Chapter 1

Introduction

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1.1 About this "Volume V: Project Activities"

This report, "Volume V: Project Activities," summarizes main activities which were implemented by the JICA Study Team for the Study (hereinafter mentioned as "the Study Team") during a 2-year study period broken down as follows:

- Phase I (Identification of Existing Conditions) April 2000 – March 2001
- Phase II (Formulation of Master Plan) May 2001 – March 2002

To achieve the above-mentioned objectives is the ultimate goal of the Study Team; however, all is in vain unless the master plan will be authorized and implemented by the Indonesian side. Therefore, besides formulation of master plan, the Study Team had conducted numbers of approaches and activities from various aspects aiming toward the acceptance and utilization of the master plan by local governments and community people as the fundamental policy and plan for lots of proposed projects/programs.

The Master Plan was carefully built up through the accumulated information and results of these various activities and based on the analysis of the Study Team. But the final result of the master plan explained in "Volume II: Master Plan" is not enough to properly explain these activities and processes done by the Study Team that are inevitable to formulate the master plan.

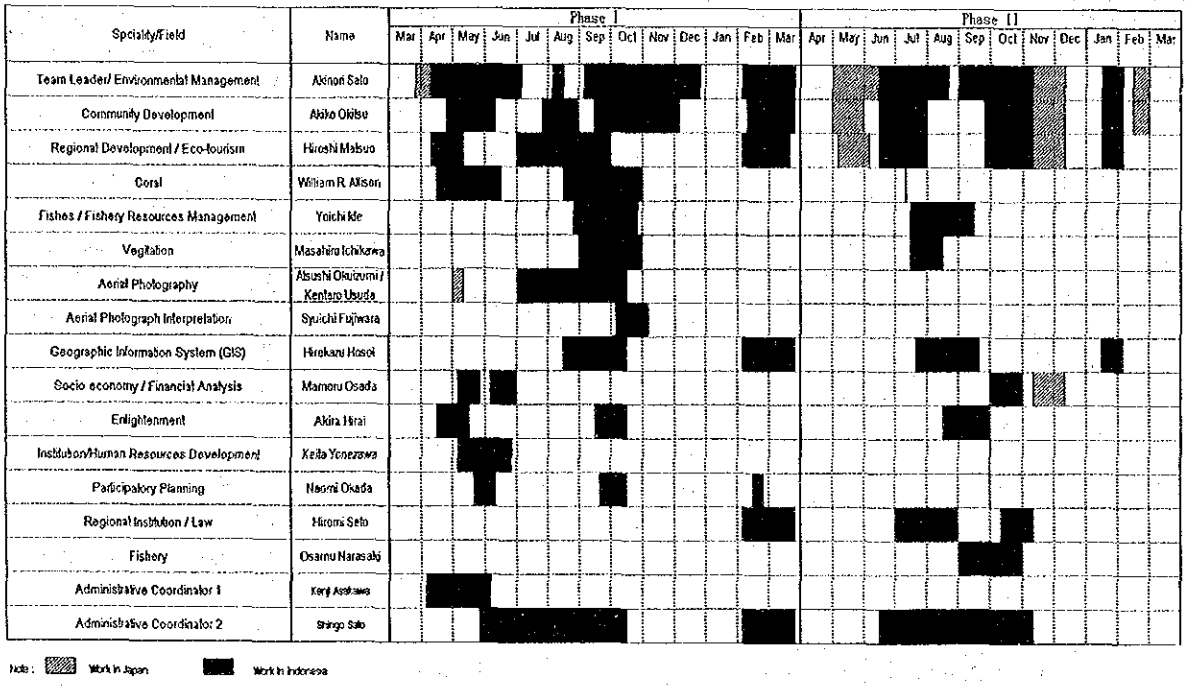
The purpose of this volume is not only to introduce each activity but also to provide examples and some ideas to the government of North Sulawesi province, and its regencies, municipalities, districts, villages and other provinces in the hope that they may formulate better master plans for coastal management by themselves in future.

(2) Members and Assignment of the Study Team

Figure 1.1 shows work schedule of the Study Team. A total of 78 manmonths was inputted to the Study. Armed with their special knowledge, these members collected secondary data and information, planned and conducted field surveys and interview surveys, and analyzed survey results, then, integrated their ideas into one master plan.

In formulation of a master plan for coastal management by local governments, the specialists should come from a mix of various fields and analysis of many aspects are required.

Figure 1.1 Assignment of the Study Team



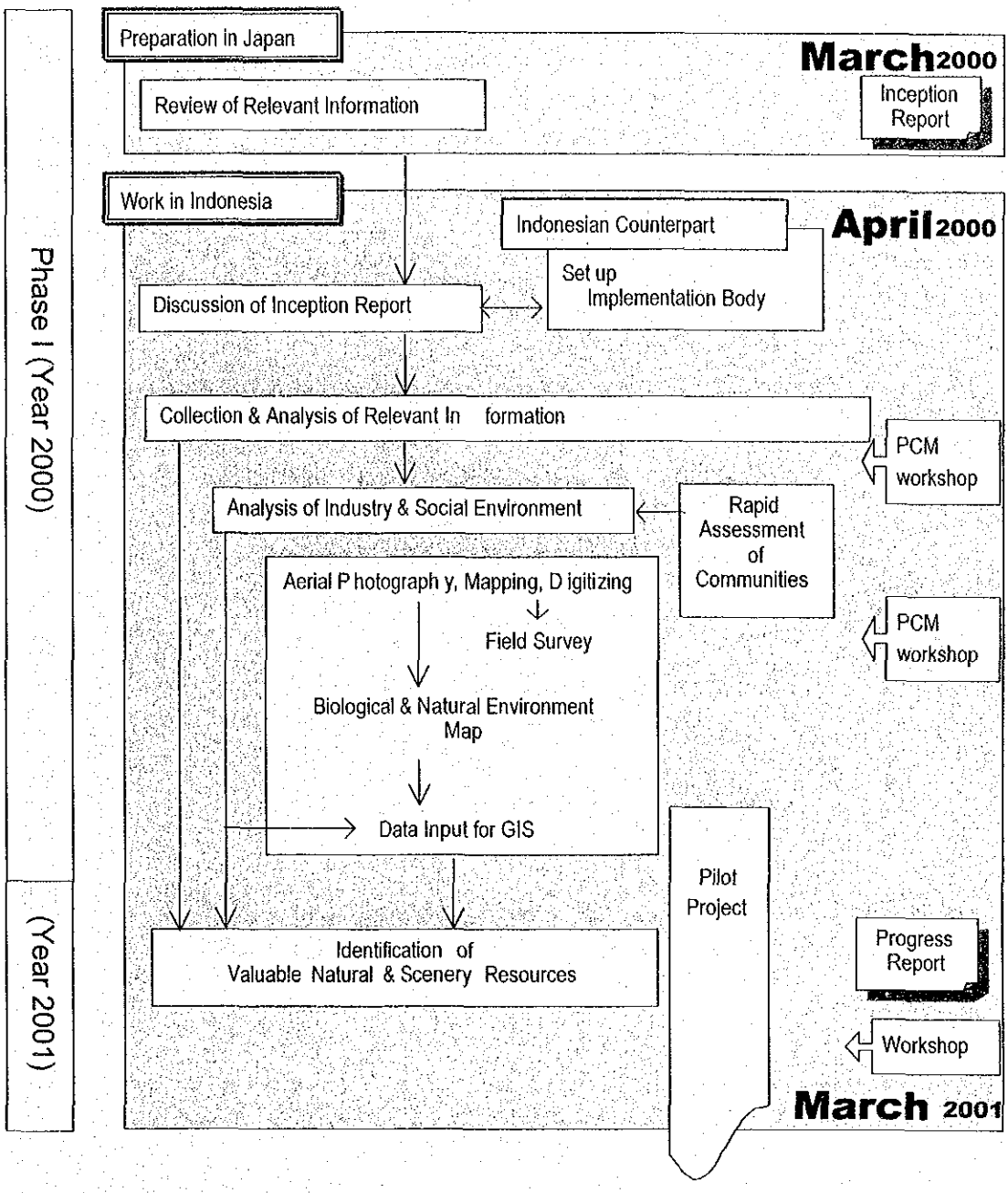
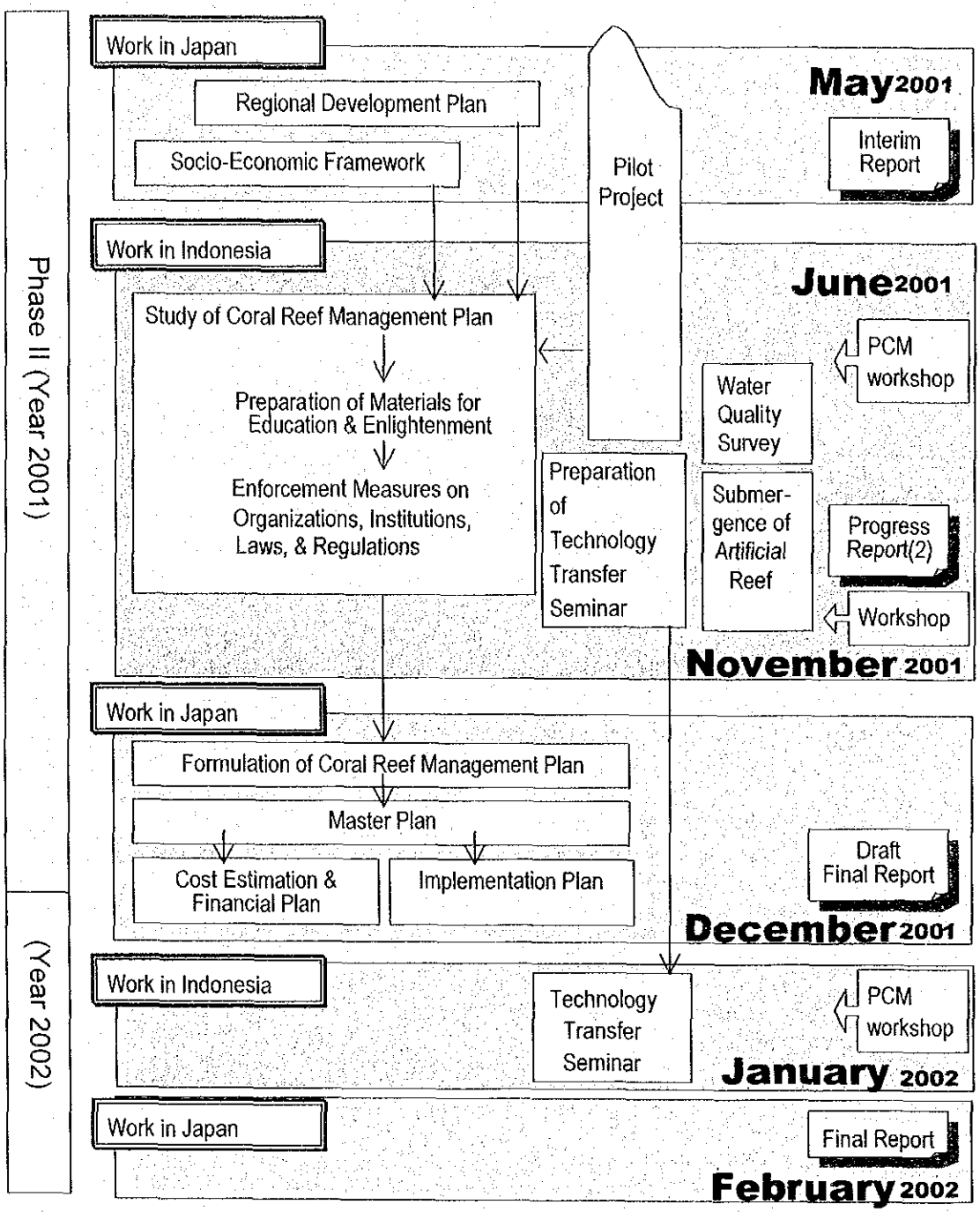


Figure 1.2 Flow of the Study (Phase I : Identification of Existing Conditions)



(cont.) Figure 1.2 Flow of the Study (Phase II : Formulation of Master Plan)

(3) Flow of the Study

Figure 1.2 outlines and shows the flow of the Study.

The Study Team commenced the activities on the 8th of April 2000. In Phase I, the Study Team collected necessary data and information through field surveys, interview survey and secondary data.

In Phase II, the Study Team continued some work conducted since Phase I and also proceeded to the formulation of the Master Plan.

Chapter 2

Study Organization and Cooperation with Related Agencies

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Study Organization and Cooperation with Related Agencies

2.1 Study Organization

In response to the request of the Government of the Republic of Indonesia (GOI), the Government of Japan (GOJ) has decided to conduct the Study on Integrated Coral Reef Management in North Sulawesi Province. Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of GOJ, dispatched the Study Team to Indonesia in April 2000.

Structure of organizations related to the Study is shown in Figure 2.1

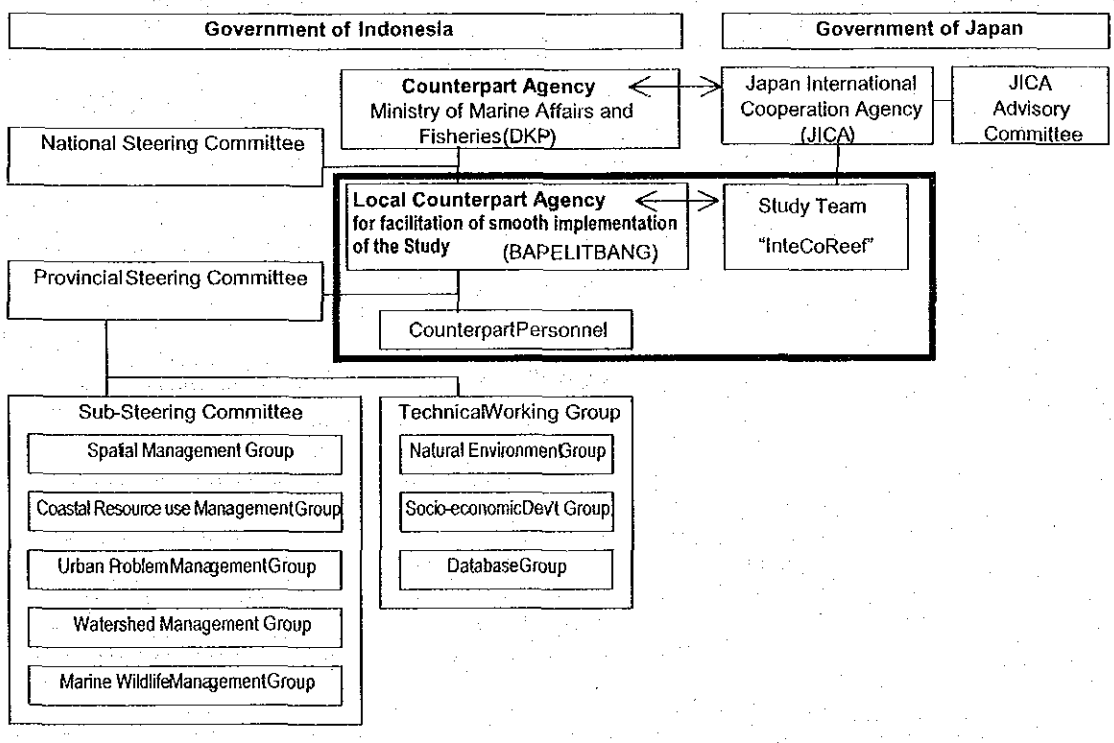


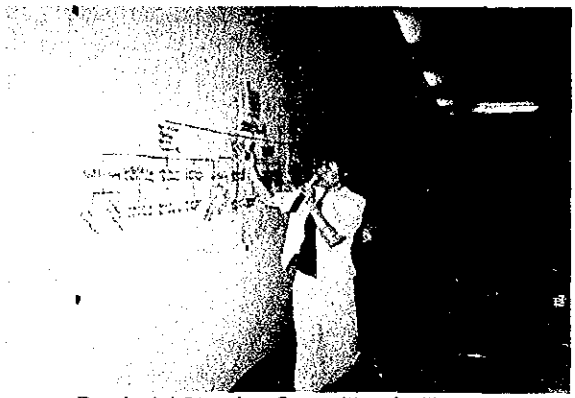
Figure 2.1 Study Organization Structure

(1) Steering Committee

Ministry of Marine Affairs and Fisheries (Departemen Kelautan dan Perikanan : DKP) was the counterpart agency on the Indonesian central government side. On the other hand, Planning, Research, and Development Agency North Sulawesi Province (BAPELITBANG) facilitated smooth implementation of the Study as local counterpart agency, since most of the work has been conducted in the local site of North Sulawesi Province

National Steering Committee supervised overall direction of the Study

Indonesian side established two steering committees, i.e., National Steering Committee and Provincial Steering Committee. The members of each committee were as follows;



Provincial Steering Committee facilitated smooth implementation of the Study

National Steering Committee	
	National Planning and Development Agency (BAPPENAS), (Chairperson) Ministry of Marine Affairs and Fisheries (DKP), (Vice Chairperson) Center of Oceanology Research and Development (LIPI), Ministry of Forestry and Plantation Estate (DEPHUTBUN), Ministry of Home Affairs (DEPDAGRI), Analysis and Applied Technology Board (BPPT), Regional Planning, Research and Development Agency North Sulawesi (BAPELITBANG North Sulawesi)
Provincial Steering Committee	
	BAPELITBANG North Sulawesi, LANAL VI Bitung, Faculty of Marine Science and Fisheries of Sam Ratulangi State University, BAPEDALDA North Sulawesi Province, Fisheries Office North Sulawesi Province, Tourism Office North Sulawesi Province, Forestry Office North Sulawesi Province, Legal Affairs Bureau North Sulawesi Province, Water Resource Management Office North Sulawesi Province, Bunaken National Park Authority,

	Office of Land Rehabilitation and Soil Conservation, Bitung Fishery Academy, BAPPEDA Manado Municipality, BAPPEDA Bitung Municipality, BAPEDA Minahasa Regency BAPPEDA Bolaang Mongondow Regency.

Table 2.1 Steering Committee Meetings

Year	Date	Title	Place
2000	May 1	1st National Steering Committee Meeting	Jakarta
	May 9	Preliminary Provincial Steering Committee Meeting	Manado
	May 27	1st Provincial Steering Committee Meeting	Manado
	Aug. 11	2nd Provincial Steering Committee Meeting	Manado
	Oct. 3	3rd Provincial Steering Committee Meeting	Manado
	Oct. 24	4th Provincial Steering Committee Meeting	Manado
	Nov. 30	2nd National Steering Committee Meeting	Jakarta
2001	Mar. 19	5th Provincial Steering Committee Meeting	Manado
	Mar. 22	3rd National Steering Committee Meeting	Jakarta
	Jun. 22	4th National Steering Committee Meeting	Jakarta
	Jul. 5	6th Provincial Steering Committee Meeting	Manado
	Sep. 25	7th Provincial Steering Committee Meeting	Manado
	Nov. 2	8th Provincial Steering Committee Meeting	Manado
	Nov. 6	5th National Steering Committee Meeting	Jakarta
2002	Jan.24	9th Provincial Steering Committee Meeting	Manado
	Jan.31	6th National Steering Committee Meeting	Jakarta

(2) *Technical Working Group*

The Study involved a lot of coordination work with government agencies and foreign aid agencies. At the beginning of the Study, three Technical Working Groups, namely, the Natural Environment Group, the Socio-economic Development Group and the Database Working Group were established.

