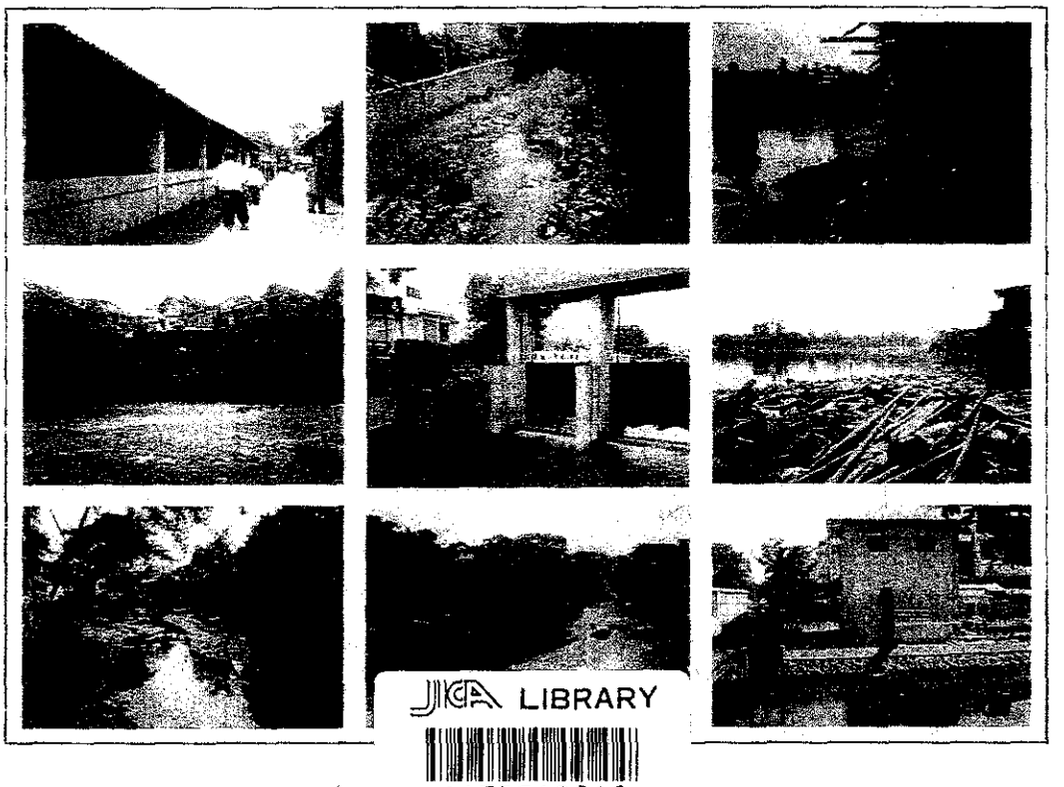
JAPAN INTERNATIONAL COOPERATION AGENCY

# URGENT INVENTORY STUDY ON DAMAGE OF FLOOD 2002 IN JABODETABEK AREA IN INDONESIA





## FINAL REPORT

MAY, 2003

PT. MITRAPACIFIC CONSULINDO INTERNATIONAL

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# CHAPTER 1
# BACKGROUND OF THE STUDY

# 1. GENERAL

Jakarta Metropolitan experienced immense floods in January and February 2002, which can find a place in history of Indonesia. The flood problem in Jakarta has never been solved so far and its control will always form an object of consideration. Generally speaking the Jakarta floods area caused by nature and by human interference so that, in its solution, the concerned authorities have to face not only technical problem but also problems of non-technical character such as the great population growth thus increasing the density of Jakarta's population.

The problem mentioned above has cause floods in Jabodetabek. Rains from January 26, 2002 to February 2002 had caused serious floods in almost all of Jakarta and its surroundings. Flood area in Jabodetabek at 2002 flood is 526 km2, which is equivalent to approximately 8.6 % of the area of Jabodetabek and the estimated population who suffered from the floods 2.5 million. The heavy inundated Jabodetabek area is 53 km2, which is 0.86 % if Jabodetabek area and reached 0.50 m for more than seven day.

Inundation seen in Jakarta in February 2002 raised the awareness of the governments about the necessity of the countermeasure against submersion and inundation. The major point of submersion an inundation in urban area is to eradicate inundation and to properly grasp flood-fragile areas. Once these points are taken into account it will become possible to plan a countermeasure against submersion and inundation.

In line with recent trend of decentralization, ranges of measures are under the responsibility of local government. However, it has been conceived that local governments in Jabodetabek are lack of public management capacities and have own interest to development area based on temporary plan. Under these circumstances, it is requested by the Government of Indonesia to conduct a survey to decapitate the damage caused by inundation in year 2002 and to recommend how to formulate countermeasure for inundation fragile areas.

Taking into account a serious of flood in Jabodetabek, the Urgent Inventory Study on Damage of flood 2002 in Jabodetabek Area was conducted under the Japan International Cooperation Agency (JICA).
The study was carried out from January 2003 to June 2003 including 3 months field survey and desktop study.

# CHAPTER 2
# APPROACHES TO STUDY

# 2. APPROACHES TO THE STUDY

## 2.1 Study Area

The study area covers DKI Jakarta and the districts of Bogor, Depok, Bekasi in the West Java Province and Tangerang in the Banten Province, as shown in the Figure 2-1 and Flood in February 2002 in Jabodetabek as shown in the Figure 2-2, selection location survey in 2003 as shown in Figure 2-3, represents the river basin is located between Cikarang and Cidurian haven an area of approximately 6,127 $km^2$, as shown in the Table 2-1.

**Table 2-1. Study Areas**

| Region | Area ($km^2$) | Population (million) |
|---|---|---|
| DKI Jakarta | 662 | 7.4 |
| Bekasi District | 118 | 1.4 |
| Bekasi Municipality | 2,371 | 3.5 |
| Bogor District | 200 | 1.2 |
| Bogor Municipality | 183 | 1.5 |
| Depok Municipality | 1,110 | 2.9 |
| Tangerang District | 210 | 1.7 |
| Tangerang Municipality | 1,273 | 1.7 |
| JABODETABEK | 6,127 | 21.3 |

*Source: BPS (Biro Pusat Statistik) 2001*

## 2.2 Outline of the Project

Collecting data/information is required to give countermeasure against flood problem in six river basin regions.

### 1) Goal

Input for policy making on urgently needed countermeasure for inundation in the environmental sector in Indonesia.

### 2) Objective

It is expected that scattered data of damage caused by inundation in the Jabodetabek region shall be collected and the causes of inundation shall be analyzed.

### 3) Output

Inundation-borne damage area data in the Jabodetabek region.

### 4) Activity and Input Plan

Request to Japanese Government : Study by consultant team

a. 3 months study by the consultant team detailed below
b. Reconnaissance survey at selected flooded areas (approximately six parties)
c. Workshop to disseminate the results of the survey (in the middle of March 2003).

## 2.3 Previous Study Report

Reference has been made during this study to the following reports :

1) The Study on Comprehensive River Water Management Plan in Jabotabek, JICA, Nikken Consultants, INC and Nippon Koei Co., Ltd., March 1997.

2) Pedoman Siaga Banjir Propinsi DKI Jakarta, Dinas Pekerjaan Umum Propinsi DKI Jakarta, Proyek Induk Pengembangan Wilayah Sungai Ciliwung-Cisadane, Oktober 2002.

3) DKI Jakarta Urban Drainage Rehabilitation Project, Pesanggrahan, Grogol, Krukut rivers and Sekretaris Drainage Channel, Field Survey Report, PT. Brantas Abipraya, PT. Infratama Yakti, Mach 2002.

4) Survey Report for the Existing Pumping Station in Jakarta, Kimpraswil/Ebara Corporation, May 2002.

5) Quick Reconnaissance Study Flood Jakarta 2002, Nedeco, June 2002.

6) Urgent Flood Survey 2002, PCI and MCI, Mei 2002.

7) Workshop Peduli banjir DKI Jakarta, Gabungan antara Grup Profesional Banjir dengan Masyarakat Swasta, Pemda DKI and Departemen Kimpraswil, Maret 2003.

8) Regional Structure Plan (RUTRW) of related District or Municipality included DKI Jakarta.

9) And other references as appeared in the Appendix.

