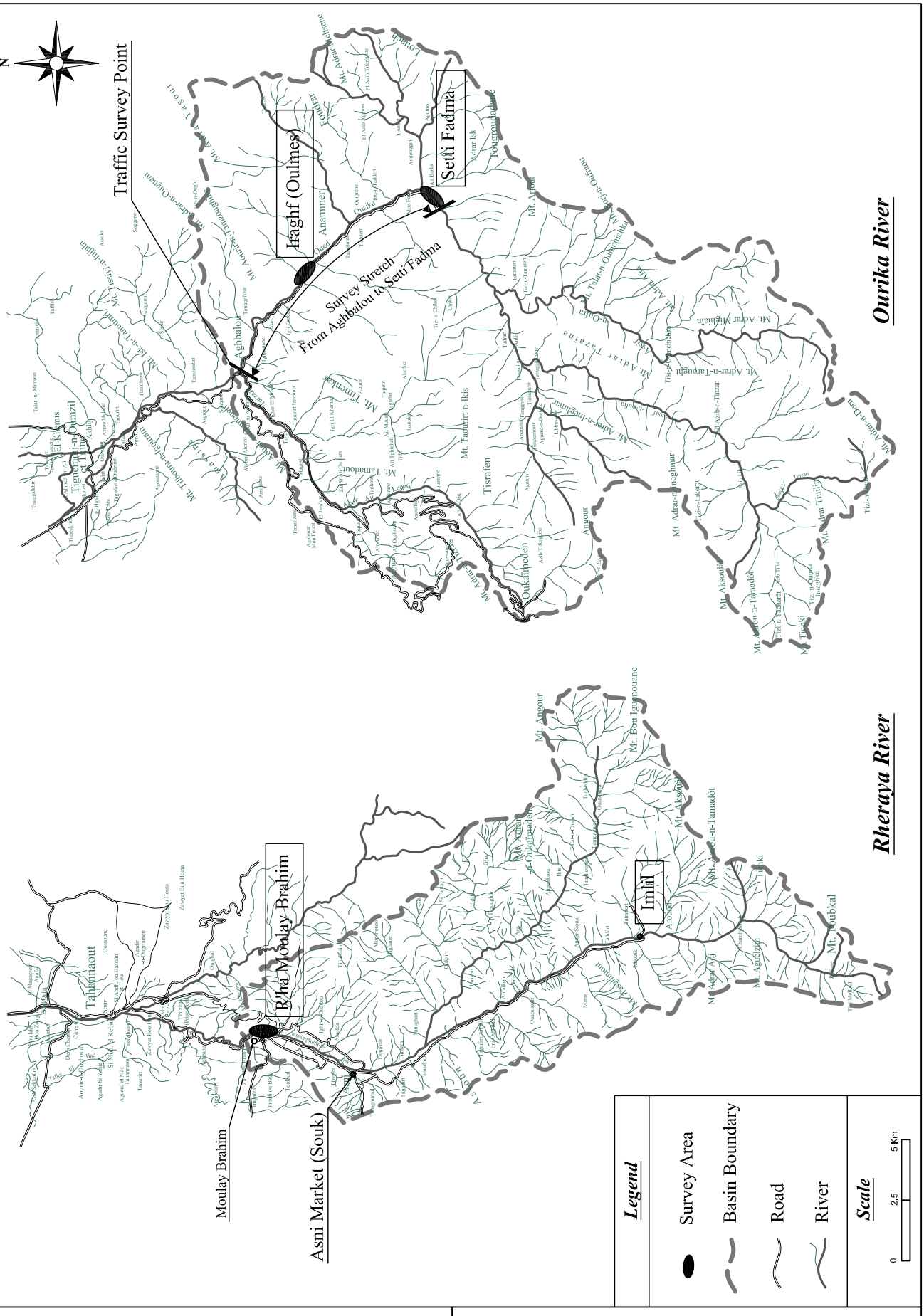
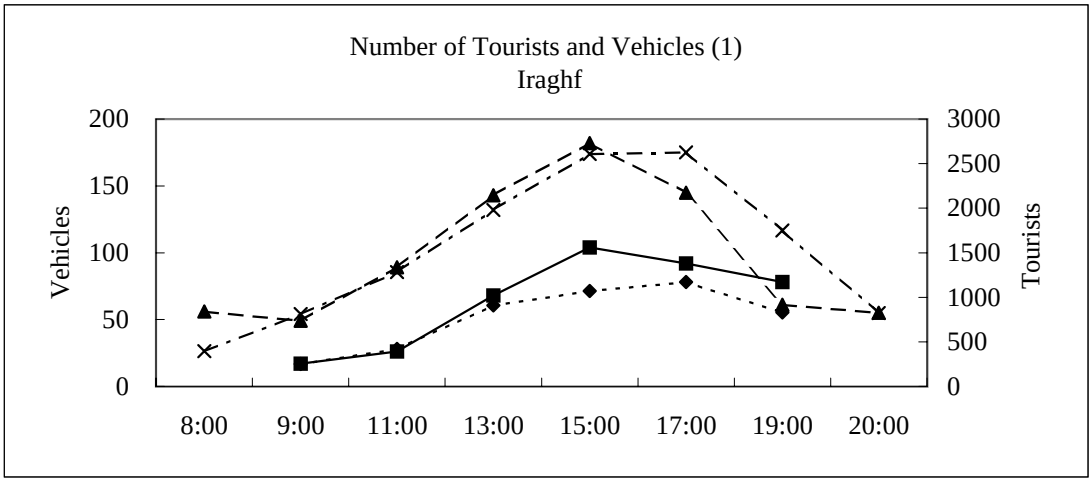
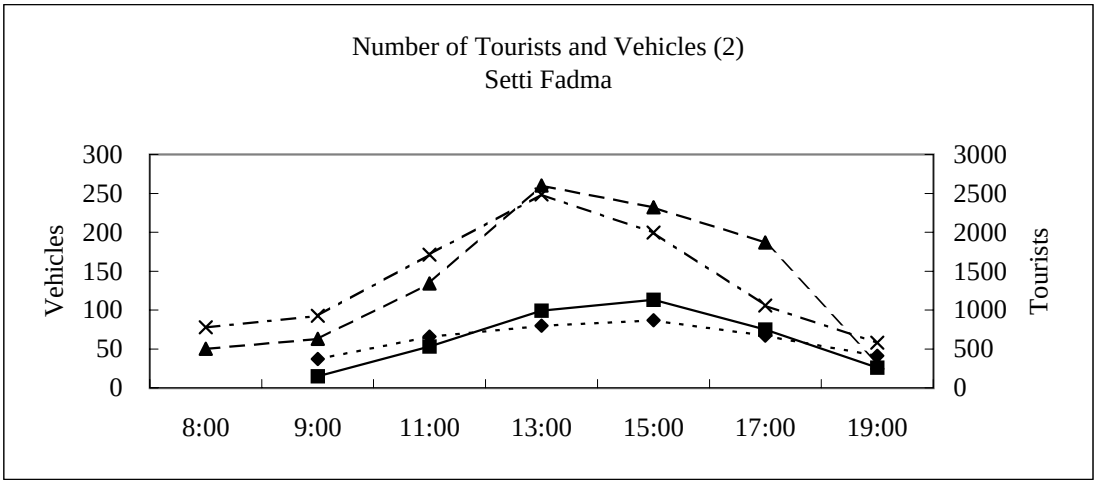
FIGURES

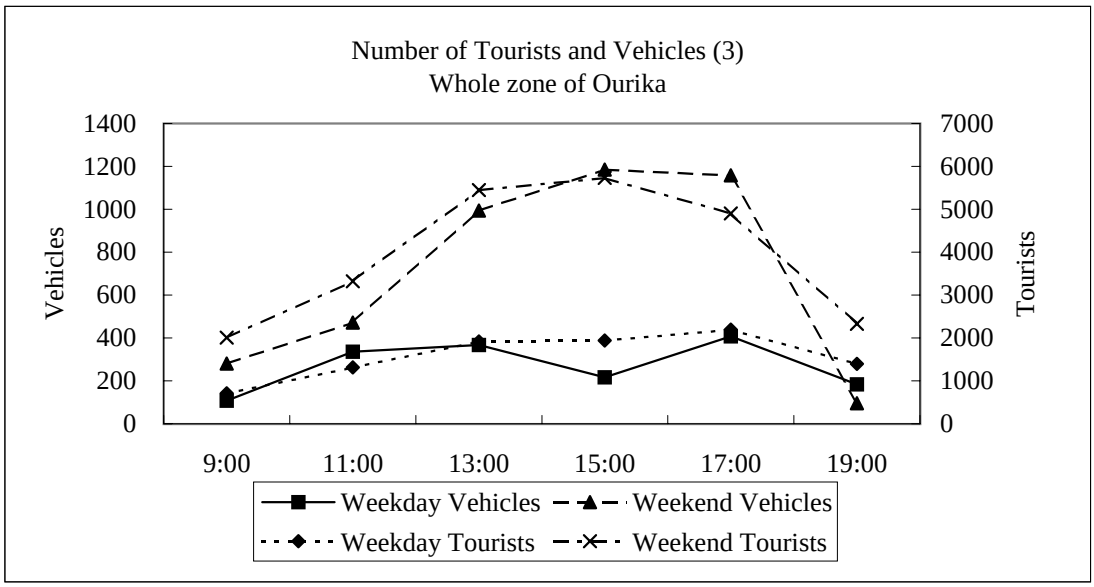


THE MASTER PLAN STUDTY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION THE KINGDOM OF MOROCCO	Fig. F.2.1 LOCATION OF TOURISM SURVEY

Ourika River

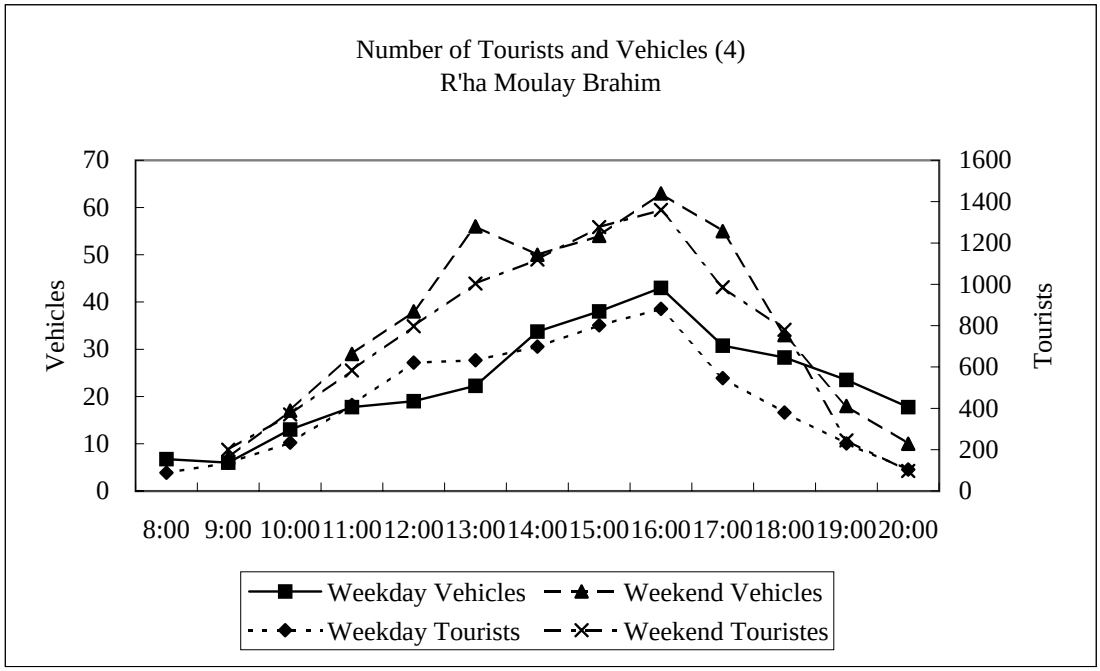




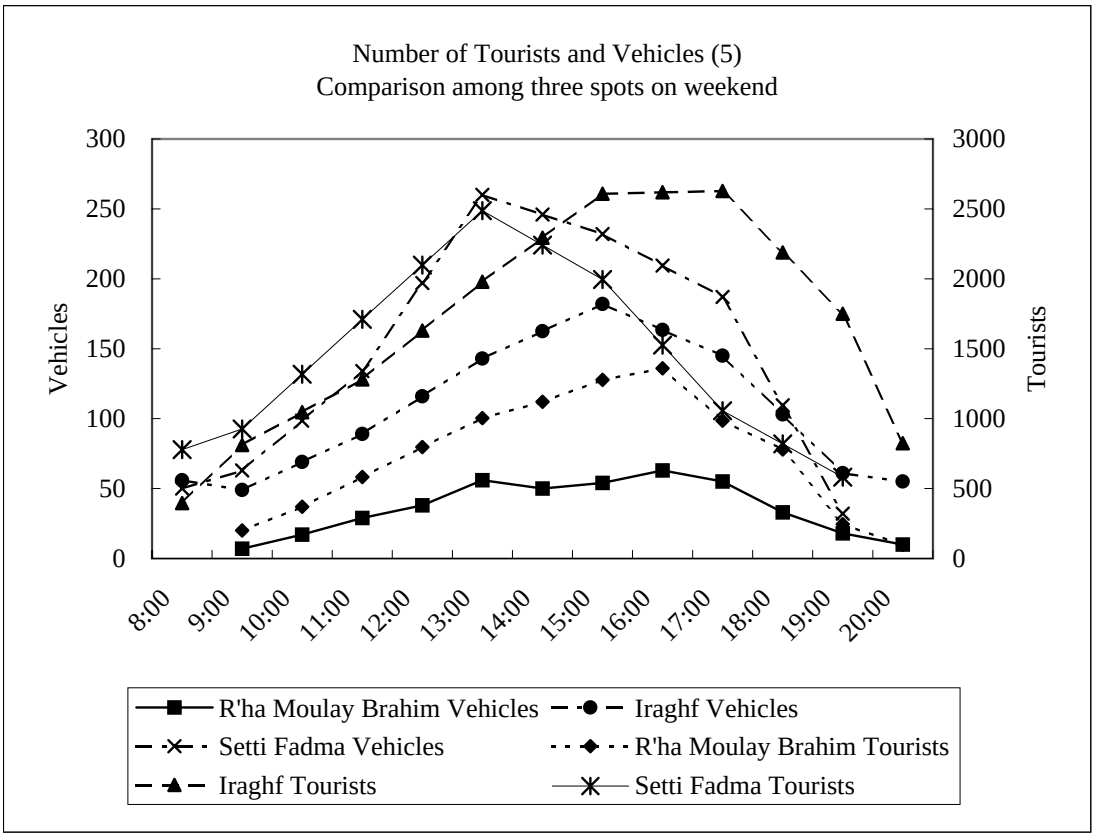


THE MASTER PLAN STUDY ON **FLOOD FORECASTING AND WARNING SYSTEM** **FOR ATLAS REGION IN THE KINGDOM OF MOROCCO**	**Fig.F.2.2 (1/3) SUMMARY RESULTS OF TOURISM SURVEY**

