Annex No.8 Environmental and Social Considerations (IEE and EIA)

THE STUDY ON
COUNTERMEASURES FOR SEDIMENTATION
IN
THE WONOGIRI MULTIPURPOSE DAM RESERVOIR
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

SUPPORTING REPORT

Annex No.8: Environmental and Social Considerations (IEE and EIA)

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CHAPTER 1 JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

JICA provided the new guidelines for environmental and social considerations in April 2004. This Study was conducted following the new guidelines. It is necessary to understand the contents of the new guidelines for ensuring environmental and social considerations. The following are the essence of the new guidelines.

1.1 Basic Policy

With respect to human rights and in view of the principles of democratic governance, the measures for environmental and social considerations are implemented by ensuring a wide range of meaningful stakeholder participation and transparency of decision-making as well as by working for information disclosure and by ensuring efficiency. The governments bear responsibility for accountability and at the same time stakeholders are also responsible for their comments.

Under the above views, JICA considers the environmental and social impacts when implementing cooperation projects.

1.2 Definitions

a. "environmental and social considerations" means considering environmental impacts on air, water, soil, ecosystem, fauna and flora as well as social impacts including involuntary resettlement and respect for human rights of indigenous people and so on.
b. "environmental and social considerations studies" means studies including baseline surveys, predicting and evaluating adverse impacts and likely impacts that projects are to have on the environment and local society, and mitigation measures to avoid and minimize them.
c. "environmental impact assessment (EIA)" means evaluating environmental and social impacts that projects are likely to have, analyzing alternative plans, and preparing adequate mitigation measures and monitoring plans in accordance with laws or guidelines of the recipient governments.
d. "strategic environmental assessment" means an assessment being implemented at the policy, planning and program level rather than a project-level EIA.
e. "screening" means deciding whether or not proposed projects are likely to have impacts that should be assessed by conducting environmental and social considerations studies according to project description and site description. JICA conducts screening by classifying proposed projects into three categories: A, B and C. Proposed projects classified as Category A are likely to have significant adverse impacts, and proposed projects classified as Category B are likely to have less adverse impacts than those of Category A projects. Category C projects are likely to have minimal or no adverse impacts.
f. "scoping" means deciding alternatives to be analyzed, a range of significant and likely significant impacts, and study methods.
g. "local stakeholders" means affected individuals or groups including squatters and local NGOs, and "stakeholders" means individuals or groups who have view about cooperation projects, including local stakeholders.
h. "Environmental Impact Assessment (EIA) level study" means a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of detailed

field surveys.

i. "Initial Environmental Examination (IEE) level study" means a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of secondary data and simple field surveys.

1.3 Basic Principles regarding Environmental and Social Considerations

JICA recognizes the following seven principles to be very important for ensuring environmental and social considerations:

a. A wide range of impacts to be addressed is covered. The types of impacts addressed by JICA cover a wide range of the environmental and social impacts.
b. Measures for environmental and social considerations are implemented at an early stage. JICA introduces the concept of Strategic Environmental Assessment (SEA) when conducting Master Plan studies, etc., and works with the recipient governments to address a wide range of environmental and social factors from an early stage. JICA makes an effort to include an analysis of alternatives on such occasions.
c. Follow-up activities are carried out after cooperation projects are terminated. JICA asks the recipient governments to incorporate the outcome of environmental and social considerations in the implementation of projects after cooperation is terminated. JICA offers cooperation projects in accordance with other requests, when necessary.
d. JICA is responsibility for accountability when implementing cooperation projects. JICA pays attention to accountability and transparency when implementing cooperation projects.
e. JICA asks stakeholders for their participation. JICA incorporates stakeholder opinions into decision-making processes regarding environmental and social considerations, and JICA ensures the meaningful participation of stakeholders in order to take considerations of environmental and social factors and to reach a consensus accordingly. Stakeholders participating in meetings are responsible for what they say.
f. JICA discloses information. JICA itself discloses information on environmental and social considerations in collaboration with the recipient governments, in order to ensure accountability and to promote participation of various stakeholders.
g. JICA enhances organizational capacity. JICA makes an effort to enhance the comprehensive capacity of organizations and operations to consider environmental and social factors appropriately and effectively at all times.

1.4 Requirements of the Recipient Governments

a. The recipient governments are requested to incorporate the outcomes of environmental and social considerations studies into their planning and decision-making process once they receive authorization for a project's implementation.
b. When JICA considers either the selection of proposed projects or the support for and examination of environmental and social considerations, JICA examines how the recipient governments meet the requirements of JICA.
c. Various documents prepared through the EIA process and reports (EIA documents) must be written in official languages or in languages familiar to people within the host countries. Documents written in understandable languages and forms for local people must be prepared and explained to them.
d. It is requested that EIA documents be made open to local stakeholders including local people. In addition, EIA documents should be available for public reading at all times, and the making of copies of these for the local stakeholders should be permitted.

1.5 Procedures of Environmental and Social Considerations

These guidelines for environmental and social considerations are to be applied for development studies, preliminary studies of grant aid projects and technical cooperation projects. The Study on Countermeasures for Sedimentation in the Wonogiri Multipurpose Dam reservoir is categorized as a "development study" including Master Plan Study and Feasibility Study at the study stage of "Full-Scale Study." According to these guidelines, the procedures of environmental and social considerations are described in Table 1.5.1 and 1.5.2.

CHAPTER 2 INITIAL ENVIRONMENTAL EXAMINATION

2.1 Purpose of Initial Environmental Examination (IEE)

The main purposes of the IEE study are:

i) To grasp the current physical, natural and socio-economic environmental conditions in the Wonogiri Multi-purpose Dam Reservoir basin and its surrounding area,
ii) To examine likely environmental and social impacts to be caused by the implementation of candidate project components in the Master Plan for countermeasures for the Wonogiri reservoir sedimentation and watershed conservation,
iii) To develop the outline of an environmental management plan, including mitigation measures and monitoring plan, to be integrated into the Master Plan, and
iv) To obtain baseline data for the scoping of Environmental Impact Assessment which will be carried out for the priority projects to be proposed in the Feasibility Study.

2.2 Scope of Work

2.2.1 Study Area

The Study Area covers i) the entire catchment of the Wonogiri Dam (reservoir area of 90 km^2 and remaining catchment area of 1,260 km^2), and ii) downstream reaches of the Bengawan Solo River from the Wonogiri Dam to the confluence with the Madiun River.

2.2.2 Scope and Method of the Study

The IEE Study was conducted through i) data collection on existing environment, ii) project description, iii) identification and evaluation of conceivable impacts and iv) development of environmental management plan.

The data collection covered the following environmental components:

Table 2.2.1 Scope of Data Collection in IEE

Category	Environmental Components
Physical Environment	Geotechnical feature / Climate / Hydrology / Air quality / Noise and Vibration / Water quality / Bed material quality / Groundwater / Soil
Natural Environment	Vegetation / Terrestrial flora and fauna / Aquatic flora and fauna / Protected species / Biodiversity
Socio-economic Environment	Administrative jurisdiction / Demography / Religion and tribe / Education / Land use / Greenbelt / Industry / Inland fishery / Socio-economic plan / Fluvial navigation / Water use / Public health / Garbage in Wonogiri Reservoir / Historical and cultural heritage / Recreational and tourism / Perception of local people

Source: JICA Study Team

2.3 Methodology

2.3.1 Data Collection

Data collection on existing environment was basically conducted based on secondary data and interview survey. The data and information collected was verified and/or supplemented through the field reconnaissance.

2.3.2 Project Description

Project description was done for the candidate project components in the Master Plan and alternatives, describing the size and dimension of structural measures and civil works involved.

2.3.3 Identification and Evaluation of Conceivable Impacts

Identification and evaluation of conceivable impacts to be caused by the implementation of the Master Plan was basically conducted through identifying and describing the likely impacts analogically based on the size of project components and existing environment and/or using the simple but effective model, indicating impact activity which was likely to cause environmental and social impacts. Impact evaluation was done in consideration of the following points:

- Importance of impacts,
- The number of people / households / area to be affected,
- Spatial extent and duration of the impacts,
- Reversibility of the impacts, and
- Possibility to cause secondary impacts.

As a result of the above examination, significant negative impacts were identified.

2.3.4 Development of Environmental Management

Environmental management framework was developed through the examination for mitigating the important negative impacts and monitoring activities.

2.4 Legal Basis

Legal basis for the IEE covered the following aspects: i) Pollution control and environmental management, ii) Environmental Impact Analysis (AMDAL), iii) Land acquisition and resettlement, and iv) Protected species and protected area.

2.4.1 Pollution Control and Environmental Management

(1) Relevant Laws/Decree/Regulation Provided by Central Government

- Law No. 5/1990: about Conservation of Living Natural Resources and Its Ecosystem.
- Law No. 24/1992: about Spatial Design.
- Law No. 23/1997: about Management of Living Environment (Clear commitment to protect the environment and natural resources, while simultaneously providing for continued economic development).
- Government Regulation No. 10/1993: about Protection of Cultural Heritage.
- Government Regulation No. 7/1999: about Conservation of Plant and Animal Species.
- Government Regulation No. 8/1999: about Utilization of Plant and Animal Species.
- Government Regulation No. 41/1999: about Air Quality Management and Pollution Control.
- Government Regulation No. 82/2001: about Water Quality Management and Pollution Control.
- Government Regulation No. 74/2001: about Hazardous Waste Material Management.
- Presidential Decree No. 32/1990: about Management of Protected Area.
- Presidential Decree No. 36/2005: about Provision of Land for Development in the Public Interest.

- Decree of Ministry of Environment No. 48/MENLH/11/1996: about Noise Standards.
- Decree of Ministry of Environment No. 49/MENLH/11/1996: about Vibration Standards.
- Decree of Ministry of Environment No. 50/MENLH/11/1996 : about Odor standards

(2) Relevant Laws/Decree/Regulation Provided by Local Government

- Decree of Central Java Governor No. 10/2000: about Standard of Gas Emission from Stationary Sources in Central Java Province.
- Decree of Central Java Governor No. 8/2001: about Standard of Ambient Air Quality in Central Java Province.
- Decree of Central Java Governor No. 5/2004: about Standard of Gas Emission from Vehicles in Central Java Province.
- Local Government Regulation of Central Java Province No. 20/2003: about Management of Water Quality and Pollution Control, at Inter-Regency/Cities in Central Java Province.
- Decree of Central Java Governor No. 660.1/02/1997: about Standard of Waste Water Quality from Industrial Activities in Central Java Province.
- Local Regulation of Central Java Government No. 22/2003: about Management of Protected Area in Central Java Province.
- Decree of Bupati Wonogiri No. 498/2002: about Establishment of Supervision Commission of Fertilizer and Pesticides in Kabupaten Wonogiri.
- Local Legislation of Wonogiri Government No. 13/2002: about Retribution from License of Timber Transportation for Community.
- Local Legislation of Wonogiri Government No. 9/2003: about Retribution from License of Fishing Business on Wonogiri Reservoir.
- Decree of Bupati Wonogiri No. 521.5/01/91/1993: about Guidance of Cropping System on Paddy Field at the Wonogiri Regency.
- Decree of Bupati Wonogiri No. 425/2003: about Change of Decree of Bupati Wonogiri No. 31/2003 regarding with Guidance for the Implementation of Local Legislation of Wonogiri Regency No. 13/2002 about License of Timber Transportation for Community.
- Decree of Bupati Wonogiri No. 484/2003: about Implementation of Land Use in Wonogiri Regency.
- Instruction of Bupati Wonogiri No. 475/2000: about Control for Polluted Sewage and Sewerage.

2.4.2 Environmental Impact Analysis (AMDAL)

(1) Relevant Laws/Decree/Regulation Provided by Central Government

- Government Regulation No. 27/1999: about Environmental Impact Analysis (AMDAL).
- Decree of State Minister of Environment No. 56/1996: about Criteria on significant environmental impact.
- Decree of Ministry of Environment No. 2/MENLH/02/2000: about Evaluation of the Guideline of AMDAL Document.
- Decree of Ministry of Environment No. 17/2001: about Type and Size of Projects and/or Activities Requiring AMDAL Document.
- Decree of Head of BAPEDAL (Environmental Impact Agency) No. KEP. 299/11/1996: about Guideline for Social Aspect in Environmental Impact Analysis

(AMDAL).

- Decree of Head of BAPEDAL (Environmental Impact Agency) No .8/2000: about People Involvement and Information Disclosure on the Analytical Process Concerning AMDAL.
- Decree of Head of BAPEDAL (Environmental Impact Agency) No. 9/2000: about Guideline of Designing of Environmental Impact Analysis (AMDAL).
- Decree of Ministry of Environment No. 40/2000: about Guideline Administration Commission of Assessor for Environmental Impact Analysis. (AMDAL).
- Decree of Ministry of Environment No. 41/2000: about Guideline of Forming Commission of Assessor for Environmental Impact Analysis (AMDAL).
- Decree of Ministry of Environment No. 42/2000: about Formation of Membership of Commission of Technical Team and Assessor of AMDAL.

(2) Relevant Laws/Decree/Regulation Provided by Local Government

- Governor's Decree of Central Java No. 25/2000: about Participation of Society and Information Disclosure during Study of Environmental Impact Analysis (AMDAL).
- Governor's Decree Notification of Central Java No. 660.1.05/08/1999: about Establishment of AMDAL Commission and Technical Team for Environmental Impact Analysis (AMDAL) in Central Java Province.
- Decree of Bupati Wonogiri No. 475/2003: about Establishment of AMDAL Commission and Technical Team for Environmental Impact Analysis (AMDAL) in Wonogiri Regency

2.4.3 Land Acquisition and Resettlement

Land provision for development in the public interest shall be implemented according to Presidential Regulation No. 36/2005, which has substituted the former legal basis: Presidential Decree No. 55/1993. The major differences of the two are as follows:

- Increase of object development for public interest (Article 5, Chapter II),
- Reinforcement for controlling land broker (Article 4, Chapter II), and
- Change of implementation method for land provision (Article 2, Chapter II)

(1) Increase of object development for public interest (Article 5, Chapter II)

Presidential Regulation No. 36/2005 provides a list of the object development for the public interest covering 21 kinds of objects, while the former Presidential Decree No. 55/1993 covered only 14 kinds. The newly covered objects include construction of Jail, Condominium, Waste disposal site, Natural and cultural preserve, Garden, Social institution place and Electricity facilities. Reservoir, dam, irrigation and water resource development are covered by the both.

(2) Reinforcement for controlling land broker (Article 4, Chapter II)

Clause 3, Article 4, Chapter II of Presidential Regulation No. 36/2005 stipulates that if the object land has been designated as the implementation location of development for public interest based on the decree by Bupati / Walikota or Governor, it is necessary for anybody who intends to buy a parcel of land in the object land to get a written permission from Bupati / Walikota or Governor depending on their authority. This is aimed at reinforcement for controlling land brokers who try to get profits by transactions of land expecting the land price rise.

(3) Addition of implementation for land provision (Article 2, Chapter II)

Land provision for development in the public interest by the government was carried out by means of "release or delivery of land rights" in the former Presidential Decree No. 55/1993. In addition to this, the newly provided Presidential Regulation No. 36/2005, land provision can be implemented by means of "abolishment of land rights."

This "abolishment of land rights" mentioned in Article 2, clause (1), b, is carried out based on the rule and regulation in Law No. 20/1961 about abolishment of land rights and objects that exist on it.

2.4.4 Protected Species and Protected Area

(1) Protected species

A "Red List," or a list of the protected species of flora and fauna, is stipulated in Indonesia by Government Regulation No. 7/1999: about Conservation of Plant and Animal Species. In total 294 species of wild animals and plants are designated by the regulation, including 70 species of mammals, 93 species of birds, 31 species of reptiles, 20 species of insects, seven (7) species of fish, one (1) species of anthozoan, 14 species of bivalve and 58 species of plants. There is no Red List provided by the local government including Central Java Province and relevant Kabupaten or Kota in the Study area.

(2) Protected Area

There is no protected area designated by central government in the Wonogiri reservoir catchment and downstream reach of the Bengawan Solo river. As for in the local government level, there are six (6) protected area in Kabupaten Wonogiri designated by Government Regulation of Central Java Province No. 22/2003: about Management of Protected Area in Central Java Province. The name, kind and the location of the protected areas are shown on Figure 2.4.1.

2.5 Candidate Project Components

The countermeasures for sedimentation problem in the Wonogiri Multipurpose Dam Reservoir comprise the following four categories, including "Do nothing for sedimentation problem in the Wonogiri reservoir."

- Countermeasures for Sediment Deposits and Garbage at Intake,
- Countermeasures for Sediment Inflow from Keduang River,
- Countermeasures for Sediment Inflow from Other Tributaries,
- Watershed Conservation, and
- No action for decreased effective storage in the reservoir.

Table 2.5.1 shows a list of candidate project components, namely alternatives. The outline of the candidate project components in these countermeasures is described in Table 2.5.2. (Refer to Supporting Report Ⅱ Annex No.7 and No.9 for the details.)

Table 2.5.1 List of Candidate Project Components

Objective	Candidate Project Components (Alternatives)
Countermeasures for Sediment Deposits and Garbage at Intake	1. Modification of the intake
	2. Relocation of the intake
	3. Garbage trapping structure at intake
	4. Garbage trapping structure at Keduang river
	5. Hydro-suction sediment removal system
	6. Hydraulic dredging
Countermeasures for Sediment Inflow from Keduang River	1. Keduang river sediment bypass
	2. Sediment sluicing by new gates
	3. Compartmented reservoir with new flushing gates

Countermeasures for Sediment Inflow from Other Tributaries	1. Sediment storage dam for sediment removal
	2. Hydraulic dredging in reservoir
	3. Dry excavation in reservoir
	4. Managing of sediments within reservoir by water releasing from the intake
	5. Re-allocation of reservoir storage capacity
Watershed conservation	1. Community-based soil conservation
No action	Do nothing for the sedimentation problem in Wonogiri reservoir

Source: JICA Study Team

2.6 Existing Environment

2.6.1 Physical Environment

(1) Topography and Geology

The watershed of Wonogiri reservoir is located in the uppermost area of the Bengawan Solo river. The topography of the area is hilly to mountainous with the elevation ranges from approx. 200 to 1,000m. The maximum elevation in the watershed is approx. 2,100m at the south slope of Mt. Lawu and the lowest is approx. 140m near the dam site. The whole watershed is dissected by several rivers, including Keduang, Tirtomoyo, Temon, Upper Solo, Alang and Wuryantoro. The B. Solo river runs northward from the reservoir and flows through Kota Surakarta. Then, it turns east in Kabupaten Sragen and then flows down to meet with the Madiuin river in Kabupaten Ngawi, East Java Province.

Geographically, Wonogiri reservoir watershed is situated around the boundary between Solo Zone and Southern Mountains Zone. These geomorphic zones of Java form belts of the east to west direction that stretches further east to the island of Bali. Geologically, Wonogiri dam reservoir area is underlain by volcanic breccia, tuff breccia, tuffaceous sandstone, calcareous sand and limestone of Miocene age belonging to the Southern Mountains Zone. Quaternary volcanic products of Solo Zone are distributed in the right bank of the Wonogiri dam and the Keduang River.

(2) Climate

The climate of the Study Area is tropical and is subject to the tropical monsoon. West wind prevails from November to April in ordinary year and brings rainy season to the river basin. During July to October, the basin area is dried up by the monsoon from the south.

The meteorological feature of the Wonogiri reservoir basin is listed in the table below. An isohyetal map of mean annual rainfall over the Wonogiri catchment was developed by use of selected 36 rainfall station from 1983 to 2003, indicating that the annual rainfall is relatively small (less than 1,750 mm/year) in upstream Solo basin, and high in both Keduang and Tirtomoyo river basins (more than 2,100 mm/year).

Table 2.6.1 Meteorological Feature of the Wonogiri Reservoir Basin

Indices	Unit	Average	Range (Min. – Max.)	Remark
Monthly temperature	ºC	29.3	28.3 – 30.4	Min: Jul., Max.: Oct.
Monthly relative humidity	%	77.4	75.4 – 79.7	Min: Oct., Max.: Dec.
Monthly rainfall	mm	165	15 - 369	Min: Aug., Max.: Jan.
Annual rainfall	mm	1,978	-	-
Monthly wind velocity	m/s	2.31	1.53 - 3.47	Min: Apr., Max.: Oct.
Evaporation (average)	mm/day	5.3	-	-

Source: Analysis of JICA Study Team based on data of meteorological stations.

(3) Hydrology

1) Watershed

The Bengawan Solo river basin flows through Central and East Java Provinces with a catchment area of approx. 16,100km^2 and a length of some 600km. The Wonogiri Dam Reservoir is located in uppermost area of the basin, with a catchment area of 1,350km^2 including the area of the reservoir (90km^2).

2) Inflow

The Wonogiri reservoir receives the water inflow from the upstream area mainly through several major rivers. The mean annual inflow volume is approx. 1.18 billion m^3 during 1983 – 2003, with a mean monthly inflow ranging from 6.1 m^3/s in August to 96.8m^3/s in February. The estimated runoff coefficient is 0.45 with the annual depth of 895 mm.

3) Outflow

The outflow from the reservoir is divided into 1) water release from spillway and 2) hydropower generation. The ratio of annual water release from spillway accounts 19% on average with a total outflow volume of 224 million m^3/year. The remainder (81%, 948 million m^3/year) is used for hydropower generation. The outflow from spillway occurs only the period from November to May on average, while that for hydropower generation occurs all through the year. During dry season, therefore, the outflow decreases and the mean discharge is around 20 -25 m^3/s.

4) Flood Control

The reservoir water level is controlled not to exceed the Control Water Level (El.135.3 m) during the flood season from December 1st to April 15th for eliminating the possibility of overtopping of a Probable Maximum Flood (PMF) on the dam crest. The reservoir provides 220 million m^3 of flood control capacity to regulate the flood discharge (SHFD). Since the completion of the Wonogiri Dam in 1980, no flooding has so far occurred in Surakarta, largest city in the Bengawan Solo River Basin. The Wonogiri Dam has much contributed to social welfare in the basin and has greatly benefited the people in the downstream area.

5) Irrigation

Irrigation water is taken from the Colo intake weir located about 13 km downstream of the Wonogiri Dam. At present, the irrigation area has been extended from 24,000 ha in the original plan to 30,000 ha where triple or double cropping farming is being practiced. Mean monthly discharges at the Colo weir in 1986-1999 are summarized in the table below. River maintenance flow decreases least in July until 2.5 m^3/s.

Table 2.6.2 Mean Monthly Discharges at Colo Weir

(unit : m^3/sec)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Release for maintenance flow	38.4	56.0	62.3	31.2	5.6	3.3	2.5	2.9	3.8	7.1	13.1	21.8
Left canal intake	2.3	2.8	2.6	2.9	2.8	2.8	2.9	2.7	3.3	2.9	2.8	2.5
Right canal intake	16.0	13.3	16.2	17.0	17.0	15.1	15.5	15.5	18.4	18.1	17.4	18.2
Total Inflow at Colo Weir	56.7	72.1	81.1	51.1	25.4	21.2	20.9	21.1	25.5	28.1	33.3	42.5

Source : CDMP Study in 2001

(4) Air quality and noise pollution

The measurement results in kecamatan Selogiri and Wonogiri, conducted by Environment, Forestry and Mining Agency of kabupaten Wonogiri, indicate that most of the analyzed parameters for ambient air are consistent with environmental standards stipulated by Decree of Environmental Minister No. KEP-02/PENKLH/1/1988 and Governor's Decree of Central Java Province No. 8/2001.

Regarding ambient noise, half of the locations exceeded the environmental standard stipulated by Decree of Environmental Minister No. KEP-48/PENKLH/11/1996 in urban area of Wonogiri town. The reason for this is considered to be caused by noise from automobiles and motor cycles. However, there is no major stationary pollution source of noise near the Wonogiri dam site.

There is no available data for ambient vibration measured in and near the Wonogiri reservoir basin. There is no source of vibration near the Wonogiri dam site.

(5) Water quality

1) Secondary data

Measurement results in 1990's conducted by PBS: PBS monitored water quality in the Bengawan Solo river at 30 points in 1995/1996, of which 12 points were located in the Study area. Measurement results indicated that the major rivers in the Wonogiri dam watershed and Bengawan Solo river were suffering from water pollution in 1995/1996, caused by soluble organic substances, fertilizers and wastes and industrial waste water from the area of Surakarta City. Parameter such as DO, BOD and COD become worse in dry season due to low discharge and high temperature.

Measurement results since 2000 by kabupaten Wonogiri: Agency of Environment, Forestry and Mining, Kabupaten Wonogiri has been monitoring surface water quality of Wonogiri reservoir and the Bengawan Solo river and its tributaries since 2000. This water quality monitoring has not always been implemented systematically, as the sampling location, time (season) and parameters analyzed are different by year. It is, therefore, difficult to give a systematic interpretation/evaluation of the measurement results. In spite of the fact mentioned above, the following tendency was drawn:

a) Wonogiri reservoir and the Bengawan Solo river and its tributaries are suffering from high concentration of organic pollutants, shown by high BOD and COD, and suspended solids.
b) Some heavy metal parameters, including Pb, Zn and Mn, were detected with the concentration exceeding the environmental standards.

Measurement Results since 2003 by PJT-I: PJT-I is monitoring the water quality in the B. Solo river from July, 2003, targeting for in-stream water quality only during dry season. Water sampling is done at 10 locations including Wonogiri reservoir, upper and downstream reaches of the Bengawan Solo river, and the Madiun river.

Water use classification to be applied for each sampling location is class II, Government Regulation No. 82/2001: about Water Quality Management and Pollution Control, according to the interview result with Bapedal, Central Java Province. Measurement results indicate that the Bengawan Solo river is suffering from water pollution by organic matter, including COD, BOD, NO2 and PO4, and sometimes heavy metal such as Pb, Cu and Zn. Based on the longitudinal profile of water quality, it is estimated that one of the polluters is effluent, including domestic

and industrial waste water from Kota Surakarta and its outskirts.

Evaluation of Water Quality: Examining the transition of water quality in the Wonogiri reservoir and Bengawan Solo river based on the data in both 1995/1996 and recent condition since 2000, it is appeared that the water quality of Wonogiri reservoir and Bengawan Solo river has not improved but has similar condition to that of mid 1990's.

2) Primary data

Ambient Water Quality: Since existing data and/or information on water quality are insufficient or not available for evaluating the water quality in the Wonogiri Dam Reservoir basin, the field investigation and laboratory test were conducted to obtain the baseline data. The sampling location consists of eight (8) points in the river, three (3) points in the reservoirs and two (2) points in irrigation canals as shown on Figure 2.6.1.