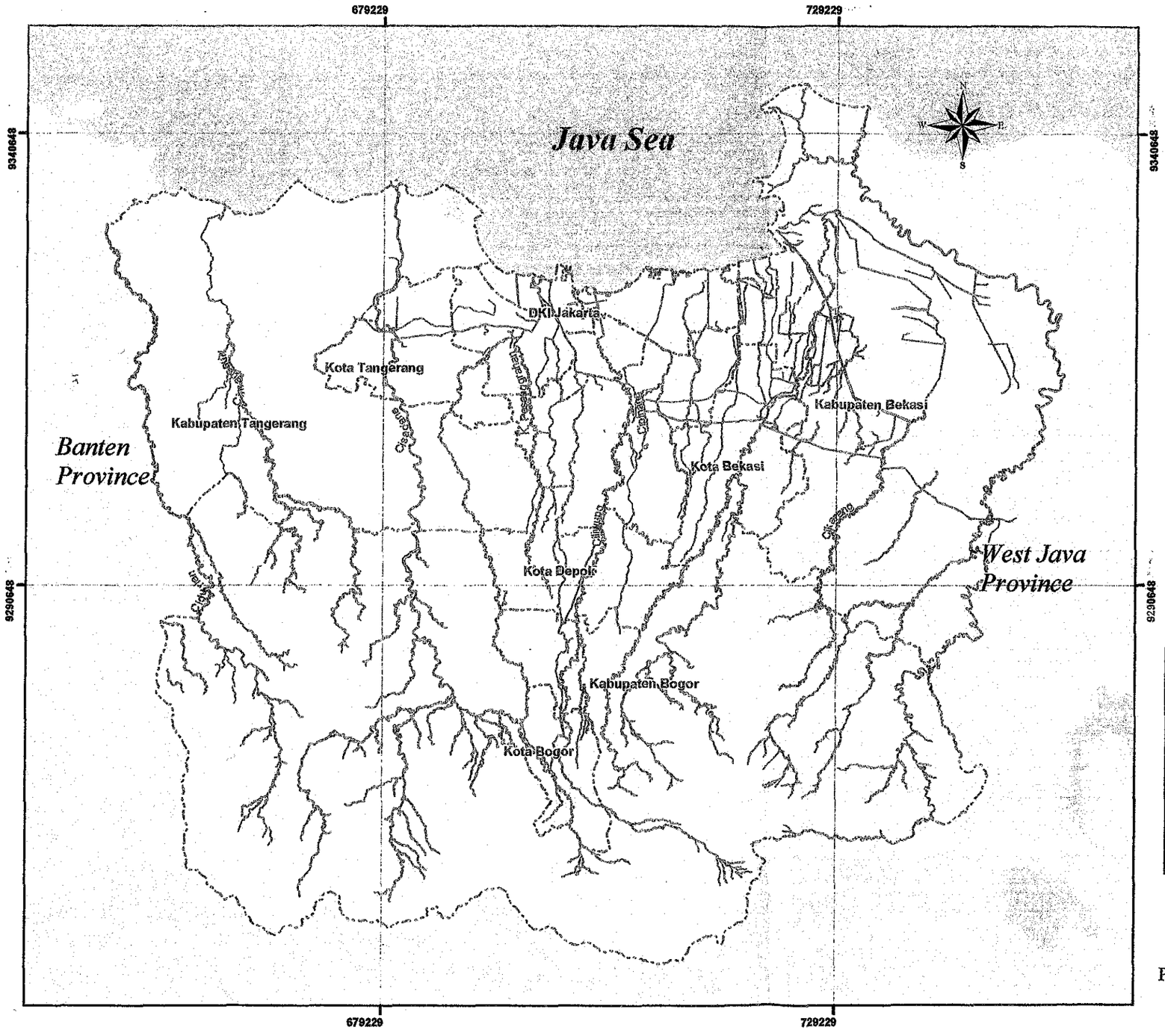


Figure 2-1
Administrative Boundary of Jabodetabek

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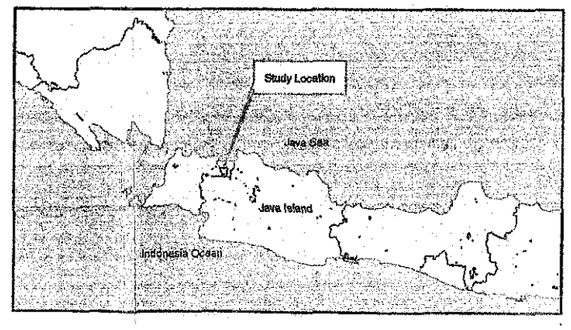
**Legend**

- District/City Boundary
- River

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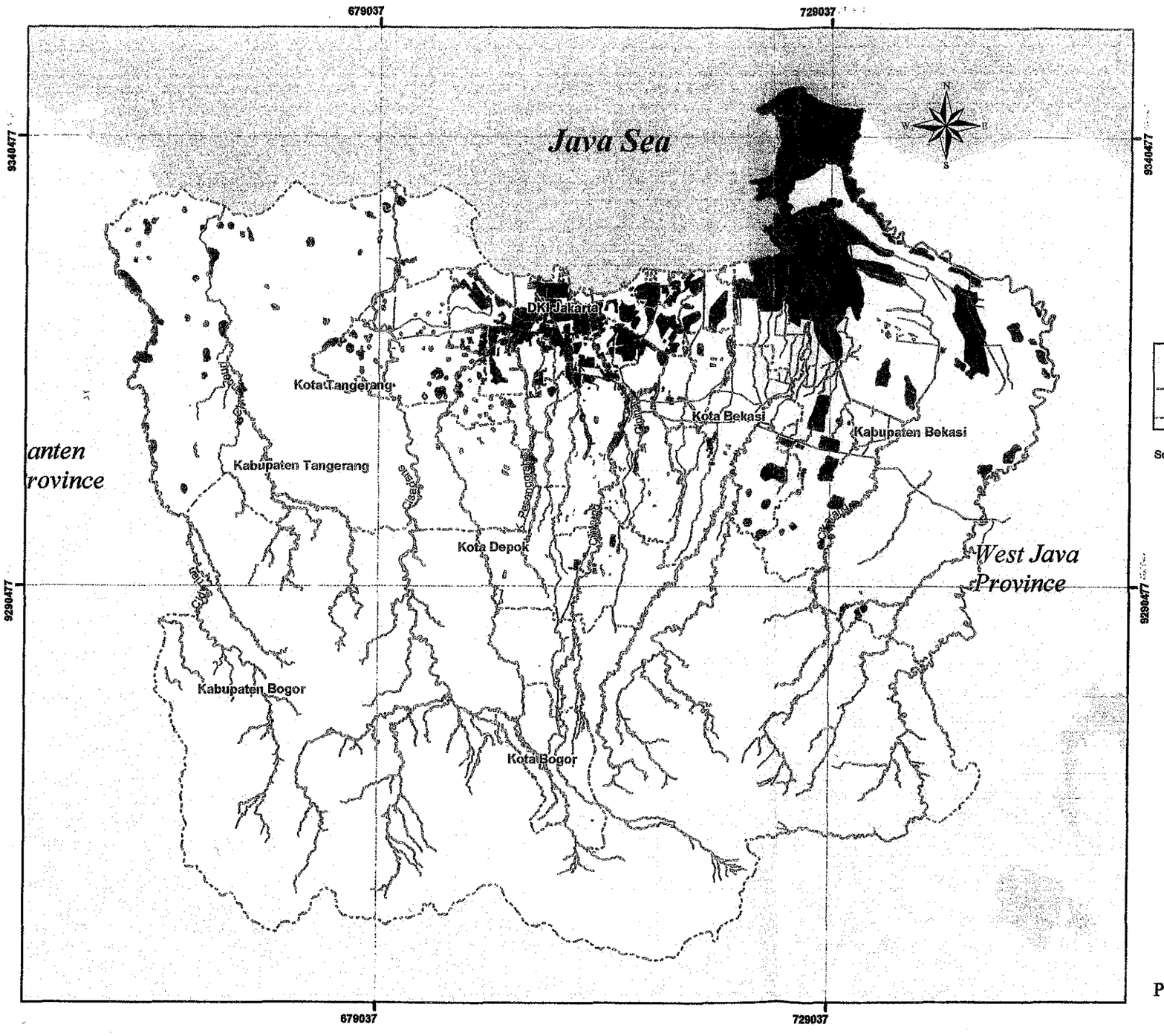