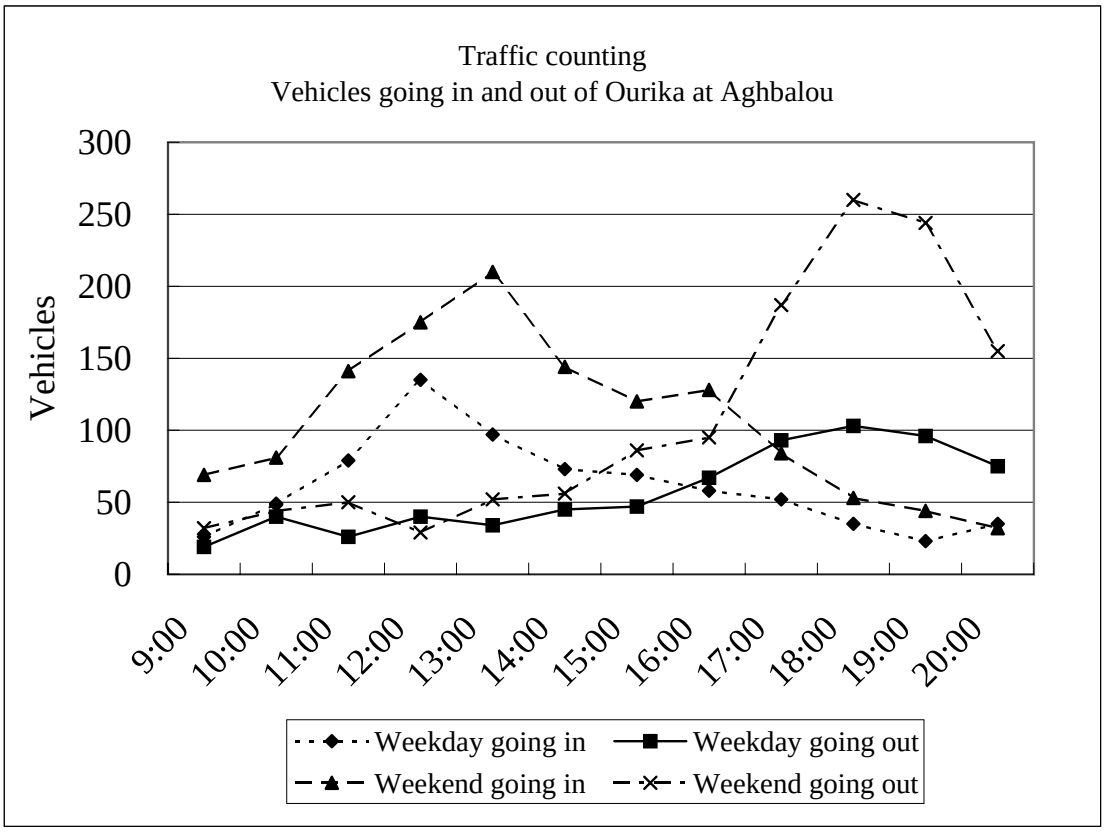
Rheraya River

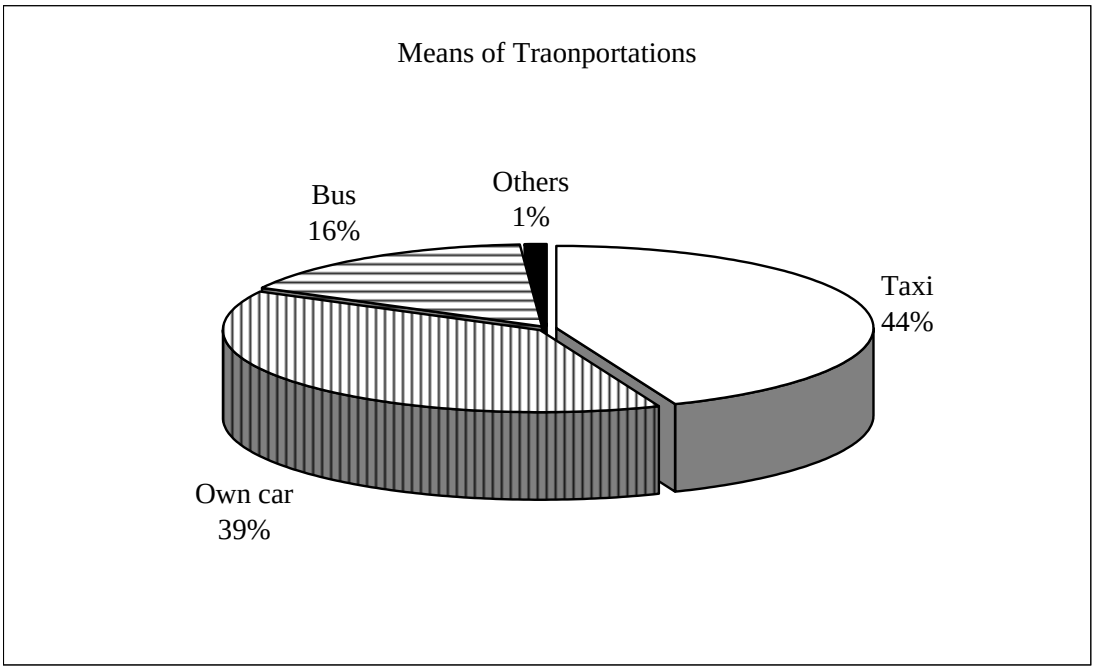


Comparison



THE MASTER PLAN STUDY ON **FLOOD FORECASTING AND WARNING SYSTEM** **FOR ATLAS REGION IN THE KINGDOM OF MOROCCO**	**Fig.F.2.2 (2/3) SUMMARY RESULTS OF TOURISM SURVEY**

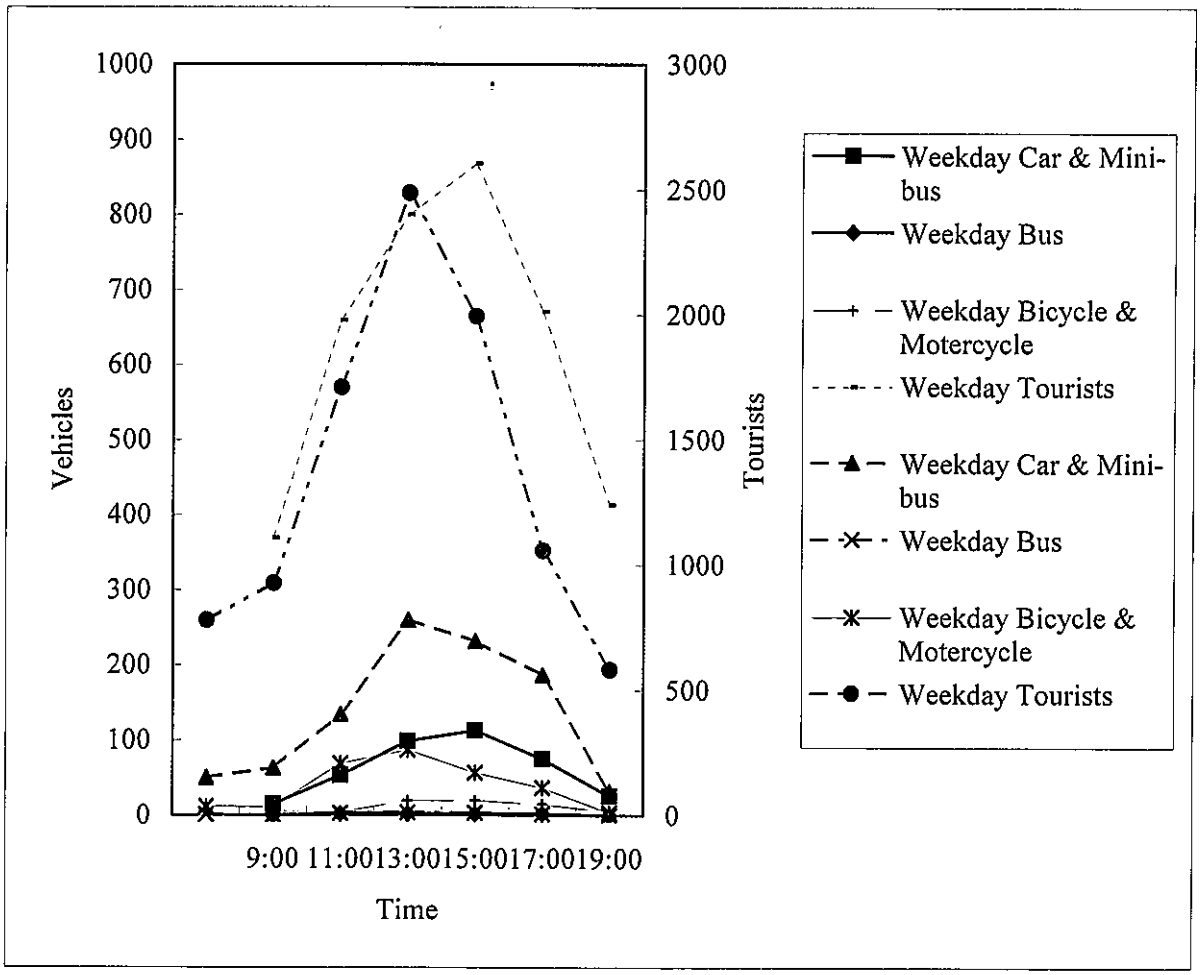




THE MASTER PLAN STUDY ON **FLOOD FORECASTING AND WARNING SYSTEM** **FOR ATLAS REGION IN THE KINGDOM OF MOROCCO**	**Fig.F.2.2 (3/3) SUMMARY RESULTS OF TOURISM SURVEY**

Number of Tourist and Vehicles
Setti Fadma

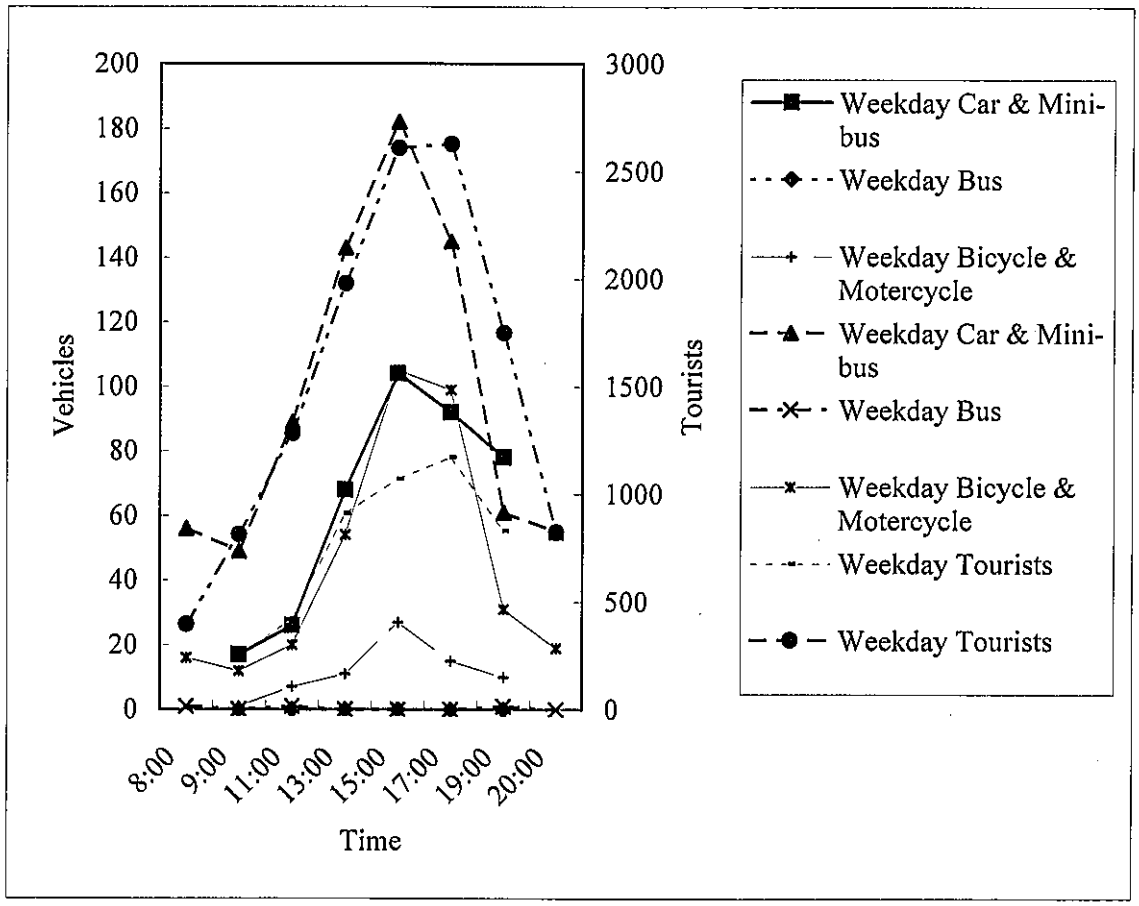
	Weekday (Thursday)				Weekend (Sunday)			
	Weekday Car & Mini-bus	Weekday Bus	Weekday Bicycle & Motercycle	Weekday Tourists	Weekday Car & Mini-bus	Weekday Bus	Weekday Bicycle & Motercycle	Weekday Tourists
					50	1	12	778
9:00	15	0	6	369	63	0	11	926
11:00	53	2	4	659	134	3	69	1710
13:00	99	2	20	800	260	4	87	2487
15:00	113	2	20	868	232	4	57	1995
17:00	75	2	15	671	187	2	37	1057
19:00	26	0	5	413	32	0	4	582



THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO	**Fig. F.2.3 (1/5) RESULTS OF COUNTING SURVEY**

Number of Tourist and Vehicles
Iraghf (Oulmes)

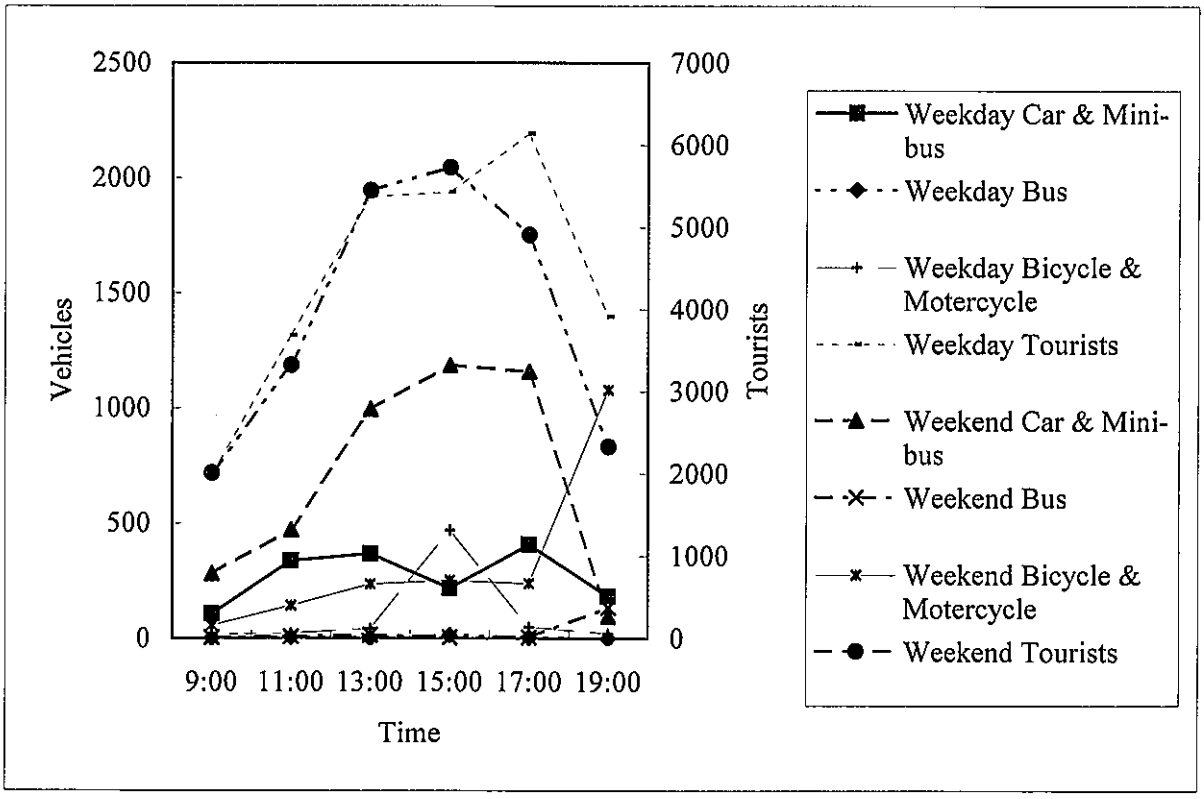
	Weekday (Thursday)				Weekend (Sunday)			
	Weekday Car & Mini-bus	Weekday Bus	Weekday Bicycle & Motercycle	Weekday Tourists	Weekday Car & Mini-bus	Weekday Bus	Weekday Bicycle & Motercycle	Weekday Tourists
8:00					56	1	16	396
9:00	17	0	1	250	49	0	12	812
11:00	26	0	7	420	89	1	20	1281
13:00	68	0	11	910	143	0	54	1979
15:00	104	0	27	1070	182	0	105	2609
17:00	92	0	15	1170	145	0	99	2628
19:00	78	0	10	830	61	1	31	1750
20:00					55	0	19	824



THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO	**Fig. F.2.3 (2/5) RESULTS OF COUNTING SURVEY**

Number of Tourist and Vehicles
Whole zone of Ourika

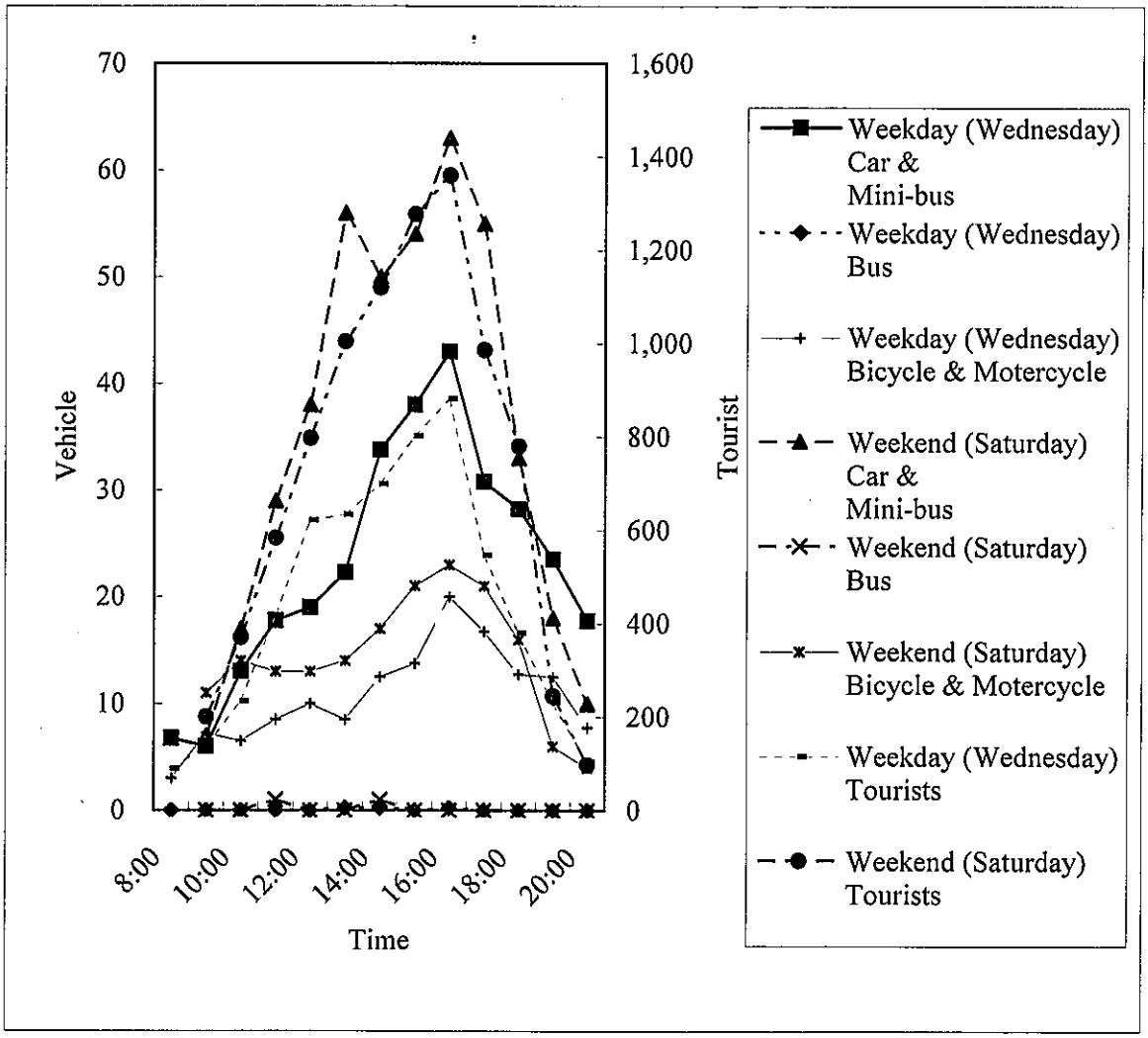
	Weekday (Thursday)				Weekend (Sunday)			
	Weekday Car & Mini-bus	Weekday Bus	Weekday Bicycle & Motercycle	Weekday Tourists	Weekend Car & Mini-bus	Weekend Bus	Weekend Bicycle & Motercycle	Weekend Tourists
9:00	107	1	16	707	281	4	57	2009
11:00	336	5	24	1314	471	8	142	3320
13:00	367	2	41	1919	994	15	235	5446
15:00	217	14	469	1938	1185	4	252	5728
17:00	407	4	50	2193	1158	6	238	4906
19:00	183	0	22	1398	96	135	1079	2332



THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO	**Fig. F.2.3 (3/5) RESULTS OF COUNTING SURVET**

Number of Tourist and Vehicles
R'ha Moulay Brahim

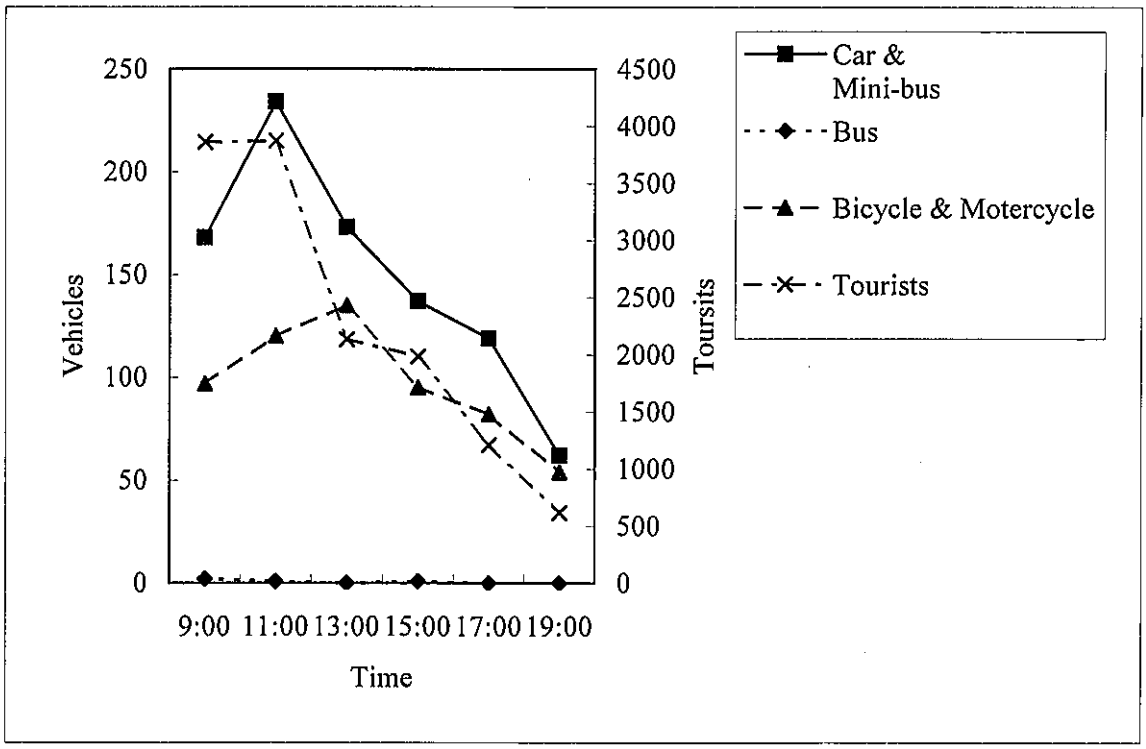
	Weekday (Wednesday)				Weekend (Saturday)			
	Car & Mini-bus	Bus	Bicycle & Motercycle	Tourists	Car & Mini-bus	Bus	Bicycle & Motercycle	Tourists
8:00	7	0	3	89				
9:00	6	0	7	136	7	0	11	200
10:00	13	0	7	234	17	0	14	370
11:00	18	0	9	416	29	1	13	583
12:00	19	0	10	621	38	0	13	797
13:00	22	0	9	633	56	0	14	1004
14:00	34	0	13	698	50	1	17	1120
15:00	38	0	14	801	54	0	21	1277
16:00	43	0	20	881	63	0	23	1360
17:00	31	0	17	546	55	0	21	986
18:00	28	0	13	380	33	0	16	780
19:00	24	0	13	230	18	0	6	245
20:00	18	0	8	104	10	0	4	97



THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO	Fig. F.2.3 (4/5) RESULTS OF COUNTING SURVEY

Number of Tourist and Vehicles
Marketday Asni (Saturday)

	Marketday Asni (Saturday)			
	Car & Mini-bus	Bus	Bicycle & Motercycle	Tourists
9:00	168	2	97	3862
11:00	234	1	120	3873
13:00	173	0	135	2134
15:00	137	1	95	1981
17:00	119	0	82	1209
19:00	62	0	54	617



