No.

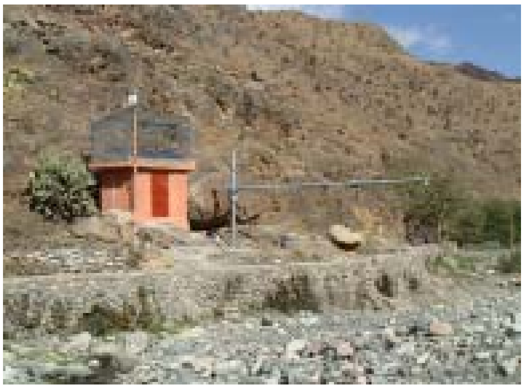
JAPAN INTERNATIONAL COOPERATION AGENCY

KINGDOM OF MOROCCO
MINISTRY OF COUNTRY PLANNING, WATER AND ENVIRONMENT
DIRECTORATE GENERAL OF HYDRAULICS

THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO

FINAL REPORT

VOLUME 1 SUMMARY



JANUARY 2004

CTI ENGINEERING INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD.

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The cost estimates in this Study are based on the prices levels indicated below and expressed in Moroccan Dirham according to the following exchange rates:

USD 1.00 = Dh 9.8638 = JPY 120.590

As of August 1, 2003

PREFACE

In response to a request from the Government of the Kingdom of Morocco, the Government of Japan decided to conduct The Master Plan Study on Flood Forecasting and Warning System for Atlas Region in the Kingdom of Morocco and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched the study team headed by Mr. Yoshiharu Matsumoto of CTI Engineering International Co., Ltd. consisted of CTI Engineering International Co., Ltd. and Yachiyo Engineering Co., Ltd. to Morocco, 5 times between March 2000 and December 2003. In addition, JICA set up the advisory committee headed by Mr. Masayuki Watanabe, Senior Advisor of JICA .

The team held discussions with the officials concerned of the Government of the Kingdom of Morocco, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Morocco for their close cooperation extended to the Team.

2004 January

Kazuhisa MATSUOKA
Vice-President
Japan International Cooperation Agency

January 2004

Mr. Kazuhisa MATSUOKA
Vice-President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report on *the Master Plan Study on Flood Forecasting and Warning System for Atlas Region in the Kingdom of Morocco.*

The study was conducted by CTI Engineering International Co., Ltd. in association with Yachiyo Engineering Co., Ltd. under contracts with Japan International Cooperation Agency (JICA) during the period from March 2000 to January 2004. In conducting the study, we have paid much attention to formulate a realistic master plan of flood forecasting and warning system with due consideration to the present situation of Morocco.

We wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, and other offices concerned. We also wish to express our deep appreciation to the Directorate General of Hydraulics, the Ministry of Country Planning, Water and Environment, and other organizations concerned of the Government of Morocco for their close cooperation and assistance extended to the JICA study team during the study.

Finally, we hope that this report will contribute to the further promotion of the master plan.

Very truly yours,

Yoshiharu Matsumoto
Leader, JICA Study Team
CTI Engineering International Co., Ltd.

Encl. : a/s

COMPOSITION OF FINAL REPORT

Volume 1 SUMMARY REPORT

Volume 2 MAIN REPORT

Volume 3 SUPPORTING REPORT

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APPENDIX B GEO-MORPHOLOGY

APPENDIX C HYDROLOGICAL AND HYDRAULICS ANALYSIS

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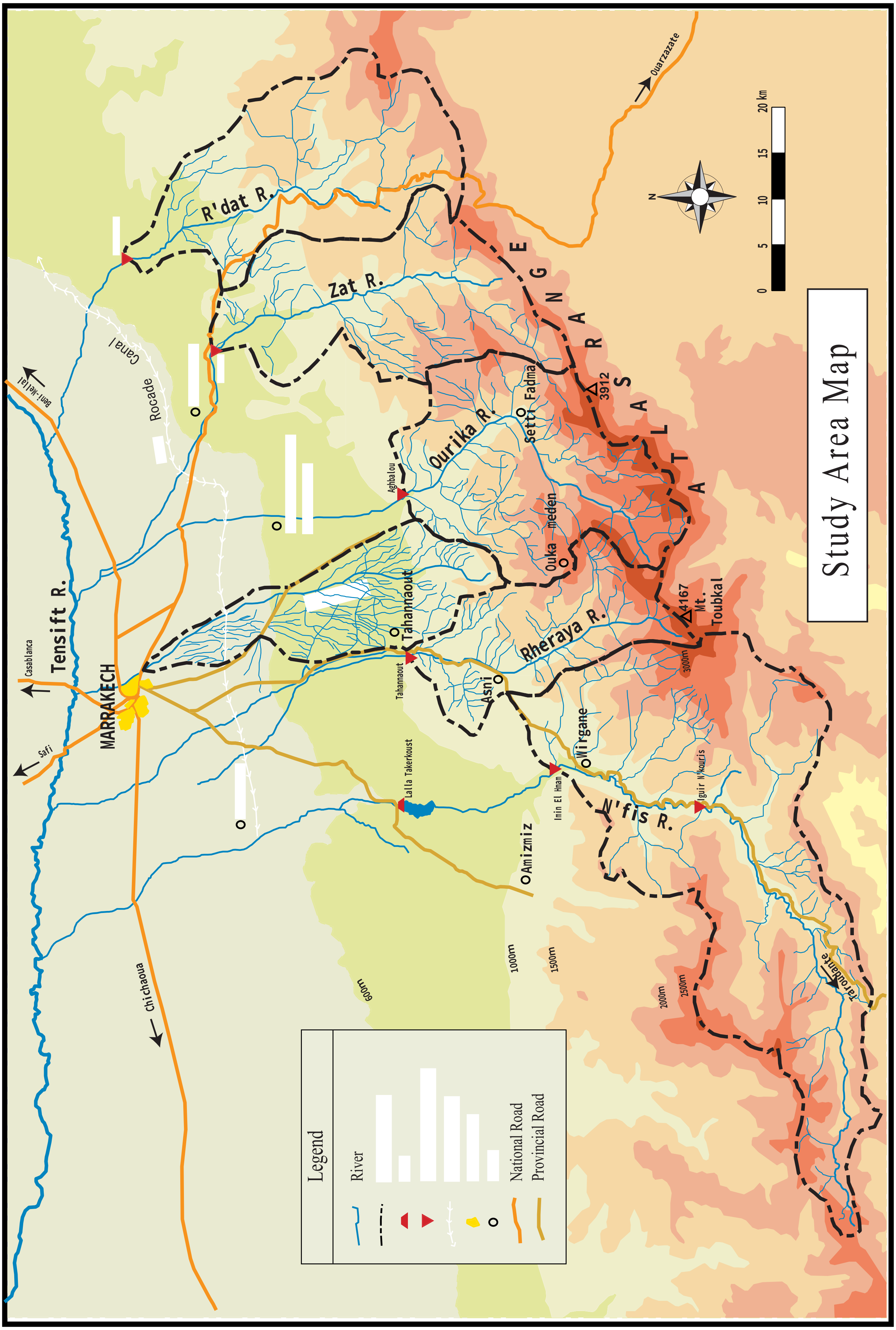
Volume 4 DATA BOOK


Study Area Map
Legend
River
National Road
Provincial Road
Tensift R.
MARRAKECH
R'dat R.
Zat R.
Ourika R.
Rheraya R.
N'fis R.
Aghbalou
Setti Fadma
Ouka meden
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Casablanca
Safi
Beni-Mellal
Chichaoua
Ouarzazate
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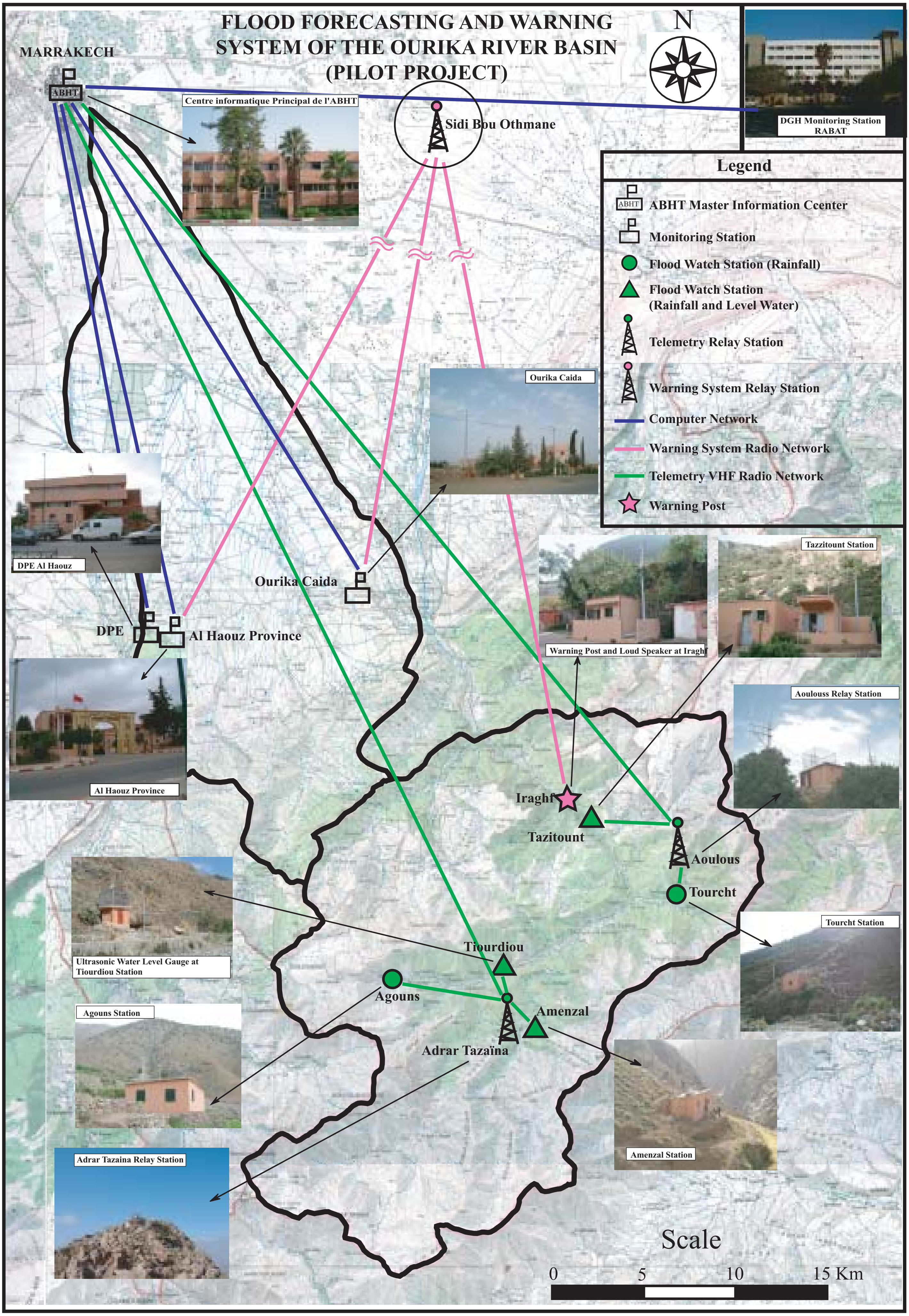
3000m
N
0 5 10 15 20 km



FLOOD FORECASTING AND WARNING SYSTEM OF THE OURIKA RIVER BASIN (PILOT PROJECT)
N
MARRAKECH
ABHT
Centre informatique Principal de l'ABHT
Sidi Bou Othmane
DGH Monitoring Station RABAT
Legend
ABHT Master Information Ccenter
Monitoring Station
Flood Watch Station (Rainfall)
Flood Watch Station (Rainfall and Level Water)
Telemetry Relay Station
Warning System Relay Station
Computer Network
Warning System Radio Network
Telemetry VHF Radio Network
Warning Post
Ourika Caida
DPE Al Haouz
Ourika Caida
DPE
Al Haouz Province
Warning Post and Loud Speaker at Iraghf
Tazzitount Station
Aoulouss Relay Station
Al Haouz Province
Iraghf
Tazitount
Aoulous
Tourcht
Ultrasonic Water Level Gauge at Tiourdiou Station
Tiourdiou
Agouns
Amenzal
Adrar Tazaïna
Tourcht Station
Agouns Station
Amenzal Station
Adrar Tazaina Relay Station
Scale
0 5 10 15 Km

EXECUTIVE SUMMARY

1. Introduction

1.1 Background

The Study Area is located in the northern slopes of the high mountains called “Haut Atlas”, ranging from 500 m to 4,000 m in altitude. Its picturesque scenery, cool air and clean water attract a lot of visitors, but the area is on the other hand vulnerable to flood and debris flow disasters due to its geo-morphological and meteorological conditions. In August 1995, a thunderstorm hit the high mountain areas of the Study Area and caused sudden flash floods and debris flows that swallowed hundreds of lives.

Since the 1995 disaster, the Government of the Kingdom of Morocco has made efforts to mitigate flood damage in the Study Area by implementing various structural and non-structural measures. As a non–structural measure, they installed six hydrological stations equipped with a radiotelephone in and around the Ourika River basin that were worst hit in the 1995 disaster. However, those previous efforts are still far from being satisfactory to assure safety of the Study Area.

Under these circumstances, the Moroccan Government requested the Government of Japan to conduct the Master Plan Study on Flood Forecasting and Warning System (FFWS) for Atlas Region. In response to the request, the Japan International Cooperation Agency (JICA) dispatched a study team heady by Mr. Yoshiharu Matsumoto to the Kingdom of Morocco at the end of March 2000.

1.2 Objectives of the Study

The objectives of the Study are:

(1) To formulate the master plan of flood forecasting and warning system for the Atlas Region; and

(2) To carry out technology transfer to counterpart personnel of GOM in the course of the Study.

1.3 Study Area

The Study Area covers 3,500 km^2 of the left bank of the Tensift River including river basins of six tributaries, the R’dat, Zat, Ourika, Issyl, Rheraya and N’fis Rivers as shown in the Study Area Map.

2. Implementation and Operation of Pilot Project

2.1 Introduction

Following basic studies of about a year, a draft Master Plan was compiled in April 2001. In the draft Master Plan an automatic telemetry system of 20 flood watch stations and an automatic remote-control system of 17 warning posts were proposed to cope with flash floods that the existing manual system hardly manage. A part of the draft Master Plan was implemented as a Pilot Project in the Ourika River Basin step-wisely between July 2001 and September 2003, in order to actually examine the effectiveness of equipment and systems proposed in the draft Master Plan.

A semi-automatic system of the first phase was completed in December 2001, and immediately its experimental operation started and continued about one and half years until when the second phase was completed to realize an full automatic telemetry system in July 2003. The experimental operation of the telemetry system was also made about one and half months from the beginning of August to mid-September 2003.

2.2 Contents of Pilot Project

As a total flood forecasting and warning system, the Pilot Project is composed of following five subsystems:

Constitution of Pilot Project

Subsystem	Phase I (Completed in December 2001)	Phase II (Completed in July 2003)
Hydrological Observation and Data Collection	Automation of hydrological observation at 5 flood watch stations (Provision of automatic tipping-bucket rain gauge and ultra sonic water level gauge)	Automation of data transmission (Provision of VHF radio data transmission system with 2 repeater stations)
Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information	Establishment of Master Information Center at DRHT and Monitoring Stations at DGH, DPE Al Haouz, Al Haouz Province and	Upgrading of data processing system along with introduction of telemetry system.
Issuance of Flood Warning	Preparation of Guidelines and Experimental Operation	
Dissemination of Flood Warning	Establishment of Iraghf Warning Post	Provision of selective call system among Iraghf Warning Post, Al Haouz Province and Ourika Caidat.
Execution of Evacuation	Preparation of Guidelines	

2.3 Experimental Operation and Technical Transfer

During the Pilot Project period, the JICA Study Team supported and monitored the experimental operation in Morocco and even from Japan while the team was back in Japan. A variety of technical transfer programs including simulation drills were also carried out to build up capacities of personnel concerned involved in the FFWS operations.

2.4 Maintenance of Equipment

In November 2001, the director of DRHT (ABHT) and the governor of Al Haouz Province agreed on on the operation and maintenance of the project as follows:

- Each organization is responsible for operation and daily maintenance of equipment and facilities that have been built and installed in its own jurisdictions, and
- DGH is responsible for preventive and correction maintenance of all the equipment.

In accordance with the agreement, every organization concerned started the operation of the Pilot Project equipment gradually after the completion of the installation works. On the other hand, ABHT made a Dh 120,000 maintenance contract of the phase-I equipment for the year 2003 with a local agent, subsidized by DGH. According to DGH, they are preparing Dh 200,000 for the 2004 contract covering both the phase-I and II equipment, Dh 80,000 up from the 2003 contract.

2.5 Evaluation of Pilot Project

The equipment generally functioned properly. Especially, effects of the telemetry system were magnificent. During the 4 August 2003 rainstorm, the automatic system made ABHT aware of the outbreak of the intensive rainstorm by sounding alarms, and provided rainfall and water level data every 10 minutes on real-time basis.

The effectiveness of the proposed guidelines during the actual floods has not been proven out unfortunately, mainly due to some simple errors. The effect of the simulation drills is beyond question. As the organizations concerned acted more quickly in every simulation drill, their understandings were improved very much. Nevertheless, the guidelines have not yet soaked into the organizations concerned completely. Further training programs and simulation drills are necessary.

Limitations of the FFWS measure as well as the Pilot Project were revealed in the recent floods. To assure the sustainable operation of the pilot FFWS, essential is machinery to support the FFWS institutionally, financially and technically. Some movements towards the creation of such machinery are advancing slowly but steadily. On 7 November 2003 a convention on the operation and maintenance of the pilot FFWS was signed by Al Haouz Province, ABHT and DPE Al Haouz.

