Supporting Report (D) Flood Forecasting and Warning System

PREPARATORY SURVEY FOR THE PROJECT ON THE DISASTER PREVENTION AND MITIGATION MEASURES FOR THE ITAJAI RIVER BASIN

DRAFT FINAL REPORT

VOLUME I : SUPPORTING REPORT ANNEX D: STRENGHTENING OF EXISTING FFWS

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CHAPTER 1 INTRODUCTION

1.1 Background

An Integrated Plan for Prevention and Mitigation of Natural Disaster Damage Risks in the Itajai River Basin (Plano Integrado de Prevencao e Mitigacao de Desastres Naturais na Basia Hidrografica do Rio Itajai) was formed by the S.C. state government in September 2009. The plan lists up 6 programs with 77 projects, which were proposed by Technological and Scientific Group (GTC). In the plan, one of the highest priority programs focuses to "Strengthen the monitoring and warning system" for natural disasters in the Itajai River Basin.

This study particularly focuses on the prevention and mitigation of flood disasters. This involves three stages (1) preparation for disaster prevention before flood events; (2) disaster measures at floods; (3) restoration and recovery after floods.

Within these stages, a series of activities: observation, data management (data transmission and monitoring), weather and flood forecasting, warning, evacuation and flood prevention is defined as "Flood Forecasting and Warning System (FFWS)" in this report.

1.2 Main objectives

This supporting report, Annex D reviews the present condition of the prevention and mitigation activities for flood disasters, especially FFWS, in the Itajai River Basin. In addition, this report aims to propose a master plan for strengthening FFWS.

The following points shall be indicated in this report.

- 1) Improvement of observation and monitoring system by installing new gauging stations and monitoring centre.
- 2) Evaluation of the existing forecasting methods and suggestion for future requirements.
- 3) Improvement of warning system using GPRS telecommunication system.
- 4) Establishment of new institutional organization and river management system including flood prevention and mitigation measures.
- 5) Estimating the cost for proposed FFWS.

CHAPTER 2 EXISTING CONDITIONS

2.1 Features of Itajai River

The Itajai River Basin ranges from Rio do Sul city in northern area of Santa Catalina state down to the Itajai Estuary; it is across three major municipalities, Rio do Sul, Blumenau and Itajai. The catchment area is 15,500 km² and the water source mainly comes from the mountainous region of Serra Geral.

The length of the Itajai River is approximately 250 km and it flows into the Sul and the Oeste River and they meet at Rio do Sul city. There are two dams in upstream, the Sul dam (catchment area of 1,273 km2) and the Oeste dam (catchment area of 1,042 km²). The Norte River (catchment area of 2,318 km²) joins into the Itajai River at Apiuna city which is located in 130 km from the Itajai estuary. The Cedros River flows into the Benedito River at Timbo city and it meets the Itajai River at Indaial city. The river slope is 1/500 and the torrent flow continues up to Blumenau city which is located 70 km from the estuary. However, the downstream of Blumenau is almost flat with 1/3,500 slope including Gaspar and Ilhota city. Furthermore, the Luis Alves River (catchment area of 580 km²⁾ flows into the Itajai River at 37.3 km upstream of Itajai city and the Mirim River (catchment area of 1,207 km²) which flows down from Bursque city meets the main river of Itajai River at Itajai city. The longitudinal profile of the Itajai River is shown in Figure 2.1.1.



Figure 2.1.1 Itajaí River Declivity Course

The river basin is classified into upper-basin, middle-basin and lower-basin according to its characteristics (Table 2.1.1). The upper-basin has Sul dam and Oesta dam for flood control purpose, the middle-basin has Norte dam also for flood control, and Bonito and Pinhal dams for power generation. The river merges into the Benedito River and then confluence with the Itajai River at Indial city.

Supporting	Report	Annex	D
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Table 2.1.1		Characteristics of the Itajai River Basin		
Itajai River	From	Slope	Basin Area	Remark
Upper Basin	190 km	1/1,200	5,041km ²	The area is mountain area more than 300m altitude, the slope around Rio do Sul is flat level and the flow is slow velocity.
Middle Basin	70 km	1/500	11,922km ²	From Rio do Sulto Blumenau, the slope is steep and the flow confluence with the Norte and Benedito river.
Lower Basin	0 km	1/3,500	14,932km ²	Between Blumenau and Itajai estuary, the slope is almost all flat, and the flow is slowly.

Source: JICA Study Team

According to the characteristics of the Itajai River Basin, the distribution of flood discharge in 5 years, 25 years and 50 years probability is estimated as shown in Figure 2.1.2.



Figure 2.1.2 Distribution of Flood Discharge for the Itajai River Basin

2.2 Existing Integrated Plan for Prevention and Mitigation of Natural Disaster Damage Risks

The existing Integrated Plan for Prevention and Mitigation of Natural Disaster Damage Risks in Itajai River Basin (Plano Integrado de Prevencao e Mitigacao de Desastres Naturais na Basia Hidrografica do Rio Itajai) (PPRD-Itajai) was formed by the S.C. state government in September 2009. The plan lists up 6 programs with 77 projects which were proposed by Technological and Scientific Group (GTC) (Table 2.2.1).

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Table 2.2.1Integrated Plan for Prevention and Mitigation of Natural Disaster Damage
Risks in Itajai River Basin

Program	Detailed Measure	Priority		
	Institutional development for the preparation for emergencies and disasters			
	1a) Qualify human resources at basic, intermediary and advanced levels			
	1a1) Oualification of teachers, technicians and community leaders for the integrated			
	support to the civil defense (natural disasters, introduction of risk management and	3		
	environmental legislation).			
	1a2) Qualification of municipal technicians in risk management.	1		
	1a3) Creation of a post-graduate course on risk management.	3		
	1a4) Qualification of municipal technicians in geological, geotechnical and			
	master plans, qualification of planning technicians from municipalities associations	3		
	from Itajaí basin municipalities and from state agencies.			
	1a5) Conduction of seminars for the integration of regional, national and international	3		
	experiences about natural disasters.	3		
	1a6) Exchange between national and international institutions in the field of risk	3		
	1a7) Definition of cooperation with high education institutions to support the civil			
	defense.	2		
No.1	1b)Structure of civil defense and other related agencies			
	1b1) Restructuring and/or implementation of civil defense agencies at state and	2		
	regional level, according to the Law in force.	5		
	1b2) Restructuring and/or implementation of municipal civil defense coordination –	1		
	1b3) Recauling of institutions responsible for emergencies, members of the state and			
	municipal systems of civil defense, including purchase of equipment, vehicles, among	3		
	others, to support disasters preparation actions.			
	1b4) Development of municipal plan(s) of civil defense.			
	1b5) Articulation between civil defense plans and the instruments of the sanitation,	•		
	nousing, environment, water resources and urban planning instruments for each	3		
	1b6) Strengthening municipal environment agencies and municipal environment	_		
	councils.	1		
	1b7) Elaboration of the plan for the issuance of warning.	3		
	1b8) Preparation of the manual of critical situations procedures.	3		
	1b9) Periodic simulation and drill of the warning plan.	3		
	1b10) Strengthening of a local inter-institutional scientific advisory group for the	3		
	reduction of disaster risks.	3		
	Monitoring and warning system			
	2a) Institutionally strengthen the monitoring and warning system			
	2a1) Implementation of an inter-institutional arrangement to strengthen the Alert			
	system of Itajaí Basin (de INFRA, SDS, civil defense, Universities, Epagri/Ciram,	1		
	Itajai Committee/water agency Foundation), and improvesment of the contacts network of the alert system at the Itajaí Basin			
No.2	2b) Structure of the warning system (equipments, methodologies and supports)			
	the warning system	3		
	2b2) Maintenance and expansion of the hydro-meteorological-oceanographic			
	telemetric network at the Itajaí Basin.	1		
	2b3) Development of models to monitor and forecast extreme events.	2		
	2b4) Development of a hillsides monitoring system.	2		

	2b5) Development of environmental monitoring methodologies including use of satellite (for rainfall/temperature).	2	
	2b6) Development, implementation and validation of warning systems.	2	
	Perception, communication, motivation and mobilization for resiliency and reduction of vulnerability		
	3a) Diagnosis of natural disasters causes (landslides and inundations) from the point of view of the affected persons (perception).		
	3a1) Diagnosis of natural disasters causes (landslides and inundations) from the point of view of the affected persons (perception).	2	
	3a2) Production of educational material about: natural disasters management, risk situations, appreciation of human life, first aid and cardiorespiratory reanimation, and technical and legal criteria for the occupation of risk areas.	2	
	3a3) Socio-educational programs for natural disasters management and related themes.	2	
	3b) Implement social participation mechanisms		
	3b1) Qualification and mobilization of volunteers for the integrated support to the civil defense.	3	
No.3	3b2) Development and maintenance of a volunteers network to support civil defense in risks.	3	
	3b3) Development and maintenance of a bank of volunteer specialists to provide support at risks.		
	3b4) Protection of populations against focal disaster risks.	3	
	3 c) Establish partnerships with utilities providers and private companies aiming at risk reduction		
	3c1) Creation of the certification seal for companies that develop good environmental conservation practices, including earthworks practices.	2	
	3d) Establish culture and attitudes change in health and communication of epidemiological studies resulting from natural disasters		
	3d1) Studies on the implications of disasters on the human health.	3	
	3d2) Importance of personal and housing hygiene in preventing epidemics.	3	
	3d3) Formation of group for psychological assistance during disaster situations.	3	
	Evaluation of disasters risks reduction		
	4a) Develop basic and thematic maps		
	4a1) Aero-survey of S.C. (SDS – 1:10,000 – 2009/2011), with priority for Itajaí basin.	3	
	4a2) Elaboration of basic mapping (1:10,000 scale for the whole basin, and 1:2,000 scale for urban areas and potential higher risk areas).	1	
N0.4	4a3) Detailed maps on soils, geology, geotechnology, land use and others, per hydrographic basin, and their land use aptitude focused on risk areas.	2	
	4a4) Maps of available social equipments – such as temporary shelters – and of relevant public and private services in natural disasters situation including local roads, natural springs and alternatives of drinking water.	2	
	(4) Develop integrated system of information on disasters		

	4b1) implementation of an integrated information system in Geographic Information system environment, containing the cartographic base and thematic maps (including geology, geo-technology, soils, rainfall, occurrence of disasters, levels of rivers in respective sections with elevation-discharge curves, among others) based on the existing information in different institutions, such as ANA, ANEEL, SDS, CEOPS, EPAGRI/CIRAM, CPRM, IBGE, Universities, Prefectures, water agency Foundation of Itajaí Valley among others, considering the need of data conversion.	1			
	4c) Register and evaluate disasters risk				
	4c1) Analysis of meteorological systems, development and evaluation of intense rainfall models, and temporal and trend analysis of rainfall in Itajaí Basin.	2			
	4c2) development of methodologies for the identification and evaluation of risk, for different types of disasters that occur in Itajaí Basin.	3			
	4c3) Creating hazard maps of risk/multiple threats areas for developing a natural disasters registration system.	1			
	4c4) Elaboration of the geo-statistics and probability analysis of the occurrence of different types of threats in the region, and identification of higher risk potential regions.	2			
	4c5) Development of the Atlas of Natural Threats at Itajaí Basin.	3			
	4d) Evaluate the drainage network				
	4d1) Inventory and registration of interventions in water courses, and evaluation of activities developed in the drainage network: study of influence (positive and negative impacts) of non-structural changes executed in the basin, and of structural measures executed in the drainage network.	2			
	Reduction of disaster risks				
	5.1) Subprogram of land use and occupation management – non-structural				
	measures.				
	measures. 5.1a) Subsidize the development of municipal urban development legislation.				
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	5.1d1) Establishment of ecological economic zones as areas intended for the implementation of commercial forests.	3
	5.1d2) Developments and implementation of municipal plans of forest coverage maintenance and enrichment, and of expansion of vegetal coverage in the urban area.	2
	5.1d3) Re-capitations and maintenance of Permanent Preservation Areas.	2
	5.1d4) Incentives to the implementation of legal reservations.	3
	5.1d5) Studies for the adoption of payment for environmental services.	2
	5.1d6) Studies on the restoration in areas affected by landslides.	3
	5.1d7) Analysis of successful step of reforestation for the containment of landslides.	3
	5.1e) Adjust the land use in rural areas	
	5.1e1) planning agricultural properties according to the aptitude of the soil and to legal restrictions.	2
	5.1e2) Implementation soil management practices that respect their natural aptitude, as well as measures of utilization, retention and infiltration of rainwater in agriculture management, in order to support the storage of water, as well as to stimulate the increase of forest coverage.	2
	5.1f) Provide a proper destination to solid waste and debris	
	5.2) Sub-program of adequate management of water courses	
	5.2a) Keep water courses in their original configuration and revitalize changed water courses	
	5.2a1) Elaboration of criteria and a guiding manual for the management of water courses.	2
	5.2a2) Projects of rivers revitalization.	3
	5.2b) Multiple use of existing hydraulic structures	
	5.2b1) Execution of inventory of existing hydraulic structures (dams, rice pads, lakes, tanks, etc.), including the verification of the compliance with technical and legal criteria in their construction.	1
	5.2b2) Evaluation of effects of the existing hydraulic structures in absorbing flood waves, and study on the optimization of such system.	2
	5.2b3) Modeling of the hydrological, hydraulic and sedimentological behavior of the drainage network, based on an updated diagnosis of the hydraulic-sedimentological situation, for evaluation of interventions with structural measures.	2
	5.2b4) Feasibility studies on water retentions and storages (at microbasin scale) through the implementation of pilot-projects.	1
	5.2c) Manage urban drainage waters	
	5.2c1) Development of drainage plans (municipal), considering the utilization, retention and infiltration of water.	2
	5.2c2) Adjustment and maintenance of existing drainage systems, according to such plans.	2
	5.2c3) Implementation of new rainwater drainage systems.	2
No 6	Recuperation of areas affected by disasters	
INO.0	6a) Identify affected areas	

6a1) Mapping areas and quantity of families affected, and classification of areas per type of intervention: with removal and without removal of occupation.	1
6b) Environmentally recuperate occupied areas, in conjunction with civil works (totally keeping the current occupation)	
6b1) Elaboration of intervention project(s), with definition of interventions to be executed (structural and non-structural).	2
6b2) Execution of the above elaborated projects, followed by future monitoring and inspection of the area.	3
6c) Environmentally recuperate occupied areas, in conjunction with civil works (but totally or partially removing the current occupation)	
 6c1) Elaboration of intervention project(s), with definition of interventions to be executed (structural and non-structural), plus: Quantification of families to be removed; Determination of the approximate cost for the implementation of the removal measure, and Definition of area for the production of regularized land lots, with housing units and available infrastructure. 	3
 6c2) Execution of the intervention project(s) above elaborated, including: Awareness building and negotiation with families; Reallocation of families; Psycho-social follow-up of reallocated families; and Environmental recuperation, destination of use for the recuperated area, monitoring and inspection. 	3
6c3) Creation of conservation units in risk areas and high risk areas, where occupation is not allowed or recommendable.	3

Source: Plano Integrado de Prevencao e Mitigacao de Desastres Naturais na Basia Hidrografica do Rio Itajai

The programs and measures are listed under the "Master Plan for Water Resources in the Itajai River Basin" (Plano Director de Recursoso Hidricos da Bacai do Itaja) that shall be implemented by the Itajai Committee (Comite do Itajai) in the future. The detailed measures for each program indicate guide lines for the prevention and mitigation of natural disaster damage risks according to the GTC.

Of those 77 projects proposed by GTC, the high priority projects regarding FFWS are described following.

i) <u>Program No.1: Institutional development for the preparation for emergencies and disasters</u>

The following projects shall be prioritized to implement and the institutional organization for flood prevention shall be established a.s.a.p. including the river management organization.

- 1a2) Qualification of municipal technicians in risk management
- 1b1) Restructuring and/or implementing civil defense agencies at state and regional level, according to the law in force.
- 1b7) Elaboration of a plan for issuance of warning.
- ii) Program No.2: Monitoring and warning system

The following projects shall be prioritized to implement and the master plan of the proposed FFWS shall include the following projects.

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- Mitigation Measures for the Itajai River Basin
- 2a1) Implementation of an inter-institutional arrangement to strengthen the warning system of the Itajaí Basin (de INFRA, SDS, civil defense, Universities, EPAGRI/CIRAM, Itajaí Committee/water agency foundation), and improvement of the contacts network of the warning system at the Itajaí Basin.
- 2b2) Maintenance and expansion of the hydro-meteorological-oceanographic telemetric network at the Itajaí Basin.

iii) <u>Program No.4: Evaluation of disasters risks reduction</u>

The following projects shall be prioritized to implement. Currently, the measure 4a2 has been in progress, as implemented by S.C. State and the basic topography map is being prepared based on the aerophoto. The measures 4b1 and 4c3 shall be coordinated with the UN after establishing a structured organization for disasters as well as after forming a management system for flood prevention.

- 4a2) Elaboration of basic mapping (1:10,000 scale for the whole basin, and 1:2,000 scale for urban areas and potential higher risk areas). The Itajai River Basin particularly in urban cities adjacent to the river courses have started preparing for basic hazardous mapping (1:10,000 scale for the whole basin, and 1:2,000 scale for urban areas and potential higher risk areas) in accordance with the urban master plan. However, the hazardous map only covers the urban areas.
- 4b1) Development of an integrated information system using geographic information system; containing the cartographic base and thematic maps (including geology, geo-technology, soils, rainfall, occurrence of disasters, levels of rivers in respective sections with elevation-discharge curves, among others) based on the existing information in different institutions, such as ANA, ANEEL, SDS, CEOPS, EPAGRI/CIRAM, CPRM, IBGE, Universities, Prefectures, water agency Foundation of Itajaí Valley among others, considering the need of data conversion.
- 4c3) Creating hazard maps of risk/multiple threats areas for developing a natural disasters registration system.

iv) Program No.5: Reduction of disaster risks

The following projects shall be prioritized to implement with consideration of the land development plan for each city.

- 5.1a3) Revision, adjustment and update of the existing municipal master plans, including the risk reduction of municipal civil defense plans.
- 5.1a4) Development and approval of a Bill (of law) for the regulation and inspection of activities such as earthwork, sand extraction and rolling stone extraction.
- 5.2a1) Elaboration of criteria and a manual for the management of water courses.
- 5.2b4) Feasibility studies on water retentions and storages (at microbasin scale) through the implementation of pilot-projects.

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v) <u>Program No.6: Recuperation of areas affected by disasters</u>

The following project shall be prioritized to implement together with preparation of the land development plan as well as hazard maps development.

• 6a1) Mapping areas and quantity of families affected, and classification of areas per type of intervention: with removal and without removal of occupation.

2.3 Existing Institutional Framework

The present activities in relation to flood prevention and mitigation in the Itajai River Basin are shared among the various institutions depending on the scale of a disaster. The related institutions and their responsibilities are shown in Table 2.3.1.

Org	anization	Activity			
ANA	National Water Authority	ANA is responsible for policy execution and implementation of the national water resources in Brazil. ANA sets up hydraulic gauging stations all over Brazil and make the rainfall and river water level data available to the related institutions. In the Itajai River Basin, ANA owns 43 rainfall gauging stations and 23 river water level gauging stations. The past records from these gauging stations have been stored in a database and available to be downloaded on their website. However, most available data is daily record only. ANA is a national institution and so that			
		currently their data is not sent at real-time to state institutions such as CIRAM.			
EPAGRI/ CIRAM	S.C. state Agricultural Research/ Hydro- meteorology Information Centre	The information centre belonging to the Depart of Agriculture sends the meteorological data to the related organizations through the Internet. The S.C. state has precipitation stations at 41 locations and the river water level stations at 15 locations. The date is transmitted to the CIRAM Information centre by Tele-meteor or Satellite system. The CIRAM carries out simulation of weather forecast by using the data and other on-line information. The weather forecast is reported on the TV, Radio and WEB sites on the Internet. In a case of any emergencies, the CIRAM directly sends the forecast to the related organizations in the state.			
FURB CEOPS	Information system control centre in Blumenauz University	The control centre of flood Information system in Blumenau University, the flood forecast in Blumenau is executed by the precipitation and river water level of SDS separate from ANA/CIRAM. At flooding, the CONDEC with Mayor will be organized to issue a flood warning.			
UNIVALI	ITAJAI University	The university is a technical adviser for the Itajai municipality. Prof. Carvalho is a member of the Itajai River Basin Committee as well as the counterpart. The specialty of Professor is ocean and coastal engineering and in charge of the disaster prevention for flooding and reinforcement of monitoring for the Itajai River.			
UNIFEBE	Brusque University	The university is a technical adviser for Brusque municipality and plans flood control dams in upstream of the Mirim River.			
AMAVI	Association in upstream municipality of the Itajai River.	The municipal associations in upstream of the Itajai River report information of the river to the related organizations in order to manage the administration in upstream.			
AMMVI	Association in midstream municipality of the Itajai River	The municipal associations in midstream of the Itajai River report information of the river to the related organizations in order to manage the administration in midstream.			
AMFRI	Association in downstream municipality of the Itajai River	The municipal associations in downstream of the Itajai River report information of the river to the related organizations in order to manage the administration in downstream.			
SEDEC	Civil defense	The civil defense for the national disaster is activity for the emergency disaster.			

Table 2.3.1	Related Institutions in FFWS
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	for national level	and carried out the Policy and management concerning the civil defense in the all Brazil.
SDC	Civil defense for state level	The civil defense for S.C. state is sent out at medium scale disaster which is not managed by municipalities. The S.C. state consist 293 political regions and 36 rural administrations. However, civil defenses are only set up in 7 municipalities in the S.C. state, and only 3 municipalities in the Itajai River Basin. The SIEDEC carries out capacity building and training for disaster prevention for the civil defenses. The SIEDEC is also in charge of planning state policy for disaster prevention.
COMDEC	Commission of civil defense for municipality	The civil defense for municipalities is sent out at small scale disaster to guide the refuges. The CONDEC usually patrols, and trains/educates the related organizations for disaster prevention. At a disaster, civil defense has to report the damage situation to the CONDEC which is formed by the Mayor.
CD Municipal Council	Council for flood prevention in municipality	The council is consisted the chairman of the Mayor and the vice chairman of the civil defense, and instruct to the civil defense in order to issue the warning and smoothly evacuate. In case of the large scale disaster, the CONDEC will request the support to state government.
GRAC	Prevention of flood in municipality	The GRAC is formed with fire fighters, polices, city officers and volunteers at a disaster. Their activity is guidance of refuge at disaster and restoration after disaster.
SDS	Economic development sustains	The SDS is the economic development sustains in the S.C. state. The SDS executes the policy and operation regarding water resources and is responsible for water use planning related to economic development. Their main mission is to permit and approve the hydropower dam and irrigation facilities, and to manage water permission. Recently, the SDS is developing a meteorological model using the radar of Urubisi's Air Force other than CIRAM and now planning to develop a flood warning system using hydrology model (America, Texas model); this is to reduce flood damage in order to avoid negative impacts on economy.
DEINFRA	Department of infrastructure for S.C. state	DEINFRA is the department of infrastructure in S.C. State. Within the Itajai River Basin, they are in charge of operation and maintenance of infrastructures in S.C. State including flood control dams
CELESC	S.C. State electronic company	CELESC is responsible for the electricity utilities in the S.C. state. They are in charge of operation and maintenance of electronic supply including power generation dams.
CASAN	S.C. State water company	CASAN is responsible for the water utilities in the S.C. state; in charge of water supply, sewage collection and maintenance.
TELECOM	Brazil Telecom	TELECOM is a major Brazilian telecommunications company.
OBRAS	Municipal public works	OBRAS is the department of public works for municipalities.
ABNT/ NBR	Brazilian National Standards Organization	ABNT is an non-profit organization that is responsible for standards and codes for technological development in Brazil.

Source: JICA Study Team

According to the prioritized measures in the integrated plan, PPRD-Itajai (refer section 2.2), the current situation of flood disaster prevention and mitigation activities in the Itajai River Basin is analyzed in the following checklist (Table 2.3.2/ Table 2.3.3/ Table 2.3.4). The checklist covers the concerned activities in three different stages: (1) preparation for disaster prevention before flood events; (2) disaster measures during floods; (3) restoration and recovery after floods. (It shall be noted that this checklist only covers three major cities, Rio do Sul in upper-basin, Blumenau in the middle-basin and IItajai (Ihota and Gaspar) in the lower basin; and so that, further detailed studies shall be required for the rest of cities in the basin.

The present issues of the Itajai River Basin are as followings.

- Currently, multiple institutions are involved in stage (1) and (2), but there is no clear institutional organization among the concerned activities.
- Universities such as UNIASSEVI, FURB and UNIVALI work as a technical adviser on river management. However, there is no institution in charge of the integrated river management for the entire Itajai River Basin.
- As a result, the conditions of the river features as well as river structures/facilities are not understood particularly at the preparation stage (1). Therefore, hazardous areas where there may be high possibility to cause serious damages by coming floods are not maintained appropriately.
- On the other hand, presently each city in Itajai River basin owns manuals for flood prevention and evacuation activities mainly for during and after flood. However, prevention activities during floods are not composed in the existing manuals and not really implemented.
- Furthermore, manuals for some activities are not standardized and/or approved officially; they are still in progress of establishment.
- in the Itajai River Basin, particularly the urban cities adjacent to the river have started preparing for basic hazardous mapping (1:10,000 scale for the whole basin, and 1:2,000 scale for urban areas and potential higher risk areas) in accordance with the urban master plan. However, the hazardous map only covers the urban areas. Furthermore, another existing issue is that the actual condition of land use is not understood well and resulting in existence of some residents in the flood hazardous areas.