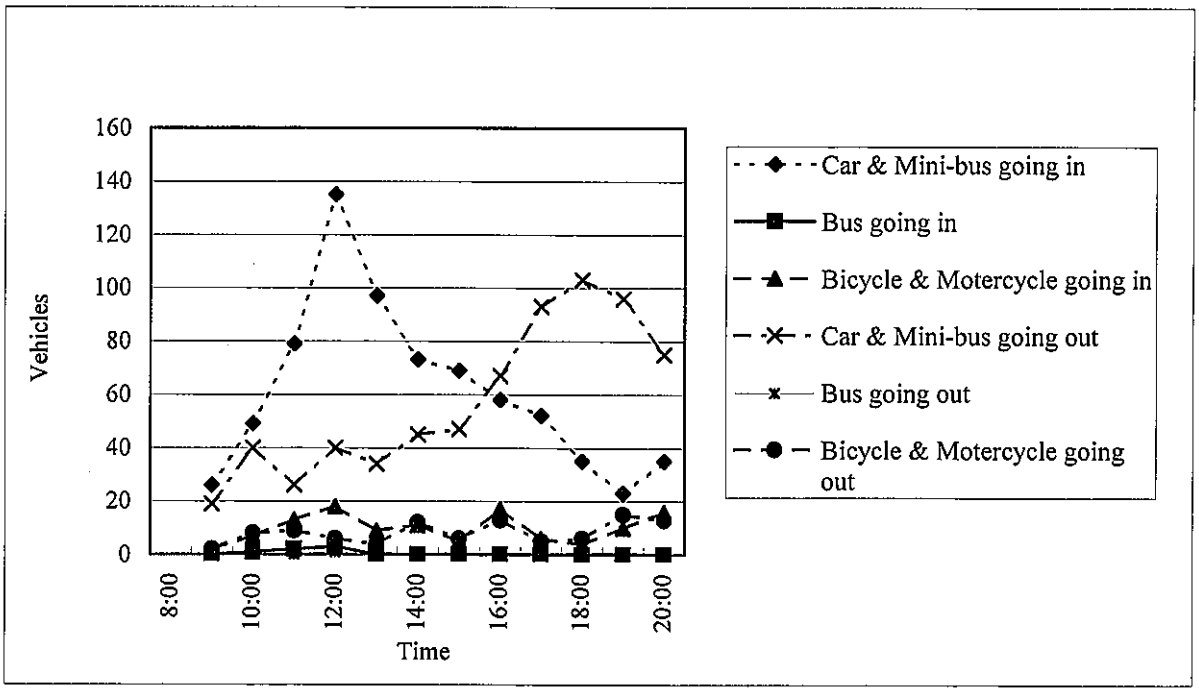
THE MASTER PLAN STUDY ON FLOOD FORECASTING AND WARNING SYSTEM FOR ATLAS REGION IN THE KINGDOM OF MOROCCO	**Fig. F.2.3 (5/5) RESULTS OF COUNTING SURVEY**

Traffic Counting
Vehicles going in and out of Ourika at Agbalou on weekday (Thursday)

	IN			OUT		
	Car & Mini-bus	Bus	Bicycle & Motercycle	Car & Mini-bus	Bus	Bicycle & Motercycle
8:00						
9:00	26	0	2	19	0	2
10:00	49	1	7	40	0	8
11:00	79	2	13	26	0	9
12:00	135	3	18	40	1	6
13:00	97	0	9	34	1	4
14:00	73	0	11	45	0	12
15:00	69	0	5	47	1	6
16:00	58	0	17	67	0	13
17:00	52	0	6	93	0	5
18:00	35	0	4	103	1	6
19:00	23	0	10	96	1	15
20:00	35	0	16	75	0	13

Accumulated

	IN			OUT		
	Car & Mini-bus	Bus	Bicycle & Motercycle	Car & Mini-bus	Bus	Bicycle & Motercycle
8:00						
9:00	26	0	2	19	0	2
10:00	75	1	9	59	0	10
11:00	154	3	22	85	0	19
12:00	289	6	40	125	1	25
13:00	386	6	49	159	2	29
14:00	459	6	60	204	2	41
15:00	528	6	65	251	3	47
16:00	586	6	82	318	3	60
17:00	638	6	88	411	3	65
18:00	673	6	92	514	4	71
19:00	696	6	102	610	5	86
20:00	731	6	118	685	5	99



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

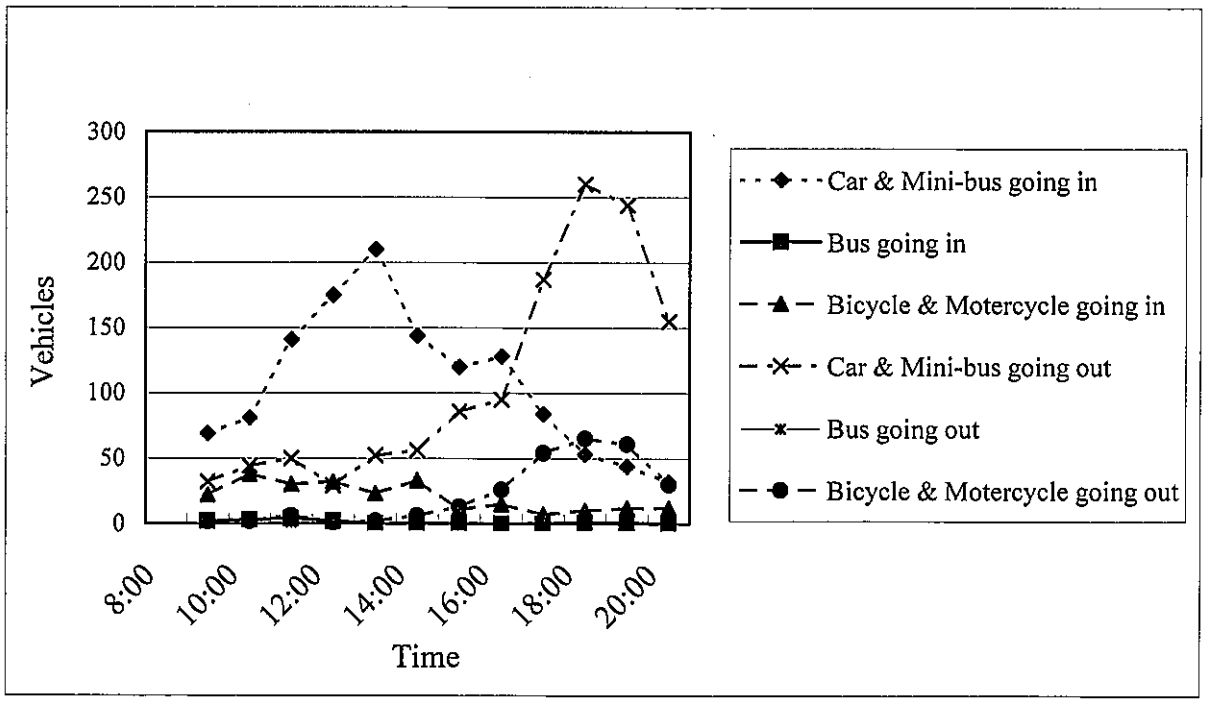
Fig. F.2.4 (1/2) RESULTS OF TRAFFIC SURVEY (Weekday)

Traffic Counting
Vehicles going in and out of Ourika at Agbalou on weekend (Sunday)

	In			Out		
	Car & Mini-bus	Bus	Bicycle & Motercycle	Car & Mini-bus	Bus	Bicycle & Motercycle
8:00						
9:00	69	2	22	32	3	2
10:00	81	3	38	44	2	2
11:00	141	4	30	50	1	6
12:00	175	2	32	29	1	1
13:00	210	0	23	52	0	2
14:00	144	0	33	56	0	6
15:00	120	0	11	86	0	13
16:00	128	0	15	95	0	26
17:00	84	0	7	187	2	54
18:00	53	1	10	260	3	65
19:00	44	1	12	244	0	61
20:00	32	0	12	155	2	30

Accumulated

	In			Out		
	Car & Mini-bus	Bus	Bicycle & Motercycle	Car & Mini-bus	Bus	Bicycle & Motercycle
8:00						
9:00	69	2	22	32	3	2
10:00	150	5	60	76	5	4
11:00	291	9	90	126	6	10
12:00	466	11	122	155	7	11
13:00	676	11	145	207	7	13
14:00	820	11	178	263	7	19
15:00	940	11	189	349	7	32
16:00	1068	11	204	444	7	58
17:00	1152	11	211	631	9	112
18:00	1205	12	221	891	12	177
19:00	1249	13	233	1135	12	238
20:00	1281	13	245	1290	14	268



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

Fig. F.2.4 (2/2) RESULTS OF TRAFFIC SURVEY (Weekend)

APPENDIX G

ENVIRONMENTAL CONSIDERATIONS

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

APPENDIX G ENVIRONMENTAL CONSIDERATIONS

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CHAPTER 1. EXISTING ENVIRONMENTAL CONDITIONS

1.1 National Strategy

In 1995 the Moroccan Ministry of the Environment published the "National Strategy for the Protection of the Environment and Sustainable Development Report", based on a study implemented by the ministry, PNUD and UNESCO. The Strategy has identified serious environmental problems facing Morocco of soil erosion, desertification and water resource scarcity due to seasons of drought. These problems have been aggravated by the rapid growth in population and economic development during the period of 1980 to 1992.

In response to these problems the Strategy has identified four areas of priority where environmental action is required; water resources management, waste management, air quality and soil erosion combating. The Strategy has also determined targets for water quality, air quality, waste management, the urban environment, soil and natural environment, and coastal areas as follows:

- Water resources (prevent resources contamination by wastewater, rationalize use and stop overexcessive pumping, etc.)
- Waste management (reduce waste generation at source, promote recycling, provide efficient and widespread collection coverage, improve conditions at landfill sites, etc.)
- Air quality (improve and monitor air emissions at industrial plants in Casablanca, Rabat, Safi and Marrakech)
- Soil erosion and natural environment (arrest deforestation, avoid excessive cultivation, fight phenomena of desertification and salination, etc.)
- Urban environment (control rapid urbanization and spread of informal housing)
- Coastal areas (arrest pollution of marine resources, stop coastal erossion, encourage planned development of coastal regions, etc.)

The facilities proposed in the master plan are deemed not to aggravate these environmental problems further.

1.2 Existing Environmental Setting

In order to determine any potential impacts on the environment that may be generated by the master plan proposed in this Study, it is necessary first to attain an understanding of the existing environmental setting in which the master plan projects shall be implemented. This understanding has been achieved through site visits and the review of reports and reference materials relevant to the Study area.

1.2.1 Location

The Study area is located in the Atlas Mountains area south of Marrakech, in Wilaya Marrakech. To the north are the prefectures of Marrakech Menara, Sidi Youssef Ben Ali (a part of which is located within the Study area) and the province of El Kelaa Des Sraghna. South are the provinces of Ouarzazate and Taroudant, to the east is the province of Azilal and to the west the province of Chichaoua.

Haouz province, where the Study Area is located belongs to the Tensift Economic Zone, which is one of the economic zones of the Kingdom. Marrakech is the economic center of the Tensift Economic Zone, which is one of seven zones.

1.2.2 History and Socioeconomic Conditions

The Study area is almost all located in Al Haouz Province. The word "Haouz" historically refers to the region covering the Atlas Mountains with Marrakech at its center. "Haouz" is believed to come from the Arabic word "hiyaza" which means possession. This name may have originated from the leading role Marrakech played with respect to its surrounding Atlas areas. In later times the Haouz region came to define the area south of Marrakech and stretching into the Atlas Mountains.

The inhabitants of the Study Area at present originate from six tribes, which all belong to the larger tribal group of "Masmouda" (reference: *LE HAOUZ DE MARRAKECH, Paul Pascon, 1983*). The Masmouda tribe was first referred to in writings of the year 1068. A 1948 map distributed the tribes by river basin as follows:

R'dat River Basin	Glaoua tribe	Issyl River Basin	Mesfioua tribe
Zat River Basin	Mesfioua tribe	Rheraya River Basin	Rheraya tribe
Ourica River Basin	Ourica tribe	N'Fis River Basin	Guedmioua and Goundafa tribes

It is interesting to note that each river basin was more or less inhabited by a specific tribe. Namely Glaoua tribe in the R'dat River, Mesfioua tribe in the Zat and Issyl River, Ourika tribe in the Ourika River, Rheraya tribe in the Rheraya River, Guedmioua and Goundafa tribes in the N'fis River Basin. These tribes are all of Berber origin and were largely native to the surrounding areas. They populated the Atlas region, which was easily defendable and supported agricultural activity.

The socioeconomic conditions of the Study area, in terms of population and economic activities have been described elsewhere in this report.

1.2.3 Natural Conditions

The water hydrology, soils, geology, topography and meteorology of the Study area have been detailed in other parts of this Report, based on data collection, field visits and surveys. These conditions shall form the background when considering the impacts of the master plan on the environment.

1.2.4 Land Use Patterns

The land use issue is very important because of the nature of the Study Area, being floodplains. The intervention of development in the floodplain is the best guarantee to increase damages and causalities during floods. In that sense the danger from floods is multiplied in the Study area.

The Study area inhabitants are mainly engaged in agriculture and the tourist industries. The field survey implemented in this Study shows that agriculture land use is dominant in the Issyl basin with 74% of total land use (orchard and agriculture) followed by N'Fis river basin where this activity accounts for 43% of the total. In these two basins agricultural lands are mostly adjacent to the riverbanks. In the other river basins the land use shares of this activity range between 25 – 35% of the total. Agricultural lands are mostly adjacent to the riverbanks. One significant feature of the Ourika and Rheraya river basins is the orchard cultivation inside the clearly identifiable river paths (which are dry most of the time). Also shepherds are bringing their sheep to the river areas, partly for feeding them waste illegally discharged there.

Facilities to support the tourist industry in the Study area such as restaurants, small shops, handicrafts and places for vehicles transporting tourists to stop and tourists to alight and spend time are built directly alongside the river path.

The land use conditions are further exasperated by the construction of houses and facilities for the inhabitants living in the river basins. Although most of the homes are built on higher grounds, we visited an elementary school constructed right alongside the river path in Sitti Fatma and the Qaid office in Ansi was also constructed alongside the river path there.

The Water Act (Law No. 10-95) contains clauses on construction of facilities near the rivers and also the requirement to prepare land use plans for river basins. However implementation of the stipulations of this law in the Study area river basins has not been observed.

1.2.5 Environmental Pollution Conditions

(1) Water Quality

The Water Quality Monitoring Department of the DHRT takes samples of surface and ground waters in the Tensifit area at least twice annually and analyzes them at its laboratories in Marrakech and DGH laboratories in Casablanca. Seven of the surface water samples analyzed in February 1999 came from the Study area river basins and are shown in the following table. The sampling locations are shown in Figure G.1.1.