Figure 2-2
Flood in February 2002
in Jabodetabek

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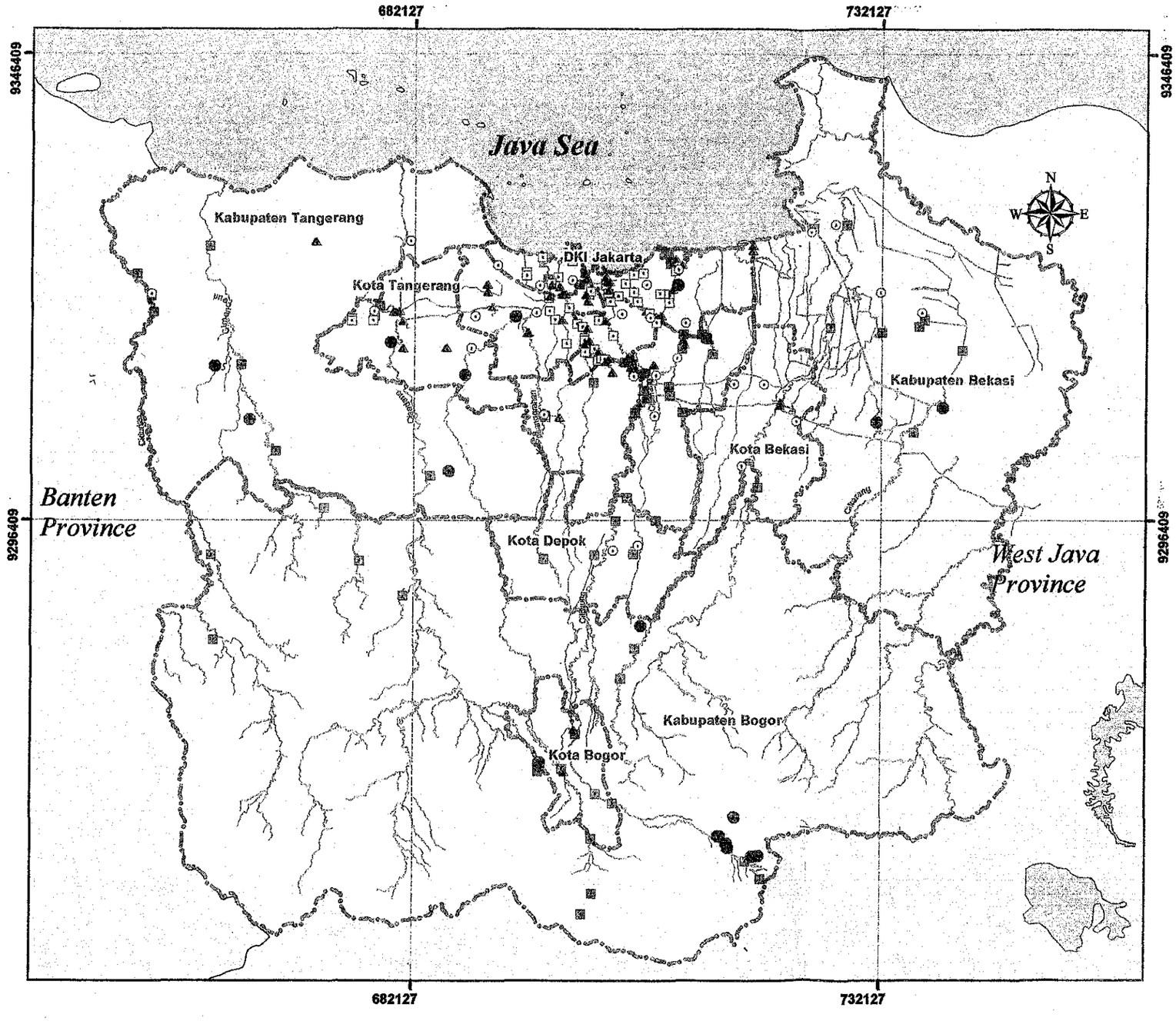


Figure 2-3
Survey Location in 2003

1:500,000

**Legend**

- District/City Boundary
- River
- River Reconnaisance Survey
- Pump
- Gates
- Damage/Impact Survey
- River Basin Development Survey

Sources : 1. Ebara
2. Local Government of DKI
3. MCI survey

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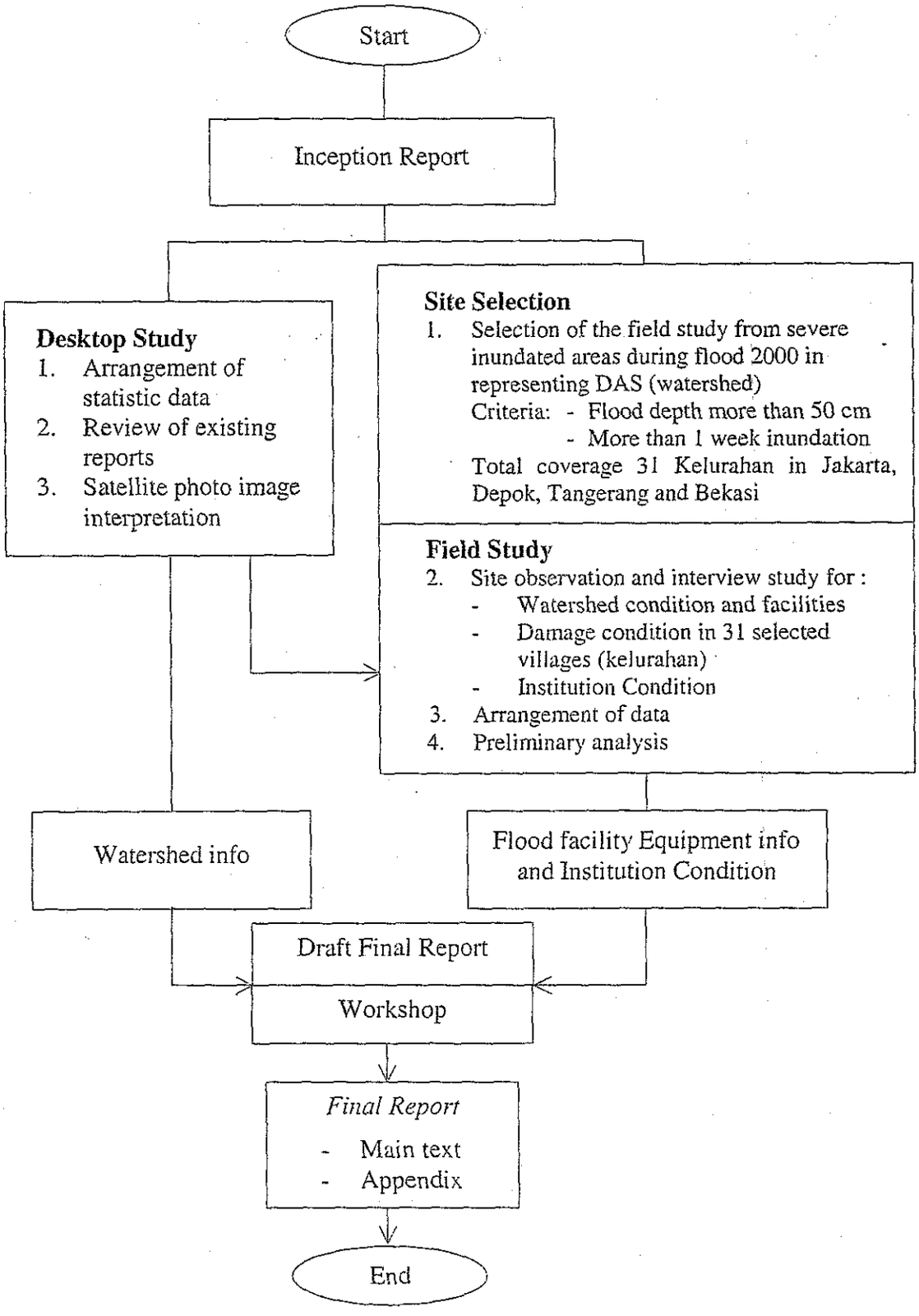
## 2.4 Approach Methodology

Team has implemented reconnaissance study as shown in the flowchart Figure 2-3.

**Figure 2-3. Approach Methodology Study**



## 2.5 Work Schedule

The study team has been implemented work schedule, as shown in the Figure 2-4.

**Figure 2-4. Work Schedule of the Study**

| No. | Work Item | December | | | | January | | | | February | | | | March | | | | April | | | | May | | | | June | | | | July | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| A | **Project Preparation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | - Tender | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | - Award | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | **Desktop and Field Study** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| C | **Reporting** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | a Inception Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | b Reconnaissance Survey Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | c Draft Final Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | d Final Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | e Workshop Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| D | **Workshop** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E | **Meeting** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Note:
Implementation

# CHAPTER 3
# FEATURES OF HYDROLOGY AND STORM WATER DISCHARGE IN JABODETABEK AREA

# 3. FEATURE OF HYDROLOGY IN JABODETABEK AREA

Location of inundation area on February 2002 scattered on DKI Jakarta, Tangerang District, Tangerang Municipality, Depok municipality, Bekasi district and Bekasi Municipality are 78 villages, 49 villages, 77 villages, 20 villages, 67 villages, and 42 villages, respectively,

## 3.1 River Basin in Jabodetabek Area

The study area is generally divided into 6 river basins as follows :

1. Cidurian and Cimanceuri river basin (1,419 $km^2$)
2. Cisadane river basin (1,476 $km^2$)
3. Ciliwung river basin (546 $km^2$)
4. Pesanggrahan river basin (627 $km^2$)
5. Cipinang river basin (412 $km^2$)
6. Cikarang river basin (1,647 $km^2$)

Total 6,127 $km^2$

Salient feature for major study six river basin is described below and as shown in the Figure 3-1.

### 3.1.1 Upstream River Basin Area

#### a. Cidurian and Cimanceuri river basin

The Cidurian river is located in the most western part of JABODETABEK. The Cidurian river originates in Mt. Kendeng (1,764m) and flows into the Java Sea. The Cibeureum river, the main tributary, joint s the Cidurian upstream of the Jakarta to Merak Toll Road crossing. The Cimanceuri river originates in the low mountains with an elevation of approximately 600 m and flows into the Java Sea; its tributaries, the Cimatuk and Cipaseun rivers, join the main river upstream of point with the Jakarta to Merak Toll Road crossing.

The upper area of Cimanceuri and Cidurian river basin overspread the district of Bogor and Tangerang in sub-district of Tigaraksa, Cikupang, Parung Panjang and Jasinga.

*Geomorphology* :

*Landform* : Hilly terrain with dominate slope ranging 25-40% in upstream Cimanceuri (P. Panjang) and undulating terrain with dominant slope 15-25% in Jasinga (Cidurian lower upstream). Low fertile soil is resulting from its materials.