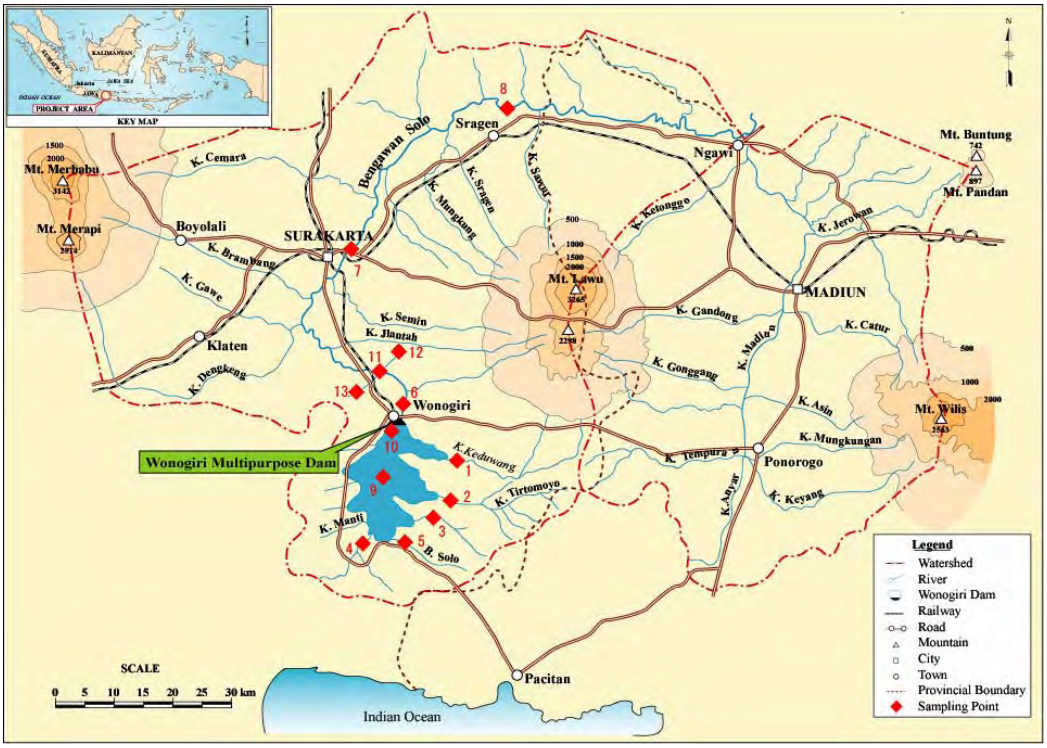


Figure 2.6.1 Sampling Location for Water and Bed Material Quality Analyses

The results of water quality analysis are summarized in Table 2.6.3. There are several parameters which exceeded the environmental standard values, such as SS, Cu, Cr6+, NO2, T-P, BOD, COD, and Coliform.

Table 2.6.4 shows the comparison result with water quality standard (Class II, Government Regulation No. 82/2001). The ratio of sampling locations exceeding the standard is 29.4% in December 2004, when is the beginning of rainy season, while 20.4% in May 2005, when is the beginning of dry season. This means that the ambient water quality deteriorates in the beginning of rainy season than in the beginning of dry season. This is supposedly because of "flushing out effect" of pollutants which have accumulated during dry season in the catchment. The parameter which deteriorates in the beginning of rainy season included Total Suspended Solids (TSS), NO2, T-P, BOD and COD, all of which are the indicators of organic pollution. In contrast, parameter on heavy metal did not show this

tendency.

Table 2.6.4 Numbers and ratio of sampling location exceeding Water Quality Standard (Class II, Government Regulation No. 82/2001)

Parameter	December, 2004		May, 2005	
	Locations which exceeded water quality standard		Locations which exceeded water quality standard	
	Nos. of locations	Ratio (%)	Nos. of locations	Ratio (%)
Total Suspended Solids (TSS)	12	92.3	0	0
Copper (Cu)	1	7.7	5	38.5
Zinc (Zn)	4	30.8	10	76.9
Chromium (VI) (Cr6+)	13	100	13	100
Nitrite (NO2)	13	100	1	7.7
Total Phosphorus (T-P)	4	30.8	2	15.4
Dissolved Oxygen (DO)	0	0	1	7.7
Biochemical Oxygen Demand (BOD)	11	84.6	6	46.2
Chemical Oxygen Demand (COD)	9	69.2	6	46.2
Coliform group	11	84.6	7	53.8
Coliform feces	10	76.9	10	76.9
Total	88	29.4	61	20.4

Source: Analysis Result of Primary Data of JICA Study Team

Comparison with Secondary Data: Comparing the primary data with secondary data, the following facts were obtained:

- The Bengawan Solo river and Wonogiri reservoir are suffering from water pollution of organic pollutants indicated by the high concentration of BOD, COD, T-P and NO2, which is a similar tendency of that of secondary data.
- These river and reservoir also showed high concentration of some parameters of heavy metal such as Zn, Cu and Cr6+, which is also a similar tendency of that of secondary data.
- These two tendency were detected at the rivers located in the upper catchment of the Wonogiri reservoir as well as Wonogiri reservoir and the Bengawan Solo river.
- Hg, which was detected with high concentration at Colo weir indicated by CDMP report (2001), was not detected at all the location in the primary data.
- The longitudinal water quality profile of the Bengawan Solo river in the secondary data showed that it deteriorates at downstream of Surakarta City, which is caused by the waste drainage from there. This tendency was also identified in the primary data.

Suspended Solids (SS) of Rivers flowing into Wonogiri Reservoir during Floods: In this Study, Suspended Solids (SS) was measured at downstream reach of the Keduang, Tirtomoyo, Temon, Upper Solo, and Alang rivers. Measurement results indicated that the average value of SS ranged from 2,300 to 5,100 mg/l (Refer to Supporting Report I Annex No.5 for the details.).

(6) Bed material quality

Since there is no available data or information on the bed material quality in Wonogiri reservoir or the Bengawan Solo river, bed material sampling and laboratory analysis was conducted at the same locations as those of water quality analysis.

A quality standard for bed material is not provided in Indonesia. Therefore, the bed material quality in the Study area is evaluated by comparing with quality standards for soil contamination provided in Japan. Likewise, the bed material quality in the study area

in case for dredging and excavation and dumping in other place is evaluated comparing with quality standards for dredged sediment for marine disposal provided in Hong Kong, Belgium, Germany, Norway and Spain.

Measurement results (Table 2.6.5) indicated that regarding the heavy metal components, it was found by comparison of the measurement results with quality standard for soil contamination in Japan that the level of concentration is far below the quality standard.

As for the evaluation for the dredging/excavation and dumping, it can be noted that the bed material quality in Wonogiri reservoir is below "Limit Value" for dumping although some of heavy metal components (Cd and Cu) are at the level of "Target Value" for management as shown in Table 2.6.6. This fact suggests the necessity of monitoring of bed material quality when dredging/excavation and dumping is to be implemented.

(7) Groundwater

There is no water supply system by PDAM in kecamatan Ngadirojo and Wonogiri near the candidate project components (bypass channel and flush gate). Local inhabitants use groundwater for their daily life taking from wells equipped with individual house. The depth of water well ranges from 10 to 30 m in general depending on the location of the house.

Water quality measurement for groundwater in wells was conducted to get primary data in this Study. The measurement results indicate that water quality of groundwater meets the Water Quality Standard of Ministry of Health No. 416/MENKES/IX/1990, except for Manganese. Water quality of groundwater can be evaluated as good condition as a whole.

The water well is made of concrete with diameter of about one (1) m in general. Judging from the depth of well bottom and groundwater level, the well is shallow and the well water is unconfined groundwater.

Shallow well equipped in individual house

Inside of water well made of concrete

Figure 2.6.2 Groundwater Well used near Candidate Structural Measure (Sand Bypass Channel)

(8) Soil

Soil in the Wonogiri reservoir watershed is classified into four (4) types: Mediteran, Lithosol, Latosol and Grumsol. Mediteran dominates (42%) in the watershed followed by Lithosol (25%), Grumsol (21%) and Latosol (12%). These soils have such characteristics as fine textured, weak cohesion and susceptible to water erosion in general.

As for soil contamination, there is no available data. Judging from the fact that there is no contamination source such as heavy or chemical industry, mining industry except for sand mining, there seems no soil contamination problem in the Wonogiri reservoir basin.

2.6.2 Natural Environment

(1) Vegetation

In the Wonogiri reservoir watershed, 57% of the whole area is covered by agricultural land use, and 20% are covered by forest land including orchard and plantation. The vegetation of these land use was studied and summarized below:

1) Agricultural Crops

Near the Wonogiri dam site, the following agricultural crops are identified to grow, namely, Pisang (*Musa paradisiaca*), Pepaya (*Carica papaya*), Jati (*Tectona grandis*), Randu (*Ceiba pentandra*), Singkong (*Manihot esculenta*), Jagung (*Zea mays*), Kacang tanah (*Arachis hypogaea*), Ubi jalar (*Ipomoea batatas*), Padi (*Oryza sativa*), Cabai merah (*Capsicum frutescens*), Kedelai (*Glycine max*), Kacang hijau (*Phaseolus radiatus*). All of which are common species in the region of Central Java.

2) Forest

Forest in the Wonogiri catchment area is categorized into two: 1) state forest (hutan negara) and 2) peoples forest (hutan rakyat). As for state forest, it is further classified into three: 1) protected forest (hutan lindung), 2) production forest (hutan produksi) and 3) less productive forest (hutan produkitivitas terbatas). No customary or traditionally owned communal forests exist in the Wonogiri watershed. Natural forest is very limited at the foot of Mt. Lawu. Afforested forest species are common one in this region. The vegetative feature of these forests is listed in the table below.

Table 2.6.7 Vegetative Feature of State Forest in the Wonogiri Catchment Area

Forest Category		Total area (ha)	Main Location	Characteristics / function	Tree species
State Forest	Protected forest	3,351	Uppermost area of Sub-basin of Keduang river	Natural forest, partly afforested / Water resources conservation, flood protection, erosion control, etc.	No data available
	Production forest	17,374	Sub-basin of Tirtomoyo, Keduang, Upper Solo and Alang rivers	Afforested forest / Production of forest products	Mersuki pine, mahogany and teakwood.
	Less productive forest	1,312	Sub-basin of Eromoko, Wuryantoro, Ngunggahan and Alang rivers	Poor land capacity for forestry production	Poor vegetation
Peoples forest		13,900	Kecamatan Pracimantoro and Giritontro	Mostly managed by owner's self-help efforts under agro-forestry system with multiple planting of trees and crops	Trees: Teakwood, sengon, mahogany, acacia and eucalyptus, Crops: maize, cassava, beans and medical crops

Source: Analysis of JICA Study Team based on Data of Perum Purhutani KPH, Surakarta

(2) Terrestrial flora and fauna

Secondary Data: Regarding terrestrial flora, the investigation conducted in 1975 and 1976 in the area of Wonogiri reservoir area recorded a total of 250 species of terrestrial flora.

As for terrestrial fauna, several data sets were obtained so far in and around Wonogiri dam reservoir as summarized in table below. Ten (10) species of mammals, 28 species of wild birds, and 10 species of reptiles were identified to inhabit in Kabupaten Wonogiri according to Forest Conservation Bureau, Region II, Surakarta, Central Java Province.

Table 2.6.8 Secondary Data on Terrestrial Flora and Fauna in the Study Area

Terrestrial flora / fauna	Location	Nos. species recorded	Year	Remarks	Data source
Flora	The area of Wonogiri reservoir	250	1975 / 1976	Before impounding water in reservoir	1)
Wild birds	ditto	6	2003		2)
Mammal	Kabupaten Wonogiri	10	2006		3)
Wild birds	Ditto	28	2006		3)
Reptiles	Ditto	10	2006		3)

Data source:

1) Summary of Environmental Studies in Wonogiri Reservoir Area, Book II, 1975/1976.
2) Data Compilation: Landscape Plan of Gadjah Mungkur Reservoir Area, 2003.
3) Forest Conservation Bureau, Region II, Surakarta, Central Java Province, 2006.

Primary data: A preliminary inventory survey was conducted for the data on terrestrial flora and fauna at seven locations in the Study area. The inventory results indicated that there are 10 to 18 flora species recorded in the around Wonogiri reservoir and its downstream area along the Bengawan Solo river. As for terrestrial fauna, an inventory was also done to supplement the secondary data. The results indicated that there were 5 to 8 fauna species at the same locations as those for flora. None of protected species of terrestrial flora was identified by the inventory survey. Regarding terrestrial fauna, protected species were identified to inhabit. (Refer to Section "(4). Protected species" later on)

(3) Aquatic flora and fauna

Secondary Data: Regarding aquatic flora, very few investigations were conducted so far in the area of Wonogiri reservoir area. An investigation in Wonogiri reservoir identified 14 phytoplankton in 2003.

As for aquatic fauna, several investigations have been done so far in and around the reservoir. Twenty five (25) species of fish, consisting of 12 species of predator and 13 species of non-predator, were recorded in 1975 before impounding water in the reservoir. In 2003, 16 species of zooplankton, 10 species of macro-benthos and 7 species of fish were identified in Wonogiri reservoir. Regarding fish species identified in the Bengawan Solo river, a total of 38 species are recorded, of which 16 is identified in the upper stream reaches.

Table 2.6.9 Secondary Data on Aquatic Flora and Fauna in the Study Area

Aquatic flora / fauna	Location	Nos. species recorded	Year	Remarks	Data source
Flora (Phytoplankton)	Wonogiri reservoir	14	2003		1)
Fish	Ditto	25	1975 / 1976	Before impounding water in reservoir	2)
Fish	Ditto	7	2003		1)
Fish	Bengawan Solo river	38	2004 - 2005	16 species in the upper reach of B. Solo river	3)
Macro-bentos	Wonogiri reservoir	10	2003		1)
Zooplankton	Ditto	16	2003		1)

Data source:

1) Data Compilation: Landscape Plan of Gadja Mungkur Reservoir Area, 2003.
2) Summary of Environmental Studies in Wonogiri Reservoir Area, Book II, 1975/1976.
3) Inventory of fish species and aquatic environment in the Bengawan Solo river, 2005

Primary Data: A preliminary inventory survey and interview survey were conducted for the data on aquatic flora and fauna at seven locations in the Study area. A total of nine (9) fish species are reported from local society or government official, of which eight (8) are edible. The fish species are common ones and tolerable for polluted condition.

As for macro-benthos, inventory results at 7 locations showed there are 5 to 7 species are identified to inhabit. Shannon-Wiener Index (ID) of macro-benthos indicated the sediment material condition in the river is slightly polluted (ID ranged from 2.1 to 2.6.). Regarding phytoplankton, inventory results at the same locations showed that there are 4 to 11 species identified to inhabit. Shannon-Wiener Index (ID) of phytoplankton indicated the river water quality varies from "not polluted" to "moderately polluted." (ID ranged from 1.57 to 3.30.).

(4) Protected species

According to the survey results of Forest Conservation Bureau, Region II, Surakarta, Central Java Province, there are several protected species to inhabit in Kabupaten Wonogiri , including the following species in the table below:

Table 2.6.10 List of Protected Species to Inhabit in Kabupaten Wonogiri

Class	Scientific Name	English Name	Local Name
Mammalia	*Muntiacus muntjak*	Antelope	Kijiang
	Panthera pardus	Leopard	Macan Tutul
	Cynogale bennetti	Otter Civet	Musang air
	Hystrix brachyura	Porcupine	Landak
	Manis javanica	Anteater	Trenggiling
Aves	*Alcedinidae*	Kingfisher	Raja Udang Putih
	Bubulcus ibis	Cattle Egret	Kuntul
	Accipitridae	Eagle	Elang
	Leptoptilos javanicus	Lesser Adjutant	Bangau tontong

Source: Forest Conservation Bureau, Region II, Surakarta, Central Java Province

Habitat of these species is limited in upper mountainous area in the Wonogiri reservoir watershed. It is worth noticing that five leopards (*Panthera pardus*) appeared in Desa Jatipurno, Kecamatan Jatipurwo situated in the foot of Mt. Lawu in the Keduang river sub-basin. This implies that these wilds animals have difficulty to get foods within their habitat.

Regarding reptiles, aquatic organisms and plants, no protected species are identified to inhabit in the Wonogiri reservoir watershed or the Bengawan Solo river.

(5) Biodiversity

Wonogiri Reservoir watershed is mostly under human-modified condition; there is only limited natural forest area in the basin. The biodiversity in the watershed is not completely clear because of the limited data availability, but it can be interpreted that the biodiversity in the basin is not very rich due to the numbers of flora and fauna species recorded so far.

2.6.3 Socio-economic Environment

(1) Administration jurisdiction

Wonogiri Multipurpose Dam Reservoir is located in kabupaten Wonogiri, Central Java

Province. The catchment area (1,350 km^2) of the reservoir spreads over three kabupaten: kabupaten Wonogiri, Pacitan and Karanganyar. More than 90% of it, however, is dominated by the administrative jurisdiction of kabupaten Wonogiri.

In the downstream area of Wonogiri dam, the Bengawan Solo river runs through three kabupaten and one kota in Central Java Province, namely Kabupaten Sukoharjo, Karanganyar, Sragen and Kota Surakarta.

(2) Demography

Population in the watershed of Wonogiri dam is approximately 938 thousand with a population density of 602 persons/km^2 in 2003. Population growth rate of Kabupaten Wonogiri from 2003 to 2004 is 0.2% according to "Wonogiri in Figure, 2004." The kecamatans with relatively high population density (more than 600 persons/km^2) in Kabupaten Wonogiri are located near the Wonogiri Dam site and south slope of Mt. Lawu. The kecamatans with relatively low population density, on the contrary, are situated in south and west part of the watershed. The number of households in the watershed is approximately 206 thousand in 2003 with an average family size of 4.5 persons/family.

(3) Religion and tribe

More than 96 % of all the people in kabupaten Wonogiri are Moslem. The rest is Christian consisting of Catholic and Protestant (3 %), and Buddhist (< 1%). Local people in the kabupaten Wonogiri are comprised of single tribe, Javanese (almost 100%).

(4) Education

According to the interview survey conducted in Kecamatan Wonogiri and Ngadirojo, only 37.5% of respondents finished junior high school or higher education. The rest finished only elementary school or lower education. The education level of the project affected area is deeply related to the level of understanding of the Project and/or management to mitigate possible negative impacts. The interview results indicate an undesirable condition, which implies the necessity of enough dissemination of the project justification.

(5) Land use

Detailed field survey conducted in this Study clarified the current situation of land use in Wonogiri reservoir watershed. Upland field dominates (32%), followed by paddy field (25%), settlement area (22%), orchard/plantations (10%), state forest (10%) and others (1%).

Upland field exists with high proportion at almost all area of the watershed expect for the south slope of Mt. Lawu and alluvial low land along river channel and near Wonogiri reservoir, where paddy field dominates. Settlement area is located scattering in the area of paddy field and in-between upland field and paddy field. Only a small ratio (20%) of forest including orchard and plantation occupies in the watershed (Refer to Supporting Report Ⅱ Annex No.9 for the details.).

(6) Greenbelt around Wonogiri Dam Reservoir

Definition and Area: According to "Space System Plan of Wonogiri Reservoir Area, Central Java Province, Ministry of Housing and Regional Infrastructure (KIMPRASWIL), 2003, surrounding areas of Wonogiri Reservoir is divided into the following:

Table 2.6.11 Land Category for Surrounding Area of Wonogiri Reservoir

Category	Elevation	Area (ha)
Permanent Inundation Area	Below 127.0 m	2,640
Tidal Low Land Area	127.0 – 138.2 m	5,964
Greenbelt Area	138.2 – 140.0 m	996

Land Ownership: All the areas listed above were acquired by Ministry of Public Works (PU) at the construction of Wonogiri Dam reservoir, and now the land ownership belongs to PU and the areas are managed by PJT-1.

Illegal Land Use in Greenbelt Area: The areas of greenbelt and tidal low land were permitted to use for cultivation by local farmers by issuing Governor Decree No. 611/22/1984 (Central Java Province) and Bupati Decree No. 254/1986 (Kabupaten Wonogiri). Although these regulations have expired in 1989, local farmers continued to occupy these areas for cultivation and it is currently ongoing. The factors for this illegal land use are considered to be the following:

- Low income is a dominant motivation factor to force local farmers to encroach the surrounding area of the reservoir for increase of agricultural production.
- No regulative enforcement to prohibit the illegal logging and cultivation in the tidal lowland and greenbelt areas by pertaining authority.
- There is no sufficient knowledge among local people about the function of the greenbelt on conservation of the reservoir.

(7) Industry

Agriculture dominates the local economy in kabupaten Wonogiri with a percentage of 52%, followed by Transportation (11%), Services (9%), and Manufacturing (7%) in 2003. In the watershed of the Wonogiri reservoir, approximately 50% of the population engages in agricultural sector. This is followed by construction sector (7.8%), and industry sector (6.2%). Most of residents have second job because of low income. According to the interview survey conducted in Kecamatan Wonogiri and Ngadirojo, 67.5 % of respondents answered that they have second job.

In watershed of Wonogiri reservoir, small size industry dominates the whole industry with a total number of 14,500 units. Among others, food manufacturing such as tempe (fermented soybean cake), tapioca flour, and interior goods such as wood furniture and bamboo cane dominate.

(8) Inland Fishery

Inland Fishery in Wonogiri watershed: Inland fishery is actively conducted in the Wonogiri watershed, divided into three categories: Germination, Aquaculture and Fishing. Germination is the production of fry fish, implemented by two types of entity: BBI (Fish Nursery Office) and UPR (Community Nursery Unit). Aquaculture, or fish culture, has been implemented since 1988 in Wonogiri reservoir, when Central Government invested in a pilot project for fish breeding in the reservoir. Fish culture is conducted also in pond and paddy field. Fishing is done in Wonogiri reservoir, lake, river and other inland water body. Of all the fish catch (946.3 ton) in 2003, 832 ton, or 88% is the production from Wonogiri reservoir.

Inland Fishery in downstream area: The fishery in the downstream area is carried out by fishing at pond (private fish pond), wet land (river or other small reservoir) or fish culture using karamba. Especially in Kabupaten Skoharjo, fishery using karamba in oxbow lakes, or old river reaches of the Bengawan Solo river, is actively conducted. The photos below

show the karamaba fishery in Desa Grogol. With this regard, oxbow lakes are separated by dike or gates with the Bengawan Solo river, so the river water does not freely flow into the oxbow lake.

Installed karamba in oxbow lake of B. Solo river

Fishermen are catching fishes near the karamba

Figure 2.6.3 Karamba Fishing in the Oxbow Lake of the Bengawan Solo River, Desa Grogol, Kabupaten Sukoharjo

Regarding fishery in the Bengawan Solo river, it is not actively carried out on the downstream reach in the area of Central Java Province. According to the officials of fishery offices of these local governments, there is no official record of commercial fish catch (products) from the B. Solo river. Only a fragmental data is obtained such as location (village) of fishing in the B. Solo river, the number of fishing people, or the kind of fish caught. In conclusion, no intensive commercial fishery is done in the Bengawan Solo river, but the fishing is done as secondary job or for their domestic consumption.

(9) Socio-economic development plan

Kabupaten Wonogiri prepared the site plan (General City Site Plan, Detailed City Site Plan (RUTRK-RDTRK) of Wonogiri City 2000 – 2010) for improvement of urban area of Wonogiri City. According to the plan, the area of Wonogiri City is divided into several blocks for development, called BWK, or Block of City Area. This plan includes the following scopes: plan of center for environmental service, land use plan, road function, clean water supply, electricity service, telephone service, drainage network system and waste dumping.

(10) Fluvial navigation

Although bridges have been built on the Bengawan Solo river, some remote locations still operate fluvial transportation for crossing the Bengawan Solo river. Table below shows the location of fluvial navigation along the river. There are at least nine (9) routes connecting left bank and right bank of the river by boat, two of which, however, have been not used yet, according to the officials of Kabupaten Sragen.

Table 2.6.12 Location of Fluvial Navigation of the Bengawan Solo River in Stretches from Wonogiri Dam until the Boundary with East Java Province

Kabupaten	Location / Desa to be connected	Current conditions
Sukoharjo	1. Desa Lawu and Ngasinan 2. Desa Ngasinan and Bulu 3. Desa Nggadingan and Snagkrah (Kota Soko) 4. Desa Serenan and Bulakan	
Karanganyar	1. Desa Miri and Gondang Rejo 2. Desa Waru and Gondang Rejo	
Sragen	1. Desa Masaran and Butuh 2. Desa Pilangsari and Plupuh 3. Desa Jenar	Closed Closed

Source: JICA Study Team

(11) Water use

According to the government officials in Kabupaten Sukoharjo and Karangnyar, there is no water use directly taking from the Bengawan Solo river for agricultural or industrial purpose, because water for agriculture in these two kabupaten is fulfilled by an irrigation cannel from the Colo Weir. In the downstream area, however, there are some areas where the irrigation water is not sufficient. According to PJT official, 1,220ha in the Central Java area is to be covered by an irrigation by direct pumping from the Bengawan Solo river.

(12) Public health

Survey on public health and sanitation covered the secondary data on major disease and health facility in this Study. The survey was conducted targeting for the four kecamatan in Kabupaten Wonogiri near the Wonogiri dam (Survey Area I) and the area along the B. Solo river (Survey Area II) including Kabupaten Sukoharjo, Karangnyar and Sragen, and Kota Surakarta. In addition, interview survey was conducted for the data on public health condition and water source. The survey results are summarized in table below:

Table 2.6.13 Public Health and Sanitation in the Survey Area

Studied Issues	Survey Area I *	Survey Area II **
Major disease	1. ISPA (36 %) 2. Toothache (25 %) 3. Arthritis (16 %)	1. ISPA (37 %) 2. Gastritis (11 %) 3. Dermatitis (10 %)
Accessibility to health facility (hospital, clinic, pharmacy, etc.)	Moderate to quite good	No problem or not in difficulty
Public health condition on house, liquid waste drainage, toilet and garbage dumping	1. Good condition: 38 % 2. Moderate condition: 62 %	No available data
Water source	Well (No PDAM system)	No available data

Note)
*Study Area I: The area near Wonogiri dam, including Kec. Wonogiri, Ngadirojo, Nguntoronadi and Wuryantoro
** Study Area II: The area downstream of Wonogiri dam, including Kab. Sukoharjo, Kota Surakarta, Kab. Karanganyar and Kab. Sragen
Source: Data at Puskesmas (Local Government Clinic) at respective area.

The most common disease in the study area is ISPA (Upper Respiratory Nasopharynx) in both area, followed by Toothache and Arthritis near Wonogiri Dam Reservoir (Survey Area I), and followed by Gastritis and Dermatitis in the lower area along the B. Solo river (Survey Area II). Regarding water borne/related disease in the study area, Diarrhea / Dysentery dominate with high ratio more than 80% (of all the water borne/related

diseases). Other ones include DHF (Dengue Hemorrhagic Fever), Cholera, Malaria, Filariasis and Typhoid.

Accessibility to health facility including hospital, clinic, pharmacy is in good condition or at least no big problem in the Study area in general. Other public health condition on house, liquid waste drainage, toilet and garbage dumping is in moderate to good conditions near Wonogiri dam reservoir. There is no PDAM system (City water supply system) except for Wonogiri town in the watershed, but local people relies on groundwater using wells for water source.

(13) Garbage in Wonogiri Reservoir

Wonogiri Reservoir is suffering from garbage problem, which often causes stop of power generation. According to Wonogiri Power Station (PTLA Wonogiri), on average 20 days per rainy season, the intake trash caused the turbines to shut down. The trash racks are then cleaned by force of divers. In addition, debris flushing through the spillway is sometimes conducted. Most of the debris reaching at the spillway is considered to come from the Keduang river basin based on the field observation.

Field inventory was conducted at the intake of power generation for identifying the components of the garbage quantitatively so as to get the base line data for evaluation of countermeasure of candidate projects.

Table 2.6.14 summarizes the components of garbage accumulated at the intake of Wonogiri dam. A total of 509 non-degradable garbage items were identified during the 5 times of inventory survey from August to September 2005. The garbage is composed of plastic bottle and bags, sandal, foam, shoes, etc. These six (6) items dominated more than 75% in number and 96% in weight of all the garbage. In addition, organic garbage consisting of bamboo and tree, and dead animals are accumulated with considerable number and weight.

Table 2.6.14 Inventory Results of Garbage Accumulated in Wonogiri Reservoir

Kind of Garbage	Number		Weight (estimated)	
	Nos.	Ratio(%)	kg	Ratio(%)
1. Plastic bottle of refreshment drinks	139	27.3	19.5	55.0
2. Large plastic bottle of mineral water	107	21.0	4.3	12.1
3. Plastic bags	60	11.8	2.4	6.8
4. Sandal	37	7.3	3.9	11.0
5. Foam	28	5.5	-	-
6. Shoes	12	2.4	4.0	11.2
Other non-degradable garbage (plastic material, various kinds of plastic bottles, can, plate and bowl, etc.)	126	24.8	1.3	3.9
Sub-total	509	100	35.4	100
Organic garbage (bamboo, tree, dead animal (fish, chicken)	many	-	-	-

Note)
Time and period of inventory: 5 times in total in August and September, 2005.
Weight is calculated by multiplying total nos. of each kind of garbage and unit weight.
Nos. of organic garbage are not clear because there were too many of them identified.
Source: Primary data in IEE Report (2006)

Field survey on garbage was also done for identifying the average condition of production (generation) of garbage from a family. It was found that the average production of garbage per capita is 4.1 kg /family /day with a family size of 4.3 persons on average, which means the average garbage production per capita amounts up to 1,000 g (1 kg)

/day.