River basin	Sample number	DO2 (Mg/l)	BOD5 (Mg/l)	COD (Mg/l)	NH4+ (Mg/l)	Tot. Phosphate (Mg/l)	Fecal coliforms (/100 ml)	Global quality
R'dat	44/54	8.4	0.7	6.5	0.002	0.084	330	2
R'dat	1915/45	6.3	5.04	14.4	5.93	0.84	1,000	4
N'Fis	1566/53	8.9	0.1	14.2	0.007	0.02	16	1
Zat	1562/52	8.1	0.1	6.5	0.005	0.017	230	2
Ourica	2089/53	8.4	1.35	6.5	0.004	0.026	930	2
Rheraya	1565/63	4.2	0.3	9.4	0.018	0.02	300	3
Zat	139/54	8.2	1.23	6.5	0.005	0.0121	500	2

Note: Global Quality; 1. Very good, 2. Good, 3. Moderate, 4. Poor, 5. Very Poor (DGH indices)
Source: DHRT, Water Quality Department, 1999

With the exception of the high concentration of ammonia in one of the two samples taken from R'dat River, the water quality of all the samples taken in February 1999 is quite good. One of the reasons for this good quality is the lack of municipal wastewater discharge to these rivers. Samples taken from Wadi Tensift west of Marrakech are very bad in quality because the municipal wastewater from the city is partly discharged in that river. However there is a plan to construct a wastewater treatment plant by the year 2003 to serve Marrakech.

The Study area depends for its drinking water on the rivers and groundwater. The area is served by the Haouz aquifer. The water quality is ranked as good by DGH. Results of the groundwater samples analyzed from this aquifer are given in the following table. The results of two other aquifers; La Bahira (north of the Study area) and Abda Doukla to the west are also included for comparison.

Aquifer	Unit	Haouz	La Bahira	Abda Doukla
Conductivity	/cm	<1,300	1,300 – 2,700	2,700 – 3,000
Nitrate (NO3)	mg/l	<25	25 – 50	50 – 100
Chloride (Cl)	mg/l	<300	300 – 750	750 – 1,000
Organic matter	mg/l	<5	5 – 8	>8
Ammonia (NH4+)	mg/l	<0.5	0.5 – 2	2 – 8
Fecal coliforms	ml	<2,000/100 ml	20,000/100 ml	20,000/100 ml
Overall Qaulity (DGH ranking)		Good	Moderate	Poor

Source: DGH, 1998-1999 publication

Water salinity is slightly high for all aquifers, but in general the Haouz aquifer has the best quality amongst the three aquifers. Overall the water quality of the surface waters and groundwater in the Study area are good and better than other heavily developed areas such as the coastal area stretching from Kenitra in the north to El Jadida in the south and along the Mediterranean coast in Nador and Oujda.

(2) Waste Management

In the Study area only the 4 centers of Ait Ourir, Oukaimeden, My Brahim and Tahanout have some limited wastewater and solid waste collection service (refer to *ETUDE MONOGRAPHIQUE DE LA PROVINCE D'AL HAOUZ, 1997*). However the services provided in these centers are primitive.

Wastewater is mainly collected separately of storm water and is either discharged into the river path or to agricultural fields for use as organic fertilizer. There is no treatment of the collected wastewater.

Solid wastes are dumped at collection points from where they are collected at irregular frequencies. In Ansi (Rheraya river basin) the waste was piled at the weekly market since 4-5 days waiting for removal. This area is located next to the river path. In Aghbalou (Ourica river basin) the waste was being dumped in the grounds occupied by the DHRT station. Some parts of the Issyl River path are being used as dumping grounds for waste generated in Marrakech. The situation is particularly serious in the Issyl River section just to the south of the Tensift River.

Concerning industrial wastewater DHRT is now in the process of listing up the industrial works in the Haouz region. These are mainly food processing works but also include some wood and textile works. The main problem is the wastewater discharged from the olive oil manufacturing plants. These pose a threat to the groundwater.

Finally reference should be made to the much construction wastes left behind from the construction activities in the Study Area because of the access problems in many parts of the Study Area.

1.2.6 Fauna, Flora and National Parks

The Study Area is located in a sub-humid climatic zone. This region supports mainly the steppes on high altitudes (Atlas) surrounded by forests. It is divided into the Sclerophyll Forests zone and the Atlas Steppes zone (refer to "*FLORE ET ECOSYSTEMES DU MAROC*, Abdelmalik Benabid, 2000).

The first zone is characterized by richness in forests spread over wide areas and remarkable biodiversity. The climate is hot and semi-arid with colder conditions on the higher lands. The major forests are *Quercus rotundifolia, Q. suber, Q. coccifera, Olea europea, Tetraclinis articulata, Juniperus phoenicea,*

Pinus halpepensis, and P. pinaster Maghrebiana. The fauna species include macaque (in limited areas), American big horn, boar, jackal, fox, lynx, porcupine, gazelle, and stag.

The Study Area is mainly located in the Atlas steppes zone. This area is significant in the small number of trees, and the vast steppes. The climate is semi-arid and sub-humid reaching severe frost conditions. The major steppes species are *Erinacea anthyliis, Astragalus boissieri, A. numidicus, Arenaria pungus,* and *Villa mairei.* The fauna species located here include American big horn, small mammals, invertebrates, etc.

The Toubkal National Park is a preserved area, which lies in the Study Area, in the basins of Ourika, Rherya and N'Fis Rivers. This park was created in 1942 (based on the same reference as above) and occupies an area of 38,000 hectares. The highest mountain in Morocco, Jbel Toubkal is located here (outside the Study Area). The major forests include *Quercus rotundifolia, Juniperus phoenicea, J. thurifera, Tetraclinis articulata* and very local *Q. faginea*. In total there are about 400 – 500 species, some of which are endangered. The fauna inhabiting the park includes American big horn, porcupine, and lynx. There are also 95 different species of birds, some of which are very rare.

1.2.7 Cultural Assets in the Study Area

The list and pertaining laws concerning the cultural assets in the Study Area that are protected were collected from the regional office of the Ministry of Cultural Affairs in Marrakech. Of relevance to this project are the following designated culturally protected areas;

- Five ancient bridges on the Issyl River, east of Marrakech city (law date 1922/1/22)
- The Asni and Ourica areas (law date 1943/1/10)
- The Setti Fatma and Zaouia areas (law dates 1949/7/21 and 1953/11/18)

The laws on protection of the cultural assets state that no construction works are to be carried out in the designated areas without first obtaining the approval of the Ministry of Cultural Affairs. Therefore the project facilities shall also be subject to obtaining such an approval.

However in discussion with the Marrakech regional office and after consideration of the project sites and scale the regional office advised that there would be most likely no objection from the Ministry on the project implementation.

1.3 Environmental Legislation

1.3.1 General

In a study prepared in 1992 ("*PROJET DE GESTION DE L'ENVIRONMENT, ANNEXE 5, ETUDE DETAILLEE DU CADRE LEGISLATIF ET REGELEMENTAIRE*"), a detailed study of the existing environmental laws and regulations was summarized. According to that study there are over 360 laws, decrees and regulations pertaining to the environment, which were issued during the period of 1913 to 1985. A breakdown by subject is shown in the following table.

Cleanliness	23	Quarries	2
Municipal wastewater	14	Continental waters	17
Public places	21	Green spaces	5
Fauna	53	Forests	26
Health	5	Mines	16
Fisheries	59	Urban planning	6
Nuclear pollution	8	HM King Hassan II environmental prize	23
Explosive products	5	Historic sites	36
Soil	5	Fraud	37

Recently The Water Act (Law No. 10-95) was promulgated. The law has established the water bodies as public hydraulic domains and made conditions for their protection, such as:

- Control of land use at the water bodies and their surroundings through planned land use, forbidding of constructions without authorizations, restricting excavations for construction materials without permission, etc.
- Controlling the water utilization of water bodies
- Establishment of basin agencies, which are public establishments responsible for implementation of the above items, as well as the water quality and construction of infrastructure necessary for flood mitigation

The Water Act states that any expropriations along the water bodies shall be made in accordance with the Dahir no. 1-81-254 issued in 1982. This Dahir sets out the juridical process for appropriating land for the public benefit and the estimation of the indemnification.

The Moroccan government, represented by the Ministry concerned with the environmental affairs has been trying to pass a global law for the protection of the environment. This law is still under discussion within the government at the time of preparation of this report. Formed of 20 chapters and 94 articles, this draft law has briefly the following content:

- Control of environmental pollutants to the atmosphere, water resources, and soil
- Control of toxics substances and wastes
- Control of liquid and gaseous effluents
- Preparation of environmental quality norms and standards
- Development of urgent improvement plans
- Preparation of environmental impact assessment
- Preparation of fines and punishments concerning environmental pollution
- Strengthening of institutional capabilities

1.3.2 Environmental Impact Assessment Law

Although the draft environmental protection law described in the previous section contains a clause on environmental impact assessment, a separate draft law and regulations for environmental impact assessment have also been prepared and are reported to be under deliberation in the Moroccan parliament at this time. There is no indication when this law will be ratified by the parliament.

Main features of the draft EIA law and regulations are as follows:

- All activities, public works, structures and industrial concerns which may have an impact on the environment, whether private or public shall be subject to an EIA (those of military nature or by direct declaration of the regime are exempt).

- The EIA shall specifically evaluate the environmental impact on

  - Humans, flora and fauna
  - Soil, water, air, climate and landscape
  - Properties and cultural assets
  - The interaction amongst these factors

- The EIA shall be prepared by the petitioner for the subject works based on the terms of reference prepared by the concerned governmental authority. The EIA report must contain the following:

  (a) A non-technical summary of the information required for public disclosure.

  (b) An abstract that summarizes the contents and conclusions of the EIA.

  (c) The description of the project principle characteristics and stages (description should include fabrication process, types and quantities of the primary materials and energy resources utilized, the liquids, gaseous and solid wastes, and other aspects which are covered by the project).

  (d) Presentation of the juridical and institutional framework in which the project shall be implemented and utilized.

  (e) A description of the biological, physical and human conditions existing at the project site before the project is implemented.

  (f) Identification and analysis of the positive and negative impacts of the project activities, works, structures and industries on the surrounding biological, physical and human environments which may be effected by the project during the phases of implementation, utilization and future development.

  (g) The predicted measures for elimination, reduction or offset of the damaging consequences of the project activities, works, structures and industries on the environment and evaluation of their costs.

  (h) The program for monitoring and follow-up of the project activities, works, structures, or industries including the required data gathering, communication and management systems that will ensure the technical requirements as defined in the EIS.

  (i) Enumerating the principle parties concerned with the project activities, structures or industries that will be consulted.

- The National Committee for EIA (to be set up) shall examine the EIA from the following aspects and based on legal stipulations:

  - Conformity with the EIA terms of reference
  - Reliability of the baseline data
  - Validity of the scientific methods adopted

- Impacts of the project on the environment
- Mitigation countermeasures proposed
- Results of the public inquiry

- The committee permanent members shall be representatives of the following agovernmental agecies:

  (a) Ministry of the Interior

  (b) Ministry of Energy and Minerals

  (c) Ministry of Equipment

  (d) Ministry of Agriculture, Rural Development and Maritime Fisheries

  (e) Ministry of Commerce, Industry and Handicrafts

  (f) Ministry of Tourism

  (g) Ministry of Health

- The National Committee shall at the time of examination of the EIS invite the president of the municipal council and all the ministerial departments directly concerned with the project to participate.

- A public inquiry shall be held on the EIA, the objectives of which shall be to inform the concerned public on the potential environmental impacts of the project and obtain their comments.

- A Committee charged with the public inquiry shall be established and presided by a representative of the department concerned for the activity under examination. The Commission shall include other members from the local authority, the municipal council, a representativde from the governmental authority responsible for the environment, and two members from the National Committee for the EIA designated by the president of the public inquiry Committee.

- The draft regulations identifies projects which shall be subject to the EIA as given in Table G.1.1.

The schedule for execution of the EIA will differ by project however the draft law sets the following time schedule once the EIA documents are submitted to the National Committee for EIA and the government authority responsible for the environment.

Schedule for Execution of EIA

Item	Period	Contents
EIA submission	3 months	Acceptance of EIA by National Committee and government authority responsible for the environment
Public inquiry	1.5 months	Public inquiry commission shall include representatives from the related local authority, municipal council, governmental authority responsible for the environment and two members from the National Committee for EIA.
Project implementation		Within 5 years of acceptance

1.3.3 Administration

However briefly the institutional setup relevant to this environmental study is as follows.

(1) Ministry of Territorial Land Management, the Environment, Urbanization and Population

In 1998 a new government was formed and the then Ministry of Environment was integrated in a larger ministry responsible for land management, the environment, urban development and the inhabitants. In this ministry there is a state secretary responsible for the environment.

(2) Water Quality Department in the DHRT

The environmental section in this department is responsible for the monitoring of the surface and ground water qualities, through sampling and testing at its laboratories. Results on the water quality are reported in the previous section.

CHAPTER 2. INITIAL ENVIRONMENTAL EVALUATION PROCESS

2.1 Objectives and Methodology

2.1.1 Objectives

The Initial Environmental Examination (IEE) is the first step in the process of preparing the Environmental Impact Assessment (EIA) for a project. The scope of this study covers the IEE for the Master Plan (M/P). The Initial Environmental Examination (IEE) shall attempt to identify whether any impacts on the environment may be expected from the implementation of the M/P on the Study area. Basically the IEE has the following two objectives:

- To evaluate whether EIA is necessary for the M/P and, when necessary to define the items which are expected to have negative environmental impacts.
- To consider from the environmental point of view countermeasures for alleviating the effects of the M/P, which would be the subject for detailed examination at the Environmental Impact Assessment phase.