3. Master Plan

Based on the evaluation of the Pilot Project, the draft Master Plan was modified and updated, as follows:

3.1 Target Area of FFWS Master Plan

Innumerable douars, roads along the rivers and tourist spots are exposed to rain-induced disasters such as river flood, debris flow, landslide and slope failure due to its topographical, geological and meteorological conditions. Therefore, prioritization is inevitable to maximize the benefits from the Master Plan by investing more to high risk areas. The FFWS Master Plan targets 16 high risk areas selected through a comprehensive examination on damage potential and past disasters. For low risk areas, other low cost or cost-free measures depending on inhabitants' voluntary activities are conceived.

3.2 Outline of Master Plan

3.2.1 Hydrological Observation and Data Collection

The Master Plan has 20 flood watch stations. 12 stations have both a rainfall gauge and a water level gauge, and the remaining 8 stations are rainfall stations. All the flood watch stations are equipped with a VHF radio telemetry system that enables automatic measurement of rainfall and water level and real-time data transmission to ABHT.

3.2.2 Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information/Notices

The collected hydrological data are processed and analyzed in ABHT which plays a role of a master information center of the Master Plan. Forecasting of river floods and a debris flows is also made by ABHT. Based on the analysis and forecasting, ABHT is to announce Flood Notices. The Flood Notices and processed flood information are distributed to related organizations through the Internet, public telephone, fax, and/or VHF radiotelephone.

3.2.3 Issuance of Flood Warnings

The governor of the Province/Prefecture is to issue Flood Warnings that directly call for caution and evacuation of inhabitants and tourists in the high risk areas, based on the Flood Notices by ABHT and other information.

3.2.4 Dissemination of Flood Warnings

The Flood Warnings are disseminated from the Province/Prefecture to warning posts and related organizations. The FFWS Master Plan has over the high risk areas a total of 17 warning posts equipped with warning broadcasting and communication equipment. Live or recorded warning messages are broadcast when directed the Province/Prefecture.

3.2.5 Evacuation

Evacuation must be made appropriately and promptly in accordance with an evacuation plan that is to be prepared for every high risk area. The evacuation plan must contain 1)Evacuation organization, 2)Operation of warning post, 3) Evacuation places and routes, 4)Stock of materials and equipment, 5)Diffusion of warning messages, 6)Guidance of evacuees, 7)Guidance of tourists, 8)Evacuation drill, 9)Public relations, 10)Evaluation of evacuation activities and updating of evacuation plan.

3.3 Institutional Plan

The FFWS, the man-machine system can work well only when both parts of equipment and manual operation work normally. In the Pilot Project, however, a lot of errors related to the institutional aspects were raised in the manual operation works. Most of them were very simple but fatal to the FFWS. In order to assure the appropriate manual operation, the following things are emphasized:

- Creation of Coordination Committee;
- Strengthening of Permanence Duty;
- Explanation and Training (Drills) for Full Understandings;
- Interactive Analysis with DMN;
- Importance of Information from Local Authorities;
- Evaluation and Grade-up Applying Management Cycle; and
- Participation of Inhabitants and Tourism related Industries.

3.4 Evaluation of Master Plan

The total cost of the Master Plan is estimated at Dh 51 million excluding that of the Pilot Project. Economic Internal Rate of Return of greater than 16% is obtained if human lives are additionally included in the benefit estimation. In conclusion, the Master Plan is generally viable in terms of economical effectiveness, social and technical acceptability and environmental impacts. If sufficient assistances of national and regional levels are available, the Master Plan could be viable financially too.

4 Recommendations

The JICA Study Team proposes the Master Plan to the Government of Morocco, and strongly recommends that the Master Plan will be implemented soon to contribute to the enhancement of the safety of inhabitants and visitors in the Atlas Region. To facilitate the implementation of the Master Plan, the following actions are earnestly desired:

(1) Establishment of Coordination Committee

A coordination committee should be realized soon for assuring of the sustainable operation of the pilot FFWS and is expected to lobby for the promotion of the Master Plan too.

(2) Sustainable Operation of Pilot Project System

Prior to the implementation of the Master Plan, it is essential to continue to operate and maintain appropriately the FFWS installed in the Pilot Project. If the pilot FFWS goes out of use, the Master Plan is out of the question.

(3) Comprehensive Approach to Disasters in Atlas Region

Comprehensive approach composed of combinations of a variety of structural and nonstructural measures is indispensable against the disasters.

(4) Installation of Radar by DMN

More accurate weather forecasts are indispensable for realization of a reliable FFWS. It is strongly recommended that DMN implement the installation of precipitation radar in or near the Atlas Region as it plans.

**THE MASTER PLAN STUDY ON
FLOOD FORECASTING AND WARNING SYSTEM
FOR ATLAS REGION IN THE KINGDOM OF MOROCCO**

**FINAL REPORT
(SUMMARY)**

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ABBREVIATIONS

ABHT	Agence du Bassin Hydraulique de Tensift, MATEE	Tensift Hydraulic Basin Agency
AEFCS	Administration des Eaux et Forest et de la Conservation des Sols	Administration of Water and Forest and Soil Conservation
AEPI	Alimentation en Eau Potable et Industrielle	Drinking and Industrial Water Supply
ANRT	Agence Nationale de Réglementation de Transmission	National Agency of Transmission Regulation
CDCL	Centre de Documentation des Collectivités Locales, MI	Documentation Center for Local Communities
CNP	Centre National des Prévisions, DMN	National Forecasting Center, DMN
DEA	Direction des Eaux et Assainissement, MAMVA	Directorate of Water and Drainage
DGCL	Direction Générale des Collectivités Locales, MI	Directorate General of Local Communes
DGH	Direction Générale de l'Hydraulique, MATEE	Directorate General of Hydraulics
DMN	Direction de la Météorologie Nationale, MATEE	Directorate of National Meteorology
DPA	Direction Provinciale de l'Agriculture, MAMVA	Provincial Directorate of Agriculture
DPE	Direction Provinciale de l'Equipement, MET	Provincial Directorate of Equipment
DRC	Direction Régionale Centre, DMN, MATEE	Central Regional Directorate, DMN
DRCR	Direction des Routes et de la Circulation Routière, MET	Directorate of Roads and on Road Traffic
DRE	Direction Régionale de l'Equipement, MET	Regional Directorate of Equipment
DREF	Direction Régionale des Eaux et Forêts, MCEF	Regional Directorate of Water and Forests
DRH	Direction de la Région Hydraulique, ME	Directorate of the Hydraulic Region
DRHT	Direction de la Région Hydraulique de Tensift, ME	Directorate of the Hydraulic Region of Tensift
DRT	Délégation Régionale du Tourisme, MT	Regional Delegation of Tourism
LPEE	Laboratoire Public d'Essais et d'Etude	Public Laboratory for Experiments and Studies

MAMVA	Ministère de L’Agriculture et de la Mise en Valeur Agricole	Ministry of Agriculture and Agricultural Development
MATEE	Ministère de l’Aménagement du Territoire, de l’Eau et de l’Environnement	Ministry of Country Planning, Water and Environment
MCEF	Ministère Chargé des Eaux et Forêts	Ministry in charge of Water and Forests
ME	Ministère de l’Equipement	Ministry of Equipment
MET	Ministère de l’Equipement et du Transport	Ministry of Equipment and Transport
MI	Ministère de l’Intérieur	Ministry of Interior
MT	Ministère du Tourisme	Ministry of Tourism
ONCF	Office National des Chemins de Fer	Railway National Office
ONE	Office Nationale de l'Electricité	National Office of Electricity
ONEP	Office Nationale de l'Eau Potable	National Office of Drinking Water
ORMVAH	Office Régionale de la Mise en Valeur Agricole d'Al Haouz	Regional Office of Agricultural Development of Al Haouz
PNUD	Programme des Nations Unies pour le Développement	United Nations Development Programme (UNDP)
PAGER	Programme d'Approvisionnement en Eau des Populations Rurales	Water Supply Program for Rural Population
PC	Post de Commande	Command Post
Plan ORSEC	Plan d'Organisation des Secours	Disaster Contingency Plan
RTM	Radio Télévision Marocaine	Moroccan Radio & Television

SUMMARY

1. Introduction

1.1 Objectives of the Study

The objectives of the Study are:

(1) To formulate the master plan of flood forecasting and warning system for the Atlas Region; and

(2) To carry out technology transfer to counterpart personnel of GOM in the course of the Study.

1.2 Study Area

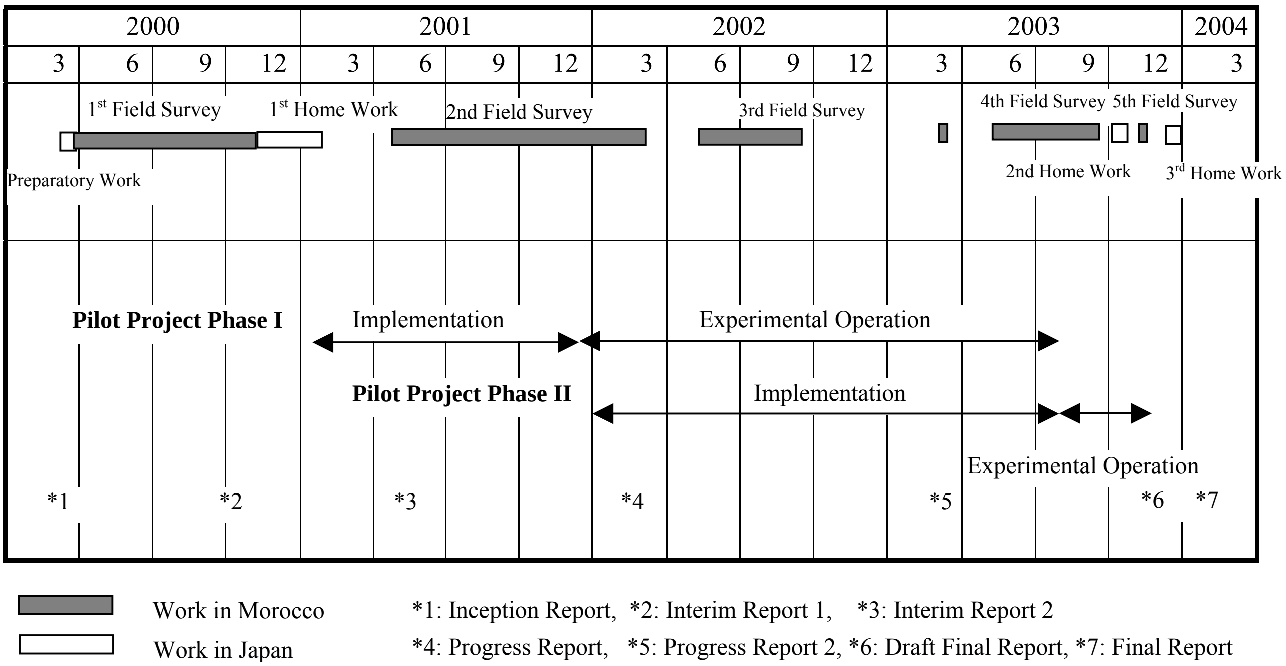
The Study Area covers 3,500 km^2 of the left bank of the Tensift River including river basins of six tributaries, the R'dat, Zat, Ourika, Issyl, Rheraya and N'fis Rivers as shown in the Study Area Map.

1.3 Study Schedule

This Study started in March 2000. According to the original schedule proposed in the Inception Report, this Study was supposed to be completed by February 2002. Due to introduction of a telemetry system as a Pilot Project and to additional study items such as simulation drills, it was decided that the study period would be extended nearly two years until around the beginning of 2004.

In the prolonged study period, a part of the draft Master Plan that was proposed in the Interim Report 2 in April 2001 was realized in the Ourika River Basin step-wisely between 2001 and 2003 as the Pilot Project. A semi-automatic FFWS that enables automatic observation was completed in 2001, and then upgraded into a full automatic telemetry system in July 2003 by adding an automatic data transmission system to the semi-automatic system.

Study Schedule



1.4 Organizational Change during This Study

Two major organizational changes that are related to this Study took place during the Study Period between 2000 and 2003.

The first one is the transition of DRHT (Direction de la Région Hydraulique du Tensift) into ABHT (Agence du Bassin Hydraulique du Tensift). The hydraulic basin agency, creation of which had been officially published by the Prime Minister's decree No. 2-00-79 dated November 14, 2000, was practically established with DRHT as a mother body in April 2002 upon the nomination of the director, together with another five hydraulic basin agencies for Sous Massa, Bouregreg, Sebou, Lokkous and Moulouya.

The other change is the transfer of DGH and ABHT from the Ministry of Equipment to the Ministry of Country Planning, Water and Environment in November 2002 as a part of the cabinet reshuffle accompanied by the creation of the new government.

2. Present Conditions of Study Area

2.1 General Conditions

The Study Area is composed of six river basins forming northwestern slopes of the High Atlas that runs in the direction of southwest to northeast on the northwestern edge of the African Continent. There are many high mountains exceeding 3,000 m in elevation in the Study Area. The mountain areas are characterized by steep slopes and poor vegetation.

The climate of the Study Area is of the arid continental type based on the Mediterranean climate. In general, the rainy season is from October to April and the dry season is from May to September. Thunderstorms often break out in the Atlas Mountains between July and October, resulting in torrential floods in the valleys in the summer tourist season.

Almost all the Study Area administratively belongs to Al Haouz Province, while the limited northern-most urban area of the Issyl River Basin falls in Sidi Youssef Ban Ali Prefecture and small southern mountainous area in Ouarzazate Province. Population of the Study Area is estimated at about 370,000 people as of 2000. The land use is featured by 47% of forests, followed by agriculture of 29% and the remaining area is shared by orchards, grass/bare areas, rocky areas and so on. The major industries are agriculture, livestock raising and forestry, from which the share of total house hold income in the provincial level is 46%, 32% and 0.1%. Tourism industry is also a major source of income.

2.2 Past Floods

Past major floods are summarized in the following table:

Past Major Floods

River Basin	Year/ Month	Major Flooded Area	Flood Damage
Issyl	1956/-	Sidi Youssef Ben Ali and along the river course (Most severe flood in the past)	Many lives were lost.
	1963/12	Marrakech city area	2 people died and 97 houses were washed away.
	1971/-	No data	Flood damage was less severe than the 1956 flood.
	1982/-	Sidi Youssef Ben Ali area	Many houses were washed away.
	1984/-	Mainly Bab Rob area	Not specified
	1986/-	Sidi Youssef Ben Ali	10 houses were washed away
	1990/1	No data	4 people died, 20 people were injured, 530 ha of agricultural area were inundated.
	1994/10	Sidi Youssef Ben Ali	8 houses were damaged
	1995/4	No data	36 houses were damaged
	1997/3	23 villages and Sidi Youssef Ben Ali	40 houses were damaged
Other Basins (R'dat, Zat, Ourika, Rheraya and N'fiss)	1949/-	No data	No data
	1967/-	- do -	- do -
	1980	- do -	- do -
	1995/8	Ourika and other areas (55 villages)	More than 200 people were killed or missing and total damage amount was DH 70 mil.
	1999/10	N'fiss, Ourika and Rheraya	Infrastructure and agricultural areas were damaged.

The most dreadful flood among them was the one on 17 August 1995. A strong convection developed by high temperature generated thunderstorms that caused intensive heavy rainfall in the high mountain areas. The heavy rainfall resulted in flash floods and debris flows in rivers and streams that swallowed hundreds of human lives mostly in the Ourika Valley. The majority of the casualties were tourists who came in the valleys to enjoy cool and clean water. Damages to houses, agricultural areas and roads were also huge. The total damage amount was estimated at Dh 70 millions.

The Aghbalau Station of the Ourika Valley recorded 1,000 m3/s, and the Tahanaout Station of the Rheraya River 680 m3/s. These peak discharges correspond to the annual maximum discharges with the return periods of 30 years and 100 years respectively.

2.3 Flood Prevention Measures

The Moroccan Government has been making efforts to implement several preventive measures against rain-induced disasters including floods, debris flows, land slides, slope failures, etc., mainly after the 1995 disaster. Due to financial and technical constraints, however, the measures are not yet enough to control the disasters. Inhabitants and tourists are still exposed to disaster risks.

2.3.1 Non-Structural Measures

Major non-structural measures that have been implemented after the 1995 disaster are as follows:

- Improvement of meteorological observation and weather forecasting by DMN;
- Introduction of Flood Watch System by DRHT (ABHT);
- Public relations and construction of parking spaces in the Ourika Valley by DPE;
- Land use Control in River with enactment of the Water Law (the “10-95 Law”); and
- Reforestation and Erosion Control by DREF.

2.3.2 Structural Measures

Structural measures are concentrated on the Ourika River Basin. There are almost no works and programs on structural measures so far against flood in the R’dat, Zat, Rheraya and N’fis Rivers, except road protection works such as revetment works and its foot protection. The structural measures implemented in the Ourika and Issyl Rivers are as follows:

Structural Measures in Ourika and Issyl River Basins

River Basin	Major Structural Measures
Ourika River	• Excavation of river channel by DPE • Blasting of large boulders by DPE • Construction of embankment by DPE • Construction of revetment works by DPE • Construction of check dams by DPE and DREF
Issyl River	• Construction of flood protection walls in Sidi Youssef Ben Ali by DPE

Among them a project for the development of the Ourika River Basin is noteworthy. This 100 million dirham project, financed by the Hassan II Fund for Economic and Social Development, is being implemented over 665 km2 of the Ourika River Basin from 2001 to 2003. Objectives of the project is to protect the population, visitors and economic infrastructure, to secure and promote hydro-agricultural infrastructures, to promote investments of eco-tourism and to contribute to the improvement of basic infrastructures and the self help of local people. The project includes 113,000 m^3 of check dams in addition to 800 ha of reforestation and improvement of the forest cover and grass land. These works definitely contributed to reduction of damage of the 4 August 2003 rainstorm.