(14) Historical and cultural heritage

There are several heritages which are historically and culturally significant along the Bengawan Solo river. Table 2.6.15 shows several important historical places along the Bengawan Solo River from Wonogiri dam to Tangen, Kabupaten Sragen. Table 2.6.16 shows social culture that is still in practice by local people.

Table 2.6.15 Historical Places Along Bengawan Solo River

No	Historical Places	Location	Activity	Special Days of Activity	Distance from River
1	Petilasan Ronggo Penambang	Nambangan, Wonogiri	Holy Place for Ziarah	Thursday night, and Month of Syura (Javanese/Islamic Calendar)	Approx. 25 meter
2	Pesanggrahan Langenharjan	Grogol, Sukoharjo	1. Resort 2. Meditation	Thursday night, and Month of Syura (Javanese/Islamic Calendar)	Approx. 25 meter
3	Cemetery of Ki Ageng Butuh	Butuh, Sragen	Ziarah to Cemetery of Previous King of Pajang	Thursday night, and Month of Syura (Javanese/Islamic Calendar)	100 meter
4	Benteng Pendhem	Tempuran, Ngawi	Tourism	Mostly during holydays	100 meter

Source : Historical Files, 2005.

Table 2.6.16 Social Cultures in the Community

No	Culture	Location	Activities	Special Days of Activity
1	Sadranan Tradition	Community Along the Bengawan Solo Catchment Area (Wonogiri-Ngawi)	Ziarah to the Cemetery of Ancestors	Once a year (End of Ruwah on Javanese/Islamic Calendar)
2	Labuhan Tradition	Community Along the Bengawan Solo Catchment Area (Wonogiri-Ngawi)	- Disposing Placenta After Giving Birth of Baby, - Disposing Used Clothes	Not Scheduled, Depends on the Need
3	Kungkum/ Meditation Tradition	Junction of River in Serenan, Kabupaten Sukoharjo and Ngawi	Ritual of Meditation by Soaking Body in the River Water	Mostly on Thursday Night
4	Tradition of Larung Gethek Joko Tingkir	Following Bengawan Solo River Flow from Langenharjan, to Jurug, Solo City	Yearly Tradition at Early Month of Syawal (Javanese/Islamic Calendar)	To Flow Gethek (Bamboo Boat) of Joko Tingkir

Source: Primary data from Field Observation, 2005.

Among listed above, Kungkum, a traditional meditation by soaking human body in the river, is normally done at the junction of rivers. Hence, this traditional ritual can be found at junctions of rivers from Wonogiri to Ngawi, East Java Province. This traditional meditation has mostly been performed on Thursday night, and in months of Suro and Ruwah, namely, the 1st and the 8th months of Javanese/Islamic calendar.

Tradition of Larung Gethek Joko Tinger is the annual tourism event of bamboo rafting on the Bengawan Solo river from Langenharijan (Sukoharjo) to Jurug bridge (Surakarta). This event is to commemorate the historical journey of Joko Tingkir, the first King of Pajang Kingdom, and is scheduled in the early month of Syawal, the 10th month of the Javanese/Islamic Calendar.

(15) Recreation and tourism

There are several recreational and tourism park along Wonogiri reservoir and the Bengawan Solo river as listed in table below. There are two recreational parks in the vicinity of the reservoir.

Table 2.6.17 List of Locations for Recreation and Toursim

No	Tourist Object	Location	Tourist Atraction	Distance from River
1	Ronggowarsito Park	Jebres, Solo City	Recreatiional Park	Approx. 25 meter from B. Solo river
2	Satwa Taru Jurug Park	Jebres, Solo City	Recreational Park and Zoo	Approx. 30 meter from B. Solo river
3	Monumem Wonogiri	Ease Side of Wonogiri reservoir	Recreational Park, Open theater	Approx. 50 meter form reservoir
4	Tourism Park	South West of Wongiri reservoir	Recreational Park, Complex of fish restaurants	Close to reservoir

Source: Primary data from Field Observation, 2005.

(16) Perception of local people on Reservoir, River and the Project

People's perception on Wonogiri Dam Reservoir and Bengawan Solo river is very important to know for analyzing the social impacts of the candidate projects and formulation of mitigation measures. It is, therefore, analyzed according to the interview survey results carried out during the field investigation. The following are the key points for understanding the people's perception and its background culture:

- People living around Wonogiri reservoir assume that the reservoir has been a part of their environment. Most people live on agriculture, and many farmers use the tidal area of the reservoir regardless of legality. Some people works informally by opening a shop, fishing or as a tourist guide. Hence, people have a strong sense of belonging to Wonogiri Reservoir.
- In spite of the fact mentioned above, people often see the reservoir as a shore of something dirty which should be dumped. It is understandable that people easily throw rubbish in the reservoir. They think that their home and surrounding environment are more important.
- The most important aspect is social environment for them, especially the social unity in each community unit, or dusun, as a "dukuh concept." Therefore, an enthusiasm for gathering and working together (gotong-royong) is very strong in a community.
- Perception on the Bengawan Solo river is similar to that on Wonogiri reservoir. Although the river has been assumed to special value in the Javanese culture, it has, at the same time, often been the location of dumping site. People have never complaint with river water quality; the most important mater is the continuity of river flow.
- Perception on the Project is that people living around Wonogiri Reservoir have only blurred perception because they are not informed about the candidate project components. Local people are waiting for the socialization of the proposed project and offering compensation.

2.7 Identification of Conceivable Impacts

2.7.1 Description of Conceivable Impacts

Conceivable impacts to be caused by the implementation of candidate project components

are examined in three stages: pre-construction, construction and post-construction (operation and maintenance) stages. The examination results are itemized in Table 2.7.1. The following is the brief description of the conceivable impacts:

(1) Countermeasures for Sediment Deposits and Garbage at Intake

1) Modification of the intake

This is aimed that intake points will not be affected by garbage in the reservoir by installation of new intake tower on the existing intake. The possible impacts are negative ones during construction works, including impacts on air quality (dust and emission gas), noise, water quality and traffic accidents and transportation. As for the impact on water quality, it is due to temporary stoppage of intake and discharge into the downstream of the B. Solo river. On the contrary, employment of local residents for construction works and increase of income can be expected as a positive impact although it is anticipated a minor one.

2) Relocation of the intake

This is aimed at the same effectiveness as the above by replacing intake structure at upper left bank approximately 300m far from the existing point. The possible impacts are similar to those of the previous case. But the magnitude of the impacts is larger because the size of civil work is much larger than the previous case. In addition, this project component contains tunneling with a length of 570m, which is to require the disposal of excavated material.

3) Garbage trapping structure at intake

This is aimed to block garbage to enter the intake by installing a weir and trash rack. The possible impacts are almost the same as those of the case of "1) Modification of the intake." But the periodical removal of the trapped garbage and disposal of it is needed.

4) Garbage trapping structure at Keduang River

This is aimed to trap garbage at the outlet of the Keduang river by installation of a weir structure. The possible impacts are almost the same as those of the previous cases. But this measure is expected to mitigate the degradation of water quality in the reservoir owing to trapping of debris at the inlet area of the Keduang river, including organic garbage before entering into the reservoir. On the contrary, however, the effectiveness to protect the intake is less than the former three cases because this measure does not directly protect the intake.

5) Hydro-suction sediment removal system

This is aimed that sediment deposits near the intake are to be removed by dredging. This system is characterized by utilizing water head difference between reservoir water level and downstream river water level. Accordingly, it will not use power pump to discharge dredged sediment to spoil bank, but discharge them into downstream river. Accordingly, there is a possibility of impacts on water quality in the Bengawan Solo river and aquatic organisms. Other impacts are almost the same as those of former ones during construction work, because this component requires a civil work to install a discharge pipe underneath the existing spillway of the Wonogiri reservoir.

6) Hydraulic dredging

This is aimed at removing sediment deposits around the intake by conventional dredging, or hydraulic dredging. This is a reliable method with relatively less significant impacts based on a lot of experience and performance, and therefore it seems to be easier to manage the adverse impacts except for the procurement of spoil bank which the dredged material is to be disposed to. The magnitude of impact, therefore, depends on the possibility of procurement of spoil bank at nearby area of planned dredging site.

(2) Countermeasures for Sediment Inflow from Keduang River

1) Keduang River sediment bypass

This is aimed at bypassing highly turbid water from the Keduang river during floods into the Bengawan Solo river at downstream of Wonogiri dam. This component includes a large scale of civil works, namely, tunneling (Length = 6,435m) underneath the existing settlement area and widening (Length=2,395m) of the existing river (a tributary of the B. Solo river) for the construction of bypass channel. Therefore there are several negative impacts whose magnitude is not minor.

This might cause local people's unrest and some conflict and/or opposition against it before the construction work. In addition, it is necessary to procure the area for disposal of excavated material spawned by tunneling, which may require land acquisition.

Impacts during construction works include topographic and geologic change, waste of excavated material, drawdown of groundwater level and inconvenience of well water use, air quality and noise, local traffic accidents and transportation. On the contrary, employment of local residents for civil workers and increase of income can be expected as a positive impact.

During operation stage of the bypass channel, discharge of highly turbid water directly to the Bengawan Solo river would increase Suspended Solids (SS) of the river more than the existing situation during floods, which might cause impacts on aquatic organisms.

2) Sediment sluicing by new gates

The objective of this countermeasure is the same as that of the previous one. The difference is the method to discharge; the turbid water from the Keduang river is to be discharged by sluicing through the gate to be newly equipped at the right bank side of the Wonogiri dam. The possible impacts are similar to those in the case of Bypass Channel, except for the following:

- Local people's unrest will be minor because this structure is confined within the area of reservoir, and therefore the land acquisition is limited only for procurement of disposal area of excavated material.
- There will be minor impacts on groundwater and well water use of local people because this measure may not includes excavation below the groundwater level.

3) Compartmented reservoir with new flushing gates

This is aimed at conducting sediment flushing periodically taking advantage of increased turn-over rate at the outlet area of the Keduang river separated by closure dike by means of steel sheet pile. In brief, this measure is a combination of the construction of sediment flushing gates and the dike connecting the dam and the

panhandle in the reservoir. Therefore, the impacts include those of the previous case plus the impacts to be caused by periodical flushing.

The flushing would cause discharge of highly turbid water into the Bengawan Solo river through flushing gates, which may cause negative impacts on aquatic organisms, especially fish. At the worse, a lot of fish might be killed or injured as the high concentration of SS may cause a respiratory impediment of fishes unless any countermeasure is made.

(3) Countermeasures for Sediment Inflow from Other Tributaries

1) Sediment storage dam for sediment removal

This is aimed to prevent sediment flowing in the major tributaries from entering into deep portion of the Wonogiri reservoir by installation of a dam at the outlet of the tributaries. The possible impacts are almost the same as those in the case of "Garbage trapping structure at Keduang River" described above in section (1).

2) Hydraulic dredging in reservoir

This is aimed at removing sediment deposits in the reservoir by conventional dredging, or hydraulic dredging. This is a reliable method with relatively less significant impacts based on a lot of experience and performance, and therefore it seems to be easier to manage the adverse impacts except for the procurement of spoil bank which the dredged material is to be disposed to. The magnitude of impact, therefore, depends on the possibility of procurement of spoil bank at the nearby area of planned dredging area.

3) Dry excavation in reservoir

This is aimed as a supplementary countermeasure with other ones by excavating sediment deposits in the upper part of the reservoir especially at the inlet of the major tributaries such as Tirtomoyo, Temon, Upper Solo, Alang and Wuryantoro rivers. The possible impacts include the negative ones during excavation works, such as impacts on air quality (dust and emission gas), noise, and traffic accidents and transportation. As the scale of this excavation is quite large, these impacts would be significant. But the spatial extent of the impacts is limited in the vicinity of the river mouth, where is rarely inhabited and far from the existing settlement area.

4) Managing of sediments within reservoir by water releasing from the intake

This is aimed at managing sediments within the reservoir by moving it from the depth of effective storage (EL. 127.0 – 136.0m) to the depth of sediment storage (EL. < 127.0m), and at draining the sediment deposits by water releasing from the existing intake in the early rainy season of the year. The designed volume of water release from the intake is to be 200 million m^3/y. This operation might cause water deficit for irrigation in downstream area and impacts on paddy fields in case of inappropriate water release operation. Therefore, it would spawn people's unrest or conflict.

5) Re-allocation of reservoir storage capacity

This is aimed at increasing the decreased effective storage by means of heightening the dam up to 2m. This measure might cause social controversy because it would require large area of land acquisition and possibly resettlement. Not only the social

controversy, but also a large scale of civil work would be needed, which may cause negative impacts on the local residents. Hence this would be the option to adopt in the future when the storage capacity of the reservoir decreased substantially.

(4) Watershed Conservation

This is aimed to mitigate soil erosion especially at 1) upland field, 2) upland field in settlement area and 3) settlement area, which are the main source areas of soil erosion, by means of terracing and planting. Technically, there will be no major negative impacts because no large scale structure will be constructed, and such activities as terracing and planning can be confined during non-farming period and accordingly impacts on farming activity is minimal. On the contrary, employment of local residents for terracing and planting works and therefore increase of income can be expected as a positive impact. In addition, there are many local people who have experienced terracing works in the World Bank Project during 1989-1994, which can mitigate the unrest and conflicts/opposition to this measure.

(5) No Action

If no countermeasure is done for ongoing sedimentation problems and watershed devastation in the upland area, the following situation would occur:

- Frequent stoppage of intake and power generation (on average, 20 times a year),
- Approximately 3.2 million m^3 of sedimentation deposits annually in the reservoir,
- Loss of effective storage will increase from 13.4% in 2005 to around 73% at 100 years later, and
- Decrease of dam safety during floods.

2.7.2 Description of Important Impacts

(1) Impacts of Land Acquisition

Table 2.7.2 shows the size and duration of civil works and its related activity such as necessity of land acquisition and stoppage of intake. Countermeasures for Sediment Inflow from Keduang River would require land acquisition for procurement of spoil bank for dredged / excavated material. Likewise, Countermeasures for Sediment Inflow from Other Tributaries would also require land acquisition except for the countermeasure: Sediment storage dam for sediment removal.

As for spoil bank area, there are several candidate sites at the east of Wonogiri (Refer to Chapter 6 for the details). Not all of the candidate sites for spoil bank are now owned by PBS, and therefore it is necessary to do land acquisition.

(2) Impacts during Construction Work

Table 2.7.2 also shows the size of civil works at construction stage or maintenance dredging. Keduang River sediment bypass requires the longest duration, i.e., 56 months to finish the construction work. Dredging or dry excavation need to do civil work every year. As for work volume, dry excavation is assumed to amount up to 2,000,000 m^3 in total. Keduang River sediment bypass, Sediment sluicing by new gates and Compartmented reservoir with new flushing gates would need 200,000m^3, 140,000m^3 and 140,000m^3 of excavation, respectively.

During construction works of Modification of the intake, Relocation of the intake, and Garbage trapping structure at intake, it is necessary to block water at the intake and to suspend power generation. Even during these construction works, water supply to

downstream will be continued through existing spillway by adjusting the construction work is carried out when the water level is higher than 127m, i.e., elevation of spillway.

(3) Impacts on Water Quality and Aquatic Organisms

The impacts of sediment flushing would cause significant negative impacts especially high contents of SS and low DO, which might cause fish killing which is observed in the case of coordinated sediment flushing of the Brantas river and other countries. In these cases, impacts were evaluated using the following index:

$SI = \log_e (SS \times T)$,

where, SI: Stress Index, SS: Suspended Solids (mg/l), and T: Duration in hours.

Dr. Sumi (2000), Kyoto University, Japan, pointed out that SI of 10 is a standard for water quality management for sediment flushing.

In the candidate project components, there are four components which might cause negative impacts on water quality and aquatic organisms in the downstream river listed below:

- Dredging and discharge of sediment deposits by Hydro-suction sediment removal system,
- Bypassing of flood water through Keduang River sediment bypass,
- Sluicing of flood water through sediment sluicing gates, and
- Flushing of flood water sediment flushing gates through compartmented reservoir.

The first component would drain the sediment deposits into the downstream river. However, the discharge volume and SS concentration is to be designed so that Stress Index (SI) will not exceed 10.

The second and the third ones will not include sediment flushing but sluicing of flood water. The SS contents would be almost the same condition as those of natural condition. Therefore, these three components would not cause serious impacts which cause fish killing in the downstream reach.

The fourth one includes the sediment flushing, which would cause the significant negative impacts unless any measure is taken. Accordingly, it is necessary to manage the water quality by gate control by means of limiting the time of flushing, duration of gate opening, etc.

(4) Impacts on Protected Area and Protected Species

There are six (6) protected areas located in kabupaten Wonogiri as shown in Figure 2.4.1. However, no impacts will be brought about to them because no physical modification is made to them.

Regarding protected species, there assumed to inhabit nine (9) protected species in the Wonogiri reservoir watershed. Habitat of these species is limited in upper mountainous area in the watershed according to the official of Forest Conservation Bureau, Central Java Province. The candidate project components will not threaten their habitat by structural measure or clearance of vegetation in upland area. Hence, there will be no impacts on protected species.

2.7.3 Evaluation of Conceivable Impacts

Conceivable impacts to be caused by the implementation of the candidate project components are evaluated using Impact Matrix. The magnitude of impacts is ranked in the following grades: negligible, minor, medium and significant.

Evaluation results are summarized in Table 2.7.3, and as follows:

- Countermeasures for Sediment Deposits and Garbage at Intake would not cause any significant negative impacts because the size/dimension of the civil works is not large except for Relocation of the intake. Civil works are confined within the reservoir area except for Garbage trapping structure at Keduang river.
- Size and dimension of civil works of Relocation of the intake is relatively big and includes civil work of tunneling, and accordingly the impact magnitude would be larger than other countermeasures for intake.
- Hydro-suction sediment removal system would discharge highly turbid water into the Bengawan Solo river, which might cause adverse impacts on fish.
- Countermeasures for Sediment Inflow from Keduang river and Other Tributaries would cause relatively big negative impacts than the others, because the size and dimension of civil works are large, especially of Keduang river sediment bypass, Sediment sluicing by new gates, Compartmented reservoir with new flushing gates, Dry excavation in reservoir and Re-allocation of reservoir storage capacity.
- The magnitude of adverse impacts would be medium or significant, including the following elements: waste, groundwater, water quality, air quality, noise and vibration, aquatic organisms, land acquisition and resettlement, and people's unrest and conflict / opposition.
- Community-based soil conservation for Watershed Conservation would cause limited negative impacts, but spawn several positive impacts, because it will not include large size of structural measure but all activities are aimed to contribute to conserve soil and improve agricultural conditions.
- No action will leave the existing undesirable phenomena of sedimentation problem as they are, including soil erosion, water quality deterioration in Wonogiri reservoir, and decrease of risk of dam during large floods.

2.7.4 Conclusion and Recommendations

Through IEE for candidate project components in the Master Plan, every conceivable environmental and social impacts were described and evaluated at pre-construction, construction and operation and maintenance stages. It was revealed that there would be several negative impacts whose magnitude is medium or significant as shown in Table 2.7.3. On the other hand, "no action" for existing sedimentation problems in Wonogiri reservoir would shorten the reservoir's lifetime faster than the original design and cause a lot of functional loss in the future, including frequent stoppage of intake and power generation, continuous sedimentation deposits in the reservoir, decrease of effective storage and dam safety.

All the candidate project components are evaluated from the environmental point of view, and the results are shown in Table 2.7.4. As a result of IEE, the following conclusion and recommendations were obtained:

- As for Countermeasures for Sediment Deposits and Garbage at Intake, Countermeasures other than Relocation of the intake are recommendable. Relocation of the intake is not recommendable because it will include relatively large scale of civil works, which may cause negative impacts with larger magnitude.
- As for Countermeasures for Sediment Inflow from Keduang River, Keduang river sediment bypass is not recommendable because it may cause adverse impacts with larger magnitude. Other two countermeasures, Sediment sluicing by new gates and Compartmented reservoir with new flushing gates would bring about relatively small impacts, and these are concluded environmentally fair.

- As for Countermeasures for Sediment Inflow from Other Tributaries, the three countermeasures, Sediment storage dam for sediment removal, Hydraulic dredging in reservoir and Managing of sediments within reservoir by water releasing from the intake, are recommendable. Re-allocation of reservoir storage capacity is not recommendable because it may cause social controversy.
- As for Countermeasures for Watershed Conservation, Community-based soil conservation is recommendable because it may spawn several positive impacts.

2.8 Environmental Management

2.8.1 Framework of Environmental Management

As described in the section "2.7 Identification of Conceivable Impacts," there would be un-negligible negative impacts. These negative impacts should be managed to mitigate when the Project is implemented. Among others, as for negative impacts whose magnitude is estimated to be medium or significant, anticipated negative impacts are required to be well minimized by mitigation measures and monitoring activities.

Mitigation measures are to be conducted through the following three approaches in Indonesia:

- Technical approach,
- Socio-economic approach, and
- Institutional approach.

Technical approach is the one to minimize the impacts by engineering and/or technology. Socio-economic approach is the one to mitigate the impacts by such actions as dissemination, consultation, and compensation, etc. Institutional approach is the one to mitigate the impacts in cooperation with government institutions by enforcement of environmental monitoring and evaluation of the impacts.

Table below shows the necessary mitigation measures and monitoring activities for negative impacts whose magnitude would be medium or significant.

Table 2.8.1 Framework of Environmental Management for Mitigation and Monitoring

Candidate project components	Impacts with medium / significant magnitude	Conceivable Mitigation Measures	Necessary Monitoring Item
Relocation of the intake	Noise and vibration during construction period	Consideration on transportation route not to use the roads near residential area and sensitive facilities such as school, clinic, etc.	Noise and vibration levels along the transportation road and in settlement area.
Keduang River sediment bypass	Generation of waste (excavated material)	Land acquisition with proper method and compensation for procurement of spoil bank area, Proper management for dumped material not to discharge to surrounding areas.	Condition of spoil bank, Complaint from local residents.
	Groundwater drawdown	Development of alternative water supply method, including a new well and development of PDAM system.	Groundwater level in wells.
	Noise and vibration during construction period	Consideration on transportation route not to use the roads near residential area and sensitive facilities such as school, clinic, etc.	Noise and vibration level along the transportation road and in settlement area.
	Impacts of highly turbid water on water quality and aquatic organisms	Dissemination and advance announcement of bypass sluicing, Gate control on timing and period of releasing flood water.	Water quality in Bengawan Solo river. Impacts on aquatic organisms (fish)
	People's unrest and conflict/opposition	Dissemination of necessity of bypass channel, including possible impacts and benefits. Compensation for inconvenience of daily life.	Comments and complaint from local residents
Sediment sluicing by new gates, and Compartmented reservoir with new flushing gates	Generation of waste (excavated material)	Same as the case of Sediment bypass channel.	Condition of spoil bank, Complaint from local residents.
	Impacts of highly turbid water on water quality and aquatic organisms	Same as the case of Sediment bypass channel.	Water quality in Bengawan Solo river, Impacts on aquatic organisms (fish)
Hydraulic dredging in reservoir	Generation of waste (excavated material)	Same as the case of Sediment bypass channel.	Condition of spoil bank, Complaint from local residents.
Dry excavation in reservoir	Generation of waste (excavated material)	Same as the case of Sediment bypass channel.	Condition of spoil bank, Complaint from local residents.
	Air quality (dust and emission gas)	Dissemination and advance announcement of the schedule of excavation work.	Complaint from local residents.
	Noise and vibration during construction period	Same as the case of Sediment bypass channel.	Noise and vibration level along the transportation road and in settlement area.
Re-allocation of reservoir storage capacity	Land acquisition and social problem	Dissemination of necessity of the Project.	Complaint from local residents.

Source: JICA Study Team

2.8.2 Competent Authority

In case that the project/proposed activity is confined within a single kabupaten or kota, the environmental agency of respective kabupaten or kota becomes a competent authority. In the case that the project/proposed activity spreads over plural kabupaten and/or kota,

the environmental agency of respective province, in which the project site is located, becomes a competent authority.

Since the project activity including its affected area spreads over the two or more kabupaten / kota, taking the impact area into consideration, Bappedal, or Environmental Management Agency of Central Java Province is to be the competent authority.

2.8.3 Environmental Management Procedure

JICA Study Team proposes the environmental management procedure illustrated on Figure 2.8.1. The project proponent, PU/PBS, is to disseminate the environmental aspect of the project, including the Environmental Management Plan and Monitoring Plan, prior to the commencement of the construction work.

During construction and operation and maintenance stages, the project implementer is to execute the necessary environmental mitigation measures as well as environmental monitoring activities. The results of the monitoring are to be reported to the competent authority, Bappedal, Central Java Province. The monitoring results are also to be disseminated to the stakeholders, including local residents, NGOs, relevant government agencies and so forth. Through the dissemination, stakeholders are expected to raise their questions, opinions and/or requests to the project implementer for mitigation of environmental and social impacts.

2.9 Information Disclosure

2.9.1 Disclosure of Drafts of Scoping

The drafts of scoping for environmental and social considerations study for the Project were written in both English and Indonesian, and were disclosed at the beginning of the Study at the government offices of the following province, kota and kabupaten:

- Central Java Province,
- Kab. Wonogiri,
- Kab. Sukoharjo,
- Kota Surakarta,
- Kab. Klaten,
- Kab. Karanganyar, and
- Kab. Sragen.

2.9.2 Disclosure of Study Results

The results of environmental and social considerations studies were disclosed to stakeholders three times during Master Plan Study: 1) at 1st Workshop in December, 2004 on the draft scoping for environmental and social considerations study, 2) at 2nd Workshop in September, 2005 on the progress of IEE Study focusing on social survey, and 3) at the 3rd Workshop in February 2006 on the result of IEE Study. The following are the summary of comments form stakeholders. All the comments are to be basically reflected to the study activities.

(1) Summary of the First Workshop

- Date: December 28, 2004.
- Venue: Novotel Hotel, Surakarta.
- Attendants: Government Officials (Central Government and Local Government), Researchers of Universities, Representatives of Project Proponents, Water Users Association (P3A), NGOs, Steering Committee members, JICA Advisory committee members, JICA experts and officials, and JICA Study team members.

- Nos. of Participants: 124 persons.
- Purposes:
  1) To introduce the schedule and outline of the JICA Study to all the stakeholders concerned,
  2) To present current progress and preliminary results of the Study,
  3) To introduce the countermeasures for reservoir sedimentation in Japan, and
  4) To exchange opinions and obtain comments from the stakeholders to reflect further study content and master planning.
- Presentation Topics:

No.	Program	Presenter
(1)	Outline of the JICA Study	Mr. Widiharjo, Subsection Chief of Planning, PBS
(2)	Fact findings related to Reservoir Sedimentation	Ir. Tri Rohadi, Mnager for Planning, PBS
(3)	Fact findings related to Watershed Management	Mr. Agus P. Saido, GIS Expert, JICA Study Team
(4)	Draft Scoping for Environmental and Social Considerations	Mr. Maulana. SK, Environmentalist, JICA Study Team
(5)	Clarification and Discussion	Dr. Fatkhan Nurrohman, Gajah Mada University
(6)	Reservoir Sedimentation and Sediment Countermeasures in Japan	Mr. Josuke Kashiwai, Chairman of Advisory Committee of JICA

Main Comments, related to environmental and social issues, raised in the Workshop:

- Most of candidate countermeasures for sedimentation issues in the reservoir only focus on a physical point of view. The main problem causing the soil erosion is attributed to not only natural phenomena but also human activities. Accordingly, this study has to orient more to social, cultural and economic aspects.
- The study does not cover groundwater that might be related to the existing watershed damages. It is necessary to know that the quantity/quality of groundwater around the reservoir, and whether the groundwater is influenced by the watershed damages or not.
- Alternatives of flushing sediment from the reservoir should be examined accurately. In addition, the urgent countermeasure of dredging needs to be re-assessed because the volume of dredging is lower than that of reservoir sedimentation.
- Environmental impact assessment (EIA level) should be carried out at the same time of detailed design.
- The study should analyze the socio-economic impact associated with the change of the people's tradition in cultivation. It would be important to give solutions if the tradition is concluded as "wrong" practices and dangerous to erosion.
- This study should present more clearly an action plan. Implementation must be followed according to the action plan.
- The countermeasure for sedimentation problem is much related to water balance, hence, the water balance needs to be analyzed.
- The study should present the utilization of the dredged sediment for other economic purposes.