Through joint effort with working group members and the Study Team members, the following outcomes were expected:

- to collect information and data effectively,
- to facilitate discussion and exchange of information, opinions and ideas,
- *to build up the capacity of counterpart agencies to formulate the plan,*
- technology transfer from consultants to counterpart personnel, and
- smooth implementation of the Master Plan after the project.

Major tasks of each Technical Working Group were as follows:

Natural Environment Group

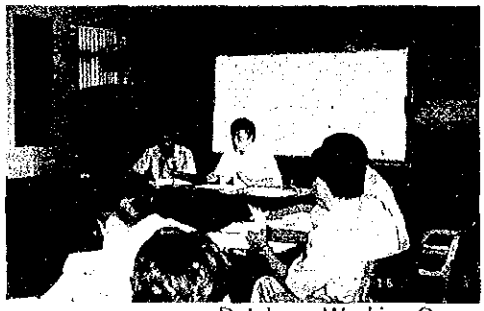
- environmental analysis of natural environment and natural resources
- examination of strategy of coral reef conservation

Socioeconomic Development Group

- present data analysis and evaluation of Community
- upgrading of quality of life of Community
- enlightenment and dissemination activity

Database Working Group

- design of useful database and its development
- spatial analysis utilizing GIS
- maintenance and upgrade of database



Database Working Group

The members of the Working Groups came from 13 agencies, including central agencies, local agencies, academic institutes, NGOs and the Study Team members. The results and outputs of Technical Working Groups were input into analysis of the existing conditions.

Table 2.2 Technical Working Group Meetings

Year	Date	Title	Place
2000	May 9	Explanation of Working Group Meeting	Manado
	May 31	Socio-economic Working Group Meeting	Manado
	Jun. 10	Natural Environment Working Group Meeting (Analysis on coastal environmental problems)	Manado
	Sep. 16	Database Working Group Meeting (Database situation in Japan/Result of Questionnaire Survey)	Manado
	Oct. 3	Socio-economic Working Group Meeting (Result of Rapid Community Survey/Selection of Technical Support for Pilot Project	Manado
2001	Jul. 9	Socio-economic Working Group and Natural Environment Working Group Meeting	Manado

(3) Sub-Steering Committee

During the Study of Phase II, Sub-Steering Committees were established by Provincial Steering Committee to analyze coastal problems and discuss formulation of the Master Plan together with the Study Team. Five sub-steering committee were grouped as follows:

- Coastal Spatial Use Management group,
- Coastal Resources Use Management group
- Urban Environmental Management group

- Watershed management group
- Coastal Ecosystem and Marine Wildlife Conservation management group

Members of Sub-Steering Committees consisted of technical staff as well as some same members of the Provincial Steering Committee. The Sub-Steering Committee meetings were held using the PCM (Project Cycle Management) method which is known as a participatory planning method.

Table 2.3 Sub-Steering Committee Meetings

Year	Date	Title	Place
2001	Jul. 26	Problem and Objective Analysis Meeting for - Urban Problem Management Group, - Spatial Use Management Group, and - Coastal Resource Use Management Group	Manado
	Jul. 27	Problem and Objective Analysis Meeting for - Watershed Management Group, and - Marine Wildlife Management Group	Manado
	Aug. 13	Problem and Objective Analysis Meeting for - Spatial Use Management Group, and - Coastal Resource Use Management Group	Manado
	Oct. 9	Issue Analysis Meeting for - Watershed Management Group, and - Urban Problem Management Group	Manado
	Oct. 11	Issue Analysis Meeting for - Marine Wildlife Management Group, and - Coastal Resource Use Management Group	Manado
	Oct. 12	Issue Analysis Meeting for - Spatial Use Management Group	Manado

(4) JICA Advisory Committee

JICA Advisory Committee members who are Mr. Masahiro Ohta, Senior on environmental policy development advisor and Ms. Naoko Nakajima, government officer of Ministry of Environment provided study direction and supervised the progress and the result of the Study.

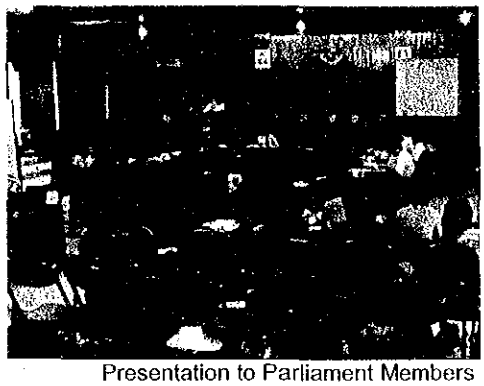
(5) The Study Team

In Figure 2.1, three organizations shown inside of bold line played a main role for implementation of the Study. The Study Team was composed of 18 experts from Pacific Consultants International (PCI) based on consignment of JICA.

2.2 Other Major Meetings

The Study Team has not only held regular meetings with governmental organizations but held several ad hoc meetings as well.

The Study Team energetically tried to facilitate the master plan through opinion exchange at these meetings, which are listed below.



Presentation to Parliament Members

Table 2.4 Other Major Meetings

Year	Date	Title	Place
2000	Apr. 24	Introduction of IC/R for BAPPEDA	Manado
	Jun. 16	Meeting with BAPPEDA-Minahasa for explanation of the Study	Tondano
	Jun. 20	Meeting with BAPPEDA-Bitung for explanation of the Study	Bitung
	Jun. 22	Meeting with BAPPEDA-Bolaang Mongondow for explanation of the Study	Kotamobagu
	Jun. 27	Meeting with BAPPEDA-Manado for explanation of the Study	Manado
	Sep. 15	Minahasa Kabupaten Task Force Meeting for Report of Study Progress	Tondano
	Oct. 28	Minahasa Kabupaten Task Force Meeting for Pilot Project	Tondano
	Nov. 2	Minahasa Kabupaten Task Force Meeting for Pilot Project	Tondano
2001	Mar. 14	Explanation and Discussion of Progress Report I for Minahasa Regency	Tondano
	Mar. 16	Explanation and Discussion of Progress Report I for Manado Municipality and Bitung Municipality	Manado
	Mar. 17	Explanation and Discussion of Progress Report I for Bolaang Mongondow Regency	Kotamobagu
	Jun. 20	Meeting with NRM/EPIQ, USAID for Zonation in Bunaken National Park	Jakarta
	Jul. 19	Meeting with NRM/EPIQ, USAID	Manado
	Jul. 27	Ceremony to Establish the Management Group for Pilot Project, Raprap Village	Raprap
	Aug.10	Technical Meeting with related agencies for Pilot Project	Manado
	Aug. 18	Beach Cleaning Contest	Raprap
	Aug. 20	Ceremony to Establish the Management Group for Pilot Project, Villages of Basaan/Basaan Satu	Basaan/ Basaan Satu
	Aug. 24, 25	Zonation training with NRM/EPIQ, USAID	Manado Tua
	Sep. 4	Meeting with Bunaken National Park Board	Manado
	Oct.30	Explanation and Discussion of Progress Report II for Bolaang Mongondow Regency	Kotamobagu
	Oct.31	Explanation and Discussion of Progress Report II for Manado Municipality and Bitung Municipality	Manado
	Nov. 1	Explanation and Discussion of Progress Report II for Minahasa Regency	Tondano
2002	Jan.24	Explanation and Discussion of Draft Final Report for Bolaang Mongondow Regency	Kotamobagu
	Jan.25	Explanation and Discussion of Draft Final Report for Minahasa Regency	Tondano
	Jan.28	Explanation and Discussion of Draft Final Report for Manado Municipality and Bitung Municipality	Manado
	Jan.30	Presentation to Governor of North Sulawesi Province and parliament members	Manado
	Jan.31	Technology Transfer Seminar	Manado
	Jan.31, Feb.1	GIS database demonstration and operation skill transfer meeting	Manado

2.3 Cooperation with Related Agencies

Coral area in North Sulawesi have been recently facing a crisis caused by inappropriate natural resource use and spatial use. It is possible that the local economy could also feel some negative impact because of the deterioration of the coastal environment. It is important, therefore, that the users of natural resources and their surrounding areas, including inhabitants, fishermen, developers, local governments and non-government organizations (NGOs), should be involved in planning process for coastal management in order to devise a useful plan for coastal area users as well as a workable plan by the stakeholders.

(1) Cooperation with Local Academic Institutions and NGOs

The Study has also seriously taken the role of coordination and cooperation among NGOs, local academic institutions and local government agencies. NGOs whose concerns are natural resources conservation and management, local universities such as Sam Ratulangi State University (UNSRAT) together with local government agencies have been deeply involved in each step of the study to aim for integration of each stakeholder's interest and for making a realistic and applicable master plan, and also for building the capacity of core personnel in coastal area management.

The combined effort of the Faculty of Fishery and Marine Science of UNSRAT and the Study Team made possible the holding of a workshop on Tourism and Coral Reef Management in August 2000 as explained in Chapter 8.

Through this 2-year project, the Study Team was also able to obtain a lot of cooperation with many professors of UNSRAT and assistance by NGOs as advisors and researchers.

(2) Cooperation and Coordination with Other Donor Agencies

In North Sulawesi province, many projects and programs related to coastal management have been implemented in the last 10 years and some are still currently on going. These projects and programs were funded mainly by the World Bank (WB), Asian Development Bank (ADB), USAID, AusAID, CIDA and the Japanese government. As of October 2001, the Coral Reef Rehabilitation and Management Program (COPEMAP) funded by WB and some other agencies, the Coastal Resources Management Project (CRMP: *Proyek Pesisir*)

and Environmental Policy and Institutional Strengthening Indefinite Quality (EPIQ), (these two CRMP and EPIQ projects are under the umbrella of the USAID-funded Natural Resources Management Program II (NRM II)), and this Master Plan Study for Coral Reef Management funded by JICA have been currently implemented in North Sulawesi.

Kabupaten Task Force Meeting with CRMP

In the past, there has been criticism that these multilateral and bilateral coastal area management projects/programs have not been showing significant results, despite the fact that millions of dollars have been spent in the last 10 years in the area. One of the reasons could be that coordination among projects and programs has not been done well, so that there has been very little 'institutional memory' accumulated through the whole experience of project implementation. As a result, some projects duplicate activities or start from scratch and do not build from the outcomes of previous projects. A number of expensive and sophisticated equipment have been left after a project ends, and no one looks after those potentially useful treasures in their projects/programs. It is, therefore, very important for the local government to put their efforts together and make the best use of the foreign money.

From the inauguration of the Study, the Study Team has been taking seriously the tasks of coordinating and cooperating with existing projects/programs in the area. The Study Team has a mindset that the nature of the study is not implementation of activities but direction and preparation of step-wise strategies and approaches for implementation of coastal management, so that other on-going and past projects/programs definitely provide the Study with precious input to formulate an adequate, applicable, and replicable master plan. For instance, the Study Team is working together with CRMP and EPIQ at the field level.

Chapter 3

Coastal Management Mapping

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Coastal Management Mapping

3.1 Background

It is possible for just about anybody to point out environmental problems, but at the same time, is unable to show any evidence. Rumors and hearsay cannot be a basis for planning. To realize both the sustainable utilization of natural resources and the conservation of coastal areas, it is indispensable to introduce a management system based on scientific data. Only scientific evidence can realize this kind of zoning process.

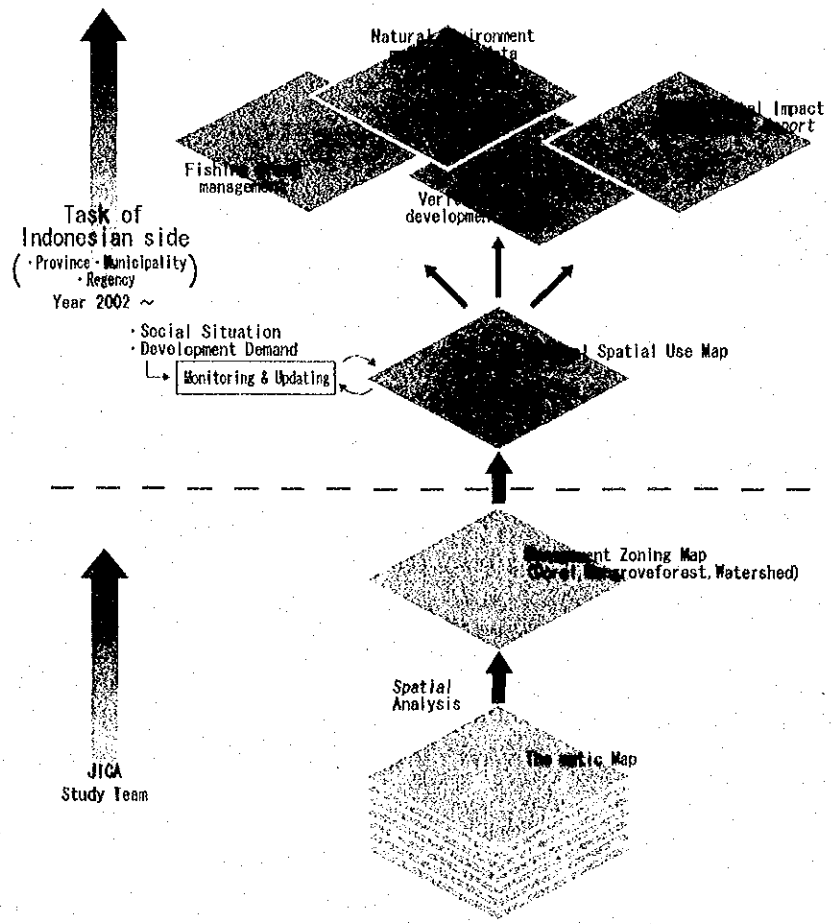
The Study is taking the scientific approach to analyze the natural environment condition of the area by taking aerial photos which cover not only coastal water but also inland area, analyzing natural conditions by several scientific surveys, and conveying the data into GIS. This is the first trial in Indonesia to take aerial photos of such a wide area and to make a detailed spatial analysis based on the photos.

That is to say, first of all, it is necessary to specify coastal area in North Sulawesi which are important to be protected and conserved from the viewpoints of preservation of ecosystem, sustainable marine productivity, etc., by conducting a precise assessment research of the target natural environment and ecosystem. This information is important, valuable and effective for appropriate management.

3.2 Objectives

The Study Team developed coastal GIS and utilized it as a tool for analysis and formulation of a master plan in the Study. But even after the Study, it is also expected that local governments and related agencies will utilize and maintain this GIS database for their administrative activities such as coastal resources management, environmental impact assessment, fishery development, conservation of coastal natural environment,

infrastructure development, issue of development permission/authorization, and the land use planning in the Study area.



Source: JICA Study Team

Figure 3.1 Utilization of Coastal GIS Database developed by the JICA Study Team

3.3 Methodology

It is desired that the database should be always updated and reflected the newest present condition.

In the study, the Study Team developed coastal GIS database based on aerial photographs taken by the Study Team. The Study Team also carried out field surveys in order to raise the accuracy of interpretation and analysis of the aerial photographs.

Important information about the inland area in the study area, such as land use, vegetation, and place of mudflow production type have been grasped through these aerial photographs. A clearer picture of the conditions of marine life as provided as well. Digital data enabled the generation of thematic maps of scale 1:50,000.

Then, the Study Team analyzed the thematic map data and finally created coastal management zoning map.

3.4 Work Period

The Study Team started taking aerial photographs in July 2000 and conducted a series of work as shown in Table 3.1.

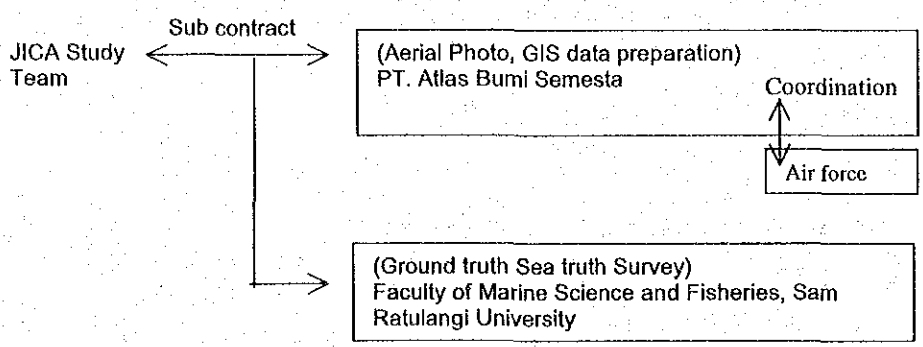
Table 3.1 Schedule of aerial photography

No.	Work Items	Duration	July	August	September	October	November	December
	AERIAL PHOTOGRAPHY							
1	Mobilization	4	4					
2	Aerial Photography(1/50,000 B&W)	39	30	9				
2-1	Dia-positive	4		4				
2-2	Contact print (3sets)	8		8				
2-3	2 Times enlargement	8		8				
2-4	Photo Index	3			3			
3	Aerial Photography(1/20,000 Color)	39	30	9				
3-1	Dia-positive	9			9			
3-2	Contact print (2sets)	14		14				
3-3	2 Times enlargement	14			14			
3-4	Photo Index	3			3			
	ORTHOPHOTO & THEMATIC MAP DATA							
1	GPS control point survey	25	25					
2	Minor order leveling	35	35					
3	Photo scanning	16		16				
4	Aerial Triangulation	24		17	7			
5	Digital terrain model(1/50,000)	50			23	27		
6	Orthophoto (1/50,000)	50			13	30	7	
7	Thematic data digitalizing	69			30	30	9	

After these work, the Study Team analyzed these data with GIS software. Analyzed data was utilized for the process of formulation of master plan.