2.4 Related Projects and Studies

2.4.1 Projects and Studies on Telemetry System

DGH has been very eagerly promoting projects and studies for automation of hydrological observation by introducing a telemetry system in accordance with the Action Plan 1999 – 2003 in Water Sector.

They are “Project on Automation of Ouergha River Bain Network”, “Mediterranean Hydrological Observation System Project (MED-HYCOS)”, “Project on Installation of Hydrological Telemetry System for Oum Er Rbia and N’fis River Basins” and “Sous/Massa Integrated Water Resources Management Project (SIWM)”.

The Ouergha project financed by the French Development Bank was installed in 2000, but a part of observed data are missing due to a problem of the HF radio data transmission system. In the MED-HYCOS Project two telemetry stations were installed in 2000 to exchange hydrological information among the Mediterranean countries. The Word Bank Oum Er Rbia and N’fis project was finally cancelled after the completion of its detailed design because of its high operation and maintenance cost to be shouldered by the basin agency of Oum Er Rbia River. The US-AID SIWM Project launched in January 2001 includes a VHF radio telemetry project of which installation is expected between July and December 2003.

2.4.2 Studies on Flood Prevention

The nation-wide study of “National Plan of Protection against Floods” was commenced by DGH in 2000 for the purposes of definition of flood types, elaboration of syntheses documents on potential risks of floods, analysis of the actual situation of the institutional frame and propositions of the improvement. The World Bank study was actually completed in 2003, proposing creation of provincial/prefectual committees on flood risk management in relation to this Study.

DRCR is conducting a study to determine essential solutions for the protection of the road P2017 in the Ourika Valley. The study is consisting of Mission I (field reconnaissance), Mission II (Identification of problems of existing protections and hydraulic studies) and Mission III (feasibility studies and presentation of study results). The study started in 2000, and in May 2001 a report of the Missions 1 and 2 were released. The Mission 3 was supposed to be completed in August 2002, but has been suspended due to lack of funds for an additional river profile survey.

2.4.3 Action Plan 1999-2003 in Water Sector

Ministry of Equipment established “Plan dé Développement Economique et Social 1999-2003”, where DGH released “Plan dé d’Action Plan 1999-2003 Secteur Hydraulique”. The five-year action plan includes various water resources development programs such as drinking water for the urban and rural, irrigation water, industrial water, hydro-electricity and flood control. Modernization of hydrological observation networks is one of the major targets of the five -year action plan.

3. Studies and Analyses

3.1 Preparation of Hazard Maps

3.1.1 Preparation of Geo-morphological Land Classification Maps

Geo-morphological land classification maps were made for the objective six river basins as a first step for the preparation of flood and sediment hazard maps. Landforms were interpreted using aerial photographs newly taken in this Study, and the results were transferred to 1/50,000 or 1/100,000 topographical map sheets. Fig.3.1 is a sample for the Ourika River, and those for the other five river basins are presented in Volume 3, Supporting Report Appendix B: River Morphology.

3.1.2 Preparation of Disaster Hazard Map

Following the geo-morphological maps, disaster hazard maps were also prepared for the six river basins to identify areas vulnerable to disasters such as debris flow, slope failure and land slide and flood inundation. Fig.3.2 is a sample of the Disaster Hazard Map for the Ourika River Basin. Those for the other basins are presented in Volume 3, Supporting Report Appendix B: River Morphology.

Damage potentials are generally functions of magnitude and occurrence probability of the natural phenomena and distribution of assets to be protected. For the hazard maps, houses and buildings, and roads were considered as important assets to be protected from the disasters.

Identified Disaster Potential Areas

River Basin	Catchment Area (km^2)	Number of Potential Debris Flow Streams	Potential Slope Failure		Potential Land Slide	
			Number of Areas	Road Length under Threat (km)	Number of Areas	Road Length under Threat (km)
R'dat	1,256	285	225	37	61	5
Zat	221	147	180	5	70	0
Ourika	495	330	240	36	23	9
Rheraya	528	145	128	14	35	2
N'fis	532	488	490	69	30	2
Issyl	421	36	17	2	7	0
Total	3,453	1,431	1,280	164	226	18

3.2 Preparation of Flood Inundation Map

Applying an one-dimensional non-uniform flow model for the N'fis, Rheraya, Ourika, R'dat, Zat Rivers and a two-dimensional dynamic flow model for the Issyl River, flood inundation areas of several return periods were identified in this Study. Fig.3.3 presents the estimated flood inundation areas near Iraghf on the Ourika River, and Fig.3.4 presents the inundation areas along the Issyl River. Those for the other rivers are given in Volume 3, Supporting Report Appendix D: Hydraulic Simulation.

3.3 Social Survey

A social survey was conducted in May and June 2000 by means of questionnaire and direct interview with 513 people in 34 selected douars damaged by flood or vulnerable to the attack of natural disasters.

More than 36% and 22% of the whole respondents made an evacuation in the 1995 and 1999 floods. The evacuation rate becomes a little higher, if the rate is limited to those who perceived possible attack of disaster, 45% in the 1995 flood and 26 % in the 1999 flood. As for the warning, about half of the people gave a warning or information to the family and neighbors immediately after noticing the danger. Danger signal can be transmitted from one place to another by loud shouts of people. In tourist places such warning was given to visitors by 55 local people in the 1995 flood and 21 in the 1999 flood, respectively. As for the local interest in forecasting system, positive answer was given by about 83% of responds to the question whether they want to participate in evacuation drill.

3.4 Tourism Survey

There are four major tourist spots in the Study Area, Irgahf (Oulmes) and Setti Fadma on the Ourika River and Imlil and R'ha Moulay Brahim on the Rheraya River. Most of the tourists gather at these locations in summer. A tourism survey was conducted for the above four tourist spots in early August, 2000 to collect information on the tourism and their concern on the flood disaster as well as flood forecasting and warning system.

In the Ourika River Basin, about 6,000 tourists and 1,200 vehicles at the maximum were counted on the whole stretch from Setti Fadma to Aghbalau on Sunday, while about 2,000 tourists and 500 vehicles were on Thursday. In the Rheraya River Basin, it is difficult to find tourists on and around Rherya River except at R'ha Moulay Brahim and Asni. R'ha Moulay Brahim is the only place where tourists enjoy the river. About 1,360 tourists and 63 vehicles were counted at the peak time at on Saturday.

As the nationality and language, the majority of tourists are Moroccans except Imlil, where most of tourists are foreigners. Arabic is the most common language among the tourists, and 94% of some 220 respondents speak Arabic, and 71% speak French. However, the local language, Berber is far less understood among the tourists, only 24% can speak Berber.

92 % of the interviewees know about the 1995 disaster and 61 % expressed their fear against a flood. Questioned about an evacuation place, 81 % answered that they would evacuate to higher places, 12 % to their cars, which corresponds to 24% of the interviewees who came by their own cars. Almost all the interviewees expressed the necessity of an alarm facility and a guide to help them evacuate in case of a flood.

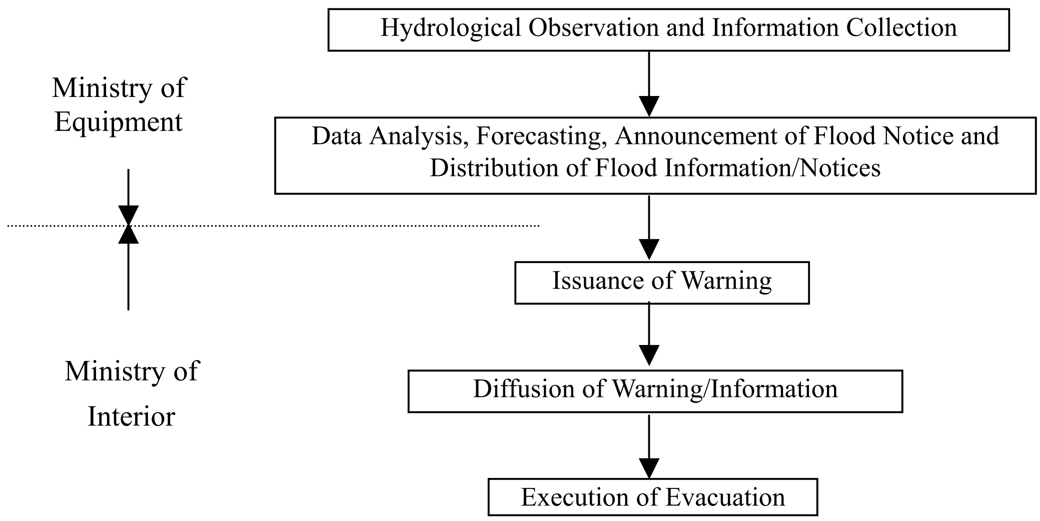
4. Flood Forecasting and Warning System Before Pilot Project

4.1 Introduction

The Flood Forecasting and Warning System in the Atlas Region has been changed drastically, especially in the Ourika Valley, through the implementation of the Pilot Project between 2001 and 2003. In this Chapter, however, the previous system that used to exist before the installation of the Pilot Project Phase-I in December 2001 is explained to help understand the situations before the Pilot Project, which the draft Master Plan aims to improve. It is also noted that at that time ABHT was DRHT, and both of DGH and DRHT (ABHT) were under the Ministry of Equipment.

4.2 Agencies Concerned for FFWS

The FFWS in the Study Area is administratively divided into two parts, namely that for the Ministry of Equipment and that for the Ministry of Interior. The Ministry of Equipment represented by DRHT, DPE and DMN is involved mainly in technical matters including observation, data collection, analyses, forecasting, announcement of flood notices and distribution of flood information/notices, etc. The roles of DRHT, DPE, DMN have not been changed at all even after the transition of DRHT to ABHT and the reorganization of the central government in November 2002, which transferred ABHT, DGH and DMN from the Ministry of Equipment to the newly created Ministry of Country Planning, Water and Environment.



Subsystem of Flood Forecasting and Warning System

The Ministry of Interior represented by the province/prefecture and lower authorities such as cercles, caidats, etc. is directly concerned with inhabitants and tourists through warning dissemination and evacuation activities.

After the 1995 Ourika disaster, the Ministry of Equipment prepared a guideline for flood management in December 1996. The guideline stipulates roles of the agencies, DPE/DRE, DRH, DRCR, DMN, etc., especially those of DPE/DRE before, during and after a flood. The ME Guideline describes special messages from DMN, courses of information dissemination among related agencies, actions to be taken according to the flood situation. In addition, names and telephone numbers to be contacted are also included in the guideline book. Due to lacks of necessary tools and equipment and to organizational problems, however, the actual operations seemed still far from those stipulated in the guidelines.

The province/prefecture has no written guideline for FFWS, although every province/prefecture has an ORSEC Plan for rescue activities in a catastrophe. In principle the governor is responsible for security of inhabitants. The governor issues warnings based on flood information/notices from relevant local authorities, DRHT and DPE, and then diffuses them to local authorities such as cercles and caidats in an order of the administrative hierarchy. Then, the local authorities call an evacuation directly or through cheikhas and mecadams to inhabitants and tourists. However, this procedure is not always undertaken. In emergency, each level of the authorities can issue warnings for evacuation by itself. Due to lacking of telecommunication measures, dissemination of flood warnings still relies very much on inhabitants' direct voice communication (shouts and cries).

4.3 Introduction of Flood Watch System after 1995 Disaster

In the Study Area there are 8 flood watch stations. Among them five and one stations were newly established in the Ourika and Rheraya River Basins respectively after the 1995 flood. These stations are equipped with a VHF/FM and/or a HF/SSB radiotelephone to report flood information to DRHT (ABHT). Fig.4.1 shows locations of the flood watch stations.

Flood Watch Stations in the Study Area

Station	River Basin	Catchment Area (km^2)	Observation Item	Telecommunication Measures
Aghbalau	Ourika	503	WL, R	T, H, V
Tazzitount	Ourika	347	WL, R	V
Tuorcht	Ourika	19	WL, R	V
Amenzal	Ourika	49	WL, R	V
Tiourdiou	Ourika	134	WL, R	H, V
Agouns	Ourika	-	R	H, V
Aremd	Rheraya	35	WL, R	V
I. N'kouris	N'fiss	848	WL, R	H

Observation Item; WL: Water Level, R: Rainfall
Telecommunication Measure; H: HF/SSB Radiotelephone, V: VHF/FM Radiotelephone
T: Telephone

4.4 Problems of Existing FFWS

In spite of the above efforts, the system was still a long way off a desired level. Problems of the FFWS before the implementation of the Pilot Project are extracted and summarized in the following table.

Problems of Existing FFWS for Study Area

Subsystem		Problems	Related Organization
Hydrological Observation and Information Collection	Observation	• Insufficient number and inappropriate deployment of rainfall and water level stations • Difficulties of manual observation of rainfall and water level • Improper equipment for water level measuring	DRHT
	Data transmission	• Inevitable verbal communication errors • Necessity of renovation and reinforcement of the relay station	DRHT
	Information collection	• Necessity of enhancement of accuracy of weather forecasting	DRHT,DMN
Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information/Notices	Data Analysis	• Poor data analyses • No consideration on debris flows	DRHT
	Forecasting	• No scientific forecasting • Scarcity of rainfall records for establishment of flood forecasting model • No consideration on debris flows	DRHT
	Announcement of Flood Notices	• No criteria for announcement of flood notices • No consideration on debris flows	DRHT
	Distribution of Flood Information/ Notices	• No visualized information • Inevitable verbal communication errors	DRHT/DPE
Issuance of Warning		• No criteria for issuance of warning • No consideration on debris flows	Province/ Prefecture
Dissemination of Warnings		• Inevitable verbal communication errors • Insufficient telecommunication measures • Language gaps between inhabitants and tourists • No alarm equipment such as a siren and a speaker	Province/ Prefecture and Lower Local Authorities
Evacuation	Facilities	• Insufficient evacuation and parking spaces	DPE, Province/ Prefecture, and DRT
	Operation	• Language gaps between inhabitants and tourists • No designation of evacuation places • No organization for assistance to tourists	Province/ Prefecture and DRT

5. Preparation of Draft Master Plan

5.1 Introduction

Following the close examination of the existing system before the implementation of the Pilot Project in the previous chapter, a draft Master Plan is once formulated in this chapter, which is to be modified and improved after the implementation of the Pilot Project.

5.1.1 Basic Conditions of Master Plan Formulation

The target completion year of the master plan is set up in 2009, assuming that the implementation of the Master Plan starts in 2005 and takes 5 years for the completion.

In the Atlas Region the most serious flood was the one in 1995, which started this Study in a certain sense. The FFWS Master Plan is to be formulated to cope with the flood conditions of the 1995 flood as the target flood. Systems are designed to meet the exceptional flood.

5.1.2 Selection of Target Areas for FFWS

Innumerable douars, roads along the rivers and tourist spots are exposed to rain-induced disasters such as river flood, debris flow, landslide and slope failure due to its topographical, geological and meteorological conditions. It is far impossible to protect all of them. Therefore, prioritization is inevitable to maximize the benefits from the Master Plan by investing more to high risk areas. In other words, the FFWS proposed in this Study will target such high risk areas alone. For low risk areas, other low cost or cost-free measures depending on inhabitants' voluntary activities should be conceived.

The classification of high and low risk areas must be based on a comprehensive examination on damage potential and past disasters. As the FFWS aims to save human lives, dead casualties in the past disasters and expected damage potentials including loss of human lives are allowed to be main indicators for selection of high risk areas. The selected high risk areas are shown in Fig.5.1.

Selected High Risk Areas

Province /Prefecture	River Basin	Area	Type of Disaster	Targets to be protected	Causalities in Past Floods
Al Haouz	R'dat	Tazlida Tributary	Debris flow	Village	3 dead in '95
	Zat	Tiferent Douar	Debris flow	Village	11 dead in '95
	Ourika	Tiguemmi-n-Oumzil et Tnite	River Flood	Village	A bridge and a village is exposed.
		Aghbalau	River Flood & Debris flow	Tourists, Village	13 dead in '95, Tourist Spot
		Iraghf	River Flood & Debris flow	Tourists, Village	180 dead in '95, Tourist Spot
		Tazzitount	River Flood & Debris flow	Tourists, Village	10 dead in '95, Tourist Spot
		El Kri	River Flood & Debris flow	Tourists, Village	2 dead in '95, Tourist Spot
		Setti Fadma	River Flood & Debris flow	Tourists, Village	8 dead in '95, Tourist Spot
	Rheraya	R'ha Mouley Brahim	River Flood	Tourists, Village	5 dead in '95, Tourist Spot
		Asni Market	River Flood	Market, Shopping Customers	Saturday Market
		Imlil	Debris Flow	Village, Tourists	2 dead in '95, Tourist Spot
	N'fis	T. N. Yakoub	River Flood	Urban Area	1 injured in '95
		Tizgui	Debris Flow	Village	6 dead in '95
		Targua	Debris Flow	Village	1 dead in '95
SYB. Ali	Issyl	Municipality of Sidi Youssef Ben Ali	River Flood	Urban Area	Many dead in '56
		Guannoune Douar	River Flood	Village	

5.2 Major Points of Improvement

5.2.1 Hydrological Observation and Data Collection

(1) Addition of Flood Watch Stations

There are generally two directions towards improvement of the present flood watch system. The first one is extension of the covering area, which will be attained by adding flood watch stations. The second one is modernization of equipment including automation by introduction of a telemetry system. A deployment plan comprised of 8 existing and 12 new stations is tentatively proposed as below (refer to Fig.5.1 and Table 5.1):

Deployment Plan of Flood Watch Stations

River Basin	Number of Rainfall Station			Number of Water Level Station		
	Existing	New	Total	Existing	New	Total
R'dat	0	1*	1*	0	0	0
Zat	0	1*	1*	0	0	0
Ourika	6 (5)	5** (1)	11** (6)	5 (5)	1 (1)	6 (6)
Rheraya	1 (1)	2** (1)	2** (2)	1 (1)	1 (1)	2 (2)
N'fis	1 (1)	3 (2)	4 (3)	1 (1)	2 (2)	3 (3)
Issyl	0	2 (1)	2 (1)	0	1 (1)	1 (1)
Total	8 (7)	12 (5)	20 (12)	7 (7)	5 (5)	12 (12)

Note: Number in parentheses is number of stations equipped with both rainfall and water level gauges.
* : The Gdrar Guedronz Station is located on the boundary of the R'dat and Zat River Basins, and counted for the two basins.
**: The Oukaimeden Station is located on the boundary of the Ourika and Rheraya River Basins, and counted for the two basins.

