3 per year) and

25% (17 million m^3 per year).

The amounts of industrial water supplied by PDAMs are estimated for 1996 based on the information collected from each PDAM. The amounts are in terms of those received by industrial customers.

Other source refers to irrigation and drainage canals in Sidoarjo Regency. There were 21 industries taking water from irrigation and drainage canals. Out of these, 17 factories are included in the PJT's customers list. Other 4 factories are not listed in the PJT list, therefore should be counted as water users from other source. The amount of water these 4 factories took was 9.2 million m^3 between January and September in 1997. This volume can be converted to an annual amount by multiplying 1.33 (12 months / 9 months), thus deriving 12.2 million m^3 per year

Table A4-32 presents the existing amount of industrial water use by type of industry and source of water. Classification of industries into three types, sugar, paper and others were made in the following manner.

- Brantas : Classification was made based on the type of product identified for all the 95 industries taking water from the Brantas River.
- Ground water : Water use by twelve largest ground water users account for 88% of the total ground water use. So type of these 12 industries were identified and the shares of sugar, paper and others derived. The same proportions were applied to the total ground water amount used.
- PDAM : No information was available for the type of industries. So all the industries are assumed to belong to " others ", since water using industries such as sugar and paper industries are unlikely to depend on PDAM's water, which is excessively purified for these industries' purpose and costly.
- Other : No information was available for the type of industries. The same proportions to those of Brantas were applied.

5.3 Projection of Industrial Water Demand

(1) Methodology

Industrial water demand is estimated according to the following formula.

IDgross = PA * ((1+PGR) * PWcfcnt)^24years

IDnet = IDgross * (1 - RR)

where, IDgross : industrial water demand in gross

PA : present amount of industrial water use

PGR : Rate of change in production

PWcfcnt : coefficient to indicate the relation between the change in the amount of water used and the change in production.

IDnet : industrial water demand in net considering recycling

RR : rate of recycling

The following summarizes the method and assumptions applied in deriving values for each of the factors above.

Present amount of water use (PA):

The existing amount used by the industries as clarified in subsection 5.2 is regarded as the present demand for industrial water. This approach assumes that the rate of water recycling is zero at present. While some factories are known to be practicing water recycling, the rate of recycling is not clarified. Based on the judgment that the proportion of factories practicing recycling is still marginal, the rate of water recycling for the total water volume is assumed to be zero. In the event that additional data are made available in this aspect at a later stage of the study, this assumption will be reviewed.

Rate of change in production (PGR) :

For sugar industry, the rate of change in production is assumed to be none, therefore the present production amount at 710,000 ton per year is assumed to remain unchanged. The following factors were considered in making this judgment.

- Production at national level is unlikely to grow dramatically due to increased consciousness toward diet and increase in alternative sweetening.
- Diversification of crops in Brantas is likely to take place in crops with higher value added than sugar cane such as various horticulture crops.
- Sugar cane production is more suited to outer islands.

The rate of change in production of paper is assumed at 6.3 % per year. The level of paper production is highly correlated with the rate of economic growth. The rate at 6.3% per year is derived by the assumed GRDP growth in Scenario 2 at 7.6 % per year and a coefficient of 0.83. This coefficient at 0.83 is derived based on the experience in Japan. In Japan the growth rate of GNP was 5.2% per year between 1965 and 1983, while that for the paper production was 4.3 % per year. This relation gives a coefficient of 0.83 (4.3/5.2).

The rate of change in the production of other industries is set at 8.3% per year. This rate was derived by adjustment between sugar, paper and all the industries. Following the Scenario 2, the growth rate of the total manufacturing sector is assumed at 8.3 % per year. Since the proportion of sugar and paper industries in production value are small, the growth rate of other industries is derived at the same rate as all the industries.

Coefficient for Water Use - Production relation (PWcfcnt) :

There is a positive correlation between the production level and the amount of industrial water use : higher the production, larger the amount of water used. PW coefficient indicates the relation between the change in industrial water use and that in production. Historical data in Japan were analyzed to derive the coefficients. To get rid of annual fluctuations, averages of five-year period were applied to deriving the coefficients.

Coefficients applied are the following.

Sugar : 0.57

Paper : 0.52

Others : 0.90

The fact that all the coefficients are below one would indicate two factors : economy of scale and improvement in production technology requiring less water for production.

Rate of recycling (RR) :

The rates of recycling applied are those of Japan in 1991. The following rates are applied.

- Sugar : 45 %
- Paper : 43 %
- Others : 52 %

(2) Result

Industrial water demand for all the sources is projected as shown in Table A4-33 and summarized as follows.

Projected Industrial Water Demand in 2020

(Unit : million m^3 per year)

Year	Sugar	Paper	Others	Total
1996	117	49	49	215
2020				
(gross)	117	104	278	499
(net)	64	59	133	257

Gross water demand refers to the amount of water required for production without recycling. It, however, takes into consideration the effect of technology improvement in manufacturing process and economy of scale. Net water demand takes into account recycling of industrial water.

The total water demand is projected to grow from 215 million m^3 per year in 1996 to 499 million m^3 per year in gross and 257 million m^3 per year, an increase of 132 % and 20 % respectively. Gross water demand of sugar in 2020 could be lower due to technological innovation for efficiency improvement. In the present study, however, this element could not be calculated since the coefficient applied works when there is a change in production level.

