

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
AGENCY FOR ADMINISTRATION
OF THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

REPORT

ON

ADDES ABABA FOOD CONTROL PROJECT

IN

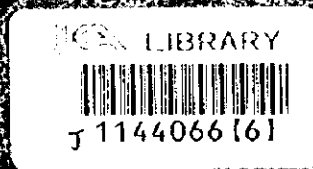
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

FINAL REPORT

VOLUME I

INCLUDING SUMMARY

MAY 1973



ETHIOPIAN PEOPLE'S COOPERATIVE

AGENCY FOR ADMINISTRATION OF THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
REGION 14 ADMINISTRATION
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

**THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA**

**FINAL REPORT
VOLUME I
EXECUTIVE SUMMARY**

MAY 1998

**NIPPON KOEI CO., LTD.
NIKKEN CONSULTANTS, INC.**

LIST OF REPORTS

- EXECUTIVE SUMMARY (*In Japanese*)
- VOLUME I EXECUTIVE SUMMARY (*In English*)
- VOLUME II MAIN REPORT (*In English*)
- VOLUME III SUPPORTING REPORT OF PHASE I STUDY
(MASTER PLAN STUDY) (*In English*)
- VOLUME IV SUPPORTING REPORT OF PHASE II STUDY
(FEASIBILITY STUDY) (*In English*)
- VOLUME V DATA BOOK (*In English*)



1144066 [6]

Applied Exchange Rate

US\$ 1.0 = Birr 6.8 = Japanese Yen 114.7

(As of June 1997)

PREFACE

In response to a request from the Government of the Federal Democratic Republic of Ethiopia, the Government of Japan decided to conduct the Study on Addis Ababa Flood Control Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Ethiopia a study team headed by Mr. Tetsuro Shigeta of Nippon Koei Co., Ltd. three times between March 1997 and March 1998.

The team held discussions with officials concerned of the Government of Ethiopia, and conducted field surveys. After the study team returned to Japan, further studies were made and the Final Report was prepared.

I hope that this Report will contribute to the promotion of the project and to the enhancement of friendly relations between two countries.

I wish to express my sincere appreciation to the officials concerned of the Region 14 Administration of the Government of the Federal Democratic Republic of Ethiopia for their close cooperation extended to the study team.

May 1998



Kimio Fujita

President

Japan International Cooperation Agency

May 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

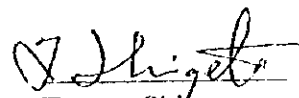
We are pleased to submit to you the Final Report on Addis Ababa Flood Control Project in the Federal Democratic Republic of Ethiopia.

The Study was carried out for a period of 14 months from March 1997 through May 1988. On the basis of the Study results, the Final Report has been prepared, presenting the formulated master plan for flood control to mitigate flood damage in Addis Ababa for the target year 2020, the selected priority projects, and the feasibility study of the priority projects.

As confirmed in the Report, the master plan has many beneficiaries in terms of human life and socio-economic activities, and the priority projects are technically viable and economically feasible. The implementation of the priority projects will create many direct benefits and simultaneously intangible and unquantifiable effects in the aspects of human lives, betterment of the living environment, and functional integrity of the capital city. Thus, the priority projects will contribute to the enhancement of human life. It is therefore recommended that the priority projects be realized at an earliest possible date as an important infrastructure development undertaking in Addis Ababa.

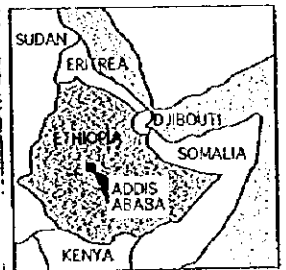
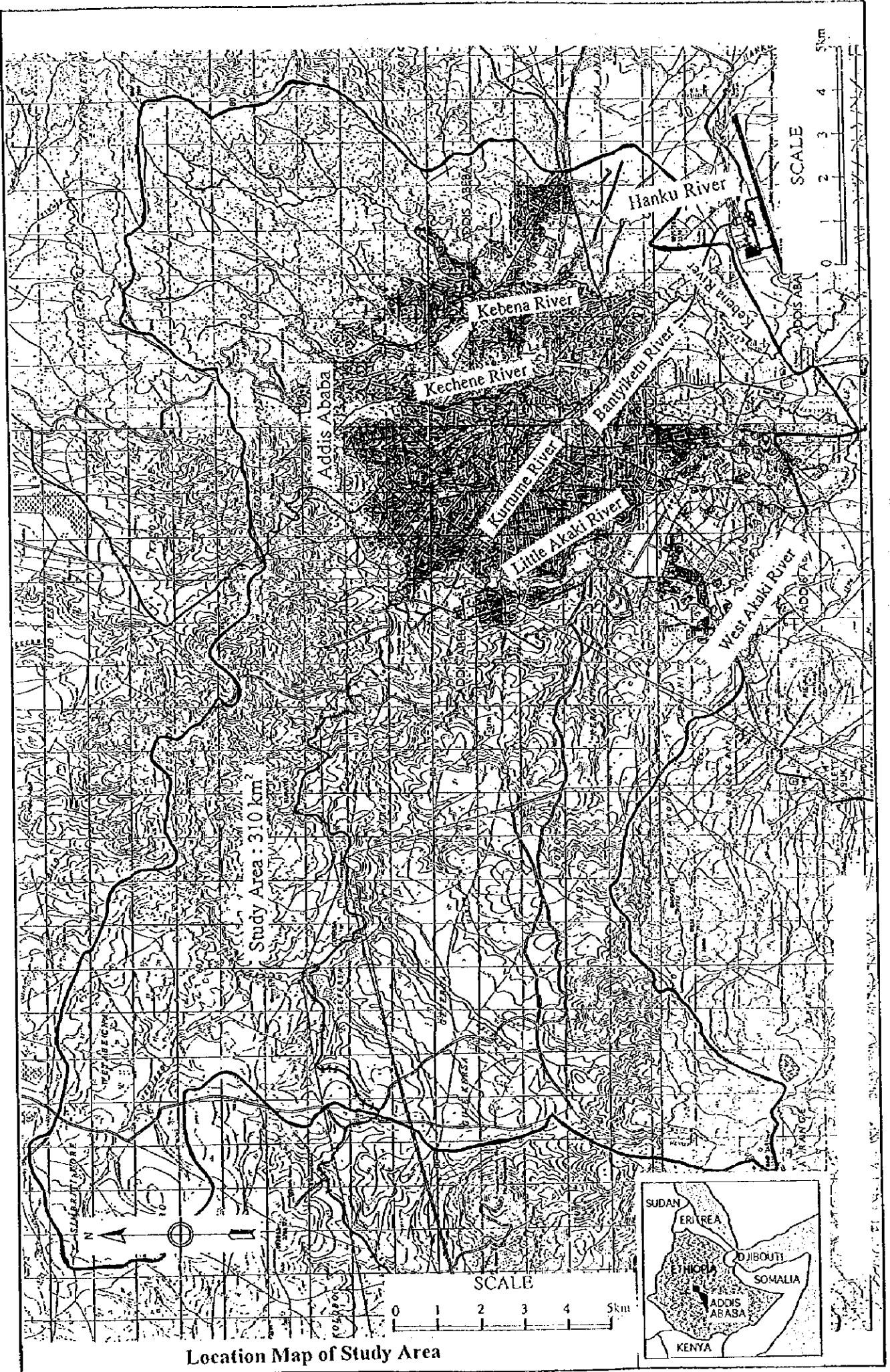
We wish to take this opportunity to express our sincere gratitude to your Agency, the Advisory Team for the Study and the Ministry of Foreign Affairs, Government of Japan. We also wish to express our deep gratitude to the Government of the Federal Democratic Republic of Ethiopia, the Region 14 Administration, the Embassy of Japan in Ethiopia, the JICA Ethiopia Office and JICA experts for close cooperation and assistance extended to us during our investigation and study.

Very truly yours,

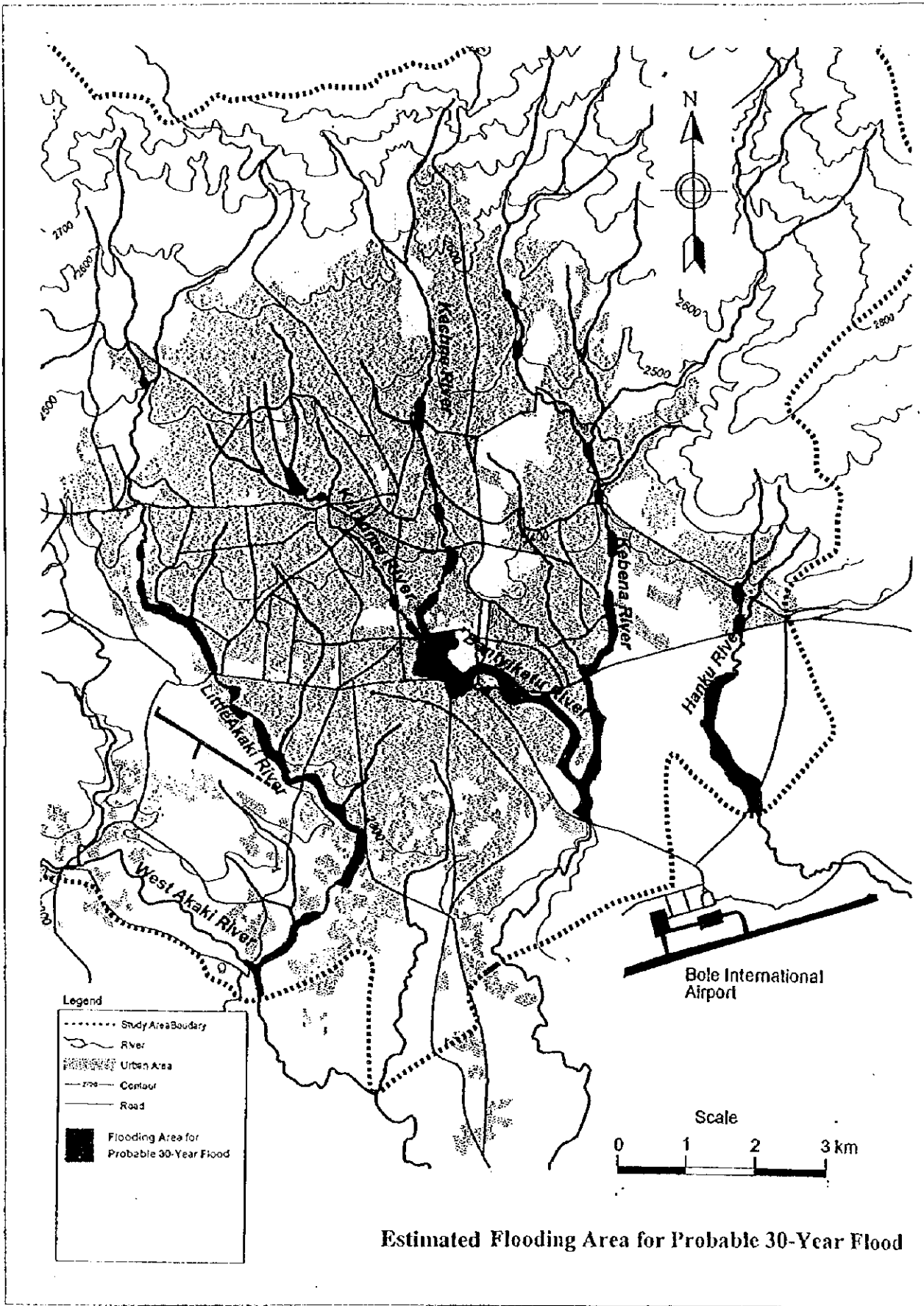


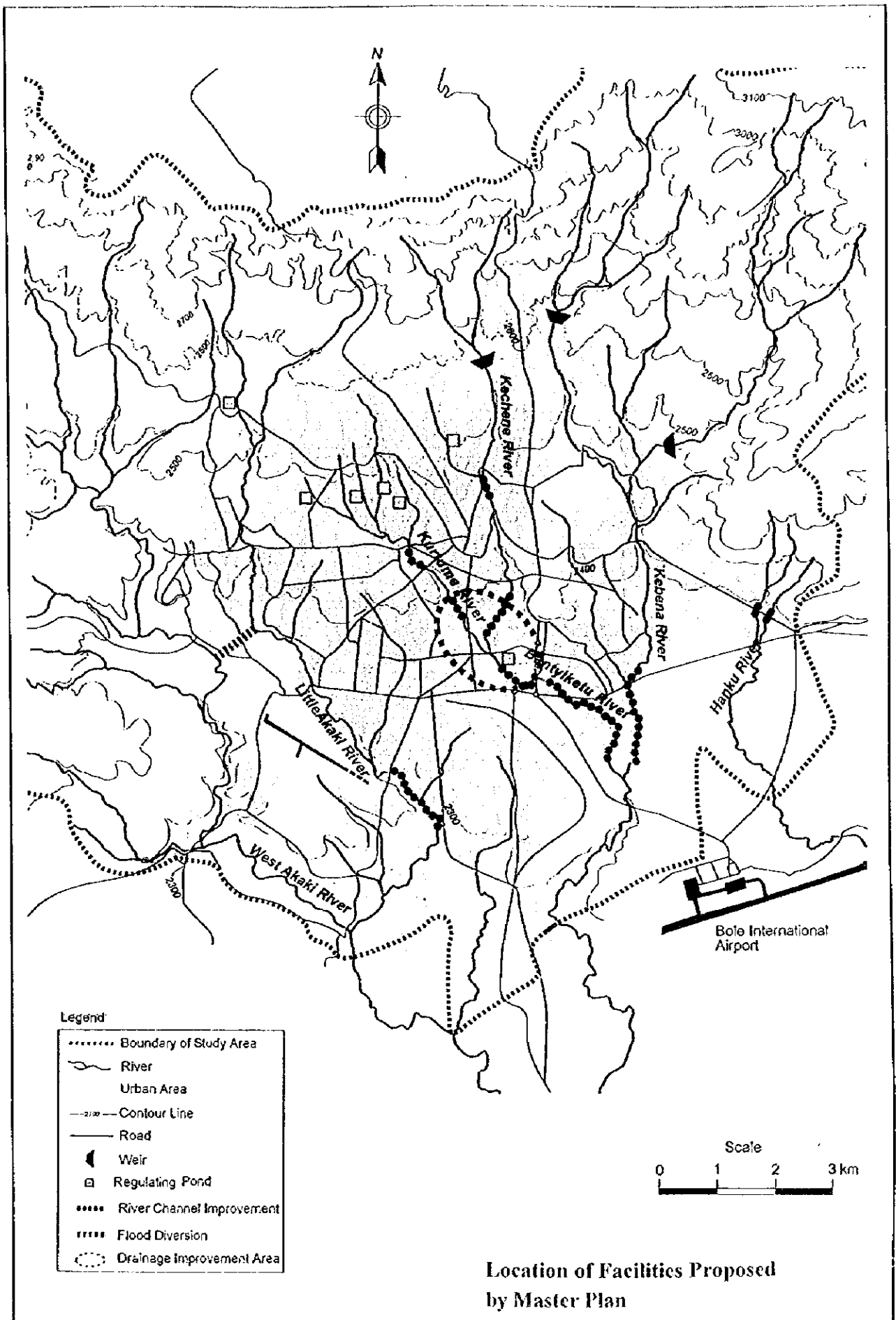
Tetsuro Shigeta
Team Leader

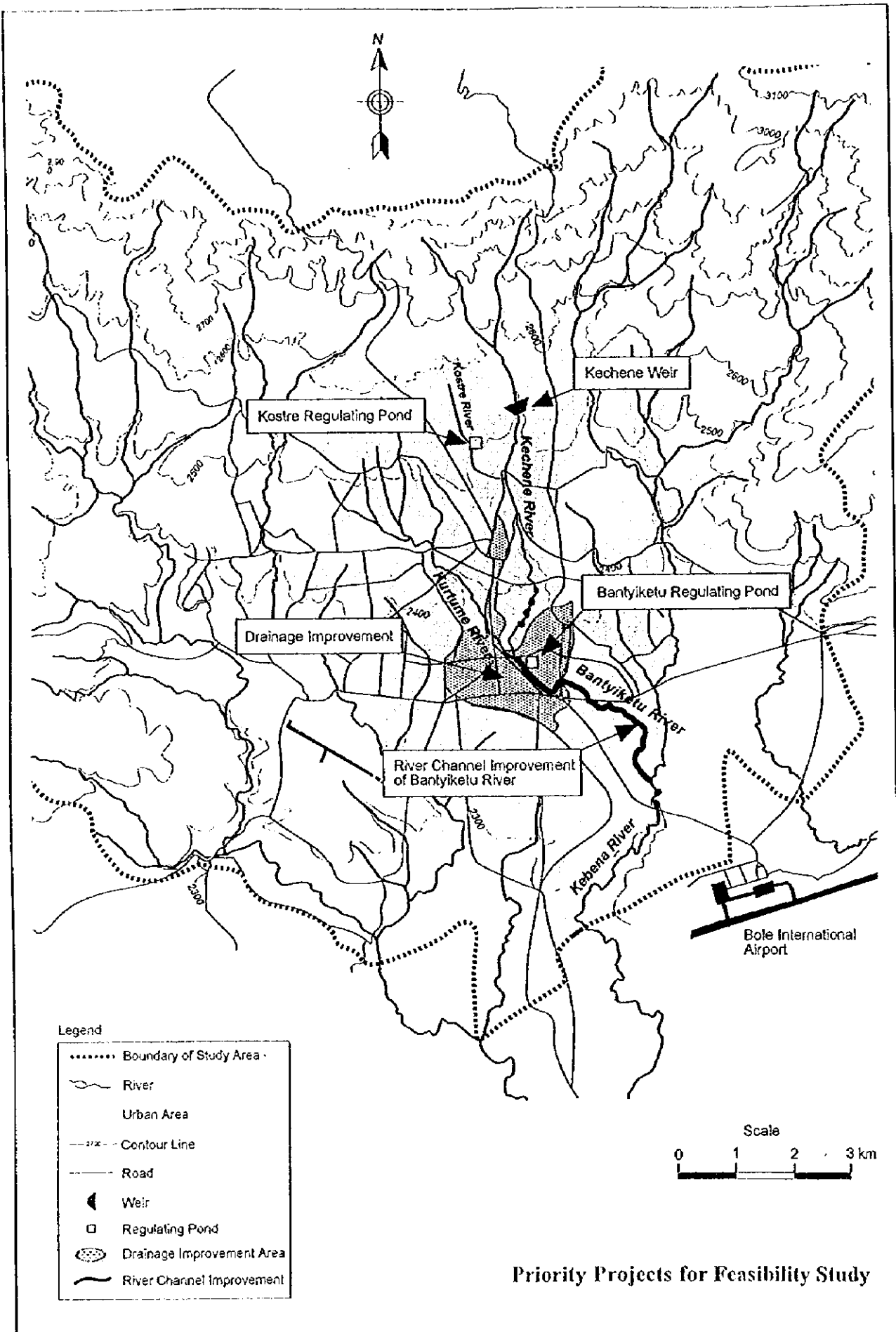
Addis Ababa Flood Control Project



Location Map of Study Area







Priority Projects for Feasibility Study

**THE STUDY
ON
ADDIS ABABA FLOOD CONTROL PROJECT
IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

COMPENDIUM**

1. FRAMEWORK

(1) Study Area

Study Area : Catchment of all rivers draining the city of Addis Ababa (Area = 310 km²)
 Area for Flood Control Plan : Municipal Area of Addis Ababa (Area=168 km²)
 Area for Urban Drainage Improvement : Central Urban Area (Lowland) (Area = 2.61 km²)

(2) Target Year : Year 2020

(3) Planning Conditions :

		Year 1997	Year 2020
Population in Study Area		1.8 million	4.4 million
Gross Regional Domestic Product (GRDP)		1,370 million Birr	8,150 million Birr
Land Use	Municipal Area	168 km ²	200 km ²
	Farmland / Forest / Others	142 km ²	110 km ²
Total		310 km ²	310 km ²

Design Discharge of Flood Control Main Streams : Probable 30 year
 Tributaries : Probable 20 year
 Design Rainfall Intensity of Urban Drainage Improvement Probable 1.5 year (30 mm/hr)

2. MASTER PLAN

2.1 STRUCTURAL MEASURES

For minimizing resettlement attributed to river channel improvement, flood retention facilities are furnished in upstream reaches. In principle, structures are designed on the basis of maintenance-free policies. Rainfall in the Study Area is of remarkably torrential one and about a half of such rainfall is recorded within 30 minutes, about 90 % within 60 minutes, their duration being not more than two hours, and such rainfall characteristics are also taken into account in design of structural measures.