		Rio du Sul (Upper Stream)		Blumenau (Middle Stream)	Ita	ajai /lhota/Gaspar (Lower Stream)	Remark	
Provision of Regulation reg. Inundation Area								
Land Use Plan	-	Master Plan (2006) urban area only	-	Master Plan (2006) urban area only	-	Master Plan (2006) urban area only]	
Development Regulation	-		-		-		1	
Building Standard	0	National Standard (ABNT/NBR)	\circ	National Standard (ABNT/NBR)	0	National Standard (ABNT/NBR)	Master plan for only urban area,	
1.1 Others							information of flood damaged	
Information of Disaster Forecasting							area relied on past record	
Information of Disaster Area	0	Past Inundated Area	0	Past Inundated/Land Sliding Area	0	Past Inundated Area	1	
Flood Hazardous Map	-		0	Urban Area Only	-		1	
Hazard Map	-		-		-		1	
Status of Dam Management								
Gate Management Manual	0	DEINFRA	0	DEINFRA	-	None	1	
Management of Warning System and Siren	0	Oeste/Sul Dam	0	Norte Dam/Cedros Ry		None	1	
Understanding of River Feature	·····	Geste/Sul Dam	····	None Dani/Cedios KV.		rtone		
Disabarga and Water Laval			0				1	
Discharge and water Lever		UNIASSEVI supports monitoring for		Technical Support		UNIVAL I monogos water loval of		
Discharged Sedimentation	-	UNIASSE VI supports monitoring for	-	EUDB/CEODS	-	UNIVALI manages water level of		
River fluctuation		rainaii and water ievel.		FURD/CEUPS		estuary.		
Estuary Condition	-		-		0			
1.2 Information of River Bank							Condition of existing river is a	
Overtopping Area	-		-		-		understood because data for	
Leakage Area		Municipal/OBRAS	-	Municipal/OBRAS	-	Municipal/OBRAS	river condition before floods	
Scouring Area	-	(28Municipal)	-	(14Municipal)	-	(5Municipal)	not available due to absence	
Cracking Area	-	(201viancipal)	-	(14.Wdineipar)	-	(Siviancipal)	river management unit.	
Collapseing Area	-		-		-		1	
Management of River Facilities							1	
Bridge	-		-		-		1	
Sluiceway	-	Municipal/OBRAS	-	Municipal/OBRAS	-	Municipal/OBRAS		
River Structure	-	*	-	•	-	- -		
A phounce ment of Flood Warning								
Obtaining of Meteorological Information	0		0		0		1	
1.3 A lert by Precipitation	······································	Discharge converted by rainfall of Oeste	$\overline{\bigcirc}$	Forecasting water level at Blumenau from	<u> </u>	Rainfall of CIRAM and water level	Evacuation warning and appr	
Obtaining of Water Level Information	-	Dam and Sul Dam	\sim	water level of Apiuna and Timbo by		at site	Evacuation warning and anno	
Abert hu Water Level Information		(Municipal)	\sim	FURB/CEOPS		at site		
Alert by water Level	0		0		-			
Method for Transmission of information					· ~ ·			
Mass Media such as TV, Radio	<u> </u>		<u> </u>		<u> </u>		Aged, handicapped people an	
1.4 Web site of Internet			0		<u> </u>		children may delay to evacua	
Warning Tower and Bulletin Board	-	TV, Radio, Internet		TV, Radio, Internet		TV, Radio, Internet	due to no patrol in the nigh	
Patrol by Civil Defense	0		0		0	l .	brown out.	
Sirens	-		-		-			
Flood Prevention activities for Evacuation								
Evacuation Plan	0		\circ		-	Gaspar: Completed	Evacuation only implemented	
Communication Network	0	Completed by CD Municipal Council	\circ	Completed by CD Municipal Council	-	Ilhote: until December	for measures of flood preven	
Evacuation Method	0		0		-	Itajai: until December		
Management of Material and Heavy								
Machinery for flood prevension								
Sheet, Pipe, Sandbag	0		\bigcirc		0		In case of lacking equipments	
1.5 Machinery	- č		ŏ		Ő	1	SC state will support	
Transportation vehicle		Municipal/OBRAS	$\overset{\smile}{\sim}$	Municipal/OBRAS		Municipal/OBRAS	Se state win support.	
P ant			<u> </u>					
Boat			-		0			
ivializement of miscellaneous goods at					1			
evacuation center					-		In case of lacking miscellane	
Water	0	CASAN	0	CASAN	0	CASAN	goods, SC state will support.	
Foods	<u> </u>	Municipal	0	Municipal	0	Municipal		
Evacuation center	0	Municipal	\circ	Municipal	\circ	Municipal		
Ordinary Inspection and Patrol							Inspection before floods	
Seasonal Patrol	0	Civil Defense	0	Civil Defense	0	Civil Defense	inspection before fiolds	
Training and Capacity Building								
	0	Civil Defense	0	Civil Defense	0	Civil Defense		
Training for Flood Prevention							Implementing by Civil Defen	
1.7 Training for Flood Prevention Training for Evacuation	- 0	Civil Defense	0	Civil Defense	0	Civil Defense	implementing by Civil Defen	
1.7 Training for Flood Prevention Training for Evacuation	00	Civil Defense State's Civil Defense	0	Civil Defense State's Civil Defense	0	Civil Defense State's Civil Defense	of SC state before floods	

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Source: JICA Study Team

Preparatory Survey for the Project on the Disaster Prevention and

Mitigation Measures for the Itajai River Basin

Supporting Report Annex D

					8			
			Rio du Sul		Blumenau		Itajai	Remark
	Recognizing of Flood Situation							Flood forecasting of Rio do Sul
	Meteorological Information	0	CIRAM/Site	0	CIRAM/Site	0	CIRAM/Site	by rainfall of Oeste Dam and
2.1	Water Level Information	-	None	\bigcirc	FURB/CEOPS	-	None	Sul Dam basins, flood
	Understanding of Site condition	0	Civil Defense	0	Civil Defense	0	Civil Defense	forecasting of Blumenau by
	Flood Forecasting	0	Municipal Engineer	0	FURB/CEOPS	-	Pom Model	Apiuna and Timbo
	Procedure of Warning Announcement							
	Warning Announcement	0	Municipal/CD Municipal Council	0	Municipal/CD Municipal Council	0	Municipal/CD Municipal Council	Residents to evacuate by
2.2	Communication Organization	0	Municipal/CD Municipal Council	0	Municipal/CD Municipal Council	0	Municipal/CD Municipal Council	announcement by CD Municipal
	Evacuation Conduct	0	Civil Defense	0	Civil Defense	0	Civil Defense	Council
	Traffic Control	0	OBRAS	\bigcirc	OBRAS	\bigcirc	OBRAS	
2.3	Coordination with related Organization	0	Municipal/CD Municipal Council	0	Municipal/CD Municipal Council	\bigcirc	Municipal/CD Municipal Council	Manual applied
2.4	Procurement of Material and others	0	OBRAS	0	OBRAS	0	OBRAS	Manual applied
	Flood Prevention activities							
	Overtopping Prevention	-		-		-		Exposition is more immortant
2.5	Scoring Prevention	-	No concrete measures regarding flood	-	No concrete meccanica according flood	-	No concrete measures regarding	Evacuation is more important
2.3	Leakage Prevention	-	prevention activities by CD Municipal	-	No concrete measures regarding hood	-	flood prevention activities by CD	for measures of disaster
	Cracking Prevention	-	Council	-	prevention activities by CD Municipal Council	-	Municipal Council	prevention.
	Collapse Prevention	-		-		-		
	Inspection and Patrol					1		
2.0	Inspection of Flood Situation	0	Civil Defense	0	Civil Defense	0	Civil Defense	
2.6	Inspection of Life Line	0	Concerned Institution	0	Concerned Institution	0	Concerned Institution	Manual applied
	checking of Evacuation Situation	0	Civil Defense	0	Civil Defense	0	Civil Defense	

Table 2.3.3 Checklist for Disaster Measures during Flood (in case of the major cities) in S.C. State

Source: JICA Study Team

Mitigation Measures for the Itajai River Basin

	Table 2.3.4 Checklist for Restoration & Recovery Activities after Flood (in case of the major cities) in S.C. State								
			Rio du Sul		Blumenau		Itajai	Remark	
	Measures for Dewatering and Drainage							work of municipal but it is	
21	Restoration of Disaster Area	0		\bigcirc		0		delayed.	
5.1	Temporary Drainage System	\bigcirc	Municipal/OBRAS	\bigcirc	Municipal/OBRAS	0	Municipal/OBRAS	Problem is drainage of inner	
	Dewatering of Inland Drainage	0				0		basin in downstream.	
	Restoration of Life Line								
	Electric Power	\bigcirc	CELESC	\bigcirc	CELESC	0	CELESC		
	Water Supply	0	CASAN	\bigcirc	CASAN	0	CASAN	Municipal is delayed the work	
3.2	Telecommunication	\bigcirc	TELECOM	\bigcirc	TELECOM	0	TELECOM	dua to financo	
- []	Restoration of Transportation	toration of Transportation					Gaspar:Gas Pipeline	due to finance.	
	Road	0	Municipal/DEINFRA	\bigcirc	Municipal/DEINFRA	\bigcirc	Municipal/DEINFRA		
	Landslide	0	DEINFRA	0	DEINFRA	0	DEINFRA		
	Removal of Obstacle								
22	Obstacle	0		\bigcirc		0		Municipal is delayed the work	
5.5	Cleaning by Dustbin Lorry	0	Municipal/OBRAS	0	Municipal/OBRAS	0	Municipal/OBRAS	due to finance.	
	Hygiene and Sanitation	\bigcirc		\bigcirc		\bigcirc			
	Report of Damage								
	Deaths and Missing Person	0		\bigcirc		0			
~ .	Inundated House and Refuge Number	0		\bigcirc		0	Municipal/civil defense but civil		
3.4	Livestock and Farm Produce	0	wunicipal/civil defense but civil defense of	0	Municipal/civil defense but civil defense of	0	defense of state/federal government	Manual applied	
	Damage Situation	0	state/rederal government when big disaster	0	state/rederal government when big disaster	0	when big disaster		
	Others	0		\bigcirc		\bigcirc	1		

Source: JICA Study Team

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From the above checklists (Table 2.3.2 – 2.3.4), the detail analysis especially about FFWS is discussed in the following. The flow diagram, Figure 2.3.1 shows the existing institutional organization and responsible activities particularly regarding to FFWS in SC State. Currently, FURB/CEOPS is charged FFWS activities for the Itajai River Basin committed by SDS. Although FURB/CEOPS is in charge of flood forecasting for the entire river basin, it is not operated well due to the following reasons.

- i. CIRAM which is the meteorological department of the SC State Gevornment collects meteorological and hydrological data that is observed at 38 gauging stations by various institutions; however, no data has been transmitted from CIRAM to FURB/CEOPS.
- ii. However, currently, FURB/CEOPS only conducts flood forecasting for Blumenau, where FURB/ CEOPS is located and not for other cities. For flood forecasting, FURB/CEOPS utilized data from the 14 hydraulic gauging stations (rainfall and river water levels gauging station as one set) operated by themselve.
- iii. The forecasted results are only informed to Defensa Civil in Blumenau. This is to say, the existing FFWS activities are not systematically planned and conducted among the related institutions throughout the entire Itajai River Basin.For flood forecasting,
- iv. For the present flood forecasting for Blumenau city, FURB/CEOPS utilized the water level data only from three stations in Blumenau, Apiuna and Timbo; the data from the rest of 11 stations are currently not utilized for forecasting.
- v. On the other hand, Defensa Civil in Rio do Sul city tries to conduct flood forecasting; however, the present forecasting is not appropriate for practical use. One of the reasons is that DEINFRA, the operator of the Oeste dam and Sul dams that locate at upstream areas of Rio do Sul has not recorded and informed the outflow discharges from the dams to the downstream rivers.



Source: JICA Study Team

Figure 2.3.1 Present Institutional Organization in SC State for FFWS

2.4 Existing Metrological and River Water Level Observation

Currently in Itajai River Basin, the hydraulic conditions (rainfall and river water level) are observed by multiple institutions for various purposes; such as FURB/ CEOPS for flood control, ANA for river/water resource management, EPAGRI for agriculture and CELESC for hydraulic power generation (refer Figure 2.3.1). The main issue is that data observation, equipments maintenance and data management has not been integrated and managed.

The numbers of related hydraulic gauging stations in the Itajai River Basin is listed in Table 2.4.1.

Table 2.4.1 The Existing G	Sauging Stations in I	tajai River Basin.
Gauging Types	FURB/CEOPS	ANA
Rainfall gauging stations	16	43
River water level gauging stations	14	23
TOTAL Number of Locations	16	66

able 2.4.1 The Existing Gauging Stations in Itajai River Basin.

Source: EPAGRI/CIRAM

Moreover, there are more gauging stations run by different institutions other than listed in Table 2.4.1.

- Itajai city: owns 9 rainfall gauging stations and 8 river water level gauging stations.
- CELESC: owns some hydraulic gauging stations around their dams and power plants.
- INMET and other universities that locate in the major cities: owns some hydraulic gauging stations.

FURB/ CEOPS has established hydraulic gauging stations at 16 locations throughout the Itajai River Basin (Figure 2.4.1) with an order from SDS in 1985. These stations were set up for the purpose of FFWS for the entire basin. Of these locations, 14 locations are rainfall and river water level gauging stations with automatic data transmission systems (using telemetry or satellite) (refer Table 2.4.2).



Source: JICA Study Team



Table 2.4.2	List of FURB/CEOPS Gauging Stations					
Location	Gauging Type	Transmission System				
Mirim Doce	Rainfall	Satellite				
Taio	Rainfall/ Water Level	Telemetry				
Rio Oeste	Rainfall/ Water Level	Telemetry				
Puuso Redondo	Rainfall	Telemetry				
Saltinho	Rainfall/ Water Level	Telemetry				
Ituporanga	Rainfall/ Water Level	Telemetry				
Rio do Sul	Rainfall/ Water Level	Telemetry				
Barra do Prata	Rainfall/ Water Level	Satellite				
Ibirama	Rainfall/ Water Level	Telemetry				
Apiuna	Rainfall/ Water Level	Telemetry				
Timbo	Rainfall/ Water Level	Telemetry				
Indaial	Rainfall/ Water Level	Telemetry				
Blumenau	Rainfall/ Water Level	Telemetry				
Salseiro	Rainfall/ Water Level	Telemetry				
Botuvera	Rainfall/ Water Level	Satellite				
Brusque	Rainfall/ Water Level	Telemetry				
14 Rainfall/Water Level & 2 Rainfall						

Source: JICA Survey Team

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The observation activities by FURB/CEOPS are not functioning well due to the following problems.

- The existing 14 gauging stations and where the existing warning levels are set (refer Table 2.5.1) are not corresponding in the locations. For an instance, there is no gauging station along Luis Alves River which is one of the major tributary rivers.
- The related equipments of the 14 hydraulic gauging stations are not maintained enough due to lack of financial source. As a result, the related equipments such as automatic data logger and transmission systems are not functioning well.
- Furthermore, many water level gauges (particularly hydraulic pressure type) are affected by riverbed erosion and sedimentation while, many rainfall gauges are blocked up with leaves.
- As considering the present condition listed above, FURB/CEOPS employ some residents, who live nearby the stations, to observe and record water levels by watching scales. However, data is not recorded appropriately in this way because some have discontinued recording from delinquency in administration payment.

Therefore, the data is not appropriate for practical use. The current situations of the existing 14 hydraulic gauging stations (rainfall and water level) are summarized in Table 2.4.3.

Exist	ting Stations	Gauging Type	Transmission System	Situation of Stations
1	Taio		Telemetry	Transmission system needs to be improved.
2	Rio Oeste		Telemetry	Monitoring equipment does not function, GSM is lefective, and there is not person in charge for maintenance.
3	Saltinho		Telemetry	Monitoring equipment does not function, GSM is lefective, and there is not person in charge for maintenance.
4	Ituporahga		Telemetry	Transmission system needs to be improved.
5	Rio do Sul		Telemetry	Operated
6	Barra do Prata		Satellite	Monitoring is not executed on time due to the failure of nonitoring equipment and absence of persons in charge for naintenance.
7	Ibirama	Rainfall/	Telemetry	Transmission system needs to be improved.
8	Apiuna	Water Level	Telemetry	Thought residents around the station observed water level because of the failure of the sensor and telemetry, they now top due to delinquency of administration payment from CEOPS.
9	Timbo		Telemetry	Operated
10	Indaial		Telemetry	Monitoring equipment does not function, GSM is lefective, and there is not person in charge for maintenance.
11	Blumenau		Telemetry	Operated
12	Salseiro		Telemetry	GSM transmission system is defective.
13	Botuvera		Satellite	GSM transmission system is defective.
14	Brusque		Telemetry	Water level gauging sensor does not function due to edimentation

 Table 2.4.3
 Situation of Existing 14 Gauging Stations under FURB/CEOPS

Source: JICA Survey Team

2.5 Existing Forecasting and Warning System

2.5.1 Meteorological Forecasting by CIRAM

CIRAM (the S.C. state's Meteorological/Hydrological Environment Center) collects all the data that is observed by multiple institutions. CIRAM connects to the Doppler Radar (SIMEPAR) that is now installed in Northern Parana area and Meso-data (1,200 m, 5,000 m and 12,000 m of SONDE) that is set in the Florianopolis Airport through the Internet (as shown in Figure 2.5.1.).

Besides these observatory data, the database (INMet, IDD and NCEp) called GEMPA and the meteorological simulation database called M9 (ETA40/20 km model and GPS 100 km model) are secured by cooperating with oversea metrological networks.

Based on WRF (15 km) program, weather forecasting is conducted by CIRAM every 1 hour, 3 hours, 6 hours and 12 hours using a model, which is established by ETA (Brazil) and WRF (America).

The weather forecasting information is announced to the S.C. state's citizen through TV, Radio and the Internet. In an emergency, information is reported to the civil defense of S.C. state government, CELESC (S.C. Electric Corporation), Fishing and Agricultural Union, at the same time, FURB/CEOPS that are located in Blumenau.

However, the current situation is that the collected data as well as the result of weather forecasting are not well organized as one database. Therefore, the information is not shared among the related institutions and so that they are not reflected to the practical FFWS.

CIRAM is now planning to upgrade the metrological forecasting by adopting satellite data from INPE. It is expected that this shall improve the precision of the forecasting.



Source: EPAGRI/CIRAM



2.5.2 Flood Forecasting and Warning Activities

The existing FFWS is not systematically planned and conducted throughout the entire Itajai River Basin. The flood forecasting is executed only in Blumenau and Rio do Sul cities. In Rio do Sul city, the City Defesa Civil has a flood forecasting method using rainfalls at the Oeste dam and Sul dam but this is not utilized for practical use. This is because the existing method does not reflect the DEINFRA's dam operation and outflow discharges from the two dams and the result is not reliable. Therefore, presently flood forecasting based on the observed data is only conducted in Blumenau city.

Other 16 cities including Itajai city have "warning levels" as guideline (based on river water level) for warning announcement (Table 2.5.1). These warning levels are established based on the past flood water level. When the river water level starts rising, the civil defenses of each city patrols and reports the river condition to CD Municipal Council immediately.

However, some of the cities have no water level gauging stations or the lack of water level gauging stations in the upstream of the cities. For example, two cities (Agu Clera and Gurabiruba) that locate along the tributary river of Brusque, and three cities in mountain region (Salete, Mirim Doce and Pouso Redondo) where have been suffering from flood damage as an influence of recent land development.

In these small cities, evacuation activities are not conducted appropriately. One of the reasons is lack of hydrological data as mentioned above and this causes delay in warning announcement Nippon Koei Co., Ltd. August 2011

particularly at night. Furthermore, in these mountain region, "flash floods" are also a serious concern, however the rainfall in the area are not monitored currently. Disorganization in forecasting, warning and evacuation activities is also one of the issues in these areas.

Itajai River	Elevation	Catchment	Normal	Standby	Warning	Emergency
Basin	EL+m	Area	level	level	level	level
(each city)		(km2)	(m)	(m)	(m)	(m)
Taio	360	1,575	4.0m	6.0m	6.5m	over 7.5m
Rio do Oeste	-	-	4.0m	6.0m	9.0m	over 9.0m
Trombudo	350	248	3.0m	4.0m	7.5m	over 7.5m
Ituporanga	370	1,670	2.0m	3.0m	4.0m	over 4.0m
Vidal Ramos	-	-	3.0m	4.0m	6.0m	over 5.0m
Rio do Sul	350	5,100	4.0m	5.0m	6.5m	over 6.5m
Ibirama	151	3,314	2.0m	3.0m	4.5m	over 4.5m
Apiuna	93	9,241	3.0m	6.0m	8.5m	over 8.5m
Benedito Novo	90	692	1.5m	2.5m	3.5m	over 3.5m
Rio dos Cedros	80	510	1.5m	2.5m	3.5m	over 3.5m
Timbo	73	1,342	2.0m	4.0m	6.0m	over 6.0m
Indaial	60	11,151	3.0m	4.0m	5.5m	over 5.5m
Blumenau	12	11,803	4.0m	6.0m	8.5m	over 8.5m
Gaspar	11	12,141	4.0m	6.0m	8.5m	over 8.5m
Ilhota	-	12,357	6.0m	8.0m	10.5m	over 10.5m
Itajai	-	15,221				

 Table 2.5.1 Warning Standards Based on River Water Level

Source: FURB/CEOPS

2.6 Existing Evacuation and Flood Prevention Activities

In Itajai River Basin, each city owns evacuation manuals that were developed based on the present flood experiences. The manuals basically include institutional organization and instructions for evacuation activities at flooding but not guidelines for detailed flood prevention activities. For example, even if river embankment or revetment is corrupted, no urgent measures (such as using sand bags to stop water) are currently implemented.

The approved official evacuation manuals only exist in Rio do Sul and Blumenau cities. These manuals regulate (1) institutional organization for each activity; (2) potentially higher risk areas; (3) refuge places for each regional block (Refer Table 2.6.1) and; (4) instructions for smooth evacuation activities. On the other hand, 13 other cities are currently developing their evacuation manuals to be approved following the two former cities.

The numbers of refuges for each regional block in Rio do Sul, Blumenau and Itajai is shown in Table 2.6.1.

Table 2.6.1	Numbers of Refuge	s Sites and Region	al Blocks fore Rio	do Sul, Blumenau a	and Itajai
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	Rio do Sul	Blumenau	Itajai
Regional Blocks	7	5	In progress
Refuge Sites	55	57	62

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According to those evacuation manuals, CD municipal council is formed by the city civil defense with the city mayor as a chairman. The city civil defense patrols and reports the river condition (including river water levels) to the council. Then, the council is responsible for flood warning announcement according to the warning level (as listed in Table 2.5.1).

In addition, GRAC, the flood prevention team is also formed by the institutions listed in Figure 2.6.1 (in a case of Blumenau city for example). GRAC is in charge of supporting and securing safe evacuation activities; however, the present situation is that they are like a communication coordinator among the related intuitions.

When a large or medium scale flood occurred, the CD municipal council reports the situation to the S.C. state's civil defense (SDC) and the nation civil defense (SINDEC) to requests their supports.



Source: JICA Study Team

Figure 2.6.1 Present Institutional Organization for Evacuation and Flood Prevention Activities in S.C. State

As an example, the evacuation manual of Blumenau city prescribes a list of institutions that are involved in GRAC (Table2.6.2).

No.	Related Organization and Party					
1	Batalhao de Infantaria	Cavalry Unit				
2	Policia Rodoviria Federal	National Road Police				
3	Batalhao de Policia Militar	Army Police				
4	Batalhao de Bombeiro Militar	Army Firefighting				
5	Policia Rodoviria Estadual	State Road Police				
6	Centrais Eletricas de Santa Catarina (CELESC)	State Power Corporation				
7	Delegacia Regional de Policia Civil/Bl	Municipality Civil Police				
8	Gerencia Regional de Educacao (GERED)	Bureau of Education				
9	Secretaria Municipal de Obras (SEMOB)	Municipality Public Works				
10	Secretaria de Servicos Urbanos (SESUR)	Bureau of Urban Service				
11	Secretaria Municipal de Saude (SEMUS)	Bureau of Sanitation				
12	Secretaria Municipal de Assistemcia Social, da Crianca e do Adolescente	Bureau of Welfare/Child				
	(SEMASCRI)	Protection				
13	Secretaria Municipal de Administracao (SEdeAD)	Bureau of Administration				
14	Secretaria Municipal de planejamento (SEPLAN)	Bureau of Planning				
15	Secretaria Municipal de Comunicacao (SECOM)	Bureau of Press				
16	Secretaria Municipal de Educacao (SEMED)	Bureau of Education				
17	Servico Autonomo Municipal de Transito e Transportes de Blumenau	Bureau of Traffic Control				
	(SETERB)					
18	Fundacao Municipal de Meio Ambiente (FAEMA)	Bureau of Environment				
19	Oi Telecomunicacoes	Bureau of Telephone				
20	Clube de Radioamador	Radio Club				
21	Centro de Operacao do Sistema de Alerta (CEOPS/FURB)	Flood Information Centre				
22	Associacao dos Profissionais de Seguranca de Blumenau e Regiao (APSEBRE)	Association of Security				
23	Camara de Diretores Lojistas (CDL)	Association of Commercial				
		Store				
24	Associacao Comercial e Industrial de Blumenau (ACIB)	Chamber of Commerce and				
		Industry				
25	Jeep Clube e Moto Clube	Jeep/Auto Motor Club				

Table 2.6.2	GRAC organization Member (in case of Blumenau)

Source: Evacuation plan of flooding in Blumenau

CHAPTER 3 MASTER PLAN FOR STRENGTHEN EXISTING FFWS

3.1 Proposal for Flood Prevention and Mitigation

From the analysis of the existing situations in the Itajai River basin, the following Table 3.5.1 outlines the proposed flood prevention and mitigation measures in accordance with the programs and projects that are highlighted in the Integrated Plan for Prevention and Mitigation of Natural Disaster Damage Risk (PPRD-Itajai). The measures are classified into (1) flood plain regulation, (2) disaster forecasting, (3) measures during disaster, (4) river management and (4) restoration and recovery activities.

Flood Prevention and Mitigation Activities	Details of Proposed Methods	Actual Measures	The Concerned Programs in PPRD-Itajai
1. Flood plain regulation	 Regulation of land use plan Building standard and codes Regulation of development Re-development plan Town planning against flood disasters Specification for building 	 Reorganization of administrative institutions Enforcement of the laws Development of penalty regulations 	 <u>Program 5</u> Land use and occupation management Urban development legislation <u>Program 3</u> Perception, communication motivation and mobilization for resiliency and reduction of vulnerability
2. Disaster forecasting	 Strengthening of observation system (gauging stations) Strengthening of monitoring, flood forecasting and warning system Development of risk map/hazard map 	 Database management Evaluation of risk 	Program 4Evacuation of disasters risk reduction
3. Disaster measure	Flood preventionEvacuationDisaster recovery	 Related organization Evacuation manual Evaluation of risk Reconstruction of lifeline 	 Program 2 Monitoring, alert and Alarm Program 6 Recuperation of areas affected by disasters Program 1 Structure of civil defense and other related agency
4. River management	 Re-organization of river management River improvement plan Inventory list/book Information center for disaster 	• Administration	 Program 1 Structure of civil defense and other related agency Program 4 Evacuation of disasters risk reduction
5. Restoration and recovery activity	 Disaster insurance Zoning of flood area Assessment of flood potential 	AdministrationInsurance Company	 Program 3 Perception, communication motivation and mobilization for resiliency and reduction of vulnerability

 Table 3.1.1
 Proposed Flood Prevention and Mitigation Measures

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Currently, preparation activities for disaster prevention before flood event are hardly implemented. This is mainly because that there is no distinct administrator of river management. It is important to organize institutional framework for river management including FFWS (refer section 3.2). To improve the institutional organization, the state government must be responsible of integrated river management for the entire Itajai River Basin.

The measures that shall be implemented by the appropriate government agencies (S.C. state government/ the administrator of river management) are listed as followings.

- The conditions of both river features and river structures/facilities should be understood, managed and maintained by the river manager. The river inventory shall also be established by the river manager to manage river water use. In addition to this, a flood information center shall be established within the administrative institution in order to strengthen FFWS.
- The potential flood areas (zones) and expected flood damages should be assessed and determined. The concerned flood hazardous areas must be reflected to the urban master plan and land use regulations of each city.
- The flood plain regulations for flood hazardous area should be developed in accordance with the master plan of land use. (The land use master plan shall be reflected the social conditions: such as living condition, industrial component and population density and the natural conditions such as hydraulics and geology.)
- A disaster insurance proponent shall be determined. In addition, the residents must be relocated from the flood hazardous area according to the land use plan and flood plain regulations.
- Official/approved manuals for flood prevention and mitigation activities for before, during and after flood disaster should be established for each city in the basin.
- The manuals also shall include hazard maps: 1:10,000 scale for the whole basin, and 1:2,000 scale for urban areas and potential higher risk areas.

3.2 Proposal for Institutional Organization for Strengthening Existing FFWS

The appropriate institutional organization must be properly constructed so that the proposed FFWS exercise effectively. Presently the FFWS conducted by FURB/CEOPS which is delegated by SDS is not functional enough and it has no good communication between FURB/CEOPS and other organizations of the SC State.

To implement improvement of the institutional organization for FFWS all over the Itajai River basin, the state government must have a responsibility for the matter as shown in Figure 3.21, but not just by local university unit.

This study proposes the improvement of 14 existing gauging stations and additional 16 gauging stations, so that all cities in the basin are able to have the flood forecasting and warning system or warning system. All of 30 gauging stations must be managed and operated by the state government unit responsible for FFWS (SDS/Defesa Civil).

i) The state government unit in charge for FFWS shall improve the flood forecasting method and waning level not only Blumenau but also other cities in the basin. On the other hand,

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EPAGRI/CIRAM of meteorological unit of the state must establish new system which transmits all hydrological and meteorological data observed by different organizations. CIRAM must manage data and develop data base system for all data comes from different organizations including aforementioned 30 gauging stations. These data must be utilized for future development of FFWS such as runoff analysis, inundation analysis and rainfall forecasting.

- ii) The result for flood forecasting should be transmitted to all of CD Municipal Counsel in the basin and the flood warning and evacuation announcement shall be implemented and evaluated by each city in consideration of warning level. Therefore the propriety of warning level shall be verified.
- iii) GRAC shall conduct evacuation activities based on the evacuation announcement. Defesa Civil of the state government unit for prevention and mitigation of natural disaster should support to make the evacuation manual and hazard map for some city which has not prepared yet.



Source: JICA Study Team Figure 3.2.1 Proposed Institutional framework for FFWS

3.3 Proposal for Target City for Flood Warning

(1) Proposal for Establishment of Warning Level

As described in Section-2.4/Chapter-2, presently 16 cities have established the warning level. However the warning level was established 25 years ago and the situations of the river channel and its riparian areas would have been changed. The existing warning level for those cities should be reviewed based on study of discharge capacity in urban area and H-Q curve at the gauging station.

At present, there is no warning level for Brusque City which is the third important city in the Itajai River Basin. In addition to those cities, Mirim Dose, Salete, Pouso Redondo located in mountainous area in upstream of Rio do Sul and Agua Clera, Gurabiruba in mountainous area along tributaries of Brusque City are endangered by sudden floods caused by local downpour as an influence of recent land development. Therefore these 6 cities have to establish the warning level newly. Hydrological gauging stations are also needed together with a siren, which is to announce evacuation warning.

The target cities for proposed FFWS including existing are shown in Table-3.3.1.

(2) Cities for Flood Forecasting

The flood forecasting for the Itajai River Basin should be conducted by an integrated system with rainfall forecasting, run-off analysis and flood forecasting in the future. Therefore, presently Defesa Civil, EPAGRI/CIRAM and SDS are planning for establishing the model.

On the other hand, Rio do Sul, Blumenau and Itajai City, which are the major cities of upper, middle and lower area of Itajai River respectively, had serious damages by floods before. These cities need a flood warning system by flood forecasting using the water level correlation formula as a provisional solution until establishment of the aforesaid model.