(2) Summary of the Second Workshop

- Date: September 8, 2005.
- Venue: Novotel Hotel, Surakarta.
- Attendants: Government Officials (Central Government and Local Government), Researchers of Universities, Representatives of Project Proponents, Water Users Association (P3A), NGOs, Farmers Group in upland areas of Wonogiri watershed, Steering Committee members, JICA Advisory committee members, JICA experts and

officials, and JICA Study team members.

- Nos. of Participants: approximately 100 persons.
- Purposes:
  1) To explain the progress of the JICA Study,
  2) To share current situation and issues on Wonogiri reservoir sedimentation and watershed condition,
  3) To share the lesson learned through past experience on watershed management by World Bank Project, and
  4) To exchange opinions and obtain comments from the stakeholders to reflect further study content and master planning.
- Presentation Topics:

No.	Program	Presenter
(1)	Introduction: i) Current Issues on Wonogiri Multipurpose Dam Sedimentation ii) Real Situation of Wonogiri Dam Watershed iii) Past Watershed Management - IBRD Project iv) On-going Watershed Management Activities - Gerhan Project (APBN) - Local Government (APBD) - Bottom-up with Community Empowerment Approach for Greening of Wonogiri Greenbelt	 JICA Study Team/IPK PWS BS JICA Study Team/IPK PWS BS JICA Study Team/IPK PWS BS and Dinas LHKP Kabupaten Wonogiri Kabupaten Wonogiri Kabupaten Wonogiri Ir. Sutioso Budirahardjo, Dipl. HE, Director of PJT 1 Bengawan Solo
(2)	Basic Concept on Sediment Management Master Plan	JICA Study Team/IPK PWS BS
(3)	On-going Socio-Economic Survey of IEE Study in the Wonogiri Dam Watershed	Ir. Endang Siti Rahayu, MS (UNS)
(4)	On-going Survey on Village Assessment and Village Action Plan	NGO - Persepsi
(5)	Research on Sedimentation Issues and Countermeasures in some Reservoirs in Central Java and DIY	Prof. Dr. Djoko Legono, Gajah Mada University (Jurusan Teknik Sipil)
(6)	Actualization of National Movement on Water Preservation	Ir. Kusnaeni, Dipl.HE – Water Preservation Partnership Network

Main Comments, related to environmental and social issues, raised in the Workshop:

- Director General of Water Resources, Ministry of Public Works, pointed out in his keynote speech that the new Law No. 7 / 2004, concerning Water Resources, which stipulates a balance among conservation, utilization and water induced disaster management aspects whereas the old version (Law No. 11/1974) had emphasized only on the aspect of water usage. He stressed that the problem of water is not only a matter of one institution for countermeasure but also involving all of stakeholders concerned based on a partnership.
- It is good for farmers in the upland area to be invited to this workshop today. Management of sedimentation problem is basically a management of human behavior, so its countermeasure should be more emphasized on the empowerment of farmers in the upland area than technical approaches.
- One of the causes of problem is poverty of farmers and constraints such as limited access to information and capital. Equity in development in the upstream and downstream areas is still unbalanced.
- It can be identified that the poverty would be an important factor in the cycle of causes of soil erosion. So the poverty alleviation is a part of disconnection of the cycle of the erosion problem causing sedimentation problem in Wonogiri reservoir.
- Result of social survey anticipated an apprehensive condition in the future that all the

young pupils and students do not want to live in villages. Young workers prefer to off-farm jobs since there is no incentive in agricultural fields.

- The main problem of Wonogiri is poverty which is causing that i) ignorance of the impact of illegal logging, ii) farming in greenbelt, and iii) building structures in greenbelt. It is, therefore, required to do socialization about conservation, urgency, impact and stipulate "Perda," i.e., local government regulation, about environmental conservation of Wonogiri.

(3) Summary of the Third Workshop

- Date: February 14, 2006.
- Venue: Quality Hotel, Surakarta.
- Attendants: Government Officials (Central Government and Local Government), Researchers of Universities, Representatives of Project Proponents, Water Users Association (P3A), Farmers Group and Forum, NGOs, Steering Committee members, JICA Advisory committee members, JICA experts and officials, and JICA Study team members.
- Nos. of Participants: approximately 100 persons.
- Purposes:
  1) To explain the progress of the JICA Study,
  2) To explain and discuss the basic strategies for master planning on Wonogiri reservoir sediment management system,
  3) To explain and discuss the basic strategies for master planning on Wonogiri watershed conservation and management, and
  4) To exchange opinions and obtain comments from the stakeholders to reflect further study content and master planning.
- Presentation Topics:

No.	Program	Presenter
(1)	Basic Strategy for Wonogiri Reservoir Sediment Management Master Plan	Mr. Minoru Ouchi, Team Leader of JICA Study Team
(2)	Erosion Sources and Sediment Yield from Wonogiri Watershed	Mr. Kenjiro Onaka, Co-Team Leader/Watershed Management/Soil Erosion Expert, presented by Mr. Agus Saido
(3)	Basic Strategy for Wonogiri Watershed Conservation and Management Master Plan	Mr. Tadahiro Fukuda, Sediment Hydraulic Expert
(4)	Village Assessment and Village Action Plan	Mr. Tetsunari Gejo, Expert of Social Investigation/Community Empowerment
(5)	Initial Environmental Examination (IEE)	Mr. Eko Budi Santosa, University of Sebelas Maret Surakarta, Ph.D
(6)	Organizational Setup for and Beneficiaries' Funding Assistance to Watershed Conservation	Mr. John Chettoe, Expert of Institution/Laws and Regulation

Main Comments, related to environmental and social issues, raised in the Workshop:

- The proposed strategy for Master Plan (M/P) was good enough; however, it has not presented an action plan of the M/P considering the custom of the people in upstream yet.
- Regarding the sediment flushing to the downstream; how is the proposed bypass channel from Keduang operated? How many percentages are flowing into the river downstream? How much sediment is entering into the reservoir? How is the impact of flushing sediment to Colo weir downstream?
- Identification of important impact shall be in quantitatively rather than qualitatively by presenting potential losses and its benefit. It is for determining the priority of

handling

- Countermeasure for sediment yield from watershed is related to conservation; the main focus is economic, social and cultural approaches in order to implement satisfactorily the conservation activity by stakeholders concerned.
- The government of Wonogiri should pay great attention to the function of the Wonogiri reservoir. The forestry section should be involved in its comprehensive countermeasures.
- The further study is required in order to solve problem of sediment deposit in front of intake caused by the Keduang river. The intake problem should be tackled in the short term plan, as well as the watershed should be conserved in the long term plan.
- GNKPA (National Movement of the Partnership for Water Preservation) should be integrated explicitly in the study and its master plan. And it is preferable that the scenario of the study and its master plan preparation should be in the direction of GNKPA.

CHAPTER 3 ENVIRONMENTAL IMPACT ASSESSMENT

3.1 Purpose of Environmental Impact Assessment (EIA)

The main purposes of EIA Study are:

i) To grasp the current environmental conditions in detail in and around the anticipated impact affected areas due to the priority project components,
ii) To predict and evaluate environmental and social impacts to be caused by the implementation of the priority project components, and the study results will be incorporated (feedback) into the Feasibility Study,
iii) To disclose the anticipated impacts as the results of EIA Study to stakeholders to understand the impacts as well as the benefits of the Project, and the opinions of stakeholders will be incorporated into the Feasibility Study, and
iv) To establish environmental management plan and monitoring plan to mitigate the anticipated negative impacts and thus to make the Project sustainable.

This EIA Study is not exactly identical with, or does not follow the procedures required for AMDAL in Indonesia. However, the methodology and scope of this EIA Study is basically the same as those of AMDAL system, and therefore the study results can be utilized for preparation of AMDAL documents at the project implementation.

3.2 Scope of Work

3.2.1 Scope of Study

This Environmental Impact Assessment (EIA) studies the environmental and social impacts to be caused by the implementation of the priority project components in the Feasibility Study.

The study is to cover data collection on existing environment, project description of priority projects, impact prediction, evaluation of impact, and formulation of environmental management plan and monitoring plan.

A range of environmental components to be studied covers physical, chemical, natural (ecological) components of environment as well as socio-economic, cultural and public health components. The phases of impact assessment cover the stage from preparation until operation and maintenance of the Project.

3.2.2 Target Project Components

This Environmental Impact Assessment (EIA) was made targeting for the project components listed in the table below:

Table 3.2.1 Target Project Components for Environmental Impact Assessment

Objective	Proposed Project Components for EIA
Sediment Storage Reservoir with New Gates	To pass through and flush out the inflow of sediment deposits and garbage from the Keduang river
Watershed Management in Keduang river catchment	To mitigate sediment yield in the catchment and thereby reduce sediment inflow into Wonogiri reservoir
Periodic Maintenance Dredging at Intake	To avoid blocking at the intake due to sediment deposits and garbage

Source: JICA Study Team

3.2.3 Scope of Environment to be Studied

Environmental Impact Assessment will cover the following scope of environment:

Table 3.2.2 Scope of Environment to be Studied in EIA

Category	Environmental Elements
Physical environment	1. Topography and geology
	2. Soil erosion
	3. Waste (dredged/excavated material / garbage)
	4. Groundwater (well water use)
	5. Water quality of Bengawan Solo river
	6. Water quality of Wonogiri reservoir
	7. Air quality (emission gas and dust)
	8. Noise and vibration
Biological environment	1. Terrestrial flora and fauna
	2. Aquatic organisms
	3. Protected species and areas
Socio-economic environment	1. Land acquisition and resettlement
	2. People's unrest and conflict/opposition
	3. Change of income/livelihood
	4. Impacts on economic activities in downstream reaches (agriculture, fishery, forestry, inland navigation, water use, etc.)
	5. Impacts on local traffic and transportation
Other	Impacts on the following components: Social culture and custom, public health, historical and cultural heritage, and other, if any.

Source: JICA Study Team

3.2.4 Study Area

Basically, the Study Area covers i) the entire catchment of the Wonogiri Dam (reservoir area of 90 km^2 and remaining catchment area of 1,260 km^2), and ii) downstream reaches of the Bengawan Solo River from the Wonogiri Dam to the confluence with the Madiun River.

The study is to focus on the area of Keduang river basin for the Project components: Sediment Storage Reservoir with New Gate. The study area for impacts on downstream reaches does not automatically cover until the confluence point with the Madiun river, but depends on the impact affected area of relevant environmental elements.

3.3 Methodology

Methodology of data collection on existing environment and impact prediction is shown in the table below:

Table 3.3.1 Methodology of Environmental Impact Prediction

a) Physical Environment

Environmental Elements	Data collection	Impacts to be predicted	Methodology of impact prediction
Groundwater	Groundwater level and well water use near the deep excavation site.	Possibility of drawdown of groundwater level and inconvenience of well water use.	Comparison of elevations of groundwater level and excavation level.
Water quality of Bengawan Solo river	Analysis of current water quality (SS) during floods based on the existing measurement results.	Changes of SS due to sediment sluicing and discharge of flood water through new gate,	Prediction using a mathematical model.
Air quality	Measurement of ambient air quality near the proposed project site and analogous case.	Change of air quality (dust, emission gas)	Prediction based on analogous case.
Noise and vibration	Measurement of ambient noise and vibration near the proposed project site and	Change of ambient noise and vibration levels at nearby residential area.	Prediction based on analogous case as well as that using a

	analogous case.		mathematical model.

b) Natural Environment

Environmental Elements	Data collection	Impacts to be predicted	Methodology of impact prediction
Terrestrial flora and fauna	Inventory in and around the proposed project sites.	The impacts on flora and fauna focusing on population, community, and biodiversity.	Analogical description based on area of vegetation clearance.
Aquatic organisms	Characteristics of plankton, macro-benthos and fish in the Bengawan Solo river, especially on life history, including food, spawning ground and tolerance of turbidity.	Possibility of injury and/or dearth of fish in the Bengawan Solo river during sediment sluicing.	Analogical prediction based on characteristics of fish, referring to the analysis using Stress Index (SI)
Protected species	Confirmation of habitat of protected species designated by Government Regulation No.7/1999 of Indonesia.	The impacts on protected species focusing on possibility of habitat disturbance.	Description based on habitat of protected species comparing with proposed project sites.

c) Socio-economic Environment

Environmental Elements	Data collection	Impacts to be predicted	Methodology of impact prediction
Land acquisition and resettlement	Land ownership and land use of the proposed project facilities and spoil bank area.	Possibility of land acquisition and resettlement as well as its magnitude.	Description based on land ownership of the area required for the Project facility and spoil bank
People's unrest and conflict / opposition	Survey on socio-culture, custom and perception on the Project.	Possibility of social unrest and conflict/opposition.	Analogical prediction based on culture, custom, perception on the Project.
Change of income/livelihood	Survey on income and livelihood conditions of local people near the Project site.	Possibility of livelihood change.	Analogical prediction based on current condition on income and livelihood.
Impacts on economic activities of downstream area (inland navigation, water use)	Survey on economic activities and water use in the downstream reaches of Bengawan Solo river.	Possibility of impacts on sand mining, inland navigation, fishery and water use.	Analogical prediction based on current situations of economic activities and description of project activity (sediment sluicing).
Impacts on local traffic and transportation	Survey on existing road near the Project site.	Volume of excavation, transportation route of excavated material to the spoil bank, and possible inconvenience during transportation.	Analogical prediction based on current condition of traffic and transportation and size of transportation required in the Project.
Social culture and historical heritage	Traditional custom and historical heritage along the Bengawan Solo river.	Possibility of impact due to project activity (sediment sluicing).	Analogical prediction based on description of project activity (sediment sluicing).

Source: JICA Study Team

Regarding scope of environmental impact assessment, the items listed below were exempted because of the following reasons:

Table 3.3.2 Reason for Exemption from Environmental Impact Assessment

Environmental Elements	Reason for exemption from impact assessment
Topography and geology	No structural measure is proposed to construct in or around the sites with geologically weak or soft ground. There is no important topography or geology in scientific viewpoint.
Soil erosion	Positive effect and benefit of watershed management, specifically by terracing in upland field are discussed in supporting report "Annex No.9: Watershed Conservation and Management."
Waste	Possibility of soil contamination due to disposal of dredged and/ or excavated materials is minor as discussed in Chapter 2: Initial Environmental Examination (IEE).
Water quality of Wonogiri reservoir	Change of water quality if Wonogiri reservoir to be caused by proposed project component, namely sediment sluicing through the new gate, is described in supporting report "Annex No. 3: Reservoir Sedimentation Analysis."
Protected areas	There will be no impact on protected areas as discussed in Chapter 2: Initial Environmental Examination (IEE).

Source: JICA Study Team

Impact evaluation was made based on the impact magnitude and importance in the following points of view:

1) People subject to impact,
2) Spatial extent of area subject to impact,
3) Intensity and duration of impact,
4) Number of other environmental components subject to impact,
5) Characteristics of cumulative impact, and
6) Reversibility or irreversibility of impact.

The judgment of significant and important impact is to be made based on the results of impact evaluation.

Environmental management for mitigation of negative impacts are to be studied based on the following approaches:

1) Technical Approach,
2) Socio-economic Approach, and
3) Institutional Approach.

3.4 Project Description

3.4.1 Target Project Components for EIA Study

The targeted project components are the priority activities adopted as urgent countermeasures in the Master Plan. As listed in Table 3.2.1, the priority project components are:

a. Sediment Storage Reservoir with New Gates, to pass through and flush out the inflow of sediment deposits and garbage from the Keduang River,

b. Watershed Management in Keduang river catchment, to mitigate sediment yield in the catchment and thereby reduce sediment inflow into the reservoir, and

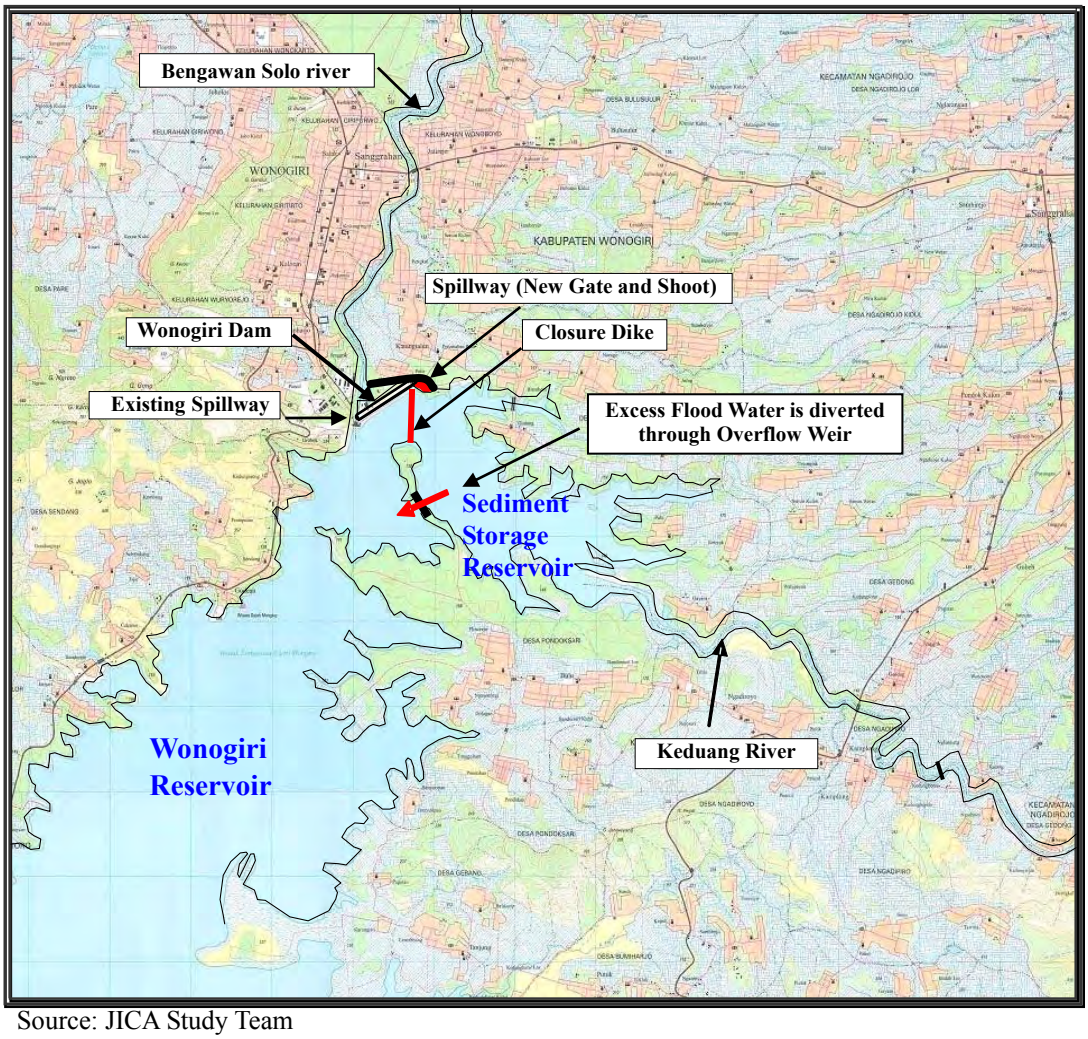
c. Periodic Maintenance Dredging at Intake, to avoid blocking at the intake due to sediment deposits and garbage.

Table 3.4.1 briefs the outline of the project components and Figure 3.4.1 (1) and (2) show their locations.

Table 3.4.1 Outline of Project Components

Components	Structure / Works	Dimension / Details
a. Sediment storage reservoir	Spillway	Shoot (Channel): L=720m, B=15m, Gate: Two units of radial gate, B=7.5m, H=7.5m.
	Closure dike	Embankment (earthfill): L=650m, H=12m (max.), and B=10m (crown).
	Overflow weir	Weir: L=250m, B=6m (crown), crest level=136m, Access road: approx. L=1,000m, B=10m.
b. Watershed management in Keduang river basin	Selected villages	82 villages with the area of more than 100ha and/or with the soil loss rate of more than 50 tons/ha/year.
	Target area and earth work volume (cutting and filling) of terracing	Approximately 11,000 ha, 6 million m^3. Soil conservation by physical measures (terrace improvement/formation, side ditches) and vegetative measure (planting at terrace lips, riser, etc.).
	Promotion of agro-forestry	Mixture of tree crops and trees, medical crops depending on slope of target area.
	Supporting program	Empowerment of beneficiary farmers and farmer groups, support programs for operation/ implementation of conservation measure.
c. Periodic maintenance dredging at intake	Procurement of equipment	Cutter-suction dredger: 600PS, one (1) unit.
	Periodic dredging	Dredging operation

Source: JICA Study Team



Source: JICA Study Team

Figure 3.4.1 (1) Location Map of Project Components (Structural Measures)

3.4.2 Sediment Storage Reservoir

Sediment storage reservoir is composed of (1) Spillway, (2) Closure dike and (3) Overflow weir. It is aimed at sluicing / flushing highly turbid water from the Keduang river during rainy season into the Bengawan Solo river.

(1) Spillway

Spillway, consisting of gate and shoot (channel), is located at right bank side of existing dam. It goes through the north side of the dam and reaches to the Bengawan Solo river at immediate downstream of the dam. The maximum design discharge from the gate is $400m^3/s$, which is the same as the maximum discharge rate of downstream river reach.

(2) Closure dike

Closure dike is aimed to compartment the sediment storage reservoir from the main reservoir (Wonogiri reservoir) by constructing dike to connect the new gate and a peninsula protruding into the main reservoir.

(3) Overflow weir

Overflow weir is aimed to discharge water from sediment storage reservoir to the main reservoir. It is located at the south of closure dike. The elevation of crest level is 136 m, which is equal to the high water level of Wonogiri reservoir. It is also equipped with a conduit to drain water from the sediment storage reservoir into the main reservoir when the water level of main reservoir is lower than 136, if necessary.

3.4.3 Watershed Conservation in Keduang River Basin

Watershed management is composed of (1) formation and improvement of terrace and side ditches, (2) promotion of agro-forestry and medical crops, and (3) supporting programs in the Keduang river basin. These components are aimed at conservation of soil and water in order to minimize erosion rate over the basin and to alleviate sedimentation in the Wonogiri reservoir.

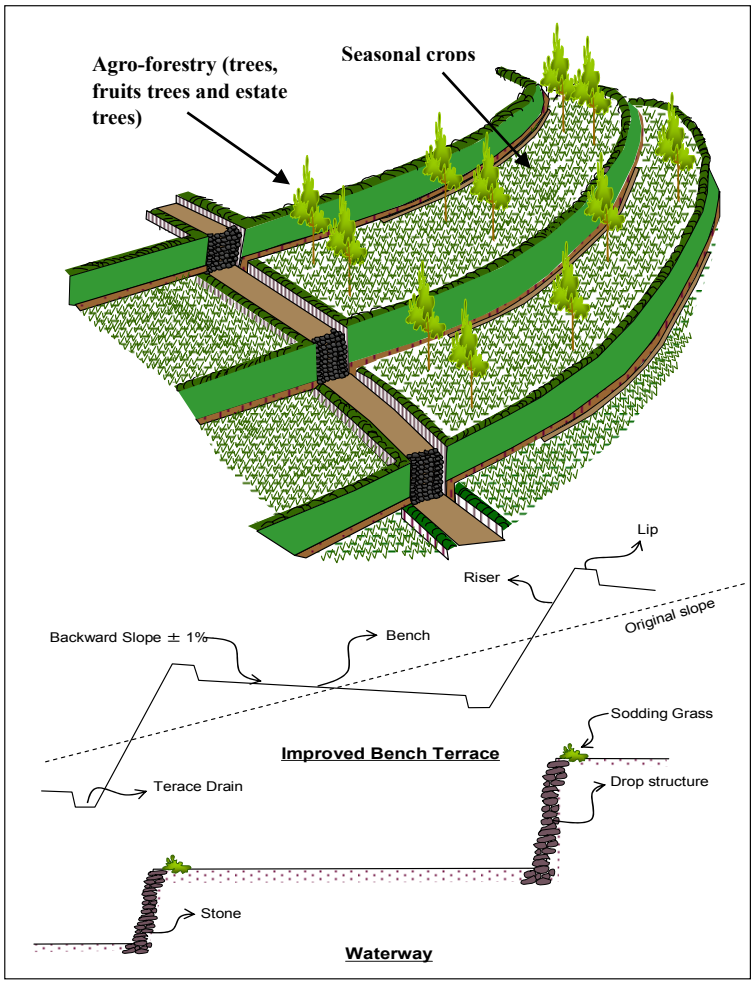
Figure 3.4.2 shows the schematic picture of bench terrace to be formed in the Project. The targeted areas for this activity include (1) upland field (4,637 ha), (2) upland field in settlement area (5,083 ha), and settlement area (1,396 ha). Necessary earth work volume (cutting and filling) for terracing is planned to be 6,231,000 m^3 in total. The area of planting at riser is planned to be approximately 4,600 ha.

3.4.4 Periodic Maintenance Dredging

Periodic Maintenance Dredging is aimed at removing sediment deposits around existing intake point by cutter-suction dredger. This method is reliable but requires a large area of spoil bank area for disposal of dredged material. Location of spoil bank is proposed at the dead space in the premise of Wonogiri reservoir area.

3.4.5 Implementation Schedule of the Project

Table 3.4.2 shows the implementation schedule of the Project activities.