Due to the lack of appropriate drainage facilities, the central urban area along both right and left banks of the Bantyketu river suffers inundation almost every time when heavy rainfall occurs and mitigation measures of drainage congestion is formulated.

River System / River	Structural Measures			
	Weir	Regulating Pond	River Improvement	Others
Bantyketu River System				
- Kechene River	1	1	1.0 km	Repair of a bridge abutment
- Kurtume River	0	4	0.8 km	-
- Bantyketu River	1	1	4.5 km	Reconstruction of an aqueduct
- Urban Drainage	-	-	-	Construction of drainage ditches (L = 1.2 km)
Kebena River System				
- Kebena River	2	0	3.1 km	
Little Akaki River System				
- Little Akaki River	0	1	1.5 km	Flood Diversion Channel (L = 1 km)
West Akaki River System	(Only non-structural measures are applied to the river system.)			
Hanku River System				
- Hanku River	0	0	0.5 km	Reconstruction of 2 culverts

2.2 NON-STRUCTURAL MEASURES

Non-structural measures of the master plan consist of the river management, watershed management and flood risk management.

- | | | |
|-----------------------|---|--|
| River Management | : | 1) Authorization of river zone |
| | | 2) Social education of river and flood, and regulation of illegal activities |
| Watershed Management | : | 1) Reforestation |
| Flood Risk Management | : | 1) Flood Warning System |
| | | 2) Flood Fighting |
| | | 3) Storage of Storm Water |

2.3 PROJECT COST

The project cost for the master plan amounts to 763.1 million Birr consisting of 751.2 million Birr for the structural measures and 11.9 million Birr for the non-structural measures.

Unit : Million Birr (Million US\$)

River System	Bantiyketu	Kebena	Little Akaki	Hanku	Total
Project Cost	154.6 (22.8)	394.5 (58.0)	211.2 (31.1)	2.8 (0.4)	763.1 (112.3)

2.4 EVALUATION OF PRIORITY BY RIVER SYSTEM AND PRIORITY PROJECTS

(1) Evaluation of Priority by River System

The structural and non-structural measures contemplated by the master plan has beneficial area of 105 km² and beneficial population of 1,345 thousand persons, and contribute to the stability of various functions fitted to the capital, Addis Abeba, and the well-being of local residents.

Priority by river system is determined based on the economic internal rate of return (EIRR), beneficial population, characteristics of land use and other factors. Among the four river systems, the Bantiyketu and the Little Akaki river systems are bestowed with sound economic viability, their EIRR being higher than 10 %.

River System	Bantiyketu	Kebena	Little Akaki	Hanku	Total
EIRR	11.7	3.5	10.6	7.2	10.8
Benefit/Cost	1.17	0.42	1.07	0.72	1.08
Beneficial area (km ²)	51	40	33	9	105
Beneficial Population (person)	610,000	280,000	420,000	35,000	1,345
Land Use	Mainly Governmental Agencies and Commercial Area	Mainly Moderately Built-up Area	Mainly Densely Built-up Area	Mainly Moderately Built-up Area	-
Priority	1	4	2	3	-

(2) Priority Projects

The Bantiyketu river system including the Kechene and the Kurtume rivers is evaluated with the highest priority among the four river systems. The priority projects are selected as a combination of structural and non-structural measures with the highest priority in terms of economic viability and social impacts in the Bantiyketu river system.

Structural measures

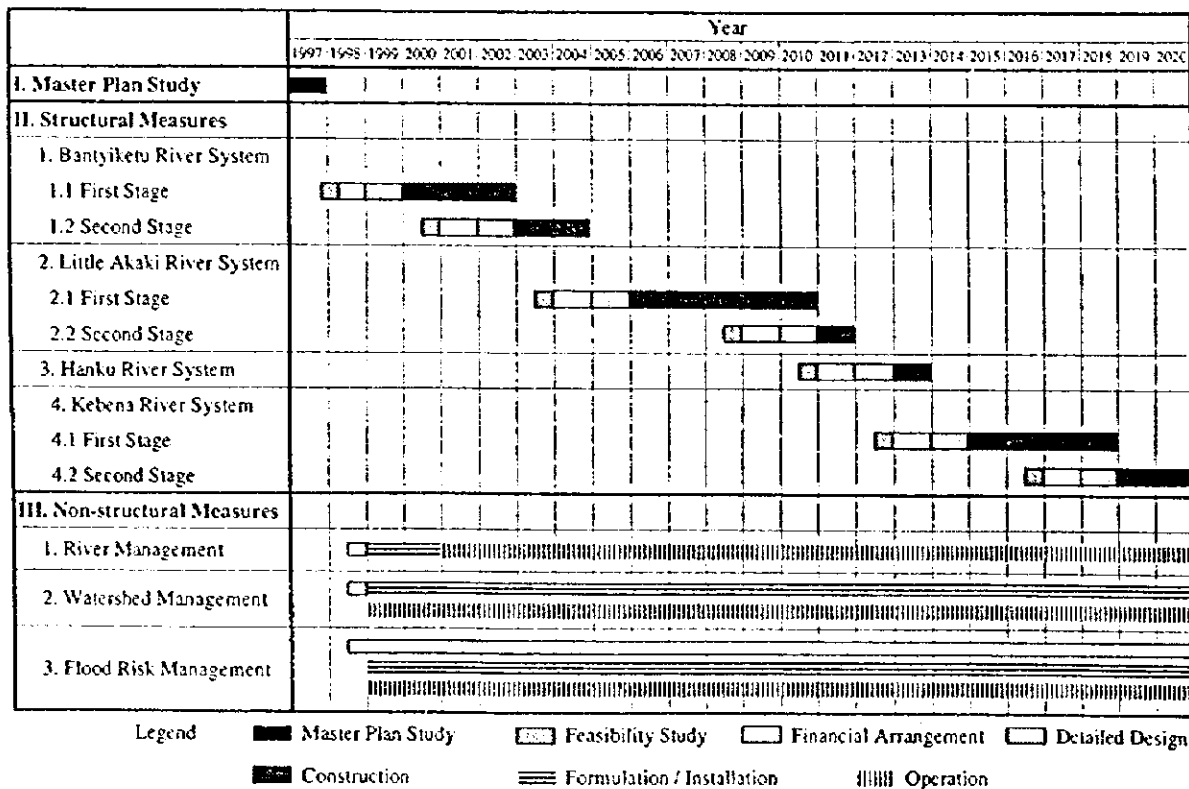
- Objective rivers : Bantiyketu and Upper Kechene rivers
- Flood Control Facilities : 1 weir, 2 regulating ponds, River channel improvement of Bantiyketu river, Associated works
- Urban Drainage Facilities : Central urban area (Lowland)

Non-structural measures

- River Management : 1) Authorization of river zone
2) Social education of river and flood
- Flood Risk Management : 1) Flood Warning System
2) Flood Fighting System

2.5 IMPLEMENTATION PLAN

The implementation plan of the structural measures are formulated in compliance with priority order by river system, periods of pre-construction and construction stages, and disbursement schedule of project cost. All the construction works will be completed in the end of 2020. The non-structural measures will also be implemented along with the structural measures until the year 2020.



Implementation Plan of Master Plan Projects

3. FEASIBILITY STUDY

3.1 FLOOD CONTROL PROJECTS

(1) Structural Measures

(a) Bantiyketu River System

The major features of the structural measures for the Bantiyketu river system are summarized as follows.

River Channel Improvement

Flood wall/Slope protection	: 11 locations, L = 2.3 km
River excavation	: 4 locations, L = 2.0 km
Earth dyke	: 1 location, L = 100 m
Reconstruction of an aqueduct	: 1 location, L = 20 m

Regulating Pond

Bantiyketu regulating pond	: Regulating volume = 73,000 m ³ , Impounding area = 29,900 m ²
Kostre regulating pond	: Regulating volume = 26,000 m ³ , Impounding area = 6,500 m ²

Reservoir by Weir

Kechene weir	: Concrete gravity weir, H = 19.5 m, Regulating volume = 96,000 m ³ , Non-emergency spillway : 3 orifices (1.2m x 1.2m)
--------------	--

(b) Urban Drainage

The urban drainage improvement plan is designed to prevent inundation of the objective area of 2.61 km² when rainfall with intensity of 30 mm/hour takes place.

Drainage Basin	Drainage Area (km ²)	Design Discharge (m ³ /sec)	Dimensions of Drainage Ditch
Northern Basin	0.25	0.7	D = 1.1 m W = 1.3 m
Eastern Basin	0.73	0.5 - 1.5	D = 1.2-1.5 m W = 1.3 m
West-southern Basin	1.63	0.7 - 1.4	D = 1.9-2.2 m W = 1.3 m
Total	2.61	7.4	

(2) Non-structural Measures

For amplifying the effect of structural measures, Addis Ababa River Board (AARB) and Addis Ababa River Management Authority (AARMA) will implement non-structural measures as follows.

River Zone	:	For proper management of rivers and river structures, open space, 5 meters in width, is provided along both banks of rivers.
Flood Warning System	:	Rainfall gauging stations are installed at 3 locations in upstream areas of the basin. Rainfall data observed is sent to and analyzed by AARMA.
Flood Fighting System	:	Communities subordinate to Kebeles undertake flood fighting under direction of AARB.
Social Education	:	Kebeles and communities hold seminars for local people under direction AARB and AARMA. The seminars concern river management, flood and illegal activities such as waste disposal, private use of riparian areas.
Reforestation	:	AARB and AARMA advise on reforestation undertaken by the agricultural bureau of Region 14 Administration

3.2 ORGANIZATION AND INSTITUTION

Addis Ababa River Board (AARB) to be newly organized under Economic Sector of Region 14 Administration is a sole organization responsible for management of all rivers in Region 14 Administration. Under AARB, Addis Ababa River Management Authority (AARMA) is to be established with its roles involving management and maintenance of rivers, investigation, planning, design and construction of projects, legislation of river management, as well as flood warning system and flood fighting system.

Responsibilities and undertaking in new organizations are as follows.

Addis Ababa River Board (AARB)	:	<ol style="list-style-type: none"> (1) Coordination with offices and agencies concerned (2) Establishment of new departments of AARMA (3) Budgetary control (4) Land acquisition
Addis Ababa River Management Authority (AARMA)	:	<ol style="list-style-type: none"> (1) River management (2) Maintenance of river and river structures (3) Issuing of Flood Warning (4) Flood fighting (5) Investigation, planning and design of river projects (6) Tendering of river projects (7) Construction supervision (8) Resettlement (9) Social education for local people
Local Communities	:	<ol style="list-style-type: none"> (1) Assistance in maintenance of river structures (2) Notification of flood warning (3) Flood fighting

3.3 PROJECT COST

Total project cost of the priority projects is estimated at 104.4 million Birr (equivalent to 15.4 million US\$).

Structural Measures:

Unit : Million Birr (Million US\$)

Weir/Regulating Pond			River Channel Improvement			Urban Drainage	Total
Kechene Weir	Kostre Pond	Bantyketu Pond	Flood wall / Slope protection	River Excavation	Associated Works		
27.6 (4.1)	8.8 (1.3)	18.6 (2.7)	19.5 (2.9)	3.9 (0.6)	1.2 (0.2)	18.3 (2.7)	97.9 (14.4)

Non-structural Measures:

Unit : Million Birr (Million US\$)

River Management		Flood Risk Management		Total
River Zone	Social Education	Flood Warning System	Flood Fighting	
2.9 (0.4)	0.1 (0.01)	2.3 (0.34)	1.2 (0.2)	6.5 (1.0)

3.4 PROJECT EVALUATION

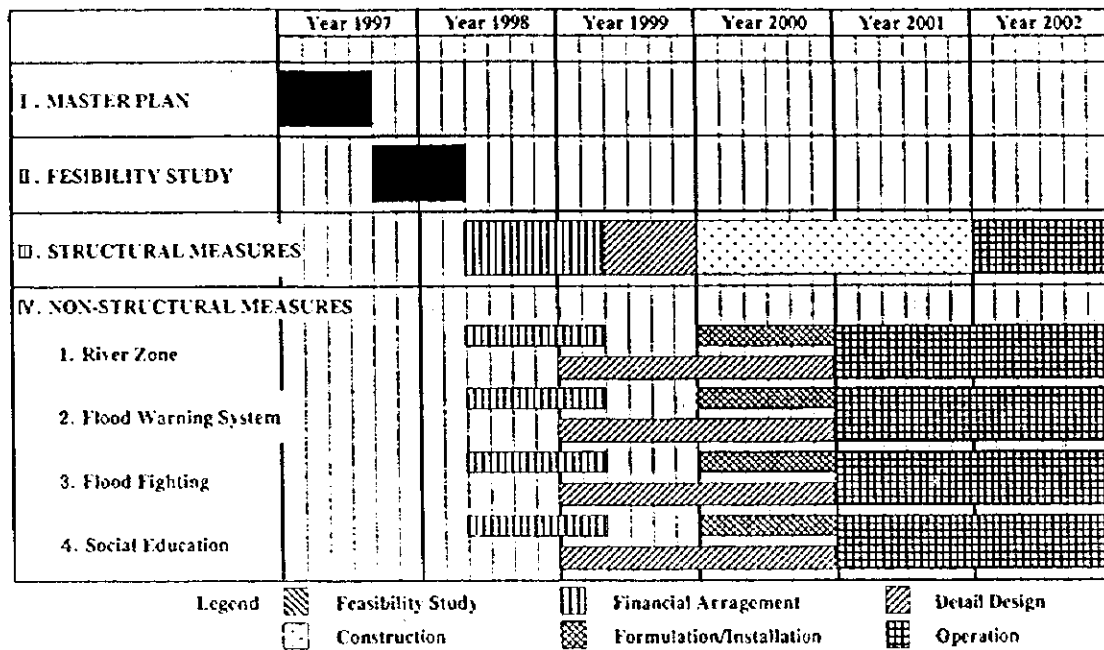
The priority projects have beneficial area of 43 km² and beneficial population of 470 thousand persons at the target year 2020, being bestowed with high economic internal rate of return (EIRR) of 12.8 %. Due to the implementation of the priority projects, only four houses are to be resettled, and there exist neither national parks nor archeological resources affected.

- (1) Annual Average Benefit : 13.6 million Birr
- (2) EIRR (%) : 12.8
- (3) Benefit/Cost : 1.29
- (4) Beneficial area (km²) : 43
- (5) Beneficial Population (person) : 470,000 (Target Year 2020) and 200,000 (Year 1997)
- (6) Impact on Natural Environment : Negative benefits are negligibly small.

In addition, the priority projects create a lot of intangible and nonquantifiable benefits such as contribution to the stability of various functions fitted to the capital, Addis Abeba, and the well-being of local residents, resulting from the distinctive improvement of living conditions and public health.

3.5 IMPLEMENTATION PLAN

After this feasibility study, it is expected that the implementation will be commenced from the year of 1999 after some period of financial arrangement. Proposed implementation plan of the priority projects is shown below.