*Rainfall* : Annual mean rainfall is in 2000-3000 mm range, with high interval during October– April.

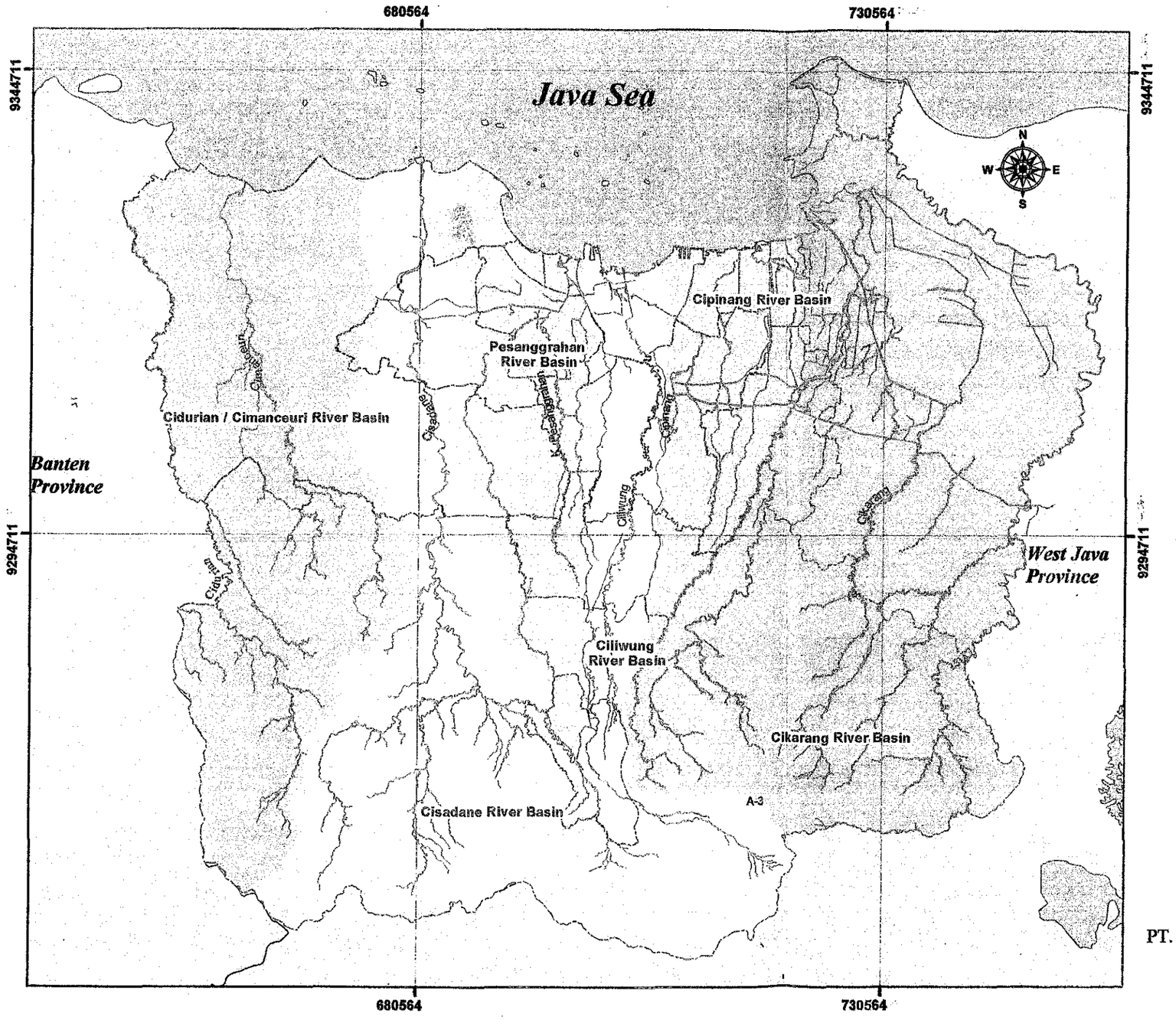



Figure 3-1
River Basin in Jabodetabek

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**Legend**

River

District/City Boundary

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**b. Cisadane river basin**

The Cisadane river is the largest river in JABODETABEK and originates on the northern side slope crowned by Mt. Kendeng (1,764 m), Mt. Perbakti (1,699 m) and Mt. Salak (2,211 m). The river flows through the city of Tangerang and flow into the Java Sea. Its main tributaries such as Cisindangbarang, Ciampea, Cianten and Cikaniki rivers join the Cisadane in the upper reaches near Parungbadak. The river basin involves vast mountainous area in the upper attachment, more than half of basin.

Cisadane upstream basin covers the area within the district of Bogor, Tangerang including Bogor municipality and sub-district of Semplak, Parung, serpong, Ciampea and Ciomas.

*Geomorphology* :

*Landform* : fertile soil from volcanic influence of hilly and mountainous system elevation 600 to 900 m above sea level, with dominant slope ranging from 15% to 60%.

*Rainfall* : Annual mean rainfall is in the 3500-4500 mm range. Wet season occurs between October – April.

**c. Ciliwung river basin**

The Ciliwung River water source is located on the northern slope of Mt. Pangrango (3,019 m) and the river flows down passing through the cities of Bogor and Depok. At Manggarai barrage, it is diverted to the Western Banjir Canal (WBC).

The upper basin of Ciliwung include the district of Bogor and Bogor municipality covers sub-district of Ciawi, Megamendung, Cisarua.

*Geomorphology* : Influence from Gede-Pangrango Volcano

*Landform* : The Ciliwung river originates on the northern side slope of Mountain Pangrango (3,019 m), and is situated in hilly and mountainous terrain with elevation 600-1000 m above sea level and a dominant slope ranging from 25% to 60%.

*Rainfall* : Annual mean rainfall is in the 4000-4500 mm range, with 205-210 rainy days per year. (Ciawi and Gn. Mas)

**d. Cikeas, Cileungsi river upstream (tributary of Cikarang River basin)**

The Cikeas river water source is located on the northern slope of Mt. Pangrango and flow down passing through the Bogor district and Bekasi District.

The Cileungsir river water source is located on the northern slope of Mt. Pangrango and flow down passing through the Bogor district and Bekasi District. Both of the

Cikeas river and Cileungsir river confluence in the lower plain with Bekasi river at Bekasi City.

The upstream of Cikeas and Cileungsi river covered the district of Bogor and Bekasi in sub-district Megamendung, Citeureup, Kedung haling, Cileungsi and Cimanggis.

*Geomorphology* :

*Landform* : Hilly region forming a valley plain elevation 200-700 m above sea- level and dominate from slope ranging 15-40%.

*Rainfall* : Annual mean rainfall is in the 3800-4000 mm range, with 188-180 rain days per year (Cibinong-Hambalang)

**e. Pesanggrahan river basin**

The Pasanggrahan river originates in the hilly area north of Bogor City and joins the Cengkareng Floodway.

The upstream area within the river basin includes Tangerang and Bogor district in sub-district of Sawangan, Ciputat.

*Geomorphology* :

*Landform* : Undulating area with elevation in the range of 75-150m above mean sea-level and dominant slope ranging between 8% and 25%

*Rainfall* : annual mean rainfall is approximately 2000 mm, with 99 annual rainy days.

**f. Cipinang river basin**

The source of the Cipinang river is Jatijajar Lake, Bogor District. The river flows through Cimanggis Sub-district in upstream area and close to the Jagorawi toll road.

*Geomorphology* :

*Landform* : Undulating area with elevation is in the 60-100 m range, above mean sea level and dominant slope 10%-25%

*Rainfall* : Annual mean rainfall is in the 1500-2500mm range.

### 3.1.2 Downstream River Basin Area

#### a. Cidurian and Cimanceuri river basin

The Cidurian and Cimanceuri rivers flow through passes Jakarta to Merak Toll Road into estuary, Tangerang District. Major sub-district included within the downstream basin of Cidurian and Cimanceuri are Kresek, Mauk, Kronjo, Rajeg all in Tangerang regency.

*Geomorphology* : Alluvial area, flat to undulating with dominate slope ranging from 2 to 8%.

*Rainfall* : Annual rainfall is in the 1500 to 2000 mm range with 70 to 90 rain days per year.

#### b. Cisadane river basin

In the downstream of Cisadane River through pass to Depok city, West DKI Jakarta and Tangerang City into estuary, and in lower plain diverted to Mookervart canal as part of floodplain drainage system.

*Geomorphology* : Alluvial areas and flat to undulating condition with slopes ranging from 2 % to 15% in middle reach and 0-8% in the lower downstream. Tidal influence is evident in Teluk Naga.

Serpong formation is the dominant geological unit and consists of alternating conglomerates, sandstone, siltstone, and clay stone with plant material, pumiceous conglomerate and pumiceous tuff.

*Rainfall* : Annual rainfall is in the 1800 to 2300 mm range, with 80 to 110 rain days per year.