3.5 Activities

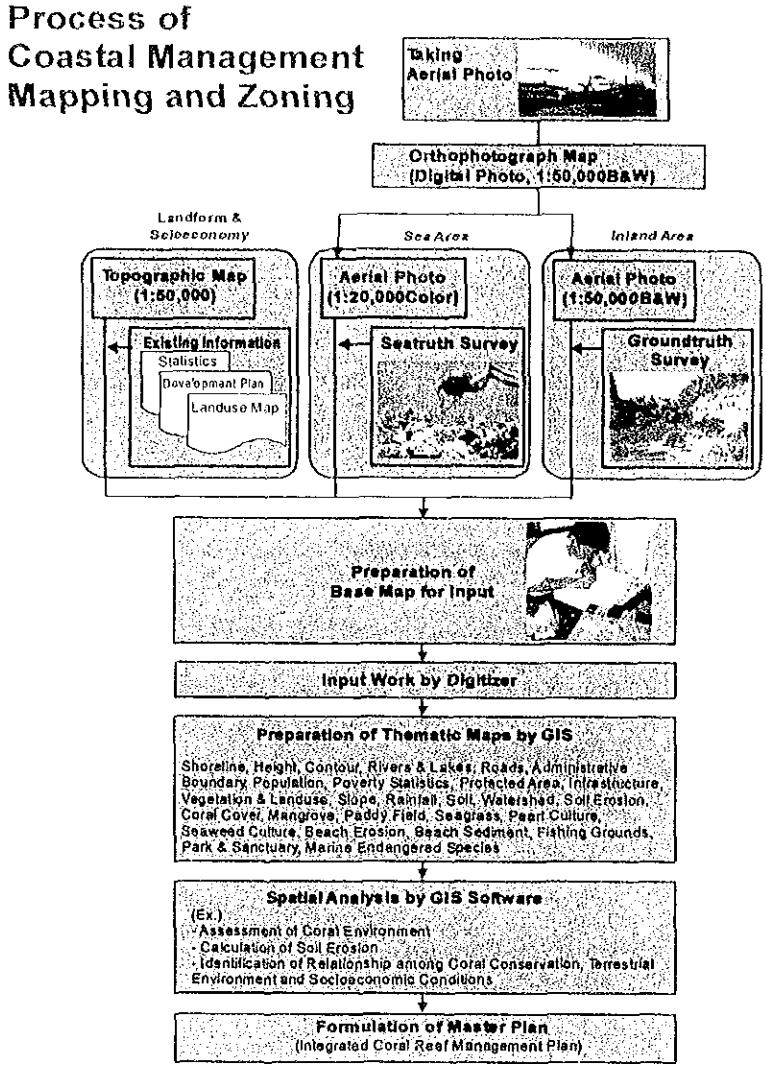
The survey was conducted in cooperation with PT Altas Bumi Semesta and Sam Ratulangi University.



Source: JICA Study Team

Figure 3.2 Survey Organization

Flow of the activities are shown in Figure 3.3.



Source: JICA Study Team

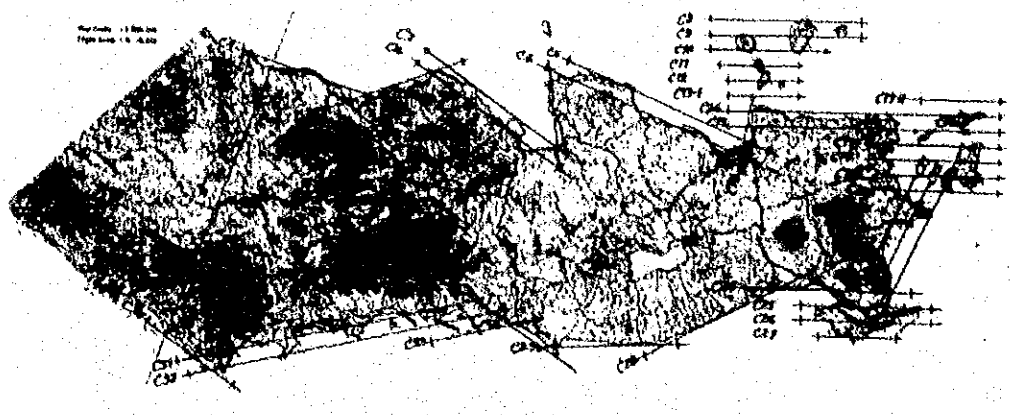
Figure 3.3 Process of Coastal Management Mapping

(1) Aerial Photography Survey

Aerial photography survey was carried out from July to September 2000, which produced two scales of photographs as follows:

- 1:20,000 for coastal area (colored)
- 1:50,000 for inland area (black & white)

Total length of flight reached 2,800 km and total number of pictures counted at 1,030 pieces.



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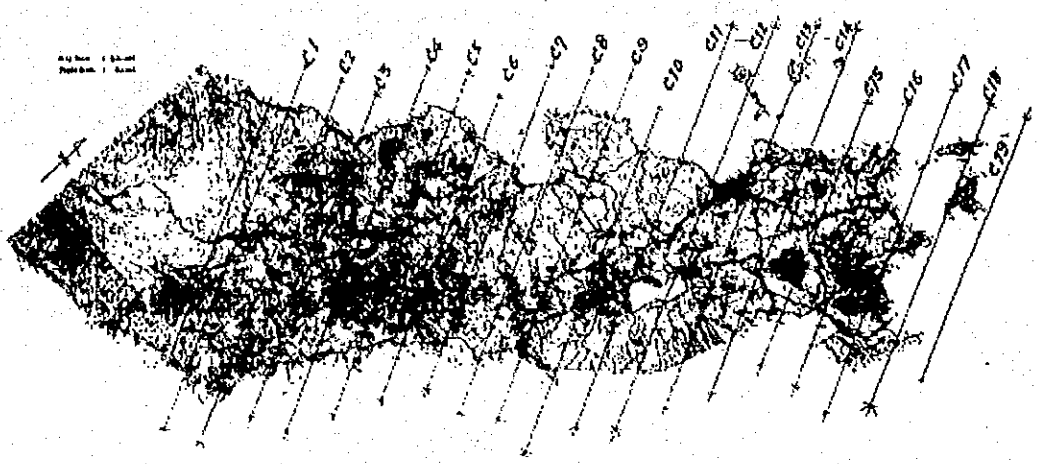


(for black and white photo)

Figure 3.4 Flight line of aerial photograph

The flying altitudes and other related information for each line are shown in Table 3.2.

Table 3.2 Schedule plan of flight line

List of Flight Line (1:20,000 Color)

Line	Height Datum(m)	Flying Height(m)	Line Distance(Km)	Number of Exposure(pcs)
1	60m	3120m	38.64	22
2	60m	3120m	29.44	17
3	60m	3120m	36.80	21
4	60m	3120m	36.80	21
5	60m	3120m	46.00	26
6	60m	3120m	47.84	27
7	60m	3120m	20.24	12
8	60m	3120m	31.28	18
9	60m	3120m	31.28	18
10	60m	3120m	23.92	14
11	60m	3120m	16.56	10
12	60m	3120m	14.72	9
13-1	60m	3120m	14.72	9
13-2	60m	3120m	16.56	10
14	60m	3120m	57.04	32
15	60m	3120m	57.04	32
16	60m	3120m	12.88	8
17	60m	3120m	27.60	16
18	60m	3120m	27.60	16
19	60m	3120m	25.76	15
20	60m	3120m	23.92	14
21	60m	3120m	20.24	12
22	60m	3120m	23.92	14
23	60m	3120m	27.60	16
24	60m	3120m	34.96	20
25	60m	3120m	27.60	16
26	60m	3120m	27.60	16
27	60m	3120m	16.56	10
28	60m	3120m	38.64	22
29	60m	3120m	29.44	17
30	60m	3120m	20.24	12
31	60m	3120m	64.40	36
32	60m	3120m	68.08	38
33	60m	3120m	22.08	13
34	60m	3120m	12.88	8
35	60m	3120m	34.96	20
36	60m	3120m	23.92	14
		TOTAL	1129.76Km	651pcs

List of Flight Line (1/50,000 B&W)

Line	Height Datum(m)	Flying Height(m)	Line Distance(Km)	Number of Exposure(pcs)
1	500	8150	27.6	7
2	600	8250	27.6	7
3	800	8450	73.6	17
4	1000	8650	78.2	18
5	1000	8650	78.2	18
6	1000	8650	78.2	18
7	1000	8650	92.0	21
8	1000	8650	87.4	20
9	1000	8650	82.8	19
10	1000	8650	82.8	19
11	1000	8650	78.2	18
12	1000	8650	78.2	18
13	1500	9150	73.6	17
14	1300	8950	92.0	21
15	1300	8950	96.6	22
16	1000	8650	96.6	22
17	1000	8650	73.6	17
18	1500	9150	69.0	16
19	1000	8650	64.4	15
20	1000	8650	69.0	16
21	300	7950	69.0	16
22	60	7710	32.2	8
23	200	7850	32.2	8
		TOTAL	1633.00km	378 pcs

The survey aircraft used in the work had airworthiness certificate. It was equipped with all the essential GPS navigation system and photographic instruments. It had the requisite photographic cruising speed and operating range, a high rate of climb, good stability while in-flight, good field of view for visual navigation and a service ceiling at full load equal to or higher than the highest altitude required for the survey.

Aerial camera used for the photography was a precision aerial photographic survey camera with a precision wide angle lens (6 inches focal length) having a valid calibration report.

The calibration report was included :

- The Maker's serial number of the camera and the serial number of the lens;
- The coordinate of the principal point with reference to fiducical marks;
- The radial distortions of the image, with reference the principal point as origin;
- The calibrated focal length at which these distortions apply;
- The certificate as by whom and when the camera was calibrated;

Aerial photography was conducted based on the following specification of work.

1) The photography was undertaken so as to provide complete stereo scopic coverage over the specified area.
2) The area was covered with straight strips of photographs having overlap of about 60 ± 5 percent. The sidelap (overlap of parallel strips of photography) shall average 30 percent in consideration of difference of ground elevation in this area. In the event of considerable variations in ground level, a reasonable increase in the specified overlaps was accepted.
3) Crab shall not exceed 10 degrees or be such that stereoscopic gaps in photography result from it.
4) Tip and tilt shall not exceed 5 degrees.
5) The centers of the first and the last photograph shall fall outside the required area boundary.
6) Exposure of photography was so that even in the shadows caused by photographic relief, satisfactory identification of details is possible.
7) Where breaks in a flight strip are necessary the minimum overlap between segments of the strip was at least three (3) exposures. Any segment of a flight strip resulting from necessary breaks shall consist of no fewer than five (5) exposures.
8) Reasonable effort was made to obtain cloud free photographs and five percent of clouds appearing in each photograph may be considered as tolerable. In no case, however, shall clouds fall on a principal point or its conjugate.
9) All flight strips was centered as closely as possible over flight lines plotted. No flight strip or segment of a flight strip shall deviate from its plotted position on the flight map such that the resulting sidelap with any adjacent strip was less than 10%. Failure of any flight strip or section thereof to meet these requirements was a cause for rejection.
10) Attention of the Contractor is directed to all existing regulations concerning restrictions and procedures on photography of classified installations and/or reproducing, publishing or selling photographs of such installations.

Then, photo-processing was done by the following conditions. Each film and each aerial negative was marked clearly of the block type lettering approximately one sixth (1/6) inch high and positioned so that each group is less than 1/8" or more than 1/4" from the related image edge of the negatives. Each negative roll was numbered consecutively staring with No. 001. End of each roll was clearly marked with:

- Contract Number or Project Designation
- Roll number, flight line number and photograph number

- Dates on which exposed, together with relevant negative numbers
- Serial number of camera optical unit and the principal distance as shown in the calibration certificate
- Corrected height (not indicated height) above mean sea level at which exposed, together with relevant negative number

Contact Prints was done by the following conditions.

- Contact prints from the negatives of the aerial photography was made on double weight semimatte standard commercial grade photographic paper and was trimmed with a margin of approximately one fourth (1/4) inch outside of the photographic image including the space necessary to show the registering instrument clearly.
- Special care was exercised to ensure the proper development and the thoroughly fixing of contact prints. All prints was cleaned and free from stains, blemishes, uneven spots, light fog, and finger marks, and was thoroughly washed to completely eliminate the hypo or any other chemicals, which would impair their permanency.

In accordance with two times enlarged photos, The number of the two times enlargements produced from 1/50,000 and 1/20,000 negative films was approximately 189 pieces and 326 pieces respectively. Supervisor of the JICA Study Team selected negative films for enlargement. As to Photo Index, a photo coverage index of the project area was prepared to check the overlaps and displacement of the flight strips against the approved flight plan. The coverage index was a line index which was prepared on the master reproducible sheet. Inspection and Re-flight was done by the following conditions.

- The contractor shall process aerial films and mark single weight contact prints immediately after the every photographic flight is completed in order to make preliminary inspection of the result and instruct re-flight, if it is needed.
- Quality Control Sheet to be used record of the result was inspected by Supervisor of the JICA Study Team.

Preparation of digital orthophoto map and digital thematic data was performed according to the following conditions and specifications.

Table 3.3 Contents of work

DESCRIPTION OF ACTIVITIES	QUANTITY	UNIT
GPS Control Point Survey	30	st.
Minor Order Leveling	200	km
Photo Scanning	377	pcs
Aerial Triangulation	355	mdls
1/50000 Orthophoto Map	20	sheets
1/50000 Digital Terrain Model	6000	km^2
Thematic Data Digitizing * see Table 3.4	59	sheets

Table 3.4 Layers for Digitizing

Large classification	Small classification	Sheet numbers of 1/50,000 map grid
Geographic features	Coastline Contour Spot height River, Lake and marshes, Swampland and so on Tideland Road	10 sheets
Social development	Boundary, Land use Public facilities Infrastructure facilities Commercial facilities Harbor facilities Community, preserve area Road scheme, Development area Natural monument and cultural assets	20 sheets
Inland	Vegetation, Soil erosion Precipitation, Soil, Slope, Danger area Land assets animals	10 sheets
Coast area	Coral reef, Fragment of death coral Damaged point of coral reef Sea floor morphology Spawning spots of sea turtles Fishing ground, Seaweed Feeding area for Dugong	19 sheets
	Total	59 sheets

Survey standards and map accuracy was as follows:

1	Reference ellipsoid	:	Bessel 1841
2	Coordinate system	:	Universal Transverse Mercator (U.T.M.)
3	Map projection	:	Transverse Mercator
4	Original coordinate	:	Indonesia 1974
			Semimajor axis : 6378160.0
			Reciprocal flattering : 298.247
	vertical		Muka laut di Mamuju, Sulawesi
5	Sheet size	:	15' × 15'
6	Map scale	:	1:50,000

GPS Control Point Survey and pricking

1) Ground control point survey at newly established points for obtaining those horizontal coordinates was conducted on the basis of the existing control points. Existing control points in the project area shall was used for aerial triangulation. Also existing point to be used was pricked for identifying its position on the two times enlargement photo or contact print by either direct pricking or eccentricity measurement if available.

2) New GPS control point was established at identifiable places such as road junction or near the conspicuous field object so that pricking its position corresponds correctly to an object shown on the two times enlargement photo or contact print, and marked with a circle, reference number by red ink.

3) The coordinates of the control points was computed based on the U.T.M. System.

4) The survey was carried out by using Global Positioning System (GPS). More than three (3) sets of the GPS instruments were used. Accuracy of GPS observation was as follows:

- Horizontal : ±10ppm x Distance (10cm / 10km) in trigonometrical closure
- Vertical : ±20ppm x Distance (20cm / 10km) in trigonometrical closure

5) GPS observation sessions were pre-planned such that signals from more than four (4) satellites can be received simultaneously. Furthermore, the following criterions were kept:

- Observation was carried out simultaneously at more than three (3) points.
- Only satellites with a vertical angle of more than 15° were observed.
- Observation hours were more than 2 hours for 4 satellites or 1.5 hours for 5 satellites.
- The observed data was used to compute the base line vectors between observed points.
- Two selected check lines (base lines) should be observed for at least two (2) hours unless the check line has been observed during two (2) separate sessions and the result is acceptable.
- Height of control points were obtained by using direct leveling of minor order.
- Distribution map and index map of control points were made.
- Descriptions of GPS control points showing place name, coordination (X,Y and Z, if available), sketch and photograph was prepared.

Minor -Order Leveling

1) Minor order leveling was carried out to obtain necessary elevation for aerial triangulation and orthophoto mapping.

2) Final proposed leveling route was selected on the aerial photos.

3) Preparation: Using (2) two times enlarged aerial photographs, all measurement points along the new leveling route was selected on the aerial photographs for pricking every 400m – 500m interval (road junction, bridge, other conspicuous field objects, etc.) before start field survey.

4) Observation

The observation was carried out according to following method:

- Leveling shall start from and close to existing B.M.
- In case where no exiting B.M. at end of leveling route, duplicate observation should be done.
- Distance in the observation between staff and instrument shall not exceed 80m.
- Distance back-sight and foresight was equalized.
- The observer shall avoid reading of the bottom 10cm and top 10cm of the staves.
- Temporary bench marks (TBM) was marked by painting at approx.1km interval on the existing permanent structures.
- Accuracy of observation was within $50mm \pm \sqrt{S}$.
- Field notes was submitted.

5) Each measurement points by leveling was pricked carefully on the two times enlarged aerial photos in the field.

Photo Scanning

1) In order to prepare digital orthophoto maps, aerial photographs was digitized as raster data by using scanners. The scanners to be employed shall high-precision film-scanners for obtaining precise measurement on the orthophoto.
2) Resolution of scanned data was 1000 DPI in average.
3) Format of the data was JPEG or other standards in Indonesia.
4) Degradation of numeric scale due to image compression was avoided.

Aerial Triangulation

1) On the basis of the results of GPS control point survey and minor-order leveling, the necessary photo coordinates of pass points and tie points for the preparation of 1:50,000 DTM and orthophoto map was obtained.
2) For 1:50,000 panchromatic aerial photographs, block adjustment by independent modeling method were applied. For 1:20,000 color aerial photographs, strip adjustment by polynomial expression was applied.
3) Transformation parameter was calculated in order to transform all the aerial photographs into orthophotos.
4) In addition to the results of GPS control points and minor order leveling, the ground control points derived from existing map (GCP-MAP) was used to meet consistencies in overlapping between digitized thematic map and orthophoto. Coordinates of GCP-MAP was measured on the existing maps.

Position of GCP-MAP to be used in aerial triangulation was shown by JICA Study Team.

1:50,000 Orthophoto Map

1) Scanned aerial photo data was transformed into orthogonal-projection image by using digital photogrammetric workstation (DPW) based upon the orientation elements obtained in the aerial triangulation.
2) Image to be employed for the transformation was central part of the aerial photographs. Peripheral part of the aerial photographs shall not be used, as larger geometrical displacement exists.
3) The orthophotos developed model by model was composed as one mosaic image data, which covers all the photographed area.
4) The orthophoto map was output at size of 1:50,000 topographic map by using high-resolution image printer.