Implementation Plan of Priority Projects

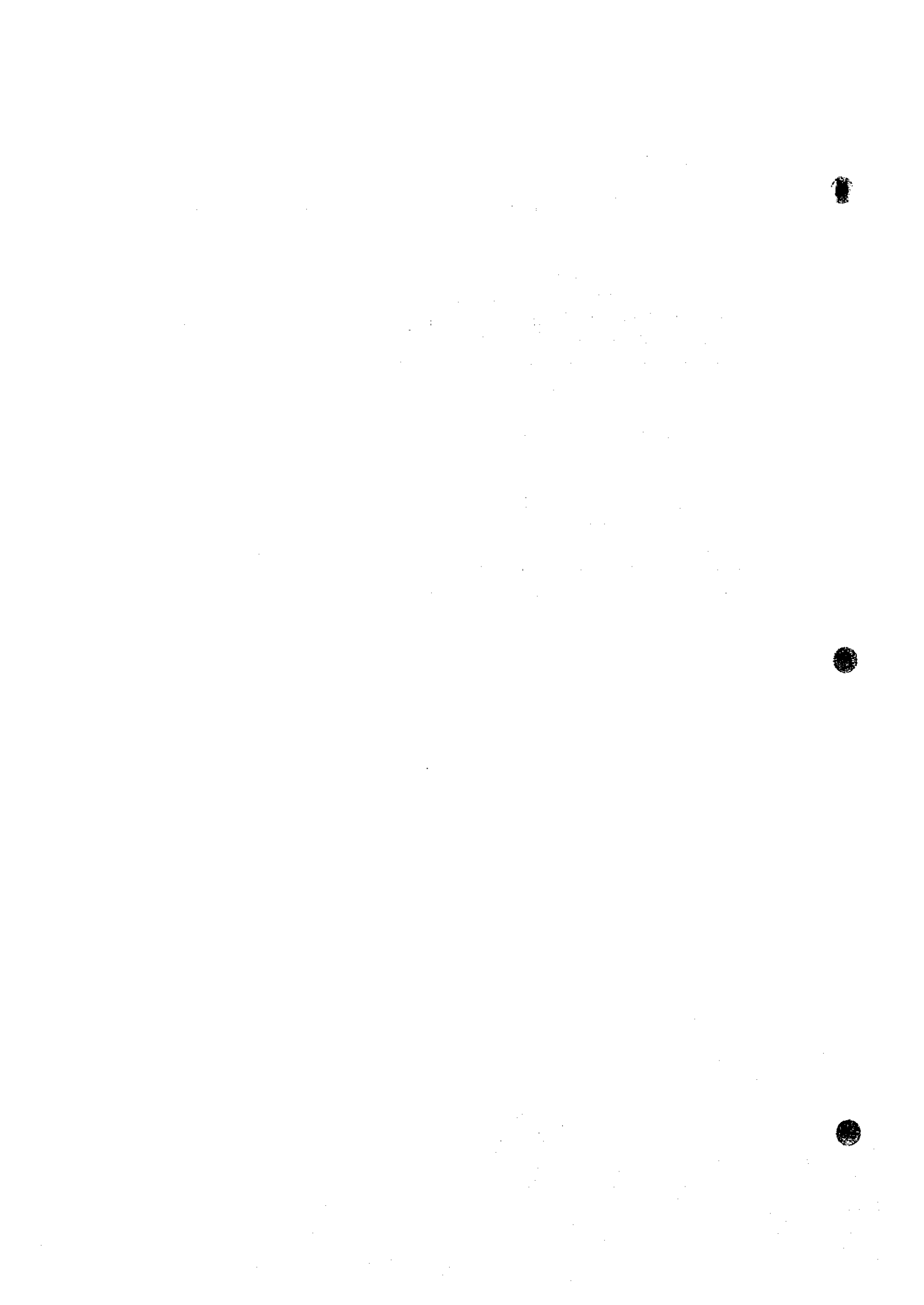
4. CONCLUSIONS AND RECOMMENDATIONS

(1) Advance toward Implementation of Structural and Non-structural Measures Contemplated by Master Plan

The amount of flood damages in the Region 14 Administration is soaring year by year with the drastic increase of population and infrastructures. It is recommended that the priority projects be first launched among projects proposed by the master plan, and that the rest of the master plan projects be continuously implemented according to the implementation plan of the master plan projects from the view point of local economic conditions and social welfare.

(2) Early Implementation of Priority Projects

Flood control measures of the Bantiyketu river and the upper Kechene river are chosen for the priority projects. 11 % of total population of the Region 14 administration enjoy direct or indirect benefits created by the priority projects, and more intangible and unquantifiable benefits are expected. The priority projects indicate high economic viability with Economic Internal Rate of Return (EIRR) of 12.8 % and Benefit-Cost ratio of 1.29 and their early implementation is strongly recommended.



**STUDY
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IN
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
EXECUTIVE SUMMARY
CONTENTS**

COMPENDIUM

	Page
CHAPTER 1 INTRODUCTION -----	1
1.1 The Study on Addis Ababa Flood Control Project -----	1
1.2 Objectives of the Study -----	1
1.3 Organization of the Study -----	1
1.4 Process of the Study -----	2
 CHAPTER 2 BACKGROUND OF THE STUDY -----	 3
2.1 General -----	3
2.2 Necessity of the study -----	3
 CHAPTER 3 PRESENT CONDITIONS OF THE STUDY AREA -----	 4
3.1 Geographical Features-----	4
3.2 Climate -----	4
3.3 Administration-----	5
3.4 Socio-economy -----	5
3.4.1 National and Regional Development Plan-----	5
3.4.2 Population -----	9
3.4.3 Economy-----	10
3.4.4 Land Use-----	12
3.4.5 Financial Conditions-----	13
3.4.6 Resettlement-----	16
3.4.7 Environmental Protection -----	17
3.5 Rivers-----	17
3.5.1 River Channel Conditions-----	17
3.5.2 Carrying Capacity -----	18
3.5.3 Water Use-----	19
3.5.4 Related Structures -----	19
3.6 Flood Damage-----	20
3.7 Drainage Congestion -----	20

	Page
CHAPTER 4 MASTER PLAN	22
4.1 Framework	22
4.1.1 Target Year and Protection Area	22
4.1.2 Objective River Systems.....	22
4.1.3 Population	22
4.1.4 Future Land Use	22
4.1.5 Gross Regional Domestic Product	23
4.1.6 Related Plans and Projects	23
4.2 Basic Concept of Flood Control Plan	23
4.2.1 Protection Area and Objective River Stretches.....	23
4.2.2 Design Scale.....	24
4.2.3 Flood Control Measures	24
4.3 Structural Measures	26
4.3.1 Bantyiketu River System including Kechene and Kurtume River ----	26
4.3.2 Kebena River System	27
4.3.3 Little Akaki and West Akaki River System.....	28
4.3.4 Hanku River System	28
4.4 Non-structural Measures	29
4.4.1 River Management	29
4.4.2 Watershed Management	30
4.4.3 Flood Risk Management.....	30
4.5 Summary of Flood Control Master Plan.....	31
4.5.1 Structural Measures	31
4.5.2 Non-structural Measures.....	34
4.6 Project Cost.....	34
4.6.1 Structural Measures	34
4.6.2 Non-structural Measures.....	35
4.6.3 Project Cost for the Master Plan.....	36
4.7 Organization and Institution.....	36
4.7.1 Organization Framework	36
4.7.2 Institutional Framework	37
4.8 Operation and Maintenance	38
4.8.1 Structural Measures	38
4.8.2 Non-structural Measures.....	38
4.9 Overall Evaluation of Master Plan	40
4.9.1 Economic Evaluation	40
4.9.2 Initial Environmental Examination	40
4.9.3 Overall Evaluation.....	41
4.10 Implementation Plan.....	44
4.10.1 Structural Measures	44
4.10.2 Non-Structural Measures	45

	Page
CHAPTER 5 SELECTION OF PRIORITY PROJECTS FOR FEASIBILITY STUDY -----	47
5.1 Priority River System-----	47
5.2 Selection of Structural Measures -----	49
5.2.1 Alternative Plans-----	49
5.2.2 Evaluation and Selection of Priority Projects-----	50
5.3 Selection of Non-structural Measures-----	52
5.4 Priority Projects for Feasibility Study-----	52
 CHAPTER 6 FEASIBILITY STUDY ON PRIORITY PROJECTS -----	 55
6.1 Basic Planning Conditions of Priority Projects -----	55
6.1.1 Flood Control Plan -----	55
6.1.2 Urban Drainage Plan -----	55
6.2 Structural Measures -----	57
6.2.1 Flood Control Plan -----	57
6.2.2 Urban Drainage Plan -----	66
6.3 Non-structural Measures -----	69
6.4 Project Cost-----	74
6.5 Construction Plan-----	77
6.5.1 Major Work Quantities-----	77
6.5.2 Construction Schedule -----	77
6.6 Organization and Institution -----	79
6.6.1 Organization for Project Implementation -----	79
6.6.2 Institution for Non-Structural Measures-----	82
6.6.3 Operation and Maintenance -----	83
6.7 Project Evaluation-----	84
6.7.1 Environmental Impact Assessment -----	84
6.7.2 Social Impact Assessment -----	84
6.7.3 Economic Evaluation -----	85
6.7.4 Conclusions of Project Evaluation -----	87
6.8 Implementation Plan -----	88
6.9 Conclusions of Priority Projects-----	90
6.9.1 Structural Measures -----	90
6.9.2 Non-structural Measures-----	91
6.9.3 Project Cost and Benefit-----	91
 CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS -----	 93

LIST OF TABLES

		Page
Table 1	Summary of Climate in the Study Area-----	4
Table 2	Present Land Use in Addis Ababa-----	12
Table 3	Budget and Expenditure of Region 14 Administration -----	13
Table 4	Capital Budget and Expenditure of Region 14 Administration -----	16
Table 5	Present Carrying Capacity and Probable Flood Discharge-----	18
Table 6	Objective River Systems -----	22
Table 7	Proposed Structural Measures-----	31
Table 8	Proposed Non-structural Measures -----	34
Table 9	Project Cost for Structural Measures-----	35
Table 10	Project Cost for Non-structural Measures -----	35
Table 11	Results of Initial Environmental Examination -----	41
Table 12	Overall Evaluation of Flood Control Master Plan-----	42
Table 13	Stage Wise Implementation Plan -----	45
Table 14	Evaluation Criteria for Priority by River System-----	48
Table 15	Summary of Evaluation of Priority by River System-----	49
Table 16	Alternative Plans for Selection of Priority Projects -----	50
Table 17	Summary of Selection of Priority Projects -----	51
Table 18	Priority Projects for Feasibility Study-----	53
Table 19	Basic Features of River Channel Improvement of Bantyiketú River	57
Table 20	Basic Features of Regulating Pond -----	60
Table 21	Basic Features of Kechene Weir -----	63
Table 22	Summary of Urban Drainage Plan-----	67
Table 23	Summary of Project Cost -----	75
Table 24	Annual Disbursement Schedule -----	76
Table 25	Major Work Quantities -----	77
Table 26	Economic Project Cost -----	86
Table 27	Annual Operation and Maintenance Cost -----	86
Table 28	Sensitivity Analysis-----	87

LIST OF FIGURES

		Page
Figure 1	Autonomous Regions and Municipalities in Ethiopia-----	6
Figure 2	Municipal Boundary of Addis Ababa -----	7
Figure 3	Organization of Economic Sector -----	8
Figure 4	Area of Addis Ababa -----	9
Figure 5	Population Projection in the Study Area -----	10
Figure 6	Gross Domestic Product -----	11
Figure 7	Land Use Plan by Addis Ababa Master Plan -----	14
Figure 8	Estimated Future Land Use-----	15
Figure 9	Flood Affected Areas in Addis Ababa -----	21
Figure 10	Rainfall Pattern-----	24
Figure 11	Structural Measures Proposed by Master Plan -----	33
Figure 12	Probable Flood Damages -----	43
Figure 13	Proposed Implementation Plan of Master Plan Projects -----	46
Figure 14	Priority Projects for Feasibility Study -----	54
Figure 15	Longitudinal Profile of Bantiyketu River -----	59
Figure 16	Plan of Bantiyketu Regulating Pond -----	61
Figure 17	Plan of Kostre Regulating Pond -----	62
Figure 18	Plan of Kechene Weir -----	64
Figure 19	Downstream View and Longitudinal Profile of Kechene Weir ----	65
Figure 20	Location Map of Drainage Area and Drainage Ditch -----	68
Figure 21	Concept of River Zone -----	70
Figure 22	Outline of Flood Warning System-----	72
Figure 23	Community Organization and Communication Chat for Flood Fighting-----	73
Figure 24	Construction Schedule -----	78
Figure 25	Overall Organization Chart for Project Implementation -----	80
Figure 26	Proposed Organization of Addis Ababa River Board and Management Authority-----	81
Figure 27	Proposed Implementation Plan of Priority Projects-----	89
Figure 28	Priority Projects -----	92

LIST OF ANNEXES

	Page
Annex-1 Gross Domestic Product	A-1
Annex-2 Population in Urban and Rural Areas of Ethiopia and Addis Ababa	A-2
Annex-3 Longitudinal Profile of Rivers (1/2).....	A-3
Annex-4 Longitudinal Profile of Rivers (2/2).....	A-4
Annex-5 Basic Flood Discharge (1/2).....	A-5
Annex-6 Basic Flood Discharge (2/2).....	A-6
Annex-7 Design Discharge Distribution (1/2)	A-7
Annex-8 Design Discharge Distribution (2/2)	A-8
Annex-9 Location of Proposed River Channel Improvement Work and River Cross Section Survey (1/4).....	A-9
Annex-10 Location of Proposed River Channel Improvement Work and River Cross Section Survey (2/4).....	A-10
Annex-11 Location of Proposed River Channel Improvement Work and River Cross Section Survey (3/4).....	A-11
Annex-12 Location of Proposed River Channel Improvement Work and River Cross Section Survey (4/4).....	A-12
Annex-13 Typical Features of River Channel Improvement Work.....	A-13
Annex-14 Typical Cross Sections of Drain Ditches	A-14

ABBREVIATIONS

Measures

Length

mm	millimeter
cm	centimeter
m	meter
km	kilometer

Area

m ² , sq.m	square meter
ha	hectare
km ² , sq.km	square kilometer

Volume

l, lit.	liter
m ³ , cu.m	cubic meter

Weight

mg	milligram
g	gram
kg	kilogram
t	ton

Time

s, sec	second
min	minute
hr	hour
d	day
yr	year

Money

Birr	Ethiopian Birr
US\$	U. S. Dollar
J. Yen	Japanese Yen

Electricity

V	volt
A	ampere
KV	kilovolt
KW	kilowatt
KWh	kilowatt hour
KVA	kilovolt ampere

Derived Measures

mg/l	milligram per liter
m/s, m/sec	meter per second
m ³ /sec, cu.m/sec	cubic meter per second
m ³ /day, cu.m/day	cubic meter per day

Other Measures

%	percent
°C	degree centigrade
BOD	biochemical oxygen demand

Organizations

OAU	Organization of African Union
JICA	Japan International Cooperation Agency
NMSA	National Meteorological Services Agency of Ethiopia
MEDAC	Ministry of Economic Development and Cooperation
MUDH	Ministry of Urban Development and Housing
NUPI	National Urban Planning Institute
WUDB	Works and Urban Development Bureau of Region 14 Administration
CSA	Central Statistical Authority
ADF	African Development Fund
IDA	International Development Association
NEPA	National Environmental Protection Authority
AFCPO	Addis Ababa Flood Control and Prevention Project Office of the Region 14 Administration
AAWSA	Addis Ababa Water Supply and Sewerage Authority of the Region 14 Administration
BCEOM	Bureau Central D'etudes Pour Les Equipments D'outer-Mer
NDPPC	National Disaster Prevention and Preparedness Committee
NCEW	National Committee for Early Warning
RDPPC	Regional Disaster Prevention and Preparedness Committee
WDPPC	Wereda Disaster Prevention and Preparedness Committee
WRDC	Wereda Disaster Relief Cell
FRDE	Federal Government of Ethiopia
AARB	Addis Ababa River Board (proposed)
AARMA	Addis Ababa River Management Authority (proposed)
ECA	European Community of Africa
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund

UNESCO	United Nations Educational, Scientific, and Cultural Organization
ILO	International Labor Organization
NGO	Non-governmental Organizations
Others	
S.N.N.P.R.	Southern Nations Nationalities and People's Region
PEP	Public Expenditure Program
PIP	Public Investment Program
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
ITCZ	Inter Tropical Convergence Zone
ALDI	Industrial Lead by Agricultural Development
EIRR	Economic Internal Rate of Return
B/C	Cost-Benefit Ratio
NPV	Net Present Value
IEE	Initial Environmental Examination
EIA	Environmental Impact Assessment
F. C.	Foreign Currency
L. C.	Local Currency
O/M, O&M	Operation and Maintenance
EL.	Elevation
DHWL	Design High Water Level



CHAPTER 1 INTRODUCTION

1.1 The Study on Addis Ababa Flood Control Project

This Final Report presents the results of the Study on Addis Ababa Flood Control Project (hereinafter referred to as 'the Study').

In response to the request of the Government of the Federal Democratic Republic of Ethiopia (hereinafter referred to as 'the Federal Government of Ethiopia'), the Government of Japan decided to conduct the Study in accordance with the relevant laws and regulations in force in Japan. Accordingly, the Japan International Cooperation Agency (hereinafter referred to as 'JICA'), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, undertook the Study in close cooperation with the authorities concerned of Ethiopia.

The Scope of Work of the Study was agreed between the Region 14 Administration of the Federal Government of Ethiopia (hereinafter referred to as 'the Region 14 Administration') and JICA on 11 November 1996 in Addis Ababa. On the basis of the Scope of Work, the Study was carried out from March 1997 and finalized in May 1998.

1.2 Objectives of the Study

The objective area of the Study (hereinafter referred to as 'the Study Area') designated in the Scope of Work covers an area of 310 km², which includes the catchment areas of the Akaki river tributaries flowing down the city of Addis Ababa.

The objectives of the Study are to formulate a master plan of flood control in Addis Ababa for the target year 2020 and to carry out a feasibility study on flood control for priority project(s) identified in the master plan study.

In addition, transfer of technology to the Ethiopian counterparts is conducted in the course of the Study.

1.3 Organization of the Study

The JICA Study Team for the Addis Ababa Flood Control Project (hereinafter referred to as 'the Study Team') was organized in accordance with the contract between JICA and the joint venture of Nippon Koei Co., Ltd. and Nikken Consultants, Inc. in March 1997. In addition, JICA organized the Advisory Team for the Study to provide technical advice throughout the period of the Study.

The Region 14 Administration provided the counterparts organized by the Addis Ababa Flood Control and Prevention Project Office (hereinafter referred to as 'AFCPO') under the Steering Committee of the Addis Ababa Flood Control and Prevention Project (hereinafter referred to as 'the Steering Committee').

The Study was successfully accomplished in joint efforts of the Ethiopian and Japanese sides.

1.4 Process of the Study

The Study was carried out for the period 15 months including the following two phases.

- Phase 1: Master Plan Study on Addis Ababa Flood Control Project, and
- Phase 2: Feasibility Study on Priority Project(s).

The Study Team presented the Inception Report to the Region 14 Administration in order to confirm the plan of operation of the Study. The contents of the Inception Report were fully discussed and mutually agreed between the Steering Committee and the Study Team on 11 April 1997.

The Phase 1 study was conducted from April 1997 to October 1997. In the Phase 1 study, the flood control master plan was formulated on the objective rivers in the city of Addis Ababa in compliance with investigations and studies on natural conditions, socio-economic conditions, damages due to past major floods and their causes. The priority projects for the succeeding feasibility study were selected from the master plan. The priority projects consist of the structural measures for the Bantiyketu and Kechene rivers and the non-structural measures such as delineation of river zone, flood warning system, flood fighting system, and social education for river and flood. The results of the Phase 1 study were compiled into the Interim Report.

The Phase 2 study was conducted from November 1997 to May 1998. The Study Team presented the Interim Report to the Region 14 Administration at the beginning of the Phase 2 study. The contents of the Interim Report were fully discussed and accepted by the Steering Committee on 11 December 1997. The feasibility study on the priority projects was commenced immediately after the acceptance of the Interim Report. In compliance with the detail investigations and studies on the priority projects, the plans of both structural and non-structural measures were formulated and their feasibility was evaluated. All the results of the Study including the master plan and the feasibility study compiled into the Draft Final Report and were fully discussed and accepted by the Steering Committee on 18 March 1998.

In compliance with the discussion and the comments from the Region 14 Administration and the JICA Advisory Committee, the Final Report has been completed in May 1998.