3.4 Proposal for Improvement/Additional Rainfall and Water Level Gauging Station

(1) Improvement for Existing Rainfall and Water Level Gauging Station

Existing 14 gauging stations described in Table-2.4.3 in Section 2.4 are foundation and are located at the most important sites for the FFWS. Therefore, improvement of equipments and updating transmission system for these stations should be prioritized for the future observation of rainfall and water level. In discussion with SDS, this improvement and updating is supposed to be implemented by the finance of the state government lead by SDS. Improvement of these existing stations must be implemented certainly.

- (2) Proposal for New Gauging Stations for Rainfall/ Water Level
- i) New Gauging Stations for Target Cities for Proposed FFWS

New gauging stations shall be installed for cities, which have no rainfall/water level gauging stations in spite of the target for setting warning level. Those cities are 11 in total such as Ilhota, Gaspar, Benedito Novo, Rio dos Cedros, Agura Clera, Burabiruba, Vidal Ramos, Trombudo Central, Pouso Redondo, Salete and Mirim Doce.

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ii) New Gauging Station for Flood Forecasting and Early Warning and Evacuation

The informations of outflow discharge from Oeste and Sul Dams for flood control located in the upstream river of Rio do Sul are necessary for the flood forecasting at Rio do Sul. Presently DEINFRA as the dam administrator has no data of outflow discharge from dams. DEINFRA should establish a system which is able to monitor the outflow discharge from dams in future. However in the present moment, new gauging stations should be installed at downstream reaches of the dams to monitor the outflow discharge. These new stations were strongly requested by Rio do Sul City. In addition to this purpose, these new stations are useful for earlier warning to Taio City and Ituporanga City.

On the other hand, existing stations of Blumenau and Brusque to be improved and new gauging stations at Gasper and Ilhota will be utilized for the flood forecasting at Itajai city. Presently municipal Defesa Civil has 9 automated rainfall stations and 8 automated water level stations inside Itajai City. It is proposed to integrate these data with the state observation system.

CELESC as the hydropower dam administrator should be responsible for data management of Rio Bonito and Pinhal dam operation, but it is difficult to establish a system immediately. Therefore new gauging stations should be installed at immediate downstream of the dams for monitoring discharge from the dams. These new stations are also useful for earlier warning to Rio dos Cedros and Timbo. Timbo City strongly requested to install CCTV cameras for visual inspection of floods together with discharge volume from dams.

As a result of above, 4 new gauging stations at immediate downstream of Oeste, Sul, Rio Bonito and Pinhal Dams are proposed to be installed with 2 CCTV careras.

iii) New Gauging Station for Establishment of Flood Forecasting Model in Future

Presently there is a rainfall station of ANA along Luiz Alves River which is a main tributary of Itajai Lower River but hourly data is not available as mentioned in Chapter-4. New gauging station is proposed to install at Luiz Alves City for establishment of flood forecasting model in future which Defesa Civil, CIRAM, and SDS is planning now. Details of the existing and proposed new gauging stations are shown in Table-3.4.1 and their locations are shown in Figure-3.4.1.

iv) Proposed New CCTV Cameras to Monitor River Situation

Presently, Defesa Civil and SDS have no regional offices in the Itajai River basin. As the administrator of river management and disaster prevention, they have to implement it far from Florianopolis. Therefore, installation of CCTV at Rio do Sul, Blumenau and Itajai City is proposed to monitor river situation from distance.

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				Target City for F	FWS				Ga	uging Station	
No.	Name of River	Name of Sta.	Existing warning	g Target Location for	Forecasting & Warning		Ex isling Gauging Station (FURB/CEOPS) (Require for replacement/up-grade) Proposed Gauging Station				Proposed Gauging Station
			indian loval	Hannig		Eq	uipment	Present Condition		Equipment	Remarks
1	Rio Itajai	Rio do Sul	0	0	Reviewing existing	0	R/W	Operational	0	CCTV	Monitoring river from Florianopolis
2	Rio Itajai	Bumenau	0	0	warning level/Establishing	0	R/W	Operational	0	CCTV	Monitoring river from Florianopolis
3	Rio Itajai	Itajai	0	0	flood forecasting formula	City g	overnment alrea	ady installed 8 water level gauges	0	CCTV	Monitoring river from Florianopolis
4	Rio Itajai do Sul	Ituporanga	0	0		0	R/W	Up-grade of transmission system			
5	Rio Itajai do Sul	Vidal Ramos	0	0	1				0	R/W	Warning for Vidal Ramos
6	Rio Itajai do Oeste	Taio	0	0	1 1	0	R/W	Up-grade of transmission system			
7	Rio Itajai do Oeste	Rio Oeste	0	0	1 1	0	R/W	Replacement of Equipments			
8	Rio Trombudo	Trombudo	0	0	1 1				0	R/W	Warning for Trombudo
9	Rio Itajai do Norte	Ibirama	0	0	Poviowing ovisting	0	R/W	Up-grade of transmission system			
10	Rio dos Cedros	Rio dos Cedros	0	0	worping water lovel				0	R/W	Warning for Rio dos Cedros
11	Rio dos Cedros	Timbo	0	0	wanning water iever	0	R/W	Operational			
12	Rio Benedito	Benedito Novo	0	0	1 1				0	R/W	Warning for Benedito Novo
13	Rio Itajai	Apiuna	0	0		0	R/W	Replacement of Equipments			
14	Rio Itajai	Indaial	0	0	1 1	0	R/W	Replacement of Equipments			
15	Rio Itajai	Gasper	0	0	1				0	R/W	Warning for Gasper
16	Rio Itajai	Ilhota	0	0	1				0	R/W	Warning for Ilhota
17	Rio Itajai Mirim	Brusque	· ·	0		0	R/W	Replacement of Equipments			-
18	Rio Itajai do Oeste	Mirim Doce		0	1 1				0	R/W	Warning for Mirim Doce
19	Rio Itajai do Oeste	Salete	· ·	0					0	R/W	Warning for Salete
20	Rio Itajai do Oeste	Pouso Redondo) -	0	Establishing warning water level				0	R/W	Warning for Pouso Redondo/Rio do Sul due to flood by housing development
21	Rio Itajai Mirim	Agua Clera		0	1 1				0	R/W	Warning for Agua Clera
22	Rio Itajai Mirim	Gurabiruba		0	1 1				0	R/W	Warning for Gurabiruba
23	Rio Itajai do Sul	Saltinho		-		0	R/W	Replacement of Equipments	Ŭ		
24	Rio Itajai do Sul	Sul Dam	-			0			0	R/W	Flood forecasting at Rio do Sul/Monitoring discharge from dam to protect Ituporanga
25	Rio Itajai do Oeste	Oeste Dam							0	R/W	Flood forecasting at Rio do Sul/ Monitoring discharge from dam to protect Taio
26	Rio Itajai do Norte	Barra da Prata		-	1.	0	R/W	Replacement of Equipments			
27	Rio dos Cedros	Pinhal Dam		-					0	R/W, CCTV	Monitoring discharge from dam to protect Timbo
28	Rio dos Cedros	Rio Bonito Dam		-	1 1				0	R/W, CCTV	Monitoring discharge from dam to protect Timbo
29	Rio Luiz Alves	Luiz Alves		-					0	R/W	To obtain hydrological data of Luiz Alves river basin for flood forecasting model
30	Rio Itajai Mirim	Salseiro	-	-	1 1	0	R/W	Replacement of Equipments		1	
31	Rio Itajai Mirim	Botuvera	-	-	1 1	0	R/W	Replacement of Equipments		1	
	TOTAL		16	22	 	14	1		19	16 R/W & 5 CCTV	<u>.</u>

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Source: JICA Study Team

Mitigation Measures for the Itajai River Basin

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Source: JICA Study Team Figure 3.4.1 Location Map for Proposed Gauging Station and CCTV

3.5 Proposal for Strengthen Systems for FFWS

The following 8 steps shall be applied to maintain and upgrade the related systems for strengthening FFWS.

- (1). Improvement of existing gauging stations (changing observation equipments)
- (2). Installing of additional gauging stations (rainfall and water level gauge)
- (3). Improvement of network system (internet) including additional monitoring stations
- (4). Extending server and establishing database of the central station (Florianopolis)
- (5). Analyzing and improvement of flood forecasting (review of water level correlation formula)
- (6). Installation of monitoring system at Monitoring Station (Rio do Sul, Itajai City)
- (7). Installation of monitoring system at Central Station (Florianopolis City)
- (8). Improvement of flood warning system and evacuation announcement

3. 5.1 Data Observation, Transmission and Monitoring System

The data of rainfall and water level from the proposed 30 gauging stations is transmitted to the server of Florianopolis' centre station through by Email of GPRS and saved to a data base. The saved data will be transmitted to the monitoring stations of Defesa Civil at Rio do Sul, Blumenau and Itajai City through the internet. The pictures of Itajai River taken in every minute by CCTV at Rio do Sul, Blumenau and Itajai City are transmitted to the Florianopolis' centre station through the internet and monitored. The schematic diagram for the proposed data network system is shown in Figure 3.5.1 and the further details of each system are as followings.

- The data transmission system shall be changed to package switching type, which transfers data from the Link Radio to the cellular-phone. This enables to send the observation data directly to the river engineer by E-mail every 10 minutes. This system should secure electric energy source with the solar panel. There is no needs of any auxiliary equipment like repeaters at the transmission points; only one stem enables to install the rainfall, river water level gauge, solar panel, battery, data register (data logger) and a telephone center.
- Furthermore, the digital system changes from GSM (Group Special Mobile) 2G (Mobile Telephone system of Second Generation) to GPRS (General Packet) 2.5G which this enables to strengthen a stable communication and efficiency of the broadband use and to increase data communication. Install or modify GPRS and/or GSM transmission system and more reliable data shall be sent through emails to the monitoring stations at real time.
- Regarding recovery of the surveillance camera for monitoring, nowadays it is possible to acquire a highly precise and light CCTV (Closed Circuit TV) at low prices. Therefore, in Rio do Sul, Blumenau and Itajaí, surveillance cameras will be installed to capture the flood



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situation in real time.

The data sent through E-mail by GPRS and/or GSM and stored into a server at the central station of Florianopolis. The stored data is then forwarded to the monitoring stations in Rio do Sul, Blumenau and Itajai through the Internet. The pictures taken every one minute at CCTV in Rio do Sul, Blumenau and Itajai city can also be sent to each city's civil defense for a real time view through the master station internet.



Figure 3.5.1 Data Observation, Transmission and Monitoring System for FFWS

3. 5.2 Proposal for Warning System and Data Management System

To improve warning system, a monitoring station should be established at Municipal Defensa Civils. one must collect data from each gauging station in order to build a database and flood forecast. In addition, surveillance equipment will be placed at monitoring stations in the Defensa Civil offices in Rio do Sul, Blumenau and Itajaí and this enables to monitor using the Internet. In Florianopolis, the facilities for monitoring will be installed as central station and the floods conditions can be captured by the river engineer

The flood warning must be announced immediately to the residents in the target cities by radio, TV, the Internet and an electronic board, which shall be set up within the cities. In hazardous areas, the patrol by the civil defense and real-time monitoring of the flood situation by CCTV enable to inform CD Municipal Council to announce earlier evacuation warning. In addition to this, sirens shall be set up in the cities and used together with the other systems; this is to urge residents who live in hazardous areas to evacuate immediately.

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CHAPTER 4 FEASIBILITY STUDY FOR STRENGTHEN EXISTING FFWS

4.1 Verification of Existing Flood Forecasting

Currently in the Itajai River Bain, flood forecasting under FFWS is only conducted in Blumenau (by FURB) and Rio do Sul (by City Defesa Civil), while the rest of cities don't conduct any flood forecasting. Even in Blumenau and Rio do Sul, the flood forecasting is not utilized for warning and evacuation activities systematically. Especially, the forecasting for Rio do Sul is still in "Trial and Error" stage.

It is recommended to establish FFWS at least for three major cities, (1) Rio do Sul, (2) Blumenau and (3) Itajai city. In this section, the existing flood forecasting formula for the two cities, Rio do Sul and Blumenau shall be verified and the recommendations for improvement of the system shall be proposed. For Itajai city which is one of the most important cities along the Itajai River, the flood forecasting method shall be proposed in this section.

For other cities and towns, it is important to maintain that the present warning system using of the warning level and these cities shall be adopted using existing gauging stations and additional gauging stations which are proposed under the study.

4.1.1 Verification of Existing Flood Forecasting Formula for Rio do Sul

The present formula for forecasting flood water level at Rio do Sul was developed by Defesa Civil in Rio do Sul City. The formula was developed by the rainfall correlation method using the rainfall at Rio do Sul (C.A.:5,042 km2), Oeste Dam (C.A.: 1,042 km2, 81km upstream of Rio do Sul) and Sul Dam (C.A.: 1,273km2, 43km upstream of Rio do Sul). The formula was developed in a trial stage therefore presently the flood/ evacuation warning shall not be implemented using the forecasted water level computed by this formula.

i) The daily average discharge shall be computed by the daily average water level using H – Q Curve at Rio do sul. The water level at Rio do Sul is ocularly observed at 7am and 5 pm daily and the observation of flood water level is conducted hourly. The daily average water level means the average of 2 times of water level for ordinary days and maximum 24 times of water level for during the flood.

Q = 44.7757 (H - 0.235) 1.48789(1)

ii) The fluctuation discharge (ΔQ) shall be computed by daily rainfall data at aforementioned 3 locations using the following formula. The fluctuation discharge (ΔQ) means the different discharge volume between that day and next day.

$$\Delta Q = 6.07 + 1.66 * (Rainfall at Rio do Sul) + 2.51 * (Rainfall at Sul Dam) + 0.45 * (Rainfall at Oeste Dam) \dots (2)$$

- iii) The daily average discharge for next day (Q2) shall be computed to add the fluctuation discharge (ΔQ) to the daily average discharge for that day.
- iv) The daily average water level for the next day shall be computed using aforementioned H-Q Curve formula (1).

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The forecasted daily average flood water level at Rio do sul was computed by using above method regarding the flood on April 2010 and the comparison between the actual daily average flood water level and forecasted daily average flood water level is shown in Figure 4.1.1. The forecasted daily average water level is 30 cm in difference from the actual and it is quite accurate.



Source:Rio do Sul, Defesa Civil Figure 4.1.1 Comparison between Actual Daily Average Water Level and Forecasted Daily Average Water Level at Rio do Sul

However:

- The forecasting method is only applicable for daily average but not allowed to compute hourly base. Therefore the forecasting method is not appropriate to utilize for the warning system. It can be used only for the warning announcement for the next day.
- The definition of the daily average water level is not clear for the ordinary day and the flood time. In case of the flood time, the daily average water level could not be computed until the end of day (12pm) therefore the water level for the next day could not be forecasted until midnight. In this case the warning for the next day maybe difficult due to preparation of the warning after midnight.

Due to those above mentioned matters, the following comments are well considered for the future.

- In future, the correlation method should be applied for the flood forecasting at Rio do Sul as an ordinary method and it must be hourly forecasting.
- However Rio do Sul has 2 flood control dams in upstream. In case of low coefficient of correlation among 2 stations in downstream of the dams and Rio do Sul, the unsteady flow-runoff analysis would be recommended including the mechanism of control gates at dams.

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• In case of the modeling of the flow-runoff analysis, in addition to the existing rainfall gauging stations, the system for transmitting data of dam discharge including the gate control status to the city/ provincial Defensa Civil by the DEINFRA as the dam operator must be set up and implemented essentially.

Herein the flood forecasting at Rio do Sul using the water level correlation method is tried and shown as followings. The forecasting flood water level at Rio do Sul is computed based on the correlation of the water level (ARIMAX Model Method) at Rio do Sul, Ituporanga and Rio do Oeste. The schematic diagram for gauging stations of Rio do Sul, Ituporanga and Rio do Oeste is shown in Figure 4.1.2. Ituporanga and Rio do Oeste are approximately located in 25 km along Itajai do Oeste River and 18 km along Itajai do Sul River upstream respectively from Rio do Sul City.



Source: JICA Study Team Figure 4.1.2 Schematic Diagram for Gauging Stations

New multiple correlation formula is created using water level at Rio do Sul, Ituporanga and Rio do Oeste and the accuracy of forecasted water level used by the new multiple correlation formula shall be confirmed with the actual flood water level at Rio do Sul.

Table 4.1.1	Summary of F	lood Forecasting F	ormula by Mult	iple Correlation at Rio do Sul

Method	Gauging Sta. 1	Gauging Sta. 2	Coefficient of Correlation	Forecasting Formula
Multiple Correlation	Using 3 hours before actual water level at Ituporanga considered arrival time	Using 3 hours before actual water level at Rio do Oeste considered arrival time	0.445	Y = 0.7908315 * (Water Level at Ituporanga) + 0.1460886 * (Water Level at Rio do Oeste) + 4.44770646

Source: JICA Study Team

The flood forecasting by the multiple correlation among Rio do Sul, Ituporanga and Rio do Oeste using the flood in April 2010 is as shown in Figure 4.1.3 and the correlation coefficient is R = 0.445 which is quite low.



Source: JICA Study Team

Figure 4.1.3 Comparison between Actual and Water level Forecasted by Multiple Correlation Formula at Rio do Sul;

Here the arrival time shall be computed by using the Kraven formula as shown as the following.

$$T (hr) = (1/3,600) x (L/W)$$

Where	T (hr):	Flood arrival time from upstream station to Rio do Sul
	L (m):	Channel Length from upstream station to Rio Do Sul
	W (m/s):	Flood velocity (refer to the following table)

Ι	1/100 <	1/100 ~ 1/200	< 1/200
W	3.5 m/s	3.0 m/s	2.1 m/s

$\mathbf{I} = \mathbf{H} (\mathbf{m}) / \mathbf{L} (\mathbf{m})$

Where, H (m): Difference in Elevation

L (m): Channel Length

The river slope for Ituporanga and Rio do Oeste is 1/800 and 1/5,000 respectively therefore the flood velocity for Ituporanga and Rio do Oeste iare are 2.1 m/s. The arrival time shall be computed as follows:

• Ituporanga: T (hr) =
$$(1/3,600) \times (25 \times 1,000/2.1) = 3.3$$
 hours
• 3.0 hours
• Rio do Oeste: T (hr) = $(1/3,600) \times (18 \times 1,000/2.1) = 2.4$ hours
• 3.0 hours

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4.1.2 Verification of Existing Flood Forecasting Formula for Blumenau

The forecasting flood water level at Blumenau is computed based on the correlation of the water level (ARIMAX Model Method) at Blumenau, Apiuna and Timbo. The schematic diagram for gauging stations of Blumenau, Apiuna and Timbo is shown in Figure 4.1.4. Apiuna and Timbo are approximately located in 61 km along Itajai River and 37 km along Benedito River upstream respectively from Blumenau.



Source: JICA Study Team Figure 4.1.4 Schematic Diagram for Gauging Stations

The water level correlation formula for the flood forecasting at Blumenau was developed by the FURB/ CEOPS in 1990's as follows.

Y(t)=1.98063 x Y(t-1) - 0.98506 x Y(t-2) + 0.009200 x u1(t-4) - 0.08732 x u1(t-5) + 0.01806 xu2 (t-4) - 0.01411 x u2 (t-5) + 0.03083(3)

where,Y(t):Forecasted water level at time of (t) hour at Blumenau stationy(t-1):Water level at time of (t-1) hour at Blumenau stationy(t-2):Water level at time of (t-2) hour at Blumenau stationu1(t-4):Water level at time of (t-4) hour at Apiuna stationu1(t-5):Water level at time of (t-5) hour at Apiuna stationu2(t-4):Water level at time of (t-4) hour at Timbo stationu2(t-5):Water level at time of (t-5) hour at Timbo station

The evacuation manual of SC states says that the evacuation shall be announced 3 hours before the flood in consideration of priority people to be protected such as aged people, handicapped people, children and tourists and so on.

The required water level at Blumenau for calculating of forecasted flood water level using the proposed formula is the 1 hour before and 2 hours before the flood therefore the following steps shall be conducted to compute the forecasted water level after 3 hours from present.

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- i) To forecast water level after 1 hour at Blumenau using present and 1 hour before water level at Blumenau
- ii) To forecast water level after 2 hours at Blumenau using forecasted water level after 1 hour and present water level at Blumenau
- iii) To forecast water level after 3 hours at Blumenau using forecasted water level after 1 hour and after 2 hours at Blumenau

The formula was developed approximately 20 years ago. This verification shall be conducted using the flood data in April 2010.

The following Figure 4.1.5 is shown the comparison between the actual flood water level at Blumenau and the forecasted flood water level (after 3 hours at Blumenau) computed by the proposed formula. The forecasted water level is quite similar to the actual one.



Source: JICA Study Team

Figure 4.1.5 Comparison between Actual and Water Level Forecasted by Present Formula at Blumenau

In addition to above verification, new multiple correlation formula is created using water level at Blumenau, Apiuna and Timbo and the accuracy of forecasted water level used by the new multiple correlation formula shall be confirmed with the actual.

Method	Gauging Sta. 1	Gauging Sta. 2	Coefficient of Correlation	Forecasting Formula		
Multiple Correlation	Using 6 hours before actual water level at Apiuna considered arrival time	Using 3 hours before actual water level at Timbo considered arrival time	0.991	Y = 1.101225 * (Water Level at Apiuna) + 0.56226 * (Water Level at Timbo) - 1.83067		
Source: JICA Study Team						

 Table 4.1.2
 Summary of Forecasting Formula by Multiple Correlation at Blumenau

Source. Fierr Study Team

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The forecasting formula by the multiple correlation among Blumenau, Apiuna and Timbo using the flood in April 2010 is quite accurate as shown in Figure 4.1.6 and the correlation coefficient is R=0.991 but not as high as the present forecasting formula (see Figure 4.1.7).

Therefore the present forecasting formula at Blumenau is still maintaining accuracy and even now it is applicable to use the present forecasting formula for forecasting flood water level at Blumenau. In future, whenever the flood comes the formula should be checked and updated if necessary.



Figure 4.1.6 Comparison between Actual and Water level Forecasted by Multiple Correlation Formula at Blumenau





4.1.3 Flood Forecasting System at Itajai City

The Itajai City has very important role for the economy in the Itajai River Basin and the flood forecasting system should be organized as same as Rio do Sul and Blumenau. However the Itajai City is located at the estuary and the city is seriously affected by the tide and influenced by the tributary of Mirim River. Therefore the forecasting of flood water level at Itajai city is very complicated and difficult.

The Defesa Civil at Itajai City has already installed new 8 water level gauges around the city in February 2011 and they are planning to set up new system for the flood warning and evacuation announcement but they has presently hard time to set up the flood forecasting system since the information in upstream such as Blumenau and Brusque is not transmitted to Itajai City.

Other hand, the Defesa Civil, SDS and EPAGRI in SC State are planning to develop the flood forecasting modeling for the flow-runoff analysis and inundation analysis but it needs more time to get accurate forecasting system using sufficient data collected by the proposed gauging stations under this FFWS. However the development of the flood forecasting modeling should be continued. Meantime the flood warning and evacuation announcement should be implemented by the SC State due to the flood water level of upstream such as Blumenau and Brusque.

4.2 Selection of Equipments and Facilities

The Master plan which is considered the additional gauging stations and necessary transmission facilities for flood forecasting and warning system are composed as followings:

- (1). Automatic rainfall gauge (tilting-siphon type)
- (2). Automatic river water level gauge (radar type)
- (3). Data logger (magnetic tape recorder)
- (4). Solar panel and battery (save electricity)
- (5). Converter to send monitored data (global mobile telecommunication system: GPRS)
- (6). Receiving system at the central station at Florianopolis (server and database)
- (7). Connection network between gauging stations (Internet/ civil defense at each city)
- (8). Connection network for the central station (Internet/Florianopolis)
- (9). Real-time flood Information system by the Internet (web site)

Observation equipments were chosen with following considerations and the monitoring components were listed in Table 4.2.1.

(1). Rainfall:

There are tipping-bucket type and tilting-siphon type. The chosen rainfall gauge for the Itajai River is tilting-siphon type with 200mm diameter brass-muzzle with sharp edge on the top, which collects rain water and water get stored in triangle siphon. Once water reach up to 0.5 mm, the siphon tilts.

(2). River water level gauge

There are pneumatic, ultrasonic and radar types. The pneumatic type has difficulty in maintenance as it gets affected by erosion and sedimentation of the river bed. On the other hand, the ultrasonic and radar types are easier in its maintenance and management. Especially the radar type does not affected by temperture and wind as well as low electric consumption and reasonable. Therefore the radar type is applied to the proposed basin.

(3). Data logger

This can record accumulative rainfall and river water level simultaneously at each interval and send the data to the central station every 10 minutes via E-mails by utilizing CDMA2000 1X radio transmission technology.

(4). Data transmission system

Rainfall and river water level data monitored at civil defense of each city get sent through the central station (Florianopolis) to the monitoring stations in Rio do Sul, Blumenau and Itajai.

(5). Flood forecasting and warning system

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The monitored data that are sent to the central station and stored in database. Based on information such as river water level of the upstream, flood forecasting is implemented in each city as following.

- iv) In Rio do Sul, it is based on information of Sul dam, Oeste dam, tributary rivers in Taio and mountain ranges and rainfall forecasting from whether report.
- v) In Blumenau, it is based on river water level of Rio do Sul, Apiuna, Indaial and Timbo.
- vi) In Itajai, it is based on river water level of Blumenau, Salseiro and Brusque as well as tidal level from the Itajai bay.

When the flood water level is forecasted and analyzed by the river water level correlation, the earlier warning is sent to each hazardous area through CD Municipal Council and the civil defense and urges immediate and safe evacuation of the residents.

The records of rainfall and river water level from each gauging station are stored in the database at the central station (Florianopolis). The records are also sent to civil defense at each city to be monitored. The following equipment is required for each monitoring center (civil defense of Rio do Sul, Blumenau and Itajai).

(6). Central station (Florianopolis)

Data transmission control Server (DTCS) to receive the monitored records, data Base (DB) server and WEB server are required. In addition, installation of DB, set up of network, system engineer, network engineer and designer for creation of maps are also needed. As equipments, three computers and radar printers and two of 52' inches-monitors (LDC) are needed. Essential items such as A/C and telephone for DB are installed to the Florianopolis and maintained as reference image of Figure 4.7.1.

(7). Monitoring center (Rio do Sul, Blumenau and Itajai)

Two computers, two 52' inch monitor (LDC) and one radar printer are needed. The system engineer is required to install these items as well as the network facilities. It is also considered that the central station at Florianopolis also requires the same facilities to monitor the flood situation in real-time.

(8). Rainfall and river water level gauge stations

Aluminum pole (250 mm diameter) with a solar panel as an electronic battery is installed. This pole has a rainfall gauge on top and a water level gauge at bottom which is set at a bridge and they are connected by a cable line to a data logger. The monitored records are sent to the Internet by the GPRS transmission via E-mails every 10 minutes and the records are saved at the central station server.

(9). CCTV

Two CCTV cameras need to be installed at each city (Rio do Sul, Blumenau and Itajai) where can monitor flood situation. CCTV needs to be connected to digital disk recorder. Pictures are taken every one minute and sent through the Internet by GPRS transmitter and then received at the central station server. These pictures are projected on monitoring screens.

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Table 4.2.1 Monitoring Components at The Central Station					
Monitor	Display	Detailed			
	Daliaf Man fan sissan	It is a river map at the Itajai Basin. When clicked at an observation			
Web Site	Relief Map for fiver	display.			
	Diagram	The flow of the Itajai River and the location of monitoring stations			
	Diagram	are showed in diagrams.			
	Daily rainfall	The rainfall graph for 24 hours at each monitoring station			
Graphia Display	Hourly rainfall	The Hydro Graph for hourly rain fall at each monitoring station			
Graphic Display	Hourly river water level	The continuous graph for hourly river water level at each			
	Hourry river water level	monitoring station			
Tabla Diaplay	Hourly rainfall	Table for hourly rainfall at each monitoring station			
Table Display	Hourly river water level	Table for hourly river water level at each station			
		The monitors at the Master station and Monitor station displays the			
Video Display	CCTV	photos that are transmitted every minute by the set CCTV at Rio do			
		Sul, Blumenau and Itajai.			

Source: JICA Study Team



Figure 4.2.1 Monitoring Center and Sample Photo

4.3 Cost Estimate for Proposed Master Plan

The cost estimation for strengthening FFWS is shown as follows.

- i) Equipments cost including installation
- ii) System development cost including consultant services

The summary of new gauging station is shown in Table 4.3.1 and the specification of equipments is shown in Table 4.3.2 as follows.

	Table 4.3.1Quantity and Location of New Gauging Stations							
	Station	Rainfall	Water Level	CCTV	Warning Tower	Warning Siren		
1	Rio do Sul			1	3	3		
2	Blumenaur			1	3	3		
3	Itajai			1	3	3		
4	Vidal Ramos	1	1			3		
5	Trombudo	1	1			3		
6	Rio dos Cedros	1	1			3		
7	Benedito Novo	1	1			3		
8	Gasper	1	1			3		
9	Ilhota	1	1			3		
10	Mirim Doce	1	1			3		
11	Salete	1	1			3		
12	Pouso Redondo	1	1			3		
13	Agua Clera	1	1			3		
14	Gurabiruba	1	1			3		
15	Sul Dam	1	1			3		
16	Oeste Dam	1	1			3		
17	Pinhal Dam	1	1	1		3		
18	Rio Bonito Dam	1	1	1		3		
19	Luiz Alves	1	1			3		
	Total	16	16	5	9	57		

Source: JICA Study Team

In addition to above, the Master Station at the Defesa Civil at Florianopolis City shall be established as described in Chapter-3 and the three (3) monitoring Centers shall be established at the Defesa Civil at Itajai City, Blumenau City and Rio do Sul City.