Source: JICA Study Team

Figure 3.4.2 Schematic Picture of Improved Bench Terrace

Table 3.4.2 Implementation Schedule of Project Activities

Work item \ Year	1	2	3	4	5	6	7
(1) Sediment storage reservoir							
1) Preparation (D/D, Tender, etc.)							
2) Construction							
a. Mobilization							
b. Spillway							
c. Closure dike							
d. Overflow weir							
e. Dimobilization							
(2) Watershed management							
(3) Periodic maintenance dredging							
a. Procurement							
b. Dredging operation							

Source: JICA Study Team

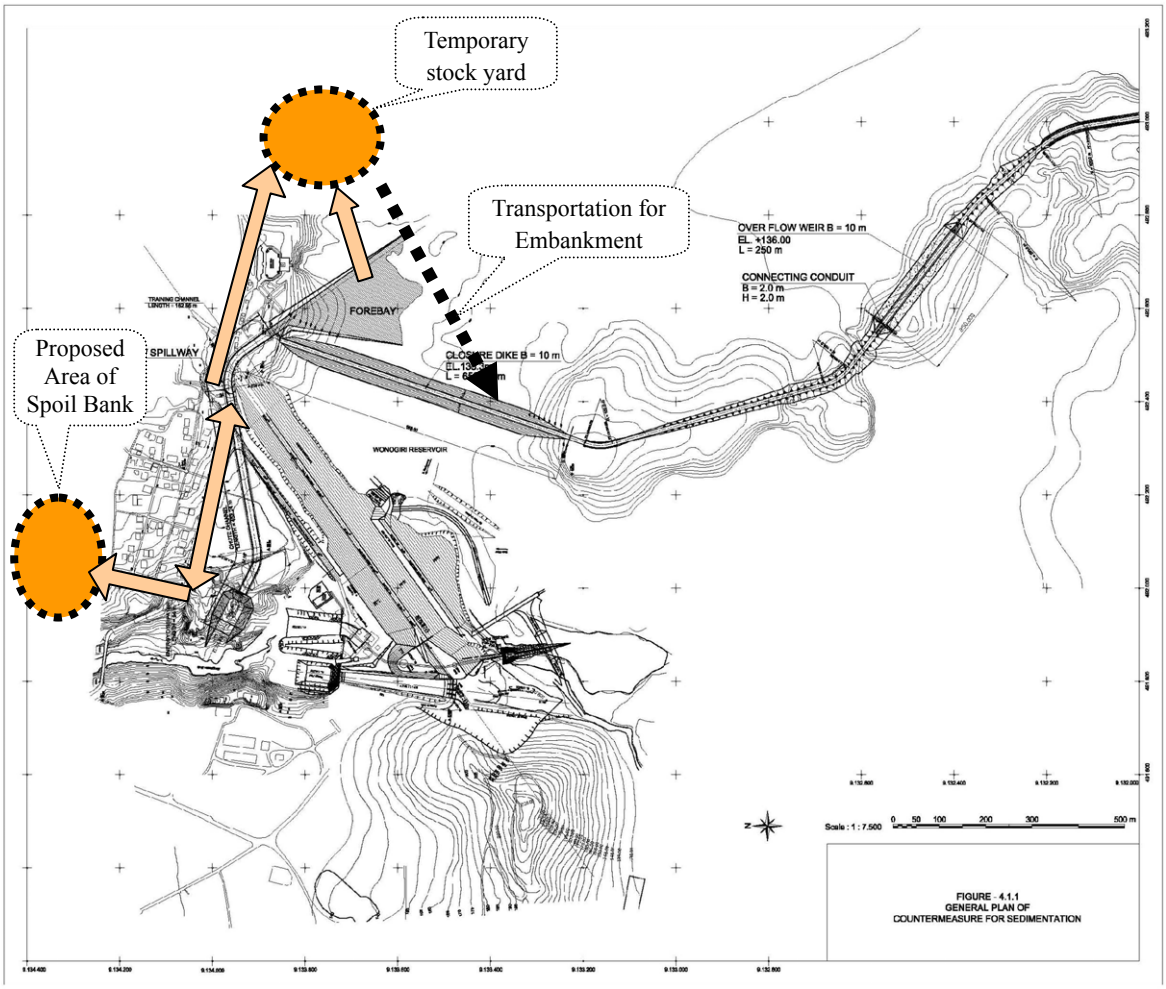
3.4.6 Size of Construction Works

Table 3.4.3 shows the volume of construction works.

Table 3.4.3 Volume of Construction Works of the Project

Component	Works	Volume	Related Figures
Spillway	Excavation of soil	370,000 m^3	
	Dumping to spoil bank	156,000 m^3	Refer to Figure 3.4.3
	Excavated materials to be used for embankment of closure dike (after temporarily stocking at the dead space in the premise of Wonogiri reservoir area).	168,000 m^3	ditto
	Concrete work	35,000 m^3	
	Backfilling to surrounding area of spillway	46,000 m^3	
	Excavation for forebay	183,000 m^3	Refer to Figure 3.4.3
Closure dike	Transportation and embankment of temporarily stocked materials	168,000 m^3	ditto
Overflow weir	Excavation and embankment	30,000m^3	
	Concrete work	11,000 m^3	

Source: JICA Study Team



Source: JICA Study Team

Figure 3.4.3 Location of Spoil Bank, Temporary Stock Yard and Transportation Route

3.4.7 Operation of Sediment Storage Reservoir

Operation rule of water level in the sediment storage reservoir is to be fixed through repeated trial and monitoring for inspection of effectiveness of sediment sluicing, environmental impact, etc. Table below shows the operation rule tentatively set up in this Study. Meanwhile, water level of the main reservoir is to be kept in existing condition so as not to waste water.

Table 3.4.4 Tentative Operation Rule of Sediment Storage Reservoir

Period	New gate	Water storage and sediment sluicing	Water level
Rainy Season			
1) Beginning of rainy season	Closed	Highly turbid water from Keduang river flows into sediment storage reservoir.	Water level goes up to 136 m and freely overflow to the main reservoir.
2) Mid rainy season until the date of April 15th	Open	Highly turbid water from Keduang river basin is drained through New Gate.	Basically lower than 136 m.
Dry Season			
From April 15th to end of dry season	Closed	Water from Keduang river basin is drained through a conduit into the main reservoir depending on the water level.	Water level in sediment storage reservoir is to be same as that in the main reservoir.

Source: JICA Study Team

3.4.8 Impact Factors

Impact factors, i.e., impact producing activity included in the project components, are listed in Table 3.4.5. The table also briefs the conceivable impacts dividing into those at Pre-construction, Construction and Operation and Maintenance Periods.

Among the three project components, sediment storage reservoir is assumed to include relatively many types of impact factors and conceivable impacts. In this EIA Study, the field survey was conducted taking the likely impacts listed in Table 3.4.5 into account in terms of selecting survey location, targeted village and economic activity, etc. The following section (Section 3.5 Existing Environment) describes the survey result on existing environment.

3.5 Existing Environment

3.5.1 Physical Environment

(1) Groundwater

1) Purpose

Groundwater survey was conducted aiming to investigate current condition of groundwater near the Project site and obtain benchmark data for impact assessment.

2) Methodology

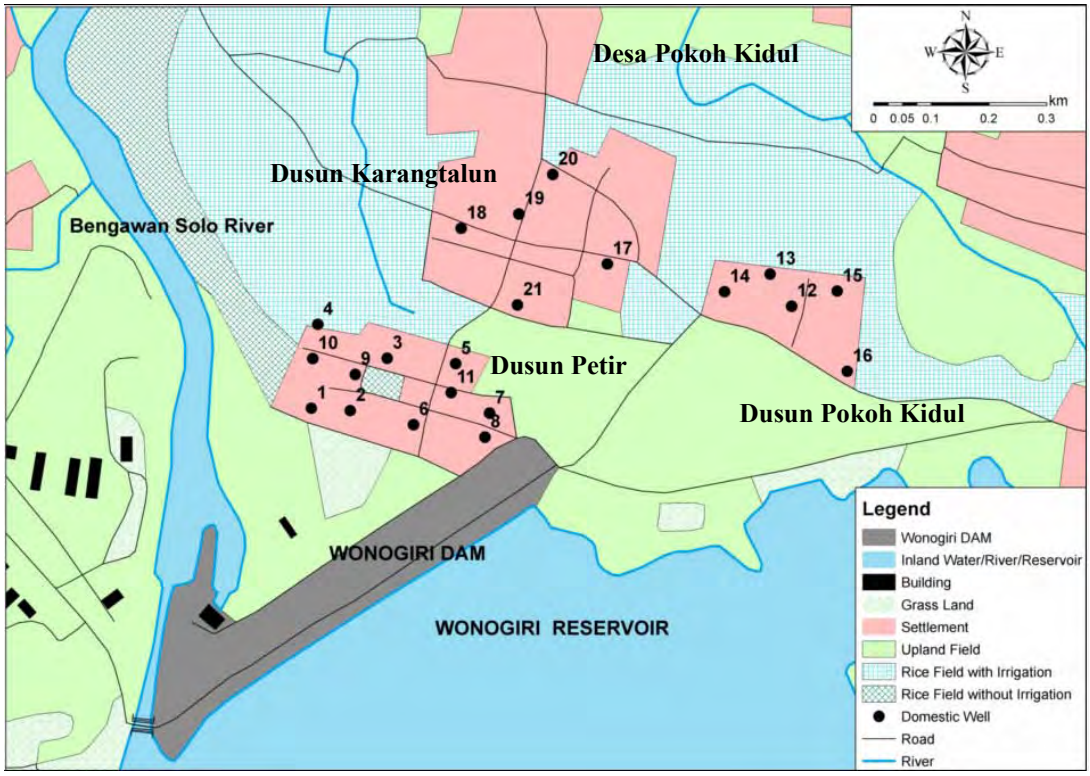
The current condition of groundwater was surveyed by inventory of existing water well according to the following method:

Date of inventory: 1) September 26th – 27th (dry season) and 2) December 12th(beginning of rainy season), 2006.

Targeted area: Dusun Petir and Karangtalun and Pokoh Kidul in Desa Pokoh Kidul (Refer to Figure 3.5.1).

Measured parameters: groundwater level, ground elevation, well bottom, water use, etc.

Method of inventory: measurement was carried out using water level meter and interview survey with well owners. Ground elevation was measured based on benchmark used for geological survey of this JICA Study.



Source: JICA Study Team

Figure 3.5.1 Location of Surveyed Wells around the Project Site

3) Results

Measurement result of current conditions of groundwater at each well is listed in Table 3.5.1, and Table 3.5.2 summarizes the survey results of groundwater. Figure 3.5.2 shows the groundwater flow direction estimated based on the groundwater elevation and geomorphology.

Survey results of groundwater detected the following conditions:

- In Dusun Petir, Pokoh and Karangtalun, which are the nearest settlement area of the structural measures of the Project, well water is used for domestic use (cooking, drinking and bathing), plant watering and livestock husbandry.
- However, PDAM, or municipality water supply system is also established in this area.
- The average groundwater depths of the three settlement areas: Dusun Petir, Pokoh and Karangtalun, are 8.81m, 7.23m and 9.49m, respectively in September, 2006, and 9.97m, 9.24m and 10.12m, respectively in December, 2006.
- The average groundwater elevations of the three settlement areas: Dusun Petir, Pokoh and Karangtalun, are 126.57m, 133.71m and 130.90m, respectively in September, 2006, and 125.40m, 131.70m and 130.27m, respectively in December, 2006.
- Water level drew down from September to December as a whole, because of little rain during the period, and the water depth of groundwater in each well

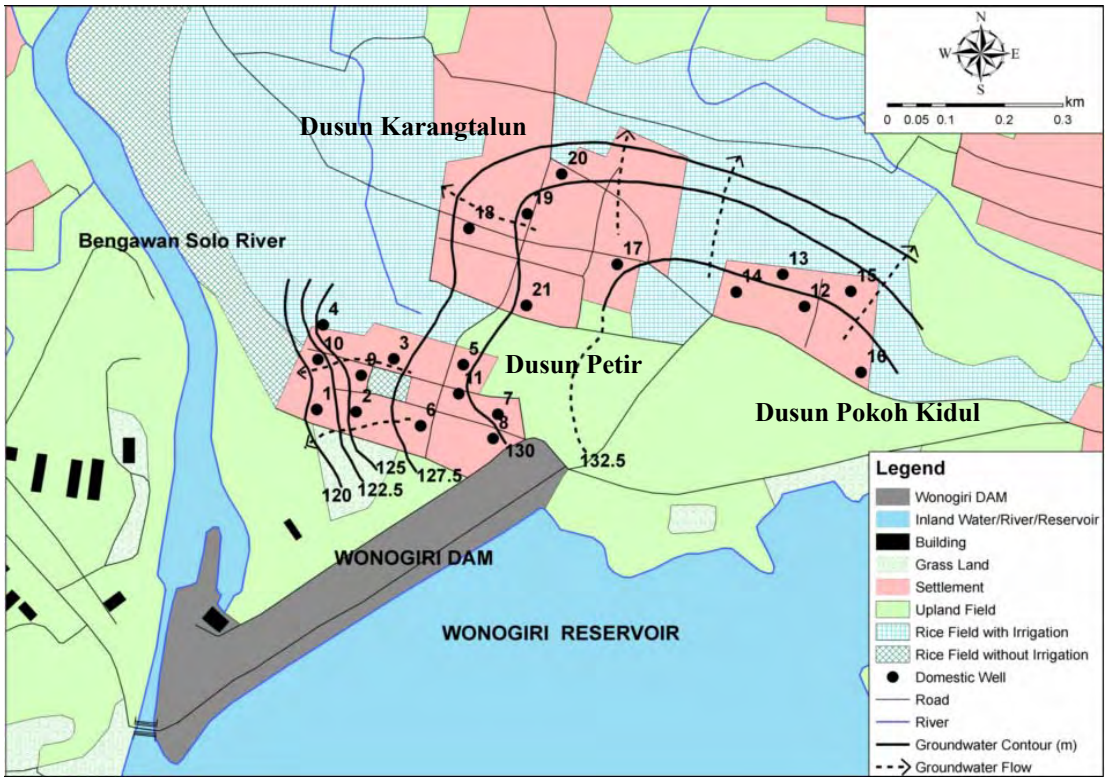
decreased.

- Groundwater flow direction in Dusun Petir is from the east to west while in Dsun Pokoh Kidul and Karangtalun, it is from the south to north reflecting the existence of water body in the Wonogiri reservoir and the geomorphology.

Table 3.5.2 Summary of Groundwater Survey at Domestic Wells

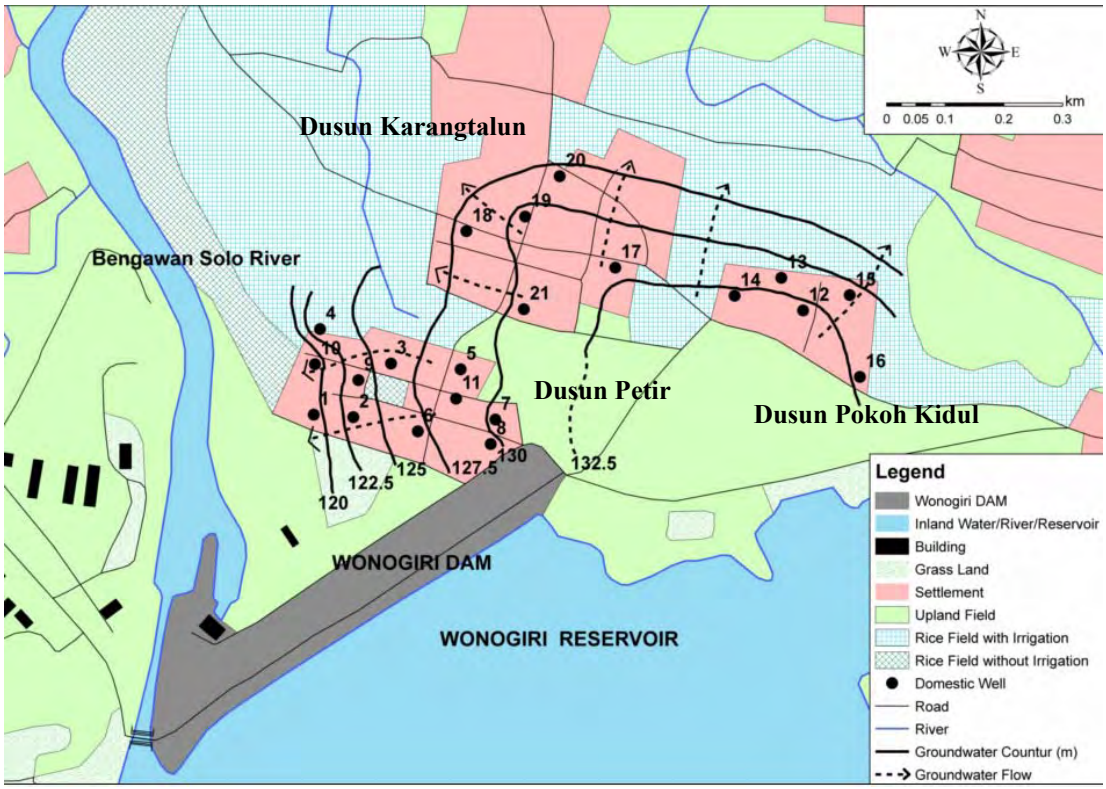
Parameter	Survey period (2006)	Summary Item	Dusun Petir	Dusun Pokoh Kidul	Dusun Karangtalun
Groundwater level (GL – m)	Sep. 26th – 27th	Min. – Max.	7.08 – 11.90	2.83 – 9.50	5.84 – 12.20
		Ave.	8.81	7.23	9.49
	Dec. 12th	Min. – Max.	7.49 – 15.19	8.44 – 10.51	6.19 – 12.90
		Ave.	9.97	9.24	10.12
Groundwater elevation (MSL +m)	Sep. 26th – 27th	Min. – Max.	120.61 – 130.94	131.65 – 138.13	129.71 – 132.28
		Ave.	126.57	133.71	130.90
	Dec. 12th	Min. – Max.	118.14 – 129.76	131.13 – 132.54	129.16 – 131.32
		Ave.	125.40	131.70	130.27
Depth of groundwater in well (m)	Sep. 26th – 27th	Min. – Max.	1.32 – 6.13	0.84 – 11.40	1.15 – 3.07
		Ave.	2.65	6.19	1.99
	Dec. 12th	Min. – Max.	0.26 – 4.21	1.47 – 10.88	0.45 – 2.72
		Ave.	1.49	5.28	1.36
Main water use	-	-	Domestic use, watering and livestock	ditto	ditto

Note) GL: Ground Level, MSL: Mean Sea Level
Source: JICA Study Team



Source: JICA Study Team

Figure 3.5.2(1) Groundwater Contour Map on 26th – 27th, September, 2006



Source: JICA Study Team

Figure 3.5.2(2) Groundwater Contour Map on 12th, December, 2006

(2) Air quality

1) Purpose

The air quality survey was conducted aiming to investigate current conditions of ambient air in and around the Project site and obtain benchmark data for impact assessment.

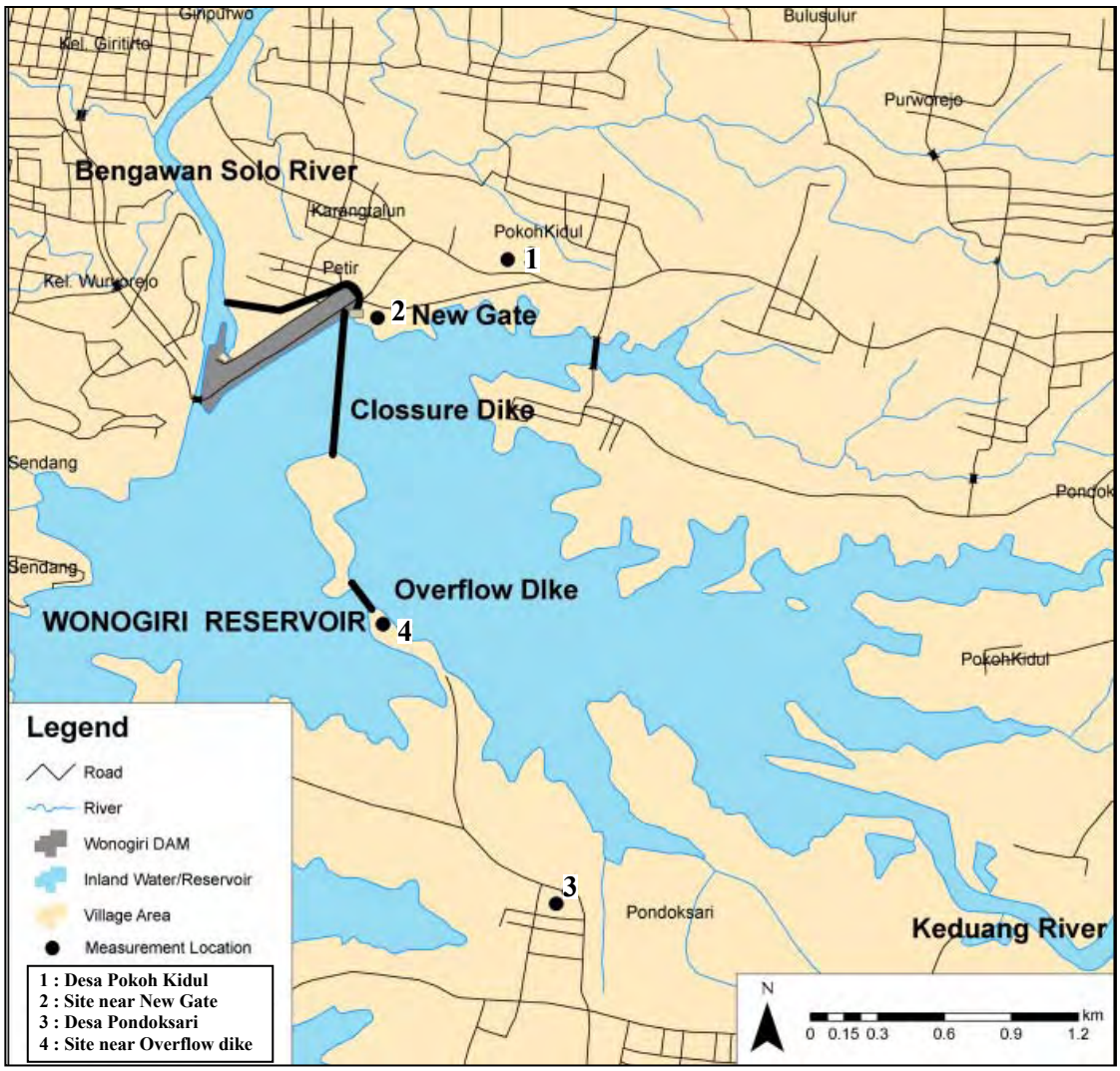
2) Methodology

The current condition of ambient air quality was surveyed by sampling and laboratory analysis according to the following method:

Date of sampling: 1) September 18th, and 2) December 12th, 2006.

Sampling locations: Four (4) locations as follows in total (Refer to Figure 3.5.3.):

1. Nearest settlement area of proposed new gate (Desa Pokoh Kidul),
2. Proposed location of proposed new gate,
3. Nearest settlement area of proposed overflow dike (Desa Pondok Sari), and
4. Proposed location of proposed overflow dike.



Source: JICA Study Team

Figure 3.5.3 Measurement Location of Ambient Air Quality, Noise and Vibration

Analyzed parameters: Based on Governor's Decree of Central Java Province No. 8/2001 regarding Ambient Air Quality Standard, the following parameters were analyzed:

(i) CO,
(ii) NOx,
(iii) SOx,
(iv) O_3,
(v) HC (Hyrdocarbon),
(vi) Pb (Lead), and
(vii) TPS (Total Suspended Particles: Dust)

3) Results

Survey result of ambient air quality is listed in Table 3.5.3. The survey result detected the following conditions:

- The concentration of air quality parameter is far below the environmental standard of Central Java Province (Governor's Decree of Central Java Province

No. 8/2001 regarding Ambient Air Quality Standard). This indicates that ambient air is not polluted in and around the Project site.

- There is no big difference in concentration of each parameter among the locations, except that SO_2 and TPS (Dust) of Location No. 3 are relatively high even through they are still below the environmental standard.
- Comparing the air quality data between September and December, survey results of O_3 and TPS (Dust) showed relatively lower in December than those of September. It is supposedly due to the moisture of air – December is in rainy season.

Table 3.5.3 Survey Result of Ambient Air Quality

Unit: µgr/Nm^3

No.	Parameter	Sampling period in 2006	Environmental Standard*)	Analysis Result			
				Location 1 (Pokoh Kidul)	Location 2 (New gate)	Location 3 (Pondoksari)	Location 4 (Overflow dike)
1.	NO_2	Sept.	316	11.530	14.465	9.184	2.562
		Dec.		12.851	12.910	13.260	2.950
2.	SO_2	Sept.	632	0.999	0.373	9.000	0.369
		Dec.		0.428	0.426	4.290	0.900
3.	CO	Sept.	15,000	365.135	166.380	284.913	280.648
		Dec.		286.460	296.870	204.610	121.090
4.	O_3	Sept.	200	19.405	21.305	10.778	26.171
		Dec.		3.860	3.840	3.870	3.850
5.	TSP (Dust)	Sept.	230	91.741	70.372	160.321	55.562
		Dec.		55.763	37.630	56.968	23.595
6.	Hydrocarbon	Sept.	160	0.2	0.4	nd	nd
		Dec.		0.1	0.2	nd	nd
7.	Pb	Sept.	2	nd	0.1	nd	nd
		Dec.		nd	nd	nd	nd

Source: JICA Study Team
nd : not detected
Note : *) Governor's Decree of Central Java Province No. 8/2001 regarding Ambient Air Quality Standard.

(3) Noise

1) Purpose

The noise survey was conducted aiming to investigate current conditions of ambient noise in and around the Project site and obtain benchmark data for impact assessment.

2) Methodology

The current condition of noise was surveyed by field investigation according to the following method:

Date of measurement: From 2:00 pm, October 14th until 2:00 pm, October 15th, 2006 (24 hours). The measurement was done once on week day.

Measurement locations: Four (4) locations, which are the same as those of air as follows (Refer to Figure 3.5.3.):

1. Nearest settlement area of proposed new gate (Desa Pokoh Kidul),
2. Proposed location of proposed new gate,
3. Nearest settlement area of proposed overflow dike (Desa Pondok Sari), and

4. Proposed location of proposed overflow dike.

Method of Measurement: The noise measurement was conducted based on the Decree of State Minister of Environment No. 48/MENLH/11/1996 regarding Noise Level Standard. Based on the measurement results, Lsm, or equivalent noise level, was calculated, and it was evaluated comparing with the noise level standard.

3) Results

Measurement results of ambient noise are listed in Table 3.5.4 and are summarized as follows:

- Lsm at all locations exceeded the standard of ambient noise for housing and residential area (55dB(A)).
- The noise level were relatively high in the morning at location 2, 3 and 4 as well as in the evening at location 2 and 3 with a noise level of more than 60dB(A). These high noise levels are spawned from vehicles for commuting during rush hours.
- Location 2 recorded the highest noise level because this location faces the road at the Wonogiri dam connecting with Wonogiri town.

Table 3.5.4 Survey Result of Ambient Noise

Unit: dB(A)

Measurement No. and Time	Location 1 (Pokoh Kidul)	Location 2 (New gate)	Location 3 (Pondoksari)	Location 4 (Overflow dike)
L1 (07:00)	53.2	64.6	64.6	66.6
L2 (10:00)	52.6	64.2	54.5	54.3
L3 (15:00)	54.0	63.4	55.4	56.0
L4 (20:00)	54.8	59.6	56.5	50.0
L5 (23:00)	55.9	54.2	55.9	54.2
L6 (01:00)	57.9	52.8	52.5	59.3
L7 (04:00)	57.7	60.7	60.3	53.2
Lsm	58.6	63.0	60.6	60.7
Noise Level Standard*	55			

Source: JICA Study Team

Note) *: Decree of State Minister of Environment No. 48/MENLH/11/1996 regarding Noise Level Standard.

(4) Vibration

1) Purpose

The vibration survey was conducted aiming to investigate current conditions of ambient vibration in and around the Project site and evaluate the impact assessment.

2) Methodology

The current condition of vibration was surveyed by field investigation according to the following method:

Date of measurement: January 2nd, 2007.

Measurement locations: Ambient vibration was measured at the same location as those of ambient noise (Refer to Figure 3.5.3.).

Method of Measurement: The vibration measurement was conducted according to the Decree of State Minister of Environment No. 49/MENLH/11/1996 regarding Vibration Level Standard. Ambient vibration data was consolidated based on the frequency range from 4 Hz to 63Hz.

3) Result

The result of ambient vibration was shown on Figure 3.5.4. Measurement results indicated that ambient vibration level was within a permitted level of vibration level standard.