CHAPTER 2 BACKGROUND OF THE STUDY

2.1 General

The Federal Democratic Republic of Ethiopia is located in the northeastern part of the African Continent and bordered on Eritrea and Djibouti to the north, Kenya to the south, Somalia to the east, and Sudan to the west. The territory extends 1,120,000 km² with a population of 55 million in 1994 that is the second largest in the African countries. Addis Ababa is the capital city of Ethiopia. The city is the center of politics and socio-economy of the country as well as an important city in Africa where the Organization of African Union (OAU) is established.

Before the Transitional Government of Ethiopia came to power in 1991, Ethiopia had been under the socialist regime for 15 years. The Transitional Government turned the former policies into democracy, decentralization and introduction of market economy as the basic policies of the country and proceeded the new economic policy issued in 1991. At present, the Federal Government of Ethiopia established in 1995 succeeds to the said policies.

2.2 Necessity of the Study

The city has suffered from serious flood damages, especially in the floods in the years 1978, 1994 and 1995. These floods caused serious social disturbances such as loss of human lives and houses, damages to various infrastructures and paralysis of socio-economic activities. The population in the city of Addis Ababa is 1.4 million in 1984 to 2.1 million in 1994 with an average annual growth rate of 3.5%. The various urban properties and infrastructures have been also developed as the population growth. In addition, riparian areas have been densely built-up with residential houses even in flood prone areas. As a result, potential flood damages are inevitably increasing year by year.

After the flood in 1978, a feasibility study was carried out to formulate a flood control plan in Addis Ababa in 1982 but the proposed works has not been implemented. The Addis Ababa Flood Control and Prevention Project was initiated after the serious flood in 1994. The project aims at implementing restoration, urgent protection measures for flood damages in 1994 and further investigation to formulate long-term flood control measures in Addis Ababa. However, any effective flood control measures have not been implemented due to a lack of comprehensive master plan for flood protection covering the whole city area in Addis Ababa.

Taking the aforesaid situations into account, the Federal Government of Ethiopia requested to the Government of Japan to formulate a flood control master plan in Addis Ababa.

CHAPTER 3 PRESENT CONDITIONS OF THE STUDY AREA

3.1 Geographical Features

The Study Area of 310 km² extends to the central part of the Ethiopian plateau. The mountain ridge extending over the north and east of the Study Area is called as Intoto Ridge. The city of Addis Ababa situates on the southern slope of the Intoto with altitudes from 2,700 to 2,350 meters. The lands of the urban area are deeply dissected by numerous valleys formed by the five major river systems, namely, Bantiyketu, Kebena, Little Akaki, West Akaki and Hanku, running towards south through such valleys. The Study Area corresponds with the catchment areas of these river systems.

The African Rift Valley strikes south-west to north-eastward about 100 km away from the city of Addis Ababa and divides the Ethiopian plateau into two parts of the east and west plateau. The Study Area is almost underlain by volcanic rocks mainly composed of basalt. Topsoil materials are composed of the weathered volcanic rocks.

The land coverage of the Study area is characterized with the significant urban area of Addis Ababa in the south and east, and intensively or moderately cultivated area, woodland, and grassland in the north and west. In the upper basis, the woodlands are composed mainly eucalyptus planted for reforestation and fuel wood production. The indigenous woodlands are also found with limited extent.

3.2 Climate

The Study Area is located near the equator but is characterized as Warm Temperature Rainy Climate because of the high altitude. The average annual rainfall amounts to 1,178 mm. The main wet season takes place from June to September and causes about 70% of annual rainfall. Seasonal variation of air temperature is less through a year. The climate in the Study Area is summarized in Table 1.

Table 1 Summary of Climate in the Study Area

Rainfall (mm)												
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
17	39	68	95	76	122	254	278	174	37	8	11	1178
Temperature (Average Maximum, °C)												
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
23.1	23.9	24.3	23.9	24.3	22.8	20.4	20.3	21.0	22.2	22.4	22.5	22.6
Temperature (Average Minimum, °C)												
JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
8.4	9.7	11.0	11.7	11.8	10.9	11.0	10.9	10.7	9.4	8.2	7.7	10.1

Source: National Meteorological Services Agency of Ethiopia (NMSA)

3.3 Administration

Ethiopia has nine regions and two special municipalities. The nine regions are Tigray, Afar, Amhara, Oromia, Somali, Benishangul Gumuz, S.N.N.P.R. (Southern Nations Nationalities and People's Region), Gambela, Harari, and the two special municipalities are Addis Ababa and Dire Dawa. Approximate location of the regions and municipalities are shown in Figure 1.

The municipal government of the Region 14 Administration governs Addis Ababa, the capital city of Ethiopia. The municipal boundary of Addis Ababa is shown in Figure 2. Addis Ababa has 6 Zones. The 6 Zones are further subdivided into 28 Weredas, consisting of 305 Kebeles and 23 Farmers Associations.

The parliament headed by the President (Mayor), is organized by 15 members. The Executive Committee as a secretariat supports the parliament. Under directions by the Vice President, there are the Economic and Social Sectors. On the other hand, there are the Administration Sector, and zonal and wereda administrations which are directed by the secretariat. The Economic Sector is organized by 7 bureaus and 4 special offices as shown in Figure 3 and is in charge of flood control and prevention in Addis Ababa as one of its duties.

The Addis Ababa Flood Control and Prevention Project Office (AFCPO) is one of the special offices under the Economic Sector and is being directly administrated and controlled by the Steering Committee of the Addis Ababa Flood Control and Prevention Project. The Steering Committee is governed by the President (Mayor) of the Region 14 Administration.

3.4 Socio-economy

3.4.1 National and Regional Development Plan

The Federal Government of Ethiopia set the Five Year Program on Development, Peace and Democracy (July 1995 – July 2000). The Ministry of Economic Development and Cooperation (MEDAC) had initiated the Program and it was approved by the parliament of Ethiopia. The program has three basic goals; ensuring accelerated and sustainable economic growth; guaranteeing peace and stability; and promoting the democratization process. The program aims average annual economic growth rate at 7 to 10%.

The Master Plan of Addis Ababa was formulated by the Region 14 Administration in 1986 and was authorized by the Ministry of Urban Development and Housing (MUDH) - National Urban Planning Institute (NUPI) in 1994. The master plan takes up various topics such as population, agriculture, industry, transport, housing, town and landscape including social services and public utilities, and land use.

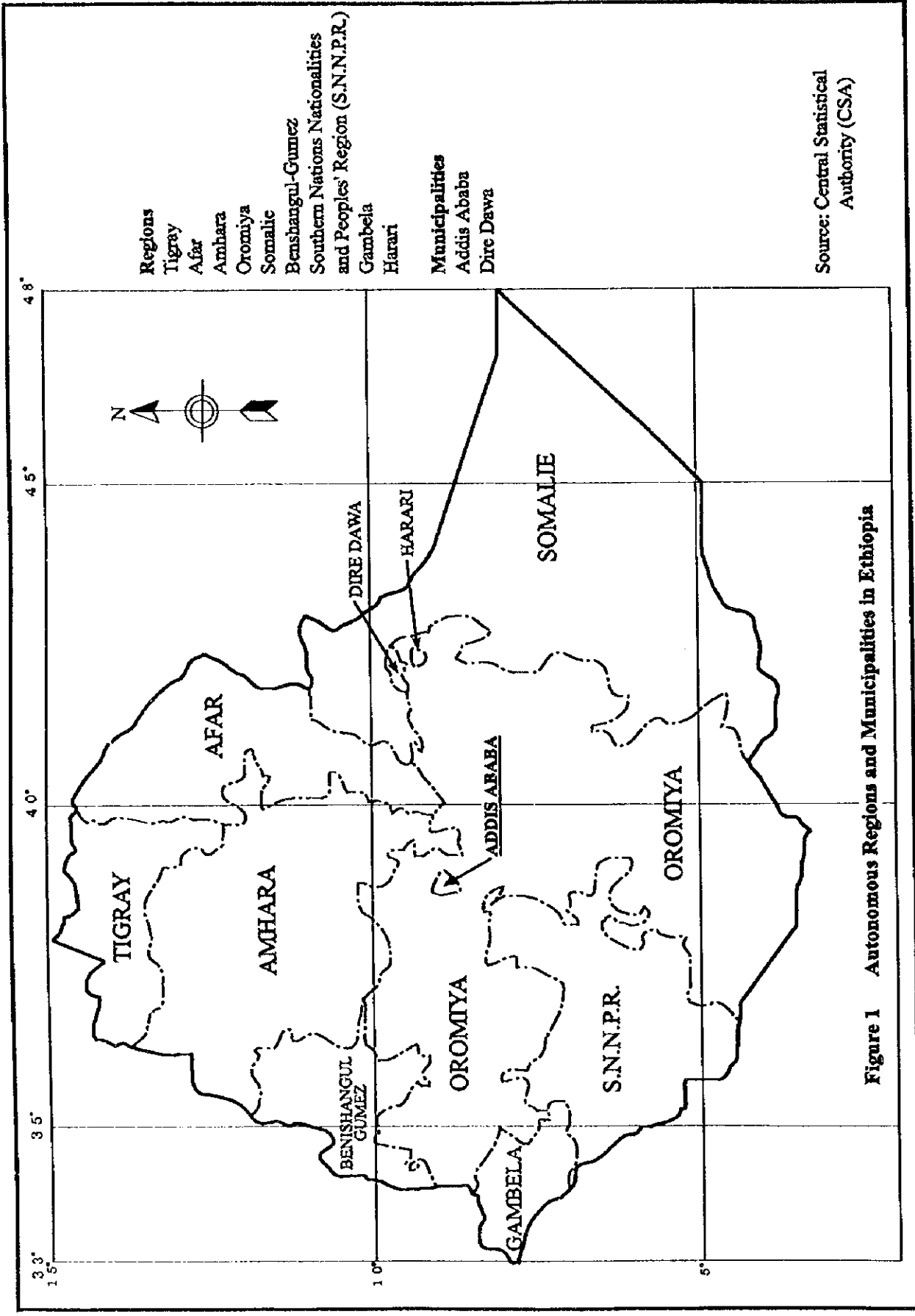


Figure 1 Autonomous Regions and Municipalities in Ethiopia

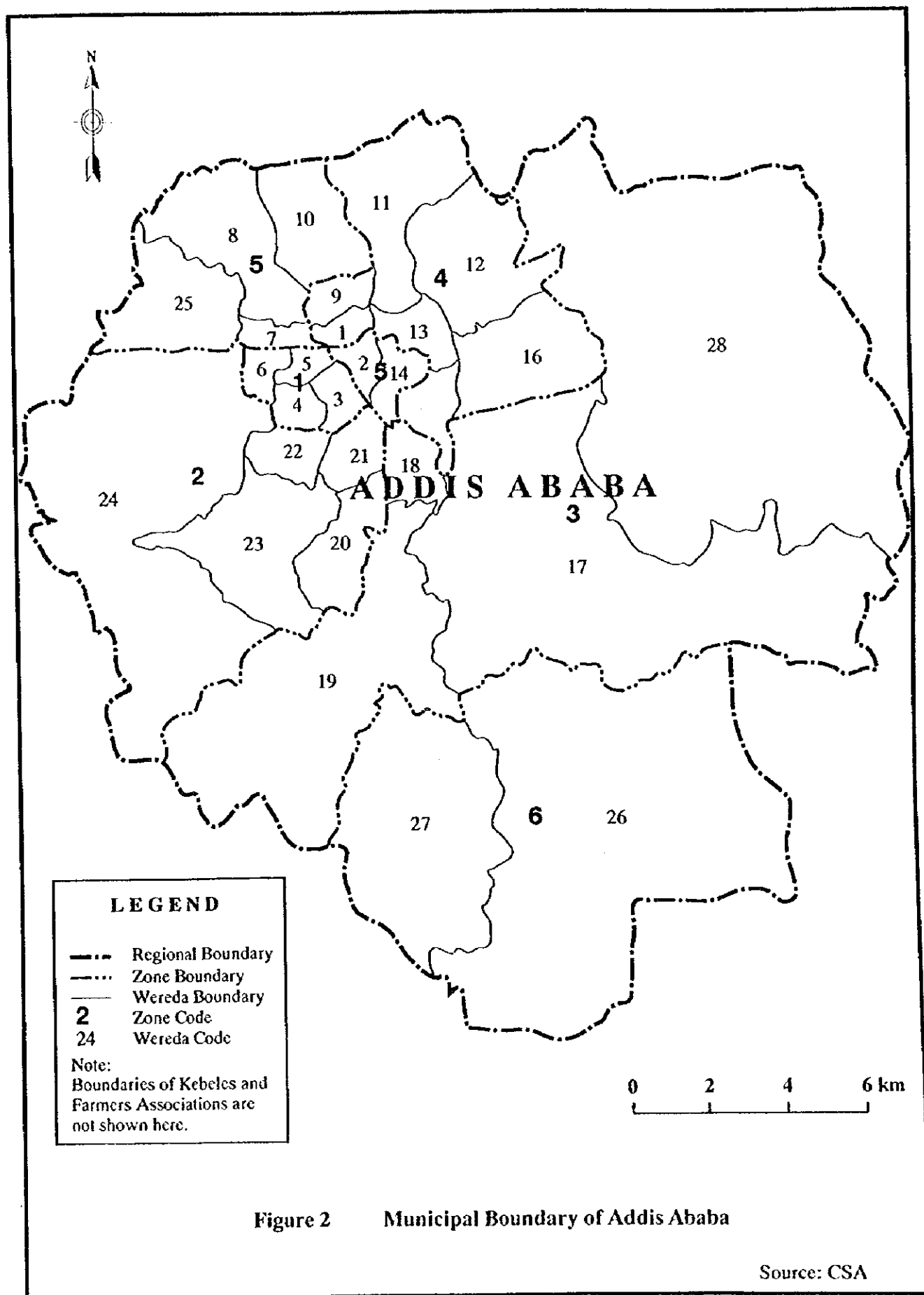


Figure 2 Municipal Boundary of Addis Ababa

Source: CSA

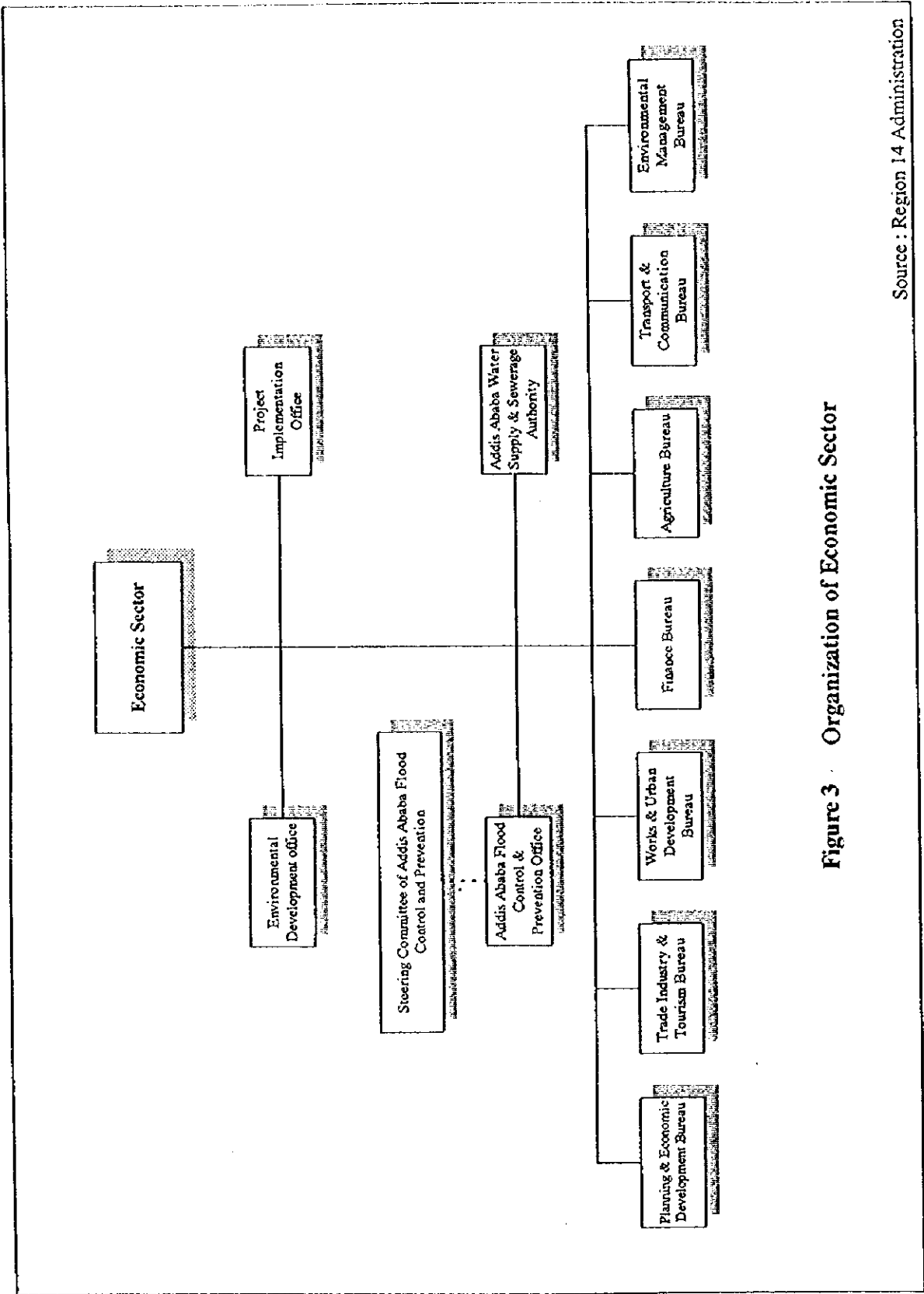


Figure 3 Organization of Economic Sector

Source : Region 14 Administration

The Region 14 Administration is preparing the five year development plan (1997/98 - 2001/02) at present but it has not been officially authorized yet. According to the draft plan, it covers economic, social, political and administrative plans including wide variety of aspects.

Out of the five year plan, flood protection is also included as one of the major concern for development. The plan includes the following items:

- a) To set a flood control master plan and a detailed plan for priority works,
- b) To take necessary measures to reduce the lighter level of loss of life and property from flooding,
- c) To identify flood prone areas and to complete the study for resettlement of the people, and
- d) To take necessary measures including construction of flood walls in line with the flood control master plan.

3.4.2 Population

In the latest Ethiopia Statistical Abstract 1995, the total population of Ethiopia was estimated at 54.9 million in 1994. The population growth rate from 1984 to 1994 was 2.6% in the whole country. Average annual growth rate of population in Addis Ababa indicates higher increasing trend than that in the whole Ethiopia. The population in the Addis Ababa increased from 1.4 million in 1984 to 2.1 million in 1994. However, the area of the Addis Ababa was expanded in 1991 as shown in Figure 4. The figures of population in 1984 and 1994 are counted within the different area basis, respectively.