(2) Information Collection Exchange with DMN

DMN, DPE, AL Haouz Province and DREF have their own observation networks, telecommunication measures and/or technology and equipment for data analyses. These organizations could provide to DRHT useful information on weather, rainfall, river condition and disasters that helps DRHT forecast a river flood and debris flow very much. In this master plan study, inter-organization collaboration with these organizations is strongly proposed to maximize utilization of information available among them in a mutual manner.

In particular, DMN is an only organization that is responsible for weather forecasting in the kingdom. The organization has many technical staff, sophisticated equipment and software, and information from this organization is very precious for the FFWS in the Study Area too. In this context, collaboration with DMN should be strengthened to collect more information including radar pictures and satellite pictures. In return DRHT can provide their real-time hydrological data that must be valuable to DMN too.

DMN has a plan to install new precipitation radar near Marrakech. With this radar, the blind area of the existing radar network will be eliminated greatly especially for the High Atlas and the accuracy of the weather forecast will be greatly improved for the Altas Region. It is recommended that the radar information be transmitted to DRHT.

5.2.2 Data Analysis, Forecasting and Distribution of Flood Information/Notice

According to the ME guideline, DRHT is to make hydraulic and hydrological analyses to interpret rainfall and water level data, and then to distribute flood information/notices to related organizations. This subsystem of the present FFWS still remains primitive, and no scientific analysis other than conversion from water level to discharge has been done. Thus, upgrading of this subsystem is of first priority and includes the following functions:

- Data analysis, which includes data processing, data storage and visualization of processed data;
- Flood forecasting applying real-time forecasting model in combination with US SCS Method and Muskingum Method. As for the debris flow forecasting, based on experimental relation between rainfall intensity-accumulated rainfall and threshold curve for possible occurrence of debris flow;
- Preparation of Flood Notices to show the level of flood risks, based on the guideline provided; and
- Distribution of flood information and Flood Notice to agencies concerned.

5.2.3 Issuance of Flood Warning

The governor of the province/prefecture is responsible for security of inhabitants and tourists in the jurisdiction in a manner of issuance of flood warning for evacuation, based on collected information including the Flood Notices from DRHT. To assist the governor to judge issuance of warnings promptly, guidelines are proposed in the Master Plan Study.

5.2.4 Dissemination of Flood Warning

Flood warnings must be promptly disseminated to inhabitants and tourists in potential dangerous areas through the local authorities in the order of Celcles, Caidats, Macherkhas, Douars in principle, but sometimes it may be short-cut depending on the risk level.

One of the most serious problems is the lacking of telecommunication measures for the most important recipients, namely inhabitants and tourists whom a disaster is threatening. An appropriate communication measure including a voice amplifier with a loudspeaker (Warning Post) to diffuse a warning to inhabitants and tourists must be introduced to the selected high risk areas as shown in Fig.5.5.

5.2.5 Evacuation

To facilitate execution of safe and prompt evacuation, guidelines are proposed for preparing of an evacuation plan including evacuation places and routes and so on.

5.3 Alternative Study on System Configuration

An alternative study on system configuration for each of the hydrological observation and data collection subsystem, the data analysis, forecasting and distribution subsystem and the warning dissemination subsystem was made.

5.3.1 Three Alternatives

Three different development levels are considered for every subsystem: namely Option-A is a manual system, Option-B is a semi-automatic system and Option-C is a fully automatic system. In this Study, to facilitate the selection of optimum one, three typical alternatives are set up as presented in Table 5.2 and summarized as follows:

- Alternative-A: Manual System (a combination of the three Option-As)
- Alternative-B: Semi-Automatic System (a combination of the three Option-Bs)
- Alternative-C: Fully Automatic System (a combination of the three Option-Cs)

The three alternatives are compared as follows:

Comparison of Three Alternatives

Alternative	Equipment Cost (Million DH)	Accuracy	Necessary Time for Total Operation*
Alternative-A	5.7	Low	1.5 to 6 hours
Alternative-B	34.3	Medium	50 min.
Alternative-C	47.7	High	30 min.

* Necessary time for total operation from observation to evacuation (refer to Table 5.3)

5.3.2 Selection of Optimum System for the Master Plan

Since disasters in the Study Area accompany loss of human lives as experienced in 1995, the necessity of the improvement of the FFWS is clear. In this Study, it is proposed from the following reasons that the Alternative-C (fully automatic system) be applied for the Master Plan:

- Introduction of an automatic system is the strategy of the action plan of DGH. In practice, automatic systems have been and will be applied in the other river basins such as Ouergha and

Sous/Massa. Judging from these situations, introduction of an automatic system is in the same direction as the modernization of hydrological observation that DGH is promoting.

- The Aternative-A based on manual operation is not preferable because of its long necessary time for the system operation.
- There is not a big gap in cost between the Alternatives-B and C, while a considerable gap in accuracy and necessary time for system operation is seen between them. Especially, the necessary time can be shorten by as much as 20 minutes, which is significant for the FFWS in this mountainous area.
- The project evaluation reveals that the Alternative-C is evaluated to be generally viable in terms of economical effectiveness, financial affordability, social and technical acceptability, and environmental impacts. An EIRR of 14.2% is estimated if loss of human lives is considered.

5.4 Outline of the Master Plan

In this Study, the Master Plan of the Atlas Region FFWS, which is a total system composed of five subsystems extending from hydrological observation and data collection to evacuation, is formulated. The outline of the Master Plan is as follows:

5.4.1 Hydrological Observation and Data Collection

The Atlas Region FFWS Plan has 20 flood watch stations. 12 stations have both a rainfall gauge and a water level gauge, and the remaining 8 stations are rainfall stations that observe rainfall only.

All the flood watch stations are equipped with an automatic telemeter system that enables automatic measurement of rainfall and water level and real-time data transmission to DRHT (ABHT). Usually the measurement and data transmission are made every an hour. Once rainfall of more than 1 mm is detected at any station, the interval of the measurement and transmission is changed into 10 minutes not to miss a sudden growth of the rainfall. A list of the flood watch stations is given in Table 5.1 and their locations and the radio network are presented in Figs.5.1 and 5.2.

5.4.2 Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information/Notices

The collected hydrological data are processed and analyzed in DRHT (ABHT) which plays a role of a master information center of the FFWS in the Study Area. Forecasting of a river flood and a debris flow is also made by DRHT. Based on the analysis and forecasting, DRHT is to announce Flood Notices. The Flood Notices and processed flood information are distributed to related organizations through the Internet, public telephone, fax, and/or VHF radiotelephone. Fig. 5.3 presents communication networks among related organizations involved in the FFWS, and Fig. 5.4 gives a schematic diagram of the computer network among DRHT (the Master Information Center) and its monitoring stations.

Definition of Flood Notices

Type of Disaster	Flood Notice	Definition
River Flood	Pre-River Flood Notice	This notice is to notify related organizations that rainfall and/or discharge has exceeded the Pre-Alert Level and situation is expected to further worsen.
	River Flood Notice	This notice is to notify related organization that rainfall and/or discharge has exceeded the Alert Level and situation is expected to further worsen.
	Cancellation of River Flood Notice(s)	This notice is to notify related organizations that rainfall and/or discharge has decreased below the Pre-Alert Level and the situation has became normal.
Debris Flow	Pre-Debris Flow Notice	This notice is to notify related organizations that rainfall has exceeded the Pre-Alert Level and situation is expected to further worsen.
	Debris Flow Notice	This notice is to notify related organizations that rainfall has exceeded the Alert Level and situation is expected to further worsen.
	Cancellation of Debris Flow Notice(s)	This notice is to notify related organizations that rainfall has decreased below the Pre-Alert Level and the situation has became normal.

Recipients of Flood Notice

Classification	Recipient
Local Authorities	Relevant Province/Prefecture, Cercles and Caidats
Other Related Organizations	DGH, Relevant DPE, ONEP, ONE, ORMVAH,DMN

5.4.3 Issuance of Flood Warnings

The governor of the Province/Prefecture is to issue Flood Warnings that directly call for caution and evacuation of inhabitants and tourists in the high risk areas, based on the Flood Notices announced by DRHT and other information. Definitions of the Flood Warnings are given as follows:

Definition of Flood Warnings

Flood Warning	Definition
River Flood Caution	This warning is to warn personnel of related organizations, inhabitants and tourists that a flood is expected.
Debris Flow Caution	This warning is to warn personnel of related organizations, inhabitants and tourists that debris flows are expected.
Evacuation Advice	This warning is to advice inhabitants and tourists to evacuate to designated places immediately.
Cancellation of Flood Warning(s)	This warning is to notice personnel of related organizations, inhabitants and tourists that the flood warning(s) has/have been cancelled.

5.4.4 Dissemination of Flood Warnings

The Flood Warnings are disseminated from the Province/Prefecture to warning posts and related organizations as shown in Fig. 5.3.

Recipients of Flood Warning

Classification	Communication Measure	Recipients
Warning Post	Warning Broadcasting System	Inhabitants and tourists
Local Authorities	Telephone, Fax, VHF Radiotelephone	Relevant Cercles, Caidats
Other Related Government Organization	Telephone, Fax	Royal Mounted Police, Civil Protection, Ministry of Interior, and other organizations involved in ORSEC Plan
Broadcasting Mass Media	Telephone, Fax	Mass Media (TV and Radio)
Tourism Related Industries (hotels, restaurants, etc.)	Telephone, Fax	Managers and Employees, then Tourists

The Atlas Region FFWS Plan has a total of 17 warning posts as shown in Fig. 5.5. These posts are provided with warning broadcasting equipment and communication equipment. Live or recorded warning messages are directly broadcast under the remote control of the Province/Prefecture. Fig. 5.6 gives a schematic diagram of the warning dissemination network.

5.4.5 Evacuation

Evacuation must be made appropriately and promptly in accordance with an evacuation plan that is to be prepared for every high risk area. The evacuation plan must contain 1)Evacuation organization, 2)Operation of warning post, 3) Evacuation places and routes, 4)Stock of materials and equipment, 5)Diffusion of warning messages, 6)Guidance of evacuees, 7)Guidance of tourists, 8)Evacuation drill, 9)Public relations, 10)Evaluation of evacuation activities and updating of evacuation plan.

5.5 Implementation Plan and Cost Estimate

5.5.1 Implementation Plan

Taking into account the urgent necessity of the full Master Plan, it is proposed that the remaining works be implemented continuously after the Pilot Project. The Master Plan is completed in 2009.

5.5.2 Cost Estimate

The project cost and the maintenance cost for the whole Master Plan including the Pilot Project is approximated as follows:

Project Cost and Maintenance of Draft Master Plan

Cost Item		Amount (1,000 Dh)
A.	Construction Cost	**60,516**
	(1)Equipment Cost	47,747
	(2)Installation and Commissioning Cost	6,384
	(3)Civil Construction Work Cost	4,386
	(4)Software Development Cost	1,000
	(5)Technical Training Cost	1,000
B.	Engineering Services Cost	**15,000**
C.	Physical Contingency (10% of (A+B))	**7,552**
D.	Project Cost (A+B+C)	**83,068**
E.	Annual Operation and Maintenance Cost	**2,387**

5.6 Project Evaluation

The proposed FFWS Master Plan is evaluated comprehensively. In conclusion, the FFWS Plan is generally viable in terms of economical effectiveness, financial affordability, social and technical acceptability, and environmental impacts, as follows:

5.6.1 Economic Evaluation and Financial Consideration

(1) Economic Evaluation

A part of this Master Plan is to be implemented as a pilot Project under this Study. Almost all the implementation cost of the Pilot Project is to be borne by JICA. Therefore, the remaining cost of Dh 60 million that is obtained by subtracting the cost of the Pilot Project of Dh 23 million from the total project cost of Dh 83 million is used for this cost-benefit analysis.

For the economic evaluation, Economic Internal Rate of Return (EIRR), Benefit-cost ratio (B/C) and Net Present Value (NPV) were calculated for the benefit considering only movable assets such as household effect, cash, livestock, vehicles and so on. EIRR cannot be calculated numerically because the benefit is too small comparing with the construction cost and O&M cost. As long as the above results, it may not be feasible for movable assets only.

As a reference, economic evaluation is examined for the benefit including human lives in addition to the movable assets. The value of a life is estimated by referring to figures used in cost-benefit analyses in USA. The results are shown in the following table.

EIRR, B/C and NPV

Item	Movable Assets only	Human Life included
EIRR	Negative	14.2%
B/C	0.07	1.4
NPV	-Dh 60 million	Dh 25 million

As noticed from the table, the project can be feasible, if the value of a human life is appreciated in the monetary term. Although it is very difficult to evaluate the human life in the monetary term properly, it is considered to include a human life to evaluate the project from the economic aspect, and, under such a condition, it is expected that the project will be feasible from the economic aspect.

(2) Financial Considerations

Since securing O&M budget is very important for sustainability of the project and local authorities are responsible for O&M, affordability of O&M cost by local authorities are discussed here. According to the technical consideration, the annual O&M cost is estimated at 5% of the equipment cost. Annual additional burdens are Dh 1,502,000 on DRHT (ABHT), Dh 722,000 on Al Haouz Province and Dh 163,000 on SYBA Prefecture.

Concerning DRHT, the annual O&M cost exceeds its hydrology-related budget (about Dh 700,000). It is required that DGH increase the budget allocation to DRHT for the proper operation of the new FFWS. Since the hydrology-related operating budget, amounts to Dh 11.2 million in 2000/01, the amount necessary to increase for DRHT is 13% of this budget. Although, the amount is not small, it is expected that DGH manages to increase budget allocation to DRHT, taking it into consideration that improvement of FFWS is promoted as a part of the national strategy by the Ministry of Equipment, and FFWS modernization has already been promoted in other regions.

Concerning Al Haouz Province, annual cost for O&M amounts to 3.9% of its total budget or 22% of its operating budget in 1999/00. The O&M cost is not small either in this case. It is also expected, however, that the Ministry of Interior manages to expand the subsidy to Al Haouz Province for keeping the O&M of the equipment because local collectivities are responsible for protecting people from disaster and it is one of the most important functions for them.

5.6.2 Consideration of Social Aspect

As the Master Plan is intended to outline a comprehensive task oriented approach to the regional development, it will certainly help improve the present situation for public interest. The plan should be socially acceptable and mutually understandable between the proponent and residents/stakeholders. Therefore, public opinion and people's reactions to the plan have been fully examined in the social study and as a result, there seems to be neither controversial issue nor negative observation.

5.6.3 Initial Environmental Evaluation Process

The potential environmental impacts as determined from the screening and scooping process are summarized in Table 5.4.

Due to the small scale of the project facilities and the procedures in place that must be followed before project implementation it is considered not necessary to make an environmental impact assessment study.

5.6.4 Technical Acceptability

To ensure sustainable operation of the Master Plan, breakdowns of equipment and systems should be in principle repaired by their suppliers under a maintenance contract. However, a certain level of technical capacity, which enables emergent operation during a flood and daily maintenance of equipment at least, is required for every execution organization in the FFWS Master Plan. In conclusion, the proposed Master Plan will be technically accepted through training programs, experimental operations, operation drills and the Pilot Project.

6. Planning and Design of Pilot Project

6.1. Planning of Pilot Project

A part of the draft Master Plan proposed in the previous chapter is implemented in three years between 2001 and 2003 as the Pilot Project. This Pilot Project aims to examine the adequacy of the draft Master Plan through the experimental operation of installed equipment and systems for a certain period.

6.1.1 Selection of Project Basin

The Ourika River Basin is selected among the six river basins as the objective river basin for the Pilot Project in consideration of being typical basin of the Study Area, utilization of existing facilities, data availability and urgency of introduction of FFWS.

6.1.2 Determination of Development Level

In order to avoid double investments in future, the Pilot Project should be implemented in the framework of the Master Plan. Therefore, the Pilot Project could be something intermediate in quantity and/or quality between the existing condition and the Master Plan.

Four alternatives of different development levels for the Pilot Project were conceived between the existing conditions and the Master Plan. Consequently the third developed alternative that includes introduction of an automatic telemetry system was selected within the budgetary and time limit of this Study. The illustration of Fig.6.1 compares the Pilot Project with the existing system.