2.1.2 Methodology

The IEE study shall be conducted taking into consideration the Moroccan draft EIA law and decree (discussed in Chapter 1 of this Appendix G), and guidelines developed by JICA and other international aid agencies. The need for EIA based on these considerations is as follows:

Moroccan Draft EIA

This M/P does not fall under the project categories which require EIA as determined in the draft executive regulations accompanying the decree. Furthermore Article 2 of the decree exempts projects ordered by the government from EIA. It is assumed that the projects developed in the M/P will be adopted by the national government because of the savings in lives they are developed for.

World Bank

In a 1989 policy paper the World Bank developed four project categories in order to determine the necessity for EIA as follows:

- Category A: Projects which normally require an EIA
- Category B: Projects which may need some limited environmental review
- Category C: Projects which normally do not need an environmental analysis
- Category D: Environmentally beneficial projects and emergency recovery projects

Considering the benefits in savings in human lives the M/P will bring to the social environment it may easily be argued that these projects will fall under Category D of the World Bank ranking.

Japan International Cooperation Agency (JICA) Guidelines

JICA has developed environmental guidelines for a pre-IEE study, which is implemented at the time of preparation of the Study Scope of Works between the Japanese government and the government of the country receiving the development study. According to this pre-IEE study, which was implemented by

the JICA Preparatory Study Team in November – December 1999, the need for an IEE in this Study to determine impacts on certain environmental aspects was considered necessary.

The IEE has accordingly been prepared as follows:

- Understanding the M/P components, implementation method and phasing
- Developing an appreciation of the environmental setting in which the M/P projects shall be implemented through data collection and site reconnaissance visits
- Screening and scooping as defined in hereafter
- Recommendations for countermeasures to offset any potential environmental impacts and determination of the need for implementation of a full EIA

2.2 Implementation of IEE

2.2.1 Project Components

The M/P has been presented in this chapter. The M/P components subject to the IEE are summarized as follows:

- New construction:
    1) Observation Stations (for equipment related to rainfall and water level measurements) (12 stations)
    2) Relay stations (tower and attached small building for maintenance) (3 stations)
    3) Warning posts (post with attached loudspeaker and adjacent small building for housing amplifier) (17 posts)
- New equipment: Measurement equipment for rain gauges and water levels, data transmission and sirens for warning

2.2.2 Screening

Environmental aspects are screened in order to identify environmental impacts on natural and social conditions, which should be examined in more detail if a full-scale environmental impact assessment is deemed necessary.

The result of the screening of the project is shown in Table G.2.1. The results of the analysis show that further environmental examination is required for the master plan projects effect on the social environment aspects of resettlement, public health, waste and risk. In the case of the natural environment there is the need to consider further any effect on the soil erosion, landscape and fauna and flora.

2.2.3 Scoping

The purpose of scooping is to clarify any significant impacts, which may be caused by the master plan projects. The results of the scoping, implemented under the JICA guidelines are shown in Table G.2.2.

No serious impacts are predicted from the master plan project implementation however there are some items where it is recommended to make further examination. For some of these items the implementing agency is legally bound to make further examination in consultation with other government agencies such as the ministry of culture (for protection of culture property), the water basin agency to be created

under law 10 (for resettlement and economic activities), the municipality officials (for resettlement requirements) and the water and forests department (for protected areas and flora and fauna). Therefore it is considered that there is no need to study these aspects in an independent environmental evaluation, as they will be considered by competent agencies.

Other aspects of concern such as construction waste, safety against landslides and wastewater drainage shall be studied in the design of the facilities and again it is considered that an independent environmental evaluation is not necessary.

2.3 Conclusion of IEE

The potential environmental impacts as determined from the screening and scoping process are summarized in Table G.2.3.

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.

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TABLES

Table G.1.1 PROJECTS SUBJECT TO EIA (under draft law)

1. Establishments classified as dangerous of the first category	2. Infrastructure projects	3. Industrial projects	4. Agricultural projects
	Transport routes (rail, road, airport) Urban zones development Industrial zones Sea ports Dams and other water storage facilities Tourist structures (especially those located at the coastal level, in the mountains and in rural areas) Waste treatment and disposal facilities Wastewater treatment facilities Dangerous or toxic materials transport	Mining (quarries, mines, cement plants, plasterworks) Energy (gas storage, oil refineries, energy transfer, thermal plans, nuclear plants, hydroelectric plants) Chemicals (manufacturers of pesticides, pharmaceuticals, paints, elastomers and peroxydes, asbestos works) Food (food conservation, dairy products, brewing, fiseries, slaughterhouses, flour mills) Textiles, leather, wood, rubber, paper and cardboard industries	Rural land exploitation Reforestation Projects on potential but uncultivated lands Aquaculture and fish farming projects

Table G.2.1 SCREENING OF MASTER PLAN PROJECTS

No.	Environmental item	Description	Evaluation	Remark
Social Environment				
1.	Resettlement	Transfer of residence/land ownership	Yes	Stations may be built where agricultural activity exists along the river
2.	Economic activities	Loss of bases of economic activities and change in economic structure	Yes	Agriculture and tourism activities in the Study area may be affected
3.	Traffic and public facilities	Impacts on schools, hospitals and present traffic conditions, such as the increase of traffic congestion	No	New stations are not expected to attract additional traffic nor create a strain on other public facilities.
4.	Split of communities	Community split due to the interruption of area traffic	No	New stations are not of the scale to hinder movement between communities or within the one community
5.	Cultural property	Damage to loss of value of religious endowments, archeological remains or other cultural assets	No	Cultural assets in the study area are few in number and far from the new station sites
6.	Water rights and rights of common	Obstruction of fishing rights, water rights, rights of common	No	Water rights are granted by the government based on the public benefit principle
7.	Public health condition	Deterioration of public health and sanitary conditions due to generation of waste and the increase of vermin	Yes	There is a fear of the effect the electromagnetic field produced by the data transmission may have on the public health
8.	Waste	Generation of construction waste, debris and ash	Yes	Generation of construction waste and daily wastes
9.	Hazards (Risk)	Increase in danger of landslides, cave-ins, etc.	Yes	Frequent mountainside land slides and land collapse
Natural Environment				
10.	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	No large scale earthworks required
11.	Soil erosion	Topsoil erosion by rainfall after reclamation and deforestation	Yes	Fear of tree clearing when constructing new stations
12.	Groundwater	Pollution of groundwater	Yes	Small amount of wastewater will be generated at the stations
13.	Hydrological situation	Changes of river discharge and riverbed condition due to landfill and drainage inflow	No	No large scale landfill expected
14.	Coastal zone	Coastal erosion by rainfall after reclamation and deforestation	No	The projects sites are far from the coastal zone
15.	Fauna and Flora	Obstruction of breeding, extinction of habitat conditions and encroachment into protected areas	Yes	Study area contains a protected zone (Toubkal National Park)
16.	Meteorology	Changes of temperature,	No	Large-scale land reclamation

		precipitation, wind, etc. due to large-scale land reclamation and building construction		and construction not included in the project
17.	Landscape	Change of topography and vegetation due to reclamation, deterioration of aesthetic harmony by structures	Yes	The beautiful landscape of the Atlas area is sensitive to any new construction sites
Pollution				
18.	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	No	Activities of the master plan facilities are not expected to generate any air emissions
19.	Water Pollution	Pollution caused by inflow of silt, sand and drainage into rivers and groundwater	Yes	Small amount of municipal wastewater will be generated at the stations
20.	Soil Contaminatio n	Contamination of soil by leakage and diffusion	No	Nature and operation of the new stations are not expected to induce soil contamination
21.	Noise and Vibration	Noise and vibration generated from project	No	No noise and vibration are anticipated other than the siren noise in case of flood warning (which under the circumstances would be welcome news)
22.	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	No disturbance to the groundwater is anticipated from the project
23.	Offensive Odor	Generation of exhaust gas and offensive odor from project facilities	No	No generation of offensive odor is anticipated from the project
Format: JICA Environmental Guidelines				

Table G.2.2 CHECKLIST FOR SCOOPING

No.	Environmental Item	Evaluation	Reason
Social Environment			
1.	Resettlement	C	Existing agriculture activity on the riverbed or within the section marked for public domain is not legal and when the land use plans are formulated for each river basin (as stipulated in Law 10/1995) resettlement will be necessary regardless of the master plan. It is important to note that it is necessary to control land use and development in the flood plains because that is the main reason for the loss in lives and properties in the occurrence of floods.
2.	Economic activities	D	Same as above for agricultural activities. Concerning tourism, the benefit in warning the tourists in order to save their lives far outweighs any loss in tourism because of fear of floods. The experience of the 1995 and 1999 floods when most of the victims were tourists is proof that tourists need to be forewarned.
3.	Traffic and public facilities	D	No effect is expected on traffic and public facilities. Warning posts may be installed in public facilities under the project but these will aid in evacuating such places immediately in case of flooding.
4.	Split of communities	D	No effect is expected from the master plan
5.	Cultural property	D	The Toubkal National Park is a protected area and any master plan facilities constructed there must be designed bearing this in mind. The agreement of the ministry of culture before construction of the stations in the study area is also legally required (see appendix). However the ministry's regional office in Marrakech expressed no major concerns related to these areas.
6.	Water rights and rights of common	D	No effect is expected from the master plan
7.	Public health condition	C	There are still many varying opinions on the effects EMF has on the human health but all research so far has found no hard evidence either to eliminate this threat or publicize it. The electric signals sent out by the transducers and communicated by radio to the processing units are not considered to impose a threat on public health at this time. Further examination while recommended is not expected to produce any judgment at this time. Therefore the project should go ahead because of its importance in saving lives.
8.	Waste	C	Provision for removal of construction wastes from difficult access areas must be made. Also removal and burial of the waste generated from the stations occupants must be considered.
9.	Hazards (Risk)	C	Consideration for the safety of people working at stations from landslides and land collapse must be made. Site selection is very important.
Natural Environment			
10.	Topography and Geology	D	No effect is expected from the master plan
11.	Soil erosion	D	No effect is expected from the master plan. There are no plans to cut trees for implementing master plan projects. The water and forests department must approve the projects before hand and they are very strict in the matter of tree cutting.
12.	Groundwater	C	It is preferable to provide a septic tank at the stations for treatment of wastewater and prevention of pollution of rivers or groundwater.
13.	Hydrological situation	D	No effect is expected from the master plan. There are no plans to

			construct any facility within the river.
14.	Coastal zone	D	No effect is expected from the master plan
15.	Fauna and Flora	C	Again the permission of the related authorities must be obtained before any construction in preserved area is approved. However no trees shall be cut and the scale of the master plan projects as not that which may pose a threat to the living species in the study area.
16.	Meteorology	D	No effect is expected from the master plan
17.	Landscape	C	The stations and the relay antenna towers will stand out in the existing landscape and this cannot be avoided. However the master plan policy is to construct the stations close to existing villages and therefore the effect will be somewhat diminished.
Pollution			
18.	Air Pollution	D	No effect is expected from the master plan.
19.	Water Pollution	C	It is better to provide a septic tank at the stations for wastewater and system for collection of waste. Discharge of any wastes in the river will lead to surface water pollution.
20.	Soil Contamination	D	No effect is expected from the master plan.
21.	Noise and Vibration	D	No effect is expected from the master plan.
22.	Land Subsidence	D	No effect is expected from the master plan.
23.	Offensive Odor	D	No effect is expected from the master plan.

Note: JICA Environmental Guidelines

Evaluation criteria:

“A”: Serious impact is expected

“B”: Some impact is expected

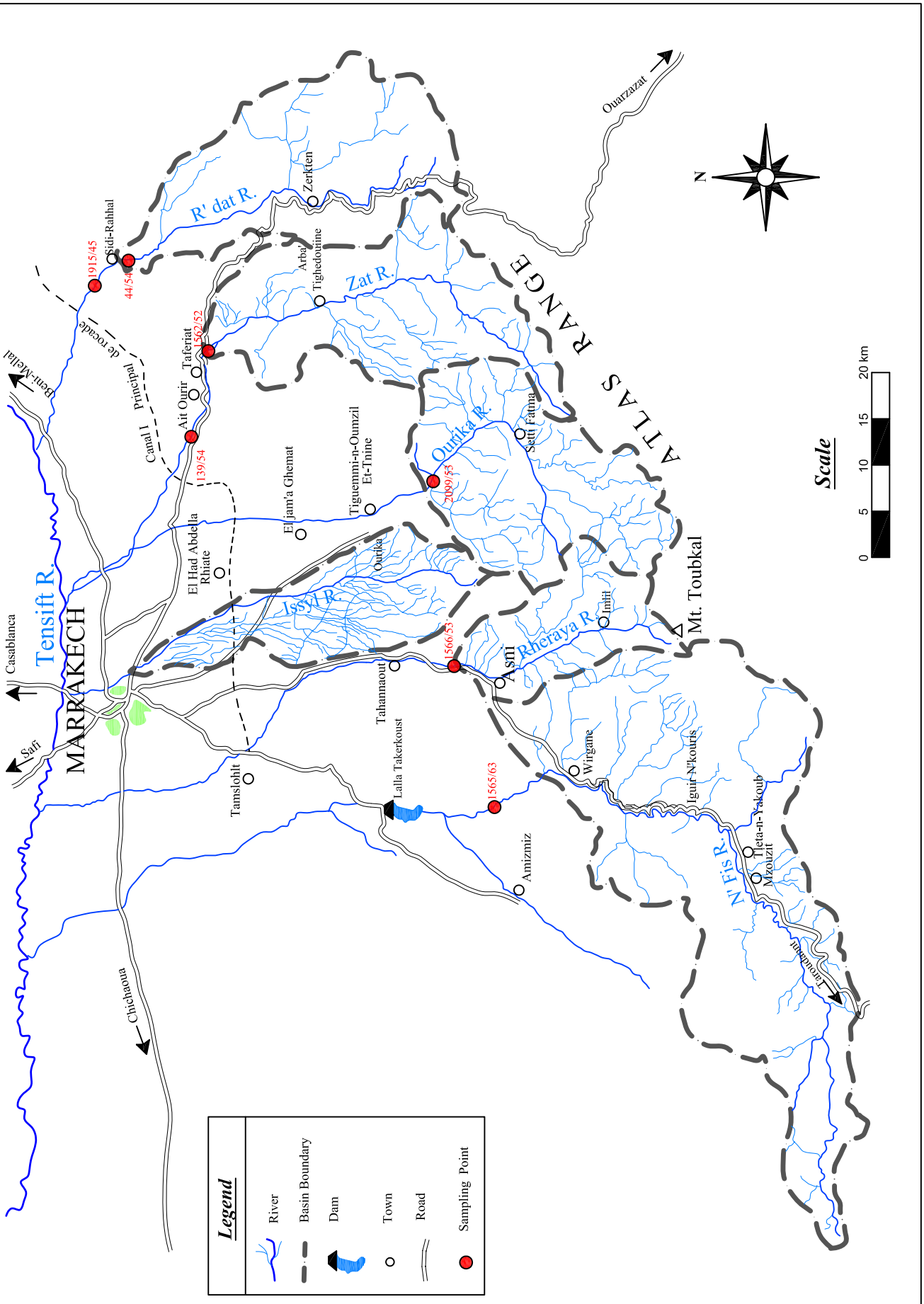
“C”: Extent of impact is unknown. Further examination is recommended

“D”: No impact is expected

Table G.2.3 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. It is important to note that it is necessary to control land use and development in the flood plains because that is the main reason for the loss in lives and properties in the occurrence of floods. 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. Also antenna will be constructed to transmit the radio signals to the processing units and the construction of these high antennas may have a negative impact on the landscape.
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.