Item	Specification	Nos.
Telemetry rainfall gauge	Radar type OTT/RLS model	16
Telemetry water level gauge	Radar type OTT/RLS model	16
Software	Automatic E-mail system	16
Solar panel/battery	Polycrystalline silicon type 12V	16
Data transmission (GPRS)	For data transmission 2.0Mbyte	16
CCTV	In-line transmission CCD	5
Data transmission (GPRS)	For CCTV 2.0Gbyte	5
Database	Memory capacity for 20 years record	5
Monitoring panel	52 inches display LDC	5
Electric bulletin board	5.0 m width and 3.0 m height	0
(warning tower)	Rio do Sul (3), Blumenau (3), Itajai (3)	9
Alarm (siren)	Large disaster warning siren, for external moisture	57

 Table 4.3.2
 Specification of Equipments

Source: JICA Study Team

The cost estimate for new gauging stations including the Master Station and Monitoring Centers is shown in Table 4.3.3.

Table 4.3.3 Cost Estimate for Proposed Gauging Stations						
Item	Nos.	Unit Price (R\$)	Amount (R\$)			
Telemetry rainfall gauge	16	5,300	84,800			
Telemetry water level gauge	16	6,800	108,800			
Software	16	-	-			
Solar panel/battery	16	17,000	272,000			
Data transmission (GPRS)	16	20,000	320,000			
CCTV	5	26,500	128,000			
Data transmission (GPRS)	5	20,000	100,000			
Database	5	120,000	600,000			
Monitoring panel	5	8,000	40,000			
Electric bulletin board (warning tower)	9	30,000	270,000			
Alarm (siren)	57	2,000	114,000			
Monitor station	3	80,000	240,000			
Central station	1	257,000	257,000			
Total			2,534,600			

Note: The cost for development of programs regarding the telemeter system is not included in the above cost.

Source: JICA Study Team

The river register book is needed to prepare for total river management together with the proposed gauging stations above. The river register book must include total 350 cross section survey (1.0 km interval) along Itajai Main River and major tributaries, cross section survey for existing water level gauges and km piles (KP) along the river. The work for river register book shall also include the development of modeling for the flood runoff analysis.

The purposes for the consultant services regarding the system development are as follows.

- vii) Tendering for procurement of equipments
- Training for concerned organizations viii)
- ix) Development for flood forecasting modeling and simulation modeling
- Establishment for H-Q curves for all water level gauging stations including existing x) and proposed stations
- xi) Study for preparation of operation system for Bonito and Pinhal Dams
- xii) Study for preparation of operation system for Oeste and Sul Dams

The cost for the consultant services for system development is shown in Table 4.3.4.

Table 4.3.4 Cost for Consultant Services for System Development							
Item	M/M	Unit Price (R\$)	Amount (R\$)				
Project Manager	10	60,000	600,000				
Hydrologist	8	50,000	400,000				
River Engineer	8	50,000	400,000				
Program Engineer	4	50,000	200,000				
Telecommunication Engineer	5	50,000	300,000				
System Engineer	5	50,000	300,000				
Network Engineer	5	50,000	300,000				
Database Engineer	5	50,000	300,000				
Supporting Staff	10	20,000	200,000				
Total	-	-	3,000,000				
Source: JICA Study Team							

Table 134 Cast for Consultant Services for System Development

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The direct cost for the propose FFWS is shown in Table 4.3.5.

Table 4.5.5 Direct Cost for Strengthening Existing FT W5							
Amount (R\$)							
2,534,600							
1,500,000							
3,000,000							
7,034,600							

 Table 4.3.5
 Direct Cost for Strengthening Existing FFWS

Source: JICA Study Team

4.4 Implementation Schedule

In order to strengthen the existing monitoring network, the additional monitoring station will be carried out to set up the rainfall and river water level gauge and to improve the data transmission system. As well as the central station which is located at Florianopolis will be established in the SDS Office in order to monitor in real time the flood in Itajai River. The items of building up for the proposed FFWS are listed in Table 4.4.1.

Item	First year		Second year				Remark		
Additional station (Nos.16)									
for Monitoring									
Setting up CCTV (Nos.5)									Including
(Rio do Sul, Blumenau, Itajai)									Bonito and
									Pinhal dams
Commissioning									
(Data Transmission)									
Flood Forecasting Analysis				5					
(Rio do Sul, Blumenau, Itajai)		L	1						
Monitoring Station									
(Rio do Sul, Blumenau, Itajai)									
Build-up of Central Station						1			
(Florianopolis)				, i					
Calibration of Monitoring									
Preparation for River Log Book									
(Cross Section Survey)									
Training of Engineer									

 Table 4.4.1
 Implementation Schedule for Proposed FFWS

Source: JICA Study Team

CHAPTER 5 RECOMMENDATIONS

5.1 Recommendations for Future

- i) The monitoring stations related to the FFWS must be increased for the future in order to apply such as the X band monitoring of Doppler radar and the weather forecasting using by the numerical model of satellite information.
- ii) It is important to organize the river management system and one governmental agency should be responsible for the total management of the Itajai River Basin. The river inventory shall also be arranged properly by the river management unit. A flood information center should be also set up inside of the organization for "River Management" in order to raise the awareness of the flood management.
- iii) The evacuation manuals have been exists only in Rio do Sul, Blumenau and Itajai cities. In these manual, the high risk areas are listed, however, hazard maps are not developed. In addition, the manual has no guidelines for flood prevention activities such as using of sand bags to stop water. Therefore, the river management unit shall improve the existing evacuation manuals and develop hazard maps for more appropriate evacuation activities. Flood prevention teams shall be responsible for conducting urgent repairing works in order to prevent and mitigate the flood damages.
- iv) The river management unit has to consider the river maintenances including preparing the river inventory book for the river improvement and repair at hazardous areas. The hazardous area must be reflected the land use plan of each city and the residents must be relocated from the hazardous area.
- v) In order to implement a safe urban planning, the master plan for land use must be prepared in considering of the social conditions such as living condition, industrial component and population density and the natural conditions such as hydraulics and geology.
- vi) The residents in hazardous area have vested rights therefore the resettlement from the hazardous area could not be implemented forcibly and it is also difficult to look for resettlement area. Therefore the implementation of the regulation of land development may have difficulty so the compulsory execution may need to ask the residents for resettlement from the hazardous area. Execution of real flood prevention activities is quite difficult since the data of hazardous area is not available due to absence of the river management unit. Civil Defense is implementing the training of flood prevention activities for during and after the floods but not for before the floods.

Supporting Report (E) Water Storage in Paddy Fields

PREPARATORY SURVEY FOR THE PROJECT ON DISASTER PREVENTION AND MITIGATION MEASURES FOR THE ITAJAI RIVER BASIN

FINAL REPORT

VOLUME III : SUPPORTING REPORT ANNEX E : WATER STORAGE IN PADDY FIELDS PROJECT

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CHAPTER 1 PROJECT CONTEXT OF THE WATER STORAGE IN PADDY FIELD

1.1 Background

(1) Mitigation Function of Water Storage in Paddy Fields

The paddy fields in the basin, accounting an area of 26.295 ha, distribute in all basins, and mainly locate in the higher basin between the Taió to Rio do Sul, Timbó area, and the lower basin among Gaspar to Itajaí. In spite of the paddy fields does not exceed 1, 8% of the total basin, the rice field has an important element for the flood regulation, being distributed in the margins of the river from higher basin to river mouth. The existence of paddy fields shows significant roll in the control / reduction of the inundations in the lower basin.

Through the rain storages in the 80% of the paddy fields (22.000 have) distributed in the basins, with the storage depths from 20 to 50 cm, it hopes to create approximately 2 to 5 thousand m^3 of capacities of storages pr hectare, equivalent to the 44 million to the 110 million m^3 of storage capacities in the Itajaí Basin. It can emphasize that this volume is equivalent to the Oeste and Sul Dams that has exclusive object to control inundation. The project has objective of exploring that capacity of reductions of rains in the paddy fields to soften the impacts of the inundations through the heightening of paddy ridge.

(2) External Factor

However, the potentiality to mitigate or attenuate an inundation does not still explore efficiently. On the other hand, in Brazil, the demands tendency, in all of the productive areas, has if more rigorous control, besides in the area of agricultural production. The main norms regulations implicated in the agricultural sector are:

- Land Tile regulation in accordance with the Forest Code (require existence of the legal reservation (RL) and the permanent reservation areas (APP), besides of riparian forest)
- Regulation of the use of agricultural defensive

In the forest Code, it forces to obtain the "Certificate of Land Title Regulation" for every rural property that requires the normalizations of the APP and of the RL.

This acquisition of the certificate of lands use regularity is forced for the all of the lands in the Brazilian territory; also, the paddy expanded in the basins also is inside of this regulation. For the acquisition of this certificate of land use regularity, the needs exist of updating them title of the soils, respecting the established requirements in the forest code of RL and of APP. They put these activities of environmental regularization becomes the increment of the costs of agricultural productions.

Besides, in the agricultural production sector, the consumers' demands in relation to safety foods have been increasing, requesting the certifications and tractability of the productive chain from seedling to commercialization.

This rigidity tendency in the control and quality demand in the productive chains, bring to increase the complexity in the production and consequently, elevation of the productions cost, until provoking rural exodus, because of the deterioration of the agricultural economy. As well as most of the rice farmers of the basin are of small scale farmers who doesn't have capacity to accompany the demands and of quality. Its tendency takes risks of abandoning rice cultivation, consequent abandonment of the paddy

and deteriorating in the decrease of the rain retention capacity in the paddy for the loss of ridge of the farming in the point of basin management.

Like this, with the abandonment of the farming caused by the rural exodus, it brings to degradations of the paddy, consequent the disappearance of the paddy ridge, and the loss of the capacity of reduction of the rains retention in the basin. To maintain and to improve the capacity of attenuation of the rains in the paddy, it is necessary to realize the measures and strategies for the producers to stay in the rural area and to motivate the productions through the measures that favor the productions of rice in the Basin.

In this project, through construction of paddy ridge that contribute in the reductions of the floods, the farmers can modernize the productive system, capable to adjust to the forest codes, taking place the necessary activities, such as topographical survey, recoveries of the riprap forests and introduction of the PIA (integral rice production). In following Fig, it is indicated the interrelations between the paddy and the project of heightening of paddy ridge:

As the measures to produce the safety foods, the Federal Government, through the Ministry of Agriculture and Livestock and Provisioning (MAP), this introducing the system of the Integrated Production of Rice (PIA) to supply at the market the rice with quality assured and good you practice of cultivations of rice, and also to obtain larger joined prices.

In order to introduce PIA practices in the basin, there are following requirements;

- Regenerations of the riprap forests and environmental regularizations.
- Heightening of paddy ridge, water management for control of weeds that make possible the least uses of pesticides.
- Prohibition of burning to mitigate emission of gases CO2.
- Introduction of the agricultural practice respectful with the environment.
- (3) Relationship between rice culture and reduction of floods by water storage in paddy

At present, the rural areas, for the rigid control of environment, are forced to respect the environmental codes that bring to increases of the costs of the productions. These restrictions are the factors of being less economical viabilities of the productions of rice and consequently in the high risks in the reductions of the income of the rural producers that in the long medium period cause the rural exodus or abandon of the paddy.

These abandonment of the paddy, result the degradations of the rice fields, especially in the disappearance of the paddy ridge, that drive the decreases of the capacities of reduction of floods. For not causing the negative chains of degradations, the needs exist of accomplishing the appropriate interventions to maintain the sustainability of the rice productions in the basins. Especially in the agricultural sector, the introductions of agricultural practice that allow the decreases of the costs and of the productivities increasing

The measures that make possible the increases of the productivities and of economicalization of the costs of productions are the mechanizations of the agricultural practice and the introductions of the resistant varieties in the uses of pesticides that control the weeds or the introductions of the cultivations of rice in added value. In the agricultural practices, the applied pesticides in the paddy fields are prohibited the discharges to the rivers at least 2 weeks. With these conditions, for the farmers, the rice culture continuities are requirements of modernizing them practice agronomic.

With these circumstances, to modernize the agricultural practice, it is necessary the heightening of the

paddy ridge and the environmental regularization that demand the uses of the respected lands use in accordance with the environmental codes through the necessary interventions, such as of topographic survey of the lands and of regenerations of RL and APP. Through the structuring of the bases of productions of rice, the producers can be insured of the continuities of the productions of rice.

Therefore, to maintain and to improve the capacity of reduction of the rains in the paddy fields, it is necessary to accomplish interventions and appropriate strategies of planting, so that the producers stay producing his/her cultivation in the referred Basin.

The project of heightening of paddy ridge of the paddy fields, besides contributing in the reductions of the floods, will allow to the farmers to modernize productive system, being adjusted to the forest code, as well as accomplishing necessary activities, such as topographical risings, recoveries of the riprap forests and introduction of integral production of rice. In following Fig, it is indicated the interrelations between the rice culture and the reduction project by the heightening of paddy ridge.



Figure 1.1.1 Relation between the Project Water Storage in Paddy fields and Rice Culture

(4) Compatibility with the Master plan of the Committee of Itajaí

The Itajaí committee, aiming at the uses of the water resources in the basins, had formulated "Water resources Plan in the Itajai Basin" composed by topic and programs. As the topic related to this project exist the theme of recovering of riprap forests and rural managements, being identified the following programs;



Figure 1.1.2 Compatibility of plan with the Itajaí Basin Water Resources Plan

1.2 General policy of plan

Objective of Plan (1)

This plan, based on the above mentioned background, in purpose to enlarge the flood reduction capacity, being used of the paddy fields expanded in the all basins, will be heighten paddy ridge and gradually to introduce the rice production with better quality and safety. As measures, it will develop the following activities:

Increase of capacity of	-	Elevation of the paddy ridge.
reduction of the floods effect		
Use of the land in accordance	-	Recovery of the riprap forest.
with Environmental	-	Incentive to use of farm land in accordance with environmental
Legislation		legislation
Safety foods Supply -		Incentive to introduce the Integrated Rice Production
Sources IICA Survey Team		

Table 1.2.1 Objective of Project and Proposed Action

Source: JICA Survey Team

Through the materialization of the elements above, the following effects will be produced:

Table 1.2.2 Action and Expected Impact				
Construction of paddy	-	Increase of the attenuation capacity of the rains in the paddy (for an		
ridge		increase from 40.000.000 to 1.000.000.000 retention m ³).		
	-	Retention of the defensive used inside of the paddy fields.		
	-	Decrease of the soil erosion loss		
Recovery of riprap forest - Transformation of the area to the rice production area balance environmental codes.		Transformation of the area to the rice production area balanced with the environmental codes.		
	-	Protection of riprap area		
- Make the bases of to a		Make the bases of to acquisition of "Certificate of legalized lands"		
Incentive to use land in	-	No penalty		
accordance with	-	Improvement to accessibility to Official Agricultural Credit		
environmental regulation				
Strengthening of PIA	-	Offer of healthy and safe foods.		
	-	maintainable and financial Stability of the producers through the production of valued rice		

. . - -

(2) Extents of Plan

The extent of the plan is expansion of the rice field in the Itajaí basin. In the following Table, it is indicated the basin area, the paddy area and the percentage regarding the total area.

	Basin (km ²)	Paddy fields (km ²)	Percentage
Total	14,933.2	262.95	1.76%
Itajaí do Oeste	3,014.9	99.45	3.30%
Itajaí do Sul	2,026.7	19.64	0.97%
Itajaí do Norte	3,353.8	10.64	0.32%
Benedito	1,500.3	30.20	2.01%
Luis Alves	580.0	19.64	3.39%
Itajaí Açú	3,358.6	60.80	1.81%
Itajaí Mirim	1,678.9	22.57	1.34%

Table 1.2.3 – Sub-basin area, Rice field's area and percentage of rice fields area

Source: JICA Survey Team



Source: JICA Survey Team

Figure 1.2.1 Paddy Area in the Itajaí River Basin



Figure 1.2.2 Paddy Area in higher Basin of Itajaí River

(3) Implementation method for the Project of Water Storage in Paddy fields

Considering the nature of this type of measure that depend on the paddy fields and the inundation risk falling directly to the producers, the project seeks to benefit both side, so much of production and of inundation mitigation in the same time, without only sacrificing the producers, exploring the paddies potentialities in the mitigation of flood and improvements of the productive infrastructures through the construction of paddy ridge. At the same time, as the compensatory measures of the paddy fields, it will be implemented the introduction of the Integrated rice production (PIA) that the producers can be adjust to the environmental demands, guaranteeing them financial means for so much, facilitating them the obtaining of the CRF.

Inside of this plan, the government will finance the construction of paddy ridge heightening works, and the producers will participate in their activities of implementing the paddy ridge in their property. The government's contribution and of the producers in the heightening of the paddy ridges will be the following:

	Governments Support	Producers Contribution
Plan	 Support for formation of the Term of Agreement of the producers. Support to organizations of the associations. Support to the obtaining of C.R.F. Topographical survey Formulation of the Plan / Project (amount of works, calendar of the works, determination of the participation) 	 Agreements between the producers and Establishment of the associations of the producers. Arrangements of the registrations of the participants' registers. Agreement among the producers in the accomplishment of the Plan. Contract of the Execution of the Project
Heightening of paddy ridge	 Dispatch of consultants Definition of the methodologies of project implementation. 	 Execution of the Construction of Heightening of Paddy Ridge Co-payment of Construction Cost

 Table 1.2.4
 Activity of the Project Rain containment in the paddy fields

Nippon Koei Co., Ltd.

November 2011

	Governments Support	Producers Contribution
	 Disbursement of Construction Cost of Heightening of Paddy Ridge (80%) Supervision of the works 	(20%)
Recovering of riprap forest		Placement of that material in the margins of Rio.Planting of nursery plants
Adjustment for Environmental legislation	 Certification of the property registration. Survey of properties. Emission of APP, R.L. Establishment of the reach of APP 	Title of the property.Certificate of Land title
Promotion of the PIA	- Technical Orientation for the PIA	- Introduction of PIA

Source: JICA Survey Team

Due to the paddy fields extend for the whole basin, and there are approximately of 2.000 farmers, there is complexity of the implantation of this plan to make format the implementation plan if it implement in contract base. Besides, because of the characteristics of this plan, and having a lot of stages of processes in materialization, it is suggested that the execution is executed in the following way:

Government			
-	Lend of services and consultancies for the		
	implementation of the Plan.		
-	Disbursement of construction Cost (80%)		

	Producers
-	Construction of paddy ridge heightening.
-	Provision of riprap forest area
-	Co-payment of Construction Cost

CHAPTER 2 WATER STORAGE IN PADDY FIELDS

2.1 Outline

(1) Scheme for the retention of flood water in the paddy fields

It is foreseen to execute the heightening of the paddy ridge (current 10 cm) for more 10 to 30 cm, hoping to increase the capacity of retention of the rains for more $2.000 \sim 3.000$ m3 for hectares, as well as it is indicated in following Fig;



Figure 2.1.1 Retention Methodology of Flood water in paddy fields

The works of paddy ridge heightening will be realized in the margins of the suitable paddy with red lines in following Fig. For not accompanying the damage in the rice production, the gates will be installed capable to control/mitigate the effects of floods, especially in the times of flowering season period of rice when larger risk of loss of the products exists.



Figure 2.2.2 Retention of Rain in paddy fields

(2) Definition of the flood depth and height of paddy ridge

The rice culture, being the certain resistant culture for flood, it allows to accomplish the control of the floods, through the floods of the fields with the appropriate water managements. However, vulnerable times exist as in the period 20 days before flowering season in that the culture can be damaged by the excess of water. The required height of paddy ridge will be defined, being considered the heights of rice, to minimize the damages that can be caused by the floods by this project. The depths of projected floods depth are the following ones;

- During the period of non cultivation, it settles down 30 cm of water depth. From the period of 20 days before the formation of the ears of rice, until the time of flower of these, the maximum depth will be of 30 cm, being the normal depth of 20 cm.
- After the seedling, given the fact of the young plants does not support for a long time be submerged, one should not leave submerged for more than 4 consecutive days

The height of the heightening is of 30 cm, to make possible the installation of floodgates and to guarantee the depth of until 30 cm of the water.



Figure 2.1.3 Cross section of Paddy Ridge

The amount of work for the paddy ridge is the following ones:

Present, (0,5+0,7):2x0.1m= 0,06 m3 After heighten: (0,5+1,3):2x0,4m= 0.36m3 Difference of earth volume: 0,30 m3

(3) Extents of Project Area

The extent of the Project will be the areas where appropriate rice field expansion exists inside of the entire paddy areas expanded in the Basin. As the first phase, it is considered 5,000 ha of the paddy expanded in the basin. The objective areas of project will be selected in the basic study phase and it will be settled down the following goals:

Paddy Areas:	26.295 has
Objective Project Area:	20.000 has
First phase Area of the Project:	5.000 has

(4) Heightening of Paddy Ridge and required work quantities

The dimensions of the works were estimated, being taken the area of Agronomic as sampling. The estimated amounts of works are;

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		,	

	Present	Projected	Cost/ha	
Total Area				
Paddy Ares	101.4 ha			
Extension of ridge	29.4 km			
Number of farm	106			
Area of Riprap forest		0.03 ha/ha	R\$ 5,000/ha	
Length of paddy ridge	m/ha	300 m/ha		
Required volume for heightening of Paddy		90 m3/ha	R\$ 3.150/ha	
ridge				
Extension of medium paddy	ha	1 ha		
Required Gate		1 per ha	R\$ 250/ha	
Specific riprap Forest area for 1 hectare	16.6 ha	0.16 ha/ha		
Length of riprap forest	5,600 m	55 m/ha		

In following Fig, the Agronomic area as a sample is indicated, in order to estimate the amounts of works requested for this measure;



Source: JICA Survey Team

Figure 2.1.4 Paddy Fields in AGRONOMICA

The estimated costs of the project, included topographical survey, formulation of the plan, environmental licensing and the environmental regulation are:

Table 2.1.2 Estimated required budget in a Contract base				
Item	Quant.	unit	Unit Price (R\$)	Total Value (R\$1,000)
Work for heightening of paddy ridge	5.000	Ha	3,400	17,000
Recovering of riprap forest	200	На	5,000	1,000
Subtotal				18.000
Design of paddy ridge	20.000	Ha	100	2,000
Detailed design and Bidding assistance	5,000	Ha	200	1,000
Construction Supervision	5,000	Ha	600	3,000
Topographic Survey	5,000	Ha	200	1,000

 Table 2.1.2
 Estimated required budget in a Contract Base

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November 2011

Item	Quant.	unit	Unit Price (R\$)	Total Value (R\$1,000)
Emission of C.R.F	500	Family	100	500
Support to Environmental Regularization	500	Family	200	1,000
Training	500	Family	1,000	500
Total				27,000

Note: The cost of measures of contention of floods in the paddy was esteemed in the following form: Works of heightening (R 3.150 / ha) + Floodgate (R 250/unit. The Cost of riprap forest was estimated in the following form: Plants (1.000 x R 3.0 / unit) + fence Source: JICA Survey Team

Implementation Method

The work of the heightening/preparation of the paddy ridge will be executed by the contractor, and the implementations work methodology is as follow:

- Promotion to the producers to participate in the project of containment of rains in paddy fields, through the explanations of its benefits and activities to be accomplished by the project.
- Formation of the Agreement among the producers on implementation of the project.
- Realization of the Study, preparation of the Projects and necessary topographic survey.
- Project Design/Estimation of Cost
- Estimation of Cost
- Request for the implementation of Works for the Coordination Unit
- Request for FDR
- Evaluation of the Project, Appraisal and Contract for the Execution of the Project
- Construction by producers
- Disbursement of Construction Cost (80%)

It is foreseen to promote the understanding of the producers, in agreement, projects and survey. This type of service will be accomplished through support activity of contracted consultancy. The place of the borrow pit of the earth for the paddy ridge heightening will be made by own local population. Also the works of the riprap forest plantations will be done as of the beneficiaries' responsibility, so much in the execution, as in the financial area.

- 2.2 Organization Chart of Project Implementation
- (1) Process

The implementation of the project will have as base, the rational and economical use of the budget, with the wide participation of the producers in the work. The State government will finance the materials and necessary machineries for the work, as well as consultancy services and training. Below, it is the organization chart of the implementation of the works:



Figure 2.2.1 Organization Chart

The executive organization of this project is the State secretariat of Civil Defense (SDC). For the implementation of this project, the SDC will be acquired the Constructor through the bidding.



Source: JICA Survey Team

Figure 2.2.2 Project Implementation Flow

In this Project, the FDR will already be applied established in the SAP, as an operational mechanism of the Project of the World Bank "MICROBACIA."

(2) Consultancy Service

The Consultancy of this operation will have the following attributions:

Formulation Stage for the Rain Water Contention in Paddy Fields

- To determine the outline of execution of the whole plan.
- To chooses of the candidate farmers and organization of the associations (final objective, 500 families of farmers).
- Verification of the participants' (final objective, 500 families of farmers) land titles situation.
- Verification of land title documents
- Topographic Survey and verification of Legal Reserve and Riprap Forest Area
- Detailed design and Cost Estimation
- Cost estimation
- Obtaining of the environmental license.
- Preparation of application document for appraisal
- Supervision and orientation of the work of heightening of walls (paddy ridge).
- Supervision of the countermeasures of APP
- (3) Technical support for the introduction of PIA

With support of the EPAGRI/SAP, the following necessary activities will be implemented for the introduction of the PIA

- Managements of defensive use and appropriate discard of package of defensive.
- Introduction of low defensive use agricultural.
- Prohibition of the burnings of the straw.
- Administration of water resources

CHAPTER 3 PROJECT IMPLEMENTATION GUIDELINE

3.1 Methodology of Execution

The process of the Project Contain of the rains in the paddy fields will be implemented in the following forms:



Figure 3.1.1 Project Implementation Process

3.2 Activity of each Phase

(1) Assembly of the rice producers of the area for the execution of the works

The assembly of the rice producers of the area, with objective of obtaining support of the municipal districts, will be established at the level of the each municipal district, town or irrigation scheme established already, and it will be unit responsible of the implementation of the work. Like this, each unit of those assemblies will be, hereafter, them unit of implementation of the construction of paddy ridge works, administering the system and also making the devolution of the financing.

It is desirable that each unit has a minimum of 10 families, so that there is a harmonic work in the works. Each assembly will have to decide on the following items:

• Participants of the project.

- Area where the project will be accomplished.
- Outline of the registrations of the earth (for adaptation to the environmental legislation).
- Measures are taken with regard to the riprap forest.
- Place from where will leave earth.
- (2) Requirement of work for the Coordination Unit of the Project

In the Project of containments of rains in the paddy fields, each association will make request to the Coordinating Unit of the Project for its implementation. The coordinating Unit will establish the order of service of each work and execution, tends in view the applications done by each area and area. The coordinating Unit will do, also, allocation of the consultants, lend of necessary machines in agreement with the applications made by each area.

(3) Paddy Ridge construction works and recovery of riprap forest

To execute the paddy ridge works and recoveries of the riprap forests will be accomplished the following activities;

- Verification of the lands registrations.
- To execute the measurement (topographic survey).
- To elaborate the project of construction of paddy ridge.
- To elaborate the project of the riprap forest.
- Project of earth (for the paddy ridge) retreat.
- To determine the amount of machines and the necessary days of use.
- Methods of reproduction of seedlings.
- Elaboration of the applications to CIDASC and FDR.

The measurement area will be basically of those foreseen for the heightening of paddy ridge, lands that are out of the Project, the costs for measurement will be covered by the proprietors. As for the riprap forests, through the verification of the land registrations, will be divided in areas of individual responsibility and community. The plan of borrow pit as for the earth will be resolution item in the assemblies of each unit, as for the place from where will be removed, and means of providing resources for such. It is also due to calculate the amount of workers, the number of necessary machines, the cost, the necessary materials, to base the applications to the CIDASC and the FDR.

As for the recovering of the riprap forest, it is just due not to foresee the species and varieties of the nursery plants, production and planting, but also from where the resources will come for so much.

(4) Application for obtaining of the environmental authorization

The allocated consultants will elaborate the document and necessary applications to the obtaining of the environmental license; especially, close to the FATMA (General office of the Environment of the State).

(5) Last confirmations of the Assemblies of the rice producers associations

Through the assemblies, it will be verified the following points:

- Lines as for the methods and means of the elevation of the barriers (of the heightening of paddy ridge).
- Methods for restoration of the riprap Forest, and their limits.
- Preparation of the document for the application for the implementation of the work

(6) Evaluation/Appraisal of requested document for the implementation of works and preparation of contract documents

The Coordination Unit will evaluate the appropriation of the construction cost requested by the producers and, after the appraisal of the document, it will be transferred the request for the FDR. Also, the Coordination Unit will make contract document subscribing the responsibility of farmers and implementation schedule, including the responsibility in the contention of rain water in their paddy fields.