6.2 Description of Pilot Project

6.2.1 General Description of Pilot Project

(1) Components of Pilot Project

The Pilot Project, illustrated in the front page, covers all the five principal subsystems as a total FFWS and aims to improve the existing system in the Ourika River Basin to some extent as follows:

Constitution of Pilot Project

Subsystem	Phase I (Completed in December 2001)	Phase II (Completed in July 2003)
Hydrological Observation and Data Collection	Automation of hydrological observation at 5 flood watch stations (Provision of automatic tipping-bucket rain gauges and ultra sonic water level gauges)	Automation of data transmission (Provision of VHF radio data transmission system with 2 repeater stations)
Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information	Establishment of Master Information Center at DRHT and Monitoring Stations at DGH, DPE Al Haouz, Al Haouz Province and	Upgrading of data processing system along with introduction of the telemetry system.
Issuance of Flood Warning	Preparation of Guidelines and Experimental Operation	
Dissemination of Flood Warning	Establishment of Iraghf Warning Post	Provision of selective call system among Iraghf Warning Post, Al Haouz Province and Ourika Caidat.
Execution of Evacuation	Preparation of Guidelines	

(2) Procurement of Equipment

Equipment for the Pilot Project are purchased in Japan by JICA under the scheme of "JICA Development Study", and then are shipped to Morocco.

(3) Implementation Schedule of Pilot Project

The Pilot Project is implemented step-wisely to ensure enough time for the Moroccan counterparts to get used to new Japanese equipment and system. The first phase is installed in October and November 2001, and the second phase is installed in June and July 2003, as presented in Table 6.1.

6.2.2 Description of Pilot Project by Subsystem

(1) Hydrological Observation and Data Collection

The five flood watch stations are upgraded step-wisely in the first year 2001 by introducing automatic gauging sensors, and in the second year 2003 by introducing a VHF radio automatic data transmission system, to complete a telemetry system. Based on the radio propagation test, a radial network was applied for the VHF radio telemetry as shown in Fig.6.2 in place of the tandem type network proposed in the Master Plan.

Fig.6.3 presents a conceptual diagram of the Pilot Project, Fig.6.4 block diagrams of equipment for the five flood watch stations and Fig.6.5 block diagrams of equipment for the two repeater stations of Adrar Tazaina and Apulouss.

(2) Data Analysis, Forecasting, Announcement of Flood Notices and Distribution of Flood Information

Rainfall and water level data are collected from the flood watch stations to DRHT (ABHT) through the existing VHF radiotelephone network in the first phase of the Pilot Project, and then an automatic data transmission system (telemetry system) is introduced in the second phase. A data processing system that processes the raw hydrological data into visualized information, is established in DRHT. For information sharing, the data processing system will be accessed through telephone lines by the four related organizations, DGH in Rabat, DPE Al Haouz, Al Haouz Province and the Ourika Caidat. A flood forecasting program composed of the SCS Method and the Maskingum Method is also developed in the first phase. Fig.6.6 presents the configuration of equipment for the Master Information Center.

(3) Issuance of Warnings

The procedure of warning issuance that was proposed in the Master Plan is operated experimentally for the Ourika Valley in the Pilot Project period. In the procedure Flood Warnings are issued by the governor of Al Haouz Province mainly based on Flood Notices announced by DRHT (ABHT)

(4) Dissemination of Warnings

A warning post is newly created at a tourist spot on the Ourika River, Iraghf (Oulmes). This warning post consists of a VHF radiotelephone, a voice amplifier and two sets of loudspeakers. The radiotelephone and the amplifier are installed at in a house newly built by DRHT. Each set of loudspeakers connected with the amplifier by a cable is installed at the top of a pole built along the river, about 600 m away from the other.

The VHF radio telephone is connected to the existing network of the Province. In the second phase of the Pilot Project, a selective call system is added to the radio telephone of the warning post. A new radiotelephone with the selective call system is also newly installed at each of Ourika Caidat and the Province in the second phase, to enable closed communication among the three.

Fig.6.7 presents block diagrams of equipment for the Iraghf Warning Post, the Al Haouz Province Monitoring Station and the Ourika Caidat Monitoring Station.

(5) Evacuation

Guidelines of evacuation activities are prepared for the Iraghf area where a warning post is installed. Some evacuation drills are also executed there.

7. Implementation and Operation of Pilot Project

The Pilot Project, which is a part of the draft master plan as tentatively proposed in Chapter 5, was implemented in the Ourika River Basin in two phases. The first phase system that can be regarded as a semi-automatic system because of its automatic hydrological observation system was installed in December 2001. About 1.5 years after the first installation was spent for experimental operation of the semi-automatic system, and then in July 2003 the Pilot Project was completed as an automatic telemetry system by adding a VHF data transmission system to the semi-automatic system.

7.1 Pilot Project Phase I

7.1.1 Implementation Work

(1) Construction Work

A water level gauge equipment house was constructed by a local contractor at the Amenzal and Tiourdiou flood watch stations. It is noted that DRHT (ABHT) also built a warning post house at Iraghf and a station house at Agouns as their undertakings for the Pilot Project.

(2) Installation of Equipment

The installation work was done by a local agent under the supervision of three Japanese engineers of Japan Radio Co., Ltd., the supplier of the equipment and materials. The local agent and the Japanese engineers formed three teams. Each team was composed of a Japanese engineer as a chief, two or three employees of the local company and a DRHT technician as an OJT (On the Job Trainee).

(3) Development of Flood Forecasting Program

A flood forecasting program based on the USSCS Method and Muskingum Method was developed and installed in the client personal computer by a local consultant company under the supervision of the Study Team.

7.1.2 Preparation of Guidelines

Following the installation work, organizations concerned commenced an experimental operation gradually with the newly provided equipment. To assist the organizations to operate the total system more systematically, new guidelines were proposed by slightly but concretely remaking those for the draft Master Plan. The new guidelines target river floods in the Iraghf area where a warning post was installed.

(1) Determination of Pre-Alert and Alert Levels of Rainfall and Water Level

Pre-Alert and Alert Levels of rainfall and water level are regarded as indicators of seriousness of the flood situation. According to the definitions of the Flood Notices, the Alert Level is considered the minimum level that might cause flood damages including loss of human lives while the Pre-alert Level is considered the minimum level in which a symptom of the growing flood can be narrowly recognized.

The flow capacity around the Iraghf area is as small as 160 m3/s, corresponding to 3 years of return period. This 3-year return period is applied for the Alert Levels of rainfall and water level at the five stations. Values at the Pre-Alert Level are tentatively proposed at around 25 % of those for the Alert Level.

(2) Dissemination Routes of DMN Messages and Flood Notices and Flood Warnings

Through discussions with the organizations concerned, dissemination routes of DMN Massage, Flood Notices by DRHT (ABHT) and Flood Warnings by the Province were determined as shown in Figs. 7.1 and 7.2.

7.1.3 Simulation Drill

A variety of technical transfer programs have been carried out during and after the installation work, so that personnel concerned could operate the installed system by themselves as soon as possible. The most important program in this phase was the global FFWS simulation drill conducted on 25 June 2002 with participation of some 140 inhabitants and tourists at Iraghf in the Ourika Valley, and all the organizations concerned. The result was acceptable. The total time for all the procedures from data collection to completion of the evacuation was reduced to about 20 minutes, less than 30 minutes of the target time for the draft Master plan, after the two test drills. The results of the simulation drills are given as follows:

Summary of Consumed Time
Until Receipt of Messages by Warning Post

Simulation Drill	Date	DMN Alert	Pre Flood Notice/ Flood Caution	Flood Notice/ Evacuation Advice	Cancellation
1st Test Simulation Drill	19 June 2002	70	76	65*	45*
2nd Test Simulation Drill	21 June 2002	7	15	18	13
Global Simulation Drill	25 June 2002	13	18	15	15

* : Consumed time until the receipt of the message by Ourika Caidat (Since the radiotelephone of the warning became out of order, the Evacuation Advice and Cancellation messages could not be transmitted to the warning post.

Summary Result of Evacuation Drill on 25 June 2002

Activities	Item		Group 1	Group 2	Group 3	Total
Gathering at Meeting Point after Broadcasting of Flood Caution	Number of Participants	Inhabitants	34	50	45	129
		Tourists	1	5	7	13
		Total	35	55	52	142
	Consumed Time (minutes)		1	5	1	N/a
Evacuating from Meeting Point to Evacuation Place after Broadcasting of Evacuation Advice	Number of Participants	Inhabitants	20	50	34	104
		Tourists	3	5	4	12
		Total	23	55	38	116
	Consumed Time (minutes)		2	3	2	N/a
Returning to Meeting Point and Resolution Broadcasting of Cancellation	Number of Participants	Inhabitants	20	40	34	94
		Tourists	3	5	4	12
		Total	23	45	38	106
	Consumed Time (minutes)		6	4	3	N/a

7.1.4 Actual Operation during 14 June 2003 Flood

In the afternoon of Saturday, 14 June 2003, a small flood took place in the Ourika River Basin. Fortunately dead nor injured casualties have been reported although flood water mixed with debris from the Tarzaza Tributary choked the bridge of the Road P2017 and undermined a mosque beside the bridge. The traffic was cut at the bridge about 5 hours.

Tarzaza Tributary: The mosque was undermined by the flood water. (taken on 19 July 2003)

The flood was the first flood after the completion of the Pilot Project Phase-I in December 2001. It is generally concluded that the conventional system of the Province worked very well but the other important part, ABHT could not play a role as a flood information provider due to its organizational problems. There was no one in the radio room of ABHT around 1530 hours when the Agbhalau Station called ABHT to inform the occurrence of the flood. It was after 1700 hours that ABHT was informed of the flood by the flood watch stations and contacted at last the province, who had known the flood already.

7.2 Pilot Project Phase II

7.2.1 Implementation Work

(1) Construction Work

A repeater station house was built on the mountain tops of Adrar Tazaina and Aoulouss, respectively by a local contractor under the supervision of the Study Team.

(2) Installation of Equipment

As practiced in the first phase, the installation of equipment was carried out jointly by Japanese engineers dispatched from Japan Radio Co., Ltd., the supplier of the equipment, employees from a Moroccan installation company and ABHT technicians as OJTs.

A special attention was paid to the grounding work for the two repeater stations located on the high mountain tops that are exposed to frequent lightning. As a result of hard excavation works of the rocky ground, the earth resistance less than 50 Ω was obtained. For the VHF radio telemetry network, 70.325 MHz and 72.325 MHz radio frequencies that were officially given to DGH by ANRT have been used. Since the two frequencies are fortunately the same as those used in the radio propagation test in June 2001, the test results could be utilized fully for the installation.

One of the most practical equipment in the second phase is an alarm indicator that was fixed on the wall of the landing of the stairs of ABHT. This alarm indicator that is connected to the radio equipment and the data processing server of the Master Information Center can sound three different alarms according to the food situation.

Upgrading of the radiotelephone network for the warning dissemination was also achieved in this phase. A new radiotelephone with a 5-tone selective call system was installed at the Province and Ourika Caidat. The same selective call system was added to the radiotelephone installed at the warning post in the first phase.

7.2.2 Radio Interference Problems

During the installation work two major interference waves were unexpectedly detected, though no interference had been observed during the radio propagation test in 2001. The interferences were so frequent and strong that they nearly killed the normal operation of the telemetry network. On Monday, 1 July 2003, almost half of data via the Aoulouss Repeater Station were lost due to the interferences.

According to a preliminary investigation by the Study Team, the two interferences seem to be caused by a phenomenon called “Abnormal Long Distance Propagation”. This phenomenon can be accidentally caused in summer by the unstable Sporadic-E ionosphere and/or pipe-shaped atmosphere formed by constant high temperature.

The Study Team officially requested an investigation by ANRT through DGH at the beginning of July 2003. In the meantime the Study Team decided under consultation with ABHT, DGH, ANRT and JICA to exchange the frequencies between the receivers and the transmitters of all the stations because the Team could not wait for the investigation of ANRT. The exchange work was made successfully between 15 and 18 July 2003.

7.2.3 Technical Transfer

A variety of technical transfer programs have been carried out during and after the installation work, especially on the telemetry system that were totally new to ABHT.

A global simulation drill was also conducted on Tuesday, 26 August 2003 using the completed Pilot Project system. The drill procedure is almost the same as the one on 25 June 2002 under the Pilot Project Phase-I, except that ABHT did not have to collect hydrological data from the flood watch stations by radiotelephone because the completed telemetry system collects them automatically.

Although about 10 minutes was wasted in the transmission of the Flood Notice from ABHT to the Province due to a congestion of the fax machine of the Province, the simulation drill was, on the whole, successful. The evacuation advice message could be broadcast at Iraght Warning Post about 17 minutes after the flood situation reached the alert level. Listening the evacuation message, some 80 voluntary participants moved smoothly to the predefined evacuation places.

The results of the simulation drill are tabulated in the following tables, where those of the drill in 2002 are also given together for comparison.

Consumed Time in Message Transmission

(minutes)

Procedure	Date	Pre Flood Notice/ Flood Caution	Flood Notice/ Evacuation Advice	Cancellation
Announcement of Flood Notice by ABHT (Data collection, Decision making and Preparation of Message)	26 Aug. 2003	5	5	3
	25 June 2002	10	10	12
Distribution of Flood Notice Message by fax or telephone from ABHT to Province	26 Aug. 2003	2	9*	6*
	25 June 2002	1	3	1
Issuance of Flood Warning by Province (Decision-making)	26 Aug. 2003	0.5	0.5	0.5
	25 June 2002	6	1	1
Dissemination from Province to Warning Post	26 Aug. 2003	0.5	0.5	0.5
	25 June 2002	1	1	1
Total	26 Aug. 2003	8	15	10
	25 June 2002	18	15	15

* : Message was sent by telephone alternatively.

Summary Result of Evacuation Drills

Activities	Item		26 August 2003			25 June 2002
			Group 1	Group 2	Total	
Gathering at Meeting Point after Broadcasting of Flood Caution	Number of Participants	Inhabitants	58 (1)	25 (0)	83 (1)	129
		Tourists	0	1 (0)	1 (0)	13
		Total	58 (1)	26 (0)	84 (1)	142
	Consumed Time (minutes)		5	7	N/a	5
Evacuating from Meeting Point to Evacuation Place after Broadcasting of Evacuation Advice	Number of Participants	Inhabitants	50 (0)	8 (0)	58 (0)	104
		Tourists	0	2 (0)	2 (0)	12
		Total	50 (0)	10 (0)	60 (0)	116
	Consumed Time (minutes)		3	5	N/a	3

Note: Number in parentheses is the number of women.
Consumed time in the 2002 drill is the maximum time of the three groups.

7.2.4 Actual Operation During 4 August 2003 Storm

The telemetry system was handed over to ABHT practically on Monday, 4 August 2003. In the evening of that day, an exceptional heavy rainfall happened in the Ourika Valley. As experienced in the past floods, the road was cut by debris at almost every tributary. About a hundred cars were trapped by the debris between Iraghf and Imintadart on their ways for escaping from the valley. The passengers were forced to spend the night in their cars until DPE cleared the road the next day. It was a miracle that these debris disasters generated no dead and injured although a parked car was crushed by rocks and several houses were intruded by mud.

The full automatic telemetry system was revolutionary. The new system alarmed ABHT, who could inform the Province of the occurrence of the intensive rainfall within 10 minutes after the rainfall exceeded the alert level, although lightening interfered the data transmission just before the commencement of the rainfall. According to an ABHT technician, ABHT could for the first time inform the occurrence of the heavy rainfall to the Province earlier than the local authorities that used to inform earlier than ABHT.

Since the radiotelephone of the warning post was not operational due to a problem of the repeater station at Sidi Boatmane, direction and information from the Provincer to the warning post was delayed. The guardian of the warning post was at a loss what to do when some inhabitants crowded to the post calling for explanations on the situations. It was about 30 minutes after the Province was informed by ABHT, when most of the tourists and inhabitants had completed evacuation already, that the guardian broadcast the warning cancellation message tape, directed by the Khalifa, the substitute of the Caidat.

There is in Iraghf a café owner who happened to see debris flow just beside his café. According to him, the debris flow took place about only 15 minutes after it began to rain. This information is very precious for understanding the astonishing speed of debris flows that hardly allow enough time for the FFWS operation.

7.3 Maintenance of Equipment

In late November 2001 representatives of the two principal organizations for the Pilot Project, namely the director of DRHT (ABHT) and the governor of Al Haouz Province had a discussion on the operation and maintenance of the project at the presence of the Study Team, and agreed verbally in principle as follows:

- Each organization is responsible for operation and daily maintenance of equipment and facilities that have been built and installed in its own jurisdictions.
- DGH, which is the main counterpart organization for the Study, is responsible for preventive and correction maintenance of all the equipment of the Pilot Project. Costs for the correction maintenance is covered by a budjet to be drawn up specially for the project.

Based on the agreement, every organization concerned started the operation of the Pilot Project equipment gradually after the completion of the installation work. On the other hand, ABHT made a Dh 120,000 maintenance contract of the phase-I equipment for the year 2003 with a local agent, subsidized by DGH. According to DGH, they are preparing Dh 200,000 for the 2004 contract covering both the phase-I and II equipment, Dh 80,000 up from the 2003 contract.

8. Evaluation of Pilot Project

As described in the previous chapters, the Pilot Project was implemented in two phases between 2001 and 2003. During these periods, the JICA Study Team supported and monitored the experimental operation in Morocco and even from Japan while the team was back in Japan. This chapter describes the evaluation of the Pilot Project based on results of the supporting and monitoring activities including a variety of trainings and simulation drills. Finally the draft Master Plan tentatively proposed in Chapter 5 is modified and updated in the following chapter in consideration of the evaluation results.

8.1 Criteria of Evaluation

The Pilot Project is a so-called man and machine system that is composed of machines (equipment) and manual operation (guidelines). The evaluation is made firstly on the two parts respectively, and then on the whole project as a total system. The criterion of the evaluation, which is commonly applied for the three is adequacy in terms of effectiveness against disasters and sustainability.

8.2 Adequacy of Equipment

8.2.1 Effectiveness of Equipment

Effectiveness of the Pilot Project equipment can be evaluated by examining their actual performances during past disasters. Table 8.1 presents performances of the equipment and the manual operations during the two flood events, the 14 June 2003 flood and the 4 August 2003 rainstorm.