#### c. Ciliwung river basin

Ciliwung river flow through pass Bogor district, Depok City, both side of South Jakarta and East Jakarta, and Jakarta Utara into sea. In the lower plain the river interconnect with drainage system of west banjir canal and covered the sub-district of Matraman, Menteng, Gambir, Sawah Besar, Tamansari and Pademangan.

*Geomorphology* : Alluvial area, flat to undulating with dominant slope ranging from 0-2% in floodplain and 2-8% in the upper downstream. Tidal influence is evident in Tanjung Priuk, Koja and Kelapa Gading.

*Rainfall* : Annual rainfall is in the 2000 to 2500 mm range with 109-135 rain days per year(Karet, Halim station)

**d. Pesangrahan river basin**

Pesanggrahan river flows through alluvial coastal plain in the lower reaches. The river courses extremely meander, in upstream to middle reach.

In the lower basin Pesanggrahan river system is assumed to include K. Angke, K. Kreo, Cengkareng drain and Mookervart canal. Area covered by the system are sub-district of Bintaro, Cipondoh, Kebon Jeruk, Grogol, Cengkareng, Penjaringan.

*Geomorphology* : Alluvial area, flat to undulating with dominant slope ranging from 2 % to 8%. Tidal influence is evident in Penjaringan.

*Rainfall* : Annual rainfall is in the 2000 to 2500 mm range.

**e. Cipinang river basin**

The Cipinang river flows through pass Toll Road of Jagorawi to East Jakarta confluence with Sunter river at Jl. I Gusti Nugrah Rai arteri road.

In the lower plain the river interconnected with drainage system of K. Sunter, Cakung drain and future eastern banjir canal. Cipinang covering area are Pondok Gede, Duren Sarit, Cakung, Kepala Gading, Koja and Cilincing Sub-district.

*Geomorphology* : Alluvial area, flat to undulating with dominate slope ranging from 2 % to 8%. Tidal influence is evident in Koja and Cilincing.

*Rainfall* : Annual rainfall is in the 1900 to 2300 mm range, with 110 to 130 rain days per year.

**f. Cikarang river basin**

The Cikarang river flows through pass Toll Road of DKI Jakarta to Cikampek to Bekasi City confluence with Bekasi river into Sea which called Cikarang-Bekasi-Sea (CBS). Linked with the drainage system of K. Bekasi CBL floodway. Covered of lower Cikarang river basin includes sub-district of Pondok Gede, Duren Sawit, Pulogadung, Kelapa Gading and Koja.

*Geomorphology* : Alluvial area, flat to undulating with dominant slope ranging from 2 % to 8%. Tidal influence is evident in Babelan and Sukatani.

*Rainfall* : Annual rainfall is in the 2000 to 2500 mm range, with 100 to 110 rain days per year.

## 3.2 Drainage System

### (1) River system and drainage system

From the storm water discharge point of view, areas are divided into the river system area and the drainage system area.

Areas discharging storm water by gravity are the river system area, and areas discharging water artificially into the drainage area.
The ground level in the river system area is relatively higher than the watercourses, and the drainage system area is lies at same level or lower than the watercourses.

Studies of river and drainage Master plan (Nedeco, 1973 and Nikken, 1996) has been comprehensively prepared and proposed priority project development for both lower and upper drainage systems. The projects remain under review, due to limitation government funding resources.

### (2) Drainage System

Basic principle of flood fighting for DKI Jakarta has been implemented as follows :

- River flows enter DKI Jakarta and surrounding area, water discharge should be managed and collected in retention area, river flow no direction into Center city region. In the middle reach river flow direction into at west and east, which is called West Banjir Canal, the flow through Cengkareng drain canal and Cakung drain canal, respectively, as shown in the Figure 3-2.

- Drainage canal has enough high elevation for gravitation system.

- Drainage system for low land area is used polder (retention pond), water control should be used pump, to pumping up water into river controlling.

- To reduce big flow discharge in river capacity, it will carry out short cut for meandering rivers.

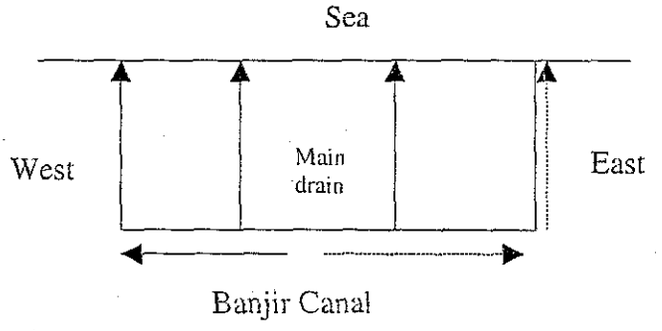



**Figure 3-2. Flood control plan of DKI Jakarta and surrounding area**

Facilities and structures related to the drainage system area classified into the drainage channel with related structures including system siphon, sluice and culvert, and the other structures such as: bridge, gate weir, drainage pump, reservoir, in Jabotabek drainage systems were developed as follows :

a. DKI Jakarta has ten drainage system as follows :

**Table 3-1. Drainage systems in DKI Jakarta**

| Region | Drainage Zone | Catchments Area (ha) | Drainage System |
|---|---|---|---|
| I. Western Region | Zone-1 | 11.300 | Cengkareng Floodway |
| | Zone-2 | 4,500 | Grogol-Sekretaris |
| II. Central Region | Zone-3 | 500 | Muara Karang |
| | Zone-4 | 17,350 | Ciliwung – Banjir Canal |
| | Zone-5 | 1,900 | Pluit |
| | Zone-6 | 1,100 | Ciliwung – Gunung Sahari |
| III. Eastern Region | Zone-7 | 2,760 | Sentiong – Pademangan |
| | Zone-8 | 1,250 | Sunter Utara (Barat) |
| | Zone-9 | 12,575 | Sunter – Cipinang |
| | Zone-10 | 8,050 | Buaran - Cakung |

Source: *The study on Comprehensive River Water Management Plan in Jabotabek JICA, 1996.*

b. Tangerang City

- Micro drainage system located in the Tangerang city on the right bank of the Cisadane river toward to the Mookervoart river.
- Small drainage system located between the Cisadane river and the Sabi river.
- Drainage system surrounded by the Angke river, ring road and Jln. Ciledug Raya.

c. Bekasi City

The urban drainage of Bekasi city distribute into system of Cikarang-Bekasi-Sea (CBS/CBL) and in the future to East Banjir Canal.

## 3.3 Management System

As appeared in Table 3-2 River Basin in Jabodetabek, all of six river basin area accommodate more than one administration region and authorities, which may requires inter regional coordination for management of respective river basin.

In other side, the development and utilization of resources within the river basin are controlled under different sector agencies. Influence of various un-integrated sector interest also occurred in the river basin development.

In Jabodetabek river basin are crossing over administration boundaries ( refer to Table 3-2 ).

**Table 3-2. River basin in Jabodetabek**

| Region | Cidurian/ Cimanceuri | Cisadane | Pesanggrahan | Ciliwung | Cipinang | Cikarang |
|---|---|---|---|---|---|---|
| DKI Jakarta | | • | • | • | • | • |
| Tangerang district | • | • | • | | | |
| Tangerang municipality | • | • | | | | |
| Bekasi district | | | | | • | • |
| Bekasi municipality | | | | | • | • |
| Depok municipality | | | | • | • | |
| Bogor district | | • | • | • | | |
| Bogor municipality | | • | • | • | | • |

Sources : *Bakosurtanal Earth Surface Map.*

The present condition of river basin flood control and management is influence with dominant factor of decentralization and inter sector coordination

a) Decentralization

Since decentralization policy responsible of central government has been transferred to district level, automatically district has big authority and responsible for water resources management.

Flood management has relationship with river basin management, so joint operation is needed between local government to local government and local government to central government.

DKI Jakarta has been shared responsible for construction, operation and maintenance of river in surrounding area with Ciliwung-Cisadane River Basin Development Main Project (PIPWSCC). PIPWSCC is under control Kimpraswil. Therefore management status between DKI Jakarta and PIPWSCC is clearly. Although, PIPWSCC is still in the project form status.

b) Inter Sector Coordination

Flood management depend on several aspects, for present the management authority majority is independent by various institutional, such as:

River : more than one river basin through pass several provinces should responsible for DGWR or by Provincial public work agency in their region.

Drainage : urban drainage system is responsible for district level or municipality (district public work office).

| | | |
|---|---|---|
| Sedimentation control (sabo) | : | Not clear |
| Retention basin | : | management system of retention basin is under district level or municipality (district public work office) |
| Recharge area conservation | : | management system is under responsibility of district or municipality, but policy is provided by central government through state ministry of environment. |
| Erosion control | : | Not clear |
| Evacuation and emergency control | : | operates under authority of District or city with a structural coordination with Bakornas. (National Coordination Board) |

# CHAPTER 4
# STUDY RESULT

# 4. STUDY RESULT

The study had been carried out with two directions. The first is a macro survey of river basin conditions by satellite photo interpretation, secondary information for related studies and the second is the site-observation and interview survey (socio-technical survey) in selected heavily inundated areas at 2002 flood event and flood facility sites.

As for the river basin information, this study remarked changing of land cover.

About the heavily inundated areas at 2002 flood, observation and interview sites were selected with criteria of inundation over 7 days with 0.50 meters depth.