1:50,000 Digital Terrain Model (DTMs)

1) DTMs was developed by measuring spot elevations at intersections of 500m-spacing grids with DPW and/or stereo-plotters.
2) The format of DTM data was exchangeable.
3) Thematic Data Digitizing
4) Manually prepared thematic maps, which grid size corresponds to existing 1:50,000 topographic maps was digitized by GIS software.
5) The digitized data was structured as digital data into each layer.
6) The structured data was expressed in a vector form.(Arcview shape file) The accuracy of digitized map data positioning was checked by superimposing on the 1:50,000 topographic map and orthophoto map.

Aerial photography, preparation of digital orthophoto map and digital thematic data was conducted by P.T. Atlas Bumi Semesta which locates in Jakarta, Indonesia as a sub-contractor under the supervision of the Study Team.

(2) Ground truth / Sea truth Survey

In addition to the aerial photography survey, ground truth and sea truth surveys were also undertaken in order to ensure the precision of aerial photograph analysis.

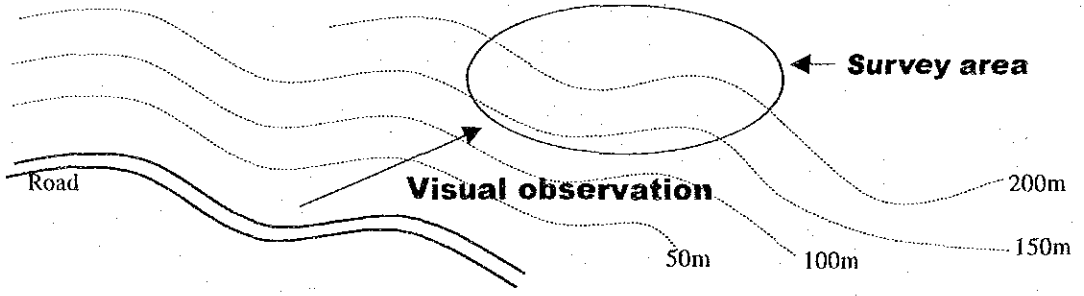
The Study Team analyzed aerial photos for preparation of thematic maps based on tone of color and pattern. The accuracy level of interpretation was increased by sea-truth and ground-truth surveys. After this analysis, digitized maps were prepared on the above-given scale of aerial photos.

The minimum grid for aerial photo analysis is 2 x 2 mm on 1:20,000 scale for the coastal water area and 1:50,000 scale for the inland area, so that accuracy level is 50 x 50 m and 100 x 100 m for the respective areas. However, accuracy level of both maps should be 100 x 100 m based on resolving power of digitizer.

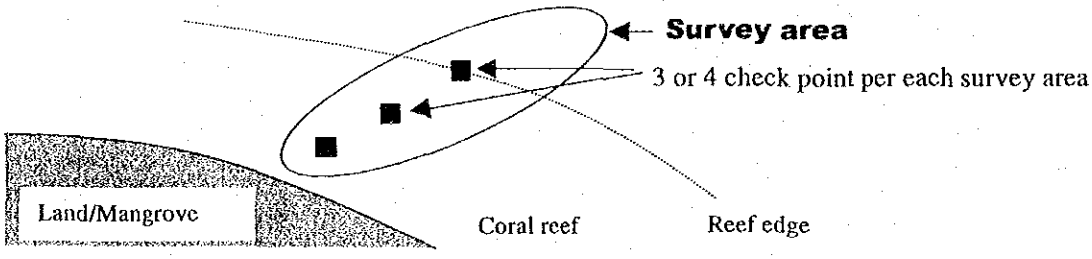
The ground truth/sea truth surveys were conducted at approximately 500 inland areas for ground-truth survey and at approximately 500 coastal water areas consisting of around 2,000 check points.

The Survey was performed in order to provide information on conditions of land use and sea bottom for aerial photo analysis. The local consultant shall identify conditions of land use and sea bottom on the field. Number of survey areas are as follows:

Land area : approximately 500 survey area



Coastal water area : approximately 500 survey areas



The Survey areas were selected after preliminary aerial photo interpretation by the Study Team. The local consultant conducted field survey based on the preliminary photo analysis. Locations of survey areas were measured by GPS (Global Positioning System) on the field. Procedures of Survey were as follows ;

- go to survey area (and check point) instructed by the study team
- measure position by GPS
- observe conditions of land use and/or sea bottom
- measure position by GPS again

At least one GPS reading was taken at each survey area. In addition GPS reading was taken from as many sampling locations as possible and also from prominent landmarks allowing precise location (e.g., jetties or other constructions that will appear in the aerial photographs).

The sea-truth and ground-truth surveys were conducted by Faculty of Fisheries and Marine Science, Sam Ratulangi State University headed by Ir. Laurentius T. X. Lalamentik as a local consultant under the supervision of the Study Team.

(4) Coastal Natural Environment / Terrestrial Environment Survey

Coastal natural environment survey and Terrestrial environment survey were conducted to identify the conditions of coastal environments. The data and information on coral conditions, shoreline forms, seagrass and algae, mangrove, environmental impacts, land use and vegetations were obtained through secondary data collection, interview survey and field survey using Manta-tow method and direct observation from shoreline and from boat.

(5) Preparation of thematic maps

The following thematic maps were prepared based on aerial photos, field surveys and collected secondary data.

Thematic maps are produced through Integration of aerial photos, field surveys and collected secondary data

Table 3.5 List of Prepared Thematic Maps

Major Division	Subsection	Item	Data Style	Base Map
Landform	Land	Coastline	line	1/50,000 topographic map
		Spot height	point	1/50,000 topographic map
		Contour	line	1/50,000 topographic map
		Main rivers	polygon	1/50,000 topographic map
		Rivers	line	1/50,000 topographic map
	Traffic	Road	line	1/50,000 topographic map
Social Development	Administrative boundary	Kabupaten & Kota	polygon	original source ,1/50,000 topographic map
		Kechamatan (district)	polygon	original source ,1/50,000 topographic map
		Desa (town) central point	polygon	original source ,1/50,000 topographic map
		Desa (town) central point	point	original source, 1/50,000 topographic map
	Other social development	Communities	polygon	abstracting 20 points form Desa (village) central point
Land Survey	Vegetation & Land Use	Vegetation & Land Use	polygon	1/50,000 topographic map, 1/50,000 B&W photo, ground survey
	Land etc	Soil erosion	polygon	Land Use, Rainfall, Soil, Contour, Spot height
		Rainfall	point/polygon	Existing material (1/1,000,000)
		Soil	polygon	1/1,000,000 Soil Map
Sea Survey	Coral reef, etc	Coral reef, etc	polygon/line	1/50,000 topographic map, 1/20,000 colored photo, sea survey

(6) Development of GIS

The Study Team developed a Geographic Information System (GIS) database based on aerial photographs, field surveys, and existing data collection. The database has been engaged in preparation of thematic maps, spatial analysis and coastal area zoning. The Study Team held a technology transfer seminar in January 2002 in Manado. And then transferred the technical knowledge of the entire system to the Indonesian counterparts. It is expected that local governments / institutions in North Sulawesi Province continue to maintain for sustainable management planning and utilize this GIS as the first component

of the coastal environmental management information system even after the mission of the Study is completed.

(7) Spatial Analysis

The coastal environmental conditions were assessed by the above-mentioned process. It is a first experience in Indonesia that spatial conditions of the coastal area are identified. Coral reef, mangrove and other conditions were identified widely in North Sulawesi. Results of analysis are explained in Volume II: Master Plan, and Volume III: Coastal Environmental Conditions and Coastal Management System.

3.6 Data Reference

The list of 24 thematic maps of the coastal GIS are as the following table.

Table 3.6 List of Thematic Maps and sources

Title	Source
Shoreline Forms	Field Survey, Aerophotos(Color)
Coral Reef Distribution	Field Survey, Aerophotos(Color)
Seagrass & Algae Distribution	Field Survey, Aerophotos(Color)
Mangrove Forest	Field Survey, Aerophotos(Color)
Nesty Beach of Seaturtle	Interview at the Sites
Fisheing Grounds	Field Survey, Aerophotos(Color), Master Plan of Protection of Coastal Area (North Sulawesi 1997/1998, Department of Public Works, Direct General of
Coastal Environmental Impacts	Field Survey, Aerophotos(Color)
Elevation	Topographical Map (1:50,000 BAKOSTANAL)
Rivers and Its Watershed	Topographical Map (1:50,001 BAKOSTANAL)
Slope	Contour
Soil Classification	Soil Map in Sulawesi (Center for Soil and Agro-Climate Reserch,1993)
Estimated Amount of Soil in Each	Slope, Landuse, Soil, Rainfall
Protected Area	Information on the Coservation Areas of the North Sulawesi Province (Department of Forestry and Estate Crops Provincial Office the North Sulawesi Province Sub-section of Conservation of Natural Resouces of the North Sulawesi, December 1998)
Administrative Boundary	Village, Boundary Map, Topographical Map (1:50,000 BAKOSTANAL)
Population Density (1999)	BPS North Sulawesi
Vegetation & Landuse	Field Survey, Aerophotos(B/W)
Infrastructure on Coastal Zone	Aerophotos(Color)
Gold Mining Site	Head of Mining and Energy Department Office of North Sulawesi Province
Poverty Level in the Study Area by Village, 1999	Potensi Desa 2000 (unpublished), BPS
Existing Tourist Facilities and Attractions	Aerophotos(Color) and Site Survey
Potential Areas for the Coastal Tourism Development	Time distance, Analysys by JICA Study Team
Coral Reef Management Zoning Map	JICA Study Team
Mangrove Forest Management Zoning	JICA Study Team
Watershed Management Zoning Map	JICA Study Team

Source: JICA Study Team

Major attributes of the data are as the following table.

Table 3.7 Major Attributes and Data Source (1)

NO.	Pathname	Data Name	Deta Type	Contents of Deta	Number of Records	The time of preparation	Preparation agency	Original sources	
1	\NTECO\DATABASE\OTHERS	flame_inside	Poly	Inside sheet for the whole area map	1	Feb-01	JICA Study Team		
2	\NTECO\DATABASE\OTHERS	flame_outide	Poly	Outside sheet for the whole area map	1	Feb-01	JICA Study Team		
3	\NTECO\DATABASE\OTHERS	grid_studyarea	Point	The point to indicate latitude/longitude	28	Feb-01	JICA Study Team		
4	\NTECO\DATABASE\OTHERS	shift_tmp	Poly	The cover not to make it indicate the data outside the frame	1	Feb-01	JICA Study Team		
5	\NTECO\DATABASE\OTHERS	studyarea_circle	Poly	The circle that the study area is surrounded	1	Feb-01	JICA Study Team		
6	\NTECO\DATABASE\OTHERS	tondano	Poly	The form of Tondano Lake	1	Feb-01	JICA Study Team		
7	\NTECO\DATABASE\INDEX	index	poly	All the sheet of the topographical map	20	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
8	\NTECO\DATABASE\INDEX	map01_talise	poly	The sheet of Map01	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
9	\NTECO\DATABASE\INDEX	map02_manadotua1	poly	The sheet of Map02	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
10	\NTECO\DATABASE\INDEX	map03_wori	poly	The sheet of Map03	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
11	\NTECO\DATABASE\INDEX	map04_likupang	poly	The sheet of Map04	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
12	\NTECO\DATABASE\INDEX	map05_tanawangko	poly	The sheet of Map05	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
13	\NTECO\DATABASE\INDEX	map06_manado	poly	The sheet of Map06	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
14	\NTECO\DATABASE\INDEX	map07_bitung	poly	The sheet of Map07	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
15	\NTECO\DATABASE\INDEX	map08_tenga	poly	The sheet of Map08	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
16	\NTECO\DATABASE\INDEX	map09_amurang	poly	The sheet of Map09	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
17	\NTECO\DATABASE\INDEX	map10_langowan	poly	The sheet of Map10	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
18	\NTECO\DATABASE\INDEX	map11_sawangan	poly	The sheet of Map11	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
19	\NTECO\DATABASE\INDEX	map12_inobonto	poly	The sheet of Map12	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
20	\NTECO\DATABASE\INDEX	map13_bilalang	poly	The sheet of Map13	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
21	\NTECO\DATABASE\INDEX	map14_kotabunan	poly	The sheet of Map14	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
22	\NTECO\DATABASE\INDEX	map15_belang	poly	The sheet of Map15	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
23	\NTECO\DATABASE\INDEX	map16_imandi	poly	The sheet of Map16	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
24	\NTECO\DATABASE\INDEX	map17_kotamobagu	poly	The sheet of Map17	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
25	\NTECO\DATABASE\INDEX	map18_nuangan	poly	The sheet of Map18	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
26	\NTECO\DATABASE\INDEX	map19_pinolosian	poly	The sheet of Map19	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
27	\NTECO\DATABASE\INDEX	map20_onnginoi	poly	The sheet of Map20	1	Nov-00	JICA Study Team	Topographical Map (1/50,000)	Bakostanal
28	\NTECO\DATABASE\COASTAL	beach erosion priority	poly	Beach Erosion	19	Feb-01	JICA Study Team	Master Plan of Protection of Coastal Area	Department of Public Works, Direct General of Irregation
29	\NTECO\DATABASE\COASTAL	bunaken national park_poly	poly	The area of Bunaken National Park	2	Feb-01	JICA Study Team	Data from Bunaken National Park Authority	Bunaken National Park Authority
30	\NTECO\DATABASE\COASTAL	bunaken national park_lin	line	The boundary of Bunaken National Park	2	Feb-01	JICA Study Team	Data from Bunaken National Park Authority	Bunaken National Park Authority
31	\NTECO\DATABASE\COASTAL	coral_area	poly	The whole area of coral reef	1	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
32	\NTECO\DATABASE\COASTAL	coral reef_all	poly	The all data of coral reef	946	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
33	\NTECO\DATABASE\COASTAL	coral_ana	Poly	The all data of coral reef for coral reef management zonens		Feb-01	JICA Study Team	coral reef_all	JICA Study Team
34	\NTECO\DATABASE\COASTAL	coral_excellent	Poly	The area which live coral of the best condition inhabits	8	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
35	\NTECO\DATABASE\COASTAL	coral_good	Poly	The area which live coral of the fair condition inhabits	31	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
36	\NTECO\DATABASE\COASTAL	coral_fair	Poly	The area which live coral of the good condition inhabits	170	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
37	\NTECO\DATABASE\COASTAL	coral_poor	Poly	The area which live coral of the poor condition inhabits	353	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
38	\NTECO\DATABASE\COASTAL	seagarass & algae	Poly	The area which seagrass or algae inhabit	304	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
39	\NTECO\DATABASE\COASTAL	sand	Poly	The area where sand accumulates	60	Feb-01	JICA Study Team	coral reef_all	JICA Study Team
40	\NTECO\DATABASE\COASTAL	coral_zoning		Coral reef management zonens	219	Aug-01	JICA Study Team	coral reef_all	JICA Study Team

Table 3.7 Major Attributes and Data Source (2)

NO.	Pathname	Data Name	Data Type	Contents of Data	Number of Records	The time of preparation	Preparation agency	Original sources	
41	UNTECO\DATABASE\COASTAL	culture	Poly	Pearl or sawead culture	35	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
42	UNTECO\DATABASE\COASTAL	degraded	Poly	Degraded(pr.bomb fishing)	54	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
43	UNTECO\DATABASE\COASTAL	dive site	Point	The points of Dive sites	68	Oct-01	JICA Study Team	Site Survey	JICA Study Team
44	UNTECO\DATABASE\COASTAL	dugons	Poly	The area where dugons were witnessed	2	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
45	UNTECO\DATABASE\COASTAL	fish or shrimp pond	Poly	Fish or shrimp pond	14	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
46	UNTECO\DATABASE\COASTAL	fishing area	Poly	Fishing area	31	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
47	UNTECO\DATABASE\COASTAL	fishing port	Point	The points of fishing ports	10	Feb-01	JICA Study Team	Fishery's Office data	Fishery Office
48	UNTECO\DATABASE\COASTAL	reclamation area	Poly	Reclamation Area	2	Feb-01	JICA Study Team	Aerophotos(Color)	JICA Study Team
49	UNTECO\DATABASE\COASTAL	shoreline	Line	Shoreline	674	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
50	UNTECO\DATABASE\COASTAL	white sand beach	Line	The shoreline of the white sand beach of the length above 300m	165	Aug-01	JICA Study Team	shoreline	JICA Study Team
51	UNTECO\DATABASE\COASTAL	shoreline_cluster	Line	Shoreline data for the analysis	739	Aug-01	JICA Study Team	shoreline	JICA Study Team
52	UNTECO\DATABASE\COASTAL	turtle nesting area	Poly	The area where sea turtle nesting were witnessed	4	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
53	UNTECO\DATABASE\COASTAL	scenic beauty	Line	Scenic beauty	5	Oct-01	JICA Study Team	Analysis*	JICA Study Team
54	UNTECO\DATABASE\INLAND	accessibility	Poly	Road accessibility (time distance)	11	Oct-01	JICA Study Team	Analysis	JICA Study Team
55	UNTECO\DATABASE\INLAND	desa_pop	Poly	the villages	221	Sep-00	JICA Study Team	Boundary: Village, Topolographical Map (1:50,000) Population: BPS North Sulawesi	BAKOSTANAL, BPS North Sulawesi
56	UNTECO\DATABASE\INLAND	coastal rural area	Poly	the coastal rural villages	221	Feb-01	JICA Study Team	desa_pop	JICA Study Team
57	UNTECO\DATABASE\INLAND	Urban area	Poly	the urban towns	221	Feb-01	JICA Study Team	desa_pop	JICA Study Team
58	UNTECO\DATABASE\INLAND	kecamatan_pop	Poly	the districts	47	Oct-00	JICA Study Team	desa_pop	JICA Study Team
59	UNTECO\DATABASE\INLAND	kabupaten_kota	Poly			Oct-00	JICA Study Team	desa_pop	JICA Study Team
60	UNTECO\DATABASE\INLAND	contour	Line	Contour	19075	Aug-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
61	UNTECO\DATABASE\INLAND	contour_ana_point	Point	The point data of contour for soil erosion analysis	765043	Aug-01	JICA Study Team	contour	JICA Study Team
62	UNTECO\DATABASE\INLAND	cont200	Line	The contour of the height above sea level 200m and more	1535	Feb-01	JICA Study Team	contour	JICA Study Team
63	UNTECO\DATABASE\INLAND	cont_height200m	Line	The contour of the height above sea level 200m	354	Feb-01	JICA Study Team	contour	JICA Study Team
64	UNTECO\DATABASE\INLAND	desa_centp	Point	Village center	739	Sep-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
65	UNTECO\DATABASE\INLAND	kecamatan_centp	Point	District center	45	Sep-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
66	UNTECO\DATABASE\INLAND	kabu&kota_centp	Point	Regency or municipality center	4	Sep-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
67	UNTECO\DATABASE\INLAND	kecamatan_lin	Line	Border of district	83	Feb-01	JICA Study Team	kecamatan_pop	JICA Study Team
68	UNTECO\DATABASE\INLAND	kabpaten_lin	Line	Border of regency or municipality	5	Feb-01	JICA Study Team	kabupaten_kota	JICA Study Team
69	UNTECO\DATABASE\INLAND	gold mining	Point	The points of gold mining	11	Feb-01	JICA Study Team	Head of Mining and Energy Department Office of North Sulawesi Province	Head of Mining and Energy Department Office of North Sulawesi Province
70	UNTECO\DATABASE\INLAND	forest reserve	Poly	Forest reserve	7	Feb-01	JICA Study Team	Information on the Coservation Areas of the North Sulawesi Province	Department of Forestry and Estate Crops Provincial Office the North Sulawesi Province Sub-section of Conservation of Natural Resouces of the North Sulawesi
71	UNTECO\DATABASE\INLAND	landuse	Poly	Land use	1287	Nov-00	JICA Study Team	Field Survey, Aerophotos(B/W)	JICA Study Team
72	UNTECO\DATABASE\INLAND	mangrove	Poly	Magrove forest	260	Nov-00	JICA Study Team	Field Survey, Aerophotos(Color)	JICA Study Team
73	UNTECO\DATABASE\INLAND	mangrove_zoning	Poly	The data for Magrove forest management zoning		Aug-01	JICA Study Team	mangrove	JICA Study Team
74	UNTECO\DATABASE\INLAND	main_lake	Poly	Main lakes	19	Feb-01	JICA Study Team	desa_pop	JICA Study Team
75	UNTECO\DATABASE\INLAND	NWP national park	Poly	Nani Watara Bone National Park	1	Feb-01	JICA Study Team	Information on the Coservation Areas of the North Sulawesi Province	Department of Forestry and Estate Crops Provincial Office the North Sulawesi Province Sub-section of Conservation of Natural Resouces of the North Sulawesi
76	UNTECO\DATABASE\INLAND	studyarea	Poly	Study area	57	Nov-00	JICA Study Team	shoreline, desa_pop	JICA Study Team
77	UNTECO\DATABASE\INLAND	out of studyarea	Poly	Outside of study Area	1	Nov-00	JICA Study Team	studyarea	JICA Study Team
78	UNTECO\DATABASE\INLAND	province_centp	Poly	Province center	1	Sep-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
79	UNTECO\DATABASE\INLAND	settlement and others		Settlement and others	506	Feb-01	JICA Study Team	landuse	JICA Study Team
80	UNTECO\DATABASE\INLAND	resort_spot	Poly	Tourist Service Facilities	18	Aug-01	JICA Study Team	Aerophotos(Color), Site Survey	JICA Study Team