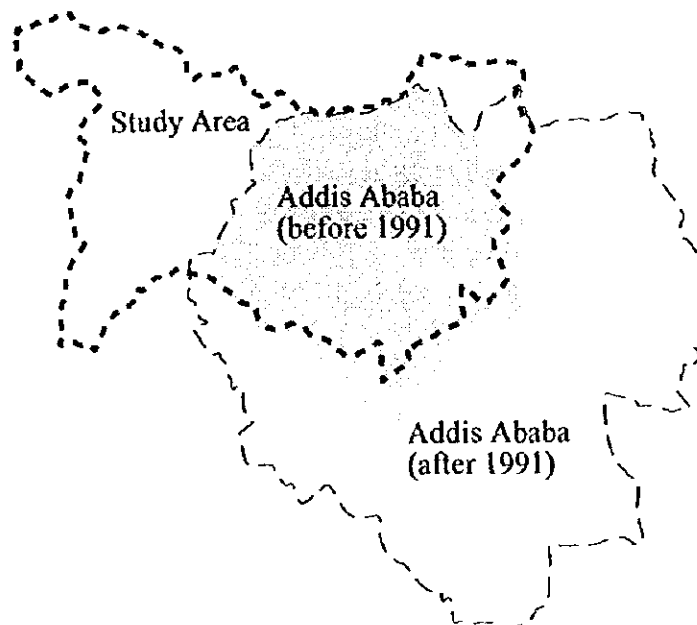


Figure 4 Area of Addis Ababa

The population growth rate in urban area of Addis Ababa is therefore estimated at 3.46% on the former area basis. On the other hand, the population growth rate of rural area of Addis Ababa is 2.94% as indicated in the Addis Ababa Master Plan.

In compliance with the considerations above, the population in the Study Area is estimated at 1.8 million in 1997 and 4.4 million in 2020 as shown in Figure 5.

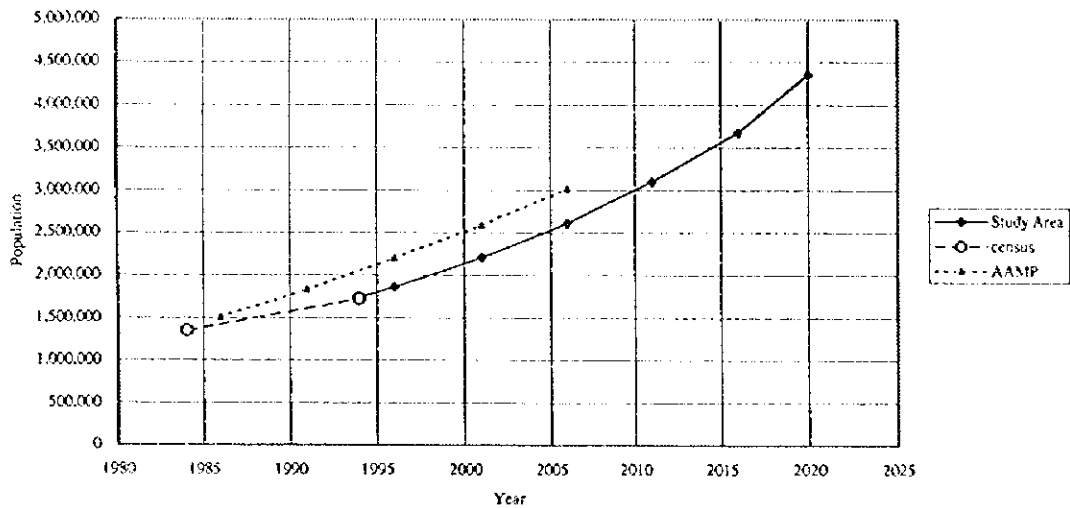


Figure 5 Population Projection in the Study Area

3.4.3 Economy

Gross Domestic Product (GDP) in 1994/95 has been estimated at 34,063 million Birr (approximately US\$5 billion) by MEDAC and GDP per capita in 1994/95 could be estimated at 609 Birr (approximately US\$90). Average annual growth rate of GDP during 10 years from 1984/85 to 1994/95 was 3.8% on 1980/81 constant factor cost basis. However, average annual growth rate of GDP per capita was only 0.5% on the same basis. This shows that the economic growth has not caught up with the rapid population growth. Figure 6 shows GDP of Ethiopia from the year 1980/81 to 1994/95.

Gross Regional Domestic Product (GRDP) of the Study Area has not been officially announced yet. For the purpose of flood control master plan, GRDP of the Study Area is estimated in a simple method using the predicted number of household and an average household income. As a result, GRDP in the Study Area is estimated at 1,370 million Birr in 1997 and 8,150 million Birr in 2020, respectively.

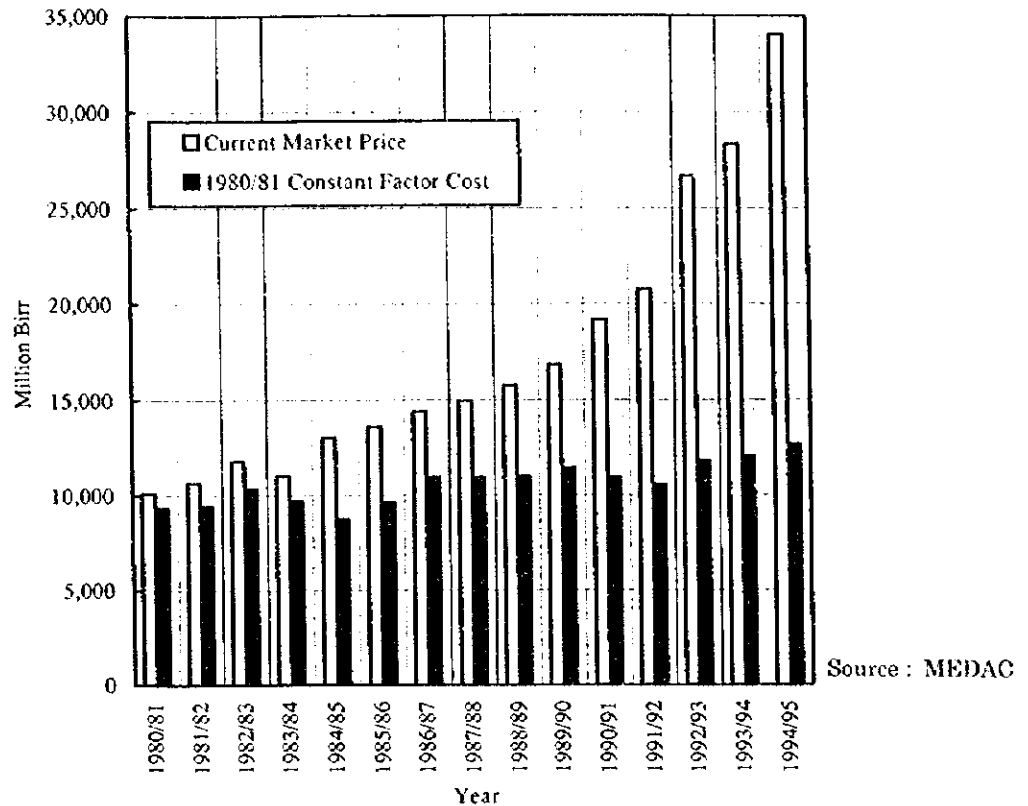


Figure 6 Gross Domestic Product

In the Five Year Program (1995-2000), it says that agriculture is the main stay of the Ethiopian economy from which about 85% of the population earns its livelihood. In the peripheral areas of Addis Ababa, there are 25 Peasant Associations with a total population of about 28,200 practicing mixed farming. The total land coverage of the Peasant Association is estimated to be 17,000 hectares, of which 65% and 17% of areas are allocated to farms and pasture lands respectively.

The Federal Government of Ethiopia aims industrialization lead by agricultural development (ADLI). Supply of raw materials for the manufacturing sector will be improved by productivity growth of the agricultural sector. According to Ethiopia Statistical Abstract on production of major manufacturing articles from 1989/90 to 1993/94 in Ethiopia, sugar production kept large at 123,300 tons in 1993/94. Production of cotton fabrics and semi-processed skins has also been increasing remarkably. As construction materials, cement, cement blocks and tubes, and iron bars are also increasing their production year by year

According to "Economic Research and Planning Department of National Bank of Ethiopia" on main export and import commodities of Ethiopia, exports of coffee

accounted for 62% in 1996/97. Other major commodities are leather and leather products and gold, accounted for 8.8% and 11.4%, respectively in the same year.

According to the Ethiopia Statistical Abstract, movement of the retail price in Addis Ababa continued with its upward trend. Average annual increasing ratio during 10 years from 1986 to 1996 was high at 7.5% in general item but it slowed down to 3.9% during 4 years from 1992 to 1996.

3.4.4 Land Use

Previous municipal area of Addis Ababa was 220 km². In 1991, the municipal area of Addis Ababa was expanded to the south and it became 510 km². Residential area including expansion area accounts for 185 km² or 36% of total area, while green area, woodland and green area for permitted use including agricultural land account for 250 km² or 49%. On the other hand, commercial and business center accounted only for 3 km² or 0.6% of the total area although a great number of traders run their business all over the urban area of the city. The land use regulation of the Region 14 Administration is basically conducted on based on the Addis Ababa Master Plan prepared in 1986.

Table 2 Present Land Use in Addis Ababa

Land Use Categories	Area (ha)	Distribution
1. Existing Built-up Residential Area	8,054	15.7%
2. Residential Expansion	10,445	20.4%
3. Party, Government and Public Institutions	2,617	5.1%
4. Higher Education and Applied Research Center	247	0.5%
5. Commercial and Business Center	303	0.6%
6. Transport Related Activities	1,759	3.4%
7. Zonal Offices	324	0.6%
8. Industrial	2,269	4.4%
9. Embassies	238	0.5%
10. Green Area	14,850	29.0%
11. Wood Land	1,662	3.2%
12. Functional Green for Permitted Use	8,518	16.6%
Total	51,284	100.0%

Source: General Land Use Scheme of Proposed Core Area of the Addis Ababa City
National Urban Planning Institute

The present urban area is already adjacent to the present and future forest area on the north and the east. According to the Addis Ababa Master Plan, the future urban area is to be expanded to the west and the south. The expansion of the urban area including industrial and commercial area to the south is going to exceed the Study Area.

The urban area expansion is to exceed the plan alignment of the ring road by about 2 to 3 km to the west. The urban area expansion to the west to the target year of 2020 seems to be limited to the urban area of the Addis Ababa Master Plan in the west in due consideration of the topography and the ring road. The western part of the Study Area exceeding the urban area of the Addis Ababa Master Plan accordingly will remain to be forest and cultivated area with dotted resettlement.

The trunk road for economic activities is extending to the south and leads to the main sea port for the country located in Djibouti. Topography to the south is relatively flat compared with the present urban area. In this regard, the urban area expansion to the south seems to be going on towards the target year of 2020. With those considerations, the future land use is estimated as shown in Figure 8.

3.4.5 Financial Conditions

The total budget of the Region 14 Administration was about 710 million Birr and it was not changed much from the fiscal years 1996/97 to 1997/98. Actual expenditure in 1996/97 was small at 518 million Birr and it was about 73% of the planned amount.

Almost all development projects are executed by bureaus and offices of the Economic Sector. The budget of the Economic Sector was decreased from 427.8 million Birr in 1996/97 to 387.7 million Birr in 1997/98. Actual expenditure of the Economic Sector was small at 262.9 million Birr and this was about 61% of the planned amount.

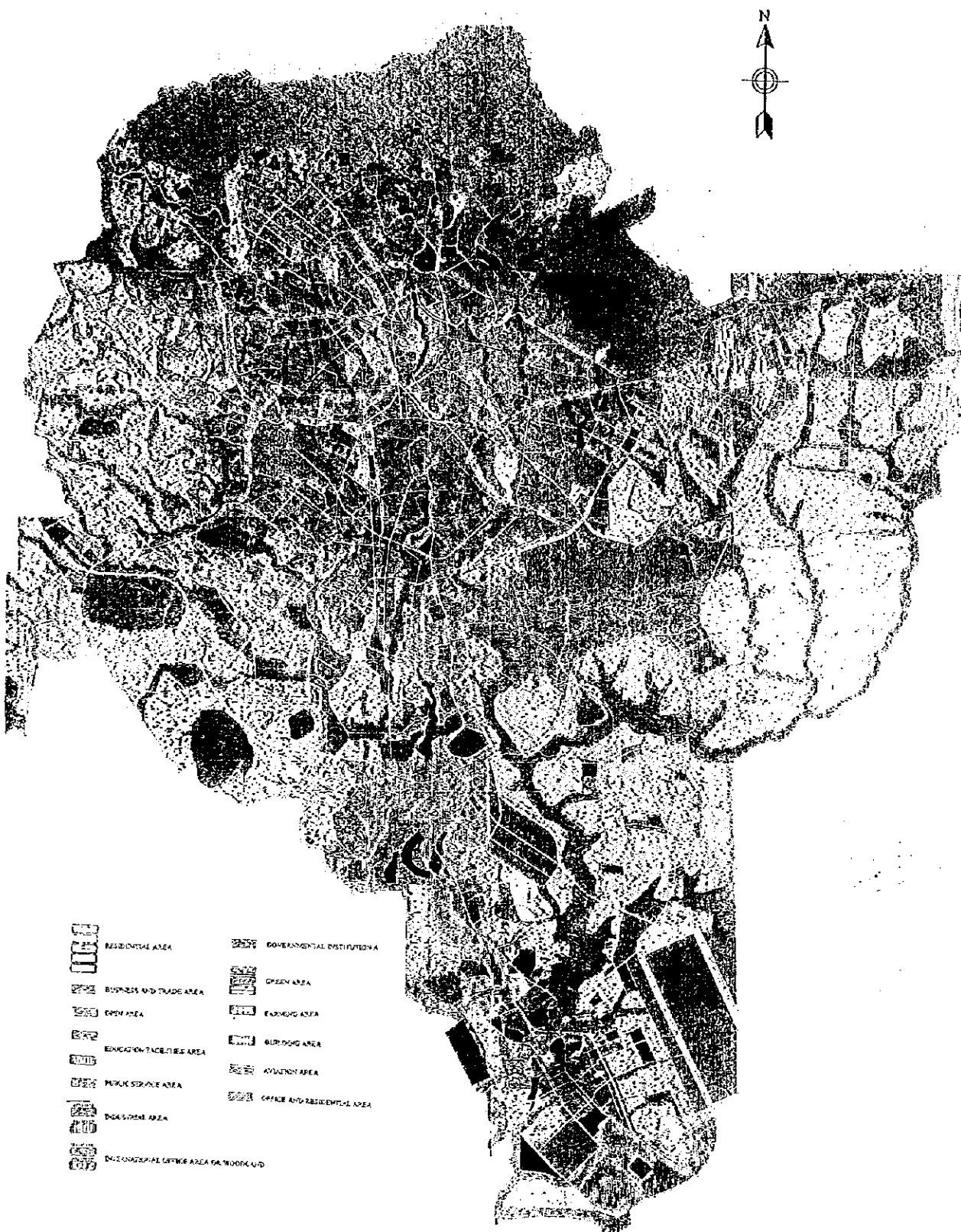
Addis Ababa Flood Control and Prevention Office (AFCPO) has started its activity since 1995/96. The budget for the first fiscal year (1995/96) was 15.7 million Birr but it decreased to 7.6 million Birr in 1996/97 and 4 million Birr in 1997/98. Actual expenditure of AFCPO was only 0.7 million Birr in 1996/97.

Table 3 Budget and Expenditure of Region 14 Administration

Physical Year 1996/97	Planned			Actual		
	Recurrent	Capital	Total	Recurrent	Capital	Total
Region 14 Administration	285.2	426.9	712.1	272.0	246.3	518.3
Economic sector	35.7	392.1	427.8	34.9	228.0	262.9
AFCPO	-	7.6	7.6	-	0.7	0.7

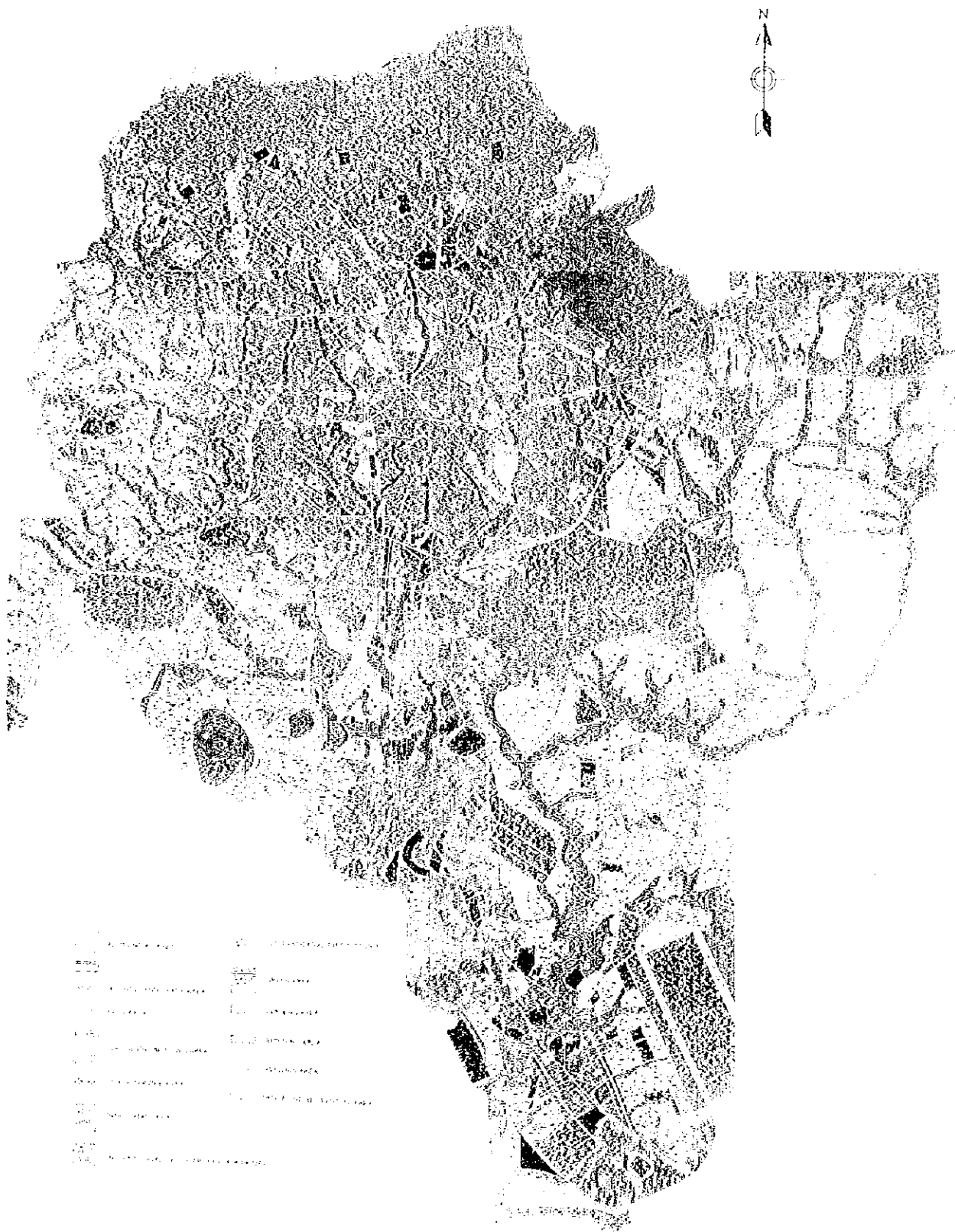
Physical Year 1996/97	Planned			Actual		
	Recurrent	Capital	Total	Recurrent	Capital	Total
Region 14 Administration	332.0	378.2	710.2	-	-	-
Economic sector	57.0	330.7	387.0	-	-	-
AFCPO	-	4.0	4.0	-	-	-