(7) Start of Works by producers and request for the disbursement

The Rice producer will carry out the paddy ridge heightening works and riprap forest recovering. The cost for the work will be requested for the disbursement.

(8) Evaluation of construction cost and disbursement

The Implementation Agency will evaluate requested construction cost and after the appraisal of the requested document will be disbursed through the FDR. The disbursed amount is 80% of the construction cost.

(9) Training for Producers

To optimize the effects of the works in this basin, besides improving the quality of the water the producers they will receive the following trainings:

- Use of defensive / discard of residues and packing.
- Introduction to the low defensive use agriculture.
- Prohibition of burnings of the straw.
- Practice of the agriculture with low use of defensive.
- Handling of water

Supporting Report (F) Environmental and Social Considerations
PREPARATORY SURVEY FOR THE PROJECT ON DISASTER PREVENTION AND MITIGATION MEASURES FOR THE ITAJAI RIVER BASIN

FINAL REPORT

VOLUME III : SUPPORTING REPORT ANNEX F: ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

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CHAPTER 1 ENVIRONMENTAL AND SOCIAL CONSIDERATION OF SELECTED PROJECTS

1.1 Introduction

The JICA Survey Team has held a series of meetings and public consultations with the relevant stakeholders in accordance with the JICA's Guidelines on Social and Environmental Consideration (2010) in the course of the master plan study. Comments and suggestions given by the stakeholders in the meetings were fully reviewed and examined in the preparation of the master plan. As a result, the JICA Survey Team adopted the disaster-prevention measures against the 50-year flood as the main framework of the master plan.

As described in the master plan, the Survey Team propsoed the implementation of the master plan in a stage-wise implementation since the implementation of the entire disaster-prevention measures against the 50-year flood would require an enormous amount of money and take a long period of time until its completion.

To this end, the Survey Team evaluated and examined all the measures proposed in the master plan for prioritization. Among others, the Team put emphasis on whether or not a consensus on the implementation of the proposed measure among the stakeholders is easy to get in the evaluation, as the meetings with the stakholders in the master plan study revealed that it would be difficult for them to accept the construction of a diversion chnnel for floodway and dykes along the river due to the likely impacts on the surrounding ecosystems and other natural environment. In fact, the Survey Team expected that the consensus building on the construction of those measures would not be easy and require a long-term process. As a result of the evaluation, the disaster-prevention measures against the 10-year flood were determined as the priority projects in the first phase.

The environemntal and social considerations in this study were carried out with the following limitations:

- i) No interview survey on socio-economic conditions, such as land ownership, family structure, and household income, was made in the areas where the land acquisition might be required, as the information of the projects were not able to open during the study due to the uncertanty about the commencement of the projects. In fact, the study team did not disclose as much information as explained in the pulic hearings at the end of the master plan study.
- ii) The topographic maps on a scale of 1:10,000 were not available when the feasibility study was made although they were supposed to be ready to use during the study. Alternatively, the topographic map of 1:50:000 and the results of a topographic survey of river conducted in the feasibility study were used for the detailed study and designing. In addition to them, the topographic maps of Itajai City on a scale of 1:2,000 was available and also used for the study on the urbanized areas of Itajai City.

The feasibility study revealed that the existing roads of Itajai Mirim River was sufficiently high and not necessarily heightened as a disaster-prevention measure. Hence, the Survey Team judged that no resettlement or extensive land acquisition except the areas to be affected by the heightening of Oeste Dam would take place.

This chapter describes: i) the results of a review of the initial environmental examination (IEE) made in the master plan; ii) the draft terms of reference for an environmental impact study (EIA) that would be needed for implementation of the priority projects; iii) the results of environmental and social considerations of the priority projects; and iv) the environment-related legislation and necessary steps and surveys for acquisition of an environmental lisense in Brazil.

1.2 Review of Initial Environment Examination (IEE) in M/P Study

1.2.1 Requirement for Envrionmental Lisense

Since the catchment of Itajai river is locate within the territory of SC state, FATMA in SC state is the responsible institution for examining environmental study reports and issuing an environmental license for the project. Therefore, the information on the environmental impact studies, especially crucial points in environmental and social assessments, were collected at FATMA in the study.

In SC state, an environmental assessment report to be submitted to FATMA varies with the extent of expected environmental impact. A proponent of a project shall submit one of the following reports based on the size, type and location of a project as described in Chapter 7 of the master plan study.

- Environmental Impact Assessment (EIA; Estudo de Impacto Ambiental)
- Simplified Environmental Study (EAS; Estudo Ambiental Simplificado)
- Previous Environmental Report (RAP; Relatório Ambiental Prévio)

As this project targets all the water sources in the whole catchment of Itajai river, FATMA is, therefore, obligated to submit an EIA report for a "macrodrenagem¹" project, which covers all the components proposed as the priority projects in the first phase.

1.2.2 Review of IEE

The Survey Team reviewed the initial environmental examination (IEE) made in the master plan study using the maps and data additionally collected in the feasibility study. The focus of the review was put on the coponents proposed as the priority projects in the first phase. The following sections describe the results of the review and Table 1.1 shows the revised environmental screening and scoping of the priority projects in the first phase. Furthermore, the provisional environmental checklist for the proposed projects is shown in Attachment-1.

(1) Water Storage in Paddy Fields

The environmental and social impacts caused by this component are expected to be negligible, as the component does not require any large-scale engineering work. The component will be implemented by CRAVIL when the topographic maps of 1/10,000 are completed and the implementable areas are determined. Having determined the target areas using the topographic maps, CRAVIL shall prepare an implementation plan and take the necessary procedures for the registration of the target areas as Legal Reserve (RL) areas according to the Forestry Law.

(2) Heightening of Sul and Oeste Dams

The lands used for heightening Sul and Oeste dams and those that might be inundated in the operation phase were considered as the areas affected by this component. In the feasibility study, the progress of the land acquisition made by the Government of SC state and the proposed designs of the dams, which were not available in the master plan study, were able to be collected and, therefore, fully reviewed and analyzed to identify and determine the potentially-affected areas. As detailed in the following sections, the assessment revealed that all the areas to be affected by the heightening of Sul dam and those up to the height of the existing spill way of Oeste dam had already been acquired, although the results of the IEE in the master plan study indicated that land acquisition and involuntary resettlement might be the possible impacts caused by the heightening of both dams.

¹ It is used as the term standing for the project including "integrated flood control" and "basin management", although its literal meaning is "large-scale drainage."

Figure 1.1 shows the potential water level of the dams with and without heightening of dam crests and the progress of the land acquisition that the Government of SC state has made so far.



Figure 1.1 Dam Heights after the Heightening of Sul and Oeste Dams and Status of Land Tenure

The heights of spillway of Sul dam will be heightened from 399.0 m to 401 m, but the dam crest will not be heighted. As the Government of SC has already acquired the potential inundation areas up to EL. 410.0 m, no further land acquisition will be required for this component. However, DNOS (former federal government who constructed Sul and Oeste Dam) has made an agreement with COOPERBASUL on the use of the lands extended from EL. 405.0 m to EL. 410.0 m elevation, which have been rarely inundated. As the agreement does not include a compensation clause on any damages caused by inundation, DNOS shall review and revise the current agreement with COOPERBASUL so as to ensure that COOPERBASUL could get compensation when such areas are inundated.

The dam and spillway crests of Oeste Dam will be heightened by 2 m, and therefore the heights of both crests will be EL. 365.16 m and EL. 362.3 m, respectively. Although Deinfra of SC state has already acquired the potential inundation areas up to 363.0 m, there is still a need to acquire the rest of the potential areas up to the height of the planned dam crest (EL. 365.16 m). In other word, the heightening of Oeste Dam is expected to affect households/communities residing in the potential inundation areas from 363.0 m to 365.16 m elevation.

An inventory of existing buildings (houses and barns) in the potential inundation areas of Oeste Dam was also carried out to assess the compensation cost for households who might be affected by heightening its dam crest. The results of the simplified inventory are described in Section 2.1.

Besides, the heightening of Oeste dam might cause the adverse impact on the river environment (e.g., water quality, river bed, and riverine flora and fauna) since the engineering works will be done on the main body of the dam and need to divert the main stream of the Oeste river during the period of its construction works. On the other hand, no adverse impact on the river environment is predicted by the heightening of Sul dam, as the engineering works for Sul dam is to heighten the spillway by two meter

and do not require any works on the mainstream of the river.

(3) Utilization of CELESC's Hydro-Electric Dams for Flood Control (Introduction of Pre-release method)

This is the measure taken by CELESC, which is the operation of Rio Bonito and Pinhal Dams in Rio dos cedros river, to mitigate the flood risk by the pre-lease of storage water in the dams when having a flood warning. An alert system needs to be installed to alarm households living in the downstream areas of both dams to cope with a potential flood risk after discharging the storage water from the dams. More details about the pre-release along with an early warning system are described in Chapters 4 and 6 in Part II of the Feasibility Study report.

(4) Installation of Floodgates in Intajai Mirim River

This measure aims to install two floodgates and one back water dyke in the old river canal of Itajai Mirim river as described in Chapter 5 in Part II of Feasibility Study report.

The places of the floodgates are located in the residential area, the construction work for the floodgates might cause a vibration and/or noise or increase trafic. The construction work might also cause turbid water in the river. However, these impacts would be negligible if the necessary mitigation measures for these impacts are to be taken by the contracotr in the construction phase. On the other hand, there is no impact predicted in the operation phase as long as the floodgates are operated properly.

As described in Chapter 5 in part II of the Feasibility Study report, driving sheet pile walls on the right bank was proposed to secure the safety of households living by the river in addition to the floodgates, as such areas on the right bank are subject to flood damage especailly by high tide and back water. The construction work associated with driving sheet pile walls is exected to generate noise and vibration in the surrounding areas, the contractor should arrange and allocate temporary accommodations for households living in such affected areas in advance.

(5) Structural Measure for Landslide

This measure is to apply slope protection measures to the slopes along the national roads to prevent landslides/slope failures. As the construction work will cause the traffic hindrance by parking a large truck in the road or blocking off one of the lanes, the contractor needs to take safety measures, such as traffic control, during the construction.

(6) Development of Flood Forecasting and Warning System (FFWS)

Since this measure does not include any structural works, no environmental impact is predicted in the construction phase. Furthermore, the system will not change the lifestyle or any socio-economic conditions of households living in the area but help them protect their lives from flood damage. Consequently, no social impact is predicted by the introduction of the flood forecasting and warning system (FFWS). It is however important to ensure that such a system can disseminate the information up to the vulnerable groups and to conduct an emergency drill with the participation of those groups using the system, so as to minimize the risk of a flood.

(7) Development of Landslide and Flush Flood Warning System

Likewise, this measure is not predicted to cause any environemntal or social impact in both construction and operation phases since the measure does not include any structural work or cause any socio-economic change. As in the case of FFWS described above, what would be requisite for ensuring the effectiveness of the system are to disseminate the information to the vulerable groups using the system and conduct suffucuent emergency drills along with the system, so that the group could react properly when having an warning by the system.

Table 1.1 Revised Environmental Screening and Scoping of the Priority Projects in the First Phase.

Γ		Landscape					<u>ه</u>	J				Landscape						c		
		Global issues: Greenhouse gas										Global issues: Greenhouse gas								
		Coastal area										Coastal area								
	-	Fauna and flora		ں ں								Fauna and flora	₽ ₽				с			
	invironmen	Groundwater									invironmen	Groundwater								
	Natural E	Solid waste		ں ں	0			ں ں		_	Natural E	Solid waste								
		Bottom sedimentation		ں ں			æ			_		Bottom sedimentation					U			
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		Offensive adar										Offensive ador								
┝		l and subsidence										l and subsidence								
		Noice and vibration		0	0		ф					Noise and vibration								
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	Poll		 .					0		_	Poll									
	-	A ir pollution	·							_		A IF pollution	ŀ	ŀ					ľ	
-		Water pollution	. 									Water pollution		ŀ					ľ	
	-	(Transmission line, roads, bridges, etc.)					0			_		(Transmission line, roads, bridges, etc.)								
	-	Im pacts of land / buildings		œ.	ė	•		•		_		Impacts of land / buildings								
		Involuntary resettlement		ė	ė	•		•				Involuntary resettlement	•						•	
	-	Impact in downstream area	'		'	ф	•	•		_		Impact in downstream area	•	•	•	ф			•	
		Im pact of agriculture		•	•	•	•	•	•			Im pact of agriculture	ė	C)	S				•	ipact
	-	Change of income, life condition	'	•	'	•	•	•	•			Change of income, life condition	•	C	S				•	-: No in
		Traffic / interference of traffic during construction	•	U U	C)	•	ė	ė	•			Traffic / interference of traffic during construction	•	·	•			•	•	known,
		Public health	•	•	•	•	•	•	•			Public health	•	·	•				•	ıre is un
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•	Soc	Indigeneous / traditional people	•	•	•	•	•	•	•		Soc	In digeneous / traditional people	•	•	•	•			•	act, C: Ir
	-	Wateruse	•	•	•	•	•	•	•			Wateruse	•	•	•	•		•	•	ive imp
		Effects / prejudice of low income people	•	•	•	•	•	•	•	_		Effects / prejudice of low income people	•	U U	O			•	U	m negat
		Benefit to urban area vs. prejudice of rural area	•	•	•	•	•	•	•			Benefit to urban area vs. prejudice of rural area	·	ပ	S				•	: Mediu
		Regional comflicts	Ą	Ą	-	-	-A	•	•			R egional com flicts	·	·	•			•	•	pact, B-
		Land use and occupation	•	•	•	•		•	•			Land use and occupation	•	ပ	ပ			, , ,	•	sitive im
		Economic and Productive activities	•	•	•	•		•	•			Economic and Productive activities	ė	ပ	S	•			•	ium pos
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		Expectation in local and regional people / Mobilization of NGO	+4	+4	+4	+ +	A+	+4	4+			Expectation in local and regional people / Mobilization of NGO	·	•	•				•	npact, E
	Construction Phase	SOCECCONDUM MACTS, POLILITION AND NATURAL ENVIRONMENT PPOPOSED MEASURES	Rain water storage in rice field	Heightening of Oeste Dam	Heightening of Sul Dam	Preliminary discharge of CELESC hydro-electric	Flood gate control installation in Itajai Mrim	Measures for landslide disaster	Flood Forecasting and Warning System (FFWD)		Construction Phase	SOGECONOME MP ACTS, POLUTION AND MATURAL ENVIRONMENT PROPOSED MEASURES	Rain water storage in rice field	Heightening of Oeste Dam	Heightening of Sul Dam	Preliminary discharge of CELESC hydro-electrix dams	Flood gate control installation in Itajai Mirim	Measures for landslide disaster	Flood Forecasting and Warning System (FFWD)	ig positive impact, A-: Big negative ir
		Frood	Basin Storage	Measures			River Improvement Measure		Others			Flood	Basin Storage	Measures			River Improvement Assure	ainceau	Others	Note: A+: Bi

1.3 Draft Outlines of TOR for EIA/RIMA Study

1.3.1 Draft Contents of EIA required for the Environmental License

A daft TOR for EIA study on the flood management project in the Itajai river basin was prepared and shown in Attachment-2. In the preparation of the draft TOR, the JICA Survey Team collected the existing TORs for the past EIA studies kept in FATMA in SC state. Although there was no EIA study made for a flood management or landslide disaster management project in SC state, those used for a basin management project in Minas Gerais state and an integrated port development project in SC state were referred for preparation of the draft TOR. The outlines of the draft TOR are shown below.

Contents of Draft Terms of Reference

1.	Back	ground				
2.	Propo	osed Project				
	1.1	Objectives				
	1.2	Project Area				
	1.3	Outlines of the Project				
3.	Scope	e of the EIA Study				
	3.1	The Study Area				
	3.2	Environmental Items to be Assessed				
	3.3	Surveys and Investigations				
	3.4	Impact Identification and Assessment				
	3.5	Preparation of Mitigation Measures				
	3.6	Preparation of Environmental Management and Monitoring Plan				
	3.7	Stakeholders Meetings				
4.	Repo	rt Making				
5.	Timeframe of the EIA Study					
6.	Expected Outputs					

1.3.2 Schedule of an EIA Study and Estimated Cost for the Study

An environmental impact assessment study is to be carried out by a consulting firm or consultants registered in the state. In general, an EIA study to be contracted out to a consulting firm/consultants encompasses: i) the preparation and finalization of TOR for the study; ii) the conduct of the study; iii) the preparation of enironmental reports (RIMA report and report for public disclosure); and iv) the arrangement and organization of public audience. Hence, the TOR for an EIA study is to be first drafted by a consulting firm/consultants after it is officially selected. The draft TOR is to be reviewed, examined and approved by FATMA in the state within 45 - 60 days after its submission. An EIA Study shall be carried out in accordance with the approved TOR. A tentative works schedule of an EIA study and estimated cost for the study are shown in Tables 1.2 and 1.3, respectively.

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Itoma		Months											
Items	1	2	3	4	5	6	7	8	9	10	(11*)	12	
Preparation of TOR	0	0											
EIA Study		0	0	0	0	0	0	0	0				
Preparation of RIMA										0			
Public consultations												0	

 Table 1.2
 Tentative Schedule of EIA/RIMA Study

Note* : The duration from the preparation of RIMA to the public consultations varies with the environmental examination institutions in the respective states

Source : JICA Study Team

					Unit: R\$
Item	Unit Cost	Unit	Quantity	Contingency (20%)	Total
Preparation of TOR	6,880	MM	2	3,430	17,150
EIA Study	57,168	MM	3	114,336	571,680
Preparation of RIMA	36,587	L.S.	1	9,147	45,734
Public consultations	26,676.0	MM	1	6,644	33,220
				Total	667,785

Table 1.3 Estimated Cost for EIA STUDY

Source : ECSA, Engenharia Socioambiental S/S

CHAPTER 2 NECESSARY LAND ACQUISITION AND RESETTLEMENT FOR PRIORITY PROJECTS

2.1 Results of Field Survey of the Target Area for Dam Heightening

2.1.1 Introduction

Oeste and Sul dams, which respectively are located in Taió city and Ituporanga city, are targeted for dam heightening. In the planning stage of the dam heightening, the state government as an implementing body shall acquire the areas, which will be potentially inundated or impounded by heightining dam crests of both dams, from land owners. Both dams are located in upper tributaries of Itajai River, Oeste dam in Itajaí do Oeste River and Sul dam in Itajaí do Sul River.

This section describes the results on the study on the potential social impacts caused by the dam heightening works and mitigation measures against potential impacts. Oeste and Sul dams both are flood control dams which usually have no strage water during the non-flooded period.

In Brazil, there are some existing Environmental Impact Assessment (EIA) studies for hydro-electric generation dam projects, while EIA for flood control dam² had not been made so far³.

The boundaries of the areas affected by the construction of Oeste and Sul dams were not ble to be determined due to lack of information, such as their design and completion drawings, as the construction works and resettlement was implemented more than 30 years ago. Accordingly, there had been no major complains made by the surrounding communities about land acquisition and dam operations of each dam site.

As described in Section 1.2, the heightening of dam is expected to affect the areas from the elevation of the existing dam crests to that of the heightened dam crests, especially for Oeste dam. In order to grasp the actual conditions of the affected area, the JICA Survey Team conducted a field survey composed of literature study and site reconnaissance as described below.

2.1.2 Survey Method

(1) Literature Study

During the literature study, the following information and data were obtained from Deinfra - SC, which is the responsible agency for operation and maintenance of Oeste and Sul dams.

- Base map of Sul Dam which shows the distribution and locations of areas to be acquired
- Engineering drawings of Sul Dam Body
- Base map of Oeste Dam which shows the distribution and locations of areas to be acquired
- Results of trial evaluation of land prices of the areas to be affected by heightening both dams
- Results of interviews to the responsible agency of dam operations and the agricultural unions

Deinfra – SC has limited data and information relevant to Oeste and Sul dams possibly due to the transfer of the responsibility for operation and maintenance of dams from DNOS to Deinfra - SC.

(2) Site Reconnaissance

Site reconnaissance survey in Oeste and Sul dams was conducted during April 15-17, and April 14-16,

² Since flood control dam does not form the inundation area, the dam storage area can be accessible by the communities during non-flooded period.

³ Environmental licensing system had not been established yet when Oeste and Sul dams were constructed.

2011, respectively with an aim to collect information required for development of a resettlement program with cost estimation. During the survey, the geographical data, such as latitude, longitude, and elevation of the houses and barns located in the affected area, were collected by using the receiver devices, TOPCOM GR-3 under Global Navigation Satellite System (GNSS).

- 2.1.3 Results of the Field Survey
- (1) Current Condition of the Affected and Surrounding Areas of Sul Dam

As for the heightening of spillway of Sul Dam, which is one of the priority projects, the design flood water level was set as EL 410.0m in consideration of the maximum water level of 10,000-year flood and freeboard in accordance with the official design standards of Brazil⁴.

According to the design drawings of Sul dam and information obtained from key informants in Deinfra - SC, land acquisition had been already completed up to EL. 410.0 m when existing dam was constructed. Heightening the spillway would not require further land aqcuisition in principle. However, the satelite images covering the affected area indicated that some buildings, such as houses and barns, were located below EL. 410.0 m. Hence, the site reconnaissance survey was conducted. During the site reconnaissance, due consideration was given to keeping the residents in the affected area from having the project information. The results of the site reconnaissance survey is shown in Attachment-3.

The survey revealed that six (6) buildings, four (4) houses with kiosk and two (2) log cabins, were located at between EL. 401.276 m and EL. 409.314 m.

Furthermore, the survey identified the present land use classes in the potentially affected areas under Sul dam as follows:

-	Paddy field (class I):	10.0 %
-	Onion farm (class III and IV):	25.0 %
-	Slope area (class V):	5.0%
-	Grassland (class VI and VII):	35.0%

- Permanent Preservation Area (APP) (class VIII): 25.0 %

Details of the land use classification are shown in Section 3.4.

(2) Current Condition of the Affected and Surrounding Area of Oeste Dam

Likewise, the design flood water level of Oeste dam was set as 365.0 m in consideration of the the maximum water level of 1,000-year flood and freeboard in accordance with the official design standards of Brazil. Consequently, heightening the existing dam by 2 m was proposed by raising the dam crest from EL. 363.15 m to EL. 365.16 m. Although the land acquisition was completed up to EL. 363.0 m when the existing dam was constructed, the rough estimation based on the topographic maps of 1:50,000 revealed that the additional 67 ha of lands still need to be acquired.

The present land use in the affected areas are classified as follows:

-	Agricultural farm	(class III):	10.0 %
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- Agricultural farm for short-term crops (class IV): 25.0%
- Perenial crops planted area (class V): 30.0%
- Grassland (class VI): 20.0%
- Steep grassland (class VII): 5.0%
- Permanent Preservation Area APP (class VIII): 10.0 %

The site reconnaissance survey further found that there were two (2) wooden houses, three (3) wooden sheds and one (1) brick house with barn in the potential affected areas between EL. 361.988 m and

⁴ Critérios de Projeto Civil de Ucinas Hidroelétricas", October, 2003

354.979 m.

2.2 Necessary Measures to be taken for Minimizing the Possible Impacts by the Heightening of Sul dam

As mentioned in 2.1.3, land acquisition was completed up to EL. 410.0 m by DNOS for construction of the existing dam. In 1981, an agreement on land use concession for the area between EL. 405.5 m and 410.0 m was concluded by DNOS and COOPERBASUL, which was a cooperative organized by the surrounding communities, to allow the members of COOPERBASUL to use the said area for animal husbandry. The contents of the said contract are shown in Supporting Report F.

Currently, Deinfra - SC, which the responsibility for operation and maintenance of the dam was given from DNOS, follows the said contract signed by DNOS without any revision and allows the members of COOPERBASUL to use the area based on the contract.

To date, there have been no serious trouble with COOPERBASUL and Deinfra – SC, despite the fact that the water storage level had sometimes reached to the maximum water level.⁵ The heightening of dam, which would increase the possibility of innundation in the concession area, might cause a negative impact on the use of the area, although its possibiloty is least-likely.

It is therefore recommended that Deinfra - SC discuss the possible negative impact with COOPERBASUL to ammend the current agreement on the use of land concession area on this occaision.

2.3 Mitigation Measures against the Possible Impacts caused by the Heightening of Oeste Dam

As described in 2.1.3, the heightening of Oeste Dam would require new land acquisition of 67 ha between EL. 363.0 m and EL. 365.16 m. The houses, sheds, some part of roads and bridges were located within the potential innundation areas as shown in Supporting Report F. With an aim to mitigate the possible negative impacts on the communities living in the possible innundation areas, JICA Survey Team proposes rerouting the existing roads and using them as dikes to protect the houses from being innundated.

Table 2.1 shows the general features of two (2) alternative measures, one with road relocation and the other with resettlement of the communities, while Table 2.2 compares the estimated costs for both alternatives.

⁵ Several overflows from the spillway of Sul dam were recorded by Deinfra-SC.

	Alternative measure-1: with road relocation	Alternative measure-2: with resettlement
Chart	River Budge of Bridge of Bridge	Land Acquisition and Compensation
General description	• Some sections of roads and bridges shall be rerouted/relocated to protect existing buildings from being inundated by heightening the dam. Hence, the height of the rerouted roads and relocated bridges shall be higher than that of the heightened dam crest.	 The buildings located in the potential inundation areas shall be relocated. Some sections of the roads and bridges, whose heights are lower than that of the heightened dam crest, shall be relocated
Merit	• No resettlement of the communities	•Less cost due to decrease of volume of construction works
Demerit	 Increase of construction cost due to road relocation Reduction of inundation area due to installation of the road 	·Resettlement of houses/communities necessary
Project cost	R\$ 4,797,000 (100%)	R\$ 2,819,000 (58.8%)

Table 2.1 General Features of Alternative Measures

Source: JICA survey team

Table 2.2 Cost Estimation

							(R\$)
			Alterna	ative of	Alterna	tive of	
			Road relocation		Compensation		Remarks
	unit	unit cost	quantity	amount	quantity	amount	
Replacement of Bridge	m2	3,000	160	480,000	80	240,000	
Relocation of Road	m	1,570	1,500	2,355,000	500	785,000	
Other works	%	30		851,000		308,000	Main works *30%
[1] Sub total (Construction cost)				3,686,000		1,333,000	
Land Acquisition	LS	966,000	1	966,000	1	966,000	
House Compensation	LS	326,000			1	326,000	3houses+3sheds
Price contingency for area delineation	%	15		145,000		194,000	
[2] Sub total (Land, Compensation)				1,111,000		1,486,000	
Total [1]+[2]				4,797,000		2,819,000	

Source: JICA survey team

The cost breakdown for land acquisition and house compensation are also shown in Table 2.3.

Land Acquisition	
7.0ha of Class III and 17.0ha of Class IV exploited with crops (R\$ 20,000.00/ha)	480,000.00
20.0ha of Class V of pasture (R\$ 15,000.00/ha)	300,000.00
13.0ha of Class VI and 3.0ha of Class VII with restrictions (R\$ 7,500.00/ha)	120,000,00
7.0ha of Class VIII of APP (R\$ 4,300.00/ha)	30,000.00
24.0ha permanent crops (R\$ 1,500.00/ha)	36,000.00
Total	966,000.00
House Compensation	
Masonry house (100.0m ²), masonry wall (240.0m), wooden shed (90.0m ²).	165,000.00
Wooden shed (72.0 m^2)	28,000.00
Wooden shed (60.0 m^2)	23,000.00
Wooden house (60.0 m^2)	30,000.00
Wooden shed (96.0 m^2)	36,000.00
Wooden house (90.0 m^2)	44,000.00
Total	326,000.00
Reserve +15%	194,000.00
GENERAL TOTAL	1,486,000.00

Table 2.3 Cost Breakdown for Land Acquisition and House Compensation

Source: JICA survey team



JICA survey team



Conclusion

In Brazil, compensation for properties affected by public works has been generally conducted in accordance with the relevant laws and regulations, while administrative proceedings have been often taken against the process of resettlement due to lack of the relevant legislation. In fact, there have been many troubles and complaints caused by insufficient and improper support/arrangement in resettlement, such as i) relocation to remote areas and ii) limited opportunities for employment in relocated areas, especially for professions that the resettled people used to engage in.

Although the cost for the alternative measure-1 with road rerouting is 1.7 times higher than that for the alternative measure-2 with resettlement as shown in Table 2.2, JICA Survey Team recommends alternative measure-1 as a more reasonable and justifiable plan in order to avoid and minimize future negative impacts in line with the basic principles of JICA Guidelines for Environmental and Social Considerations.

2.4 Process of Resettlement under Oeste Dam and the Proposed Resettlement Program

2.4.1 Introduction

While the JICA Study Team recommends the relocation of road, the state government might possibly select the alternative measure-2 since the number of target families to be relocated is limited. If so, the preparation and submission of necessary plans, such as resettlement plan and monitoring plan, will be required.