According to the table, the equipment generally functioned properly. Especially, effects of the telemetry system were magnificent. During the 4 August 2003 rainstorm, the automatic system made ABHT aware of the outbreak of the intensive rainstorm by sounding alarms, and provided rainfall and water level data every 10 minutes on real-time basis.

It is true that a few problems were also found during the experimental operation. Data lacking of the telemetry data took place during the 4 August 2003 rainstorm probably due to influence of lightening. A big gap between the rainfall quantities measured by the automatic and manual rain gauges was also found during the same rainstorm at the Tazzitount Station. In order to reduce the probability of the interference by lightening, it is recommended to change the setting of the telemetry system to call the flood watch stations from the repeater stations again (7 times at the maximum) if abnormal data are received. Regarding the rainfall gap, there is no clue available to verify this problem. It is very important to continue to pay attentions to the comparison of rainfall quantities between the manual and automatic gauges.

8.2.2 Sustainability of Equipment

To secure sustainability, durability on other words, the equipment should be free from chronic or fatal problems. When certain equipment are broken down, they must be repaired or replaced with correct ones as soon as possible. From this point of view, information on troubles of the equipment and their repairs was collected and seven major troubles were identified as given in Table 8.2.

These troubles were not so technically difficult, except for those of the RTUs that required special treatment of the Japanese supplier. All the troubles were solved within a month, and neither chronic nor fatal problem was found in the Pilot Project. Since most of the troubles were solved by the JICA Study Team, the capacity of the organizations concerned for handling such troubles has not been practically challenged yet.

8.3 Adequacy of Guidelines

8.3.1 Effectiveness of Guidelines

The effectiveness of the guidelines for the operation of the Pilot Project was measured by performances during actual floods like that of the equipment if the operation follows the guidelines. DMN messages were collected to compare with the actual flood conditions, and the frequency how often the Pre-alert and Alert Levels were reached was investigated using the database stored in the data processing server at the Master Information Center of ABHT.

As a result, the effectiveness of the proposed guidelines during the actual floods has not been proven out unfortunately, mainly due to simple errors that should be solved prior to discussions on the guidelines. Although the effectiveness was confirmed tentatively in the simulation drills, the real evaluation may be postponed to the next flood. The DMN messages are not so accurate but still worthy of relying on. As far as 21-month hydrological data are concerned, no reason is found to change the Pre-alert and/or Alert Level values of rainfall and water level. It can be concluded that the current guidelines can be continued until any specific problem on them is identified.

8.3.2 Sustainability of Guidelines

The sustainability of the guidelines depends upon how much the guidelines were accepted by the personnel concerned. The Study Team has made every effort to explain to, discuss and consult with them about the guidelines through meetings and simulation drills. The organizations concerned also have been cooperative with the Study Team in every occasion. As seen in the simple errors experienced in the recent floods, however, the guidelines have not yet soaked into the organizations concerned completely. Further training programs and simulation drills are necessary.

The effect of the simulation drills is beyond question. As the organizations concerned acted more quickly in every simulation drill, their understandings were improved very much. As far as understood from the performances during the actual floods, however, it is true that their actual reactions were still far from satisfactory levels. This is probably not only due to individual problems of the personnel concerned but also due to organizational problems including those of tools (telephone, fax) and the permanence system.

8.4 Adequacy as Total System

8.4.1 Effectiveness of Total System

Since the completed total system was not operated appropriately during the actual floods, the effectiveness of the total system has not been verified yet. If the total system is operated as properly as the simulation drills, the necessary consecutive procedures from data collection to evacuation can be completed within about 20 minutes, l0 minutes less than the target of the Master Plan. Even if in a real situation the procedures are not undertaken as smoothly as the simulation drills, the 10 minute margin is still considered significantly large. It is no exaggeration to say that the simulation result showed a high possibility of the pilot FFWS.

Some limitations of not only the Pilot Project but also this non-structural measure, FFWS itself, were revealed by the recent floods. Flash floods and debris flows from tributaries caused by local rainfall are too fast for the FFWS. They do not allow enough time for the operation of the FFWS. Although no causality was reported fortunately in the Pilot Project, the treatment of visitors who come by car remains an issue of disaster prevention in this region. There are still many problems that cannot be solved by FFWS alone.

8.4.2 Sustainability of Total System

To assure the sustainable operation of the pilot FFWS, essential is machinery to support the FFWS institutionally, financially and technically. Since the Study Team executed considerable parts of those supports in the Pilot Project, such machinery has not been completed yet among the organizations concerned. However, Some movements towards the creation of the machinery are advancing slowly but steadily.

The greatest achievement of these movements is the signing of a convention on the operation and maintenance of the pilot FFWS that was made in November 2004. The remaining steps are to create a coordination committee and to execute responsibilities as stipulated in the convention.

(1) Signing of Convention

The JICA Study Team has been advising the Province and ABHT to conclude a convention on the operation and maintenance of the pilot FFWS among the related organizations since the first phase. Al Haouz Province, ABHT and DPE Al Haouz finally signed the convention on 7 November 2003, witnessed by the JICA Study Team and the JICA Advisory Committee.

(2) Responsibilities of Province and ABHT

This convention stipulates concretely the responsibilities of Al Haoz Province and ABHT in relation to the operation and maintenance of the pilot FFWS, as follows:

Responsibilities of Province and ABHT

Al Haouz Province	ABHT
• Create a committee of FFWS operation and follow-up; • Be in charge of FFWS operation as far as it is concerned, regarding decision making, issuance and dissemination of flood warnings and evacuation; • Supervise and assist the Ourika Caïdat and Igharf Warning Post; and • Assure the daily maintenance and the protection of the equipment under its jurisdiction and inform the ABHT about any equipment breakdown necessitating its intervention.	• Be in charge of FFWS operation as far as it is concerned, regarding data observation, collection, processing and analysis, forecasting and issuance of flood notices; • Assure the daily maintenance and the protection of the equipment installed in the ABHT and in the hydrological stations; • Assure preventive and regular maintenance of all the equipment installed within the framework of the Pilot Project; and • Assure the correctional maintenance of all the equipment (the reparation or the replacing of all broken down equipment).

(3) Creation of Committee

The convention also stipulates creation of a committee for operation and follow-up of the pilot FFWS, which is to be presided over y the governor of the province. The committee members are Al Haouz Province, ABHT, DPE Al Haouz, DREF High Atlas, DMN Marrakech, Civil Protection of Tahanaout and Royal Mounted Police of Tahanaout, but the governor as the chairman can invite any other organization if necessary. ABHT is to assure the committee secretariat.

The committee is to assure the coordination between the different organizations and to organize simulation drills. The committee is supposed to meet at least twice a year to evaluate the organizations' performances and the system operation after each event. The committee will also take charge of the implementation of the Master Plan once it is approved.

8.5 Conclusion

Based on the above discussions, the evaluation results are summarized as follows:

Summary of Evaluation

Criteria	Considerations	Evaluation	Issues
Adequacy of Equipment	Effectiveness	B	• Measures against lightning should be considered.
	Sustainability	B	• Maintenance works should be assured.
Adequacy of Guidelines	Effectiveness	B in simulation drills but practically unknown	• The guidelines of which effectiveness was confirmed tentatively in the simulation drills should be examined in actual floods.
	Sustainability	C	• Strengthening of permanence system and provision of necessary equipment is indispensable. • Training programs and simulation drills should be executed regularly.
Adequacy of Total System	Effectiveness	B	• Effectiveness against flash flood and debris flows of tributaries is insufficient. • There are still many problems that cannot be solved by FFWS alone.
	Sustainability	B	• Machinery to support the pilot FFWS is indispensable.

A: excellent, B: good , C: fair, D: poor

9. Modification of Master Plan

9.1 Introduction

In the two and half years after the proposition of the draft Master Plan, the Pilot Project was implemented step-wisely, immediately followed by its experimental operation. DRHT that was supposed to be an execution agency of the Master Plan was practically transformed into ABHT (Basin Agency) in this period. In modifying the draft Master Plan, not only the evaluation results of the Pilot Project, but also some changes during the two and half years were taken into consideration. Points of the modification are summarized in the following table:

Points of Modification

Item		Modification	Reason for Modification
Basic Condition of Master Plan	Target Completion Year	Long term implementation is considered as an alternative.	• More severe financial conditions are expected for implementation of Master Plan in relation to transition of DRHT to ABHT.
Modification of Subsystem	Hydrological Observation and Data Collection Subsystem	Redesigning of radio network for telemetry system is made.	• The radial network established in the Pilot Project should be utilized for the telemetry network of Master Plan.
	Diffusion of Flood Warnings	Semi-automatic system is introduced.	• Cost reduction is desirable. • Potential of semi-automatic system was verified in Pilot Project.
Modification of Operation and Maintenance Plan (Strengthening of Institutional Plan)		Creation of a coordination committee is proposed.	• To assure sustainability of the FFWS, necessity of such a committee was revealed through Pilot Project. • Such a committee has been proposed in in the National Master Plan against Flood by DGH.
		Strengthening of Permanence duty is emphasized.	• Failures due to the present loose permanence duty were revealed in Pilot Project.
		Necessity of explanation and training (simulation drills) for full understanding and improvement of FFWS is emphasized..	• Failures due to poor understandings of FFWS procedures were revealed in Pilot Project.
		Necessity of interactive analysis with DMN is emphasized.	• Importance of weather forecast was recognized through Pilot Project.
		Importance of information from local authorities is emphasized.	• Importance of information from local authorities was reconfirmed through Pilot Project.
		Importance of evaluation and grade-up applying management cycle is emphasized.	• Necessity of this management cycle is a must for sustainable development of FFWS.
		Importance of participation of inhabitants and tourism related Industries is emphasized.	• Importance of cooperation of local inhabitants was realized again through the Pilot Project.
Necessity of comprehensive approach for disaster prevention		Comprehensive approach including a variety of structural and nonstructural measures is recommended.	• Limitation of FFWS and necessity of comprehensive approach was reconfirmed through Pilot Project.

9.2 Modification and Updating

9.2.1 Target Completion Year of Master Plan

The financial conditions of ABHT that is expected to be the executive organization of the Master Plan are becoming severer than at the time of the draft Master Plan, especially upon the transition from DRHT to the more independent basin agency of its superior organization, DGH. The cancellation of the telemetry project in the Oum Er Rbia may be a good example to understand such severe financial conditions of the basin agencies. Under these situations, ABHT is alternatively planning to implement the Master Plan in a longer period so that the annual disbursement could be reduced. In due consideration of the financial conditions and the views of ABHT, a case of 10 years of implementation period is additionally proposed as a more realistic scenario. 10 years might be the longest limit as the implementation period of the telecommunication sector where technical innovation is so dynamic.

Target Completion Year

Alternative	Implementation Period	Completion Year
Alternative-1	5 years	2009
Alternative-2	10 years	2014

9.2.2 Modification of Subsystem

The telemetry radio network of the Hydrological Observation and Data Collection subsystem is updated by incorporating the existing network installed in the Pilot Project. To reduce the cost for the Warning Dissemination subsystem, a semi-automatic indirect warning dissemination system of which potential was verified through the Pilot Project is introduced in place of the directly remote-controlled system proposed in the draft Master Plan.

(1) Redesigning of Telemetry Network

The Adrar Tazaina Repeater Station and the Aoulouss Repeater Station were to be further relayed by the Oukaimedan Station in the old Master Plan as shown in Fig.5.2. The tandem-type network was afterward modified in the Pilot Project into a radial network that is generally more reliable. A new network diagram was prepared for the new Master Plan by following the radial network of the Pilot Project as much as possible as shown in Fig.9.1.

(2) Redesigning of Warning Dissemination Subsystem

The indirect semi-automatic system of which effectiveness was verified in the Pilot Project is proposed for the Master Plan except for the Ourika Valley. 11 warning posts equipped with broadcasting equipment are created. These posts are usually unmanned and maintained voluntarily by local inhabitants, but communication with the province/prefecture is secured through a radiotelephone when necessary. For the Ourika Valley that includes 6 warning post located close to each other, a remote control system is proposed in a more integrated manner. The Iraghf Warning Post where a guardian is stationed 24 hours a day plays a role of a sub-control center for the other five unmanned warning posts in the valley. A modified diagram of the warning system network is presented in Fig.9.2.

With the above modification, the total equipment cost of the warning dissemination subsystem is reduced by Dh 5.4 million, from Dh 15,7 million to Dh 10.3 million.

9.2.3 Modification of Operation and Maintenance Plan

The FFWS, the man-machine system can work well only when both parts of equipment and manual operation work normally. In the Pilot Project, however, a lot of errors related to the institutional aspects were raised in the manual operation works. Most of them were very simple but fatal to the FFWS.

In order to assure the appropriate manual operation, the following things are newly proposed or reiterated again:

- Creation of Coordination Committee;
- Strengthening of Permanence Duty;
- Explanation and Training (Drills) for Full Understandings;
- Interactive Analysis with DMN;
- Importance of Information from Local Authorities;
- Evaluation and Grade-up Applying Management Cycle; and

- Participation of Inhabitants and Tourism related Industries.

9.2.4 Necessity of Comprehensive Approach for Disaster Prevention

As revealed in the recent floods, it is impossible to totally prevent and/or mitigate rain-induced disasters in the Atlas Region such as floods from main rivers and tributaries, debris flows and slope failures with the FFWS alone. Comprehensive approach composed of combinations of a variety of structural and nonstructural measures is essential against the disasters. It is declared that the FFWS Master Plan should be positioned among the multiple measures.

9.3 Implementation Plan and Cost Estimate

9.3.1 Implementation Plan

As explained in Subsection 9.2.1, two implementation plans, namely 5-year and 10-year implementation plans were proposed. The two implementation schedules are illustrated in Table 9.1. In the Alternative-1: 5-year Implementation, the Master Plan is implemented at once in 5 years between 2005 and 2009. In the Alternative-2: 10-year implementation, it is implemented in three phases between 2005 and 2014 according to the priority order in terms of damage potential. The first priority should be given to the Ourika River Basin, the second to the issyl and Rheraya River Basins, and the third to the rests.

9.3.2 Cost Estimate

The project cost and the maintenance cost for the whole Atlas Region FFWS Plan including the pilot project is approximated as follows:

Project Cost and Maintenance Cost for FFWS Master Plan

(Dh'000)

Cost Item	Pilot Project	After Pilot Project				Total
		Ourika	Issyl + Rheraya	Others	Subtotal	
A. Construction Cost	**16,612**	**17,229**	**9,656**	**10,213**	**37,097**	**53,710**
(1)Equipment Cost	12,826	13,497	7,498	7,929	28,924	41,750
(2)Installation and Commissioning Cost	2,072	1,552	947	1,003	3,503	5,574
(3)Civil Construction Work Cost	1,178	1,497	832	879	3,208	4,386
(4)Software Development Cost	269	341	190	200	731	1,000
(5)Technical Training Cost	269	341	190	200	731	1,000
B. Engineering Services Cost	**4,029**	**4,186**	**2,326**	**2,459**	**8,971**	**13,000**
C. Physical Contingency (10% of (A+B))	**2,064**	**2,141**	**1,198**	**1,267**	**4,607**	**6,671**
D. Project Cost (A+B+C)	**22,706**	**23,556**	**13,179**	**13,939**	**50,675**	**73,381**
E. Annual Operation and Maintenance Cost	**641**	**675**	**375**	**396**	**1446**	**2,087**

9.4 Project Evaluation

The modified Master Plan is evaluated comprehensively. In conclusion, the FFWS Plan is generally viable in terms of economical effectiveness, social and technical acceptability, and environmental impacts. If sufficient assistances of national and regional levels are available, the Master Plan could be viable financially too.

9.4.1 Economic Evaluation and Financial Considerations

(1) Economic Evaluation

For the economic evaluation, Economic Internal Rate of Return (EIRR), Benefit-cost ratio (B/C) and Net Present Value (NPV) were recalculated for the modified Master Plan. The results are shown in the following table.

EIRR, B/C and NPV

Item	Alternative-1 (5-year Implementaton)		Alternative-2 (10-year Implementation)	
	Movable Assets only	Human Life included	Movable Assets only	Human Life included
EIRR	Negative	16.7%	Negative	19.7%
B/C	0.08	1.6	0.08	1.7
NPV	-Dh 50 million	Dh 31 million	-Dh 45 million	Dh 31 million

As noticed from the table, the project can be nearly feasible, if the value of a human life is appreciated in the monetary term. Although it is very difficult to evaluate the human life in the monetary term properly, it is considered to include a human life to evaluate the project from the economic aspect, and, under such a condition, it is expected that the project will be feasible from the economic aspect.

As for the comparison of the two alternatives, EIRR of the longer-term implementation is slightly bigger that the other. Considering many assumptions applied for the analyses, however, this small difference seems meaningless. The implementation period would rather be determined in consideration of the financial conditions.

(2) Financial Considerations

Annual additional burdens for the maintenance of equipment are Dh 1,502,000 on ABHT, Dh 540,000 on Al Haouz Province and Dh 45,000 on SYBA Prefecture if the total maintenance cost of Dh 2,087,000 is divided according to the cost of the equipment installed in their jurisdictions.

These burdens are not small for all the three organizations, though those for Al Haouz Province and SYBA Prefecture were considerably reduced from the draft Master Plan. Involvement and assistance of regional and even national levels is a must, similar to the Pilot Project, of which maintenance cost is shouldered by DGH. The proposed coordination committee is expected to become a propeller for promoting the Master Plan.

9.4.2 Consideration of Social Aspect

Main concern about social aspects is acceptance of the Master Plan by local inhabitants and tourists in the Study Area who are supposed to be the beneficiaries.