Table 3.7 Major Attributes and Data Source (3)

NO.	Pathname	Data Name	Data Type	Contents of Data	Number of Records	The time of preparation	Preparation agency	Original sources	
81	\NTECO\DATABASE\INLAND	rainfall	Poly	Rainfall	69	Nov-00	JICA Study Team	Rain fall statistics,October 1999	Meteorological and Geographycal Agency, Manado Station
82	\NTECO\DATABASE\INLAND	soil	poly	Soil	93	Nov-00	JICA Study Team	Soil Map in Sulawesi	Center for Soil and Agro-Climate Reserch
83	\NTECO\DATABASE\INLAND	slope_study	Poly	Slope	33868	Feb-01	JICA Study Team	contour (by Spatial Analysis of Arcview)	JICA Study Team
84	\NTECO\DATABASE\INLAND	soil_erosion	Poly	Soil Erosion	67501	Feb-01	JICA Study Team	lunduse, soil, rainfall, slope_study (by Spatial Analysis of Arcview)	JICA Study Team
85	\NTECO\DATABASE\INLAND	road_all	Line	Roads	9800	Aug-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
86	\NTECO\DATABASE\INLAND	river_poly	Poly	The main rivers or lake which have territory	112	Aug-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
87	\NTECO\DATABASE\INLAND	river_line	Line	Rivers	17455	Aug-00	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
88	\NTECO\DATABASE\INLAND	turism resources	Point	Turisum resources	39	Oct-01	JICA Study Team	Site Survey	JICA Study Team
89	\NTECO\DATABASE\INLAND	watershed	Poly	Watershed	91	Feb-01	JICA Study Team	Topolographical Map (1:50,000)	BAKOSTANAL
90	\NTECO\DATABASE\INLAND	watershed_lin	Line	Watershed boundary	38	Feb-01	JICA Study Team	watershed	JICA Study Team
91	\NTECO\DATABASE\INLAND	watershed_zoning	Poly	Watershed management zones	8733	Aug-01	JICA Study Team	watershed	JICA Study Team
d-1	\NTECO\DATABASE\INLAND	desa_family.dbf	DBF	The number of households of poverty family of villages in study area	741	Feb-01	JICA Study Team	Potensi Desa (Podes) Sensus 2000 dan Manahasa Regency, Bolaang Mongondow Regency, ManadoMunicipality, Bitung Municipality	BPS North Sulawesi
d-2	\NTECO\DATABASE\INLAND	seaturtle.dbf	DBF	Identify or no identify nest beach of seaturtle	741	Aug-01	JICA Study Team	Interview at the sites	JICA Study Team

Source: JICA Study Team

After the Study, a data of coastal GIS with computer equipments were handed to BAPELITBANG North Sulawesi Province. Work results of field surveys and original data of analyses are kept as follows.

Table 3.8 List of Data Holder of Coastal GIS Work Results

Data	Data holder
Negative films of aerial photo	Air force, Government of Indonesia
Contact prints 1:50,000 Black & White	BAPELITBANG North Sulawesi
Contact prints 1:20,000 Color	BAPELITBANG North Sulawesi
Two times enlargement contact prints 1:50,000 Black & White	BAPELITBANG North Sulawesi
Two times enlargement contact prints 1:20,000 Color	BAPELITBANG North Sulawesi
Photo Index Map 1:50,000 Black & White	P.T. Atlas Bumi Semesta, Jakarta
Photo Index Map 1:20,000 Color	P.T. Atlas Bumi Semesta, Jakarta
Daily report and Flight report	P.T. Atlas Bumi Semesta, Jakarta
Camera calibration Certificate	P.T. Atlas Bumi Semesta, Jakarta
GPS control point survey	P.T. Atlas Bumi Semesta, Jakarta
Minor order leveling	P.T. Atlas Bumi Semesta, Jakarta
Photo scanning (digital aerial photo data)	P.T. Atlas Bumi Semesta, Jakarta
Aerial triangulation	P.T. Atlas Bumi Semesta, Jakarta
Orthophoto maps 1:50,000 (printed out)	BAPELITBANG North Sulawesi
Orthophoto maps 1:50,000 (digital data)	BAPELITBANG North Sulawesi (Coastal GIS)
Digital terrain model	BAPELITBANG North Sulawesi (Coastal GIS)
Digital thematic map data	BAPELITBANG North Sulawesi (Coastal GIS)

Source: JICA Study Team

Chapter 4

Water Quality Survey

Chapter 4
Water Quality Survey

4.1 Background

It is said that Illegal gold mining, excessive use of agricultural chemicals / fertilizers, and domestic waste water effect coastal But water quality survey implemented in the Study area in the past were focused on only specific small areas and not continuous but ad hoc surveys. In order to realize cost effective coastal management, accurate assessment of the water quality situation and scientific analysis are necessary. Under decentralization regime, responsible agencies of monitoring of coastal water in local government are BAPEDALDA and local laboratories, but their skills on water quality monitoring are less than excellent. Under these circumstances, the Study Team conducted water quality survey in cooperation with local agencies concerned.

4.2 Objectives

There were two purposes in carrying out the water quality survey this time. They included the following:

- To identify existing water quality conditions in the Study Area.
- To transfer coastal water quality monitoring techniques such as sampling and water quality analysis skills to local governments in order to continuously carry out coastal water quality monitoring.

To achieve these objectives, The Study Team sub-contracted with Environmental Management Center (EMC: PUSARPEDAL *Pusat Sarana Pengendalian Dampak Lingkungan*) to manage and supervise this survey. The EMC, located in Jakarta, is an organization of BAPEDAL. The EMC as a technical supporting center for environmental research has a wide range of activities to implement the major environmental programs set by government. Strengthening environmental monitoring capacities across Indonesia is

one of the EMC tasks, which include technology transfer of technical perspective to local laboratories.

BAPEDALDA organized a survey team with local agencies comprising, laboratory of Ministry of Industry, laboratory of Ministry of Public Health in cooperation with BAPELITBANG North Sulawesi Province.

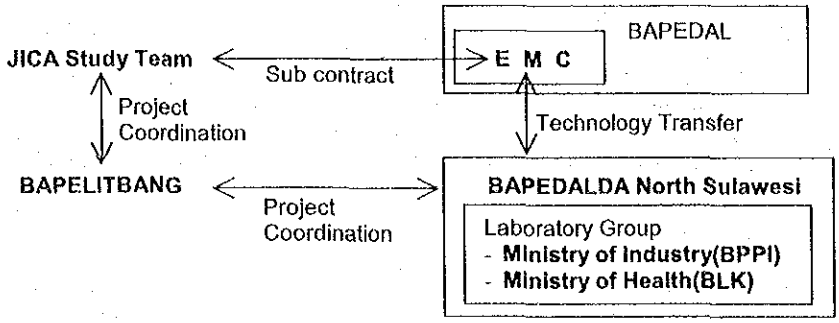


Figure 4.1 Survey Organization

Table 4.1 Members of Water Quality Survey and Technology Transfer

EMC
Bagus Bina Edvantoro M.Sc. (Team Leader)
Siti Rohmah (Deputy Leader)
Niniek Triana W
Rita
Asrul
Heny Puspita Rokhwani
Alfrida South
Ema Wita
Hafidz
Diah
Masaoki Kobayashi (EMC, JICA Expert)
Hiroyuki Kurumiya (EMC, JICA Expert)
Yasuhide Hisamoto (EMC, JICA Expert)
BAPEDALDA North Sulawesi
A.Dondokambey
Dahri M. Tahir SE
Danso Ayhuan Spi
Nelly Korah
Marhein, kawengian SE
Laboratory of Ministry of Industry (BPPI)
Meiske Lumingkewas
Amelia Walangitan, and other 3 staffs
Laboratory of Ministry of Health (BLK)
Dominggus
Ludya, and other 6 staffs

Note: Titles omitted from names

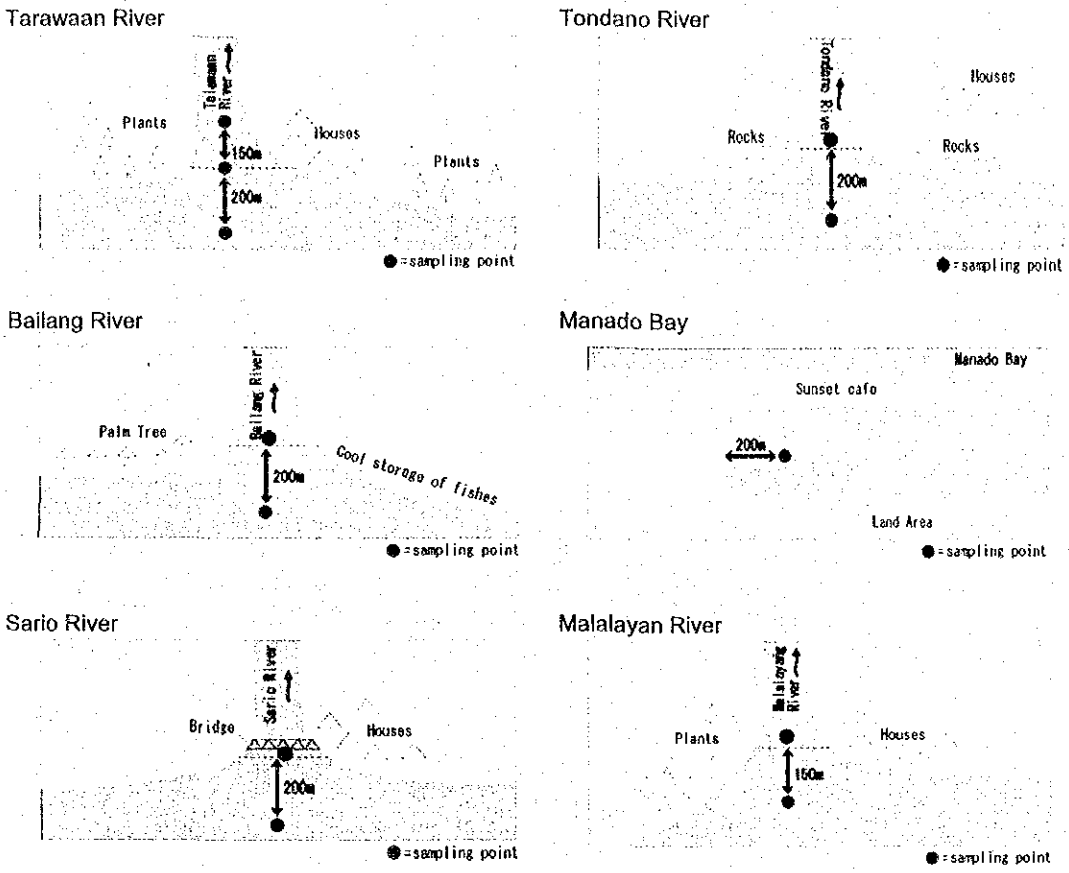
4.3 Methodology

To survey industrial wastewater, water samples, sediment samples and biological samples were taken at rivers and river mouths of the basin where the gold refining factories and agricultural land exist nearby the watershed. And to survey wastewater from the urban area, some points on the coastal area of Manado Municipality and Bitung Municipality were selected. Locations of sampling points are shown in the table below.

Table 4.2 Locations of Sampling Points

Sampling Area		GPS location
Manado Area	Talawaan river	01°37'02N 124°52'13E
	Talawaan river mouth	-
	200m from Talawaan river mouth	-
	Tondano river	01°30'17N 124°50'65E
	200m from Tondano river mouth	01°30'06N 124°50'18E
	Bailang river	01°30'43N 124°50'64E
	200 m from Bailing river mouth	01°31'28N 124°50'11E
	Manado bay	01°29'20N 124°50'05E
	Sario river	01°28'12N 124°50'06E
	200m from Sario river mouth	01°28'54N 124°49'50E
	Malalayang river	01°27'53N 124°49'30E
	150m from malalayang river mouth	01°27'67N 124°49'23E
Bitung Area	Danoubu river	01°26'20N 125°07'21E
	Danoubu river mouth	01°25'51N 125°07'52E
	200m from Danoubu river mouth	01°25'41N 125°07'92E
	Bitung Port (Bitung ferry pier)	01°26'20N 125°11'59E

Source : JICA Study Team



Source : JICA Study Team

Figure 4.2 Location Specifics of Sampling Points

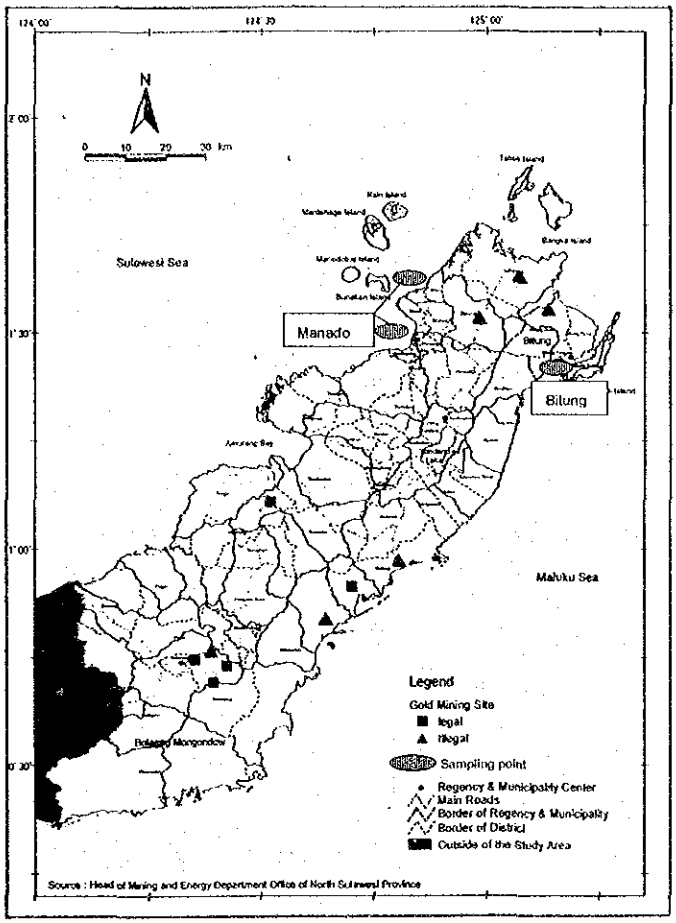


Figure 4.3 Locations of Water Quality Survey

Source : JICA Study Team

4.4 Work Period

Sampling of water started on September 2001 and the final report by EMC was submitted to the Study Team on January 2002.

Table 4.3 Work Schedule of Water Quality Survey

	Activities	September 2001		October		December		Jan. 2002
1.	Laboratory procurement							
2.	Survey and sampling 1							
3.	Analysis and technical transfer 1							
4.	Survey and sampling 2							
5.	Analysis and technical transfer 2							
6.	Survey and sampling 3							
7.	Analysis and technical transfer 3							
8.	Data interpretation							
9.	Final report							

Source : JICA Study Team

4.5 Activities

The procedure taken in the conduct of the survey follows.

4.5.1 Sampling

Water samples and sediment samples were taken at rivers and/or river mouth of the basin. Biological samples were also taken at river mouth and coastal water. To raise accuracy and avoid singularity, the sampling was done one more time.

A number of sampling points of each area was selected with emphasis on the river water, sea water and sediment samples. Water samples were collected by Van-Dorn water sampler under different depth (0.5 and 5 m depth). Sediment samples were collected by grab sampling method on the bottom of the river and sea using Eckman – Berdge Sediment Sampler. Sample containers and preservation were conducted according to the standard method (SNI: *Standarisasi Nasional Indonesia*, National Standard of Indonesia) which is normally used for general routine monitoring program. Quality control and assurance programs were always included in each sampling activity, such as field blank and field recovery samples. Sediment samples were placed in a plastic bag or polyethylene containers. All samples were placed in icebox and covered with ice during the transportation to the laboratory. Samples were kept in a cooling room at < 4oC and analyzed immediately. Sample container and preservation technique of each parameter was outlined in the following table.