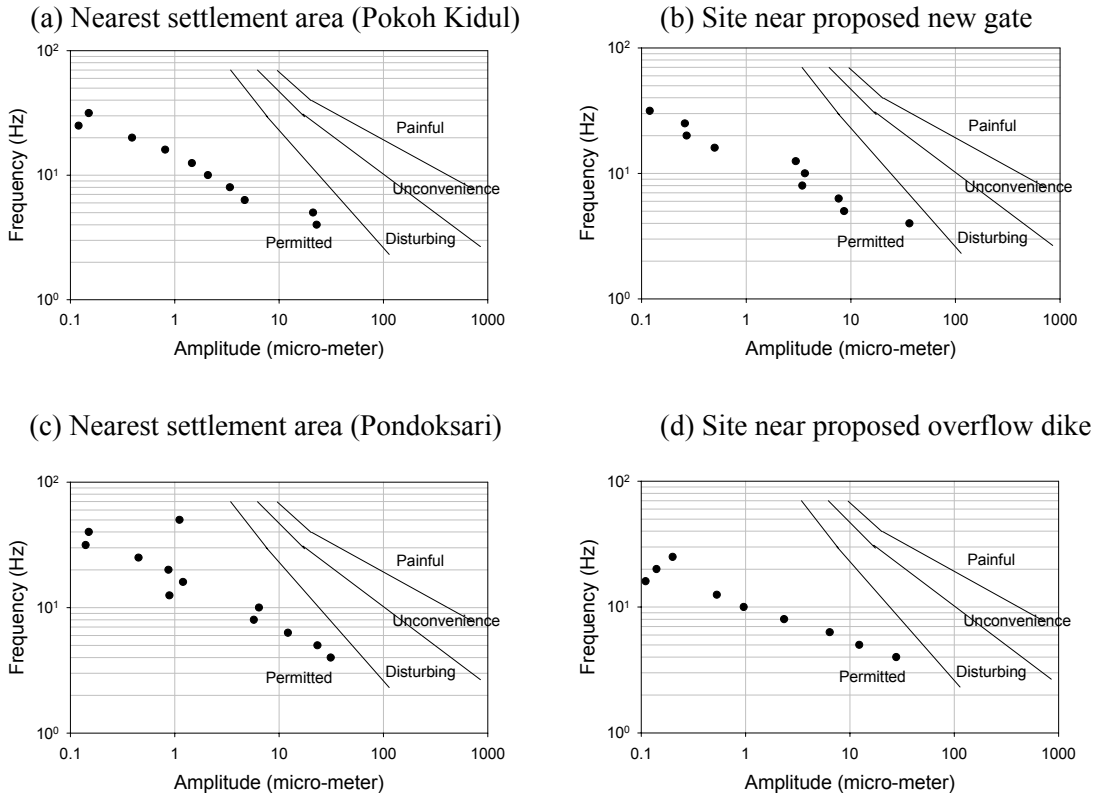


Figure 3.5.4 Measurement Result of Ambient Vibration

(5) River channel environment

1) Purpose

The survey on river channel environment in downstream of the Bengawan Solo river was conducted aiming to investigate current conditions of river area usage on the downstream reach of the river. The survey results will be used for the basis of impact assessment.

2) Methodology

Targeted activity of survey: The survey was conducted focusing on the following activities on the downstream reaches of the B. Solo river until the confluence point with the Madiun river based on the study result of IEE conducted in Phase I of this Study:

- Sand mining,
- Inland navigation,
- Water use for PDAM,
- Water use for irrigation, and
- Fishery.

Method of data collection: Data collection was made through the following:

- Collection of secondary data,
- Interview with government agency in charge and its relevant organizations,
- Interview with local people, especially sand miner, farmer, operator of fluvial navigation, and fishermen, and
- Field reconnaissance and investigation.

Period of survey: The survey mentioned above was implemented from September to October, 2006.

3) Results

a. Sand Mining

Survey result on sand mining conducted in the Bengawan Solo river is listed in Table 3.5.5 and 3.5.6, and the survey results is summarized as follows:

- There are three types in method of sand mining conducted on the Bengawan Solo river, namely, sand mining by 1) motor pump, 2) boat or raft and 3) manual tools.
- Sand mining is mainly done during dry season, but sand mining by motor pump can also be conducted during rainy season although the mining volume decreases.
- Location of mining activity spreads widely in the reaches of Bengawan Solo river from Wonogiri reservoir until the confluence point with the Madiun river through Kabupaten Wonogiri, Sukoharjo, Karanganyar, Sragen and Ngawi.
- Permission/agreement for sand mining is just given by the local community around of intended sand mining site and/or sometimes by Kepala Desa / Kulurahan (village chief). However, the license of sand mining by motor pump is to be given by Agency on Environment of respective Kabupaten.
- According to Mining Bureau of Central Java Province, estimated volume of mined sand is 30,000 – 50,000 m^3, which is considered to cause imbalance of supply and demand, erosion of river bank and near bridge pier.

Table 3.5.5 Result of Interview Survey with Local Government on Sand Mining

No.	Items to be surveyed	Kabupaten Wonogiri	Kabupaten Sukoharjo	Kabupaten Sragen	Kabupaten Ngawi
1	Competent authority	Local government (Agency on environment)	Local government (Agency on environment	Local government (Agency on environment)	Local government (Agency on environment)
2	Kinds of material	Sand, gravel and stone	Sand	Sand	Sand
3	Price of the material per m^3	No available data	No available data	No available data	Sand : Rp.100,000-150,000/m^3
4	Method of collecting material	By motor pump and boat	By motor pump, boat and manual tools	By boat	By motor pump and manual tools
5	Amount of workers and instruments	10 workers / 5 boats	10 workers by manual tools, 5 workers / boat, 1 worker/motor pump	30 workers / 2 - 4 boats	3-10 workers / 1-2 motor pumps
6	Working hours	8 hours/day	6 hours /day	8 - 9 hours /day	6 - 8 hours /day
7	Working days	7 days/week	5 - 6 days/week.	7 days/week	6 days/week
8	Average volume of mining	5.8 m^3/day	6 – 8 m^3/day, 40 m^3/week, 200-240 m^3/month.	30-50 m^3/day	52,5 m^3/day *(Note: 15 trucks per day at 1 location)*
9	Objective of usage	Material for building	Material for building	Material for building	Material for building
10	Season of sand mining of the year	Dry season only.	Dry season only.	Mainly dry season, In rainy season, mining volume decreases.	Dry season only.

Source: Data from Agency on Environment and Mining of Kabupaten Wonogiri, Sukorharjo, Sragen and Ngawi.

Table 3.5.6 Result of Interview Survey with Sand Miner of Different Types in the Bengawan Solo river

No.	Items to be surveyed	(1) Sand mining by **motor pump**	(2) Sand mining by **boat or raft**	(3) Sand mining by **manual tools**
1	Competent authority	Local government: (Kabupaten)	Camat (Head of Sub-district)	Kelara Desa / Kelurahan (village chief)
2	Price of material per 1 m^3 *(Note: Where 1 truck = 4 m^3)*	Sand : Rp. 22,500 to 42,500/m^3	Sand : Rp. 50,000 to 57,500 /m^3	Sand : Rp. 32,500 to 50,000/m^3 Gravel : Rp. 45,000/m^3
3	Amount of workers and instruments	One motor pump per one location, 10 workers for 1 motor pump.	2-3 workers for a boat or raft.	One worker *(Note: a location include about 15 workers, they work alone and not as a group.)*
4	Working hours	9-13 hours/day *(Note: working time per day depend on demand of sand.)*	7 hours/day	9 hours/day
5	Working days	7 days/week	7 days/week	7 days/week
6	Average volume of collecting material	40 - 69 m^3/day, 280-483 m^3/week *(Note: About 10 to 17 truck carry sand material every day)*	4 m^3/day *(Note: 10 boats or raft of sand = 1 truck = 4 m^3)*	4 m^3/week
7	Season of sand mining of the year	Mainly dry season, In rainy season, mining volume decreases.	Dry season only.	Dry season only.

Source: Primary Data of JICA Study Team

Location: Desa Pulosan, Kec. Wonokerto, Wonogiri, (a) Collecting Sand by motor pump, (b) Collected sand material, (c) Truck with a capacity of 4 m^3 and (d) Erosion on left and right sides of the river.

Figure 3.5.5 Photo of Sand Mining by Motor Pump in the Bengawan Solo River

b. Inland Navigation

Inland navigation across the Bengawan Solo river was surveyed in IEE Study, and in total 9 navigation routes were identified, although the two of them were already closed. Survey result on inland navigation in this EIA Study is listed Table 3.5.8 and their location is shown on Figure 3.5.6. The current situation of inland navigation is summarized as follows:

- There are 14 navigation routes established for crossing the Bengawan Solo river along the reach from Wonogiri Reservoir and the confluence point with the Madiun river. Of which 10 routes are currently in operation.
- Most of these navigation use manual rowing boat operated by 1 – 4 workers. The way for getting a license depends on the number of passengers. An auction for the license is performed for a location where there are a large number of passengers.
- Inland navigation on the B. Solo river is usually done all through the year. During flooding in rainy season, however, it is not operated because of safety reason.
- The income of boat operators ranges from Rp. 5,000 to 25,000 depending of the number of passengers.

Table 3.5.7 Location of Inland Navigation in the Bengawan Solo River

City/Regency	Location/Village	Note
Sukoharjo	1. Desa Ngasinan and Bulu	Close
	2. Desa Lawu and Ngasinan	Close
	3. Dusun Guyangan, Desa Lawu, Kec. Nguter	Active
	4. Desa Kluwih, Desa Nglengking, Kec. Bulu	Active
	5. Desa Serenan and Bulakan	Close
Surakarta	1. Dusun Beton, Desa Kampung Sewu	Active
	2. Desa Nggadingan and Sangkrah	Active
Karanganyar	1. Desa Miri and Gondang Rejo	Active
	Dusu Karang Desa Wuri Kragan, Kec. Gondang Rejo and Dusun Sapen, Desa Kebak, Kec. Kebak Kramat	Active
	3. Desa Waru and Gondang Rejo	Active
Sragen	1. Sidokerto and Plupuh	Close
	2. Sidodadi and Masaran	Active
Ngawi	1. Karangpucang	Active
	2. Selopuro	Active

Source: Primary Survey of JICA Study Team

(a) Desa Masaran, (b) Desa Sidokerto, and (c) Desa Plupuh, Kabupaten Sragen.
Source: JICA Study Team

Figure 3.5.7 Photo of Inland Navigation in the Bengawan Solo River

c. Water use for PDAM

- Water source of PDAM is deep well and spring over Mt. Lawu (i.e. PDAM of Wonogiri, Sukoharjo, Jurug (Surakarta), Karangayar, Sragen and Ngawi). However, the water of the B. Solo river is also used as water source only at PDAM of Wonogiri and Jurug.
- PDAM of Wonogiri and Jurug takes water from the Bengawan Solo river by submerged water pump with a capacity of 60 l/s and 100 l/s, respectively, although the water intake decreases in dry season. The intake point is shown on Figure 3.5.5.
- According to a government official, water treatment plant of PDAM is suffering from a large amount of pollutant from industrial waste from factories located along the Bengawan Solo river. Sediment deposit in the river does not cause any problem for water treatment.

d. Water use for Irrigation

Water use for irrigation from the Bengawan Solo river is done by water intake for irrigation canals at Colo Weir located about 14 km downstream of Wonogiri reservoir.

In dry season, water distribution for irrigation in east and west irrigation canals can reach 15.50 and 5.25 m^3/sec, respectively in months of May, June and July, and it gradually decreases in months of August and September, and finally reaches to 0 (zero) m^3/sec in month of October and November. Irrigation areas from the east and west irrigation canals are 20,240 ha and 7,500 ha, respectively (Perum Jasa Tirta I, 2006).

Large discharge over the year causes erosion and landslide on riverbank at some places of the canals. Therefore, maintenance of canals is periodically carried out once a year in month of October and November in primary and secondary irrigation canals while maintenance work for tertiary canals is performed regularly by farmers. It is important to notice that sediment deposit in canals is not caused by soil material coming from Wonogiri reservoir but from landslide or erosion that occurred in embankment or canal itself.

e. Fishery

Results of interview survey with local government (Bureau of Fishery of relevant Kabupaten) and local fishermen along the Bengawan Solo river are listed in Tables 3.5.8 and 3.5.9, respectively. The current situation of inland fishery in the Bengawan Solo river is summarized as follows:

- Inland fishery in the Study area is carried out in the Bengawan Solo river or at the fish pond along the river. Fish pond is mainly located in Kabupaten Sukoharjo, some of which are established in an oxbow lake, an old river channel.
- Fishing in the B. Solo river is carried out everyday when the existing spill way of Wonogiri gate is closed. Fishing is performed using fish net, fish hook, and gill net.
- Competent authority to give permission for fishing in the Bengawan Solo river is Bureau of Fisheries (Dinas Perikanan) of respective Kabupaten. Every fisherman has a certain location of fishing. But fishermen also do fishing

outside of their licensed location without any permission.

- Targeted fish species for fishing includes Bader (*Cyclocheilichthys enoplos*), Jambal (*Pangasius nasutus*), Betutu (*Oxyeleotris marmorata*), Nila (*Oreochromis niloticus*), Sogo (*Mystus nemurus*), Kutuk (*Channa striata*) and Udang (*Macrobrachium sp.* / P*alaemon sp.*).
- According to local fisherman in the B. Solo river, fishing is not a main job but usually a building laborer. Income from fishing is about Rp. 20,000 – 100,000 per day depending on the fish catch of the day.
- In rainy season, fishermen usually can catch more than in dry season because fish grow in rainy season and the weight of fish is larger than that in dry season.
- According to local fishermen, most of fish species in the B. Solo river spawn in early rainy season, or December.

Table 3.5.8 Summary of Interview Survey with Local Government on Fishery in Bengawan Solo River

No.	Items to be surveyed	Bureau of Fisheries Wonogiri	Bureau of Fisheries Sukoharjo	Bureau of Fisheries Karanganyar	Bureau of Fisheries Sragen	Bureau of Fisheries Ngawi
1	Location of fishery	River	River	River	River	River
2	Kinds of the dominant fish	Lele (inpond), Nila (in pond), Patin (in pond)	Nila hitam/merah, Gabus /kutuk	Sapu-sapu, Patin, Nila, Lele	Sapu-sapu	Wagal, Tawes, Wader, Sepat, Belida, Betutu, Mujair
3	Spawning period of the fish:				n.a.	n.a.
	Nila	February	Rainy season	Dec - Ma		
	Patin	February	Ditto	Jan - Feb		
	Sapu-sapu	-	Ditto	Jan - Feb		
	Lele	no special time	Ditto	Jan - April		
4	Name of organization or group of fishery	Kelompok tani pembudidaya ikan	Mina Lestari, Mina Rejeki, Mina Makmur.	Sumber Rejeki in desa Karangturi, Gondang rejo	n.a.	n.a.
5	Method of fishing	Fish net, Gill net	Fish net, Fishhook,	Fish net, Fishhook	Fish net, Fishhook	Fish net, Fishhook
6	Average income from fishing /month	Rp. 450,000 - 550,000	Rp. 400,000	Rp. 300,000	Rp. 400,000	
7	Competent authority to give a permission for fishing in the river	Local government (Bureau of Fisheries)	Local Government (Bureau of Fisheries)	Local government (Bureau of Fisheries)	Local government (Bureau of Fisheries)	Local government (Bureau of Fisheries)
8	Other data and information related to fishery.	Number of fish increase in rainy season	Prohibited to use fish bomb for fish catch	Peak performance of fishermen are in early rainy season	n.a.	n.a.

Source: JICA Study Team

Table 3.5.9 Summary of Interview Survey with Local Fishermen in Bengawan Solo River

No.	Items to be surveyed	Interview Results
1	Interviewee and location	Fisherman on downstream reach of Wonogiri reservoir (1 km downstream from Wonogiri dam)
2	Main location of fishing	Bengawan Solo river *(Note: Every fisherman has a certain location for catching fish. They are not permitted to fish outside of their location except the owner give permission.)*
2	Dominant kinds of fish caught	Bader; Jambal; Betutu; Nila; Bader; Sogo; Kutuk; Udang
3	Spawning period of the fish	Many fish spawn in early rainy season (e.g. December)

No.	Items to be surveyed	Interview Results
4	Name of fisherman's group belonging to	Karang Talun fisherman with member about 50 people.
5	Type of fishing	Fish net, Sanber (for catching of shrimp/udang)
6	Average Income of fishermen	Income of fisherman is about Rp. 20,000 to Rp. 100,000 per day and it depends to kinds and weight of fish that they catch every day.
7	Competent authority to give a permission for fishing in the river to fishermen	Local government (Bureau of Fisheries (Sub Dinas Perikanan)),
8	Other data and information related to fishery	Fish catching is performed every day when reservoir gate is closed. Fish catching are not main job of fisherman. While the main job is building laborer, In rainy season the fisherman get the fish amount more than in those of dry season, because weight of fish in rainy season is greater than in those of dry season.

Source: JICA Study Team

3.5.2 Natural Environment

(1) Terrestrial Flora

1) Purpose

The investigation of terrestrial flora was conducted aiming to inventory plant species in and around the Project site, understand the current condition of terrestrial flora and identify whether protected species inhabit or not.

2) Methodology

The investigation of terrestrial flora was conducted in the following method:

Date of investigation: The inventory survey was conducted twice: one in dry season and the other is in rainy season. The first survey was conducted on October 23rd and 29th and 31st, 2006, and the second was conducted on January 25th, 2007.

Location of the investigation: The investigation was conducted at six locations (Refer to Figure 3.5.8).

Method of data collection: Inventory of wild plant species was carried out by line census and quadrant method with an area of 1m x 1m, or 5m x 5m, or 10m x 10m, depending on the vegetation, at each survey location. In addition, cultivation crops and trees were inventoried in and around inventory site for wild plant species.

3) Results

Table 3.5.10 summarizes the survey results for terrestrial flora, and Table 3.5.11 and 3.5.12 show all the plant species identified and cultivation crops, respectively.

As a result of inventory survey in October (dry season), 120 wild plants and 38 cultivation crops were identified in total by quadrant method, while in January (rainy season), 212 wild plants and 48 cultivation crops were identified by line census method. The overall numbers of species of wild plants and cultivation crops were 220 and 48, respectively.

Table 3.5.10 also shows the number of these species by survey location. Among the six (6) survey locations, Location No. 6: Bupakan, the highest location near the forest area around the summit of Mt. Lawu scored the largest number at both in dry season and rainy season.

Of all the plant species, there was no protected species designated by Government Regulation No. 7/1999 regarding Conservation of Plant and Animal Species.

Table 3.5.10 Number of Flora Species Identified at Survey Location

Survey Period	Category	Inventory Location*						Total
		L1	L2	L3	L4	L5	L6	
October, 2006 (Dry season)	Wild Plant	24	38	21	32	32	47	120
	Cultivation Crop	8	6	7	14	21	21	38
January, 2006 (Rainy season)	Wild Plant	67	51	55	71	80	86	212
	Cultivation Crop	13	6	11	17	23	27	48

Note) *: Inventory Locations are as follows:
L1) Site near the proposed new gate (Dusun Petir and Dusun Pokoh Kidul),
L2) Site near the separation dike (Dusun Pondoksari),
L3) Candidate spoil bank site (grass-track racing area in Dusun Petir),
L4) Site near planned terrace work (near Kuduang river) (Desa Senpukerep),
L5) Site near planned terrace work (in dry land area) (Desa Jendi), and
L6) Site near planned terrace work (in mountainous area) (Desa Bubakan)

Source: Primary Data of JICA Study Team

Table 3.5.11 (1/2) Result of Inventory Survey of Terrestrial Flora (Wild Species)

No.	Species	No.	Species
1	*Acacia auriculiformis*	56	*Chrysopogon aciculatus*
2	*Acacia villiosa*	57	*Cinnamomum burmanni*
3	*Acalypha indica*	58	*Clitopria ternate*
4	*Accacia pennata*	59	*Clotararia anagyroides*
5	*Accacia tomentosa*	60	*Cocos nucifera*
6	*Adiantum sp*	61	*Coleus sp*
7	*Agave sp*	62	*Collocasia esculenta*
8	*Ageratum conizoides*	63	*Commelina diffusa*
9	*Ageratum houstonianum*	64	*Cosmos caudatus*
10	*Albizzia chinensis*	65	*Costus sp*
11	*Amaranthus gracilis*	66	*Crassocephalum crepidioides*
12	*Amaranthus spinosus*	67	*Crepidioides*
13	*Amorphophallus campanulatus*	68	*Crotalaria anagryoides*
14	*Annanas comossus*	69	*Crysopogon aciculatus*
15	*Annona muricata*	70	*Curcuma aeruginosa*
16	*Annona hispida*	71	*Curcuma domestica*
17	*Annona Sarikaya*	72	*Curcuma heyanaeana*
18	*Annona squamosa*	73	*Curcuma xanthorrrhiza*
19	*Arisaema triphyllum*	74	*Curcuma zedoaria*
20	*Arthemisia hispida*	75	*Cycas rumphii*
21	*Arthemisia sp*	76	*Cyllingia monochephala*
22	*Arthemisia vulgaris*	77	*Cynodon dactylon*
23	*Artocarpus altilis*	78	*Cyperus difformis*
24	*Arundia setosa*	79	*Cyperus halpan*
25	*Axonopus compressus*	80	*Cyperus kyllingia*
26	*Bambusa bkmuea*	81	*Cyperus rotundus*
27	*Bambusa spinalis*	82	*Cyperus sp*
28	*Bambusa spinosus*	83	*Dalbergia latifolia*
29	*Bambusa vulgaris*	84	*Dalbergia sp*
30	*Barleria cristata*	85	*Delicos lablab*
31	*Bidens biternata*	86	*Delonix regia*
32	*Bombax ceiba*	87	*Dendrocalamus asper*
33	*Bombax malabaricum*	88	*Deris heterophylla*
34	*Boreria alata*	89	*Desmodium gangeticum*
35	*Bougenvialle spectabilis*	90	*Desmodium heterocarpon*
36	*Bridelia stipularis*	91	*Digitaria adscendens*
37	*Brugmansia soaveolens*	92	*Digitaria nuda*
38	*Caladium bicolor*	93	*Dioscorea alata*
39	*Calliandra falcataria*	94	*Dioscorea esculenta*
40	*Calliandra sp*	95	*Dioscorea hispida*
41	*Callotropis gigantea*	96	*Dioscorea pentaphylla*
42	*Canna coecinea*	97	*Dracaena fragrans*
43	*Canna edulis*	98	*Echinochloa colonum*
44	*Casia seamea*	99	*Eichornia crassipes*
45	*Cassia alata*	100	*Elephantopus scaber*
46	*Cassia fistulosa*	101	*Eleusin indica*
47	*Cassia leschenaultiana*	102	*Enterolobium cyclocarpum*
48	*Cassia sp*	103	*Eragrostis uniloides*
49	*Cassia tomemtosa*	104	*Eriocaulon truncatum*
50	*Ceiba pentandra*	105	*Erythrina subrumbans*
51	*Cenophodium album*	106	*Eugenia cumini*
52	*Centotheca lappace*	107	*Eulalia amaura*
53	*Chlerodendrum paniculatum*	108	*Euphorbia hirta*
54	*Chloris barbata*	109	*Ficus benjamina*
55	*Chromolaena odorata*	110	*Ficus septica*

Note) Data of Inventory Survey: Oct. 23rd, 29th and 31st, 2006 and Jan. 25th, 2007
Source: Primary data of JICA Study Team

Table 3.5.11 (2/2) Result of Inventory Survey of Terrestrial Flora (Wild Species)

No.	Species	No.	Species
111	*Flacaurtia indica*	**166**	*Pennisetum paniculatum*
112	*Gigantochloa apus*	**167**	*Pennisetum purpureum*
113	*Gladiolus gandavensis*	**168**	*Pennisetum spicatum*
114	*Gleicena sp*	**169**	*Phillanthus niruri*
115	*Gloriosa superba*	**170**	*Phylanthus urinaria*
116	*Haemanthus multiflorus*	**171**	*Phynus merkhusii*
117	*Heliotrophium indicum*	**172**	*Physalis minima*
118	*Heliotropium elongatum*	**173**	*Pithecellolum dulce*
119	*Hibiscus rosasinensis*	**174**	*Plantago major*
120	*Hibiscus tillianceus*	**175**	*Pogonathenum paniceum*
121	*Hippeastrum splendens*	**176**	*Richardia brassiliensis*
122	*Hybiscus rosasinensis*	**177**	*Roripha indica*
123	*Hyptis rhomboidea*	**178**	*Rotbelia exaltata*
124	*Imperata cylindrica*	**179**	*Rubus molucanus*
125	*Ipomoea fistulosa*	**180**	*Ruellia humilis*
126	*Ipomooea abscura*	**181**	*Saccharum officinarum*
127	*Isachne globosa*	**182**	*Saccharum spontaneum*
128	*Ishaemum timorense*	**183**	*Salacca edulis*
129	*Isotoma longiflora*	**184**	*Sambucus javanica*
130	*Ixora paludosa*	**185**	*Sauropus androgynus*
131	*Jatropha curcas*	**186**	*Scirpus grossus*
132	*Jatropha multifida*	**187**	*Senecio conchifolius*
133	*Kaemferia galangal*	**188**	*Sericocalix sp*
134	*Lagerstromia floribunda*	**189**	*Sesbania sesban*
135	*Languas galanga*	**190**	*Sida acuta*
136	*Lantana camara*	**191**	*Sida hispida*
137	*Leearsia hexandra*	**192**	*Sida rhombifolia*
138	*Leonotis nepetifolia*	**193**	*Solanum arvensis*
139	*Lepistemon flavescens*	**194**	*Solanum capsicastrum*
140	*Lespedeza juncea*	**195**	*Solanum nigrum*
141	*Leucaena glauca*	**196**	*Solanum torvum*
142	*Leucaena leucocephala*	**197**	*Sonchus arvensis*
143	*Leucas lavandufolia*	**198**	*Sporobolus tremulus*
144	*Macararga friloba*	**199**	*Starchypeta hispida*
145	*Mallotus philippinensis*	**200**	*Starchypeta indica*
146	*Malpighia sp*	**201**	*Starchypeta sp*
147	*Maranta arundinaceae*	**202**	*Sylendrella nodiflora*
148	*Melastoma sp*	**203**	*Syzgium polyanthum*
149	*Michelia alba*	**204**	*Syzygium aqueum*
150	*Mimosa indica*	**205**	*Syzygium sp*
151	*Mimosa invisa*	**206**	*Tectona grandis*
152	*Mimosa odorata*	**207**	*Terminalia cattapa*
153	*Mimosa pudica*	**208**	*Thevetia peruviana*
154	*Mirabillis jalappa*	**209**	*Thevetia sp*
155	*Misusops elengi*	**210**	*Thitonia sp*
156	*Moghania lineata*	**211**	*Toona sureni*
157	*Momordica charantia*	**212**	*Torenia polygonoides*
158	*Morinda citrifolia*	**213**	*Tylophora villosa*
159	*Muntingia calabura*	**214**	*Urena lobata*
160	*Nerium oleander*	**215**	*Waltheria americana*
161	*Ocimum basilicum*	**216**	*Wedelia biflora*
162	*Opuntia vulgaris*	**217**	*Xyris pauciflora*
163	*Oxalis corniculata*	**218**	*Zingiber aromaticum*
164	*Panicum repens*	**219**	*Zingiber officionale*
165	*Paspalum conjugatum*	**220**	*Zingiber purpureum*

Note) Data of Inventory Survey: Oct. 23rd, 29th and 31st, 2006 and Jan. 25th, 2007
Source: Primary data of JICA Study Team

Table 3.5.12 Result of Inventory Survey of Terrestrial Flora (Cultivation Crops)

No.	Species	Local Name
1	*Albizzia cinensis*	Sengon
2	*Anacardium occidentale*	Jambu mete
3	*Annona muricata*	Sirsak
4	*Arachis hypogaea*	Kacang Tanah
5	*Arthocarpus heterophylus*	Nangka
6	*Arthocarpus indicus*	nangka
7	*Averhoa carambola*	Belimbing
8	*Bambusa vulgaris*	Bambu kuning
9	*Carica papaya*	Pepaya
10	*Ceiba pentandra*	Randu
11	*Cocos nucifera*	kelapa
12	*Collocasia esculenta*	Talas
13	*Curcuma domestica*	kunyit
14	*Delichos lablab*	Kara
15	*Dioscorea esculenta*	Gembili
16	*Dioscorea hispida*	Gadung
17	*Durio zibethinus*	Durian
18	*Gigantochloa apus*	Bambu
19	*Gnetum gnemon*	Melinjo
20	*Ipomoea batatas*	Ubi jalar
21	*Kaemferis galangal*	Kencur
22	*Languas Galanga*	Laos
23	*Leucaena leucocephala*	Lamtoro
24	*Mangifera indica*	Mangga
25	*Mangifera odorata*	Kuweni
26	*Manihot esculenta*	Singkong
27	*Melia azederach*	Mindi
28	*Musa paradisiaca*	Pisang
29	*Nerium oleander*	oleander
30	*Oryza sativa*	Padi
31	*Parkis speciosa*	Pete
32	*Pennisetum purpureum*	Rumput gajah
33	*Persea americana*	Alpukat
34	*Phaseolus vulgaris*	Kacang Merah
35	*Psidium guajava*	Jambu biji
36	*Sacharum officinarum*	Tebu
37	*Sweetenia macrophyla*	Mahoni
38	*Sweetenia mahagoni*	mahoni
39	*Syzygium aquaeum*	Jambu air
40	*Syzygium aromaticum*	cengkeh
41	*Tectona grandis*	Jati
42	*Theobroma cacao*	Cokelat
43	*Toona sureni*	Suren
44	*Vigna radiata*	kacang ruji
45	*Vigna sinensis*	Kacang panjang
46	*Vigna unguiculat*	Kacang Panjang
47	*Zea mays*	Jagung
48	*Zingiber officinale*	Jahe

Note) Data of Inventory Survey: Oct. 23rd, 29th and 31st, 2006 and Jan. 25th, 2007
Source: Primary data of JICA Study Team

(2) Terrestrial Fauna

1) Purpose

The investigation of terrestrial fauna was conducted aiming to inventory animal species inhabiting in and around the Project site, understand the current condition of terrestrial fauna and identify whether protected species inhabit or not.