## 4.1 River Basin Information

Essential information of river basins relating to the flood events is the land cover information that effect run-off of storm water. In general vegetation area is low and slow run-off from the plantation/comparing with the paved land and bare land.

Upstream area of each basin in Jabodetabek is originally the plantation area functioning as groundwater recharge area with buffering run-off of storm water. These upstream plantation areas had prevented or mitigated from flood in the downstream area. However, housing developments were accelerated in the upstream area since 1980s the present upstream area has a higher run-off coefficient and lower recharging function of groundwater than before. Consequently the frequency and scale of flood event in downstream area is increasing.

Comparing three Landsat data took in 1989, 1997, 2002, changing the plantation area with housing area in the upstream of river basin is obvious. (Refer to Table 4-1 and Figure 4-1 to 4-3)

**Table 4-1. Land Cover Change in Jabodetabek area**

| Upstream | | | (100 Ha) | Downstream | | (100 Ha) |
|---|---|---|---|---|---|---|
| Land cover | 1989 | 2002 | Deviation | 1989 | 2002 | Deviation |
| Wet | 171 | 110 | (61) | 746 | 692 | (54) |
| Open | 104 | 174 | 70 | 675 | 510 | (165) |
| Green | 2,710 | 2,314 | (397) | 1,895 | 950 | (945) |
| Urban | 123 | 349 | 226 | 376 | 1,416 | 1,038 |
| Unidentified | 0 | 162 | 161 | 0 | 127 | 127 |
| Total | 3,109 | 3,109 | 0 | 3,692 | 3,692 | 0 |

| Total | | | (100 Ha) | | | (%) |
|---|---|---|---|---|---|---|
| Land cover | 1989 | 2002 | Deviation | 1989 | 2002 | Deviation |
| Wet | 918 | 802 | (115) | 13 | 12 | -2 |
| Open | 779 | 684 | (95) | 11 | 10 | -1 |
| Green | 4,606 | 3,264 | (1,342) | 67 | 48 | -19 |
| Urban | 498 | 1,762 | 1,264 | 7 | 26 | 19 |
| Unidentified | 0 | 288 | 288 | 0 | 4 | 4 |
| Total | 6801 | 6,801 | 0 | 100 | 100 | 0 |