Table 4.4 Sampling Technique for Each Parameter Used for the Survey

No	Parameter	Analytical method	Preservation	Sample container
1.	Temperature	Thermometer	-	-
2.	pH	pH meter	-	-
3.	DO	DO meter(Horiba)	-	-
4.	TOC	TOC meter		100 mL dark glass bottle
5.	*Transparency*	*Sacchi Disk*	-	-
6.	Suspended solid	Gravimetry	Filtration and kept at 4°C	200 mL poly-ethylene
7.	Conductivity	Conductivity meter (Hach)	-	-
8.	Turbidity	Turbidity meter (Horiba)	Filtration and kept at 4°C	-
9.	Salinity	Salinometer (Horiba)	-	-
10.	Total N	UV/vis spectrophotometer	Filtration and kept at 4°C	1 L polyethylene
11.	Phosphate	UV/vis spectrophotometer	Filtration and kept at 4°C	100 mL glass bottle
12.	Coliform bacteria	MPN method	Kept at 4°C	100 mL sterilized dark glass bottle
13.	Organochlorine pesticide	GC/MS	Kept at 4°C	1 L dark glass bottle
14.	*Total mercury* (Hg)	Hg analyzer (cold vapor AAS)	Acidified with HNO_3 (pH < 2)	500 mL dark glass bottle
15	Total NH3	Phenate method		

Source: EMC

4.5.2 Analysis Items

General parameters were carried out according to the standard method (SNI) which was modified by EMC. Total coliform analysis was determined by MPN (most probable number) method. Total Hg content was determined by the method developed by Dr. Hirokatsu Akagi (Minamata Institute , Ministry of Environment, Japan). Organochlorine pesticide was analyzed by gas chromatography method after extraction and purification sample procedure. All the analysis was conducted in triplicate and will also involve QA/QC program such as blank samples, recovery samples and standard samples for evaluation of data reliability.

Sampling and analysis were for the following parameters:

(1) For General Parameters

a) Samples

- Seawater samples: pH, Temperature, COD or TOC, DO, SS, Salinity, Turbidity
- River water samples: pH, Temperature, COD, DO, SS, Salinity, Turbidity

b. Sampling Points (19 samples)

- Seawater samples: 11 points
- River water samples: 7 points

c. Sampling Layer

- Water samples: Surface water

(2) For Mercury Contamination

a. Samples

- Water samples: T-Hg, R-Hg
- Sediment samples: T-Hg, R-Hg

b. Sampling Points (30 samples)

- Seawater samples : 9 points
- River water samples: 6 points
- Sediment samples: 15 points

c. Sampling Layer

- Water samples: Surface water
- Sediment samples: Surface

(3) For Pesticide

a. Samples

- Water samples: Organochlorine, Pesticides
- Sediment samples: Organochlorine

b. Sampling Points (29 samples)

- Seawater samples: 9 points
- River water samples: 6 points
- Sediment samples: 14 points

c. Sampling Layer

- Water samples :Surface water
- Sediment samples: Surface

(4) For Organic Water Pollution

a. Samples

- Seawater samples: SS, TOC, Total-N, Phosphate, Total Coliform
- River water samples: SS, TOC, Total-N, Phosphate, Total Coliform

b. Sampling Points (26 samples)

- Seawater samples: 13 points × 2 layers
- River water samples: 6 points

c. Sampling Layer

- Water samples :2 layers : Surface water and 5 m below surface) or
  1 layer of Surface water, 1m above the bottom
  (In case the depth doesn't reach 5m)

Brief methods of analytical procedure used in the laboratory is outlined in Table 4.16.

4.5.3 Technology Transfer

Technical skills for water quality sampling and chemical analysis shall be transferred to the local government staffs by EMC survey members through joint work as "on the job-training" involving selection of sampling points, sample collection in the field and analytical practice in the laboratory. Samples collection was conducted together among EMC, local laboratories (Laboratories of Ministry of Health(BLK) and Ministry of Industry(BPPI)), the Study Team and BAPEDALDA. The samples were divided in accordance to the type of analysis which was performed. For general parameters and domestic parameters, all the samples were analyzed by local laboratories after technology transfer provided by EMC. While, parameter of total mercury (Hg) as well as

organochlorine pesticides were analyzed by EMC laboratory since the local laboratory rarely conduct the analysis of such parameters especially for the sea samples. However, the technical transfer was also given to the local laboratories for the above analyses by EMC, so the monitoring of mercury and organochlorine pesticides could be carried on by the local laboratory in the future.

And furthermore, a technical guidance for sampling and analysis for marine monitoring programs was prepared not only for the person who participated this survey but also for staff in other laboratories in relation with the program of integrated coastal management in the province. It is expected that this guidance will be utilized by the local government in North Sulawesi to continuously monitor the coastal marine as specified in the guideline.

4.6 Result of Survey

4.6.1 Water Quality in River

(1) Water sample

According to the quality standard for river water set by Government Regulation no. 20/1990 regarding environmental quality standard for B category (drinking water purposes requiring the initial treatment), the permissible value for a number of parameters are outlined as follows:

Table 4.5 Standard of River Water

Item	Standard
- Temperature	: normal $\pm$ 3°C
- pH	: 5-9
- Dissolved oxygen	: $\geq$ 6 mg/L
- Suspended solid	: $\leq$1000 mg/L
- NH_3	: $\leq$0.5 mg/L
- Nitrate	: $\leq$10 mg/L
- Nitrite	: $\leq$1 mg/L
- Mercury	: $\leq$0.001 mg/L (1 µg/L)
- Aldrin and dieldrin	: $\leq$0.017 mg/L (17µg/L)
- Chlordane	: $\leq$0.003 mg/L (3µg/L)
- DDT	: $\leq$0.042 mg/L (42µg/L)

Source: Government Regulation No. 20/1990, compiled by EMC

Based on the results of analysis for river water samples, most samples for the measurement of temperature, suspended solid and pH are within the range of the quality standard set by Indonesian Government, except the pH value for Sario river reached 10.52

which was characterized by the strong odor of H_2S. Similarly, concentrations of dissolved oxygen in most river water samples fall in the permissible value, except in Bailang river and Sario river where the concentration were found to be low 3.85 and 2.72 mg/L, respectively and these sampling locations had high content of H_2S. Total N concentrations in the river water samples ranged between 0.48 and 6.07 mg/L. The government does not set the quality standard for total N, but it was set in the form of nitrate and nitrite Therefore, the results on total N cannot be compared with the existing standard set by Indonesian Government regulation. Furthermore, the concentration of NH_3 analyzed by EMC was still below the quality standard. Concentrations of harmful substances in all river water samples for mercury and organochlorine pesticides (aldrine and DDT) are under compliance of government regulation.

(2) Sediment sample

The government has not established the regulation for river sediment samples yet, so it needs to be compared with the existing conditions in other area in Indonesia or regulations of other countries. The concentrations of total mercury in rivers where gold mining sites exist (South Sumatera, Jambi and South Sulawesi) had a range from 20 to 2,120 ng/g dry weight basis. Furthermore, permissible value for total mercury in sediment set by instruction October 28, No.119 instruction by Director of Water Quality Conservation, Japanese Environmental Agency is 25 ug/g (25,000 ng/g).

Sediment Sampling

Based on the results of total mercury concentrations sampled in North Sulawesi, it showed that the concentrations in river sediment samples ranged from < 0.1 to 1,234 ng/g. Generally, the results of river sediment in the Study area were considered to be lower than other area in Indonesia. Besides, the results were also much lower than the standard established by Japan.

4.6.2 Water Quality in Marine

(1) Water sample

According to the quality standard for marine water set by Minister Decree of Environment no. 02/1988 regarding sea water quality standard in Indonesia, the permissible value for a number of parameters are outlined as follows:

Table 4.6 Standard of Marine Water

Item	Standard
- Temperature	: 23-30°C
- pH	: 6-9
- Transparency	: ≤ 30 m
- Turbidity	: ≤ 30 turbidity unit
- Suspended solid	: ≤ 23 mg/L
- Salinity	: 10 ‰
- DO	: ≥ 5 mg/L
- NH_3-N	: ≤ 4 mg/L
- NO_2-N	: None
- Organochlorine	: ≤ 0.042 mg/L (42 µg/L)
- Mercury	: ≤ 0.005 mg/L (5µg/L)
- Coliform	: ≤ 1000 Cell/100mL

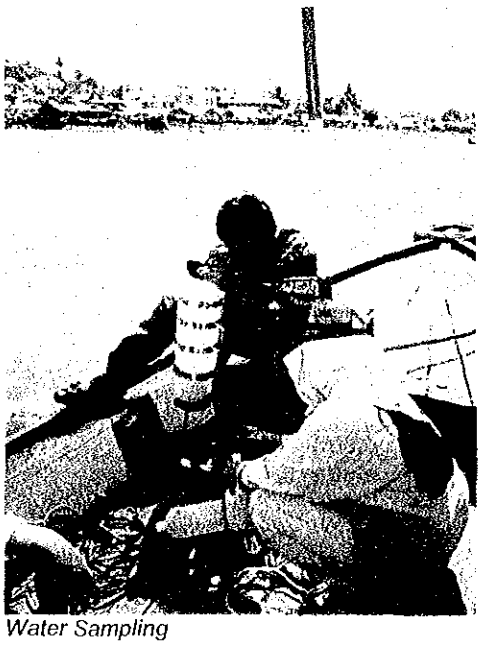
Source: Minister Decree of Environment no. 02/1988, compiled by EMC

The results on general paramcters for most sea water samples including water temperature, pH, transparency and dissolved oxygen (DO) are within the limit of permissible values, except in a number of sampling points where are found to be beyond the standard, such as for water temperature at sampling points as follows: sea water about 200 m from Danowudu river mouth (30.1°C), Talawaan river mouth (30.3-31.6°C), Manado bay (30,3-31.4°C) and Sario river mouth (30.5°C); for pH measurement at sampling location of sea water about 200 m from Malalayang river mouth (pH value was10.52). At several sampling points, turbidity values were greater than the set quality standard including Tondano river mouth (53 NTU), Danowudu river mouth (52 NTU), sea water about 200 m from Tondano river mouth (53 NTU) and sea water about 200 m from Bailang river mouth (35 NTU). NTU are normally used as the unit of turbidity which stands for Nephelometric Turbidity Unit. Salinity parameter at a number of locations were found to be higher than regulation, such as sea water about 200 m from Danowudu river mouth (34.9 ‰), Bitung ferry pier (35.3 ‰), Tondano river mouth (33.3 ‰), Bailang river mouth (35.1 ‰), sea water about 200 m from Talawaan river mouth (35 ‰), sea water about 200 m from Sario river mouth (32.0 ‰), and Sario river mouth (35.4 ‰).

Suspended solid measurement at several sampling points is indicated to be higher than criteria in the regulation involving Danowudu river mouth (58.0 mg/L), Tondano river mouth (35.5 mg/L), Talawaan river mouth (25.0 mg/L) and the value was becoming much higher when sampled on 02 November 2001 with the result as follows: Danowudu river mouth (852 mg/L), Tondano river mouth (167 mg/L), Bailang river mouth (205 mg/L). The results of total N in all sea water samples are found to be greater than the Japanese

environmental quality standard (0.2 mg/L) and the concentrations of total N in the samples during the survey ranged from 0.48-6.07 mg/L. Similarly, the content of total P in most sea water samples are higher than the Japanese environmental quality standard (0.02 mg/L) and the concentrations of total P in the samples collected around Manado ranged from 0.01-0.38 mg/L.

Concentrations of harmful substances in all river water samples for mercury and organochlorine pesticides are under compliance of government regulation. However, at some sampling points the concentrations of organochlorine pesticides in sea water samples were greater than the regulation from other countries, such as concentrations of DDT which was recommended by standards from ASEAN and Hawaii was 0.13 μg/L. While, the sampling locations where DDT contents are higher than above standard including Bailang river mouth (0.689 μg/L) and Manado bay (0.198 μg/L).



Water Sampling

Marine environment quality set by Florida Government has more stringent mercury standard which should be less than 0.025 μg/L. It showed that many sampling places in Manado has greater concentrations of Hg than the value set by Florida Government including Tondano river mouth (0.11 μg/L), Talawaan river mouth (0.59 μg/L), Manado bay (0.15 μg/L) and Malalayang river mouth (0.18 μg/L).

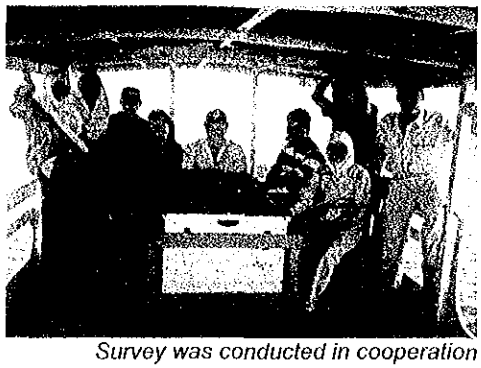
(2) Sediment sample

The Indonesian government does not establish the regulation for sea sediment samples yet, so it needs to be compared with other area in Indonesia or the regulations of other countries. Samples taken at sea sediment of Jakarta bay in 1996 had a range from 130 to 1,630 ng/g dry weight basis. Sea sediment samples collected far further from the shoreline in thousand islands in 2001 had a range from 6 to 1,730ng/g dry weight basis. The survey results of concentrations of mercury in sea sediment samples in the Study area ranged from 0.1 to 768 ng/g were lower than sea sediment levels surveyed in Jakarta bay. Besides, the results were also much lower than the standard 25 ug/g (25,000 ng/g) established by Japanese Government.(October 28, No.119 instruction by Director of Water Quality Conservation, Japanese Environmental Agency)

4.6.3 Outcomes of technology transfer

(1) Capacity building of human resources

a) Knowledge of local government on the sampling activity especially for sea water survey was improved with regards to selection of sampling point, field data recording, sample collection, sample handling, sample preservation, sample transportation and sample storage.



Survey was conducted in cooperation with Local Laboratories
Photo: JICA Study Team

b) Local laboratories (BLK and BPPI) gained the ability to analyze a number of parameters particularly for seawater and sediment samples. Presently, both laboratories are able to analyze TOC, Total N, Total P(or Phosphate) and total mercury either in fresh or sea water samples as a result of technical transfer from EMC. The other general parameters had also been handled by local laboratories, which consists of pH, temperature, conductivity, turbidity/transparency, salinity, and DO, and total coliform. However, the analysis of organochlorine pesticides still needs to be upgraded for local laboratories due to limitations of laboratory accessories, glassware and instrumentation.

c) Technical skill on the program of quality assurance and quality control (QA/QC) for sampling and laboratory practices had also been provided in order to produce highly reliable data. The practices started from sampling, washing, cleaning, chemical preparing, sample pretreatment (blank, recovery sample, replicate samples), standard curve for calibration, analytical result and simple statistic calculation (standard deviation and percent recovery).

Technology Transfer to Local Laboratories

(2) Laboratory tools assistance

In accordance with a number of glassware and chemicals required for this survey, these were handed from EMC to local laboratories after this survey as below:

- Glassware: separating funnel, extraction bottle, conical flask (for pesticide analysis) and others.
- Chemicals: $SnCl_2$, $KMnO_4$, ascorbic acid, some microbiological media and others.

(3) Comments on technical transfer

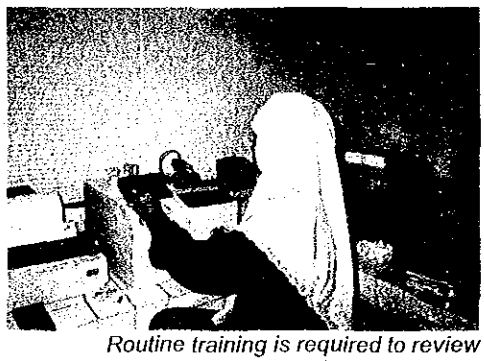
a) Coordination between local laboratories and BAPEDALDA needs to be strengthen for the implementation of monitoring on environmental quality programs, especially for the management of coral reef in North Sulawesi.

b) Routine training for local laboratory on the practice of sampling and analysis needs to be undertaken to review the knowledge and skills so they can keep and maintain the high precision and accuracy data.

c) Power generation in laboratories should be sufficient for daily operation in order to prevent the power failure, which potentially causes damage the analytical instruments in the laboratory.

d) The distillation apparatus for water needs to be upgraded particularly for generating distilled water for the analysis purposes such as mercury, metals, sulfate, phosphate, etc.

e) Chemical storage needs to be more attention, as this would affect the deterioration and life of chemicals.



Routine training is required to review the knowledge and skills

f) A number of supporting accessories need to be procured for pesticide analysis in the laboratory such as shaker, rotary evaporator, some glassware and others.