The following sections further describe the processes of resettlement and compensation.

2.4.2 Resettlement Process

(1) Type of Applicable Compensation Measures

The resettlement program aims to secure the livelihoods of the resettled families/people providing necessary support to restore their livelihoods but not to alter their cultural features.

According to the general process of resettlement in the country described in Section 9.3.3, JICA Survey Team proposes the following options as compensation measures for properties to be affected by the heightening of Oeste dam. Nevertheless, the amount of compensation for losses shall be valuated in accordance with World Bank Operation Manual (OP) 4.12, Annex A- Involuntary Resettlement Instruments (WB OP 4.12, Annex A)⁶ as stipulated in JICA Guidelines for Environmental and Social Consideration (2010).

1) Compensation for Assets

Value of existing buildings and lands shall be appraised to determine the amount to be paid in cash to the affected families in accordance with the process described in Section 3.3. In valuation, it is important to estimate the compensation in accordance with WB OP 4.12, Annex A as described above.

2) Individual Resettlement (Commitment Letter, CC)

The target public is responsible for searching and selecting the land and other properties equivalent to those they originally owned. If the implementing body judges that the properties selected by the target public meets the criteria set in the agreement between the implementing body and the affected families, the implementing body shall purchase the selected properties.

3) Individual Resettlement of Special Cases (CE)

In case the target public has some limitations/handicaps who need a special care or considerations in its families, special arrangements shall be made such as allocation of urban lots instead of rural ones (but the size of the lots should be lower than the affected one.).

(2) Target Public for Resettlement

As for the heightening of Oeste dam, the following persons are expected to be the target public:

- the person who conducts economic activities in the affected area
- the person who lives in the affected area but has no legal property in the same
- the person who has his/her property/ies in the area remaining unused by heightening the dam
- the person who depends on the affected property/ies for his/her livelihood

⁶ Compensation for losses shall be valuated by the replacement cost, which is defied below.

[&]quot;For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes. For land in urban areas, it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes. For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of any registration and transfer taxes. In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset. Where domestic law does not meet the standard of compensation at full replacement cost, compensation under domestic law is supplemented by additional measures so as to meet the replacement cost standard." (Source: World Bank OP 4.12, Annex-A)

(3) Resettlement Process

1) Individual Resettlement

In the case of individual resettlement, the implementing body shall issue the Commitment Letter (CC) which shows the estimated cost of the affected properties so that the target public can have an idea on the amount of compensation.

Upon the issuance of CC, the target public shall search and select the properties, and inform the implementing body of the selected properties. The implementing body shall examine the appropriateness of the selected properties prior to the approval of its acquisition. Having validated the legitimacy and appropriateness of the properties, the implementing body will permit the acquisition/purchase of the property and sign on to the official document for purchase.

In the procedures of individual resettlement, the following points shall be considered.

- Size of lot acquired

The size of lot acquired will range from 3.0 ha to 17.0 ha depending on the family structure and its type based on CSE (See Section 3.3). In determination of the size of lot, due consideration shall be paid to the concept of "replacement cost" defined in WB OP 4.12 Annex-A.

- Buildings for acquisition

Likewise, the buildings in each lot shall be determined in consideration of the family structure and type of houses based on CSE (See Section 3.3). Likewise, WB OP 4.12 Annex-A shall be referred for estimation of compensation for losses.

- Option for the commitment letter

The target public can prepare its request in writing on the acquisition of properties. Once such a request is developed in writing, no revision is allowed.

- Technical assistance for recovery of livelihoods

The implementing body is responsible for provision of ad hoc technical and social assistance for the target public upon the acquisition of the new property/ies to restore its livelihoods.

- Mode of reimbursement

In case that the target public is non-owner of the affected area, reimbursement of the resettlement cost might be required. The implementing body and the target public will go into negotiations and determine whether or not the repayment is arranged. In case the repayment is required, the mode of reimbursement such as total or partial reimbursement, should also be discussed between the implementing body and the target public.

2) Special Cases of Individual Resettlement (CE)

The special case of individual resettlement (CE) shall go through similar procedures and give similar considerations in the process of resettlement in principle. It is noted that the size of lot can be determined according to the features of the affected families.

The necessary considerations to be made in determining the size of lot are described below.

- Lots size for acquisition

Rural lots

Area remaining unused shall be preferably utilized for resettlement of the target public in the rural area.

The lower limit of the area of rural lots shall be eighteen (18) ha according to the Minimum Fraction of Parceling (FMP) as defined by the National Institute of Colonization and Agrarian

Reform – INCRA.

<u>Urban lots</u>

The target public who selects urban area to reside shall have the right to acquire the minimum size of lot in accordance with the central and/or local government legislation.

- Mode of reimbursement

The target public, who is the owner, heir, or other claimants of the affected lands and properties, shall be exempted from any payments, except the transfer of the affected lands and properties to the implementing body as a payment.

If the value of the existing properties acquired exceeds the benefit which the target public can obtain from the resettlement, the balance shall be paid in cash to the target public.

CHAPTER 3 ENVIRONMENTAL LEGISLATION, GENERAL RESETTLEMENT PROGRAM, AND MONITORING PROGRAM IN THE POST-RESETTLEMENT IN BRAZIL

3.1 Legislation relating to Compensation

The major legislation relating to environmental and social considerations in Brazil is presented in Section 7.2 in Part I of the master plan study.

The Constitution of the Federative Republic of Brazil in 1988 stipulates that any projects shall pay sufficient monetary compensation to people who own the areas affected by projects prior to its implementation. The same also stipulates that the compensation shall include the costs for the maintenance of the environmental quality, necessary environmental management works, and land acquisition for reforestation in permanent preservation areas (APP).

A proponent of a project shall have the legal responsibility for land acquisition for implementation of a project. In a dam construction project, the implementing body of the government shall be responsible for acquiring the construction sites following the proper process of land acquisition. In case the implementing body and the affected families/people can not reach an amicable agreement on land acquisition, the implementing body shall take the necessary legal measures for compulsory land acquisition.

In Brazil, various laws and regulations relating to land acquisition and compensations have been enacted and implemented since the first regulation was enacted in 1821. The applicable laws and regulations, which are currently effective, are shown below.

- Constitution of the Federative Republic of Brazil, as of 05/10/88;
- Decree-Law No. 3,365, as of June 21, 1941, and as amended, and complementarily the Code of Civil Procedures (CPC);
- Federal Law No. 4,132, as of September 10, 1962;
- Brazilian Association of Technical Standards (ABNT), as of 2004, for appraisal of rural properties (NBR 14,653-3), and of urban properties (NBR 14,653-2).

It is noteworthy that there is no legislation or regulation specifying the procedures for resettlement, although the regulations and guidelines on estimation of compensation and compulsory land acquisition are already in place. Therefore, in most of the projects in the past, the framework for resettlement needed to be determined through negotiations with the affected families/people.

The following sections highlight the relevant points of the existing legislation on land acquisition in Brazil.

3.1.1 Constitution of the Federative Republic of Brazil, 05/10/1988

The Constitution of the Federative Republic of Brazil of 1988, which was enacted on May 10, 1988, brought important innovations to the conditions of land acquisition. Clause 14 of Article 5 in the Constitution is summarized below.

- Article 5: Everyone is equal before the law, with no distinction of any nature. The law shall ensure to the Brazilian people and foreign residents in the Country the inviolability of the rights to life, to freedom, to equality, to safety and to property, under the following terms.
- Clause XIV: The law shall define the procedure for land acquisition for need or public interest, through a fair and previous compensation in cash, except for the cases provided for in this Constitution.

3.1.2 Federal Decree-Law No. 3,365 dated June 21, 1941.

The Federal Decree-law No. 3,365, as of June 21, 1941, provides for land acquisition for public-interest purposes. This Decree-Law specifies the rules and process of the land acquisition in Brazil and also referred to by the Code of Civil Procedures in Article 271. On January 29, 1999, this Decree-Law was partially amended by Law No. 9,785.

3.1.3 Federal Law No. 4,132 dated September 10, 1962

This Federal Law defines the procedures for land acquisition for public-interest purposes. It was amended by Law 6,513 in December 20, 1977 (art. 31).

3.1.4 Others

Federal Decree No. 24,643 of July 10, 1934, amended by Federal Decree No. 35,851 on July 16, 1954, defines so-called the Code of Waters in item "b" of Article 151 as shown below.

Article 151 item b: to acquire private buildings, and in pre-existing authorizations, the goods, including private waters upon which the concession is granted, and the rights which might be necessary, according to the law regulating land acquisition for public interest, being responsible for the resettlement and payment of compensations.

The Brazilian Association of Technical Standards (ABNT) in 2004 defines the standards for asset appraisal, such as general procedures in NBR 14,653-1, standards for asset appraisal in urban areas in NBR 14,653-2, and the same in rural areas in NBR 14,653-3.

3.2 Comparison between JICA's Guidelines on Environmental and Social Considerations and Relevant Legislation in Brazil

Table 3.1 shows a comparison between JICA's guidelines on environmental and social considerations and relevant legislation in Brazil.

	Tere vante Begista			
No.	Descriptions	Relevant Legislation in Brazil and their		
		Summaries		
1) JI	CA Guidelines for Environmental and Social Consideration			
1.	Involuntary resettlement and loss of means of livelihood are to	Not available (or follow social convention /		
	be avoided when feasible by exploring all viable alternatives.	protcol)		
	When, after such an examination, avoidance is proved			
	unfeasible, effective measures to minimize impact and to			
	compensate for losses must be agreed upon with the people			
	who will be affected.			
2.	Peopl who must be resettled involuntarily and people whose	Not available (or follow social convention /		
	means of livelihood will be hindered or lost must be	protcol)		
	sufficiently compensated and supported by project proponents			
	etc. in a timely manner.			
3	Host countries must make efforts to enable peole affected by	Article 5 of Clause 24 in the Constitution of Brasil		
	projects and to improve their standard of living, income	The article stipulates the procedures for land		
	opportunities, and production levels, or at least to restore these	acquisition with fair and advance monetary		
	to pre-project levels.	compensation in consideration of the public benefit		
		and necessity.		
		Decree-Law No. 3365 (June 21,1941)		
		This dicree stipulates the rules on and processes of		
		condemnation/expropriation for public projects as		
		well as any other purposes for public interest. The		
		decree defines that an owner of properties		
		expropriated/acquired for pubic interest shall be		
		compensated in cash.		
Т	Prior comensation, at full replacement cost, must be provided	Article 5 of Clause 24 in the Constitution of Brasil		
	as much as possible.	Same as above.		
5.	For projects that will result in large-scale involuntary	CONAMA Resolution No. 01 (as of Jan. 23, 1986)		
	resettlement, resettlement action plans must be prepared and	The resolution stipulates that an EIA report shall be		
	made available to the public. In preparing a resettlement	discosed to the public and SEENV or the		
1	action plan, consultations must be held with the affected	municipality government should hold the public		

Table 3.1 Comparison between JICA's Guidelines on Environmental and Social Considerations and Relevant Legislation in Brazil

No.	Descriptions	Relevant Legislation in Brazil and their Summaries
	people and their communities based on sufficient information made available to them in advance.	hearings or consultation meetings on a project and its potential impact. <u>CONAMA Resolution No. 09 (as of Dec. 3, 1987)</u> The resolution defines the purpose of the public hearings/consultations, outlines of public hearings/consultations (e.g., timing, timeframe, frequency, and venues), responsible agency, and the necessity of documentation of the hearings/consultations.
6.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	CONAMA Resolution No. 01 (as of Jan. 23, 1986) Same as above. CONAMA Resolution No. 09 (as of Dec. 3, 1987) Same as above.
7.	Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitopring of resettlement action plans and measures to prevent the loss of their means of livelihood.	Not available (or follow social convention / protcol)
8.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	CONAMA Resolution No. 01 (as of Jan. 23, 1986) Same as above. CONAMA Resolution No. 09 (as of Dec. 3, 1987) Same as above.
World	Bank Safeguard Policy, OP 4.12 and OP 4.12, Annex A	E-1
9.	Upon identification of the need for involuntary resettlement in a project, the borrower carries out a census to identify the persons who will be affected by the project, to determine who will be eligible for assistance, and to discourage inflow of people ineligible for assistance. (WB OP4.12 Para 6) The results of a census survey covers: (i) current occupants of the affected area; (ii) standard characteristics of dispalced households; (iii) the magnitude of the expected loss; (iv) information on vulnerable groups or persons; and (v) provisions to update information on the displaced people's livelihoods and standard of living. (WB OP4.12 Annex A Para 6)	<u>rederal Decree No. 7342 (as of October 26, 2010)</u> This decree institutionalizes the registration of the losses of properties of the persons who will be affected by a dam construction project for hydroelectirc generation. Types of losses to be registered and the organization (the inter-ministrial committee) to administer the registration are defied in the decree.
10.	Displaced persons may be classified in one of the following three groups: (a) those who have formal legal rights to land; (b) those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets-provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan; and (c) those who have no recognizable legal right or claim to the land they are occupying. (WB OP4.12 Para 15)	Not available (or follow social convention / protcol)
11.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. These strategies may include resettlement on public land, or on private land acquired or purchased for resettlement. (WB OP4.12 Para 11)	No regulation
12.	The resettlement plan or resettlement policy framework also include measures to ensure that displaced persons are: (i) offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living; and (ii) provided with development assistance in addition to compensation measures, such as land preparation, credit facilities, training, or job opportunities.(WB OP4.12 Para 6)	Not available (or follow social convention / protcol)
13.	To achieve the objectives of this policy, particular attention is paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, indigenous peoples, ethnic minorities, or other displaced persons who may not be protected through national land compensation legislation.(WB OP4.12 Para 8)	Not available (or follow social convention / protcol)
14.	In case that impacts on the entire displaced population are minor or fewer than 200 people are displaced, an abbreviated resettlement plan may be required.(WB OP4.12 Para 25)	Not available (or follow social convention / protcol)

Source: JICA Study Team

Although legislation and regulations on land acquisition and compensation are in place in Brazil, the resettlement and livelihood support after relocation have been generally based on the social convention or

protocol according to Brazilian Constitution so far. However, the environmental examination for environmental licensing has been getting strict and examining a resettlement plan with its monitoring plan in the examination as there have been many troubles and complaints caused by insufficient and improper support and arrangements in resettlement, such as i) relocation to a remote area and ii) limited opportunities for employment in a relocated area, especially those for the professions that the affected people engaged in before resettlement.

It is therefore necessary for the state government to carry out an EIA study and resettlement measures pursuant to the JICA guidelines (JICA Guidelines for Environmental and Social Consideration) and those used by the international funding institutions, such as World Bank, so that the state government could avail of the loan scheme of the international funding institutions for implementation of the Project.

Consequently, it is recommended that an EIA Study should be carried out in accordance with the draft TOR attached to this report. Considering the sound financial status of the state government, the JICA Study Team judges that it would not be much difficult for the state government to finance the conduct of the EIA study for the project.

- 3.3 General Resettlement Procedures in Brazil
- 3.3.1 Basic Concepts

Some basic concepts to be considered in the formulation of a resettlent program for the people who would be affected by the construction of a dam are defined:

Socioeconomic records (questionnaire) – **CSE**: means a structured interview survey with a set of preset questionnaires. As CSE aims to statistically analyze the socio-economic profiles of the affected families in a quantitative and qualitative manner and prepare a resettlement program for all the potential families regardless of the possession of land and other assets in the affected areas, the interview survey shall target all the families living in the potential inundation areas and construction site.

Directly affected area: or simply **"affected area"**: means the area/areas that will be used for construction or heightening of dam crests and those that might be inundated or impounded after the heightening of a dam. A strip of permanent preservation area (APP) around the permanent reservoir area is also included in this category. APP is not necessarily formed in a flood control dam in general, but it might be required when necessary.

Affected property and affected people: means assets and families associated with or located in the affected areas. The terms are used as herein defined except when otherwise explained.

Workforce (**FT**): means the number of available workers/laborers who are engaged in agricultural development and exploitation works. The current data on workforce are estimated on the basis of the age structure in each family.

"Target Public" of a resettlement program: means the people directly and indirectly affected by the implementation of a project, which include; land owners, illegal occupants, tenants, investor and its partners, community organizations, salaried workers, and children of land owners and the other relevant people. The target public shall be defined in each step of a resettlement program.

3.3.2 Resettlement Measures and Alternatives

In general, the target public of a resettlement program under a dam construction project for hydropower generation will be compensated or provided an alternative land for resettlement. The outlines of the resettlement measures are summarized below.

Compensation consists of the total or partial acquisition, with cash payment, of affected properties

and/or areas including the unfeasible remaining areas⁷ and any profits to be generated from the economic activities based on/in the affected properties as well as areas. The amount of the compensation will be determined by a mutual agreement between a proponent and the respective affected families/persons.

Provision of alternative lands means to provide the target public with alternative lands and assists them in relocating themselves to such lands. It consists of the following types of measures.

- a) Collective Rural Resettlement (RRC): where rural lots with basic social infrastructure will be allotted to the whole communities in the affected areas.
- b) Small Rural Resettlement (PR): where individual electrified houses and barns with a water supply system will be allotted to the affected families.
- c) Individual Resettlement (Commitment Letter, CC): where the individual affected families will have negotiations with a proponent and determine the value of the affected areas and properties. In principle, each family is responsible for searching his/her relocating land and its associated facilities, which should be equivalent to the values of his/her affected properties/areas. The acquisition and registration of such properties shall be done by a proponent.
- d) Resettlement in Remaining Area (AR): where land use rights for farming will be granted to the affected families. The areas that will neither be affected by a project nor be designated as APP among those acquired by a proponent for a project will be used for this purpose.
- e) Resettlement in Special Cases (CE): where a special arrangement, such as arrangement for urban lots or downsizing of lots from the original plan, will be made for the affected families that have persons in need of special attention (e.g., the aged and disabled).

Due consideration shall be given to the socio economic aspects of the affected families in the preparation of a resettlement program. In particular, the conservation of customary norms/customs related to land and traditional culture in the affected areas shall be considered in a resettlement program.

Furthermore, in case CSE reveals that any indigenous communities or special social categories (such as Quilombos) might be affected by a project, specific standards should be employed to pay due attention to their traditional and cultural characteristics and peculiarities.

In principle, each target public shall select the resettlement measure by themselves considering the respective socio-economic as well as traditional characteristics and according to the guidelines and criteria based on the case studies in the past.

Furthermore, after the estimated values of the affected areas are presented to the target public, additional options should be determined and selected on the basis of the results of CSE in a participatory manner. Such a participatory process and continuous discussions would enable them to appraise their own conditions and determine appropriate resettlement measures.

3.4 Procedures for Compensation and Land Acquisition

The following sections describe the procedures taken for compensation and land acquisition in a dam construction project for hydropower generation as an example for the administrative procedures for compensation and land acquisition. Although these procedures are considered applicable to a project for the construction of a flood control dam in principle, there is a need to further examine whether or not all the procedures described below can be applied to the proposed project in a further study, since the existing flood control dam projects are rather scarce as compared to those for hydro-generation

⁷ The unfeasible remaining area means the area located outside the affected area but owned by the same owner and where the owner will not be able to gain profit from any economic activities based in.

dams.

Based on the mutual agreements on land acquisition between a proponent and the affected families/people, compensation for the affected properties and lands and assets including the lands remaining unused due to a project should be made in money in principle. The close communication and good relationship between a proponent and the affected families/people is crucial to smooth progress of the land acquisition process as the land acquisition is based on negotiations with owners of the affected properties in principle. The amount of compensation for the affected lands and properties will be estimated on the basis of data and information collected through a market research on the prevailing market prices, in addition to the comments from the representatives of the owners of the affected lands and properties.

A field survey is to be carried out to assess the affected lands and properties with the presence of the land owners or their delegates/agents. The survey shall cover the lands that would not be directly affected by a project but should remain unused due to project activities and the properties owned by tenants or illegal occupants who do not have the ownership of the lands as well.

In case a proponent and land owners can not reach a mutual agreement on compensation, the compulsory land acquisition process will be taken based on the Public Declaratory Resolution on Public Facilities in the Affected Areas issued by the National Agency of Electric Energy (ANEEL). The Resolution is applicable to only the case when an amicable agreement with land owners is judged impossible to reach.

The procedures for compensation along with the implementation of a project are summarized below.

(1) Preparation of the Registration Sheet

Prior to the field assessment surveys on the lands and properties that would be affected by a project, project outlines and other relevant information shall be disclosed to the owners or persons responsible for management of the properties as the first step of the process. In simultaneous with the disclosure of the project information, a proponent shall explain the procedures for land acquisition and compensation as well as the applicable guidelines on the same to them. At the same time, a field survey team will take the formal permission from the owners for entering the affected areas for assessment. The survey team shall prepare the Registration Sheet for each owner's properties filling in data and information of the target properties and obtain informed consent for the sheet from the owner with his/her signature.

(2) Demarcation of Maximum Flood Elevation Line and of the Permanent Preservation Area(APP)

A field survey shall be carried out to delineate the maximum flood elevation level and boundaries of APP along the permanent reservoir⁸ so as to clearly demarcate the areas to be inundated/impounded.

(3) Determination of the Acquired Land and Properties

The distribution and areas of the potential land use types in the acquired lands shall be clarified by delineating the boundaries of the acquired lands and classifying the potential land use types in the same.

(4) Market Research on Prices and Determination of Unit Values

Unit values for buildings (non-reproductive immovables) and for the perennial crops (reproductive immovables) will be set to estimate the costs of replacement and reproduction. The information related

⁸ There is no official comment from environmental agency (FATMA), it is not clear whether it is necessary to set APP around the temporal reservoir.

to agricultural production (e.g., agricultural input, labor, and other operational costs including sales) and any other economic activities in the area shall be used for setting the unit values.

The value of the bare land will be estimated on the basis of information and data collected from the market research and interviews to available sources, such as realtors, notaries, brokers, unions, municipalities, banks, and other agricultural experts. It is necessary to collect sufficient information to set the reliable prices/values in line with the standard prices in the region.

An inspection survey shall be carried out to clarify the features of the lands, such as potential land capability, current management practices, and accessibility, for land acquisition. The unit value for compensation shall be determined by estimating the price of the bare land based on a statistical analysis of the above-mentioned data and assessing the quantity as well as quality of buildings and perennial crops existing in the lands.

The procedures described above are essential to ensuring the reliability of appraisal of the amount of compensation and avoiding future disputes that might be caused by any speculations.

The market research shall be carried out by an expert. A proponent and the affected families/people shall select the representatives who will verify the process of the survey to ensure the validity of the results of the research. In general, the market research shall target the affected families/people and those who own similar properties in the surrounding areas/municipalities.

Once the surveys for setting the unit values are completed, a matrix table showing the amounts of compensation shall be prepared. The table shall be reviewed and examined by a proponent and the representatives of the affected families/people for approval. The amounts of compensation shall be reviewed every six months and updated whenever the market prices rise drastically.

Table 3.2 shows the sample amounts of compensation described in Commitment Letter for individual houses around Oeste Dam.

SITUATIONS	HOUSE VALUE	ROOF VALUE	LAND VALUE	TOTAL (R\$)
House Type I = 54.00 m^2	31,398.00	33,480.00	202,550.00	267,428.00
House Type II = 63.00 m^2	35,961.00	33,480.00	202,550.00	271,991.00
House Type III = 72.00 m^2	40,963.00	33,480.00	202,550.00	276,993.00
House Type I. Minimum S = 40.50 m^2	23,388.00	0.00	45,000.00	68,388.00
House Type II. Minimum S = 45.00 m^2	24,536.00	0.00	45,000.00	69,536.00
House Type III. Minimum $S = 50.00 \text{ m}^2$	23,388.00	0.00	45,000.00	68,388.00
House Type I. Maximum S = 40.50 m^2	23,388.00	23,315.00	137,500.00	184,203.00
House Type II. Maximum $S = 45.00 \text{ m}^2$	24,536.00	23,315.00	137,500.00	185,351.00
House Type II. Maximum $S = 50.00 \text{ m}^2$	26,659.00	23,315.00	137,500.00	187,474.00

 Table 3.2
 Cost Estimation for Commitment Letters

Source: JICA survey team

(5) Literature Survey

A literature survey shall be carried out to review and analyze the processes necessary for i) transfer of ownership of the lands and properties and ii) acquisition of easements recorded in the recording office and notary public office. Furthermore, this survey aims to i) confirm the ownership of the affected lands and properties; ii) identify the potential beneficiaries of compensation; and iii) collect other

documents relating to lands and properties (e.g., legal documents, payment of taxes, registration of pledge, and registration and transfer of mortgage), to verify the validity of compensation.

(6) Assessment of Affected Properties

To assess the lands and properties affected by a project in a qualitative and quantitative manner, a field survey shall be carried out to clarify the land-related information (i.e., i) classification of potential land capability, ii) present land use, iii) forest classification, iv) vegetation and forest covers, and v) density of forests in the affected areas) and to make an inventory of the existing properties and facilities, such as perennial crops, buildings, roads, electric power lines, telephone lines, wells, ponds, springs being used for water supply, community facilities, and tourism facilities.

The field survey shall be conducted by experts or a professional company with a wide range of expertise, and its results will be evaluated and validated by a proponent.

(7) Appraisal of Affected Properties

The appraisal of properties shall be conducted in accordance with the official standards of the country for land evaluation⁹, namely NBR 14653-3 and NBR 14653-2, which shall be applied to rural and urban properties, respectively.

Criteria for appraisal of reproductive immovables, such as perennial crops, and non-reproductive immovables, such as buildings, shall be determined by a evaluation method for immovables and economic values for crops.

The appraisal of buildings shall be estimated on the basis of the costs estimated for wrecking of buildings, transportation of materials, and rebuilding. In the case of residential buildings, the amount of appraisal estimated in the same manner shall be the basis for determining the range of the rental cost.

On the other hand, the appraisal of lands shall be based on the land capability, which has the following eight (8) classes.

Class I: Arable land without any limitations on production of annual and perennial crops, usage of pasture, and planting of trees. The soils are fertile and have a deep effective soil layer with a high capacity of water retention. The area has a low risk of flood and no shallow groundwater.

Class II: Arable land with few limitations on crop production and soil conservation. For example, the soils indicate either less or excess CEC (Cation Exchange Capacity) and needs some amendment for crop production. However, the area can be used for crop production with proper management in general.

Class III: Arable land with some limitations on crop production and soil conservation. The area would be rapidly degraded without application of soil conservation measures or other necessary management practices. The area might need to introduce complex conservation measures for production of annual crops suitable for the climatic conditions. In case of sloping land, the area is further classified into sub-classes according to the slopes. Intensive farming will accelerate the possibility of soil erosion. On the other hand, a risk of flood is the major limitation of this class of area in the plain land.

Class IV: Land only used for cropping in a short period of time and not used for crop production continuously over years. The soil fertility is low to medium and clay content in soil texture is 15~60%. The soils are generally deep and rather well drained.

Class V: Land suitable for perennial crops, pasture, and trees, but not for annual crop. The soils are rather shallow (less than 1.2 m) and have gravel fraction (less than 5 % gravel content). The area is

⁹ Developed by Brazilian Association of Technical Standards (ABNT)

rather dried.

Class VI: Land in which perennial crops, pasture and trees can be grown but no annual crop can grow. The soils are infertile, well drained, and with $5\sim10$ % gravel content, although the area is flat with rather deep soils (more than 2 m).

Class VII: Land in which perennial crops and trees may not grow well. Like the area categorized as Class VI, the area needs to introduce appropriate soil conservation measures and other land management practices to minimize the soil erosion/degradation potentials. The soils extending flat to gently rolling terrain are infertile, well-drained, and rather shallow (less than 0.5 m). The area is dried.

Class VIII: Land not suitable for crop production or afforestation/reforestation. Consequently, the area can be used only for habitat for wild animals, sites for recreation, and water storage or harvesting facilities. Inundation area, mangrove forest, and barren or rocky area are calssified as this class.

Even if the area is owned by Navy, the same procedures for appraisal shall be followed. A simplified estimation is not allowed for the land owned by Navy.

If any floras of native species exist in the remaining unused area, the value of such floras shall be appraised and compensated along with other properties. However, those in permanent preservation area (APP) shall be kept untouched and maintained as they are. The value can be appraised but any alternation is not allowed.

Compensation for short-term crops will not be made if the notice of the date of resettlement is made more than six months before. On the other hand, if the notice is made less than six months before and short-term crops can not be harvested by the time of resettlement due to time constraints, the value of short-term crops shall be compensated.

Roads, wells, water supply systems, and electric lines in the affected areas shall be compensated by rebuilding/reconstructing the same based on the cost evaluation method.

(8) Administrative Technical Reports

An administrative technical report, which is to be used for the reference for compensation, shall be prepared for the respective properties. The report describes i) the expected values of land/property, ii) the potential effects caused by a project, and iii) the amount of compensation.