For inhabitants, their strong concern was proved in the Pilot Project. About 30 % of the inhabitants voluntarily participated in the evacuation drill on 25 June 2002 held at Iraghf of the Ourika Valley. This high rate is a proof of high interests of the inhabitants, and the interests probably came from the memories of the catastrophe in 1995. Since such shocking experience caused by natural disasters is shared among the other high risk areas, it is natural to think that inhabitants of the other high risk areas also understand necessity of preventive measures. In this sense the local inhabitants have an aptitude to accept the Master Plan, though assistances and initiatives of local authorities is necessary for them to develop themselves to create evacuation organizations.

According to an interview to tourists in the Ourika Valley made in 2000, 92 % of the interviewees answered that they knew the 1995 catastrophe. The high rate is welcomed and should be maintained or improved more. In the evacuation drills in 2002 and 2003, however, the participation from tourists was very limited, probably because they did not wanted to be disturbed. Efforts to publicize the past disasters and the FFWS shall be made continuously, not discouraged by the failures in the drills.

9.4.3 Initial Environmental Evaluation

The Initial Environment Evaluation(IEE) on the draft Master Plan concluded that it was considered not necessary to make an environmental impact assessment study because no serious impacts was predicted due to the small scale of the Master Plan project. The fact that no adverse impacts of the Pilot Project have been reported is also supporting this IEE. The same conclusion can be given to this modified Master Plan that is too slightly different from the old one.

9.4.4 Technical Acceptability

The Pilot Project was a good opportunity for technical transfer. In this project period of about two years between 2001 and 2003, a variety of training programs and simulation drills were held for personnel concerned. The experimental operation was a runway for them to take off by themselves.

Especially ABHT technicians who joined the installation works learnt a lot about the high-tech equipment from the Japanese engineers. Although it is still difficult even for them to repair the equipment, they became capable of the operation of the pilot system at least. It can be said that ABHT is almost ready to accept the Master Plan.

On the other hand, insufficient understandings of personnel of the Province, Ourika Caidat and the Iraghf Warning Post were also disclosed in the Pilot Project. Most of the personnel concerned of the local authorities are not originally technical staff, and need to be more educated and trained. Thus ABHT is to train these personnel in the Master Plan. To promote such inter-organization cooperation will be one of the roles of the provincial/prefectural coordination committee.

10. Comprehensive Approach to Disasters in Atlas Region

In the Atlas Region all kinds of rain-induced disasters are possible. They are river floods, debris flows, land slides, slope failures, falling rocks, as repeated so often in the past. This Report describes the Master Plan of FFWS against the disasters in the region. However, the FFWS has its own limitations in terms of effectiveness. The FFWS is originally not a measure to eliminate all the damage completely but only a supporting measure to forewarn the people about the disaster risks. The safety of the people could not be assured unless they themselves take appropriate actions, for example evacuate promptly to safe places, to avoid the risks based on the warnings given by the FFWS. Depending on the magnitude and characteristics of the disaster, however, they can fail even if they do their best. Furthermore, damage to immovable assets such as infrastructures, buildings and agricultural products is unavoidable with the FFWS alone.

To substantially mitigate the disaster risks in the region, comprehensive approach is indispensable. Combinations of several structural and nonstructural measures should be provided in addition to the FFWS. Some conceivable structural and non-structural measures are introduced briefly, as below:

10.1 Structural Measures

As a basic infrastructure for disaster prevention structural measures should be provided on a certain level at least. Non-structural measures are generally employed to compensate for what the structural measures cannot cover.

To cope with the habitual flood damage, agencies concerned had provided several structural measures such as check dams, river channel widening and deepening, construction of embankment in the Ourika and Issyl river basins, as discussed before. However, these measures are still insufficient in both quality and quantity. In the other basins, few structural measures have been provided.

10.1.1 Applicable Structural Measures

Applicable structural measures in the Study Area are mainly composed of those for debris flow control, erosion control and river flood flow, control, and summarized as follows:

Applicable Structural Measures

Classification	Measures	Areas
Debris Flow Control	• Large check dam • Small check dam • Channel works • Sand pocket works	Upstream, mountain basin, potential debris flow disaster stream
Erosion Control	• Small sil • Hillside works • Reforestation works	Whole basin especially upstream
River Flood Flow Control	• River channel improvement including widening, excavation of river bed and embankment • Dam and reservoir	Up, middle and lower stream

10.1.2 Considerations for Introduction of Structural Measures

The introduction of structural measures may need a huge cost and a long time. To effectively introduce structural measures from the economical and technical viewpoints, the following considerations should be made:

- Detailed Investigation on Disaster Conditions;
- Preparation of Framework to introduce Structural Measures;
- Formulation of Master Plan; and
- Multipurpose Utilization of Structural Measures.

10.2 Non-structural Measures

In addition to the above structural measures and the proposed FFWS Master Plan, the following non-structural measures are proposed to assure a desirable safety level in the Atlas Region:

- Publication of Flood Risk Maps;
- Monitoring of Debris Flow Potential Streams;
- Introduction of Traffic Control;
- Introduction of Land Use Control and Guidance; and
- Provision of Facilities for Tourists.

10.2.1 Publication of Hazard Maps

In general, the publication of a hazard map is broadly adopted as one of the useful non-structural flood mitigation measures. Through the publication of such a hazard map, the residents could be aware of the extent of possible disaster areas and the available evacuation routes during the disaster. The hazard maps and the inundation maps prepared in this Study are useful for this purpose.

10.2.2 Monitoring of Potential Debris Flow Streams

To prepare against debris flows, it is necessary to evaluate in advance possibility of debris flows for every debris flow potential stream. Actions only after rainfall starts can be too late. Preparation in normal times is important. In this sense, it is recommended to monitor geographical changes in the stream after a rainfall of a certain intensity. This makes possible detection of a rise in potential of debris flows. For facilitating the monitoring, a card like a medical one, called “stream monitoring report” is proposed as Table 10.1.

When occurrence of debris flows is forecasted according to the stream monitoring report, measures including restriction of any activity in the area along the torrent and removal of materials causing disasters like big rocks should be taken in advance to mitigate potential damage.

10.2.3 Introduction of Traffic Control

More than 700 vehicles on weekdays and around 1,300 vehicles on holidays come into the Ourika Valley and most of them park on the road along the Ourika River course, mainly at Iraghf and Setti Fadma. The necessary length of road to park all these vehicles in a line would be about 10 km, assuming that about 7m is required for parking one vehicle. Since this 10km distance corresponds to that between Iraghf and Setti Fadama, the whole section of the tourist site would be full of parked cars. Under this congested situation, it would be difficult for tourists as well as inhabitants to move the vehicles smoothly in the case of emergency.

Not only the tourist spots but also the roads along the rivers are dangerous. Most of the stretches of the roads are exposed to flash floods and debris flows from tributaries and slope failures. The tourists tend to rush to drive out of the dangerous valley to safer low flat areas once it starts to rain. However, it takes about 30 minutes from Iraghf and about 45 minutes from Setti Fadma to drive to the safe Al Haouz Plain even under normal conditions. Whether they can successfully escape from the valleys under all the risks, it depends upon how it rain in these durations. It might be wise to refrain from using cars during a flood for avoiding secondary disasters.

Recently, in Ourika Valley, parking on one side of the road has been introduced as one of the traffic control measures. However, it seems difficult to solve the traffic problem as well as the damages expected in floods by only this means. It is worth examining the introduction of drastic traffic control like park and ride system as practiced in the other countries such as Japan, Switzerland and Austria.

10.2.4 Land Use Control and Guidance

Land use control and guidance is very important to prevent disorderly land development, which could leads to an increase of damage potential in hazard areas and to devastation of river basins. The Water Law (“10-95 Law”) also stipulates occupation of the public water domains, and is expected to be a legal background for execution of land use control.

Besides, as far as the Ourika Valley is concerned, the Urban Agency of Marrakech is formulating a land use plan along the Ourika Valley from Tnine Ourika to Setti Fadma. The plan will include zoning and prohibition of establishments or buildings in zones prone to floods or debris flows. At present, the agency is collecting hydrological information for the zoning from ABHT. It is desirable to prepare similar land use plans for the other river basins, referring to the hazard maps and the inundation maps prepared in this Study.

10.2.5 Provision of Facilities for Tourists

Since the Study Area is famous as one of the major tourist spots in North Africa, a large number of tourists visit in summer, especially the Ourika Valley, to enjoy the cool and clean water. Thus, the Study Area is one of the precious resources for the tourist industry. However, basic facilities for the tourism industry are poor in quality and quantity, and inadequate, especially in assuring safety against disasters caused by floods and debris flow. Evacuation sites, evacuation routes with lights and warehouses should be provided at least.

11. Conclusions and Recommendations

11.1 Conclusions

This Study was commenced in March 2000 with two objectives, (1) to formulate a Master Plan of flood forecasting and warning system for the 6 sub-basins with a total area of 3,500 km^2 on the left bank of the Tensift River, and (2) to carry out technical transfer to Moroccan counterpart personnel.

Following basic studies of about a year, a draft Master Plan was compiled in the Interim Report 2 in April 2001. In the draft Master Plan an automatic telemetry system of 20 flood watch stations and an automatic remote-control system of 17 warning posts were proposed to cope with flash floods that the existing manual system hardly manage.

A part of the draft Master Plan, was implemented as a Pilot Project in the Ourika River Basin step-wisely between July 2001 and September 2003, in order to actually examine the effectiveness of equipment and systems proposed in the draft Master Plan. A semi-automatic system of the first phase was completed in December 2001, and immediately its experimental operation started and continued about one and half years until when the second phase was completed to realize an full automatic telemetry system in July 2003. The experimental operation of the telemetry system was also made about one and half months from the beginning of August to mid-September 2003.

During the Pilot Project period, the JICA Study Team supported and monitored the experimental operation in Morocco and even from Japan while the team was back in Japan. A variety of technical transfer programs including simulation drills were also carried out to build up capacities of personnel concerned involved in the FFWS operations.

The effectiveness of the telemetry system was obvious. During the 4 August 2003 rainstorm, the system detected the first 1 mm raindrop and immediately warned ABHT. Thanks to this system ABHT could for the first time inform the occurrence of the intensive rainfall to Al Haouz Province earlier than its local authorities. On the other hand, several problems, mostly concerning the manual operations that are the mate to the equipment system for comprising the total FFWS, also arose during the Pilot Project. Weakness of permanence system, misunderstandings or insufficient understandings of personnel concerned on the operations, etc were revealed.

Based on the evaluation of the Pilot Project, the draft Master Plan that was compiled two and half years ago were modified and updated slightly. In due consideration of the severe financial situations mainly accompanied by the transition of DRHT into ABHT, the Master Plan was proposed to be implemented alternatively in a longer implementation period of 10 years in addition to 5 years proposed in the draft plan. A semi-automatic system was introduced partially to the warning dissemination system. Necessity of provincial/prefectural coordinating committee as machinery for assuring sustainable and appropriate operation of the Master Plan was emphasized in the operation and maintenance plan of the Master Plan.

The total cost of the Master Plan is estimated at Dh 51 million excluding that of the Pilot Project. Economic Internal Rate of Return of greater than 16% is obtained if human lives are additionally included in the benefit estimation. In conclusion, the Master Plan is generally viable in terms of economical effectiveness, social and technical acceptability and environmental impacts. If sufficient assistances of national and regional levels are available, the Master Plan could be viable financially too.

11.2 Recommendations

The JICA Study Team proposes the Master Plan of the FFWS in the Atlas Region to the Government of Morocco, and strongly recommends that the Master Plan will be implemented soon to contribute to the enhancement of the safety of inhabitants and visitors in the Atlas Region. To facilitate the implementation of the Master Plan, the following actions are earnestly desired:

(1) Establishment of Coordination Committee

Necessity of machinery for assuring the sustainable operation of the pilot FFWS is recognized among personnel concerned as stipulated in the convention signed by Al Haouz Province, ABHT and DPE Al Haouz. This committee should be realized soon and is expected to lobby for the promotion of the Master Plan too.

(2) Sustainable Operation of Pilot Project System

Prior to the implementation of the Master Plan, it is essential to continue to operate and maintain appropriately the FFWS installed in the Pilot Project. If the pilot FFWS goes out of use, the Master Plan is out of the question.

(3) Comprehensive Approach to Disasters in Atlas Region

Comprehensive approach composed of combinations of a variety of structural and nonstructural measures is indispensable against the disasters.

(4) Installation of Radar by DMN

More accurate weather forecasts are indispensable for realization of a reliable FFWS. It is strongly recommended that DMN implement the installation of precipitation radar in or near the Atlas Region as it plans.

TABLES

Table 5.1 PROPOSED NETWORK OF FLOOD WATCH STATIONS IN STUDY AREA

Serial	Station	Observation Item	New or Exsiting	River Basin	Altitude (m)	Catchment Area (km2)	Residence House
1	Adrar Guedrouz	Rainfall	New	R'dat/ Zat	2,160	-	New
2	Aghbalau	Rainfall & Water Level	Existing	Ourika	1,070	495	Existing
3	Tazitount	Rainfall & Water Level	Existing	Ourika	1,270	347	Existing
4	Tourcht	Rainfall & Water Level	Existing	Ourika	1,650	19	New
5	Amenzal	Rainfall & Water Level	Existing	Ourika	2,230	49	New
6	Tiourdiou	Rainfall & Water Level	Existing	Ourika	1,850	134	New
7	Agouns	Rainfall	Existing	Ourika	2,200	-	New
8	El Azib-n-Tinzar	Rainfall	New	Ourika	1,950	-	No Need
9	Amddouz	Rainfall	New	Ourika	2,200	-	New
10	Ihdjamene	Rainfall	New	Ourika	1,750	-	New
11	El Jam' ane	Rainfall & Water Level	New	Ourika	1,400	54	New
12	Oukaimeden	Rainfall (Relay Station)	New	Ourika/Rheraya	3,270	-	No Need
13	Aremd	Rainfall & Water Level	Existing	Rheraya	1,950	35	Existing
14	Arg	Rainfall & Water Level	New	Rheraya	1,600	48	New
15	Iguir N'kouris	Rainfall & Water Level	Existing	N'fis	1,100	848	Existing
16	Taous	Rainfall & Water Level	New	N'fis	1,340	290	New
17	Iguer	Rainfall & Water Level	New	N'fis	1,580	100	New
18	Tizgui	Rainfall	New	N'fis	1,800	210	New
19	Ait bou Zguia	Rainfall & Water Level	New	Issyl	640	-	New
20	Ouaguejdit	Rainfall	New	Issyl	1,000	-	New

Table 5.2 THREE ALTERNATIVES FOR MASTER PLAN

System			Option A	Option B	Option C
Sub-system	Component	Item			
Meteo-hydrological Observation and Data Collection	Neteo-hydrological Observation	Observation Equipment	Manual Observation	Automatic Observation	Automatic Observation
	Data Collection	Data Transmission Equipment	Radio Communication by voice	Radio Communication by voice	Radio Telemetry System
Data Analysis and Forecasting of Flood and Debris Flow	Data Processing	Data Management Equipment	Manual data processing	Computer Data Processing	Computer Data Procesing and Home Page service
	Data Distribution	Data Monitoring Equipement	Data distribution by telephone and Facsimile	Equipt with PC for data monitoring at agencies concerned	Equipt with PC for data monitoring at agencies concerned with Internet Service
	Data Transmission	Transmission Method	Telephone Line	Telephone Line	Own Radio network and Telephone Line as Back-up
Dissemination of Warning	Warning Command	Warning Control Equipment	Warning Control Equipment is not installed at Caidat.	Simple Warning Control Equipment is installed at each Caidat	Issuance Warning message at Provincial Office directly through Warning Control Equipment
	Warning Dissemination	Warning Post	Off-line Voice amplifier at each Warning Post	Off-line Voice amplifier at each Warning Post	On-line Voice amplifier at each Warning Post
	Message Transmission	VHF Radiotelephone or Telephone Line	No transmission line is provided. Caidat goes to the Warning Post and broadcasts warning message	Between Caidat and Warning Post connects by Public Subscriber Telephone and VHF radiotelephone	Own VHF Radio Network

Table 5.3 ESTIMATION OF NECESSARY TIME FOR FFWS OPERATION

<table>
<tr><th colspan="2">Subsystem</th><th>Alternative-1</th><th>Alternative-2</th><th>Alternative-3</th></tr>
<tr><td rowspan="2">Hydrological Observation and Data Collection</td><td>Hydrological Observation</td><td>5 to 30 min.</td><td>0</td><td>0</td></tr>
<tr><td>Data Collection</td><td>10 min.</td><td>5 min.</td><td>0</td></tr>
<tr><td rowspan="3">Data Analysis, Forecasting and Data Distribution</td><td>Data Analysis</td><td>25 min.</td><td rowspan="2">15 min.</td><td rowspan="2">5 min.</td></tr>
<tr><td>Forecasting</td><td>10 min.</td></tr>
<tr><td>Distribution of Flood Notice</td><td>10 min.</td><td>5 min.</td><td>5 min.</td></tr>
<tr><td colspan="2">Issuance of Warning</td><td>5 mim.</td><td>5 mim.</td><td>5 mim.</td></tr>
<tr><td colspan="2">Warning Dissemination</td><td>15 min. to 5 hrs.</td><td>10 min.</td><td>5 mim.</td></tr>
<tr><td colspan="2">Evacuation</td><td>10 min.</td><td>10 min.</td><td>10 min.</td></tr>
<tr><td colspan="2">Total Necessary Time</td><td>90 min. to 6 hrs.</td><td>50 min.</td><td>30 min.</td></tr>
</table>

Table 5.4 POTENTIAL ENVIRONMENTAL IMPACTS

No.	Environmental item	Potential impact
Social Environment		
1.	Resettlement	New stations need to be constructed in close proximity to the river, and in some places agriculture activity may be affected and people working/living there may need to resettle. However based on the water law no. 10/1995 these people have only provisional right to occupy such lands, which are located within the land reserved for hydraulic public domain. This law should serve as a very useful tool to regulate land use in the flood plain.
2.	Economic activities	Main activities in Study area include agriculture and tourism. Agriculture may be affected as described above. Emphasizing flood-warning systems through installation of sirens, warning signboards and evacuation drills may scare away tourists in areas as Setti Fatma, Iraghf, and Imlil and have a negative impact on the local economy.
3.	Waste	Some stations may be constructed in areas with difficult access, such as Iguer, Tizgui abd El Azib-n-Tinzar. It is necessary to provide for removal of construction wastes after construction as well as waste generated from the stations use. The M/P requires that stations be constructed near to villages and therefore the waste may be transported to the villages.
4.	Hazards (risk)	In many places in the Study area mountains surrounding the river path have steep slopes and potential for land collapse and landslide from the mountainside is observed. Station sites should be selected in safe areas in order to decrease the risk to the operators and equipment in these stations. Site selection and engineering designs should also consider this problem carefully.
Natural Environment		
5.	Groundwater	Stations should be installed with septic tanks and waste management system should be in place to minimize effect on groundwater. However this should be studied in the design phase taking into consideration situation in the surrounding villages.
6.	Fauna and Flora	So far no endangered species have been identified in the Study area. However cutting of trees for installation of siren posts or antennas should be avoided because of the scarcity of trees in the Study area. The competent authorities must issue permits for building and they are in the best position to protect against endangering living environment and also protected areas.
7.	Landscape	Many of the existing stations do not blend well with the surrounding landscape. In tourism areas more care may be taken in the selection of construction materials and finishing works to improve that condition.
Pollution		
8.	Water pollution	Stations should be installed with septic tanks and waste management system should be in place to minimize effect on both surface and groundwater. These measures shall be considered during the design stage.