Table 4.7 Result of Basic Parameters 1 (by Local Laboratories)

Sampling sites	Sampling Point	Detail of depth (m)	Suspended solid (mg/L)	TOC (mg/L)	Total N (mg/L)	Phosphate (mg/L)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Transparency (m)	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung																	
(Oct 18,2001)	Danowudu river	0.3	48.0	3.94	1.38	0.18	13.25	fair	27.1	transparent	odourless	8.44	-	0.2	<0.1	23	7.96
	Danowudu river mouth	0.3	58.0	4.57	0.83	0.23	14.45	fair	27.2	transparent	odourless	7.74	-	0.2	<0.1	22	6.86
	200 m from Danowudu river mouth	0.3	2.5	4.94	0.67	0.04	15.15	fair	29.5	transparent	odourless	8.18	-	52.3	35.0	<1	6.62
		3.0	2.0	3.69	1.31	0.04	15.2	fair	28.9	transparent	odourless	8.22	-	52.4	35.0	<1	7.18
	Bitung ferry pier	0.3	3.0	3.79	0.78	0.03	12.02	fair	29.0	transparent	odourless	8.37	-	51.5	34.0	<1	6.68
		3.3	6.0	3.88	4.16	0.02	12.15	fair	28.7	transparent	odourless	8.25	-	52.1	34.0	<1	6.68
II. Manado																	
(Oct 18,2001)	Tondano river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tondano river mouth	0.3	35.5	1.75	1.07	0.09	9.10	fair	28.4	transparent	foul	7.76	1.6	32.2	15.0	9	5.77
		3.5	35.0	1.19	1.56	0.11	9 20	fair	28.0	transparent	foul	7.50	1.6	38.7	25.0	8	5.60
	Bailang river	0.5	-	-	-	-	-	fair	-	transparent	odourless	-	-	-	-	-	-
	Bailang river mouth	0.3	28.5	4.30	0.95	0.03	9.55	fair	30.0	transparent	odourless	7.99	1.5	51.0	34.0	4	6.18
		3.5	13.5	3.82	1.95	0.04	10.02	fair	30.0	transparent	odourless	8.09	1.5	51.3	34.0	5	6.14
	Talawaan river	0.3	8.5	6.98	0.48	0.08	11.30	fair	30.8	transparent	odourless	6.89	0.5	7.9	0.8	8	6.66
	Talawaan river mouth	2.0	25.0	3.65	0.88	0 07	11.37	fair	30 3	transparent	odourless	7.22	1.0	7.9	0.4	13	6.35
	200 m from Talawaan river mouth	0.3	5.5	3.44	1.59	0.04	12.25	fair	30.6	transparent	odourless	7.63	11.0	2.6	0.5	6	6.78
		7.0	4.0	4.23	6.07	0.11	12.03	fair	29.8	transparent	odourless	8.11	11.0	52.5	35.0	<1	6.61
	Manado bay	0.3	1.0	5.08	0.74	0.06	14.13	fair	30.9	transparent	odourless	7.82	7.0	45.8	29.0	1	6.51
		3.0	6.5	4.81	1.30	0.05	14.16	fair	31.4	transparent	odourless	8.07	7.0	47.1	32.0	2	7.06
	Sario river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sario river mouth	0.3	2.5	4.21	0.95	0.01	13.55	cloudy	30.5	transparent	odourless	7.96	12.0	50.0	32.0	<1	6.12
		4.0	2.5	3.64	1.49	0.03	14.00	cloudy	30.2	transparent	odourless	8.21	12.0	52.2	32.0	<1	6.45
	Malalayang river mouth	0.3	1.0	4.15	1.21	0.03	15.45	cloudy	29.5	transparent	odourless	7.61	3.5	49.10	30.0	<1	6.46
		5.0	2.5	5.86	0.98	0.25	1540	cloudy	28.0	transparent	odourless	7.68	3.5	51.10	30.1	<1	6.25

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.8 Result of Basic Parameters 2 (by EMC)

Sampling sites	Sampling Point	Detail of depth (m)	Suspended solid (mg/L)	TOC (mg/L)	Total N (mg/L)	Total NH3 (mg/L)	Phosphate (mg/L)	Total coliform (cells/100 mL)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Transparency (m)	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung																			
(Oct 18,2001)	Danowudu river	0.5	48.0	4.24	1.03	<0.04	0.16	> 2400	13.25	fair	27.1	transparent	odourless	8.44	-	0.2	<0.1	23	7.96
	Danowudu river mouth	0.5	58.0	5.07	0.55	0.22	0.20	> 2400	14.45	fair	27.2	transparent	odourless	7.74	-	0.2	<0.1	22	6.86
	200 m from Danowudu river mouth	0.5	2.5	4.26	1.46	<0.04	0.03	130	15.15	fair	29.5	transparent	odourless	8.18	-	52.3	35.0	<1	6.62
		2.3	2.0	4.95	1.37	<0.04	0.04	> 2400	15.2	fair	28.9	transparent	odourless	8.22	-	52.4	35.0	<1	7.18
	Bitung ferry pier	0.5	3.0	4.84	2.11	0.04	0.03	> 2400	12.02	fair	29.0	transparent	odourless	8.37	-	51.5	34.0	<1	6.68
		3.3	6.0	6.21	2.26	<0.04	0.04	> 2400	12.15	fair	28.7	transparent	odourless	8.25	-	52.1	34.0	<1	6.68
II. Manado																			
(Oct 18,2001)	Tondano river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tondano river mouth	0.5	35.5	4.60	1.55	0.08	0.05	> 2400	9.10	fair	28.4	transparent	foul	7.76	1.6	32.2	15.0	9	5.77
		1.0	35.0	4.61	1.35	0.10	0.03	> 2400	9.20	fair	28.0	transparent	foul	7.50	1.6	38.7	25.0	8	5.60
	Bailang river	0.5	-	-	-	-	-	-	-	fair	-	transparent	odourless	-	-	-	-	-	-
	Bailang river mouth	0.5	28.5	4.30	2.38	<0.04	0.04	> 2400	9.55	fair	30.0	transparent	odourless	7.99	1.5	51.0	34.0	4	6.18
		1.0	13.5	4.91	2.04	<0.04	0.04	> 2400	10.02	fair	30.0	transparent	odourless	8.09	1.5	51.3	34.0	5	6.14
	Talawaan river	0.3	8.5	5.79	1.00	<0.04	0.05	> 2400	11.30	fair	30.8	transparent	odourless	6.89	0.5	7.9	0.8	8	5.68
	Talawaan river mouth	2.0	25.0	4.65	0.92	0.04	0.12	920	11.37	fair	30.3	transparent	odourless	7.22	1.0	7.9	0.4	13	5.35
	200 m from Talawaan river mouth	0.5	5.5	4.18	2.12	<0.04	0.06	540	12.25	fair	30.6	transparent	odourless	7.63	11.0	2.6	0.5	6	6.78
		7.0	4.0	3.88	2.29	<0.04	0.05	2	12.03	fair	29.8	transparent	odourless	8.11	11.0	52.5	35.0	<1	5.61
	Manado bay	0.5	1.0	4.75	1.26	0.04	0.05	> 2400	14.13	fair	30.9	transparent	odourless	7.82	7.0	45.8	29.0	1	6.51
		5.0	6.5	4.89	1.56	<0.04	0.03	540	14.16	fair	31.4	transparent	odourless	8.07	7.0	47.1	32.0	2	7.06
	Sario river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	200 m from Sario river mouth	0.5	2.5	4.51	2.16	<0.04	0.02	70	13.55	cloudy	30.5	transparent	odourless	7.96	12.0	50.0	32.0	<1	6.12
		5.0	2.5	4.25	2.11	<0.04	0.03	920	14.00	cloudy	30.2	transparent	odourless	8.21	12.0	52.2	32.0	<1	6.45
	200 m from Malalayang river mouth	0.5	1.0	3.49	2.05	<0.04	0.04	> 2400	15.45	cloudy	29.5	transparent	odourless	7.61	3.5	49.10	30.0	<1	6.46
		5.0	2.5	5.93	2.30	<0.04	0.38	47	1540	cloudy	28.0	transparent	odourless	7.68	3.5	51.10	30.1	<1	6.25

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.9 Result of Basic Parameters 3 (by EMC)

Sampling sites	Sampling Point	Detail of depth (m)	Suspended Solid (mg/L)	TOC (mg/L)	Total N (mg/L)	Phosphate (mg/L)	Total coliform (cells/100 mL)	Time (WITA)	Climate	Water temp. (°C)	Colour	Odour	pH	Transparency (m)	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung																		
(Nov.2, 2001)	Danowudu river	0.5	392	3.31	0.55	<0.003	>2400	12:06	fair	27.9	brown	odourless	8.43	0.4	0.2	<0.1	58	6.83
	Danowudu river mouth	0.5	852	2.10	0.82	<0.003	>2400	12:50	fair	28.9	brown	odourless	8.57	0.4	0.2	<0.1	52	6.28
	200 m from Danowudu river mouth	0.5	16	3.33	1.57	<0.003	0	13:34	fair	30.1	transparent	odourless	8.32	5.25	52.0	34	<1	6.90
		2.3	16	4.91	1.72	<0.003	2	13:38	fair	30.0	transparent	odourless	8.36		52.3	35	<1	6.69
	Bitung ferry pier	0.5	49	2.79	1.71	<0.003	>2400	11:14	fair	29.4	transparent	odourless	8.34	4.25	52.1	34	<1	6.18
		3.3	9	2.78	1.64	0.01	350	11:22	fair	29.3	transparent	odourless	8.34		52.3	35	<1	7.37
II. Manado																		
(Nov.2,2001)	Tondano river	0.3	-	-	-	-	-	17:15	rainy	26.6	brown	odourless	8.35	0.2	0.1	<0.1	456	5.56
		2.0	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
	Tondano river mouth	0.5	167	6.64	0.95	<0.003	<2400	10:25	fair	27.8	brown	odourless	8.05	0.7	19.4	14.9	20	7.08
		1.0	132	4.90	1.09	<0.003	<2400	10:30	fair	29.6	brown	odourless	8.12		49.5	33.3	53	7.25
	Bailang river	0.5	-	-	-	-	-	9:45	fair	26.7	brown	odourless	7.21	0.3	13.8	8	88	7.10
	Bailang river mouth	0.5	205	4.56	0.67	<0.003	>2400	10:00	fair	29.9	transparent	odourless	8.30	0.4	47.9	31	35	6.44
		3.0	4	4.92	1.30	<0.003	1600	10:07	fair	29.8	transparent	odourless	8.32		52.2	35	32	6.28
	Talawaan river	0.3	-	-	-	-	-											
	Talawaan river mouth	2.0	-	-	-	-	-											
	200 m from Talawaan river mouth	0.5	-	-	-	-	-											
		7	-	-	-	-	-											
	Manado bay	0.5	9	5.33	0.77	<0.003	>2400	10:50	fair	30.6	transparent	odourless	8.40	2.4	42.8	28	6	6.18
		5.0	-	7.24	1.76	<0.003	1600	10:55	fair	30.2	transparent	odourless	8.42		52.2	35	<1	6.60
	Sario river	0.3	-	-	-	-	-	12:56	rainy	28.7	black	H_2S	10.46	0.2	6.0	0.2	6	3.40
		2.0	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
	200 m from Sario river mouth	0.5	22	4.89	2.04	<0.003	>2400	11:17	fair	30.3	transparent	odourless	8.60	-	51.3	34	<1	6.59
		5.0	38	4.91	1.69	<0.003	1600	11:23	fair	30.2	transparent	odourless	8.40		52.2	34	<1	6.80
	200 m from Malalayang river mouth	0.5	3	8.02	1.29	<0.003	>2400	12:45	rainy	26.8	black	odourless	10.52	0.5	0.4	<0.1	8	5.90
		5.0	20	7.25	1.67	<0.003	>2400											

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.10 Harmful Substances In Water Samples 1

Sampling sites	Sampling Point	Detail of depth (m)	Total Hg (mg/L)	Lindane (mg/L)	Heptachlor (mg/L)	Aldrin (mg/L)	o,p-DDE (mg/L)	p,p-DDE (mg/L)	p,p-DDD (mg/L)	Endrin (mg/L)	o,p-DDD (mg/L)	p,p-DDT (mg/L)	o,p-DDT (mg/L)	Metoxychlor (mg/L)	Range of depth (m)	Detail of depth (m)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Conductivity (mS/cm)	Salinity ($^0/_{00}$)	Turbidity (NTU)	DO (mg/L)
I. Bitung (Sep 25, 2001)	Danowudu river	0.3	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	15:10	fair	29.7	transparent	odourless	7.92	0.2	<0.1	11	9.24
	Danowudu river mouth	0.3	-	< 0.002	< 0.002	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	11:42	fair	30.1	transparent	odourless	7.53	0.1	<0.1	11	8.65
	200 m from Danowudu river mouth	0.3	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	12:40	fair	29.6	transparent	odourless	8.15	52.4	34.7	3	9.32
		3.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.0	12:50	fair	28.9	transparent	odourless	8.60	52.7	34.9	5	9.6
	Bitung ferry pier	0.3	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	13:45	fair	28.0	transparent	odourless	8.16	53.1	35.2	<1	9.01
		3.3	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.0	13:55	fair	27.9	transparent	odourless	8.18	53.2	35.3	<1	9.09
II. Manado (Sep 26, 2001)	Tondano river	0.3	0.13	< 0.002	< 0.002	0.059	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	8:35	fair	26.6	brown	foul	7.16	0.3	0.1	24	6.24
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	8:40	fair	26.7	transparent	foul	7.43	0.3	0.1	22	6.4
	Tondano river mouth	0.3	0.11	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	8:50	fair	27.8	transparent	foul	8.05	19.4	14.9	20	7.08
		3.5	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.5	8:55	fair	29.6	transparent	foul	8.12	49.5	33.3	53	7.25
	Beilang river	0.5	0.63	< 0.002	< 0.002	0.078	< 0.002	0.096	< 0.002	< 0.002	< 0.002	0.133	< 0.002	< 0.002	0.5	0.5	9:30	fair	29.0	transparent	odourless	7.95	47.9	30.1	30	3.85
	Beilang river mouth	0.3	0.02	0.007	< 0.002	< 0.002	< 0.002	< 0.002	0.006	0.028	0.003	0.013	< 0.002	< 0.002	0.5	0.3	9:50	fair	29.7	transparent	odourless	8.22	52.8	35.1	9	9.01
		3.5	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.5	9:45	fair	29.6	transparent	odourless	8.24	52.8	35	1	8.88
	Talawaan river	0.3	0.68	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:00	fair	29.3	transparent	odourless	7.53	7.8	0.8	10	7.69
	Talawaan river mouth	2.0	0.59	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	11:15	fair	31.6	transparent	odourless	8.20	52.4	34.8	3	9.26
	200 m from Talawaan river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:20	fair	28.8	transparent	odourless	8.28	53.4	35.4	<1	9.48
		7.0	-	-	-	-	-	-	-	-	-	-	-	-	*10.0*	*7.0*	*11:30*	*fair*	*28.7*	*transparent*	*odourless*	8.32	53.7	35.6	<1	9.75
	Manado bay	0.3	0.15	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	14:15	fair	30.3	transparent	odourless	8.30	53	35	1	7.65
		3.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.0	14:30	fair	30.4	transparent	odourless	8.33	52.9	35	1	7.38
	Sario river	0.3	0.41	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	14:40	fair	30.3	slight green	H_2S	6.66	50.8	25	5	2.72
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	15:10	cloudy	30.3	transparent	odourless	8.21	53.5	35.3	<1	8.9
	Sario river mouth	0.3	0.07	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	15:15	fair	29.9	transparent	odourless	8.14	53.4	35.4	1	9.33
		4.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	4.0	15:35	cloudy	30.3	transparent	odourless	8.13	53.4	35.3	1	8.37
	Malalayang river	0.3	0.18	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	15:50	fair	26.5	transparent	odourless	7.63	0.45	0.1	8	9.81
	Malalayang river mouth	0.3	0.18	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002													
		5.0	-	-	-	-	-	-	-	-	-	-	-	-												

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.11 Harmful Substances In Water Samples 2

Sampling sites	Sampling Point	Detail of depth (m)	Total Hg (mg/L)	Lindane (mg/L)	Heptachlor (mg/L)	Aldrin (mg/L)	o,p-DDE (mg/L)	p,p-DDE (mg/L)	p,p-DDD (mg/L)	Endrin (mg/L)	o,p-DDD (mg/L)	p,p-DDT (mg/L)	o,p-DDT (mg/L)	Metoxychlor (mg/L)	Range depth (m)	Detail depth (m)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Transparency (m)	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung (Nov.2, 2001)	Danowudu river	0.5	-	0.012	0.057	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	12:06	fair	27.9	brown	odourless	8.43	0.4	0.2	<0.1	58	6.93
	Danowudu river mouth	0.5	-	< 0.002	0.005	0.003	< 0.002	< 0.002	< 0.002	0.007	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	12:50	fair	28.9	brown	odourless	8.57	0.4	0.2	<0.1	52	6.28
	200 m from Danowudu river mouth	0.5	-	< 0.002	< 0.002	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.5	13:34	fair	30.1	transparent	odourless	8.32	5.25	52.0	34	<1	5.90
		2.3	-	-	-	-	-	-	-	-	-	-	-	-	5.0	2.3	13:38	fair	30.0	transparent	odourless	8.36		52.3	35	<1	5.88
	Bitung ferry pier	0.5	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.5	0.3	11:14	fair	29.4	transparent	odourless	8.34	4.25	52.1	34	<1	5.18
		3.3	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.3	11:22	fair	29.3	transparent	odourless	8.34		52.3	35	<1	7.37
II. Manado (Nov.2, 2001)	Tondano river	0.3	<0.1	< 0.002	0.031	0.123	< 0.002	0.008	< 0.002	< 0.002	< 0.002	0.012	< 0.002	< 0.002	0.5	0.5	17:15	rainy	26.6	brown	odourless	8.25	0.2	0.1	<0.1	456	5.56
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	-	-	-	-	-	-		-	-	-	-
	Tondano river mouth	0.5	<0.1	0.005	0.034	0.043	< 0.002	< 0.002	0.013	< 0.002	0.007	0.01	< 0.002	< 0.002	0.5	0.3	10:25	fair	27.8	brown	odourless	8.05	0.7	19.4	14.9	20	7.38
		1.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	3.5	10:30	fair	29.6	brown	odourless	8.12		49.5	33.3	52	7.25
	Beilang river	0.5	<0.1	0.023	< 0.002	< 0.002	< 0.002	0.026	< 0.002	0.617	< 0.002	0.054	< 0.002	< 0.002	0.5	0.5	9:45	fair	26.7	brown	odourless	7.21	0.3	13.8	8	88	7.10
	Beilang river mouth	0.5	<0.1	0.012	< 0.002	0.084	0.033	0.051	0.056	< 0.002	0.057	0.689	< 0.002	< 0.002	0.5	0.5	10:00	fair	29.9	transparent	odourless	8.30	0.4	47.9	31	35	6.44
		3.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	1.0	10:07	fair	29.8	transparent	odourless	8.32		52.2	35	32	5.28
	Talawaan river	0.3	-	-	-	-	-	-	-	-	-	-	-	-													
	Talawaan river mouth	2.0	-	-	-	-	-	-	-	-	-	-	-	-													
	200 m from Talawaan river mouth	0.5	-	-	-	-	-	-	-	-	-	-	-	-													
		7.0	-	-	-	-	-	-	-	-	-	-	-	-													
	Manado bay	0.5	<0.1	0.007	0.015	0.005	< 0.002	< 0.002	1.515	0.03	< 0.002	< 0.002	0.007	< 0.002	0.5	0.3	10:50	fair	30.6	transparent	odourless	8.40	2.4	42.8	28	6	5.18
		5.0	-	-	0.091	0.088	0.026	0.007	0.009	0.155	-	0.198	-	-	5.0	3.0	10:55	fair	30.2	transparent	odourless	8.42		52.2	35	<1	5.60
	Sario river	0.3	<0.1	0.010	< 0.002	< 0.002	< 0.002	0.026	0.038	0.042	0.033	0.019	< 0.002	< 0.002	0.5	0.5	12:56	rainy	28.7	black	H_2S	10.46	0.2	6.0	0.2	6	3.40
		2.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	-	-	-	-	-	-		-	-	-	-
	200 m from Sario river mouth	0.5	<0.1	< 0.002	< 0.002	< 0.002	< 0.002	0.004	0.008	< 0.002	0.003	0.003	< 0.002	< 0.002	0.5	0.3	11:17	fair	30.3	transparent	odourless	8.60	-	51.3	34	<1	5.59
		5.0	-	-	-	-	-	-	-	-	-	-	-	-	5.0	4.0	11:23	fair	30.2	transparent	odourless	8.40		52.2	34	<1	5.80
	Malalayang river	0.5	<0.1	0.013	< 0.002	< 0.002	< 0.002	< 0.002	0.004	0.118	< 0.002	< 0.002	-	-	0.5	0.5	12:45	rainy	26.8	black	odourless	10.52	0.5	0.4	<0.1	8	6.90
	200 m from Malalayang river mouth	0.5	<0.1	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002														
		5.0	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002													