Source: Finance Bureau of Region 14 Administration



Source : Addis Ababa Master Plan,
National Urban Planning Institute

Figure 7 Land Use Plan by Addis Ababa Master Plan



Source: Addis Ababa Master Plan
 National Urban Planning Institute

Figure 7 Land Use Plan by Addis Ababa Master Plan

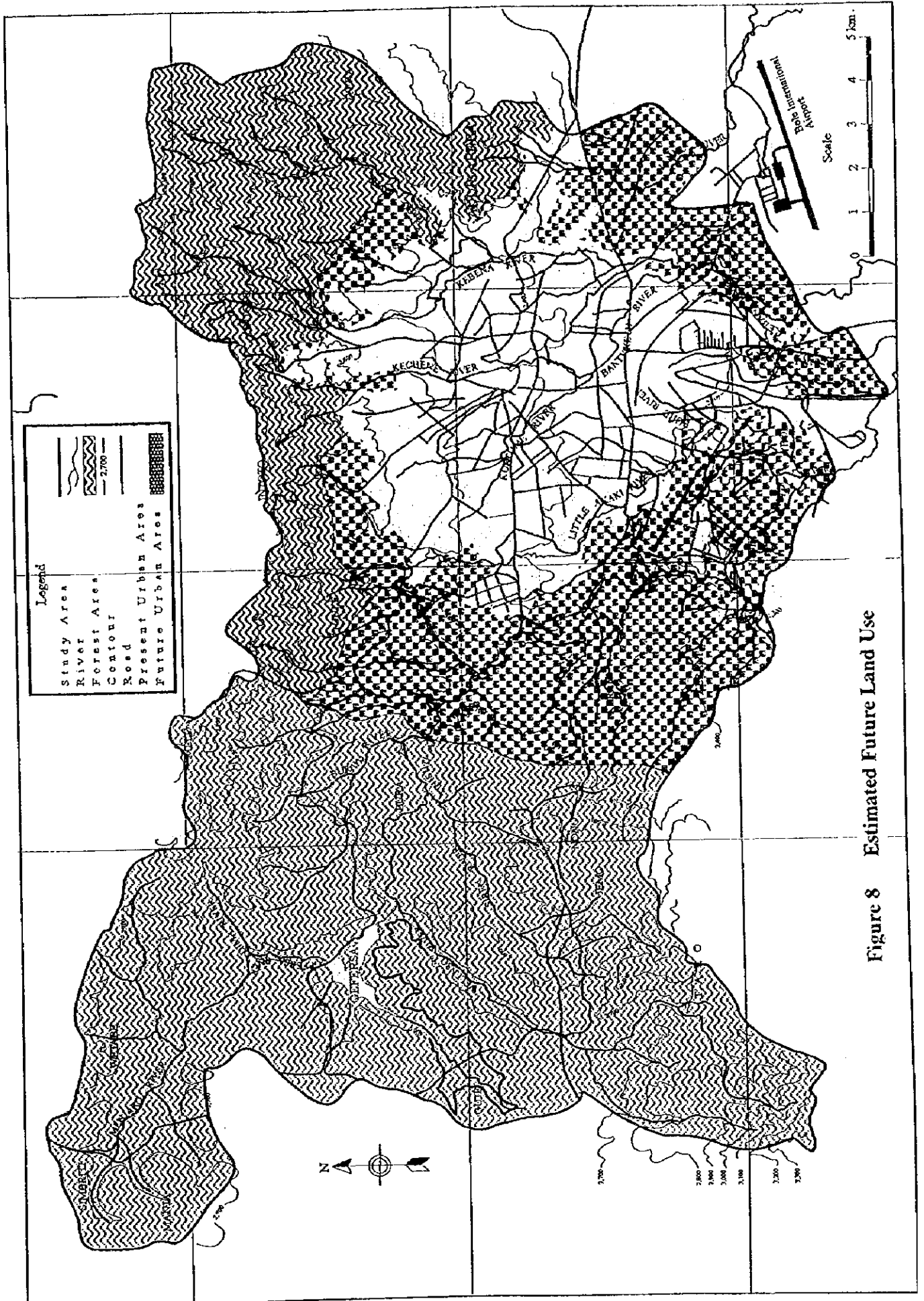


Figure 8 Estimated Future Land Use

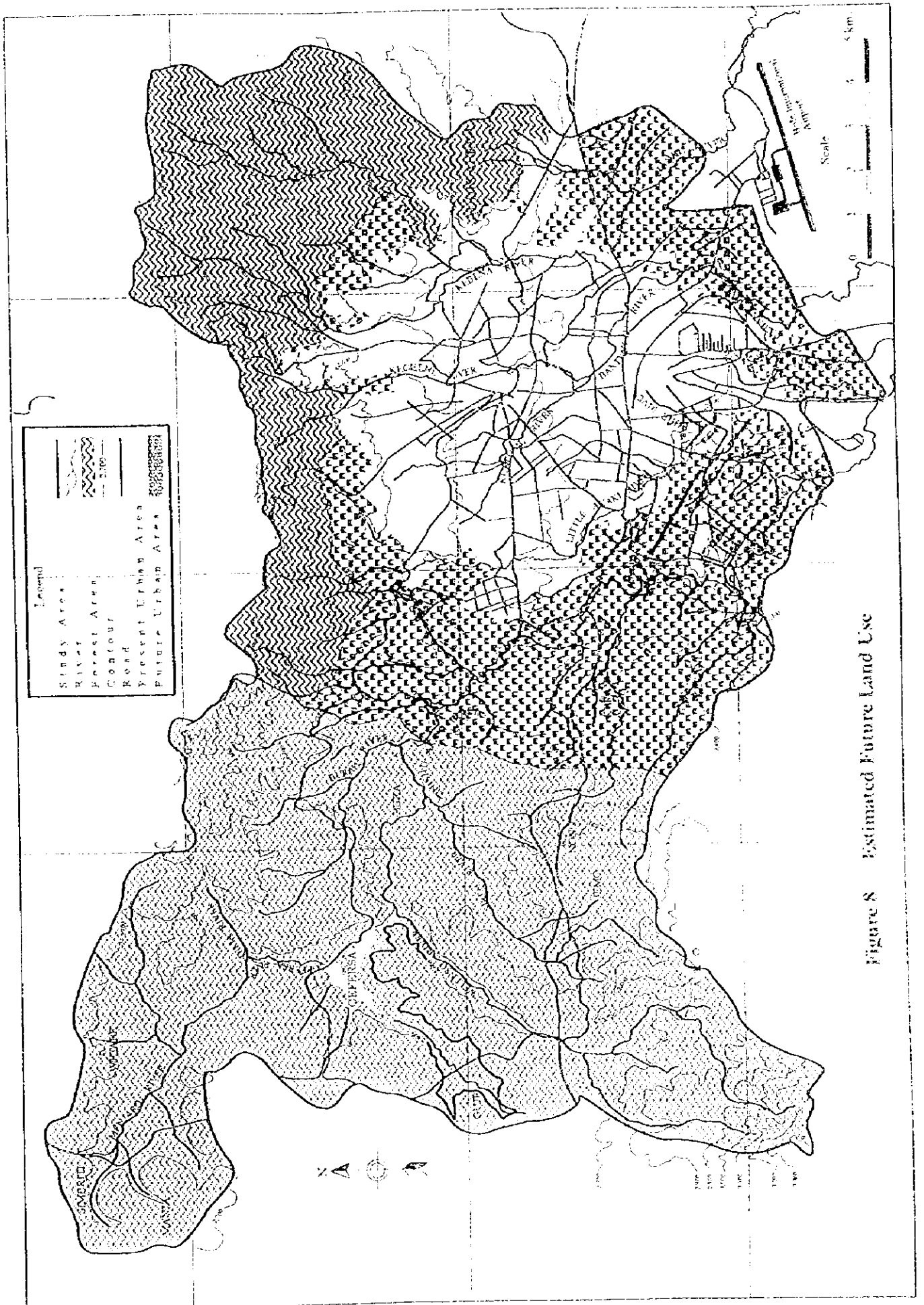


Figure 8 Estimated Future Land Use

The source from the municipal government revenue accounted for about 70% of the planned budget amount both in the Region 14 and the Economic Sector. On the other hand, the total of the foreign loans and assistants/grant accounted for nearly 30% of the planned budget amount.

Table 4 Capital Budget and Expenditure of Region 14 Administration

	Region 14 Administration				Economic Sector			
	Budget		Expenditure		Budget		Expenditure	
	10 ⁶ Birr	%	10 ⁶ Birr	%	10 ⁶ Birr	%	10 ⁶ Birr	%
Local Funds	293.6	69	196.4	80	276.3	70	186.7	82
External Loans	83.3	20	28.1	11	76.9	20	23.8	10
External Assistance	37.3	9	18.4	7	26.2	7	14.6	6
Others	12.7	3	3.4	1	12.7	3	2.9	1
Total	426.9	100	246.3	100	392.1	100	228.0	100

Source: Finance Bureau of Region 14 Administration

In the physical year 1996/97 the budget for water supply and sewerage amounted to 232.6 million Birr and it accounted for 59% of the budget for development projects. The budget for flood control was 7.6 million Birr and it accounted for 2% of the total budget for development projects.

3.4.6 Resettlement

According to the present practice, the Works and Urban Development Bureau should prepare a new land for resettlement when resettlement is needed for implementation of a project. The compensation cost for houses should be estimated by implementing agency of project. The estimated compensation amount to house owner is paid by the Region 14 Administration.

On the resettlement, those people who have owned their houses can receive the compensation and may afford to construct their own houses on the site prepared by the government. Those people who have been living in rented houses is provided with the land and house. The cost of land preparation and construction of house are borne by the government. But the cost of the new rent should be borne by the people. In this case, some people may not afford to pay the new rent cost, then the people can not move from their place to the new resettlement place even though the land and houses are provided by the government.

Presently the government is considering a new policy that low cost houses should be constructed in an appropriate area and the new rent should be decided based on the income level of the people so that the people can easily resettle to the new area. The rent to be paid by the settler based on the new system may not cover the maintenance cost of the houses. The insufficient portion will be borne by the government according to the new policy.

3.4.7 Environmental Protection

Following the United Nations Conference on Environment and Development that was held in June 1992 in Rio de Janeiro in Brazil, the Federal Government established the Ministry of Natural Resources Development and Environmental Protection. Then the National Environmental Protection Authority (NEPA) was formed under the Ministry as an independent agency. NEPA is responsible for environment policy and legislation. The Environmental Protection Bureau was established under the Region 14 administration.

The Environmental Policy of Ethiopia is taken from "Vol. II Policy and Strategy" of the documentation of the Conservation Strategy of Ethiopia. The Environmental Policy of Ethiopia focuses on the environmental policy component of the Conservation Strategy of Ethiopia. The Environmental Policy of Ethiopia was issued on April 2, 1997 by the Secretariat for the Conservation Strategy of Ethiopia, the Environmental Protection Authority in collaboration with the Ministry of Economic Development and Cooperation. After the approval of the policy in April 1997, related regulations will be formulated from now on under this established national policy on environment.

In line with the policy of protection of wild life in the country, the Ethiopian government designated National Parks in the area where wild life concentration is found in the country. Presently 9 areas are designated as National Park and 4 wildlife sanctuaries have been established. The heritage of Ethiopia's long history is found especially in the northern part of the country. Some historical assets are also found near Addis Ababa. These National Parks and historical assets are located outside of the Study Area.

At present, there are 10 city parks, administered by the Park Team of the Region 14 Administration with the coverage area of 113.89 hectare. In addition, there are 2 nursery parks in the city. Most of these parks are located along the objective rivers of the Study. For formulation of the flood control master plan, this situation should therefore be taken into considerations of environmental protection.

3.5 Rivers

3.5.1 River Channel Conditions

In the city of Addis Ababa, riverbank is composed of topsoil materials underlain by volcanic rocks. The rocks outcrop on riverbed in most of the reaches. Deposition of coarse materials is partly observed around confluence and bending portion where river channel becomes relatively wide. Riverbed gradient varies from 1/20 to 1/100 and flow velocity becomes more than 4 m/sec during flood. Riverbanks are therefore prone to erosion and scouring. Sediment transport force of river channel is quite high

due to the said riverbed slope and flow velocity. Sediment deposition causing riverbed variation is not observed. Riverbed variation is therefore scarce in the rivers flowing down the city.

3.5.2 Carrying Capacity

The rivers in the Study Area are grouped into the five river systems: the West Akaki, the Little Akaki, the Kebena, the Bantiyketu with two tributaries of the Kechene and Kurtume, and the Hanku. Probable flood discharges of the rivers are estimated by runoff analysis on the basis of the storm rainfall records. Present carrying capacity of the objective rivers is evaluated by hydraulic analysis using the results of the river cross section survey conducted from May to July 1997. Probable flood discharges and carrying capacities of the rivers are summarized below.

Table 5 Present Carrying Capacity and Probable Flood Discharge

River System/ River	Carrying Capacity (m ³ /sec)	Probable Flood Discharge (m ³ /sec)				
		2-year	5-year	10-year	20-year	30-year
Bantiyketu River system						
Kechene River	50 - 250	65	90	105	120	130
Kurtume River	30 - 150	50	70	85	95	100
Bantiyketu River	30 - 150	120	160	190	215	230
Kebena River System						
Kebena River	150 - 800	200	280	320	370	400
Little Akaki River System						
Little Akaki River	50 - 300	110	145	170	195	215
West Akaki River System						
West Akaki River	400 - 800	280	380	450	510	550
Hanku River System						
Hanku River	20 - 150	50	65	75	90	95

The Kechene and the Kurtume show sufficient carrying capacity for probable 10-year flood in general but the cross sections with lower carrying capacity exist at a few locations. In the Bantiyketu, almost 50% length of the surveyed stretch has carrying capacity less than 150 m³/sec or probable 5-year flood.

The middle reaches of the Kebena in the distance between 4 and 7 km from the boundary of the Study Area, shows the minimum carrying capacity of 120 m³/sec. The most of this stretch has carrying capacity less than 300 m³/sec or probable 7-year flood.

The stretch of the Little Akaki in the distance between 3 km and 9 km from the West Akaki confluence has a several number of cross sections with low carrying capacity ranging from 40 to 100 m³/sec, which is less than probable 2-year flood.

The stretch of the Hanku in the distance between 1.5 km and 2.5 km from the southern boundary of the Study Area indicates quite low carrying capacity of 20 m³/sec or less. This stretch is a part of the natural retarding basin expanding over the lower reaches. Low carrying capacity is also seen around the distance of 4 km where the small culvert exists.

The West Akaki indicates sufficient carrying capacity against 500 m³/sec or probable 20-year flood in the most of the surveyed reaches.

3.5.3 Water Use

There exist five vegetable grower associations that take water of the rivers in the Study Area for irrigation purpose. The total irrigation area is 223 hectare. The records of water intake from those rivers are not available.

The Addis Ababa Water Supply and Sewerage Authority (AAWSA) is supplying domestic water for the city. The intakes for domestic water are located along the Legedadi river near the Legedadi reservoir which is located outside of the Study Area to the east and along the West Akaki river near the Gefersa reservoir which is located in the Study Area in the west. These intakes are located far upstream of the objective area of the flood control master plan of Addis Ababa.

3.5.4 Related Structures

The Gefersa dam constructed in 1938 is located in the upper basin of the West Akaki river. The dam is of gravity arch with a reservoir of some 5 million m³.

There are several completed flood protection works along the Little Akaki river. They are mainly walls to protect houses from flood flow. The total length of the walls is some 1,400 meters. The Addis Ababa Flood Control and Prevention Project Office (AFCPO) of the Region 14 Administration has constructed these walls in the last 2 years. Besides, there are many walls and revetment works along the major channels. These have been constructed privately as bank protection works and building foundations.

There exist some 150 bridges over the major river channels in the urban area. Most of the bridges are for car traffic furnished with sidewalks. Bridge type is mainly limited to either stone masonry arch bridge or reinforced concrete (RC) bridge. Abutment and pier are mostly made of stone masonry. Out of those bridges, some bridges form a constriction of river due to short span, although they have the function of flood flow retardation and velocity control towards lower reaches. Besides, there are many water supply and sewer pipelines which cross the major river channels.

There exist 17 irrigation intake weirs in the Study Area for growing vegetables managed by vegetable grower associations.

3.6 Flood Damage

The Study Area is characterized by intensive rainfall in short time and steep riverbed slopes. In addition, the river courses, especially in the middle reaches of the Little Akaki and Bantiyketu including two tributaries of the Kechene and Kurtume, are constricted owing to occupation of buildings and houses. When heavy rainstorm occurs in the upper basins, water level in the middle and lower reaches rises rapidly with a short concentration time of few hours. The floods are considerably flashing with destructive flow velocities. Deforestation in the mountain has also worsened the conditions due to reduction of water retention in the upper basins.

The flood occurred in August 1978 caused serious damages throughout Addis Ababa, especially in the Bantiyketu river system: 23 keftegnas out of 25 keftegnas, 108 kebeles out of 289 kebeles. 1,255 houses and 6,000 people were affected and most of them were made homeless. Furthermore, 12 people were killed. Kebele offices, vehicles and community facilities were also damaged.