**Figure 4-1. Landsat Imagery of Jabodetabek 1989, 1987 and 2002**

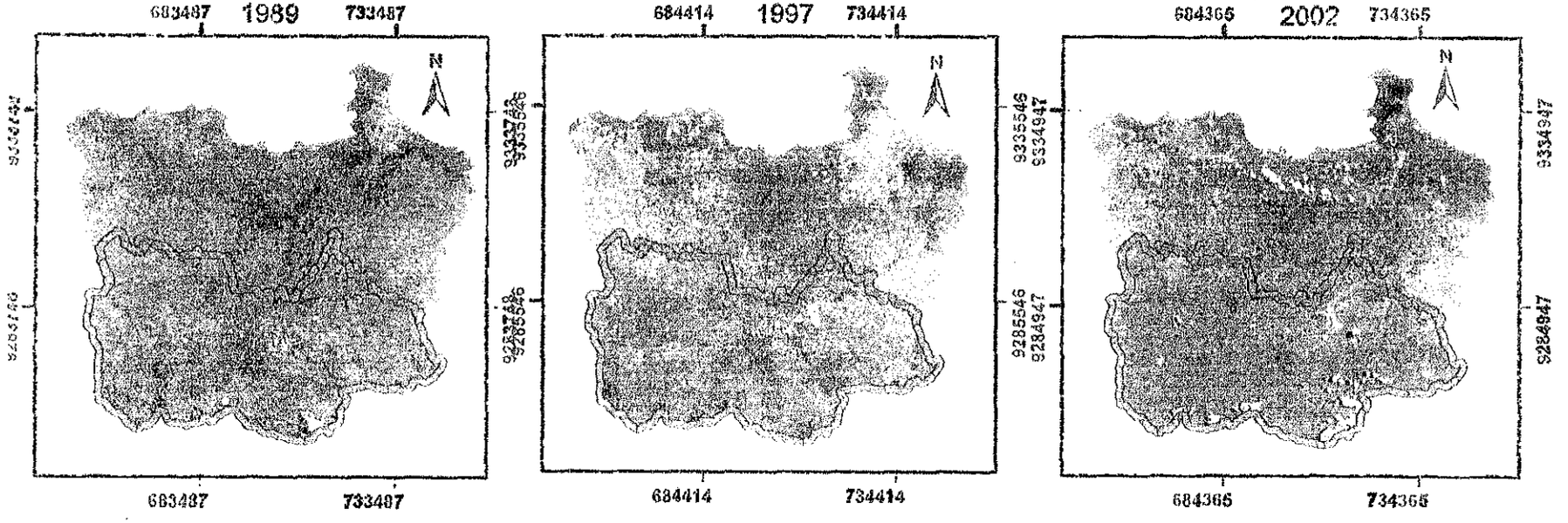


**Figure 4-2. Landcover of Jabodetabek 1989 to 2002**

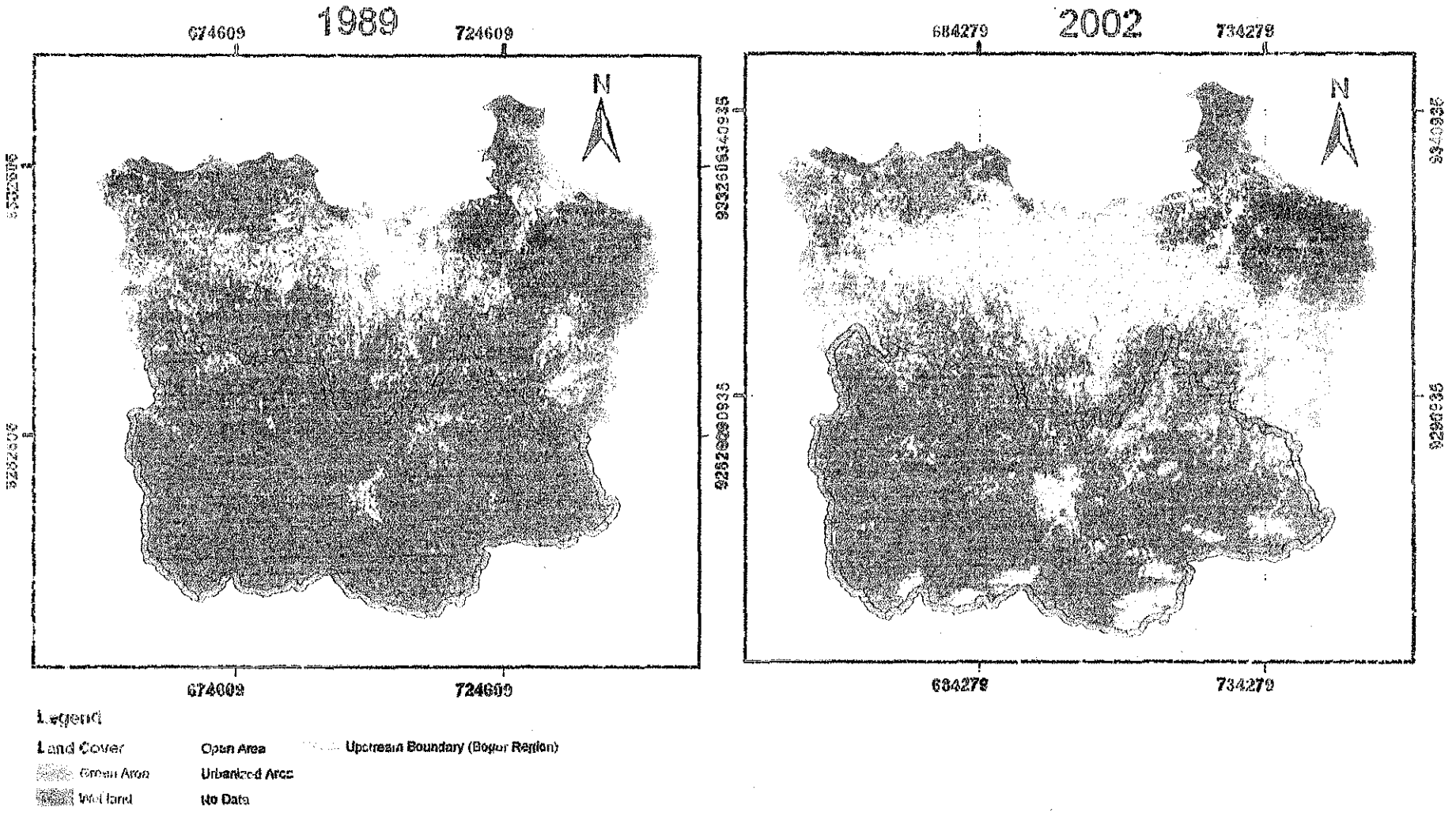
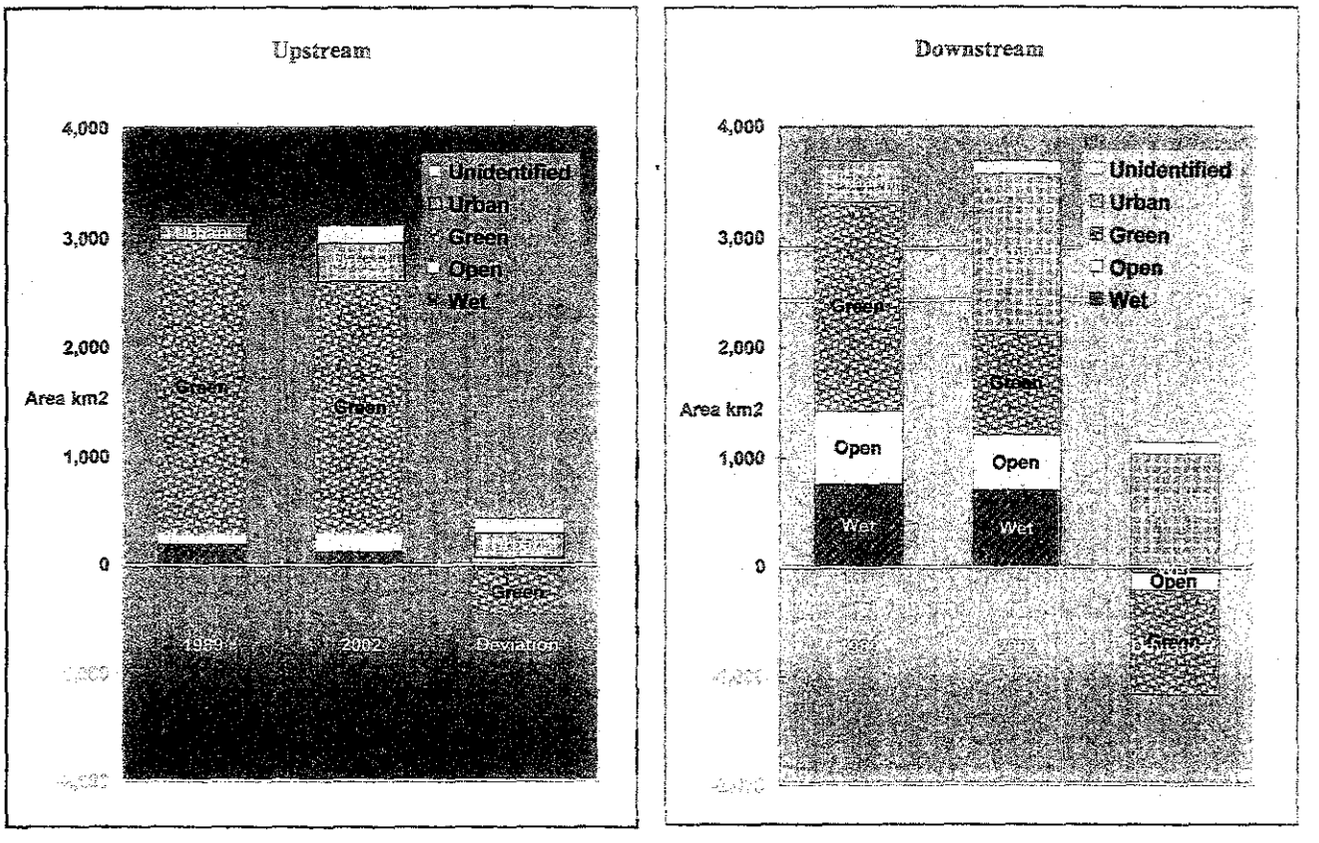
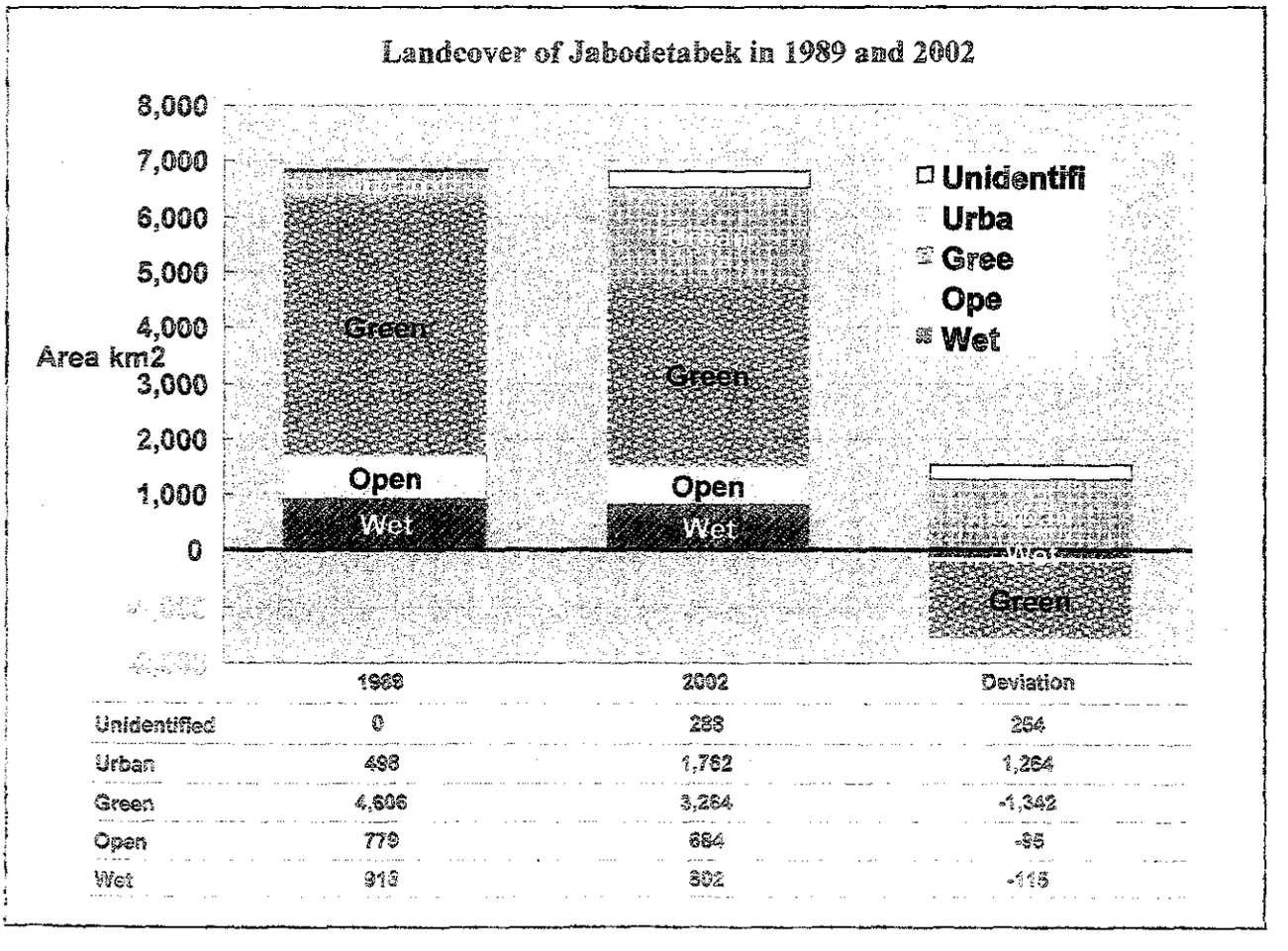


**Figure 4-3. Change of Land Cover**




| | 1989 | 2002 | Deviation |
|---|---|---|---|
| Unidentified | 0 | 288 | 254 |
| Urban | 498 | 1,762 | 1,264 |
| Green | 4,606 | 3,264 | -1,342 |
| Open | 779 | 684 | -95 |
| Wet | 918 | 802 | -115 |

Land cover categories is described in the table as follows:

| LANDCOVER | EXAMPLE |
|---|---|
| URBAN | Paved surface,<br>Mass of structures |
| GREEN | Mass of trees, Mixture of trees with medium density, Rain-fed and Dry-fed field, Bush. |
| WET LAND | Water surface for example paddy field, ponds, rivers, etc.. |
| OPEN AREA | Bare land, Soil surface |
| UNIDENTIFIED | Area which cannot be analyzed a specific land cover due to cloud, etc. |

Salient feature of land use in each basin is described here under, river basin study result and inventory of river condition as shown in the Table 4-2 and Table 4-3, respectively; more detailed information of land use is shown in the Appendix.