(9) Negotiations

The negotiations for property acquisition shall not involve anyone who might envision obtaining economic or political benefits from the negotiations, but be made through a direct communication with each owner of property

Compensation shall be based on the administrative technical reports on the respective affected properties. A proponent for a project shall be responsible for issuance of a deed of transfer and registration of the lands to be transferred to the affected families/people in the recording office. The final payment of compensation shall be adjusted by deducting the expenses for registration of new properties for the affected families/people.

(10) Payment

A proponent shall make a payment within 30 days, on the condition of the submission of an ownership certificate, from the date of the mutual contract on the amount of compensation. In the cases of Individual Resettlement (CC) and Special Cases (CE), a part of the final payment might be used for procurement of new properties.

(11) Deadline for Transfer of Properties

In case that the payment of compensation is made or Individual Resettlement (CC) is selected as the method for acquisition, the owner shall transfer the occupied land to a proponent by the deadline for transfer. The deadline shall be determined by a proponent in principle, but it should be adjusted with the conditions of the owners, especially when buildings/facilities are removed in the affected area.

As long as an implementation schedule of a project is not affected, the deadlines for transfer of the affected lands can be extended within a certain timeframe as an exceptional case. In that case, a proponent shall make an agreement on free use of the acquired land with the affected families/people, so that they could use such areas until the new deadlines set by the agreement.

(12) Compulsory Acquisition in accordance with Public Utility Declaration Resolution - DUP

Compulsory land acquisition shall be carried out in accordance with the ANEEL Resolution No. 279/2007 otherwise known as the Public Utility Declaratory Resolution. DUP would be applied in case the amicable land acquisition can not be made due the breakdown of the negotiations on compensation or the defect in the documents on land ownership, which are the bases for a proponent to pay compensation. In some projects, compulsory compensation might be undertaken at the state or municipal level.

In the early stage of the project, sufficient deliberation on whether or not the Resolution can be applied to a flood control dam project shall be made in consideration of the nature of the project. In fact, the Resolution stipulates the legitimacy of land acquisition for a hydropower project, and therefore, the same is considered applicable to a flood control dam as its nature is similar to a hydropower dam.

(13) Granting of Ownership

In case the legal process (or compulsory acquisition) for granting of ownership is required due to the breakdown of the negotiations or disputes over the conveyance of estate, an expert report relevant to the issue shall be prepared for granting of ownership at least six months before the start of impounding.

(14) Prioritization of Properties to be acquired

The land acquisition of the inundation areas shall be carried out in both river banks, from the downstream to upstream if possible. Furthermore, the following lands should be prioritized.

- Construction site and access roads to the site
- · Areas to be fully affected or fully acquired
- Areas to be partly affected and whose owners prefer to have partial compensation
- · Areas identified as partially affected
- (15) Criteria to Examine the Possibility of Continuation of Livelihood Activities in the Remaining Areas

The existing livelihood activities in the remaining areas shall be assessed to examine the possibility of the continuation of them. If the assessment reveals that i) the cost incurred for basic infrastructure necessary for the existing livelihood activities in the remaining areas will be higher than that for resettlement or ii) the remaining areas are too remote from basic infrastructure to maintain the existing livelihoods, the continuation of the livelihood activities would be judged impossible. In addition, in case the remaining areas are susceptible to landslide due to its slopes or geological characteristics, the continuation of the livelihood activities would not be allowed.

In case any investment have been made for agricultural development even in the area where no agricultural activity had been undertaken before a project, the possibility of continuation of the

agricultural activities in such areas shall be deliberated.

If the existing agricultural activities, namely livelihood activities, can be continued in the remaining area, a proponent shall only acquire the areas to be inundated/impounded and its surrounding areas for protective vegetation strips (APP).

On the other hand, if the continuation of the existing activities is considered impossible or infeasible to support the livelihoods of families, a proponent shall acquire the whole area including the remaining area unless the owners of the areas officially request the exclusion of the remaining areas from land acquisition.

- 3.5 Typical Resettlement Monitoring Program in Brazil
- 3.5.1 Introduction

Due consideration should be given to: i) agricultural production and economic activities (e.g., agricultural activities, any complementary activities, market supply, and commercialization); ii) social interaction (e.g., resumption of community activities and reformation/restructuring of social structure); and iii) arrangement of basic infrastructure (e.g., houses, education facilities, health facilities, and transportation facilities) during the process of resettling the affected families/people. To this end, a systematic monitoring program needs to be implemented during the process of resettlement, so as to ensure the transparency of the process and remedy the resettlement activities when necessary.

3.5.2 Justification

The main aim of the monitoring program is to identify the positive and negative aspects of the various measures (monetary compensation, commitment letter, resettlement in the remaining areas, individual resettlement, and special arrangements/cases) taken for development of new communities in the course of resettlement

The monitoring program is to target thee families/people resettled/relocated ("resettled/relocated families/people"). Having analyzed the negative aspects identified, the monitoring program is to provide effective alternatives and means to minimize the negative factors, such as provision of technical and social guidance.

Forcing people to change the living environment by any reasons other than personal interest might cause social disruption or seriously threaten the basis of civil society. It is therefore important to restore the lifestyle of the affected families/people, provide necessary support for restoration, and continue monitoring of the resettled/relocated families/people in new areas. The monitoring program would be helpful in having the feedbacks from the resettled/relocated families/people and identifying the needs of technical and social assistance for them.

3.5.3 Objectives

The main objective of the monitoring program is to collect the information relevant to the resettled/relocated families/people in the different stages of a resettlement program to evaluate the process of resettlement from the economic and financial viewpoints and to propose any improvement when necessary. Specifically, the program aims to:

- evaluate the changes in lifestyle of families/people living in the areas directly or indirectly affected by a project in the different stages of a resettlement program
- validate the effectiveness and validity of a resettlement program
- monitor the families who recognize the discrepancy between the plan of a resettlement program and the results of the same or who propose revising the guidelines adopted for resettlement

3.5.4 Goals

The goal of the monitoring program is to propose the necessary activities for improvement of a resettlement program as described above. The milestones to be achieved by the monitoring program are to monitor and survey all the resettled/relocated families in different locations at the respective stages (i.e., T0, T1, T2, and T3 stages) within three years from resettlement.

3.5.5 Environmental Indicators

Information to be monitored are: i) the level of satisfaction, ii) the level of family income, and iii) the level of solidarity of new communities of the resettled/relocated families. Furthermore, the following environmental indicators shall be monitored for three years.

- Opposition movement of resettled families/people against the results of the resettlement program;
- Proportion (Percentage) of resettled families/people satisfied with the effectiveness of resettlement;
- Proportion (Percentage) of resettled families/people who remove to other places in a short period of time;
- Degree of crop diversification;
- Proportion (Percentage) of resettled families/people who are able to engage in a job/occupation that enable them to enhance their standard of living;
- Level of increase of crop productivities
- Changes in average family income
- State of adaptation of resettled families/people to the respective new locations
- Level of improvement of social indicators
- Degree of discrepancy between the plan and results of the program
- Degree of introduction of new technologies in agricultural production.

3.5.6 Target Groups

The monitoring program is to target: i) directly-affected people, ii) people forced to relocate, iii) people without house or employment, and iv) people who are not able to obtain property compensation.

3.5.7 Basic Concepts

The resettled families/people should be followed up and the resettlement measures and their process shall be evaluated in the different stages of a resettlement program. The results of CSE/socio-economic survey will be used for evaluation.

Stage	Aims of monitoring			
T0-T0 Stage (when the monitoring activity starts):	Survey and grasp the socio-economic conditions of the affected families/people prior to resettlement through CSE.			
T1- T1 Stage (six months after resettlement):	Evaluate the current situations of the resettled/relocated families.			
T2- T2 Stag (18 months after resettlement):	Assess the socio-economic conditions of the resettled/relocated families.			
T3- T3 Stage (30 months after resettlement):	Evaluate the stability of the resettled/relocated families			

3.5.8 Methodological procedures

The monitoring program is to employ quantitative and qualitative surveys, a questionnaire survey using a set of questionnaires, and a semi-structured interview survey to grasp the feelings and sentiments of the ressetled/relocated families. A quantitative survey can reveal the level of satisfaction/dissatisfaction and other qualitative socio-economic aspects before and after resettlement, while the quantitative survey can measure the inter-annual changes in the pre-determined milestones and environmental indicators. Those surveys to be employed shall encompass different approaches that have the respective pre-determined timeframe, interrelate each other, and have the respective clear aims and methodologies.

The results of CSE shall be used as the baseline data to clarify the changes in socio-economic conditions of the resettled families/people through periodical monitoring activities.

Monitoring activities will be carried out in accordance with the following timeframe:

- T0: Before resettlement of families
- T1: Six months after resettlement
- T2: One year after T1
- T3: another one year after T2, when the life of the resettled/relocated families would become stable

3.5.9 Development of Program

The monitoring program is to be developed in consideration of its timeframe and methodologies required.

(1) "T0" STAGE – Before Resettlement

An interview survey will be carried out to determine the baseline of the ressetled/relocated families before resettlement. Hence, the families to be affected by a project will be targeted by this monitoring activity. The changes in the socio-economic conditions will be assessed on the basis of the data collected in this stage.

(2) "T1" STAGE – Six Months after Resettlement

A semi-structured interview using questionnaires will be conducted six month after resettlement to assess if the resettled/relocated families are adaptable to their new environment and evaluate if the unification of the resettled/relocated families as a new community progress as planned. Feelings and sentiments of resettled/relocated families along with good and bad points of the results of resettlement will be grasped through such an interview survey.

(3) "T2" STAGE – One Year after "T1"

The survey at this stage aims to grasp the socio-economic conditions of the resettled/relocated families considering the vulnerability of the respective families. Data on the second year cropping, such as area cultivated, crop yields, and sales of products, will be collected and analyzed for this purpose. The same questionnaires used in T0 Stage will be used in this stage.

(4) "T3" STAGE – One Year after "T2"

This stage aims to assess the degree of social stabilization of the resettled/relocated families by evaluating the effect of compensation payment on the household economy at the third year.

Hence, a structured questionnaire survey, which would enables a quantitative economic and financial analyses with cross-checking and social interaction analysis of the resettled/relocated families, will be carried out in this stage.

3.6 Environmental Management and Monitoring Programs

All the activities relating to envrionmental management, supervision and monitoring in the construction and operation phases shall be planned in EIA/RIMA as the environmental management and monitoring programs in accordance with the methods/procedures defined by the relevant environmental legislation in Brazil. Contents and composition of envoironmental management and monitoring programs will be determined and finalized in consulation with the relevant organizations in the process of the preparation of EIA/RIMA.

The following items shall be included in the envoironmental management and monitoring programs.

i) Environmental Lisence:	It shall describe the environmental impact assessment study and the proposed measures to avoid and mitigate the expected impact.
ii) Environmental Management and Control:	It shall include the descriptions about environmental training for laborers, health management of laborers, and pollution preventive measures (e.g., dust, traffic, noise, and vibration).
iii) Enviromental Monitoring:	It describes a monitoring plan in the construction and operttaion phases.

A proponent shall be responsible for environmental monitoring, but its implementation (e.g., field monitoring activities) is generally contracted out to a consulting firm/consultants or university.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)		
(1) EIA and Environmental Permits		 (a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the 	(a) N (b) N (c) N (d) N	 (a) The proposed projects has been just identified and selected by the JICA Preparatory Survey as the proposed measures to be implemented in the first phase, recently. Hence, the official process of EIA has yet to start so far. (b) ditto (c) ditto (d) ditto 		
Explanation	(2) Explanation to the Local Stakeholders	host country's novernment? (a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N	 (a) Same as above. Explanation of the proposed project to the local stakeholders shall be made in the course of a EIA study. (b) ditto 		
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) The JICA Preparatory Survey has assessed the alternatives with social and environmental considerations.		
2 Pollution Control	(1) Water Quality	(a) Is there a possibility that changes in river flow downstream (mainly water level drawdown) due to the project will cause areas that do not comply with the country's ambient water quality standards?	(a) Y	(a) There is a possibility of polluting the quality of the downstream water by the construction of two floodgates on the Itajai Mirim River; however such a potential impact could be negligible by the application of a proper construction method, such as a prevention measure to treat turbid water. The heightening of Oeste dam might also cause the adverse impact on the river environment since the engineering works will need to divert the main stream of the river during the construction works. However, such an effect could also be minimized by the application of a proper construction method.		
	(2) Wastes	(a) In the case of that large volumes of excavated/dredged materials are generated, are the excavated/dredged materials properly treated and disposed of in accordance with the country's standards?	(a) N	(a) No potential impact can be expected.		
	(3) Subsidence	(a) Is there a possibility that the excavation of waterways will cause groundwater level drawdown or subsidence? Are adequate measures taken, if necessary?	(a) N	(a) No potential impact can be expected.		
	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country' s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) No protected area exists around the project sites.		
3 Natural Environment	(2) Ecosystem	 (a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that hydrologic changes, such as reduction of the river flow, and seawater intrusion up the river will adversely affect downstream aquatic organisms, animals, vegetation, and ecosystems? (e) Is there a possibility that the changes in water flows due to the project will adversely affect aquatic environments in the river? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? 	(a) N (b) N (c) N (d) Y (e) Y	 (a) No valuable forests (e.g., primeval forests and tropical rain forests) or ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats) are encompassed by the projects. (b) No habitat of endanger species is confirmed in and around the project sites. (c) No significant ecological impact is expected. (d) Errors in operation of the floodgates on the Itajai Mirim River might cause the drastic reduction of the downstream flow of the river and eventually affect the aquatic organisms in the flow adversely. Nevertheless, such a potential effect is considered negligible as long as the floodgates are properly operated. (e) Ditto 		
3 Natural Environment	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the project will adversely affect surface water and groundwater flows?	(a) Y	(a) Pre-release of storage water in Rio Bonito and Pinhal dams may drastically increase the downstream flow of the Rio dos Cendros River. Hence, an early warning system to alert households living in the downstream areas about the potential risks is proposed as a project component		
	(4) Topography and Geology	(a) Is there a possibility that excavation of rivers and channels will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas?	(a) N	(a) No excavation of rivers and channels is planned in the project.		
4 Social Environment	(1) Resettlement (2) Living and Livelihood	 (a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensation policies prepared in document? (e) Is the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established? (b) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect the downstream fisheries and other water uses? (c) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? 	(a) Y (b) N (c) N (d) Y (e) Y (f) N (g) N (i) N (j) N (j) N (j) N (j) N	 (a) Although the relocation of road along with the heightening of Oeste dam is proposed to avoid involuntary resettlement and land acquisition, the State Government might decide to acquire about 67 ha of potential inundated area and relocate a total of three houses and four barns in the said acquired area. It is recommended that a proper compensation acceding to the relevant legislation in Brazil and OP. 4.12 of World Bank should be made in case that the government select the option of land acquisition and involuntary resettlement. (b) The project has been just formulated, and the state government has not made the final decision whether or not the project will result in involuntary resettlement. (c) Ditto. (d) Compensation prior to the resettlement is defined by the federal legislation. (e) Decree Law No. 3365 defines the rules on compensation. (f) No resettlement plan has been prepared yet as the project has been just formulated and the state government. (g) Ditto (h) Ditto (i) Ditto (j) The project near proposed in the feasibility study prepared by JICA Preparatory Survey. (b) The project on pre-release of stored water in Rio Bonito and Pinhal dams might affect the downstream areas if the dams are not properly operated. However, as long as the pre-releasing is properly done, the adverse effect on the downstream areas is expected to be negligible. (c) There is no possibility of outbreak of water-borne or water-related 		
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no heritage site in and around the project sites.		

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) The construction work of the new floodgates on the Itajai Mirim River might affect the landscape of the town, as its proposed sites are located in the center of the town. Nevertheless, the expected impact would be minimal as the construction work will be only temporary and not result in any essential affective of the cityscape.
4 Social Environment	(5) Ethnic Minorities and Indigenous Peoples	 (a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected? 	(a) N (b) N	 (a) No ethnic minority lives in and around the project sites. (b) Ditto
	(6) Working Conditions	 (a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or 	(a) Unknown (b) Unknown (c) Unknown (d) Unknown	 (a) As long as the contractor follows the construction environmental management plan, which will be prepared in the course of the EIA study, any malpractice on working conditions is not predicted. (b) Ditto (c) Ditto (d) Ditto
	(1) Impacts during Construction	 (a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures reduce an ensure the social environment, are adequate measures considered to reduce impacts? 	(a) Y (b) Y (c) Y	 (a) The feasibility study prepared by JICA Preparatory Survey proposed adequate measures to mitigate possible impacts during the construction. (b) Ditto (c) Ditto
5 Others	(2) Monitoring	 (a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the program to the programmer of the	(a) N (b) N (c) N (d) N	 (a) The monitoring plan will be prepared in the course of the EIA study which will be initiated by the State Government in future. (b) Ditto (c) A monitoring framework will be prepared as a part of the monitoring plan, which will be prepared in the course of the EIA study. (d) A monitoring report system will be prepared in the part of the monitoring plan.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry checklist should also be checked.	(a) N	(a) The Forestry checklist is not applicable to any of priority projects.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone laver. or global warming).	(a) Not applicable	(a) No impact to trans-boundary or global issues is expected.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriat

regarding the term. Country standards: mentioned in the adove table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
 In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience
 Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of th country and locality in which the project is located.

ATTACHMENT-2: DRAFT TERMS OF REFERRENCE (TOR) FOR AN EIA STUDY ON THE IMPELMENTATION OF THE PRIORITY PROJECTS

1. Background

The Itajai River basin with a catchment area of 15,221 km² locates in the center of the State of Santa Catarina in the southern part of Brazil. Riparian areas along the Itajai River and its tributaries have been suffering from flood damage due to repeated inundation. After the consecutive attacks by large flood in both years 1983 and 1984, the following studies were carried out under the technical cooperation between the Government of Federative Republic of Brazil and the Government of Japan.

- The Itajai River Basin Flood Control Project (1986-88) (Master plan study and feasibility study)
- The Lower Itajai River Basin Flood Control Project (1988-90) (Feasibility study)

The Government of the Sate of Santa Catarina requested the Japanese ODA Loan for implementation of the Itajai River Flood Control Project. However, the Loan Agreement (L/A) was not concluded due to lack of guarantee of the Government of the Federative Republic.

A catastrophically heavy rainfall hit the Sate of Santa Catarina from November to December in 2008, resulting in serious impacts due to flood and sediment-related disasters in the Itajai River basin. The Government of the Sate of Santa Catarina showed the willingness to implement the the disaster prevention project for the Itajai River basin with technical and financial assistance by the Government of Japan. The execution of the Preparatory Survey for the Project on Disaster Prevention and Mitigation Measures for the Itajai River Basin was agreed between the Government of the Sate of Santa Catarina and the Government of Japan on November 5th 2009.

The JICA Preparatory Survey formulated a master plan for flood and sediment disaster prevention and mitigation measures for the Itajai River basin, and proposed implementing several priority projects after assessment of their viability.

This document is the draft terms of reference (TOR) for an EIA study on the selected priority projects, which specifies the scope of the Study to be fulfilled by an institution/organization that will be engaged in the conduct of the Study.

2. Proposed Projects

2.1 Objectives

The main objective of the proposed priority projects is to reduce and minimize the risk of flood and sediment disasters in the entire Itajai river basis. Specifically, the priority projects aim to prevent the towns and human life from the 10-year level flood.

2.2 Project Area

The priority projects cover the whole basin of the Itajai River. The following sections describe the natural and socio-economic conditions of the Project Area.

2.2.1 Socio-economic Conditions

The total population in the Itajaí River basin in 2009 was recorded at 1.23 million, which is

about 20% of the total population in the Santa Catarina State. The average annual population growth in the period of 1970-2009 was 2.0 % as shown in the table below. Cities of Itajaí, Blumenau and Brusque show higher population growth. On the other hand, population growth in the upper Itajaí River basin shows a stagnation or decreasing trend, indicating a significant migration towards the middle-scale cities. The services sector prevails in terms of GRDP in the Itajaí River basin, which accounts for around 50.2% of the GRDP. In Itajaí city, the port services sector is the most important economic activity. The industrial sector is has been the major engine of economic growth in the regions of Brusque, Timbó, Blumenau and Ibirama. The services sector has been recently growing at an average growth rate over 20% in all the regions.

2.2.2 Topography and Geology

The Itajai River Basin is surrounded by mountains with elevations varying from 200 to 1,750 m, except on the Atlantic Ocean side. In the whole Itajai River basin, area rate of altitude range below 100 m is approximately 11%, the range 500 m to 1000 m is predominately 53%, and the range above 1000 m does not reach 1%. The geology of Itajai River Basin has the base from Archean to Proterozoic eons, which compose the stable continent of South America, and above it, there are sedimentary rocks from the Paleozoic and Mesozoic eras, and in the upper layer, there are basaltic rocks run off in the Mesozoic era. Except for the alluvial portion that stretches out in the lowland of the Atlantic coast and the lowland of the banks of rivers, in general, the geology are old in the northeast region and young in the southwest region. In the upstream areas of the basin, there are rocks from the Paleozoic to Mesozoic eras. In the middle and lower portions, there are sedimentary rocks in the Paleozoic era, and metamorphic rocks from the Archean to Proterozoic eons.

2.2.3 Meteorology and Hydrology

The average annual basin mean rainfall in the period of 1950-2008 is 1,560 mm. The maximum annual rainfall is 2,632 mm in 1983 and the minimum is 2,632 mm in 1983. However, in 2008 when the most serious flood disaster recently occurred, the annual basin mean rainfall is 1,899 mm. This is due to the concentration of the rainfalls in the lower part of Itajaí River basin from Indaial city during the 2008 flood. The monthly rainfall shows relatively low from April to August, gradually increasing from September onward, and the highest occurs in January and February. However, historical large floods occurred both in July 1983 and August 1984 even during the period of relatively low rainfalls. The annual mean discharges in 1980-2004 are 40 m³/s at the Ituporanga station, 131 m³/s at the Rio do Sul station, and 269 m³/s at theIndaial station. The annual mean discharge at the Blumenau station is 340 m³/s. Although wet and dry seasons are not clearly divided, the monthly mean discharges from September to February are generally higher than the annual mean discharge.

2.2.4 Land Use

The forest area accounts for 64.6% of the whole basin, followed by the agricultural land use of crops and pastures with 36.7%. Table 1 presents the current land use in the flood vulnerable area along the Itajaí River. Major urban areas in the basin are located in the flood vulnerable areas, and thus most of the basin population lives in these flood prone areas.

Table 1	Present Land Use with	thin the Itaj	jai River	[•] Basin in 2000
Land Use	Category	Area (k	(2 xm²	Ratio (%)
Crops/pastures	4,591.69	36.7		
----------------	-----------	-------		
Forests	9,644.44	64.6		
Rice paddies	241.22	1.6		
Urban region	367.13	2.5		
Water bodies	88.75	0.6		
Total	14,933.23	100.0		

Source: JICA Survey Team (based on IBGE data)

2.3 Outlines of the Project

2.3.1 Priority Projects for the First Stage

The State Government in the Santa Catarina decided to set of the 50-year flood as the final goal of flood security level in the master plan. In view of the required huge investment and long period for realization, the State Government decided to takes a stage-wise development approach. Consequently, the State Government adopted a security level for around 10-year flood level for the first stage of implementation.

Along this line, the following projects were finally selected by the Sate Government as priority ones for the first stage of implementation:

- i) Water storage in the paddy fields
- ii) Heightening of the existing flood control dam and change of gate operation method (2 dams)
- iii) Utilization of the existing hydropower generation dam for flood control (2 dams)
- iv) Strengthening of the existing flood forecasting and warning system (FFWS)
- v) Installation of two floodgates on the Itajai Mirim River in Ttajai city

Together with the above, the following two projects were chosen for the first stage of implementation to prevent any sediment disasters.

- i) Slope protection of roads at 13 locations
- ii) Installation of early warning system for sediment disaster and flush flood
- 2.3.2 Outlines of the Priority Projects

(1) Water Storage in Paddy Fields

This plan aims at enlargement of the flood retention capacity, being used of the paddy fields expanded in the all sub-basins with provision of heightened paddy ridge and gradually to introduce the rice production with better quality and safety. As measures, it will develop the following activities:

Increase of capacity of reduction of the	- Elevation of the paddy ridge.
floods effect:	
Use of the land in accordance with	- Recovery of the riprap forest.
environmental legislation:	- Incentive to use of farm land in accordance with environmental legislation
Safety foods Supply:	- Incentive to introduce the Integrated Rice Production

It is foreseen to execute the heightening of the paddy ridge (current 10 cm) for more 10 to 30 cm, hoping to increase the capacity of retention of the rains for more $2.000 \sim 3.000$ m3 for hectares, as

well as it is indicated in following figure:



Source: JICA Survey Team

Retention Methodology of Flood water in paddy fields

(2) Heightening of the existing flood control dam and change of gate operation method

(2 dams)

a. Heightening of Oeste Dam

It appeared by the topographic survey and hydraulic calculation of the design discharge that the non-overflow section of the dam body should be heightened by 2.01 m, although the spillway section is by 2.0 m. The following figure shows the designed sections.



Designed Sections of the Oeste Dam

From the hydraulic viewpoints, it was proposed to install an energy dissipater along with the heightening of the dam. The energy dissipater is generally installed at the outlet of spillway to dissipate large energy of the overflowed water of spillway. Heightening of the spillway might cause larger energy since the overflow head becomes higher. The proposed dissipater is of the submerged bucket type considering that river water level immediately downstream of the dam is always high enough as illustrated below.



Proposed Energy Dissipater at the Oeste Dam

b. Heightening of Sul Dam

The Sul dam is proposed to heighten only the spillway section by 2.0 m because of sufficient freeboard to the dam crest after heightening as illustrated below.



Source : JICA Survey Team

Figure 23 Comparison of Overflow Depth of Design Discharge on the Spillway of Sul Dam

As shown in the figure, the maximum overflow depth of design discharge of 2,570 m³/s (= 10,000-year flood) is 7.0 m under the present spillway. However, even though the spillway is heightened by 2.0 m, there would be more than 1.0 m space as a freeboard.

c. Modification of the Operations

The following figure shows the proposed flood control operation at the Oeste dam.



Method of Flood Control at the Oeste Dam

If all the gates are fully opened during the 10-year flood, maximum flood discharge in Taio city is estimated 520 m³/s. This discharge exceeds the current flow capacity of 440 m³/s in Taio city. Therefore, the required peak cut for the 10-year flood at the Oeste Dam is estimated 80 m³/s. It is desirable to close fully the gates during the flood as long as possible, expecting flood control effect in Rio do Sul city and simplification of the operation.

Likewise, the following figure shows the proposed flood control operation at the Sul dam. If all the gates are fully opened during the 10-year flood, maximum flood discharge in Rio do Sul city in the Itajai do Sul River is estimated 570 m³/s. This discharge exceeds the current flow capacity of 440 m³/s in Rio do Sul city. Therefore, the required peak cut for the 10-year flood at the Sul dam is estimated 130 m³/s.



Method of Flood Control at the Sul Dam

(3) Utilization of the existing hydropower generation dam for flood control

The existing two hydropower generation dams of CELESC in the Rio dos Cedros River, named the Rio Bonito and Pinhal dams, are proposed to be used for flood control by means of pre-releasing when an impending flood is predicted. The proposed pre-releasing aims at creation of flood control space in reservoir by means of lowering the reservoir water level by releasing the stored water before flood inflow into the reservoir.

In order to regulate the outflow discharge from both dams not to exceed 140 m³/s for the

10-year flood with a peak discharge of $210 \text{ m}^3/\text{s}$, the required flood control volume to be created by pre-releasing was examined by simulation of reservoir operation at both dams. The required volume for pre-releasing was estimated to be 1.4 million m³ for the Rio Bonito dam and 3.2 million m³ for the Pibhal dam, respectively, as shown below.

	Rio Bonito Dam	Pinhal Dam
Maximum water level in operation	EL.589.5 m	EL.652.0 m
Drawing down by pre-releasing	0.5 m	1.0 m
Water level after pre-releasing	EL.589.0 m	EL.651.0 m
Volume for flood control by pre-releasing	$1.4 \text{ x } 10^6 \text{ m}^3$	$3.2 \times 10^6 \text{ m}^3$
Maximum inflow discharge	85 m ³ /s	125 m ³ /s
Maximum outflow discharge	$60 \text{ m}^{3}/\text{s}$	85 m ³ /s
Reduction of discharge at the peak time of	$25 \text{ m}^{3}/\text{s}$	$45 \text{ m}^{3}/\text{s}$
inflow		
Operation of gates during flood control	Constant opening	Constant opening
Gate opening of the spillway	0.5 m	1.0 m
Gate opening of the intake	2.6 m	2.6 m
Operation of gates before flood control	Keep the water level at EL.	Keep the water level at EL.
	589 m (inflow = outflow) by $($	651 m (inflow = outflow) by
	operating intake gate	operating intake gate
Operation of gates after flood control	Keep the water level at EL.	Keep the water level at EL.
	589.5 m (inflow = outflow)	652 m (inflow = outflow) by
	by operating spillway gate	operating spillway gate

 Table 19
 Required Flood Control Volume to be Created by Pre-releasing at Two Dams

Source: JICA Survey Team

(4) Strengthening of the Existing Flood Forecasting and Warning System (FFWS)

Setting 13 new rainfall and water level gauging stations and 3 CCTVs is proposed in order to strengthen the existing FFWS. Moreover, 3 gauging stations and 2 CCTVs shall be added at the 2 flood control dams (Sul and Oeste dams) and 2 hydropower dams (Rio Bonito dam, Pinhal dam) through the meeting with concerned organizations (Defesa Civil, SDS and CEOPS/ FURB) and the workshop held on Apr. 29, 2011 regarding FFWS and dam operation.