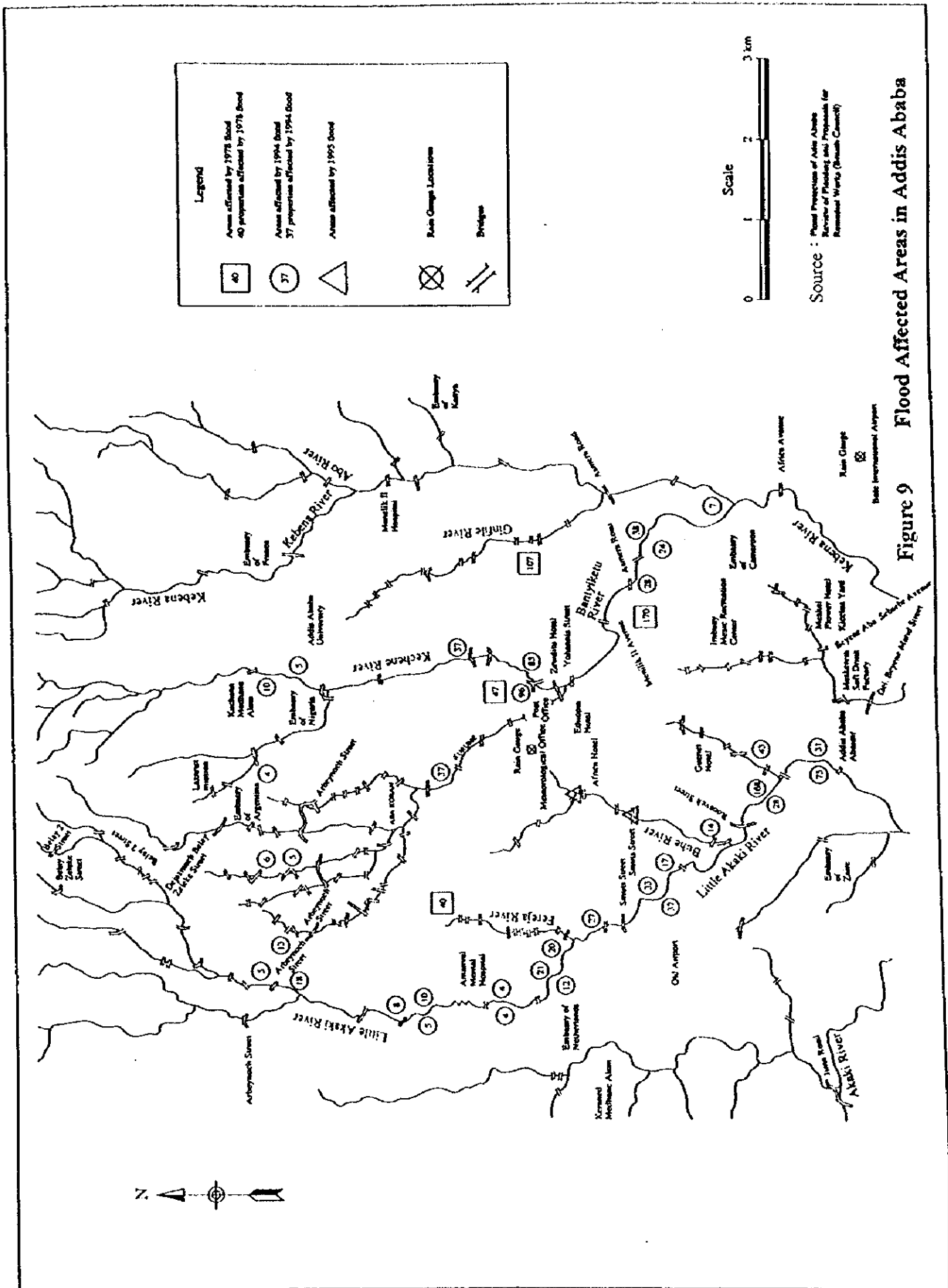
In August 1994, 7,655 people were affected and 2,880 people lost their houses. Three people were killed. 461 families require re-housing in 5 zones and 18 kefitenya. The flood damages mainly extend to the Little Akaki river system.

Detailed flood damage survey has not been made for August 1995 flood. However it appears that the flood in August 1995 affected a wide area in Addis Ababa according to result of the interview survey conducted in this Study.

3.7 Drainage Congestion

In the rainy season, stagnant water is observed at places in the Addis Ababa. Especially the local drainage area that drains to the Bantiyketu river in the reaches between the Filwiha bridge and the Finfine bridge on the Menelik II avenue, suffers from drainage congestion almost every time of heavy rainfall. This is mainly due to the lack of appropriate drainage facilities to the Bantiyketu river. In this area there exist many important facilities, such as the independent square, the agencies of the central government of Ethiopia, the international agencies, shops, hotels, and offices of private enterprises. This area is also an important place from the viewpoint of road and railway transportation.

In view of the above, the drainage congestion in this area should be solved as soon as possible in keeping step with the river improvement of the Bantiyketu river.



CHAPTER 4 MASTER PLAN

4.1 Framework

4.1.1 Target Year and Protection Area

The target year for the master plan is set at the year 2020. Protection area is the present densely populated area and under-developing area in the eastern part of the Study Area. Whereas, for new urban areas to be extended in the future, land use regulation in line with the Addis Ababa Master Plan, is recommended to avoid flooding problem which will be newly involved.

4.1.2 Objective River Systems

The following seven rivers in the five major river systems are the objective rivers for flood control master plan.

Table 6 Objective River Systems

River System	Catchment Area (km ²)
1. Bantiyketu River System	29.3
Kechene River	
Kurtume River	
Bantiyketu River	
2. Kebena River System	59.8
Kebena River	
3. West Akaki River System	172.2
West Akaki River	
4. Little Akaki River System	30.8
Little Akaki River	
5. Hanku River System	11.1
Hanku River	

4.1.3 Population

The population in the Study Area is estimated at 1.8 million in 1997. As discussed in the previous section, the population will increase in 4.4 million in the target year 2020.

4.1.4 Future Land Use

Future land use in the Study Area is estimated on the basis of the Addis Ababa Master Plan as discussed in the previous section. The present urban area of 168 km² in the Study Area will expand to 200 km² in the target year 2020.

4.1.5 Gross Regional Domestic Product

Gross Regional Domestic Product (GRDP) of the Study Area has not been officially announced yet. For the purpose of flood control master plan, GRDP of the Study Area is estimated in a simple method using the predicted number of household and an average household income. As a result, GRDP in the Study Area is estimated at 1,370 million Birr in 1997 and 8,150 million Birr in 2020, respectively.

4.1.6 Related Plans and Projects

For the formulation of the flood control master plan, the following plans and projects are taken into consideration.

- a) Addis Ababa Master Plan
- b) Addis Ababa Flood Control and Prevention Project
- c) Reforestation
- d) Addis Ababa Water Supply Project
- e) Master Plan for Development of Wastewater Facilities for the City of Addis Ababa
- f) Addis Ababa Ring Road Construction Project
- g) Feasibility Study on Flood Protection and Storm Sewer System of Addis Ababa

4.2 Basic Concept of Flood Control Plan

4.2.1 Protection Area and Objective River Stretches

Protection area and objective river stretches of a flood control master plan, are decided with due considerations of the present situation of flood damage, land use and socio-economic development in the future in the target year of 2020.

The flood control plan covers 5 river systems consisting of 7 rivers in the present densely populated area and under-developing area in the eastern part of the Study Area. These objective rivers are principal ones characterized by destructive flood flow coming directly from the mountain areas.

As for urban areas to be developed in the future such as southern part out of the Study Area, land use regulation in line with the Addis Ababa master plan are recommended to avoid the similar flooding problems in the future.

The local drainage area that drains to the Bantiyketu river in the reaches between Filwiha and the Finfine bridges on the Menelik II avenue has poor condition of drainage of local storm. This area is one of the most important areas in Addis Ababa from the

view point of existence of important agencies of the central government of Ethiopia and the international agencies, and the place of importance of the road and railway transportation. In due consideration of the above from the socio-economic view point, this area is selected for the objective area for drainage improvement.

4.2.2 Design Scale

The design scale (protection level) of the flood control master plan is justified based on scales of the remarkable past floods, basin size, and balance of safety level between main channel and tributaries. The design scale is selected as 30-year return period for the main river channels (Bantiyketu, Kebena, West Akaki and Little Akaki) and 20-year return period for tributaries (Kechene, Kurtume and Hanku), respectively.

4.2.3 Flood Control Measures

(I) Characteristics of Natural and Social Conditions of Floods and Rivers

Rainfall in the questioned area is of remarkably torrential one and about at half of such rainfall is recorded within 30 minutes, about 90 % within 60 minutes, their duration being not more than two hours (See Figure 10). In addition, slopes of the objective river channels are considerably steep varying from 1/20 to 1/100. Therefore, flood has destructive flow with high velocity.

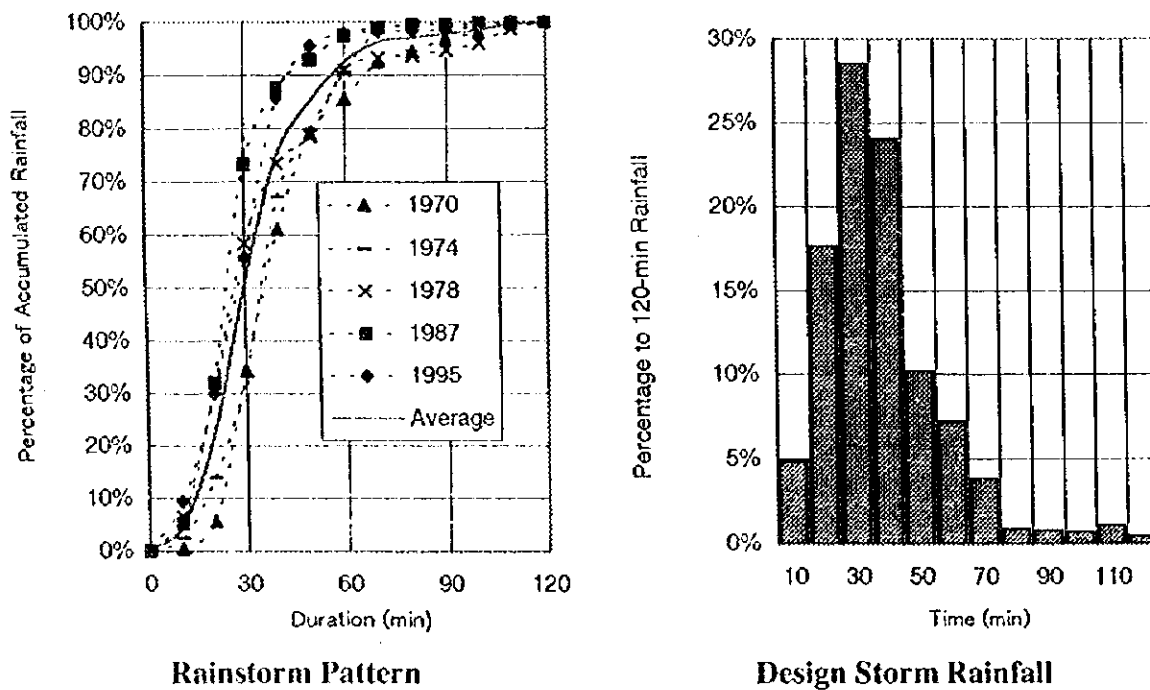


Figure 10 Rainfall Pattern

The objective rivers had been originally wide and deep in size. In the recent decades, many people have moved into the river bank areas, which are easily submerged by flood, especially on the terraces in the incised valleys. As the results, tremendous numbers of houses and buildings exist on the river bank areas.

These natural and social characteristics of the floods and rivers are basic considerations in setting up the flood control measures. In mitigation of flood damage in the urban areas, a special attention must be paid to resettlement of riverine people to be involved. The flood control measures are therefore prepared in terms of both structural and non-structural measures

(2) Basic Concept of Structural Measures

Structural measures are provided on the condition that flood discharge will be regulated by flood retention facility as much as possible in upstream reaches and remaining discharge to downstream reaches will be protected by river channel improvement. It aims at minimizing negative social impact, namely, resettlement by implementing river channel improvement with due consideration to the present condition that most of riverine areas to be protected has already been built up densely. Promising river structures are reservoir or regulating pond, diversion channel, river channel improvement including flood wall and bank protection. Structural measures therefore consist of limited extent of river channel improvement in combination with the said flood retention facilities and diversion.

(3) Basic Concept of Non-structural Measures

Non-structural measures are proposed in relation to the river management, watershed management and flood risk management.

River management aims at discharging flood safely and keeping functions of river channels and flood control facilities. For this purpose, 1) Authorization of river zone, 2) Social education for river and flood and 3) Guideline of structural design are proposed.

Watershed management purposes conservation of soil and flood retention in the mountain areas. It is an essential part of the non-structural measures from the viewpoint of not only flood control to directly reduce runoff to downstream reaches but also environment. Reforestation of the deforested mountain areas and planting of trees in the open spaces of urban areas are taken into account.

Flood risk management includes 1) Flood warning system by means of rainfall observatories, communication lines and sirens, and 2) Flood fighting system organized by community, 3) Storm water storage in gardens, public spaces and private houses.

4.3 Structural Measures

4.3.1 Bantiyketu River System including Kechene and Kurtume Rivers

(1) Kurtume River

A structural measure by channel improvement only is not socially accepted in view of present riverine area conditions. On the other hand, open areas to retard run-off from the upper basins are available in the middle reaches. These areas are designated to reduce flood peaks to downstream as regulating pond. In this regard, the following structural measures are proposed.

- 4 Regulation Ponds
 - Kurtume No.1 Regulating Pond: Storage 7,200 m³
 - Kurtume No.2 Regulating Pond: Storage 23,000 m³
 - Kurtume No.3 Regulating Pond: Storage 12,000 m³
 - Kurtume No.4 Regulating Pond: Storage 7,200 m³
- River Channel Improvement
 - Floodwall: Total length 800 m
 - Bank Protection for Bridge: 10 bridges
 - Velocity Control Structure / Drop Structure: 10 locations

(2) Kechene River

The basic idea for the Kechene river is the same as those of the Kurtume river. In the Kechene river basin, one site for construction of weir with fairly large storage capacity and one open area for regulating pond are identified in the upper and middle reaches, respectively. The following structural measures are proposed.

- 1 Reservoir by Weir
 - Kechene Weir: Storage 115,000 m³
- 1 Regulating Pond
 - Kostre Regulating Pond: Storage 21,000 m³
- River Channel Improvement
 - Floodwall: Total length 980 m
 - Bank Protection for Bridge: 7 bridges
 - Repair of Bridge Abutment: 1 bridge
 - Velocity Control Structure / Drop Structure: 10 locations

(3) Bantiyketu River

The river channel is constricted in the stretch between the Filwiha and Finfine bridges. There is an open area just downstream of the Filwiha bridge on the left bank. A combined scheme of regulating pond and channel improvement is therefore conceivable.

Further, the existing natural retarding basin in the lower reaches is taken into account. The following structural measures are proposed.

- 1 Regulating Pond
 - Bantiyketu Regulating Pond: Storage 54,000 m³
- River Channel Improvement
 - Excavation: 33,500 m³
 - Floodwall: Total length 1,950 m
 - Bank Protection: Total length 800 m
 - Rehabilitation on Irrigation Intake Weir: 1 location
 - Rehabilitation of Aqueduct: 1 location

(4) Urban Drainage Improvement

Flood control measures will mitigate the damage due to the overflowing of flood from rivers, but it does not always mitigate the damage due to the inundation resulting from the poor condition of drainage. But since the objective of this Study is the preparation of flood control master plan and is not the preparation of drainage master plan, the drainage improvement is here proposed very locally just as the auxiliary measures for to enhance the flood control plan in Addis Ababa.

The local drainage area that drains to the Bantiyketu river in the reaches between Filwiha and the Finfine bridges on the Menelik II avenue is selected for the objective area for urban drainage improvement.

In due consideration of the balance with the design scale of flood control plan in Addis Ababa and the rainfall intensity generally adopted in other countries, rainfall intensity of 30 mm/hour is adopted for the design scale for drainage improvement. This corresponds to the return period of 1.5 years.

In consideration of low cost and easy maintenance in future, road side ditch is proposed as the structural measures for drainage improvement. In addition, the road side ditch is proposed just as the terminal drainage ways to the Bantiyketu river. It is considered that secondary and tertiary drainage ways would be prepared or improved after drainage master plan is formulated in future. Basic features of the drainage improvement are shown below.

- Drainage Basin : 2.48 km² consisting of 4 sub-basins
- Length of Drainage Ditch : Total length 4,000 m

4.3.2 Kebena River System

The upper basin has several promising sites of flood retention. In order to minimize resettlement in the riverine areas, the reservoir schemes reducing flood peaks to the

downstream reaches are proposed. The existing natural retarding basin in the upstream of the Urael bridge is also taken into account. The lower Kebena from the confluence with Bantiyketu to the Bole railway-bridge is to be improved by means of a channel improvement.

- 2 Reservoirs by Weir
 - Kebena No.1 Weir: Storage 212,000 m³
 - Abo Weir: Storage 332,000 m³
- River Channel Improvement
 - Floodwall: Total length 3,100 m
 - Bank Protection for Bridge: 12 bridges
 - Velocity Control Structure / Drop Structure: 12 locations

4.3.3 Little Akaki and West Akaki River Systems

The West Akaki river generally forms deep and wide valley with sufficient carrying capacity. Land use along the West Akaki river are, as a whole, of open areas covered by grassland and woodland. It is therefore proposed that the present land use along the West Akaki river be maintained and regulated in the future.

On the other hand, the river bank areas in the middle reaches of the Little Akaki are presently occupied by the dense houses and buildings. In case a channel improvement only is applied, voluminous resettlement will be needed. Accordingly, river channel improvement of the Little Akaki needs to be limited. Whereas, a flood diversion plan from the Little Akaki river to the West Akaki river is conceivable on the condition that the present land use along the West Akaki river be maintained and regulated in the future.

- 1 Regulating Pond
 - Little Akaki Regulating Pond: Storage 54,000 m³
- 1 Flood Diversion from Little Akaki River to West Akaki River
 - Total Length 970 m (Channel Portion 320 m and Tunnel Portion 650 m)
- River Channel Improvement of Little Akaki River
 - Floodwall: Total length 1,050 m
 - Bank Protection for Bridge: 9 bridges
 - Velocity Control Structure / Drop Structure: 16 locations

4.3.4 Hanku River System

The existing flooding problem in the river basin has been locally limited. There is no suitable place to retard run-off in the mountain areas. In the lower reaches of the Hanku river near the International Airport, there exist extensively wide natural retarding basins. Under the condition that such natural retarding basins remain and be

maintained as they are at present condition, widening of the existing culverts across under the Fikre Maryam Aba Techan Street in the middle reaches is taken proposed.

- Reconstruction of 2 Culverts

4.4 Non-structural Measures

4.4.1 River Management

(1) Authorization of River Zone

For the purpose of river management, it is necessary to delineate the river zone covering river channel and some extent on both riverbanks. The river zone is utilized for operation and maintenance of river channel and facilities, flood fighting and other activities related to river management. In order to achieve this purpose, authorization of the river zone is required with a legislation of municipal bylaw. Delineation of river zone area is proposed as follows.