2) Methodology

The investigation of terrestrial fauna was conducted in the following method:

Date of measurement: The inventory survey was carried out twice: one in dry season and the other is in rainy season. The first survey was conducted on October 23rd and 29th and 31st, 2006, and the second was conducted as a supplemental on 7th and 9th of December 12th, 2006.

Location of the investigation: The investigation was conducted at the nearby locations as those of terrestrial flora (Refer to Figure 3.5.8.).

Scope of targeted fauna species: Targeted fauna species covered: Mammal, Aves (wild birds), Reptile, Amphibian and Insect.

Method of data collection: Identification of fauna species was carried out by line census, pint census and field sign method.

3) Results

Table 3.5.13 summarizes the result of inventory survey for terrestrial fauna and Table 3.5.14 shows all the fauna species identified.

As a result of inventory survey, five (5) species of mammals, 21 species of wild birds, two (2) species of reptiles and 19 species of insects were identified.

Among six (6) locations, Location No.6, Bupakan, which is the highest location near the forest area around the summit of Mt. Lawu scored relatively larger number of mammal, reptile and insects. Regarding wild birds, Location No. 1 and 2 scored relatively high supposedly due to these two locations are situated near the water area, i.e., Wonogiri reservoir.

Of all the fauna species identified during inventory survey, there was no protected species designated by Government Regulation No. 7/1999 regarding Conservation of Plant and Animal Species.

Table 3.5.13 Number of Fauna Species Identified at Survey Location

Category	Inventory Location*						Total
	L1	L2	L3	L4	L5	L6	
Mammals	0	0	0	1	1	2	4
Wild birds	10	12	7	7	8	8	21
Reptiles	0	1	0	0	0	1	2
Insects	7	7	8	6	10	12	19

Source: Primary Data of JICA Study Team

Note) *: Inventory Locations are as follows:

L1) Site near the proposed new gate (Dusun Petir and Dusun Pokoh Kidul),
L2) Site near the separation dike (Dusun Pondoksari),
L3) Candidate spoil bank site (grass-track racing area Dusun Petir),
L4) Site near planned terrace work (near Kuduang river) (Desa Senpukerep),
L5) Site near planned terrace work (in dry land area) (Desa Jendi), and
L6) Site near planned terrace work (in mountainous area) (Desa Bubakan)

Table 3.5.14 Result of Inventory Survey of Terrestrial Fauna

No.	Species	Local Name
(1) Mammal		
1	*Macaca sp*	Kera
2	*Panthera pardus*	Harimau kumbang
3	*Paradoxurus hermaproditus*	Musang
4	*Sus scrofa*	Babi hutan
5	*Trichys fasciculata*	Landak
(2) Aves		
1	*Aegitina tiphia*	Pleci
2	*Apus afinis*	Burung layang
3	*Celeus brachyurus*	Pelatuk
4	*Collocalia esculenta*	Sriti
5	*Collocalia sp*	Sriti
6	*Corvus enca*	
7	*Egretta intermediat*	Kuntul
8	*Egretta sp*	Kuntul
9	*Galus sp*	Ayam hutan
10	*Halcyon cyanoventris*	Tengkek
11	*Lanius cristatus*	
12	*Lanius schach*	Pentet
13	*Lonchura leucogaster*	Pipit
14	*Parus major*	Glatik wingko
15	*Prinia familiaris*	
16	*Pycnonotus aurigaster*	Kutilang
17	*Seicercus grammiceps*	Prenjak
18	*Spizaetus bartelsi*	Elang jawa
19	*Streptopelia bitorquata*	Derkuku
20	*Turnix silvatica*	Puyuh
21	*Zosterops palpebrosus*	Pleci
(3) Reptile and Amphibian		
1	*Mabouya sp*	Kadal
2	*Rana sp*	Katak
(4) Insect		
1	*Adalia bipunciata*	Kepik
2	*Anax junius*	Capung
3	*Brachytropes portentosus*	Gangsir
4	*Calopteryx maculata*	Capung
5	*Chloealtis sp*	Belalang
6	*Chloeoaltis sp*	belalang
7	*Colias eurytheme*	Kupu
8	*Conocephalus sp*	Belalang
9	*Enalagma hageni*	Capung
10	*Epicordulia sp*	Capung
11	*Feniseca torquinius*	Kupu
12	*Gryllus sp*	Jengkerik
13	*Limenitis archipus*	Kupu
14	*Magicicada septemdecim*	Tonggeret
15	*Megabombus pensylvanicus*	Lebah kumbang
16	*Melanoplus sp*	Belalang
17	*Pantala flavescens*	Capung
18	*Pieris sp*	Kupu
19	*Spharogemon sp*	Belalang

Note) Data of Inventory Survey: Oct. 11th, 13th and 18th, 2006
Source: Primary data of JICA Study Team

(3) Aquatic Biota

1) Purpose

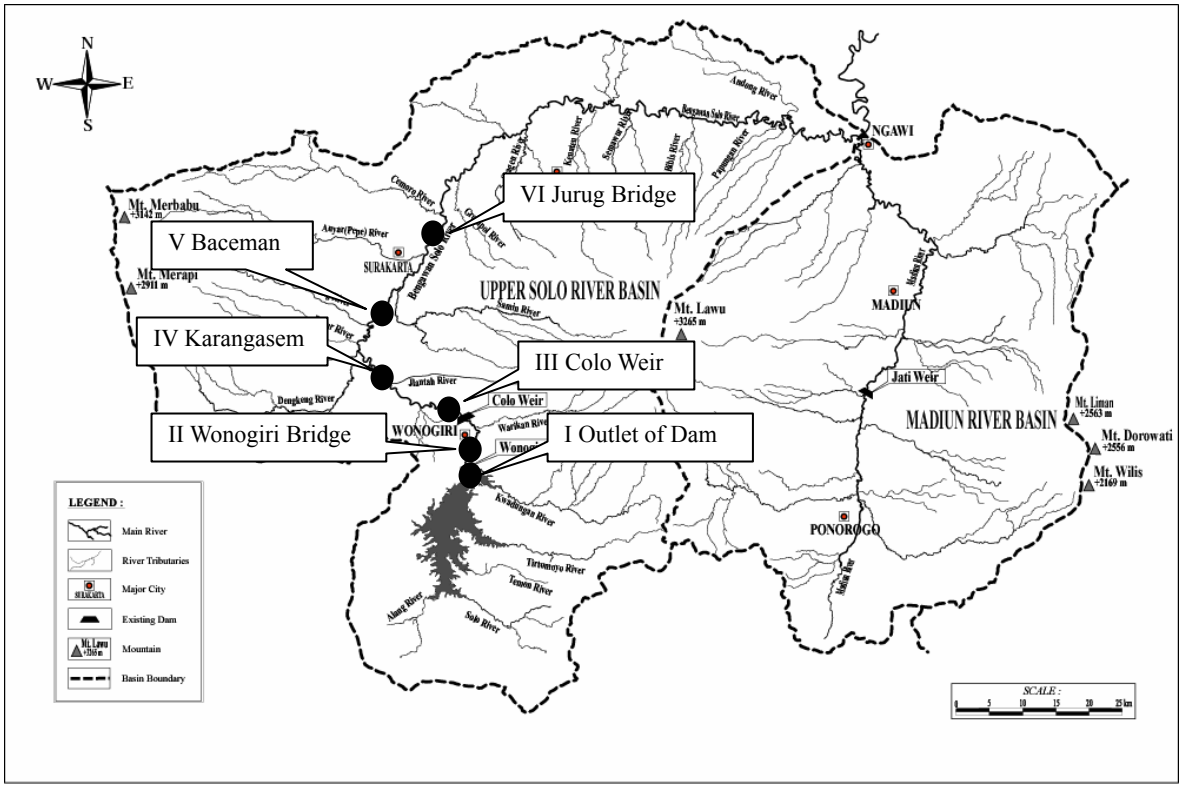
The investigation of aquatic biota was conducted aiming to inventory aquatic organisms inhabiting in the Bengawan Solo at the downstream reach of Wonogiri reservoir as a basic condition for the impact prediction and evaluation.

2) Methodology

Six (6) measurement station was established from the outlet of Wonogiri reservoir through Jurug Bridge, Surakarta City. At each station, the investigation of aquatic biota was conducted by inventory survey and water quality survey according to the following method:

Date of measurement: The inventory survey was conducted on October 11th, 13th and 18th, 2006.

Location of measurement station: The inventory survey was conducted at six (6) stations as shown on Figure 3.5.9.



Source: JICA Study Team

Figure 3.5.9 Survey Location of Aquatic Biota

Scope of targeted aquatic organisms: Targeted aquatic biota is plankton (phyto-plankton and zooplankton), macro-benthos, and nekton (fish). In addition, basic habitat condition of each measurement station was surveyed including physical and chemical factors.

Method of data collection: Inventory survey was conducted by the methods shown in the table below:

Table 3.5.15 Method of Data Collection on Aquatic Biota

Category	Sampling / Catching	Identification / Analysis
Plankton	Taking of ambient river water and filtering using plankton net.	Identification of taxon was done based on authorized plankton guidebook. The number of plankton was counted using microscope.
Macro-benthos	Sludge/Bottom material was sampled at edge, pool and riffle in the river using Ekman dredger or server.	Identification of taxon was conducted authorized literatures.
Nekton (Fish)	Fish was caught using fish gears such as gill net, fouling gear, etc.	Identification of taxon was done based on website data base (www:fishbase.org).

Source: JICA Study Team

Further, evaluation of ecology of fish and macro-benthos was investigated based on literature survey, information from web sites and interview with authorized experts (Dr. Namastra Probosunu, Head of Laboratory of Aquatic Ecology, Gadjah Mada University), focusing on location of spawning ground and time (season) of spawning.

Measured parameters: As for plankton, Density and Diversity index was calculated to evaluate the habitat situation and biodiversity in the Bengawan Solo river.

Physical condition at the measurement station was surveyed targeted for the following parameters: air temperature, water temperature, water depth, transparency and turbidity. Chemical condition at the measurement station was surveyed targeted for the following parameters: DO, Dissolved CO_2, pH, Alkalinity, Organic matter.

3) Results

a. Physical condition

Physical condition of measurement station is listed in Table 3.5.16. As a whole, the observed parameters indicated the comfortable condition for aquatic organisms to live in the river, except for one condition: water temperature of station No.3 was 37°C . This is because the measurement was conducted in the mid day.

Table 3.5.16 Physical Conditions of each Measurement Station

Parameter (unit)	Measurement station					
	I	II	III	IV	V	VI
Air Temperature (°C)	32	38	36	32	29.5	28
Water Temperature (°C)	31.5	32	37	33	31	32
Water depth (cm)	55	80	65	50	40	30
Transparency (cm)	30	43	30	30	24	15
Turbidity (mg/l)	53.7	28.7	22.95	24.85	38.7	23.7

Note) Refer to Figure 3.5.9 for Measurement Station.
Source: JICA Study Team

b. Chemical condition:

Chemical condition of measurement station is listed in Table 3.5.17. Chemical conditions of measurement station were suitable except for measurement station VI: Jurug Bridge.

In general, aquatic organisms, especially fish, requires DO of at least 3 mg/l for inhabit. However, the DO at station VI was 1.55 mg/l. Besides at station VI, other

parameters showed un-suitable conditions, including high dissolved CO_2 (44.4 mg/l) and high organic matter (49.34 mg/l). The reason for these bad conditions are estimated due to the pollution by domestic and industrial pollutant drained in the upstream of this station, which resulted in depletion of dissolved oxygen..

Table 3.5.17 Chemical Conditions of Measurement Station

Parameter (unit)	Measurement station						Requirement (in general)
	I	II	III	IV	V	VI	
DO (mg/l)	3.44	3.9	8.05	9.05	4.35	1.55	> 3
CO_2 (mg/l)	7.7	5.12	6.4	5.6	8.2	44.4	≤ 10
pH	6.9	6.9	7.2	7.,1	7.25	7.1	6-9
Alkalinity (mg/l)	118	115	88.2	110.3	133.75	205	≥ 20
Organic matter (mg/l)	22.3	30.84	24.67	25.79	30.205	49.34	

Source: JICA Study Team

c. Plankton

Survey results are summarized in Tables 3.5.18 and 3.5.19. The Inventory result of plankton indicated the following:

The number of plankton identified at each station ranged 6 – 37 species. Station No. 5 scored maximum and station No.6 did minimum.

Regarding Density index and Diversity index, No.3 scored the most stable condition, but Station No. 6, on the other hand, recorded worst condition, which is in line with the result of water quality analysis.

Among the plankton species identified to inhabit, *Synedra* and *Nitzschia* are the most common ones at each station.

Table 3.5.18 Result of Plankton Survey

Parameter (unit)	Measurement Station					
	I	II	III	IV	V	VI
Number of species	33	25	36	28	37	6
Density (individuals/l)	612	776	1,489	1,233	857	180
Density index	1,350	1,250	2,809	2,387	1,172	0.310

Source: JICA Study Team

Table 3.5.19 Dominant Plankton Species at Measurement Station

No.	Stations	Dominant species
1	Outlet of Wonogiri Reservoir	*Synedra, Nitzschia, Copepoda, Branchionus, Merismopedia, Surirella, Melosira,* and *Tabellaria*
2	Wonogiri Bridge	*Synedra, Diatome, Nitzschia, Chroococcus, Cocconeis, Nostoc, Tabellaria*
3	Colo Weir	Synedra, Melosira, *Chroococcus, Nitzschia, Cosmarium, Chlorococcum, Pelomyxa, Polycystis* and *Closterium*
4	Karangasem	*Synedra, Cosmarium, Nostoc, Surirella, Fragilaria, Chlorella, Chroococcus, Diatome, Tabellaria* and *Navicula*
5	Baceman	*Synedra, Chlorella, Melosira, Nitzschia,* and *Tabellaria*
6	Jurug Bridge	*Synedra* and *Nitzschia*

Source: JICA Study Team

d. Macro-Benthos

Survey results are summarized in Tables 3.5.20, and the inventory result of macro-benthos indicated the following:

The number of macro-benthos identified at each station ranged from 5 to 7 species, which is more even than the case of plankton species. Among the macro-benthos species identified to inhabit, *Margaritiferidae, Sphaeriida*e and *Thiaridae* are identified to habit at every station.

At location No. 6, *Tubifex* and *Chironomidae* dominated and these species are filter feeder and feed detritus that are the indicator of polluted water, which is in line with the survey results of water quality and plankton.

Table. 3.5.20 Distribution of Macro-benthos at Measurement Station

No	Species	Density*					
		St. I	St. II	St. III	St. IV	St. V	St. VI
1	*Margaritiferidae*	++	++	++	++	++	+
2	*Sphaeriidae*	++	++	++	++	+	+
3	*Thiaridae*	++++	+++	++	+++	+	+++
4	*Pomacea*		++	++	++	++	
5	*Larva Insect*	++	+	++			+++
6	*Tubifex*	+	+	++	++	++	++++
7	*Crabs*			++			
8	*Chironomidae*						+++
9	*Small crustacean*						++++
	Nos. of sepcies	5	6	7	5	5	7

Note) * : +; few, ++; moderate, +++; many, ++++; more
Source: JICA Study Team

d. Nekton (Fish and Shrimp)

Survey results are summarized in Tables 3.5.21 through 3.5.24, indicating the following points:

Inventory: As listed in Table 3.5.21, the number of fish species including shrimp species identified as a result of inventory survey was 14 in total. The number at station No. 1 was the most (9 species), followed by station No. 3 (6 species).

Data on fish species reported by local fishermen to have caught in 2005 (Table 3.5.22) indicated a total of 34 fish species and 2 shrimp species. Dominant family is Cyprinidae (consisting of 11 species), followed by Cichlidae (4 species), Pangasidae (3 species), Bagridae (3 species), and Ospronemidae (2 species).

This data on fish species is almost same as the survey result of Utomo et. Al (2005) which recorded 38 species of fish along the Bengawan Solo river from Wonorigi reservoir until the river mouth near Surabaya.

All of the inventoried fish species are commonly found in the waters in Indonesia and none of species is listed as endangered species nor designated as Protected Species by Government Regulation No. 7/1999 regarding Conservation of Plant and Animal Species.

Fish Ecology: Most of Cypinidae species are herbivorous feeding phytoplankton, plant, algae, root of plant, or omnivorous which can also feed zoo benthos, worm, insect, detritus. Species of Cichidae deed phytoplankton and benthic algae (Refer to Table 3.5.24).

Carnivous fish species are Hampala macrolepidota, which deed fish and aquatic insects. Species of Bagridae and Pangasidae have similar behavior; they feed detritus, insects, worms, crustaceans and fish.

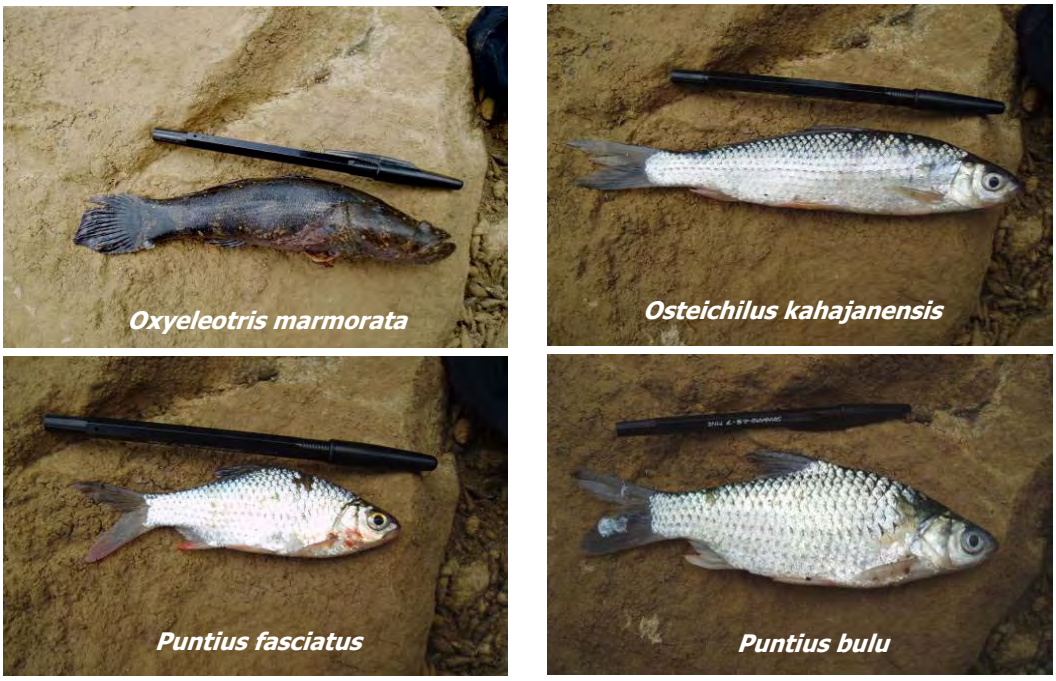
Family of Cyprinidae spawns in the rainy season, especially in early rainy season when water level begins to rise although some species can spawn throughout the rainy season such as Hampala sp. On the other hand, fish species of Pangasidae, Bagridae family spawns in dry season (Refer to Table 3.5.24).

Table. 3.5.21 Fish Species caught during Inventory Survey

No.	Local Name	Scientific Name	Station identified
1	Bader	*Puntius bulu*	1, 3
2	Bader	*Puntius fasciatus*	1, 3, 4
3	Wader	*Osteichilus kahajanensis*	1, 3
4	Wader	*Rasbora vaillanti*	1, 3
5	Nila	*Oreochromis niloticus*	1
6	Sapu-sapu	*Liposarcus pardalis*	4, 5, 6
7	Betutu	*Oxyeleotris marmorata*	1
8	Jambal siam	*Pangasius* sp.	1
9	Wader cethul	*Lebistes* sp.	3, 4, 5, 6
10	Boso	*Callogobius hasselti*	4
11	Wader	*Mystacoleucus marginatus*	1, 3
12	Uceng	*Nemachilus* sp.	4
13	Keting	*Mystus gulio*	1
14	Julung tawar	*Hemirhamphodon* sp.	5, 6

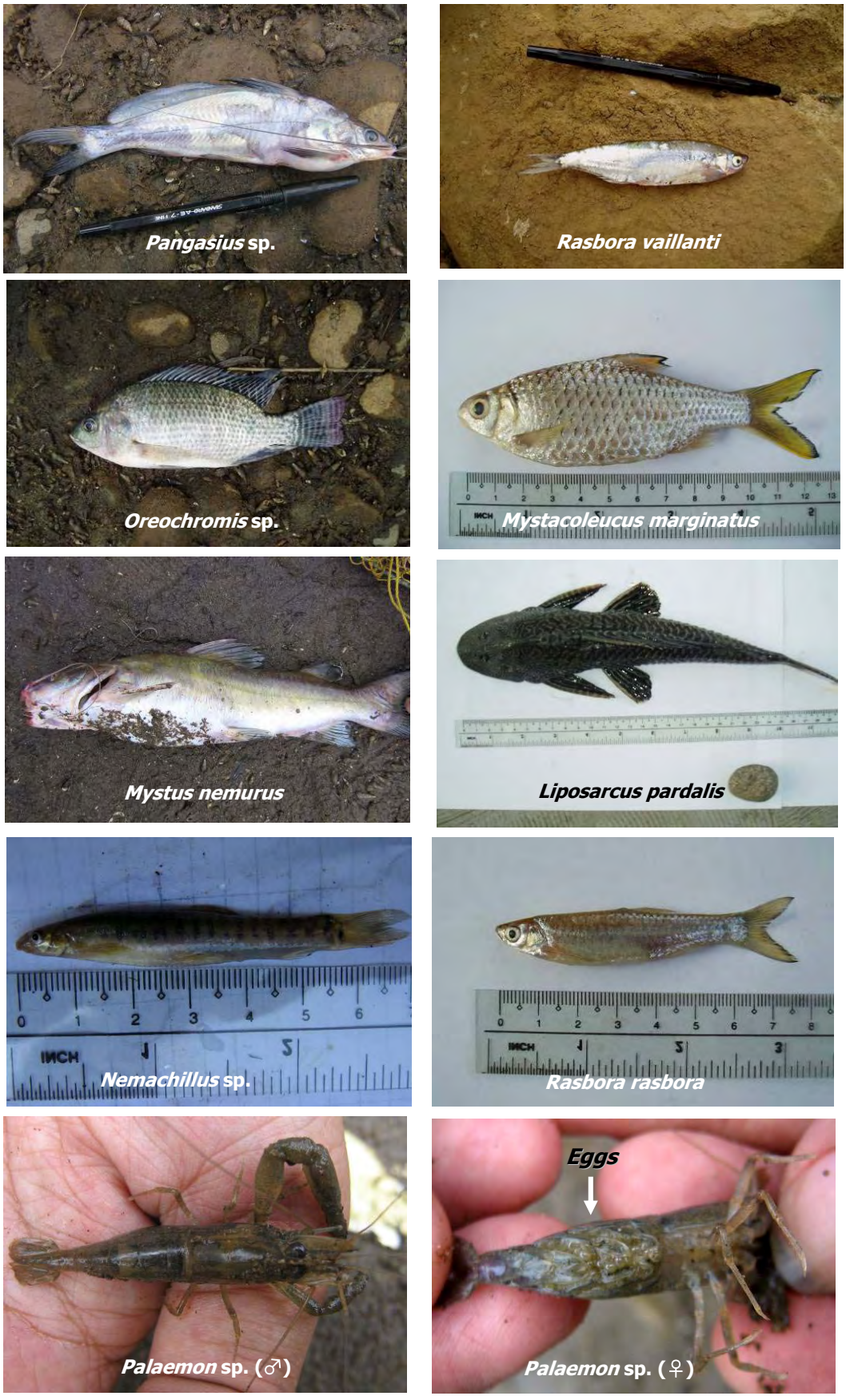
Source: JICA Study Team

Note) None of fish was caught at station II, supposedly because poison fishing was done on the previous day according to local fisherman.



Source: Primary Data of JICA Study Team

Figure 3.5.10 Photo of Nekton (Fish and Shrimp) Inventoried in the Bengawan Solo River



Source: Primary Data of JICA Study Team

Figure 3.5.10 Photo of Nekton (Fish and Shrimp) Inventoried in the Bengawan Solo River (Cont.)