FIGURES



THE MASTER PLAN STUDY ON
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Fig. G.1.1 Locations of Water Samples

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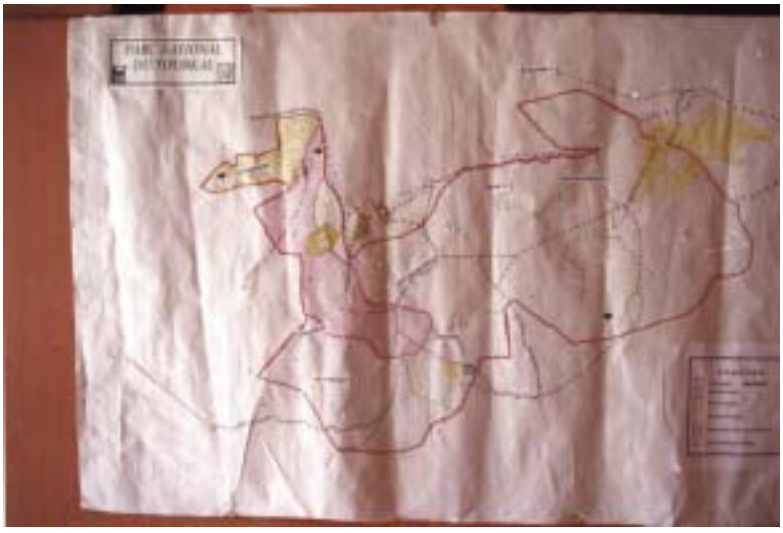
PHOTOGRAPH 5 SOIL ERROSION PROBLEM



PHOTOGRAPH 6 MAP SHOWING BORDERS OF TOUBKAL PROTECTED RESERVE

APPENDIX H

STRUCTURAL MEASURES

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APPENDIX H STRUCTURAL MEASURES

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The Study Area, consisting of the Issyl, Ourika, Rheraya, N'fis, Zat and R'dat Rivers' Basins, is located in a mountainous area called the Atlas Region with steep slopes ranging from the elevation of 3,000 m to 4,000 m high. In this area, annual rainfall increases in proportion to the altitude and rainfall concentrates in a short period of time that sometimes causes a severe flood. Due to the topographic and meteorological conditions, flood discharge suddenly emerges immediately after a storm. In August 1995, the heavy rainfall continued for several hours, causing a severe flood that resulted in the enormous flood damages; 151 casualties and total damage amount of Dhs. 70 millions, and the damaged areas are mainly the rivers of the Ourika, Rheraya, N'fis, Zat and R'dat Rivers. Subsequently, the flood on March 1997 in the Issyl River caused 40 houses losses in 23 villages, and the flood on October 1999 in the Ourika, Rheraya and N'fis Rivers caused the damages on the infrastructure and agricultural areas.

Judging from these conditions of flood damages as well as the topography and the geology, disaster type in the Study Area could be divided into the following two categories:

1) Flooding/inundation of river/rain water in the Issyl River and the downstream of the other five rivers

2) Debris flow at the midstream and the upstream in the Ourika, Rheraya, N'fis, Zat and R'dat Rivers

Generally, protection measures against flood and inundation as well as debris flow are classified into the following two measures:

1) Non-structural Measures: Forecasting, warning, flood fighting and evacuation activities against disaster

2) Structural Measures: Construction of river works such as a flood control dam, a dyke and a check dam in order to prevent disaster

The study targets formulating the master plan on flood forecasting and warning system, named Non-structural Measures. However the disaster prevention measures against flood and debris flow fundamentally should include both structural and non-structural measures, and the structural measures are also one of the important pillars of the disaster prevention measures although there exists the issues of a source of revenue.

This report does not include concrete plan and design as well as economic evaluation, but presents the basic policy and the conceptual plan of structural measures against flood and debris flow damages. The main study items are listed as follows:

1) River Conditions
2) Flood Damages
3) Existing Structural Measures and Future Plans for Flood Control
4) Basic Policy on Structural Measures for Flood Control
5) Conceptual Plan on Structural Measures for Flood Control
6) Recommendations

[1] This study was conducted during the year 2000. No updating of the institutional set up was included except that related to the creation of the ABHT.

APPENDIX H STRUCTURAL MEASURES

CHAPTER 1. RIVER CONDITIONS

1.1 Main River Course

As for the Ourika, Rheraya, N'fis, Zat and R'dat Rivers, the characteristics of main rivers and principal tributaries were analyzed based on the maps of 1/50,000 and 1/100,000. Longitudinal sections of the main river courses are comparatively shown in the following table and the figure. The detain sections by the rivers are referred to ANNEX-1.

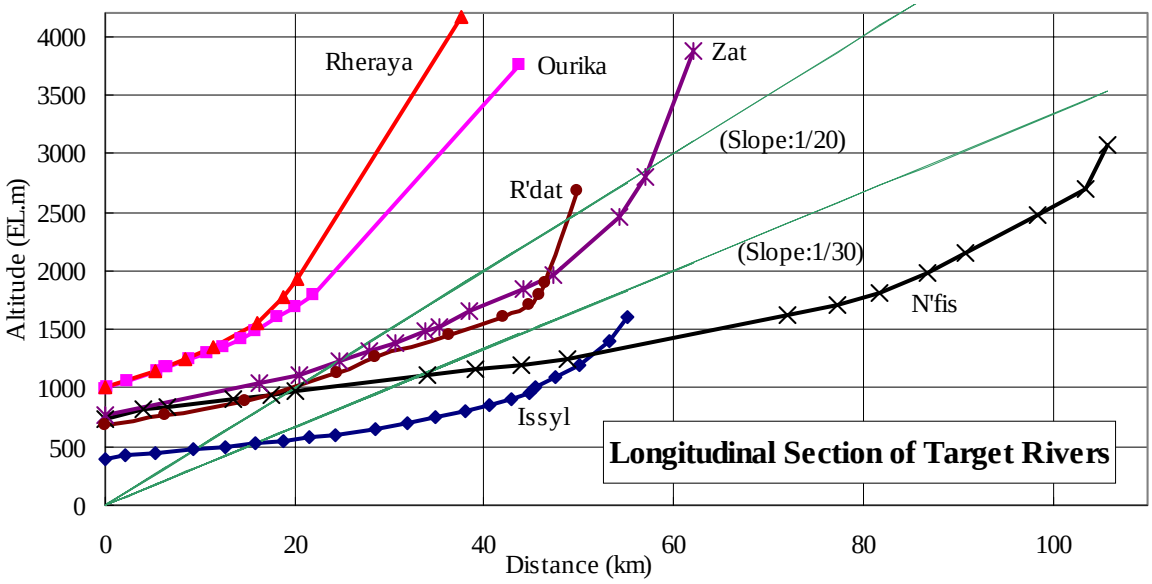
Of the target six rivers, the Issyl River has the gentlest slope with 1/60-1/50 in the middle and the downstream. The river slope in the Ourika and Rheraya Rivers is steepest showing 1/10-1/40, and that in the Zat and R'dat Rivers is slightly gentler showing 1/40-1/70, then that in the N'fis River is gentler giving 1/60-1/100.

The two slope lines of (1/20) and (1/30) indicate the river sections where debris flow might come to a stop and a deposit. The river sections where debris flow could reach are, as shown in the table, 10-20 km from the control points in the Ourika and Rheraya Rivers, 40-50 km in the Zat and R'dat Rivers and over 90 km in the N'fis River. Debris flow is not expected to happen in the downstream of those sections. As for the Issyl River, debris flow could happen in only mountainous sections over 50 km upstream from the confluence of the Tensift River.

River Slope

River	River Slope						
	0-10 km	10-20 km	20-30 km	30-40 km	40-50 km	50-60 km	Over 60 km
Issyl	1/160-1/88	1/140-1/112	1/112-1/68	1/68-1/50	1/50-1/24	1/24-1/9	-
Ourika	1/43-1/35	1/35-1/20	1/20-1/18	1/18-1/11	-	-	-
Rheraya	1/38-1/27	1/27-1/9	1/9-1/8	1/9-1/8	-	-	-
N'fis	1/100-1/60	1/100-1/120	1/93-1/100	1/110	1/120	1/100	1/70-1/6
Zat	1/60	1/60	1/57-1/43	1/43-1/22	1/30-1/22	1/14-1/8	1/5
R'dat	1/80	1/80-1/50	1/42-1/27	1/43-1/30	1/30-1/4	-	-

Note: The shade shows the sections possible to run and deposit debris flow.

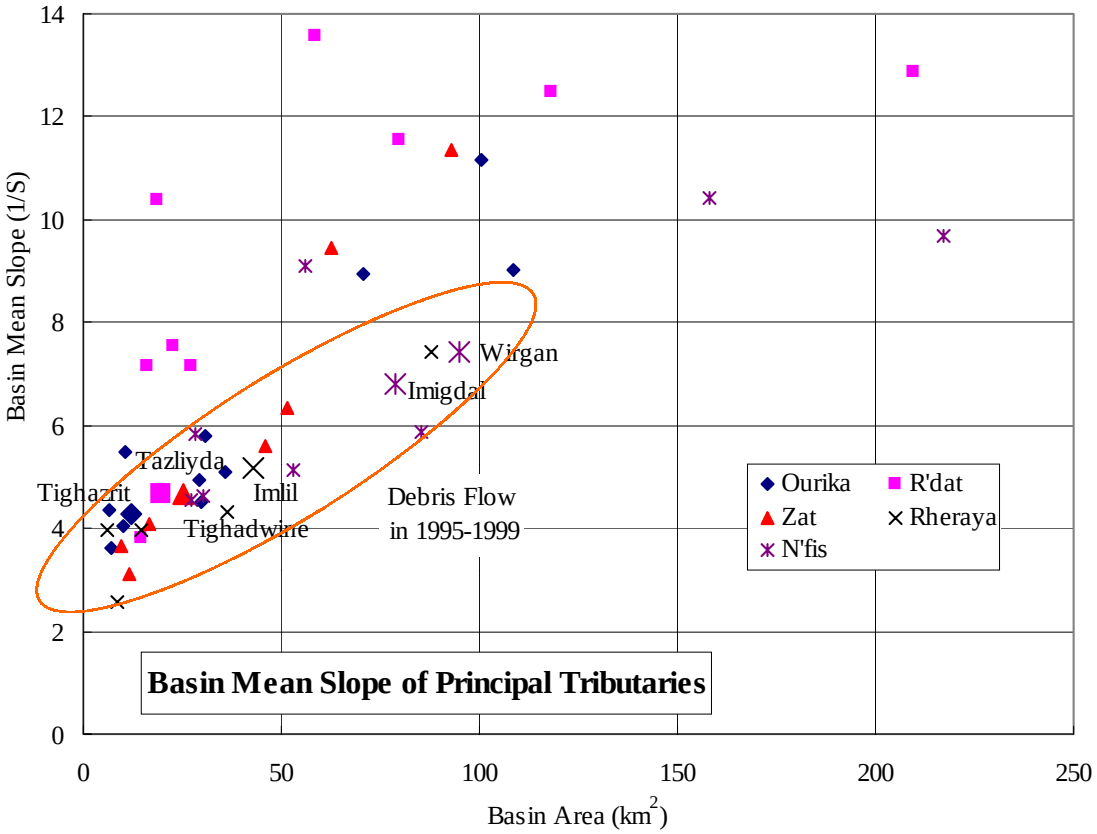


1.2 Basin Mean Slope of Principal Tributaries

The basin mean slope of the principal tributaries except the Issyl River is summarized in the next table, and is graphically shown in the following figures.

Basin mean slope of the principal tributaries becomes larger according to the increase of basin area. The basin mean slope shows 1/4 – 1/6 under the basin area of 50 km^2, 1/6 – 1/10 within that of 50 – 100 km^2 and less than 1/10 over that of 100 km^2. It is recognized that the basin mean slope of the tributaries of the R'dat River is relatively gentler than the others but the basin mean slope in the other tributaries is almost the same each other.

The tributaries where debris flow happened in 1995, 1997 or 1999 are pointed in the following figure. It shows that in the tributaries with steep slope, debris flow happened in the wide range of basin areas.



CHAPTER 2. FLOOD DAMAGES

2.1 Flood Damages Identified in the Site

Site reconnaissance was carried out in the target six rivers. Damaged sites and their conditions were investigated mainly on the flood damages in August 1995 and October 1999. The flood damages based on these investigation, interviews and some study reports are summarized in the follows. Refer to ANNEX-2.