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.12 Harmful Substances In Sediment Samples 1

Sampling sites	Sampling Point	Detail of depth (m)	Total Hg (ng/g)	Lindane (ng/g)	Heptachlor (ng/g)	Aldrin (ng/g)	o,p-DDE (ng/g)	p,p-DDE (ng/g)	o,p-DDD (ng/g)	Endrin (ng/g)	o,p-DDD (ng/g)	p,p-DDT (ng/g)	o,p-DDT (ng/g)	Metoxychlor (ng/g)	Range of depth (m)	Detail of depth (m)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung	Danowudu river	0.3	-	< 0.1	1.821	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.5	0.3	11:10	fair	29.7	transparent	odourless	7.92	0.2	<0.1	11	9.24
(Sep 25, 2001)	Danowudu river mouth	0.3	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.5	0.3	11:42	fair	30.1	transparent	odourless	7.53	0.1	<0.1	11	8.65
	200 m from Danowudu river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	12:40	fair	29.6	transparent	odourless	8.15	52.4	34.7	3	9.32
		3.0	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	3.0	12:50	fair	28.9	transparent	odourless	8.60	52.7	34.9	5	9.6
	Bitung ferry pier	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	13:45	fair	28.0	transparent	odourless	8.16	53.1	35.2	<1	9.01
		3.3	-	< 0.1	3.693	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.09	< 0.1	< 0.1	< 0.1	5.0	3.0	13:55	fair	27.9	transparent	odourless	8.18	53.2	35.3	<1	9.09
II Manado	Tonano river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	8:35	fair	26.8	brown	foul	7.16	0.3	0.1	24	6.24
(Sep 26, 2001)	Tondano river	2.0	322.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	2.0	8:40	fair	29.7	transparent	foul	7.43	0.3	0.1	22	6.4
	Tondano river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	8:50	fair	27.8	transparent	foul	8.05	19.4	14.9	20	7.08
		3.5	207.8	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	3.5	8:55	fair	29.6	transparent	foul	8.12	49.5	33.3	53	7.25
	Bailang river	0.5	869.3	< 0.1	2.919	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.5	0.5	9:30	fair	29.0	transparent	odourless	7.95	47.9	30.1	30	3.85
	Bailang river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	9:50	fair	29.7	transparent	odourless	8.23	52.8	35.1	9	9.01
		3.5	788.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	3.5	9:45	fair	29.6	transparent	odourless	8.24	52.8	35	1	8.99
	Talawaan river	0.3	1234.4	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:00	fair	29.3	transparent	odourless	7.53	7.8	0.9	10	7.69
	Talawaan river mouth	2.0	70.3	-	-	-	-	-	-	-	-	-	-	-	5.0	2.0	11:15	fair	31.6	transparent	odourless	8.20	52.4	34.8	3	9.26
	200 m from Talawaan river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:20	fair	28.8	transparent	odourless	8.28	53.4	35.4	<1	9.48
		7.0	133.8	-	-	-	-	-	-	-	-	-	-	-	10.0	7.0	11:30	fair	28.7	transparent	odourless	8.32	53.7	35.5	<1	9.75
	Manado bay	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	14:15	fair	30.3	transparent	odourless	8.30	53	35	1	7.65
		3.0	72.7	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	3.0	14:30	fair	30.4	transparent	odourless	8.33	52.9	35	1	7.38
	Sario river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	14:40	fair	30.3	slight green	H_2S	6.66	50.8	25	5	2.72
		2.0	93.6	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	2.0	15:10	cloudy	30.3	transparent	odourless	8.21	53.5	35.3	<1	8.9
	Sario river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	15:15	fair	29.9	transparent	odourless	8.14	53.4	35.4	1	9.32
		4.0	39.9	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	4.0	15:35	cloudy	30.3	transparent	odourless	8.13	53.4	35.3	1	8.27
	Malalayang river	0.3	15.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.5	0.3	15:50	fair	26.5	transparent	odourless	7.63	0.45	0.1	8	9.91
	Malalayang river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-												
		5.0	4.6	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1												

Note : - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.13 Harmful Substances In Sediment Samples 2

Sampling sites	Sampling Point	Detail of depth (m)	Total Hg (ng/g)	Lindane (ng/g)	Heptachlor (ng/g)	Aldrin (ng/g)	o,p-DDE (ng/g)	p,p-DDE (ng/g)	p,p-DDD (ng/g)	Endrin (ng/g)	o,p-DDD (ng/g)	p,p-DDT (ng/g)	o,p-DDT (ng/g)	Metoxychlor (ng/g)	Range depth (m)	Detail depth (m)	Time (WITA)	Climate	Water temp (°C)	Colour	Odour	pH	Transparency (m)	Conductivity (mS/cm)	Salinity (‰)	Turbidity (NTU)	DO (mg/L)
I. Bitung	Danowudu river	0.3	-	< 0.1	1.821	< 0.1	3.429	< 0.1	< 0.1	1.252	< 0.1	0.255	0.396	0.029	0.5	0.3	12:06	fair	27.9	brown	odourless	8.43	0.4	0.2	<0.1	58	5.83
(Nov.2, 2001)	Danowudu river mouth	0.3	-	< 0.1	< 0.1	1.281	< 0.1	< 0.1	< 0.1	1.785	0.295	< 0.1	< 0.1	< 0.1	0.5	0.3	12:50	fair	28.9	brown	odourless	8.57	0.4	0.2	<0.1	52	5.28
	200 m from Danowudu river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	13:34	fair	30.1	transparent	odourless	8.32	5.25	52.0	34	<1	6.90
		3.0	-	0.277	< 0.1	83.735	< 0.1	< 0.1	< 0.1	190.223	30.973	< 0.1	5.055	4.331	5.0	2.3	13:38	fair	30.0	transparent	odourless	8.36		52.3	35	<1	6.69
	Bitung ferry pier	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:14	fair	29.4	transparent	odourless	8.34	4.25	52.1	34	<1	6.18
		3.3	-	31.606	3.893	< 0.1	0.733	< 0.1	0.443	0.231	0.44	< 0.1	< 0.1	< 0.1	5.0	3.3	11:22	fair	29.3	transparent	odourless	8.34		52.3	35	<1	7.27
II. Manado	Tondano river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	17:15	rainy	26.6	brown	odourless	8.35	0.2	0.1	<0.1	456	5.56
(Nov.2, 2001)		2.0	41.96	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	7.486	0.24	0.162	< 0.1	< 0.1	5.0	2.0	-	-	-	-	-	-		-	-	-	-
	Tondano river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	10:25	fair	27.8	brown	odourless	8.05	0.7	19.4	14.9	20	7.08
		3.5	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	28.868	< 0.1	1.167	103.543	1.202	5.0	3.5	10:30	fair	29.6	brown	odourless	8.12		49.5	33.3	53	7.25
	Bailang river	0.5	< 0.1	< 0.1	2.919	< 0.1	0.701	< 0.1	< 0.1	2.492	1.815	< 0.1	< 0.1	2.927	0.5	0.5	9:45	fair	26.7	brown	odourless	7.21	0.3	13.9	8	88	7.10
	Bailang river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	10:00	fair	29.9	transparent	odourless	8.30	0.4	47.9	31	35	6.44
		3.5	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	1.0	10:07	fair	29.8	transparent	odourless	8.32		52.2	35	32	6.28
	Talawaan river	0.3	-	-	-	-	-	-	-	-	-	-	-	-														
	Talawaan river mouth	2.0	-	-	-	-	-	-	-	-	-	-	-	-														
	200 m from Talawaan river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-														
		7.0	-	-	-	-	-	-	-	-	-	-	-	-														
	Manado bay	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	10:50	fair	30.6	transparent	odourless	8.40	2.4	42.8	29	6	6.18
		3.0	< 0.1	0.133	0.788	< 0.1	0.916	< 0.1	0.679	2.095	0.747	< 0.1	15.467	0.92	5.0	3.0	10:55	fair	30.2	transparent	odourless	8.42		52.2	35	<1	6.60
	Sono river	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	12:58	rainy	28.7	black	H_2S	10.46	0.2	6.0	0.2	6	3.40
		2.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	2.0	-	-	-	-	-	-		-	-	-	-
	Sono river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	11:17	fair	30.3	transparent	odourless	8.60	-	51.3	34	<1	6.58
		4.0	-	< 0.1	< 0.1	< 0.1	< 0.1	0.103	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5.0	4.0	11:23	fair	30.2	transparent	odourless	8.40		52.2	34	<1	6.80
	Malalayang river	0.3	157.55	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	4.94	< 0.1	< 0.1	< 0.1	0.13	0.5	0.5	12:45	rainy	26.8	black	odourless	10.52	0.5	0.4	<0.1	8	6.90
	Malalayang river mouth	0.3	-	-	-	-	-	-	-	-	-	-	-	-														
		5.0	-	< 0.1	0.966	1.39	< 0.1	0.195	< 0.1	< 0.1	< 0.1	< 0.1	6.588	< 0.1														

Note: - = not analysed

Source: EMC compiled by JICA Study Team

Table 4.14 Properties of Sediment Sample Used for Analysis 1

Sampling sites	Sampling Point	Depth (m)	Condition of sediment	Odor	Colour
I. Bitung	Danowudu river	1.0	silt	muddy	brownish dark
(25/9/2001)	Danowudu river mouth	0.5	silt	fish and shell	greyish dark
	200 m from Danowudu river mouth	0.5	-	-	-
	200 m from Danowudu river mouth	5.0	sandy	muddy	greyish dark
	Bitung ferry pier	0.5	-	-	-
	Bitung ferry pier	4.0	sandy	fish and shell	greyish dark
II. Manado					
(26/9/2001)	Tondano river	0.5	-	-	-
	Tondano river	3.5	sandy with gravel	mud and slight H2S	dark
	Tondano river mouth	0.5	-	-	-
	Tondano river mouth	5.0	clay	foul and fish	dark
	Bailang river	0.5	clay with some domestic wastes	slight H2S	dark
	Bailang river mouth	0.5	-	-	-
	Bailang river mouth	4.5	clay	slight H2S	dark
	Talawaan river	0.7	clay	muddy	brownish dark
	Talawaan river mouth	3.5	sandy	muddy	dark
	200 m from Talawaan river mouth	0.5	-	-	-
	200 m from Talawaan river mouth	12.0	sandy	muddy	dark
	Manado bay	0.5	-	-	-
	Manado bay	7.0	sandy	foul and fish	brownish dark
	Sario river	0.5	-	-	-
	Sario river	3.5	clay with some domestic wastes	oily	dark
	Sario river mouth	0.5	-	-	-
	Sario river mouth	6.5	silt	oily	dark
	Malalayang river mouth	0.5	-	-	-
	Malalayang river mouth	5.5	sandy	foul and fish	dark

Table 4.15 Properties of Sediment Sample Used for Analysis 2

Sampling sites	Sampling Point	Depth (m)	Condition of sediment	Odor	Merkury (mg/gr)	Colour
I. Bitung						
(2/11/2001)	Danowudu river	1.0	-	-	-	-
	Danowudu river mouth	0.5	-	-	-	-
	200 m from Danowudu river mouth	0.5	-	-	-	-
	200 m from Danowudu river mouth	5.0	-	-	-	-
	Bitung ferry pier	0.5	-	-	-	-
	Bitung ferry pier	4.0	-	-	-	-
II. Manado						
(2/11/2001)	Tondano river	0.5	-	-		-
	Tondano river	3.5	sandy with gravel	mud and slight H2S	41.95	dark
	Tondano river mouth	0.5	-	-		-
	Tondano river mouth	5	clay	foul and fish		
	Bailang river	0.5	clay with some domestic wastes	slight H2S	nd	dark
	Bailang river mouth	0.5	-	-	-	-
	Bailang river mouth	4.5	-	-	-	-
	Talawaan river	0.7	-	-	-	-
	Talawaan river mouth	3.5	-	-	-	-
	200 m from Talawaan river mouth	0.5	-	-	-	-
	200 m from Talawaan river mouth	12	-	-	-	-
	Manado bay	0.5	-	-	-	-
	Manado bay	7	sandy	foul and fish	nd	brownish dark
	Sario river	0.5	-	-	-	-
	Sario river	3.5	clay with some domestic wastes	oily	nd	dark
	Sario river mouth	0.5	-	-	-	-
	Sario river mouth	6.5	-	-	-	-
	Malalayang river	0.5	-	-	-	-
	Malalayang river	5.5	sandy	foul and fish	157.55	dark

Table 4.16 Method of Analysis in the survey

A. Total mercury in water sample

1) 100 ml water sample was poured to a 200 ml test tube and 15 ml of KMnO4 solution was added to the flask.
2) 1 ml of concentrated HNO_3 solution and 1 ml of concentrated H_2SO_4 solution were added.
3) Sample solution in a flask was mixed thoroughly after adding each solution above and allowed to stand for 15 minutes.
4) 10 ml of $K_2S_2O_8$ solution was added and the tube was heated for 2 hours at 95°C using water bath.
5) Sample was allowed to stand until room temperature and hydroxylamine hydrochloride was added until purple color dissapeared
6) The sample solution was cooled down to room temperature and concentration of mercury was determined with cold vapour AAS (Automatic Hg analyzer, Hg-5000).

B. Total mercury in sediment sample

The procedure for sample preparation was developed by the National Institute Minamata Disease (NIMD), Japan.

1) 2-3 grams of sediment sample were weighed and placed in 50 ml measuring flask.
2) 2 ml of HNO_3 and 1 ml of H_2SO_4 were added and allowed to stand for 5 minutes.
3) 2 ml of $HClO_4$ was added to sample solution.
4) Sample solution was heated at 250°C with hotplate for 30 minutes.
5) The flask was then cooled down to room temperature.
6) Digested sample was added with distilled water (Hg free) and made up to 50 ml.
7) This sample solution was prepared for determination of total mercury concentrations using cold vapour AAS (Automatic Hg analyzer, Hg-5000).

C. Organochlorine pesticides analysis

1) Prior to analysis, all glassware was washed with laboratory detergent and rinsed three times with distilled water. After air-drying, the glassware was rinsed with aceton solvent and hexane three times each.
2) 1 L water sample was extracted with 50 mL hexane for two times or 20 g sediment sample was extracted with 50 mL aceton and subsequently with hexane for two times (double extraction).
3) Water content in the extract was removed by Na_2SO_4 anhydrous addition.
4) After purification with floricyl column and concentrated until detected with GCMS which was equipped with HP-1 column.
5)

D. Phosphate analysis in sea water

1) Sea water samples collected were immediately filtered with Whatman 0.45 µm.
2) 50 mL sample was poured into 100 mL Erlenmeyer.
3) 1 drop of phenolphthalein was added. If red color appeared, H_2SO_4 solution was added in dropwise until the color disappeared.
4) 8 mL of mixed reagent was added and shake until the solution was homogenous.
5) Mixed reagent was prepared by mixing 50 mL 5 N H_2SO_4 with 5 mL sodium antimonyl tartrat solution , 15 mL ammonium molibdate solution and 30 mL ascorbic acid solution in 250 mL Erlenmeyer. The solution was mixed carefully until homogenous and kept in a glass bottle. This solution was only stable for 4 hours.
6) The solution was allowed to stand for 10-30 minutes.
7) The absorbance of solution was measured with UV/vis spectrophotometer at wavelength 880 nm.

E. Total N analysis in water

1) 50 mL water sample was poured into a glass bottle with heat-resistance (300 mL Duran bottle).
2) 10 mL NaOH-$K_2S_2O_8$ was added and immediately covered with stopper and shaken carefully.
3) Samples were placed in autoclave and heated at 120°C for 30 minutes.
4) Samples were removed and filtered.
5) 25 mL of filtrate was puured into a 50 mL beaker glass.
6) 5 mL HCl (1+16) was added and pH was adjusted between 2 and 3.
7) Absorbance was measured with UV/vis spectrophotometer at wavelength 220 nm.

F. TOC analysis in water samples

1) 50 mL of water sample was poured into 100 mL beaker glass.
2) Samples were filtered when containing high amount of suspended solid.
3) Perchloric acid was added in dropwise until pH was 3.5
4) If samples contain high amount of chloride or halide, pH was adjusted to 4.5 with the addition of 0.1 M perchloric acid or 0.1 M sodium hydroxide.
5) Volume of the addition was recorded and dilution ration was calculated.
6) Aliquot was introduced to the analytical instrument (UV/vis spectrophotometer) according to the specified volume.

G. Suspended solid in sea water

I. Weight measurement of blank filter paper

1) Filter paper (0.45 μm) was placed on the funnel
2) Filter paper was rinsed with 20 mL distilled water and sucked with air pump
3) Rinsing was repeated until filter paper was clean from tiny particles
4) Filter paper was removed and dried in oven at 103-105°C for 1 hour
5) Filter paper was removed and placed in a desiccator for 10 minutes
6) Filter paper was weighed with analytical balance
7) Steps number 5 through 6 were repeated until the weight of paper was stable.

II. Sample measurement

1) Filter paper prepared above was placed in a filtering unit
2) Water sample was mixed until homogenous and placed in a filtering unit; sample size taken was according to the concentration of suspended residue so that the weight was 2.5-200 mg
3) Sample was filtered and suspended residue was rinsed with 10 mL distilled water for 3 times
4) Filter paper was removed and dried in oven at 103-105°C for 1 hour
5) Filter paper was placed in a desiccator for 10 minutes
6) Filter paper was weighed with analytical balance
7) Steps number 5 through 6 were repeated until the weight of paper was stable.

H. Coliform bacteria analysis

1) 10 mL water sample was inoculated in 5 series of test tubes containing BGLB liquid media.
2) Sample was diluted with sterilized water with dilution factor 10^0, 10^{-1}, 10^{-2}, then 1 mL sample was inoculated into 5 series of test tubes containing 9 mL BGLB broth media
3) Test tubes were incubated at 35°C for 24 hours
4) Microbial positive growth was examined in each series of test tube by indicating gas formation in Durham tube
5) Positive growth (gas formation) in each series was recorded and converted in index table

of Most Probable Number (MPN).

I. Total NH3 analysis

1) 25 mL sample was poured into 50mL Erlenmeyer flask.
2) Following chemicals were added with thourough mixing after each addition. 1 mL phenol solution, 1 mL sodium nitroprusside solution and 2.5 mL oxidizing solution. Oxidizing solution consists of 100 mL alkaline citrate solution and 25 mL sodium hypochlorite (should be prepared freshly).
3) Samples were covered with plastic wrap or paraffin wrapper film
4) The color development was observed at room temperature (22-27 °C) in subdued light for at least 1 hour (color is stable for 24 hours).
5) A blank and at least two other standards were prepared by diluting ammonia solution into the sample concentration range. Standards were treated the same as sample.
6) Absorbance was measured at 640 nm using spectrophotometer.