### 4.1.1 Upstream River Basin Area

a. Cidurian and Cimanceuri river basin

*Location of survey* : Jasinga and P. Panjang sub-regency

*River condition* :
- Wider with moderate flow in lower upstream and steep gorge in upstream areas
- Bed river material: sand and gravel

*Land use* :
- Cultivation dominated by tree crops or fruits requiring less tilling.
- Rubber plantation covers 2,050 ha in Jasinga and 760 ha in Rumpun
- Some sawah is cultivated in the lowlands using natural rainfall.
- Sand mining in Jasinga and quarry mining in Pasir Panjang, both large concession sites
- New development is less intense compared to Ciliwung upstream

b. Cisadane river basin

*Location of survey* : Lido, Rancamaya, Ciomas and Bogor municipal

*River condition* :
- Narrower with rapid flow in upstream area and moderate to high bank slope.
- River bed material consists of sandy soil and boulders
- Significant sedimentation and erosion.
- Construction of housing close to riverbanks
- Slope protection to river banks in irrigated rice areas and settlement areas (Ciomas)

*Land use* :
- Cultivation dominated by irrigated rice (non-technical) in

flat undulating lower upstream area (Ciomas and Lido)
- Extensive tilling of upland crops (palawija) occurs in ex-tea plantation areas as significant cultivation practices (Lido).
- Lido Lake as retention basin, is has slowly changing into agriculture and property development.
- High intensity of development for settlement (vacation home) for Jakarta consumer (Mutiara Lido, Lido resort properties).
- New development in Ciomas sub region as Bogor municipal extension.
- New development area at Rancamaya its there own detention pond for drainage and flood control.
- Lido floating restaurant in the Lido lakes will influence water quality in the near future.

c. Ciliwung river basin

*Location of survey* : Tugu and Cisarua sub-district, Bogor regency and Depok city.

*River condition* :
- Narrow with rapid flow in upstream area, with moderate to steep banks
- Bed material of sandy soil and boulders
- Significant sedimentation and erosion has occurred
- Small house occupy along tributary rivers.

*Land use* :
- Cultivation is dominated by commercial agriculture (e.g. tea) 647 ha according to data 1999.
- Extensive ploughing and tilling is carried out in the up land areas, previously use as tea plantation in order grow seasonal crops such as onion, corn, sweet potato, carrots and cabbage (Cisarua and Tugu).
- Extensive change in land use from agriculture to settlement has occurred area during the last 10 years
- River conservation through community participation is starting under forestry agency (Tugu)

d. Cikeas, Cileungsi river upstream (tributary of Cikarang river basin)

*Location of survey* : Gn. Geulis, Sentul, Gn. Putri

*River condition* :
- Wider river with moderate flow in lower upstream with steep valley slopes in upstream area (Gn. Putri and Gn. Geulis)
- River bed material: sand and gravel
- Minimal sedimentation and erosion as indicated by clarity of water

*Land use* :
- Future settlement areas occupy a large part of the upstream watershed, approximately 12500 ha for

residential and industrial use are being developed along the Jagorawi Toll road.
- Cultivation model is dominated by tree crops with limited rainfed sawah in lowland area
- The upstream watershed accommodates 5 golf courses (Gn. Geulis, Bukit Pelangi, Bukit Sentul, Permata Sentul and Jagorawi)

e. Pesanggrahan river basin

*Location of survey* : Semplak and Sawangan sub-district.

*River condition* :
- Pesanggrahan river originates in the hilly area north of Bogor city at an elevation of approximately 175 m, and flow to the Cengkareng floodway
- Pesanggrahan River has formed steep sided valleys, but in the lower reaches the river flows through alluvial coastal plain.
- Width become narrower to downstream due to housing development
- River bed material: sandy soil
- Erosion and sedimentation has occurred in lower areas due to extensive development.

*Land use* :
- Cultivation model is dominated by tree or fruits requiring less tilling
- Some sawah is cultivated by natural rainfall in the low lands
- The upper and mid-stream watershed will be completely urbanized in the near future

f. Cipinang river basin

*Location of survey* : Cibubur and Cilangkap sub-district.

*River condition* :
- In the upper and middle reaches, the Cipinang river has formed shallow dissected valleys, whereas in the lower reaches, it flows through alluvial coastal plain
- River bed material: sandy soil
- Riverbanks are used for garbage disposal
- Construction of housing along riverbanks
- Dykes are damaged in several locations.

*Land use* :
- Cultivation model dominated by tree crops or fruits requiring minimal tilling.
- Some paddy field (sawah) is cultivation in the lowland, utilizing natural rainfall.
- The upper and middle reaches will be completely urbanized in the near future

### 4.1.2 Downstream River Basin Area

a. Cidurian and Cimanceuri river basin

*Location of survey* : Kresek, Kronjo, Mauk, Tigaraksa and Cikupa.

*River condition* :
- The flood elevation was 2.5m above river bank in 2002
- River width ranging from 20 to 30 m (Cimanceuri) and 30-45 m (Cidurian) with water level 1.5-2.5 m below top of banks in dry season.
- Significant sediment has occurred in river estuary
- Significant tidal impact along 6 km of Cimanceuri estuary
- Cimanceuri divides into Cipayeuh, Cimaneh, Kali Pekong and Cikulutuk system. Cidurian River has lower watershed on eastern side, which overflows into the Cimanceuri system.
- Planting of tree crops to protection the river is not intensive; local people planting bananas as secondary crops along the river area (Kresek)
- Road infrastructure includes a district road built on dyke along side the river

*Land use* :
- Large areas of rainfed sawah occupy the upper areas. Irrigated sawah is cultivated between Cimanceuri and lower part of Cidurian, which includes aquaculture ponds along the coast (Mauk, Kronjo, Kemiri).
- Large areas of new settlement and industrial development occupy mid reach Cimanceuri watershed in Balaraja, Cikupa and Tigaraksa (larger than 5050 Ha) along Jakarta Merak Toll way.

b. Cisadane river basin

*Location of survey* : Priuk Jaya and Teluk Naga (Tangerang), Serpong, Tangerang Municipal.

*River condition* :
- River width is 80-100 m in lower downstream. Cisadane system includes watersheds at K. Sabi, K. Cigaren, K. Cihumi, K. Cisodong, Karawaci, Jeletreng and Cisauk. In dry season, the water level of the river remains around 3-4 m below ground level in the estuary.
- Significant sediment has occurred in middle reach downstream due to soil conditions along riverbank. Solid waste and garbage have accumulated downstream from residential and industrial.
- Ox-bow created by meandering is utilized for storage in residential areas of golf courses in middle reach watershed (Serpong).

*Land use* :
- Upland rainfed and lower irrigated sawah, including, aquaculture, dominate the area in estuary watershed (Teluk Naga)

- Flooding and inundation occured in Periuk Jaya settlement property because it lies in a depressed area adjacent to a detention facility.
- Large settlement areas (townships) are developed in the midstream Cisadane watershed; Bumi Serpong Damai, Villa Melati, Gading Serpong, Alam Sutra, Kota Modern (total estimated area exceeds 9000Ha).
- Kota Modern, Alam Sutra preserve the existing ox-bow lakes as detention facilities to control flooding.
- Industrial area along west Cisadane uses raw water from the river and transfers industrial waste to the same river.

c. Ciliwung river basin

*Location of survey* : Kel. Bukit Duri, Pengadegan, Kampung Pulo, Waduk Setiabudi.

*River condition* :
- Along the riverbank a lot of illegal semi-permanent housing or temporary construction has been constructed.
- Height of dyke is not sufficient for present flood levels.
- Bends of river caused by meandering have sedimentation from erosion and garbage deposit, which cause a disturbance to river flow.
- Ciliwung River includes the Kali Gongseng, Condet, K. Cijantung and K. Sugutamu systems

*Land use* :
- Settlement and infrastructure development occupy the lowland and depressed areas.
- Urban drainage problems in fringe areas (i.e. outside large property development and at boundaries of rural area)
- Population density is over 300 per ha in northern parts of DKI Jakarta and this contributes to the excessive garbage and solid waste in the river.
- Illegal settlement in the river area
- River is still being used for disposal of garbage and solid waste.

d. Cikeas, Cileungsi river upstream (tributary of Cikarang river basin)

*Location of survey* : Kec. Tambelan, Kec. Babelan dan ds. Sukatani.

*River condition* :
- Tidal influence in North region of Jabodetabek.
- Height of dyke is not enough to cover flood discharge.
- Flood plain area is destroyed by garbage.
- Residential housing along riverbank
- River meanders

*Land use* :
- Topographic condition is relative flat as it is a flood plain area.
- Urban drainage problem in fringe area between property developments.
- Density of population is 220 to 250 people per ha and includes high-density area.

e. Pesanggrahan river basin

*Location of survey* : Kel. Kapuk Muara, IKPN Bintaro, Tegal Alur.

*River condition* :
- Extensive erosion at river bends, width 6-8 m in the middle reach downstream.
- Garbage was spread along parts along the river.
- Permanent settlement along riverbank.
- Tidal influence occurs in lower part (Cengkareng drain)

*Land use* :
- Topographic condition is relative flat as it is a flood plain area.

f. Cipinang river basin

*Location of survey* : Kel. Kebon Pala, Cipinang Melayu, Penas Tanggul

*River condition* :
- River bends and some other areas with reduced with cause bottlenecks.
- Residential housing along river bank
- Dyke embankment is non-existent or is not high enough.
- Water is polluted from factory wastewater.

*Land use* :
- Large area is used for agriculture (technical irrigated rice), poultry and agriculture in estuary:
- Residential of drainage system is inadequate.
- Industrial area along west Cikarang river uses raw water from the river and discharge industrial waste into the same river.

The inventory condition of each major rivers are explained in the following Table 4-3. Sketches of river profile of Ciliwung, Cisadane, Cikarang/Bekasi and Pesanggrahan are appeared in the Figure 4-4 until Figure 4-7.