Table 3.5.22 Fish/shrimp Species Reported to be Caught in 2005 by Local Fishermen

No.	Local Name	Scientifiec Name	English Name	Familia
1	Bader	*Puntius gonionotus*	Barb	Cyprinidae
2	Tawes	*Puntius javanicus*	Barb	Cyprinidae
3	Keprek abang	*Puntius sp.*	Barb	Cyprinidae
4	Bang-bangan	*Cyclocheilichtys enoplos*	Barb	Cyprinidae
5	Karper lumut	*Osteochilus schlegelii*	Carp	Cyprinidae
6	Lukas	*Dangila cuvieri*	Carp, minnow	Cyprinidae
7	Seren	*Cyccheilichthis* sp.	Carp	Cyprinidae
8	Wader	*Mystacoleucus marginatus*	Carp	Cyprinidae
9	Nilem	*Osteochilus hasseltii*	Silver sharkminnow	Cyprinidae
10	Palung	*Hampala macrolepidota*	Hampala barb	Cyprinidae
11	Wader	*Rasbora* sp.	Scissortail rasbora	Cyprinidae
12	Jambal siam	*Pangasius hypopthalmus*	Shark catfishes	Pangasiidae
13	Jambal lokal	*Pangasius nasutus*	Shark catfishes	Pangasiidae
14	Wagal/jendil	*Pangasius polyuranodon*	Shark catfishes	Pangasiidae
15	Garingan	*Mystus microcanthus*	Asian redtail catfish	Bagridae
16	Keting	*Mystus gulio*	Long whiskers catfish	Bagridae
17	Sogo/tagih	*Mystus nemurus*	Asian redtail catfish	Bagridae
18	Mujahir	*Orechromis mossambicus*	Mozambique tilapia	Cichlidae
19	Nila	*Oreochromis niloticus*	Nile tilapia	Cichlidae
20	Lele lokal	*Clarias batrachus*	Walking catfish	Clariidae
21	Lele dumbo	*Clarias gariepinus*.	African catfish	Clariidae
22	Sepat siam	*Trichogaster pectoralis*	Snakeskin gourami	Osphronemidae
23	Sepat rawa	*Trichogaster tricopterus*	Three spot gourami	Osphronemidae
24	Belut	*Monopterus albus*	Swamp eel	Synbranchidae
25	Betik	*Anabas testudines*	Climbing Pech	Anabantidae
26	Betutu	*Oxyeleotris marmorata*	Marble goby	Eleotridae
27	Bloso	*Callogobius hasselti*	Hasselt's goby	Gobiidae
28	Julung Tawar	*Hemirhamphodon* sp.	Needle fish	Hemithampidae
29	Kutuk	*Chana striata*	Snakehead murrel	Chaniidae
30	Lemper	*Notopterus notopterus*	Bronze featherback	Notopteridae
31	Lempuk	*Ompok bimaculatus*	Butter catfish	Siluridae
32	Sapu-sapu	*Liposarcus pardalis*	Amazon sailfin catfish	Loricariidae
33	Uceng	*Nemachilus* sp.	River loach	Balitoridae
34	Wader cethul	*Poecilia* sp.	Guppy	Poecilidae
35	Urang	*Macrobrachium* sp.	Freshwater giant prawn	Palaemonidae
36	Urang	*Palaemon* sp.	Freshwater prawn	Palaemonidae

Source: Interview survey with local fishermen

Table 3.5.23 Food Item of Main Fish Species Inhabiting in the Bengawan Solo River

No	Scientific Name	Familia	Food Item
1	*Osteichilus kahajanensis*	Cyprinidae	Phytoplankton, plant, benthic algae/weeds
2	*Rasbora vaillantii*	Cyprinidae	Benthic alga, weeds, worm
3	*Rasbora rasbora*	Cyprinidae	Benthic alga, detritus, worm, weeds
4	*Puntius bulu*	Cyprinidae	Submerged plants as well as on some filamentous algae and insects, zoobenthos
5	*Puntius fasciatus*	Cyprinidae	Filamentous alga, submerged plant, zoobenthos and insect.
6	*Mystacoleucus marginatus*	Cyprinidae	Zoobenthos, benthic algae/weeds, plant, crustacean, worm, annelid
7	*Cyclocheilichthys enoplus*	Cyprinidae	Bivalves, roots of plants, zooplankton, green algae, insect larvae, crustaceans and fish
8	*Hampala macrolepidota*	Cyprinidae	Fish and aquatic insect.
9	*Dangila cuvieri*	Cyprinidae	Phytoplankton, periphyton, benthic algae and zooplankton
10	*Osteochilus hasselti*	Cyprinidae	Roots of plants, unicellular algae, on periphyton, phytoplankton and some crustaceans.
11	*Mystus gulio*	Bagridae	Detritus, zoobenthos, zooplankton, benthic invertebrates
12	*Mystus nemurus*	Bagridae	Exogenous insects, aquatic insect larvae, shrimps, other crustaceans and fishes
13	*Pangasius* sp.	Pangasiidae	Benthic insect larvae, worms, crustacean, mollusks, insects, submerged plants and seeds
14	*Pangasius hypophthalmus*	Pangasiidae	Feeding on fish and crustaceans as well as on vegetable detritus
15	*Monopterus albus*	Synbranchidae	Fishes, worms, crustaceans, and other small aquatic animals, and also feeds on detritus.
16	*Oreochromis* sp.	Cichlidae	Phytoplankton, benthic algae
17	*Oxyeleotris marmorata*	Eleotridae	Small fishes, shrimps, aquatic insects, mollusks and crabs
18	*Channa striata*	Channidae	Fish, frogs, snakes, insects, earthworms, tadpoles and crustaceans
19	*Macrognathus aculeatus*	Mastacrembelidae	Detritus, insect larva
20	*Ompok bimaculatus*	Siluridae	Vegetable matter, fish, crustaceans, insect and mollusks
21	*Clarias batrachus*	Clariidae	Insect larvae, earthworms, shells, shrimps, small fish, aquatic plants and detritus
22	*Clarias gariepinus*	Clariidae	Insect larvae, earthworms, shells, shrimps, small fish, aquatic plants and detritus
23	*Trichogaster* pectoralis	Osphronemidae	Aquatic plants, invertebrates, detritus
24	*Liposarcus pardalis*	Loricariidae	Amorphous particulate organic matter, filamentous algae

Source: Information from secondary data including literature, web sites and interview with authorized experts.

Table 3.5.24 Spawning Habits and Season of Fish in the Bengawan Solo River

No	Scientific Name	Familia	Spawning
1	*Osteichilus kahajanensis*	Cyprinidae	Guarders, nesters. Spawning during rainy season, especially at early season.
2	*Rasbora vaillantii*	Cyprinidae	Nonguarders, open water/substratum egg scatterers. Spawning all year, peak at rainy season.
3	*Rasbora rasbora*	Cyprinidae	Nonguarders, open water/substratum egg scatterers. Spawning all year, the peak at rainy season.
4	*Puntius bulu*	Cyprinidae	Nonguarders, open water/substratum egg scatterers. Spawning at dawn, the early of rainy and dry season.
5	*Puntius fasciatus*	Cyprinidae	Nonguarders, open water/substratum egg scatterers. Spawning at dawn, the early of rainy and dry season
6	*Mystacoleucus marginatus*	Cyprinidae	Spawns when water levels begin to rise, during rainy season, especially at early season
7	*Cyclocheilichthys enoplus*	Cyprinidae	Spawns during the rainy season, probably on the floodplains or inundated riparian forests.
8	*Hampala macrolepidota*	Cyprinidae	Spawns throughout the rainy season (October-March).
9	*Dangila cuvieri*	Cyprinidae	Spawns all year, mainly at dry season.
10	*Osteochilus hasselti*	Cyprinidae	Spawns during the rainy season, especially at early season
11	*Mystus gulio*	Bagridae	Spawns all year
12	*Mystus nemurus*	Bagridae	Spawns during May-July
13	*Pangasius* sp.	Pangasiidae	One clear seasonal peak per year, April-July
14	*Pangasius hypophthalmus*	Pangasiidae	Non guarders, open water/substratum egg scatterers. One clear seasonal peak per year, May-June
15	*Monopterus albus*	Synbranchidae	Spawning all year, mainly at rainy season
16	*Oreochromis* sp.	Cichlidae	Spawning all year, the peak at the early of rainy and dry season
17	*Oxyeleotris marmorata*	Eleotridae	Guarders, nesters. Spawns all year, mainly at dry season.
18	*Channa striata*	Channidae	Guarders , clutch tenders. Breeds in ditches, ponds and flooded paddy fields. Spawns all year.
19	*Macrognathus aculeatus*	Mastacrembelidae	Nonguarders, open water/substratum egg scatterers
20	*Ompok bimaculatus*	Siluridae	Spawns at the early of dry and rainy season
21	*Clarias batrachus*	Clariidae	Spawning period is during the rainy season, when rivers rise. One clear seasonal peak per year. One clear seasonal peak per year
22	*Clarias gariepinus*	Clariidae	Spawning period is during the rainy season, when rivers rise
23	*Trichogaster* pectoralis	Osphronemidae	Guarders, nesters. Spawn all year.
24	*Liposarcus pardalis*	Loricariidae	Spawns all year.

Source: Information from secondary data including literature, web sites and interview with authorized experts.

(4) Protected Species

1) Purpose

The survey of protected species was conducted aiming to collection of data and information on the ecology of nine fauna species which were informed to inhabit in the Wonogiri reservoir watershed by Forest Conservation Bureau, Region II, Surakarta, Central Java Province, during IEE Study. The survey result will be used as basis for the impact prediction and evaluation.

2) Targeted Species

Targeted species for the survey are listed in Table 2.6.10 (Refer to Section 2.6 Existing Environment, Chapter 2 Initial Environmental Examination.).

3) Methodology

Collection of data and information on ecology of the protected species, such as environment of habitat, location of spawning ground and period, food, etc., was conducted based on literature survey. The possibility of inhabit of the protected species in question in and around the Project site was judged comprehensively based on all the information and data obtained during this EIA Survey.

4) Result

Table 3.5.25 shows ecological characteristics of protected species. Among the species listed in the table, information on Porcupine (*Hystrix brachyuran*) was obtained from local people. It was confirmed that Porcupine inhabit in Desa Jendi, Kecamatan Girimarto, Kabupaten Wonogiri (refer to Figure 3.5.11). In addition, according to an article of newspaper (Suara Merdeka, on June 22nd, 2006), there was information that Leopard (*Panthera pardus*) was identified to inhabit in Desa Tanjungsari, Kecamatan Jatisrono in Kabupaten Wonori, located south slope of Mt. Lawu.

Table 3.5.25 Ecological Characteristics of Protected Species

Class	Scientific Name	English Name	Local Name	Habitat	Food	Spawning ground /period
Mammal	*Muntiacus muntjak*	Antelope	Kijang	Forest with shrubs/ herbals	Young leaf of grass, trees and fruits	December to January
	Panthera pardus	Leopard	Macan tutul	Thick, wide forest with a lot of shrubs	Small mammals or birds	
	Cynogale benneti	Civet	Musang air	Shrubs around river or pond / lake	fishes	
	Hystrix brachyuran	Porcupine	Landak	Under trees, especially bamboo, inside the hole dug.	insects	2-3 times per year, 2 young born in a litter
	Manis javanica	Anteater	Trenggiling	Forest with shrubs	Insects (ant)	
Aves	*Alcedinidae*	Kingfisher	Raja udang putih	Trees around river or pond / lake	fishes	In a hole type nest on a cliff
	Bubulcus ibis	Cattle egret	Kuntul	Trees around swamp / pond / lake	Insects, fishes, frog	Nesting on trees, coincided with food availability, usually wet season
	Accipitridae	Eagle	Elang	Forest	Smaller birds, rabbit and other small mammals	
	Leptoptilos javanicus	Lesser adjutant	Bangau tontong	Trees around river / pond / lake	Fishes	

Source: Secondary data

Source: JICA Study Team

Figure 3.5.11 Nest of Porcupine (*HystrixBbrachyuran*) Identified in Desa Jendi, Kecamatan Girimarto

3.5.3 Socio-economic Environment

(1) Purpose

Survey on socio-economic environment was conducted aiming to understand the current situation of socio-economy and socio-cultural conditions in and around the Project site. The data and information are the basic condition for the impact prediction and evaluation.

(2) Scope of the Survey

Survey on socio-economic environment in this EIA Study covers and consists of the following issues:

No.	Category	Elements
1	Socio-economy	Demography, Livelihood condition, Land use, Land ownership, Land price, Recreational activity
2	Socio-culture	Perception on Wonogiri reservoir, Religion, Education, Conflict mediator / Leadership, Unrest/Opposition to the Project, Tradition and Custom, and Cultural heritage.

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(3) Methodology

Data collection for social conditions were carried out by the following methods:

- Literature survey (secondary data collection),
- Questionnaire survey, and
- Interview survey (in-depth interview).

Literature survey was carried out for collection of statistical data on demography, economic condition, land use condition, religion and education. Questionnaire survey was carried out for collection of specific data on livelihood condition, perception on the Project, conflict/unrest/opposition. Interview survey was further made for identification of features and characteristics of socio-economy and socio-culture.

The number of respondents of questionnaire and interview survey is 100 persons. Respondents were randomly chosen from the following four (4) villages (Refer to Figure 3.5.12.), with a quota of 25 respondents each:

1) Desa Pokoh Kidul (as the representative area located near the Project site),
2) Desa Pondoksari (ditto),
3) Desa Gedon (as the representative area of watershed conservation), and
4) Desa Jendi (ditto).

In addition, another 40 respondents, whose occupation is sand miner, inland navigation operator, or fishermen, were chosen along the Bengawan Solo river for data collection on socio-economic condition.

(4) Result

1) Socio-economy

a. Demography

Basic demographic statistics of the four the surveyed villages are as follows:

Table 3.5.26 Demographic Statistics of the Surveyed Villages

Item	Pokohkidul	Pondoksari	Gedong	Jendi
Area (km^2)	9.71	5.73	10.19	3.02
Population	5,351	2,421	4,735	3,715
Nos. of households	1,180	511	1,165	786
Average family size (persons/family)	4.5	4.7	4.1	4.7
Population density (prs/km^2)	551	422	464	1,230
Agricultural population density* (persons/ha)	5.5	8.0	4.7	12.7
Dependency ratio**	1.23	0.39	0.64	0.56

Source: Statistics Office of Kabupaten Wonogiri, 2004

Note) *: Agricultural population density is defined as the ratio of population divided by agricultural area (ha).
**:Dependency ratio is defined as the ratio of population of people with age of under 14 plus over 60 divided by population of people with age between 15 – 59.

b. Livelihood condition

Regarding occupation, farmer is the majority (85%) in the surveyed villages, followed by laborers (5%), office workers (3%) and fishermen (3%). Most of people have two types of occupation: primary occupation and secondary one.

Income of the people in the surveyed villages comes from primary as well as secondary jobs as mentioned above. Average income is estimated to be Rp. 7.265 million / year, or Rp. 605,000/month according to questionnaire survey. Assuming the average family size as 4.5, per capita income is Rp. 1.614 million / year, which is equivalent to 428 kg of rice (as a price of rice is Rp. 3,600/kg.) Based on the criteria of Sayogya (1978), they are categorized as "poor people (<480 kg of rice)."

Regarding the people along the B. Solo river, average income of sand miner is the most (Rp. 892, 000 / month on average), followed by operation of inland navigation operator (Rp. 635,500) and fisherman (Rp. 432, 000).

c. Land use

Land is a main asset for farmers and in the target villages it is usually divided into three categories: 1) paddy field (sawa), 2) upland field (tegalan) anf/or orchard (kebun), and 3) home yard. The average area of these land categories is shown in table below:

Table 3.5.27 Average Area of Land Asset in the Surveyed Vallages

No	Type of land	Average area (ha)	Percentage (%)
1.	Paddy field:		
	land I	0.15	25.4
	land II	0.03	5.1
	SubTotal	0.18	30.5
2.	Upland field :		
	land I	0.23	39.0
	land II	0.02	3.4
	land III	0.01	1.7
	SubTotal	0.26	44.1
3.	Homeyard:		
	land I	0.15	25.4
	land II	0.003	0.5
	SubTotal	0.15	25.9
	Total	0.59	100

Source: Result of primary data analysis, JICA Study Team, 2006

On average, farmers possess two locations of paddy field but the area is less 0.2 ha in total. Regarding upland field, they have it at three (3) locations, and for home yard, they have two (2) locations. The total area of lands belonging to each respondent is 0.59 ha on average. In upland fields, the products of *palawija* crops, e.g., maize and cassava, are dominant.

The dominant livestock in the surveyed villages is cow and goat while the buffalo and pig is very rare. Cow and goat are common because of easy maintenance and production of fertilizer as by-product of breeding. Regarding husbandry, chicken is the dominant in this area, while duck and goose is rare.

d. Land ownership

Status of land ownership and its manner of transaction is shown in table below. Land authority of respondents is usually derived from trading or inheritance. It should be noticed in the table below that paddy or upland fields on green belt or *tidal low land area*, i.e., area located at the elevation in-between high water level and low water lovel of Wonogiri reservoir, are not permitted for cultivation at present. Nevertheless, 30 – 40 % of respondents are using the area for their cultivation although they recognize these lands belong to the government (BBWS BS).

e. Land price

Land price in the surveyed area is shown in the table below:

Table 3.5.28 Land Price Around the Project Site

Location	Average land price (Rp. / m^2)	Remarks
Dusun Petir, Desa Pokoh Kidul	40,000 – 60,000	Market price
Desa Pondoksari	20,000 – 30,000	Ditto
Desa Jendi	approx. 20,000	Ditto
Desa Gedong	30,000 – 50,000	Ditto

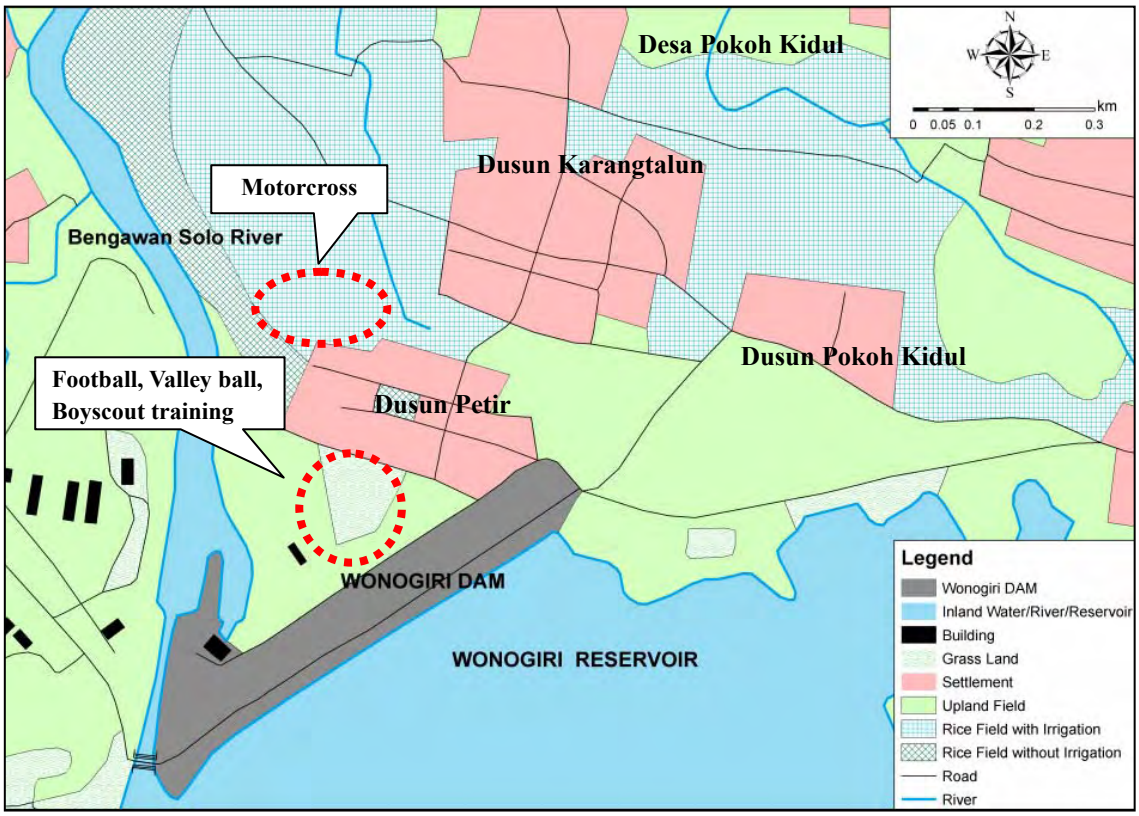
Source: Interview survey with Local people

f. Recreational activity

Local people often use some areas around Wonogiri reservoir, especially in the vicinity of dam site, for their recreational and education activities, including:

- Football and valley ball,
- Boyscout training, and
- Motocross

The main locations for these activities are shown on Figure 3.5.13. Among these activities, motocross will not be continued because they are often criticized by nearby residents due to noise problem.



Source: JICA Study Team

Figure 3.5.13 Location of Recreational Activity around Wonogiri Dam

2) Socio-culture

a. Perception on Wonogiri reservoir

- There are many people (57%) who give little attention to the Wonogiri reservoir so the sedimentation problems in the reservoir is not properly understood by local people although the sedimentation issue itself is informed to them through mass media.
- Most of the people (74%) regarded Wonogiri reservoir as such that gives more advantages to the people in Kabupaten Sukoharjo, Karanganyar, Surakarta, Sragen, Boyolali and East Java Province.
- One of the people's need/hope is to get detailed information about the project activities. Many people expect the socialization of the Project activities in advance.
- Another request of the local people is the recruitment of them for the project-related jobs, especially of farmers who do not have own fields for cultivation or who are unemployed.
- Local people expect that the sluicing can be done in rainy season so that it will flow away through the gate and drain rapidly.
- Many people have the perspective that there will be no harmful impact on the Bengawan Solo river as long as the sluicing does not make shallow the river, make flood or kill the fish.
- Most of people (73%) agree to the Project activities to sluice sediment deposits in the reservoir to the Bengawan Solo river while there is a few people (4%) who disagree to the Project and feel worry since they believe that sluicing may be harmful for the paddy field and fish in the river.

- Many respondents expect (48%) that the project will create new job opportunity, especially for the unemployment or no-land farmers. At the same time, however, they (60%) indicate that the project will affect farmers who work at the *tidal low land area* in the reservoir and fishermen who work in the Bengawan Solo river.

b. Religion

- Almost all of people (98%) in the Study area are Moslems and a few of them (1.8%) are Christian. There is only a few (0.2%) Buddhist but no Hindu. There has been no problem such as violence caused by the conflict among different religion so far.

c. Education

- Most of local people (62.6%) are in a low level of education as they did not graduate from any of school or graduated only from elementary school. This is followed by the people who graduated from junior high school (20.3%). The people who graduated from senior high school or college/university are relatively small ratio (17.1%).

d. Conflict mediator / Leadership

- Village head and religious figure are thought to be proper mediator when a conflict among the people happens. A majority of local people (81%) have much faith on the government as a conflict mediator. The village elderly and police officer are the other conflict mediator in people's point of view.
- Another solution to solve conflict is using a society discussion forum, commonly called as "*musyawarah*."
- Based on in-depth interview, it was revealed that no conflict which arouses a violence ever occurred in the Study area, which indicates that this area is a rather peaceful and moderate society.
- That is, therefore, why there is no figure of a spiritual leader (*Kyai*) or other figures to be a leader in the society as a negotiator or a mediator for conflict.

e. Unrest / Opposition to the Project

- From in-depth interview, it was revealed that there is no interest group, who is in opposition to the project implementation, but the potential of quasi groups, which consists of people who discuss the impact to be caused by the project upon people's life, already exists.

f. Tradition and Custom

- There existed a traditional "Cleaning Ceremony," in the Study area. This ceremony is a big occasion for the villagers to be grateful for the gifts and welfares given by God. The villagers cleaning ceremony is lead by the village elderly and commonly performed in the month of *Suro* in Javanese calendar.
- There are so many sacred places around Wonogiri dam reservoir such as cemetery or big tree. Local people believe that the sacred places have magic that can guard it by holy spirits. Nowadays, however, the belief on the traditional myth of sacred places has gone away as the result of development of religions in the society.

g. Cultural Heritage

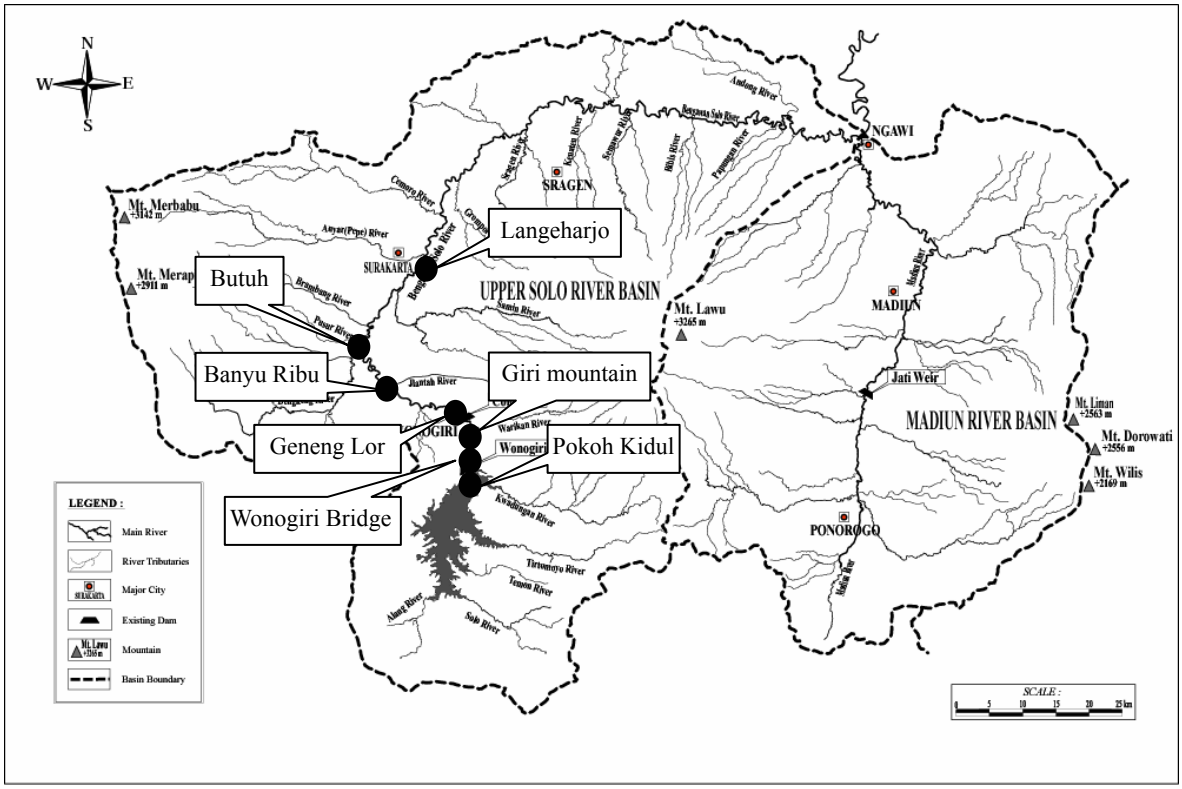
- Along the Bengawan Solo river, there still conducted the ceremony of "*Bersih Deso*," or village cleaning. It is also called as "*Rosulan*." The activity is held on the river banks organized and supported by local government.

- There are several cultural heritages along the Bengawan Solo river as listed below:

Table 3.5.29 Cultural Heritage Along the Bengawan Solo River

No.	Name	Description
1	*Jamasan* and *Ruatan*	• A traditional ritual in cleaning sacred items in Kab. Wonogiri, conducted in the month of *Suro* (Javanese Calendar), • This ceremony is promoted by Tourism and Art Board Sub-agency of Kab. Wonogiri.
2	*Ritulasan* Event	• A competition that utilizes river, such as Pillow Battle (*Gepuk Guling*), Catching Ducks in the river, and Boat Race. • It is held by *Karang Taruna,* or youth group, in Kab. Wonogiri and Kab. Sukoharjo.
3	*Gethek Joko Tingkir*	• A joint event of Kab. Wonogiri, Sukoharjo, Surakarta, Karanganyar and Sragen in order to vitalize tourism. • This event originated from *Joko Tingkir* who is a well-known Javanese who traveled in the Bengawan Solo river. • The event was held in 2002 but was stopped from then because of non-success and budgetary reasons.
4	*Grebeg Syawal* and *Larung Joko Tinngkir*	• An event covering various art performance annually held by Kota Surakarta. • It is held for a week at Jurug Recreation Park located along the Bengawan Solo river after the Moslem ceremonial day of Idul Fitri.
5	*Kungkum*	*Kungkum* is an activity to sit periodically in the river for a certain hours to have heart contemplation. The Bengagawan Solo river is one of the objects for it. Not only the people who live near Bengawan Solo river but also those who live far from it often participate in the ceremony. Major places for *Kungkum* are as follows (Refer to Figure 3.5.14): 1) Kab. Wonogiri: • Desa Pokoh Kidul (below PLTA), Kota Wonogiri, • Mento Wonogiri bridge, Kota Wonogiri, • Under Giri mountain, Kota Wonogiri, and • Geneng Lor (confluence of Aser and B. Solo rivers), Kota Wonogiri. 2) Kab. Sukoharjo • Banyu Ribu, Kecamatan Tawangsari, • Butuh, Kecamatan Baki, and • Langeharjo, Kecamatan Grogol

Source: JICA Study Team



Source: JICA Study Team

Figure 3.5.14 Location of Major Places for Traditional Custom "*Kungkum*"