Table 6.1 IMPLEMENTATION SCHEDULE OF PILOT PROJECT

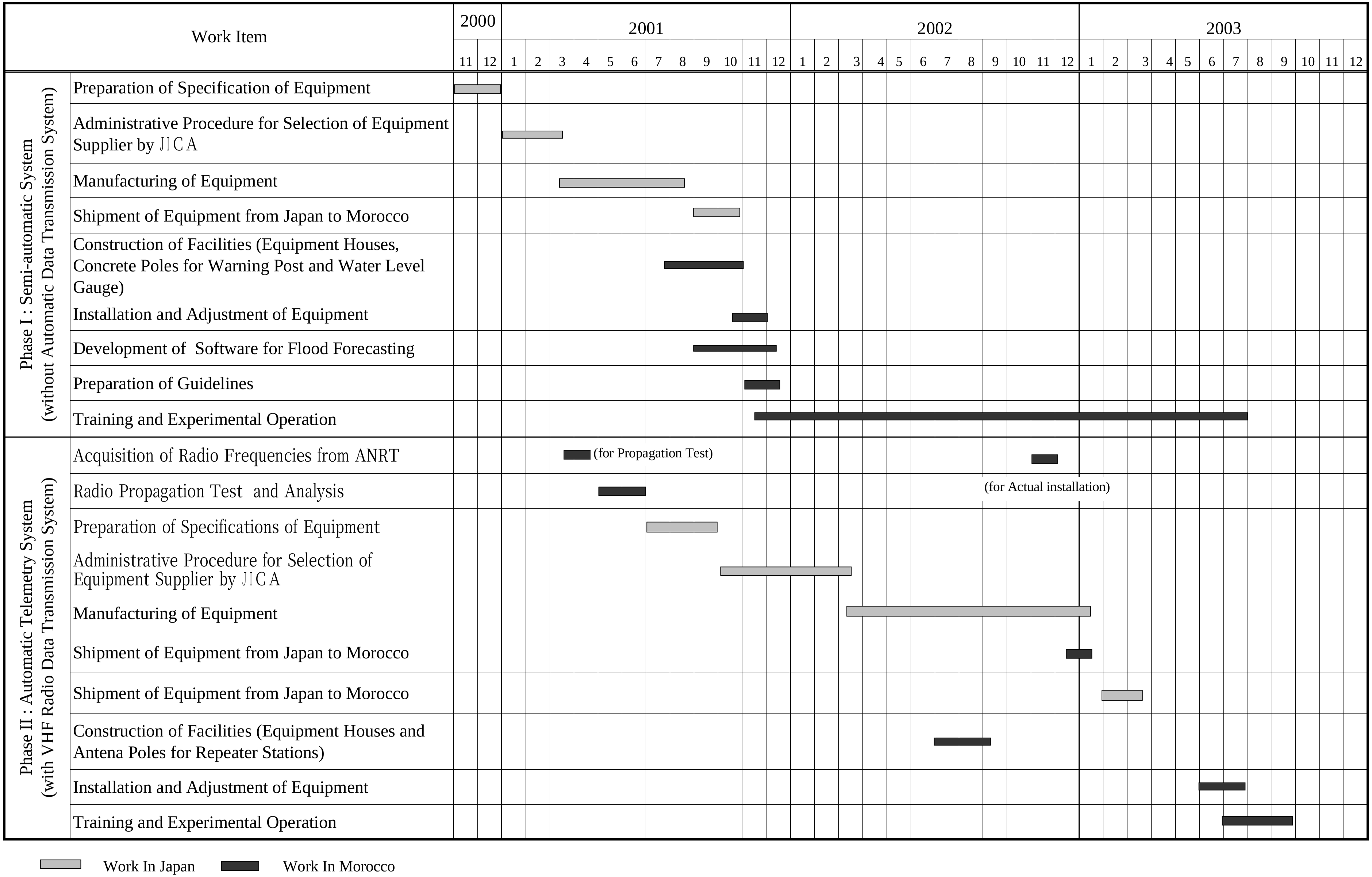


Table 8.1 (1/2)   PERFORMANCE OF PILOT PROJECT FFWS DURING FLOODS

Subsystem	Equipment/ Manual Operation	Input by Pilot Project		14 June 2003 (under Phase I System)			4 August 2003 (under Phase II System)		
		Item	Phase	Consumed Time (min)	Performance	Identified Problems	Consumed Time (min)	Performance	Identified Problems
Hydrological Observation and Data Collection (ABHT)	Equipment (Including Software)	Tipping Bucket Rainfall Gauge	I	90	A	None	15	unknown	A big gap of observed rainfall of 41.5 mm was identified between the automatic tipping bucket gauge and the manual gauge at the Tazzitount Station.
		Ultrasonic Water Level Gauge	I		A	None		A	None
		Remote Terminal Unit (RTU)	I		B	• RTU of Agouns Station was not operational due to breakdown by lightning.		A	None
		VHF Data Transmission System	II		N/a	N/a		B	• A few data before and at the beginning of the rainfall were lost due to the interference by lightning.
	Manual Reading of Data on RTU and Verbal Communication between Stations and ABHT	Trainings and Guidelines	I&II		D	• The radio operator of ABHT was absent when the Aghbalau Station tried to inform him of the occurrence of the flood. ABHT knew the flood only 2 hour later.		D	• ABHT did not know the DMN Pre-alert Meaasage. • ABHT could not contact the flood watch stations until about 1 hour after the beginning of the rainfall because the key of the radio room was not found.
Data Processing, Forecasting, Dissemination of Flood Information and Notices (ABHT)	Equipment (Including Software)	Data Processing System	I & II	10	A	None	5	A	None
		Flood Forecasting Software	I		C	• Accuracy is low. Modification of parameters is necessary after accumulation of hydrological data.		C	The same as the 14 July Flood.
		Flood Information Monitoring System (Dial-up Connection)	I		C	• Only 2 monitoring stations of the 4 stations could access to ABHT simultaneously because only 2 telephone lines are available at ABHT.		C	The same as the 14 July Flood.
		Telemetry Supervisory System	II		N/a	N/a		A	None
	Dissemination of Flood Notices by Telephone/Fax	Training and Guidelines	I & II		D	• ABHT informed only after the flood by telephone. Fax machine was inaccessible by the FFWS operation team.		C	• ABHT informed only by telephone. Fax machine was inaccessible by the FFWS operation team.

A: Excellent, B: good, C: Fair, D: Poor

Table 8.1 (2/2) PERFORMANCE OF PILOT PROJECT FFWS DURING FLOODS

Subsystem	Equipment/ Manual Operation	Input by Pilot Project		14 June 2003 (under Phase I System)			4 August 2003 (under Phase II System)		
		Item	Phase	Consumed Time (min)	Performance	Identified Problems	Consumed Time (min)	Performance	Identified Problems
Issuance of Warning (Province)	Issuance of Flood Warnings by Province	Training and Guidelines	I	5	C	• The Flood Information Display of the monitoring PC was not referred because the operators were not yet familiar with the operation of the display.	5	C	The same as the 14 July Flood.
Diffusion of Flood Warning (Province, Warning Post)	Equipment	VHF Radiotelephone at Iraghf Warning Post	I	10	N/a	Not the radiotelephone but a mobile telephone was used for communication.	30	N/a	Due to a breakdown of the Sidi Bou Outhamane Repeater Station, the radio network was not operational.
		Warning Broadcasting Equipment at Warning Post	I		A	None		B	• A metal mast for suspending the cable from the warning post to the second laud speakers was crashed by debris, but broadcasting was still operational.
		Selective Call System among Warning Post, Caidat and Provine	I & II		N/a	N/a		N/a	Due to a breakdown of the Sidi Bou Outhamane Repeater Station, the radio network was not operational.
	Dissemination of Flood Warnings	Trainings and Guidelines	I&II		C	• The dissemination route (Province – Caidat - Warning Post) was different from that of the Global Simulation Drill in 2002 (directly Province – Warning Post). • Communication between the warning post and the Province was not made.		C	• The dissemination route (Province – Caidat - Warning Post) was different from that of the Global Simulation Drill (directly Province – Warning Post). • The obscure direction confused the guardian of the warning post. • The tape message of cancellation was broadcast at the warning post without any precaution or any evacuation advice.
Execution of Evacuation	Evacuation Activities	Trainings and Guidelines	I	5	C	• An evacuation organization has not been formed yet.	10	C	• An evacuation organization was not formed yet. • Inhabitants and tourists evacuated by themselves before the broadcast.
Total System	Total Consumed Time from Detection of Occurrence of Flood/Rainfall to Evacuation			**30**	C	• ABHT could not contribute at all to the dissemination of flood information. (The network of the province worked in stead.)	**30**	C	• ABHT could have announced the flood notice 5 to 10 minutes earlier if they had contacted the Tazzitount Station. • 30 minutes was wasted for convey the flood warning from the province to the warning post via the khalifa of Ourika Caidat.

A: Excellent, B: good, C: Fair, D: Poor

Table 8.2 MAJOR TROUBLES OF EQUIPMENT AND THEIR MEASURES DURING EXPERIMENTAL OPERATION

Subsystem	Station	Troubled Equipment	Trouble of Equipment			Measure	
			Date of Occurrence	Trouble	Assumed Cause	Date	Measure
Data Processing	Master Information Center (ABHT)	Connection between the client PC and the Server	15 Aug. 2002	No connection	Mis-opeation of the client PC	4 Sep. 2002	Restoration by Sohime under direction of JRC
Data Processing	Master Information Center (ABHT)	Switching Hub	15 Aug. 2002	Failure	High temperature in the room	unknown	Naturally restored
Hydraulic Observation and Data Collection	Agouns	Remote Terminal Unit (RTU)	May 2003	Breakdown of DC/CD Converter	Over-voltage caused by lightening	May 2003	Replacement of the broken RTU with the spare one by ABHT technician.
						5 July 2003	Replacement of three circuits with newly modified ones by Study Team (JRC)
Hydraulic Observation and Data Collection	Amenzal	Remote Terminal Unit (RTU)	June 2003	Breakdown of DC/CD Converter	Over-voltage caused by lightening	18 June 2003	Replacement of three circuit boards with newly modified ones by Study Team (JRC)
Diffusion of Flood Warning	Iraghf Warning Post	DC UPS	June 2003	Not charged.	Low and unstable voltage of power supply	July 2003	Provision of an automatic voltage regulator by Study Team
Diffusion of Flood Warning	Iraghf Warning Post	One metal mast for supporting the cable between the post and the second laud speakers.	4 Aug. 2003	Crushed by debris	Debris flow during the rainstorm	21 Aug. 2003	Replacement of the metal mast with two concrete masts by the Study Team
Diffusion of Flood Warning	Iraghf Warning Post	Radiotelephone	Aug. 2003	Unstable communication with Caidat and Province	Low signal strength	18 Aug. 2003	Replacement of the non-directional antenna with a directional antenna by Study Team.

Sohime : The Moroccan company that signed the maintenance contract of the Pilot Project equipment with DGH.
JRC: Japan Radio Co., Ltd, the Japanese supplier of the Pilot Project equipment

Table 9.1 IMPLEMENTATION SCHEDULE OF MASTER PLAN

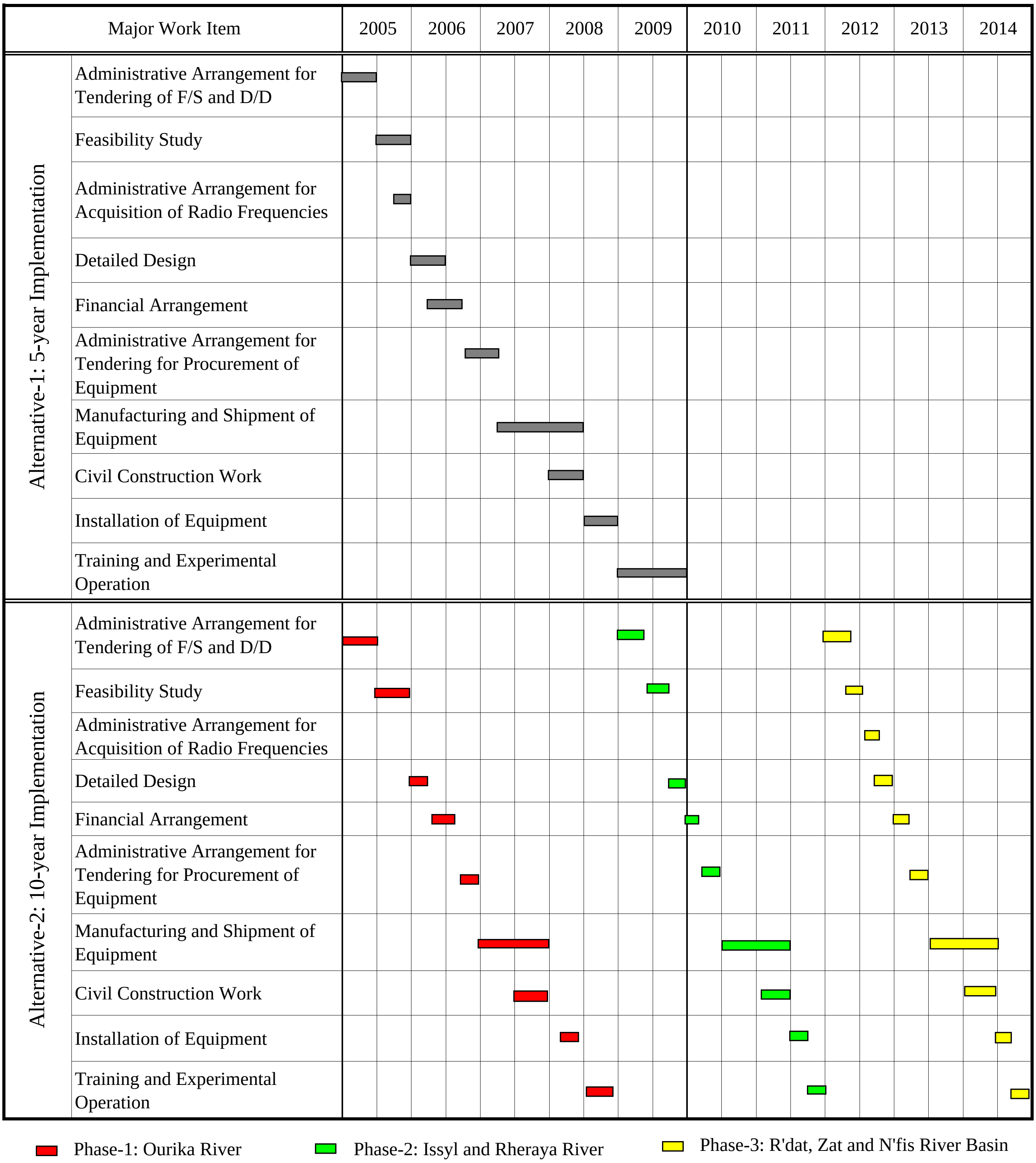


Table 10.1 DEBRIS FLOW POTENTIAL STREAM MONITORING REPORT

Item	Contents	Remarks
Date	Day Month Year （Name of Inspector： ）	Rainfall mm （Date of event）
Name of Torrent	No. and Name Location	
Assets to be Protected	Road（ m） Houses（ Nos.）Land（ ha） Features as tourist spot（ Ex. Bathing spots）	
Torrent	Ruins of Debris Flow Estimated Volume of Sediment (Width ,Depth) Change of Height of Bed (Up Down) Discharge （Water Level cm, Width m）	Height of Staff Gauge
Slope	Ruins of Slope Failure Vegetation	
Others	Observation：Potentiality of Disaster	
Photograph	Upstream (Fixed Point): Riverbed、 Slope	
Photograph	Middle-stream (Fixed Point): Riverbed, Slope	
Photograph	Downstream (Fixed Point): Riverbed, Slope	
Photograph	LocationS detected drastic change from previous observation	