A water balance situation in the Brantas River Basin is anticipated to become increasingly tight in the future. Under this circumstance, it will become difficult to obtain industrial water without any constraint. Each industry will be required to increase efficiency in water use so that the need for water supply from outside source can be minimized. It seems that there is a much room for improving water use efficiency in Brantas. The following table briefly compares the water consumption rates in sugar and paper industries in Brantas and Japan. It should be borne in mind, however, that these values are rough based on broad definitions and composition of type of products, therefore useful for a comparison of the magnitude of water consumption rates.

Industrial Water Consumption Rates in Japan and Brantas

(Unit : m^3 / ton of product)

Item	Gross demand		Net demand	
	1996	2020	1996	2020
Sugar				
Brantas	165	165	165	91
Japan	87	-	48	-
Paper				
Brantas	84	42	84	24
Japan	53	-	30	-

In the case of sugar industry, the present rate in Brantas is about 3.4 times larger, while that in paper industry is 2.8 times higher in terms of net demand considering water recycling. These differences will be reduced or reversed by 2020 on the premise that improvement in technology proceed and water recycling more widely applied. In this sense, these consumption rates and the industrial demand projected for 2020 are rather target figures than pure forecast of likely trend. In order to achieve this target, concerted efforts will be required on the part of each industry and PJT and local and central governments. The information collected during the second survey in Indonesia indicates that industries are keen to promote efficiency improvement. On the part of the public sector, it would be necessary to prepare a set of measures to promote efficiency improvement in industrial water use such as follows.

- adjustment of water tariff system
- public support in financial aspect for industries attempting to improve manufacturing process or introduce water recycling system
- active dissemination of information for technological innovation and recycling in cooperation with international organizations such as UNEP.

Water Demand for the Main Stream of Brantas River

Industrial water demand for the main stream of the Brantas River is made basically in the same manner as the total industrial water demand. Out of 95 industries taking water from the Brantas River, 84 factories are those taking water from the main stream of the Brantas River. Projected industrial water demand is shown Table A4-34 and summarized as follows.

Projected Industrial Water Demand in 2020 for the Main Stream of Brantas River

(Unit : million m^3 per year)

Year	Sugar	Paper	Others	Total
1996	50	28	26	104
2020				
(gross)	50	60	147	257
(net)	28	34	71	132

5.4 Industrial Water Demand in Madura Island

The Madura Island is known to be endowed with limited water resources. To support development with such a magnitude as has been planned, water supply from outside the Madura Island is inevitable. Cipta Karya (Directorate General of Human Settlements, Department of Public Works) is responsible for preparing a water supply plan to the Madura Island. The existing plan by Cipta Karya projects the following demand for industrial, domestic and business and commercial uses.

Year	liter/second	m^3/day
2010	112	9,676
2020	221	19,094

The assumptions applied in making these estimates include 100 ha development for industries and water consumption rate at 0.25 liter per second per hectare of industrial land area, which is the standard used in Taiwan. Assumptions in other aspects are not known. The existing Kayoon water treatment plant taking water from the Surabaya River is the planned source of water supply for meeting these demands in Madura. Submarine water pipeline is currently planned as water conveyance means.

The Madura development plan is an ambitious and challenging plan to create a new center for industrial, business and residential functions in the Madura Island. The planned construction of 5.4 kilometer long bridge costing US$ 250 million is anticipated to spearhead the development in Madura. Once the bridge is completed, the magnitude of development would be far beyond the development of a 100 hectare industrial estate, for which a water supply plan is prepared by Cipta Karya. The magnitude of the water demand in Madura, once the planned development is realized, can be estimated based on the water demand in Brantas and the proportions of the land areas as follows.

a. Total area of the Madura Island : 4,887 km^2

b. Area of flat land (defined as the land below) altitude of 200 meters in the Brantas Basin : 6,072 km^2

c. a / b : 80 %

d. Water demand for domestic, industrial and business and social uses in 1996 in Brantas : 526 million m^3/year

e. Water demand in Madura with development (d. times c.): 421 million m^3/year or 13 m^3/ second

On the premise that the same level of development as in the present Brantas Basin be realized in whole Madura, the water demand in Madura is estimated to be 421 million m^3 per year or 13 m^3 per second. A critical prerequisite for the Madura development, therefore, would be to secure the supply of water of this magnitude from the sources outside the Madura Island.

5.5 Water Demand Projection for Business and Social Uses

Water demand for business and social uses is projected as follows.

Projected Water Demand for Business and Social Uses

(unit : 10^6 m^3/year)

Source of water	1996	2020	Annual growth rate (%/yr)
Brantas River	37.6	103.3	4.3
Other source	10.1	27.7	4.3
Total	47.7	131.0	-

Annual growth rate at 4.3% per year is assumed on the basis of high correlation between water demand and social activities which is influenced by the size and growth of population and business activities. The following growth rates are the basis of 4.3% per year.

- Assumed growth rate of the service sector : 7.6% per year
  (Annex 17. " Socio-economic Framework")
- Population growth rate assumed : 1.0% per year (same)
- Average : 4.3 % per year