The warning system based on flood forecasting is also required for Itajai city. However flood water level at Itajai city is rather difficult to forecast due to tidal effects of sea water and flood flow from the Itajai Mirim River.

(5) Installation of two floodgates on the Itajai Mirim River in Ttajai city

Riparian area along the Old Mirim is generally low varying EL.1.0 to 3.0 m. On the other hand, the area along the Canal is relatively higher elevation in around EL.3.0 to 4.0 m. Though the Canal has larger flow capacity, the Old Mirim has caused frequent flooding and inundation to its riparian area. Two floodgates on the Old Mirim are proposed to mitigate inundation along the Old Mirim as shown below.



Location Map of Floodgates in Old Mirim

The upstream gate would be closed when the discharge from the Itajai Mirim reaches to the flow capacity of the Old Mirim, in this respect, operation needs the information on the water level of the Old Mirim in the urban area (in the downstream area of the BR-101).On the other hand, the downstream gate would be closed when the water level at the downstream end of the Old Mirim reaches to the critical water level. Therefore, the operation of downstream gate also needs the information on the water level at the downstream end of the Old Mirim.

The effectiveness of the flood gates is evaluated in the following table.

Inundation depth	Area (m ²)	Area (m ²)	Effectiveness
(m)	without gate control	with gate control	(m ²)
< 0.5	2,216,400	564,400	1,652,000
0.5 - 1.0	1,299,600	527,600	772,000
1.0 - 1.5	848,800	242,000	606,800
1.5 - 2.0	431,600	22,000	409,600
2.0 - 2.5	441,200	0	441,200
2.5 - 3.0	40,000	0	40,000
Total	5,277,600	1,356,000	3,921,600

Estimated Inundation Area along the Lower Old Mirim

Source: JICA Survey Team

Main features of the designed floodgates are summarized below.

Main Features of Floodgates				
Gate	Downstream Gate	Upstream Gate		
Nos. of Gate	3	3		
Span of Gate	12.5 m	12.5 m		
Foundation Elevation	EL5.0 m	EL4.3 m		
Bottom Elevation of Gate	EL1.0 m	EL1.0 m		
Main Structure	Separate slab and pier	Separate slab and pier		
	EL. 7.70 m	EL. 12.00 m		
Gate Pier	6.00 m wide	11.20 m wide		
	14.20 m high	17.80 m high		
Gate Operation System	On the top of pier	On the top of pier		
Apron Length	6.0 m	8.0 m		
Sheet Dile for Second	Downstream 2.0 m	Downstream 2.5 m		
Sheet Plie for Seepage	Upstream None	Upstream 5.5 m		
Bayatmant	Downstream 10.0 m	Downstream 10.0 m		
Revelment	Upstream 10.0 m	Upstream none		
Stair	Installed	Installed		
	Pile foundation	Pile foundation		
Foundation	Pier :L=11.0 m ϕ 400 mm	Pier :L=27.0 m ϕ 400 mm		
	Slab :L=11.0 m ϕ 300 mm	Slab :L=27.0 m ϕ 300 mm		

6 T1

Source: JICA Survey Team

(6) Slope Protection of Roads at 13 Loations

All of the priority sites are road slops, and the structural measures will be planed to ensure full width road traffic against 60 years heavy rain. Because that high possibility of human lives lost is recognized on 13 priority sites. Type for measures will be selected by learning from existing measures of similar condition slopes, which have not been occurred disaster even under 60 years heavy rain

Comparison of alternatives of cutting slope reinforcement measure for 1,000 m2 is carried out. Reinforced earth method of PP fiber/ cement/sand is recommendable, because it is advantage of all evaluation items of the cost, construction period, and landscape. The selection criteria of structural measures against valley side slope collapse are shown below. The vegetation works, and open ditch is included in basic measures to prevent sediment discharge.

Slope condit	ion		Typical measure alternatives	Common item
Height (H) of collapse H>10	Height (H) and w H/W > 0.5	vidth (W) of collapse	Pilling, or large block placing	Tree planting Open ditch
	Height (H) and w H/W ≤ 0.5	vidth (W) of collapse	Gully filling by gabion and longitudinal drainage	
Height (H) of collapse	Height (H) and width (W) of	Embankment on slope foot is Possible	Embankment	
H≦10	H/W > 0.5	Embankment on slope foot is Impossible	Pilling, or large size block placing	
	Height (H) and $H/W \leq 0.5$	width (W) of collapse	Gully filling by gabion and longitudinal drainage	

Structural Measures against Valley Side Collapse

Source: JICA Survey Team

(6) Installation of Early Warning System for Sediment Disaster and Flush Flood

An automatic rain gauge will be installed in each city for the early warning purpose. Location of automatic rain gauge will be determined by following procedure. Redundant data communication will be established by both of VHS (very high frequency connection) of CELESC system and GPRS (general packet radio services) to secure information communication even under stormy condition.

The early information for the public is important, Defesa Civil-SC delegates EPAGRI/CIRAM the announcement of the rainfall level of attention/warning by web-page and/or mass media, as a part of routine or emergency weather report. The computer system of the early warning shall be included the function of automatic sending electronic mail to Defesa Civil-SC, mayor/Defesa civil staff of each city, and EPAGRI/CIRAM staffs in charge.

The Defesa Civil of municipalities will prepare the detailed hazard map (S=1:10,000), and will designate the risk areas/houses, emergency evacuation building such as schools and/or churches, evacuation route. The disaster education about the evacuation will be also conducted. Santa Catarina State shall clarify the responsibility of the municipalities/mayors about evacuation order in a law. The capacity of a municipality is not enough for the evacuation order generally. The Defesa Civil-SC shall coordinate the support of the municipalities, using human resources of universities, engineer of public/private, and/or international technical assistance. The early warning system shall be started as soon as possible. And then, the risk areas/houses which shall be evacuated would be designated one by one by the maximum effort of municipalities to make mature the early warning system.

3. Scope of the EIA Study

3.1 The Study Area

The EIA study shall generally cover the whole basin of the Itajai river in Santa Catarina. Specifically, the study shall focus on the areas to be affected by the priority projects, such as those used for heightening of the existing dams and potential inundation areas by the heightening of the dams, etc.

3.2 Environmental Items to be Assessed

The JICA Preparatory Survey conducted the initial environmental examination (IEE) to identify the potential environmental impacts that the priority projects would cause in the construction and operation phases. Table 1 shows the results of the IEE made in the feasibility study of the JICA Preparatory Survey. Based on the results of the IEE, the items to be assessed in the EIA Study are identified as follows.

Items	Items	Construction	Operation	Related Projects
Natural	Landscape	TBA	TBA	Floodgate construction
Environment				Landslide measures
	Fauna and Flora	TBA	TBA	Heightening of Oeste dam
				Rainwater storage in rice field
				Floodgate construction
	Bottom sedimentation	TBA	TBA	Heightening of Oeste dam
				Floodgate construction
	Topography and geology	-	TBA	Floodgate construction
Pollution	Noise and vibration	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
				Floodgate construction
				Landslide measures
	Solid waste	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
				Landslide measures
	Air Pollution	TBA	-	Landslide measures
	Water Pollution	TBA	-	Heightening of Oeste dam
				Floodgate construction
Socio-economic	Impact on regional	TBA	-	Floodgate construction
impact	infrastructure			
	Impact on lands/buildings	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
	Involuntary resettlement	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
	Land acquisition	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
				Floodgate construction
	Impact on downstream areas	TBA	TBA	Preliminary discharge from dam
	Impact on agriculture	-	TBA	Heightening of Oeste dam
				Heightening of Sul dam
				Rainwater storage in rice field
	Change of income	-	TBA	Heightening of Oeste dam
				Heightening of Sul dam
	Traffic during construction	TBA	-	Heightening of Oeste dam
				Heightening of Sul dam
				Floodgate construction
				Landslide measures
	7700			
	Effects on low income	-	IBA	Heightening of Oeste dam
	groups			Heightening of Sul dam
	Expansion of economic	-	IBA	Heightening of Oeste dam
	Designal conflicts			Heightening of Outer Jam
	Regional conflicts	IBA	-	Heightening of Culder
				Deinweten store star is signification
				Rainwater storage in rice field
				Landalida manageras
	Land use and ecouration	<u> </u>		Landshue measures
	Land use and occupation	-	IDA	Heightening of Sul dam
				Floodgate construction
				1 1000gate construction

Items to	be	Assessed	in	the	EIA	Study

Items	Items	Construction	Operation	Related Projects
	Impact on economic and productive activities	TBA	-	Heightening of Oeste dam Heightening of Sul dam Rainwater storage in rice field

Note : TBA: To be assessed.

3.3 Surveys and Investigations

3.2.1 Overall Methods

The surveys and investigations in the EIA study shall be composed of two ways, literature reviews and field investigations. The literature reviews aim to collect data and information relevant to the priority projects as well as the natural and social conditions of the study area, while the field investigations encompass several types of specific surveys that aim to collect the detailed information on the ground.

3.2.2 Review of the Proposed Projects

The final report prepared by the JICA Preparatory Survey shall be reviewed in the beginning of the EIA study to get a clear picture of the proposed projects as well as the natural and social conditions of the project sites.

3.2.2 Overall Framework of the Data Collection

The following information shall be collected for assessment of the aforementioned items in the EIA study. Some data and information shall also be verified and supplemented by field surveys as specified in this TOR.

Itom	Seene and Coverage	Action to be taken	Study area
nem	Scope and Coverage	Action to be taken	Study area
Topography,	• Terrain pattern	• Collection of additional relevant	Itajai river basin
Geology and	• Regional geological and soil	documents as necessary	
Soil	characteristic		
	 Land subsidence condition 		
Hydrology	River flow discharge	• Collection of secondary data of river flows	Itajai Mirim river Rio dos Cedros river Main streams of Oeste and Sul dams
	• Rain fall data	• Collection of additional secondary data of rainfall (if necessary)	Itajai river basin
Air Quality	 Air quality parameter determined by the regulations of the Federal and/or State Government Predicted load of air pollutants from the construction works for slope protection measures 	 Collection of regulations of the Federal/State government on air quality standards Collection of additional air quality monitoring data collected in the proposed sites for slope protection measures (if any) 	Proposed sites of construction of slope protection measures
Traffic	• Existing vehicle traffic amount on relevant trunk road at the construction sites for Oeste dam, Sul dam, Floodgates on the Itajai Mirim river, and slope protection measures	Traffic survey at the construction sites	Construction sites for Oeste dam, Sul dam, Floodgates on the Itajai Mirim river, and slope protection measures

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Item	Scope and Coverage	Action to be taken	Study area
Water Quality	 Physical, chemical and biological parameters determined by the regulations of the Federal and/or State Government Water quality of the downstream flow of Oeste dam and Itajai Mirim river 	 Collection of regulations of the Federal/State government on air quality standards Water quality sampling survey in the downstream flow of Oeste dam and Itajai Mirim river 	Downstream flow of Oeste dam Itajai Mirim river
Noise and Vibration Level	 Equivalent Sound level (Leq) Predicted result of noise and vibration level by construction works for the heightening of Oeste and Sul dams, floodgates in the Itajai Mirim river, and slop protection measures. Existing noise and vibration levels around the construction site for the floodgates in the Itajai Mirim river 	• Collection of monitoring data of noise and vibration levels around the construction site for the floodgates in the Itajai Mirim river	Construction sites for Oeste dam, Sul dam, Floodgates on the Itajai Mirim river, and slope protection measures
Flood Condition	• Past record of flooding in the downstream of Rio dos Cedros river	• Collection of secondary data or records of past floods (if available)	Rio dos Cedros river
	• Past record of inundation in the areas potentially affected by the heightening of Oeste and Sul dams	• Collection of secondary data or records of past floods (if available)	the areas potentially affected by the heightening of Oeste and Sul dams
Terrestrial Ecology	 Existing vegetation and its general characteristic in the existing paddy fields and the construction site for Oeste dam List of major aquatic organisms in the Itajai Mrim River and the downstream flow of Oeste dam. 	 Collection of general information of flora and fauna in the existing paddy fields and the construction sites for Oeste dam Collection of secondary data of aquatic organisms in the Itajai Mrim River and the downstream flow of Oeste dam 	Paddy fields for rainwater storage Construction site for the heightening of Oeste Dam Itajai Mirim river Downstream flow of Oeste dam
Land Use	 Existing land use in the areas potentially affected by the heightening of Oeste and Sul dams Existing land use in the downstream area of the Itajai Mirim river 	 Collection of secondary data on the existing land use in the areas potentially affected by the heightening of Oeste and Sul dams and the downstream area of the Itajai Mirim river Collection of high resolution satellite image analysis of the areas mentioned above Site reconnaissance survey in the areas mentioned above 	Areas potentially affected by the heightening of Oeste and Sul dams Downstream area of the Itajai Mirim river
Transportation	 Network and mode of transportation in and around the construction site for the floodgates in the Itajai Mirim river Traffic volumes and composition Traffic congestion and capacity of road network 	• Traffic survey to grasp the current traffic volume, composition, traffic congestion, and assess the capacity of road network in the construction site for the flood gates in the Itajai Mirim river	Construction site for the flood gates in the Itajai Mirim river

Item	Scope and Coverage	Action to be taken	Study area
Socio economic conditions	 Current socio economic conditions (agricultural production, land use, major livelihoods, assets, other livelihood activities, income and expenditures, etc.) of i) communities/households who use the paddy fields which will be used for water storage and ii) those who live in the areas potentially affected by the heightening of Oeste and Sul dams Statistic socio economic data of the household economy of those living in urban and rural areas in the State 	 Household interview survey to all the households living in the affected areas and using the paddy fields for water storage Collection of statistic socio-economic data of typical households in the State 	Households living in the areas potentially affected by the heightening of Oeste and Sul dams Households using the paddy fields for water storage
Inventory of land and buildings	 Delineation of the areas that will be potentially affected by the heightening of Oeste and Sul dams Inventory of existing buildings and other assets in the potentially affected areas Prevailing market prices of buildings and other associated assets in the potentially affected areas Delineation of the areas that will be potentially affected by construction of the floodgates in the Itaiai Mirim river 	 Topographic survey in the potentially affected areas Inventory of existing buildings and other associated assets in the potentially affected areas Cadastral data of the affected areas Market research on buildings and other assets that should be compensated by the project Topographic survey in the potentially affected areas Cadastral data of the affected areas 	Areas potentially affected by the heightening of Oeste and Sul dams Households usin Areas which need to be acquired for construction

The results of the examination of the collected data and information shall not only be described in the main text of the report, but also summarized in tables, graphs, drawings and maps so that the implications of the collected data and information would be understandable. Furthermore, the environmental standards and regulations, legal systems relating to the implementation of EIA in Brasil shall be briefly described in the EIA report.

3.2.3 Collection of Existing Data

As specified in section 3.2.2, the following data and information shall be collected at the relevant government offices as well as other institutions/organizations.

- a. Tographic maps covering the Itajai river basin
- b. Geological maps covering the Itajai river basin
- c. Soil maps covering the Itajai river basin
- d. Land use map covering the Itajai river basin
- e. River flow data of the Itajai Mirim River, Rio dos Cedros River, Downstream flows of Oeste and Sul dam
- f. Government regulations on air quality standards

- g. Any air quality monitoring data in the vicinity of the proposed sites for slope protection measures
- h. Government regulations on air quality standards
- i. Any monitoring data of noise and vibration levels around the construction sites for the floodgates in the Itajai Mirim River
- j. Secondary data or records of past floods of the Rio dos Cerdos River and the areas potentially affected by the heightening of Oeste and Sul dams
- k. Information of flora and fauna in the existing paddy fields for water storage and the construction site for Oeste dam
- 1. Secondary data on aquatic organisms in the Itajai Mirim River and the downstream flow of Oeste dam
- m. Secondary data on the existing land use in the areas potentially affected by the heightening of Oeste and Sul dams and the downstream area of the Itajai Mirim River
- n. Statistic soico-economic data of typical households in the stage
- 1. Cadastral data of the areas potentially affected by the heightening of Oeste and Sul dams

3.2.4 Procurement/Collection of High Resolution Satellite Images

The latest high-resolution satellite images covering the areas potentially affected by the heightening of Oeste and Sul dams shall be procured or collected to assess the present land use in the affected areas and confirm the existing buildings and other assets or infrastructure in the areas.

3.2.5 Field Surveys

The following field surveys shall be carried out to collect detailed and updated data and information on the ground.

(1) Traffic Survey

In order to set the baseline of the traffic conditions in the construction sites for the floodgates in the Itajai Mirim River, a traffic survey specified below shall be carried out.

No. of survey plots:	2 points in each construction sites (The locations of the
	sampling points shall be identified when this draft TOR is
	finalized.)
Mode of survey:	Traffic count survey (to count the type and nuumber of
	vehicles passing by the survey plots from 6:00 to 18:00)
Frequency:	One week in the dry season
Other information recorded:	Hours when traffic conjunction takes place in a day

(2) Water Quality Sampling Survey

A water quality sampling survey shall be carried out in the downstream flow of Oeste dam and the Itajai Mirim River to fix the baselines of the water quality of both flows. The specifications of the survey are as follows.

No. of sampling plots:	5 points in each flow (The locations of the sampling points			
	shall be identified when this draft TOR is finalized.)			
Mode of sampling:	Sampling shall be made at three layers, namely surface,			
	middle and bottom layers.			
Analytical items in the field:	pH, Color, Odor, DO			
Analytical items in the laboratory:	BOD (5days at 20°C), Total Conliform Bacteria, Feca			
	Coliform Bacteria), COD, Suspended Solids, NO3-N,			
	NH ₄ -N			
Timing of sampling:	Dry season and rainy season (two times in total) (All the			
	samplings shall be taken at the same time.)			
Sampling and Analytical Methods:	Water sampling and analytical methods shall follow the			
	methods internationally accredited.			

(3) Field Reconnaissance Survey

A field reconnaissance survey shall be carried out in the following areas and for the following aims:

- a. Grasp the present land use and existing flora and fauna in the areas potentially affected by the heightening of Oeste and Sul dams and the downstream area of the Itajai Mirim River
- b. Confirm the existing flora and fauna in the paddy fields to be used for water storage
- (4) Topographic Survey

A topographic survey shall be carried out to demarcate the area to be acquired for the heightening of Oeste dam.

(5) Socio Economic Survey (Household Interview Survey)

A household interview survey shall be carried out to clarify the socio economic conditions of the following households/families:

- 1) Households who live in or have their assets in the areas potentially affected by the heightening of Oeste and Sul dams; and
- 2) Households who own the paddy fields to be used for storage of flood water.

The scope of the household interview survey is outlined below.

Target households: All the households categorized into those specified above

Mode of survey: Questionnaire survey

- Survey Items: Structure of family, History of family, Occupation, Ethnicity, Land use, Land tenure, Land holding size, Major agricultural products, Current livelihood activities, Income level, etc.
- Others: The awareness level about the proposed projects (the heightening of Oeste and Sul dams) among those who would be potentially affected shall be

confirmed with their intentions.

(6) Inventory of Existing Buildings and Other Assets

Simultaneously with the household interview survey, an inventory of existing buildings and other assets shall be carried out in the areas potentially affected by the heightening of Oeste and Sul dams. The scope of the inventory is outlined below.

Targets: All the buildings and assets existing in the potentially affected areas.
Mode of survey: Direct measurements and interview survey to the households
Survey Items: Size of land occupied by the households, Type of house, Appearance of house, Size of house, Year of construction, Any immovable properties except house in the area, and Any movable properties in the house and area

(7) Market Research on Buildings and Other Assets

A market research shall be carried out to clarify the current prevailing market prices of: i) lands similar to those to be acquired for the heightening of Oeste dam; ii) buildings existing in the potentially affected areas; iii) other immovable properties owned by the affected families/households; and iv) farm inputs needed for establishment of productive farms.

3.4 Impact Identification and Assessment

Having analyzed the data and information gathered through the collection of data and field surveys, the magnitude and extent of potential environmental impacts caused by the implementation of the priority projects shall be estimated and evaluated as quantitatively as possible. As specified in the JICA Guidelines for Environmental and Social Considerations (2010), the impacts with regard to environmental and social considerations including the derivative, secondary and cumulative impacts shall be assessed.

3.5 Preparation of Mitigation Measures

Feasible and cost effective mitigation measures shall be prepared for all the project activities likely to have adverse impacts. The aim of the mitigation measure is to prevent or reduce the negative impacts predicted in the course of the priority projects. In the formulation of the mitigation measures, the following aspects should be taken into account.

- a. level of mitigation
- b. method of mitigation
- c. expected result and effect of the mitigation measures
- d. timing of application
- e. duration of application
- f. institutional arrangement necessary for application
- g. cost necessary for application of the mitigation measures

In case that any impacts (residual impacts) that can not be prevented or reduced by the mitigation measures are identified and predicted, the necessary compensation for such impacts shall be estimated instead of the mitigation measures.

3.6 Preparation of Environmental Management and Monitoring Plan

An environmental management and monitoring plan (EMMP) shall be prepared and compiled in the EIA report. The EMMP shall include but not be limited to the following.

- a. Environmental construction management plan
- b. Information sharing and dissemination plan
- c. Resttelement and rehabilitation plan with social development plan
- d. Pollution control plan (water, air quality, noise, and vibration)
- e. Flood management plan
- f. Environmental management plan in the construction and operation phases
- g. Institutional arrangement for implementation EMMP

Furthermore, the outlines of the EMMP shall be compiled in a/ summary table/s described below.

Project activities	Impact Description	Mitigation/ Enhancement Measure	Cost of mitigation/ Enhancement	Institutional Responsibility	Schedule	Guarantees Understanding/ Contract
I. Construction						
A. Social						
Environment						
B. Natural						
Environment						
C. Pollution						
II. Operation and						
Maintenance						
A. Social						
Environment						
B. Natural						
Environment						
C. Pollution						

Sample of Summary Table of the Environmental Management Plan (EMP)

Sample of Summary Table of the Environmental Monitoring Plan (EMP)

Project activities	Parameters	Location	Frequency	Responsibility	Estimated Cost
I. Construction	A. Social				
Phase	Environment				
	B. Natural				
	Environment				
	C. Pollution				
II. Operation and	A. Social				
Maintenance Phase	Environment				
	B. Natural				
	Environment				
	C. Pollution				

3.7 Stakeholders Meetings

In order to comply with the JICA Guidelines for Environmental and Social Considerations (2010), the stakeholders meetings shall be organized to consult with the relevant stakeholders on the respective priority projects. The specifications of the stakeholders meetings are as follows:

Timing of the meetings:	Two times per priority program (In the beginning of the EIA study and			
	When the EMMP is drafted) (A total of 12 times for 6 priority			
	projects)			
Place of the meetings:	Strategic places where key stakeholders for each priority project can			
	gather			
Aims of the meetings:	Introduction of the project activities, hearing of the opinions of local			
	stakeholders, comments on the project as well as EMMP, etc.			

The discussions made in the stakeholders meeting shall be notated and compiled in the EIA report.

4 Report Making

The EIA report (RIMA) shall be prepared in the language accessible to the public as specified by Article 3 of CONAMA Resolution No. 237/97. The report shall include figures, maps, tables, graphs, and other means to make the contents of the report understandable. The suggested table of contents of the report is as follows.

- 1) Introduction and background of the study
- 2) Objectives and rationale of the study
- 3) Scope and methodologies of the study
- 4) Results of the environmental study
- 5) Results of the stakeholders meetings
- 6) Environmental impact assessment
- 7) Proposed mitigation measures against likely adverse impacts
- 8) Environmental management plan
- 9) Compensation / resettlement plan (if necessary)
- 10) Environmental monitoring plan
- 11) Conclusion

5 Timeframe of the EIA Study

The entire work for the EIA study shall be completed <u>xxx days (to be specified based on the schedule of the project)</u> from the commencement of the study.

6. Expected Outputs

The following outputs shall be prepared and submitted at the end of the Study.

- a. Three (3) hard copies of the EIA report with one (1) soft copy
- b. One (1) soft copy of raw data collected through the EIA study
- c. One (1) soft copy of database of the project affected households and their properties



Sul Dam





PROPRIEDADES CADASTRADAS - BARRAGEM SUL

NOME	DESCRIÇÃO	N (m)	E (m)	Z (m)	OBSERVAÇÕES
BASE	PONTO BASE	6957007.418	642804.525	413.292	MARCO DE APOIO
ALÍRIO RODE	CA1	6956368.893	644048.549	423.335	CASA
NILTA KUSTER	CA2	6956351.789	644060.331	422.652	PAIOL E ESTUFA
NADIR KUSTER	CA3	6956320.452	644078.267	421.531	PAIOL E ESTUFA
NADIR KUSTER	CA4	6956296.238	644092.898	421.950	CASA
OSNI VIRGILIO LUIZ	CA5	6955161.104	648421.599	412.536	CASA
OSNI VIRGILIO LUIZ	CA6	6955153.814	648409.210	410.578	RANCHO E ESTREBARIA
PROPRIETÁRIO NÃO IDENTIFICADO	CA7	6948175.215	653250.231	408.527	CONJUNTO DE CASAS
PROPRIETÁRIO NÃO IDENTIFICADO	CA8	6948144.395	653235.867	409.011	CASA E COMÉRCIO
PROPRIETÁRIO NÃO IDENTIFICADO	CA9	6948126.473	653229.632	409.314	CASA E OFICINA
HINKEL	CA10	6948251.314	653882.203	413.479	CASA - FOI OBTIDO APENAS O SOBRENOME DO PROP.
ANDRELINO LUSTEMFELD	CA11	6948318.347	653813.247	412.875	CASA
ANDRELINO LUSTEMFELD	CA12	6948341.862	653806.099	411.920	RANCHO
ANDRELINO LUSTEMFELD	CA13	6948320.455	653769.248	411.866	RANCHO E ESTUFA
ANDRELINO LUSTEMFELD	CA14	6948210.623	653552.180	401.276	RANCHO
MARIA LIDIA KISTER	CA15	6946682.560	652333.010	411.605	CASA
LUIZ TAVARES	CA16	6944914.639	653070.136	419.079	CASA
LUIZ TAVARES	CA17	6944943.138	653067.350	413.514	ESTREBARIA
HONORIO STEINHAUSER	CA18	6944859.859	653693.151	410.218	CASA
HONORIO STEINHAUSER	CA19	6944909.887	653694.293	404.776	RANCHO E ESTREBARIA
LUCAS DIAS	CA20	6941988.432	653758.654	414.151	CONJUNTO DE CASAS COMPOSTO POR DUAS CASAS, UM RANCHO E UM RANCHO COM ESTREABARI
PROPRIETÁRIO NÃO IDENTIFICADO	CA21	6939860.005	654760.957	421.208	CASA
PROPRIETÁRIO NÃO IDENTIFICADO	CA22	6939836.909	654772.980	419.286	RANCHO
TADEU WALTER	CA23	6939935.844	654484.026	412.928	CONJUNTO COMPOSTO POR DUAS CASAS, TRÊS RANCHOS E UM RANCHO COM ESTREBARIA
EIXO	EIXO	6956946.858	642675.940	410.172	EIXO BARRAGEM
EIXO	EIXO	6956977.810	642685.667	410.198	EIXO BARRAGEM
EXTRAÇÃO DE AREIA	EXTRAÇÃO DE AREIA	6956025.651	644421.362	387.354	
PONTE EM CONSTRUÇÃO	PONTE	6954440.742	646454.696	404.136	PONTO PEGO ALEATORIAMENTE EM CIMA DA PRIMEIRA VIGA - FOTO
ACESSO PARA PONTE	ACESSO PARA PONTE	6954359.824	646471.263	406.405	
ACESSO PARA PONTE	ACESSO PARA PONTE	6954319.047	646480.768	406.873	
PONTE ACESSO PINGUIRITO	PONTE ACESSO PINGUIRI	6939620.556	655752.251	414.226	O PONTO FOI COLETADO EM CIMA DO APOIO DA PONTE, O QUAL ESTÁ BEM ABAIXO DAS CASAS DA











DATA:

JUNH0/2011

OPERADOR:

SERGIO

ESCALA:

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		FOLHA
		UJ I
1:3000	SC	





RIO JARARACA





verificação das áreas atingidas ção 410m - Barragem Sul le Ituporanga - SC	
LOCAL: ITUPORANGA	FDLHA
	07
) ESTADD: SC	





verificação das áreas atingidas ação 410m - Barragem Sul de Ituporanga - SC
0 COCAL: ITUPORANGA MUNICIPID: ITUPORANGA ESTADO: SC