- Location with flood wall : 5 meters outside from wall
- Location without wall : 5 meters outside from river bank line

(2) Social Education for River and Flood

It is one of important activities to enhance public awareness for river and flood. Rivers need to be regarded as public properties, namely, not only drainage ways but also open spaces with green area in the city.

Firstly, it is desired to enlighten public awareness for rivers. It is proposed to hold forum and ceremony or concert to "Love River". Also campaigns through mass media of TV and radio are proposed to enlighten the public awareness.

Secondly, it is proposed to prohibit disposal of solid waste and soil into the river zone, with a legislation of municipal bylaw in connection with the said authorization of river zone.

(3) Guideline of Structural Design

The flood control facilities are desired to design and construct appropriately for their purposes. For this purpose, a guideline of design needs to be prepared for major structures involved in the proposed flood control master plan.

4.4.2 Watershed Management

Conservation of soil and flood retention function in the mountain areas is an essential part of the non-structural measures from the viewpoint of not only flood control to directly reduce runoff to downstream reaches but also environment. Accordingly, reforestation of the deforested areas in the mountain areas and planting of trees in the open spaces of urban areas are proposed.

4.4.3 Flood Risk Management

(1) Flood Warning System

The floods in the mountainous areas are brought to the urban areas in a short time with 1 to 2 hours. It is quite difficult to promptly forecast flood scale. In this regard, a warning system by siren is a practical tool of flood damage mitigation. The warning is made when the accumulated rainfall amount exceeds 8 mm per 10 minutes.

In this system, 3 rainfall observatory stations are installed in the mountain areas of the Kebena, Kechene and Little Akaki rivers. Along 6 major river channels of the Bantuyketu, Kechene, Kurtume, Kebena, Little Akaki including a part of West Akaki and Hanku rivers, small towers for siren and electrical lines are installed with an approximate distance of 500 meters.

(2) Flood Fighting System

It is a valuable activity to carry out flood fighting, to minimize flood damage brought in flooding time. This activity is proposed to proceed in the community level (Kebele) in line with the existing available National Disaster Prevention and Preparedness Management Policies. Further, it is necessary to train residents living in riparian areas through periodical exercise.

The construction of storage houses with necessary materials and tools are required for this activity. The storage houses need to be constructed at each 2 locations in the respective rivers of the Kurtume, Kechene, Bantuyketu, Kebena, Little Akaki and Hanku rivers.

(3) Storage of Storm Water in the Basin

It is also desired to temporarily store storm water at gardens in private houses, open spaces in public facilities and campuses of universities. Such devise has a surprising effect not only to decrease run-off into the rivers but also to save water consumption in domestic purposes. In this activity, a campaign of enlightenment for community level will be a main work.

4.5 Summary of Flood Control Master Plan

4.5.1 Structural Measures

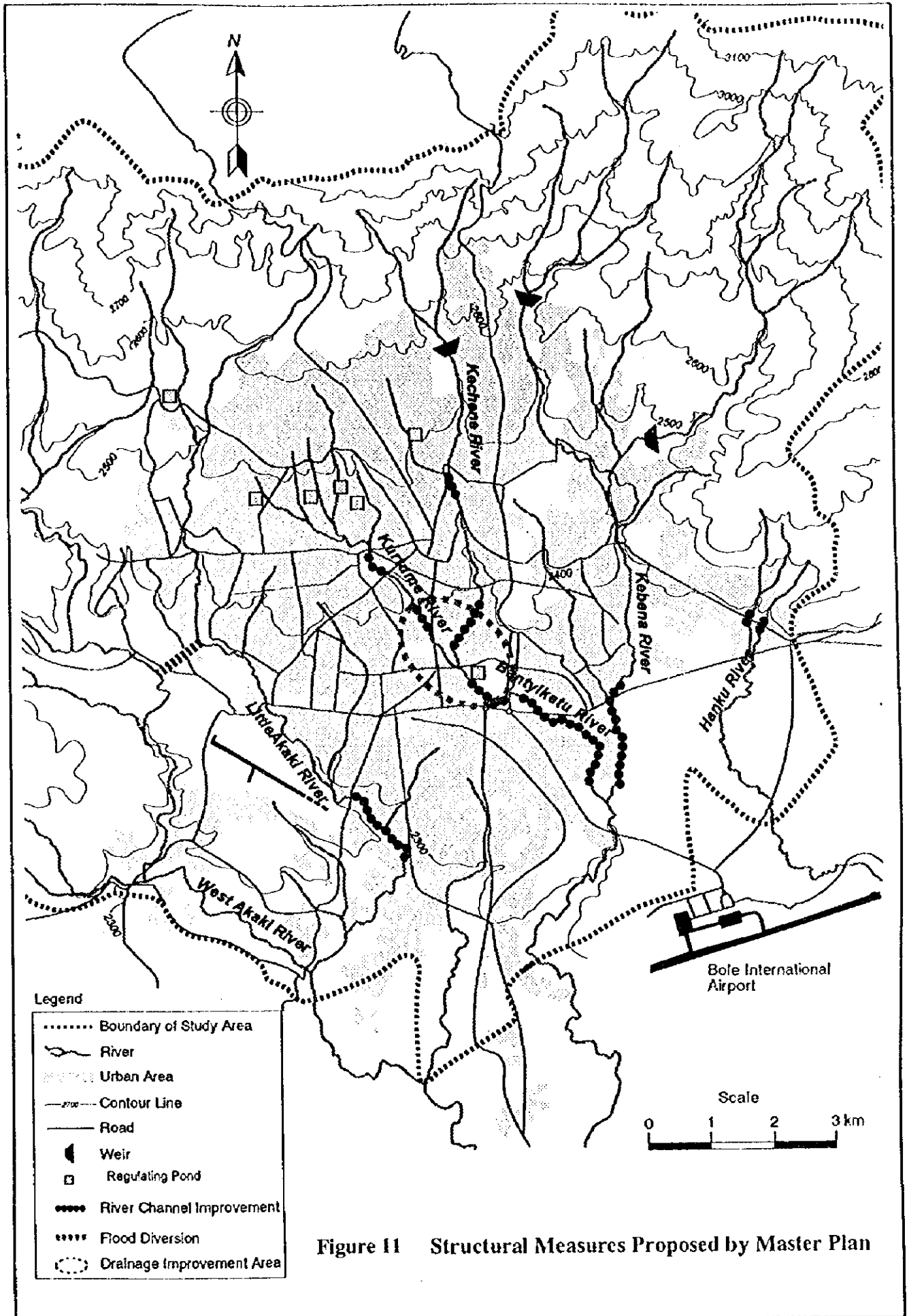
The features of the structural measures of the flood control master plan are summarized as follows. Locations of the proposed structures are shown in Figure 11.

Table 7 (1/2) Proposed Structural Measures

River System	Proposed Structural Measures			
	Reservoir by Weir	Regulating Pond	Channel Improvement	Others
Bantiyketu				
Kurtume River		<ul style="list-style-type: none"> • Kurtume No.1 Regulating Pond - Storage: 7,200 m³ • Kurtume No.2 Regulating Pond - Storage: 23,000 m³ • Kurtume No.3 Regulating Pond - Storage: 12,000 m³ • Kurtume No.4 Regulating Pond - Storage: 7,200m³ 	<ul style="list-style-type: none"> • Floodwall - 800 m • Bank Protection for Bridge - 10 bridges • Velocity Control Structure - 10 locations 	
Kechene River	<ul style="list-style-type: none"> • Kechene Weir - Storage: 115,000 m³ 	<ul style="list-style-type: none"> • Kostre Regulating Pond - Storage: 21,000 m³ 	<ul style="list-style-type: none"> • Floodwall - 980 m • Bank Protection for Bridge - 7 bridges • Velocity Control Structure - 10 locations 	<ul style="list-style-type: none"> • Repair of Bridge Abutment - 1 bridge
Bantiyketu River		<ul style="list-style-type: none"> • Bantiyketu Regulating Pond - Storage: 54,000 m³ 	<ul style="list-style-type: none"> • Excavation - 33,500 m³ • Floodwall - 1,950 m • Bank Protection - 300 m 	<ul style="list-style-type: none"> • Drainage Improvement - Road Side Ditch: 4,000 m • Rehabilitation of Aqueduct - 1 location

Table 7 (2/2) Proposed Structural Measures

River System	Proposed Structural Measures			
	Reservoir by Weir	Regulating Pond	Channel Improvement	Others
Kebena Kebena River	<ul style="list-style-type: none"> • Kebena No.1 Weir - Storage: 212,000 m³ • Abo Weir - Storage: 332,000 m³ 		<ul style="list-style-type: none"> • Floodwall - 3,100 m • Bank Protection for Bridge - 12 bridges • Velocity Control Structure - 10 locations 	
West Akaki West Akaki River				<ul style="list-style-type: none"> • (Land Use Regulation)
Little Akaki Little Akaki River		<ul style="list-style-type: none"> • Little Akaki Regulating Pond - Storage: 54,000 m³ 	<ul style="list-style-type: none"> • Floodwall - 1,050 m • Bank Protection for Bridge - 9 bridges • Velocity Control Structure - 16 locations 	<ul style="list-style-type: none"> • Flood Diversion - 970 m Channel: 320 m Tunnel: 650 m
Hanku Hanku River				<ul style="list-style-type: none"> • Reconstruction of 2 Culverts • (Land Use Regulation)



4.5.2 Non-structural Measures

The features of the non-structural measures of the flood control master plan are summarized as follows.

Table 8 Proposed Non-structural Measures

Proposed Non-structural Measures	Descriptions
River Management	
Authorization of River Zone	Delineation of river zone covering river channel and extent of 5 meters from both river banks for river management activities
Social Education for River and Flood	Enlightenment of public awareness for river and flood to maintain proper river conditions
Guidelines of Structural Design	Preparation of guidelines for design of river channel and river structures
Watershed Management	
Reforestation	Recovery and conservation of woodland in upper basins
Flood Risk Management	
Flood Warning System	Installation of rainfall gauges, communication lines and sirens for flood warning activities
Flood Fighting System	Sand bagging, temporary protection for erosion and evacuation etc. to be organized by community
Storm Water Storage	Provision temporary storage at open spaces in public facilities

4.6 Project Cost

4.6.1 Structural Measures

The project cost is estimated as the sum of construction cost, resettlement cost, administration cost, engineering service cost, physical contingency and price contingency.

Implementation of the structural measures in the master plan is expected to commence after completion of this Study in May 1998. Construction of priority project(s) will start in the year 2000. All the structural measures in the master plan will be completed in the end of the year 2020. The period of implementation therefore amounts to 21 years. Implementation of the structural measures will be proceeded by river system according to the priority order as discussed in the succeeding section.

In compliance with the implementation plan, the project cost for the structural measures of the master plan is estimated. The project cost amounts to 751.2 million Birr for the structural measures as shown in Table 9.

Table 9 Project Cost for Structural Measures

(Unit: million Birr)

Item	River System				Overall
	Bantyketu	Kebena	Little Akaki	Hanku	Total
Construction Cost	72.5	87.2	83.2	0.8	243.8
Resettlement Cost	7.4	4.3	2.9	0.0	14.6
Engineering Service Cost	10.9	13.1	12.5	0.1	36.6
Administration Cost	7.3	8.7	8.3	0.1	24.4
Physical Contingency	19.6	22.7	21.4	0.2	63.9
Price Escalation	31.0	256.1	79.6	1.3	368.0
Total	148.6	392.1	208.0	2.5	751.2

4.6.2 Non-structural Measures

The non-structural measures in the master plan will be implemented in parallel with the structural measures up to the year 2020.

As mentioned previous section, several kinds of instruments and materials need to be installed for implementation of the proposed non-structural measures. The project cost for non-structural measures is estimated as installation cost for required instruments and materials as shown in Table 10. The project cost for the non-structural measures in the master plan amounts to 11.9 million Birr.

Table 10 Project Cost for Non-structural Measures

(Unit: thousand Birr)

Item	River System				Overall
	Bantyketu	Kebena	Little Akaki	Hanku	Total
River Management	96	36	48	0	180
Watershed Management	22	46	24	8	100
Flood Risk Management	3,417	1,346	1,780	156	6,699
Physical Contingency	707	286	370	33	1,396
Price Escalation	1,773	716	929	82	3,500
Total	6,015	2,430	3,151	279	11,875

4.6.3 Project Cost for the Master Plan

As a conclusion of the project cost estimate, the project cost for the master plan amounts to 763.1 million Birr consisting of 751.2 million Birr for the structural measures and 11.9 million Birr for the non-structural measures.

On the other hand, the annual operation and maintenance cost is estimated at 1.42 million Birr/year consisting of 1.27 million Birr/year for the structural measures and 0.15 million Birr/year for the non-structural measures, respectively.

4.7 Organization and Institution

4.7.1 Organizational Framework

AFCPO has carried out the restoration and urgent flood protection works after the 1994 flood under the Steering Committee headed by the President of the Region 14 Administration. The role of AFCPO also covers investigation and implementation of long-term flood protection measures in Addis Ababa. However, the present activities of AFCPO are likely to be limited to local works like design and construction supervision of flood protection wall. The organization of AFCPO has not been fully constructed due to insufficient assignment of experts and supporting staffs prescribed in the present organization structure. A major reason of such status of AFCPO is that authorized long-term plan for flood protection has not been available in Addis Ababa.

It is strongly recommended that the organizational framework should be reconstructed and reinforced for the implementation of the flood control master plan. As seen in the present organization of the Region 14 Administration, the bureaus and authorities under the Economic Sector undertake the public works in Addis Ababa. The bureaus and authorities have powers and are sufficiently staffed for achieving their responsibilities.

The flood control master plan will be implemented as public works in Addis Ababa. The role of the Steering Committee and AFCPO, which are presently designated as organization in charge of flood protection, will cover the various kind of responsibilities for both structural and non-structural measures. Especially, AFCPO will have the responsibilities for all the practical works for the implementation. However, it is difficult for the present AFCPO to achieve the responsibilities further required.

Consequently, it is proposed that the organizational framework for the flood control master plan will be formulated in the similar manner to the present bureaus or authorities in the Region 14 Administration in terms of responsibilities, powers and staffing.

As a proposal by this Study, a new organizational framework comprises 'Addis Ababa River Board' entirely controlling the implementation of the flood control master plan, and 'Addis Ababa River Management Authority' executing practical works for the implementation such as plan, design, construction supervision, operation and maintenance.

4.7.2 Institutional Framework

For the implementation of the flood control master plan, first of all, legal background for river management needs to be clarified and established. The Steering Committee and AFCPO will be authorized as organization for river management in the Region 14 Administration.

Legal arrangement for river management will be conducted by the parliament of the Region 14 Administration with the proposal of the Steering Committee. AFCPO will provide necessary information to the Steering Committee on the basis of investigations and studies for individual matters on river management.

Authorization of river zone is a base of river management and needs to be enforced in the earliest stage of the implementation of the flood control master plan. Regulations for land use, permissions and prohibitions will be established as bylaw of the Region 14 Administration. Necessary adjustments for river zone will be provided with informal green area designated by the Addis Ababa Master Plan.

Reforestation is presently conducted by the different organizations other than AFCPO. It is therefore proposed that these organizations will continue their reforestation activities but AFCPO will need to make consultations with them from the viewpoints of river management.

The National Disaster Prevention and Preparedness Management has the institutional system for disseminating precautions and relief actions throughout the country. Whereas, flood warning and fighting require a similar institutional system to be operated by community organizations. It is therefore proposed that flood warning and fighting will be proceeded with the National Disaster Prevention and Preparedness Management. The Steering Committee will coordinate establishment of required institutional system for flood risk management.

4.8 Operation and Maintenance

4.8.1 Structural Measures

AFCPO requires authorization of its powers and responsibilities to control all the rivers and related structures mentioned above in order to maintain designed functions of river channels and related structures.

AFCPO will be principally responsible for operation and maintenance of rivers and related structures, which have been constructed by AFCPO and will be constructed in the course of the implementation of the flood control master plan.

For flood protection walls constructed by private sectors, AFCPO will conduct inspection to detect any problem from the viewpoints of river management. AFCPO will direct the owners to maintain their structure and give the order of improvement if required. After the commencement of the flood control master plan, construction of private structure without permission by AFCPO will be prohibited in the river zone.

The Gefersa dam and irrigation intakes have been constructed by public organizations. Such organizations are responsible for operation and maintenance of their own structures. Besides, AFCPO will also conduct inspection from the viewpoints of flood protection. AFCPO will recommend or order the organizations to improve their structures if any problem is detected. For construction of new structure in river zone, AFCPO will consult the organization in charge to coordinate with the flood control master plan.

The same conditions will be applied for bridges, water supply pipelines, sewers and other related structures constructed by public works. The Steering Committee will be in charge of coordination between AFCPO and organizations concerned.

4.8.2 Non-structural Measures

(1) River Management

After authorization of river zone, illegal activities in the zone will be strictly prohibited. AFCPO will make inspection and monitoring in river zone. When such illegal activities are detected, the Region 14 Administration will undertake proper counter actions in accordance with laws and regulations.

In relation to the river management in the Study Area, improvement of social infrastructures and enlightenment of public awareness for river will be important solutions to prevent the said illegal activities. These will be very helpful for achieving the objectives of river management, which are not only flood protection but also improvement of river environment. It is therefore proposed that the Region 14

Administration will make necessary efforts to improve the social infrastructures and enlighten public awareness.

Land use for riparian areas of the West Akaki and Hanku rivers will be regulated based on the concept of informal green area by the Addis Ababa Master Plan.

(2) Watershed Management

At present, the following organizations proceed reforestation in Addis Ababa.

- a) Bureau of Agriculture of Region 14 Administration
- b) Enterprise of Addis Ababa Fuel Wood Development and Marketing Organization
- c) Ethiopian Heritage Trust and Other Agencies

These organizations have different objectives of reforestation, namely, soil conservation, fuel wood production and recovery of indigenous woodland. Even though the objectives and future plans are different at present, it is suggested that the organizations continue the reforestation activities in Addis Ababa with their experiences, and that coordination and integration will be necessary between the organizations for the purpose of effective watershed management.

It is also proposed that AFCPO will participate in the reforestation and make consultations with the organizations from the viewpoints of river management.

(3) Flood Risk Management

The community organizations will conduct operation and maintenance for flood risk management. Major items are:

- a) Inspection and maintenance of equipment for flood warning (rainfall gauge, communication line, radio, siren, etc.),
- b) Inspection and maintenance of facilities for flood fighting (storehouse, stored materials, etc.)
- c) Periodical training of flood warning and fighting activities, and
- d) Education and popularization for flood warning and flood fighting activities.

Leaders of communities will be requested to conduct these works. AFCPO will direct the operation and maintenance works. Performance of communication and information system for flood warning and fighting will be periodically confirmed by all the organizations concerned with flood risk management upon direction by the Steering Committee.