2.1.1 Issyl River

(1) Top of Alluvial Fan

The bridge located in the top of alluvial fan of the Issyl River disturbed flood flow causing flood damages to the bridge itself and to agricultural land around. The particle size of riverbed stone is 30 - 80 cm in diameter. The basin upstream of this bridge has no flood damages. Refer to Photo-I1.

(2) Road Bridge of R513 across Issyl River

Floodwater overflows to the right side of the river because of this bridge as obstruction. Overflowing water runs through villages and farmlands, causing flood and inundation damages. Some dykes were constructed to prevent flooding along the right side of the river. Refer to Photo-I2 and I3.

(3) Inundation due to Irrigation Channel named Rocade Canal

Irrigation channel named Rocade Canal runs from the east to the west on the alluvial fan of the target six rivers and ends to flow down in the N'fis River. This water also provides potable water for Marrakech with 70 % in usual and 100% in summer. Since the Rocade Canal was made mostly with embankment and has a little drainage channel under-across the canal, the upstream villages and farmlands were inundated like a lake. The Rocade Canal was constructed on 1984. Flood damages were not severe before the construction but became larger due to its obstruction of floodwater. Refer to Photo-I4 and I5.

(4) Drainage Channel

In the mid-stream of the Issyl River, there are many small creeks, gathering rainwater into the Issyl River. However as these small creeks has no enough drainage capacity, flooding and inundating occur in each creak itself. This overflowing water attacks urban areas of Marrakech and forces it inundated. The drainage channels were and have been constructed to gather rainwater and inundating water flowing down into the Issyl River. Tassoltante Intercepting Drainage Canal is the largest intercepting drainage channel in the basin. Refer to Photo-I6 and I7.

(5) Sidi Youssef Ben Ali and Marrakech Medina

Issyl River floods have been damaging many years to the prefecture of Sidi Youssef Ben Ali. The bridge shown in the photo-I8 was the obstruction for floodwater and was damaged a few times, resulting in overflowing to the right side of the river. Floodwater attacked the many houses in the left downstream of the bridge and broke them (Photo-I9). Since the discharge capacity of the Issyl River in this area is small, dyke embankment was constructed. Refer to Photo-I10, I11 and I12.

2.1.2 Ourika River

(1) Road in Aghbalou Village

The left road a few hundreds upstream of Aghbalou gauging station is very low level and is only 2 - 3 m high from the riverbed level. Moreover as this road is located in a water colliding front of the river, overflowing river water runs down through the road and damages the road. Although emergent road improvement works were carried out after the 1995 flood damaged it, this road was again flushed away by the 1999 flood. Current road improvement works are river excavation and clearing, dykes, concrete revetment works and its foot protection works. Refer to Photo-O1 and O2.

(2) Tighazrit Tributary in Iraghf (Ourmes) Village

Tighazrit Tributary is recognized as the most dangerous tributary in the Ourika River. The debris flow that happened in the 1995 disaster destroyed the bridge and the road around. Afterward, since 15 small check dams were set up in this tributary (Photo-O3), no debris flow happened and only water flew down to the main river in the 1999 flood. However, as these protection works concentrated on stopping dangerous debris from the upstream, regular and floodwater is flowing on the road (Photo-O4).

(3) Ourmes Village

The Ourmes Village is one of the tourism spots in the Ourika River and the river shores become a good and suitable rest area. Some tourists died being caught under the 1995 flood. Refer to Photo-O5.

(4) Road in Tazitount Village

The road of the left bank of the river was flown away by the 1999 flood. The flood protection works such as river excavation, revetment works, foot protection works and road-reinforced works are being implemented. Refer to Photo-O6.

(5) Setti Fadma Village

There were some casualties of tourists in Setti Fadma in the 1995 flood. Tourists felt danger when they saw flood flow and tried to run away by their cars. But while there were many tourists doing so and the road was congested with traffic, river water level became high and some tourist cars were caught under floodwater flowing down on the road. The photo-O8 seems to be the actual spot of this casualty. As the wide valley like the photo-O7 becomes narrow river course with large rocks like the photo-O8, it is imagined that floodwater was rapidly rose in level and flew down over the road, then finally flushed away cars with tourists.

(6) Agadir-n-Ait Boulmane Village

Ourika River forms an extensive valley a few km upstream of Setti Fadma. This is the village of Agadir-n- Ait Boulmane. A dam used to be planned around this village but it was abandoned due to geological and economic problems. Refer to Photo-O10.

(7) Summary of the Flood Damages on August 17th, 1995

Based on the report "Development for the protection of the Ourika Valley, Achievements and Perspectives, November 1999, DGH", Flood damages on August 17th, 1995 are summarized as follows:

- Most of the structures along or near the lower riverbed have been totally or partially destroyed, above all along the stretch 12km-long between Aghbalou and Setti Fadma. Damages are larger in the outlet of the tributaries.
- The road was seriously damaged along the most steep river course, which is between Iraghf and Setti Fadma.
- Most of the low terraces that stand for the main agricultural areas for local population are covered with the seat of heavy blocks with more or less thick, preventing any development.
- Hundreds of trees, mainly walnuts have been uprooted.

2.1.3 Rheraya River

(1) Top of Alluvial Fan

At the top of the alluvial fan of the Rheraya River, a house near the riverbed and a submersible bridge were flushed away due to the 1995 flood. Refer to Photo-R1 and R2.

(2) Tahannaout Gauging Station

The left side road around Tahannaout gauging station was inundated because of the lowness in level and is partly damaged in the 1995 and 1999 floods. The gauging station was also inundated till near the roof. The 1995 flood washed the bridge away and the bridge newly constructed was bended by the 1999 flood. The flood discharges are estimated by ABHT to be 680 m^3/sec and 500 m^3/sec in the 1995 and 1999 floods respectively. Refer to Photo-R3 and R4.

(3) Moulay Brahim

The mausoleum of Moulay Brahim is famous as one of the holy ground in Marrakech. Many peoples come and used to sometime stay near/in the shores of the Rheraya River, where the August 1995 flood happened and caused the 5 dead and the 7 injured. Some farmland was also damaged. It has already prohibited that people stay a night in the Rheraya River. Refer to Photo-R5.

(4) Imlil Village

Imlil Village is always clouded by tourists and is the start point of a trail up to the mountain of Toubkal that is the highest in Morocco. The 1995 flood damaged many tourists in this place and the images on this flood and damages are described in the museum as follows:

> **Images or the Flood on 18th August 1995:** The large boulders at the southern end of Imlil (which was not eroded much itself) diverted flood flow down the main street washing away 40-parked cars. There is still evidence of damaged cars in the village – for example the car wrapped around the tree near the place where mules rest. Other evidence visible nearer the Kasbah includes tiny stones imbedded in the trees and bark stripped from only one side of some trees. Refer to Photo-R8 and R9.

2.1.4 N'fis River

(1) Wirgane Tributary

The debris flow occurred in the Wirgane Tributary on August 1995 and flushed away a part of the bridge (Photo-N1). The bridge was repaired and the debris deposit was excavated (Photo-N2).

(2) Imigdal Tributary

The debris flow happened in the Imigdal Tributary on August 1995. The small bridge was broken and the road was damaged at the exit of the tributary. Much deposit of debris still can be seen in the main course of N'fis River. Refer to Photo-N3 and N4.

(3) Tasaft Tributary

Debris flow happened in the Tasaft Tributary and damaged to the road. Refer to Photo-N5 and N6.

2.1.5 Zat River

(1) L'hager River- Confluence of Ourika River and Bourouihat River (small river between Ourika and Zat Rivers

The Bourouihat River is the downstream river with the basin between the Ourika and Zat Rivers. This river is merged with the downstream of the Ourika River and forms the L'hager River at 15 km east-southeast of Marrakech City, named the Kritou Village. This area has typical flood damages in the downstream of the study area. The river courses are not stable and are moved flood-by-flood flooding and scouring roads, farmlands and houses. The 700 m dykes with gabion works are being constructed at left side of the Bourouihat River to protect farmlands and houses around. About 80 households (320 inhabitants) live in this area. Refer to Photo-Z1 and Z2.

(2) Ait Ourir Village

The bridge (Photo-Z3) near Ait Ourir Village (Ait Haddi) across the Zat River disturbed the flood flow in 1995, and caused erosion and inundation to the market located in the left side of the river although gabion dykes tried to protect this area (Photo-Z4). As it is requested by the government that this market should be resettled because of flood danger, it has become ruins presently. No flooding occurred in 1995.

(3) Arba Tighedouine Village

Arba Tighedouine Village is famous of Wednesday market and is crowded with many rural inhabitants on that day. Some houses are located in the Zat River terrace (Photo-Z8), though no flood damages were happened and are expected. However some farmland is found to be flood-vulnerable.

(4) Tifarent Village in Tighadwine Tributary

Debris flow or land slide occurred in 1995 and flushed some houses and killed 9 inhabitants at the Tifarent Village in the Tighadwine tributary of the Zat River (Photo-Z11). Besides a school also was destroyed by 1995 flood (Photo-Z12).

2.1.6 R'dat River

(1) Sidi Rahal Gauging Station

Sidi Rahhal gauging station was established in 1963 (Photo-D1). The weir of the station was partly broken by the 1999 flood. Flood damages downstream of this station in 1995 and 1999 were limited to farmland and livestock with no casualties. The flood in 1995 could not be forecasted and floodwater suddenly came to the station. They had no time to make their livestock be evacuated. No flood protection activities were done around.

(2) Zerkten Tributary

Debris flow (or land slide) happened in 1995 or 1999 and the traffic of the national road was interrupted due to the sedimentation of debris. No protection works are implemented. Refer to Photo-D3.

(3) Tazlyada Tributary

Debris flow flushed away some houses and killed 10 inhabitants on October 1999. After the people heard the sound of "Boom", they run away and the debris flow with about 10 m high attacked the place within 15 minutes. Much sedimentation including large rocks still can be seen in the river (Photo-D4). How the debris flow happened is assumed as follows; 1) land slide in the upstream, 2) a natural dam was formulated, 3) it collapsed due to floodwater and 4) the debris flow happened. No protection works were carried out for the time being. Refer to Photo-D4, D5 and D6.

(4) Algu Village

Algu Village is located in high mountain area, where are little damages by the 1995 flood but three (3) houses were flushed away and six (6) inhabitants died due to the 1999 flood. They escape at least once a year feeling the signs based on hard rainfall, thunder or crying voice. Refer to Photo-D7, D8 and D9.

2.2 Flood Damages to Agriculture and Main Roads

Based on "Analysis Report of the flood on October 27th and 28th 1999 in the Al Haouz Province", flood damages to the agriculture are summarized in the following table.

Flood Damages to Agriculture on 27th and 28th October 1999 in the Study Area

Rural Community	River System	Agricultural land (ha)	Fruit Plantation (feet)	Vegetable Garden (ha)	Agricultural Equipment (m)
Setti Fadma	Ourika	34	5,429	4.35	184
Asni	Rheraya	91	102,356	-	73
Wirgane	N'fis	11.95	16,617	-	-
Imigdal	N'fis	112.50	3,801	-	4,200
Talat N'Yacoub	N'fis	45	57	2,610	3,000
Tighadouine	Zat	20	-	1,123	730

Based on "Recorded damages on the Road Networks of the DPE of Al Haouz, Inundation of October 1999", flood damages are summarized in the following table. The amount of damages reached Dhs. 31.4 million consisting of:

- P 2017 (Marrakech-Setti Fadma): Dhs. 11.25 millions
- R 203 (Marrakech-Taroudant): Dhs. 10.15 millions
- P 2015 (Asni-Imlil): Dhs. 10.00 millions

Flood Damages to Principal Roads on October 1999

Flood Date	Road	Location	Cause	Damages
11th to 15th, October 1999	P 2017 (R 513) Marrakech to Ourika	8 locations PK47+000 to PK60+100	Flood of Ourika River	- A part of masonry revetment was scoured and washed away. - A part of road platform was washed away. - Concrete revetment became unstable.
	P 2015 Asni to Imlil	PK8+000 to PK16+000	Flood of Imlil River	- A part of road platform was washed away. - Deposition of sand and stone from Imlil River
28th, October 1999	P 2017 (R 513) Marrakech to Ourika	14 locations PK46+600 to PK60+300	Flood of Ourika River	- A part of masonry revetment was scoured and washed away. - A part or the total of road platform was washed away.
	N9 Marrakech to Ouarzazate	KP317+000 to PK333+000	Tributary Flood in R'dat River	- Deposition of sand and stone on road platform by flood and landslide
	P 2015 Asni to Imlil	KP6+000 to KP16+000	Flood of Imlil Tributary	- A part of road platform was washed away in different sections.
	P 2030 P2017 to Oukaimeden	KP 5+400	Tributary flood	- Deposition of sand and stone on road platform
	R 203 Marrakech to Taroutant	KP38+000 to KP46+000	Flood of Rheraya River	- A part of road platform was washed away in different sections.
		KP66+000 to KP125+000	Flood of N'fis River	- A part of road platform was washed away in different sections. - Deposition of sand and stone on road platform by landslide
		KP73+800	Flood of Imigdal Tributary	- Deposition of sand and stone on road platform by landslide
		KP90+000	Flood of Amzoughni Tributary	- Deposition of sand and stone on road platform
		KP94+000	Flood of Agoundis Tributary	- Deposition of sand and stone on road platform - Revetment was completely scoured and washed away.
		KP99+000	Flood of Tassaft Tributary	- Embankment (about 5 m) under revetment was scoured and washed away.
		KP119+000	Flood of a tributary	- Deposition of sand and stone on road platform by landslide

2.3 Classification of Flood Damages Phenomena

Based on the site reconnaissance, interviews and existing study reports for flood damages, the flood disaster phenomena could be divided into the following three cause types, namely 1) debris and earth flow, 2) flood flow and 3) inundation. Flood damages in the study area are classified and are shown in the following table according to the said types.

Classification of Flood Damages

Phenomena	Type	River and Location	Main Objects to be Protected	Remarks
Debris/ Earth Flow	Main River	Setti Fadma: Ourika	Inhabitants, Tourists, Vehicles, Houses, Road, Farmland	When a natural dam by sedimentation in main river course stops flood discharge, river water level sometime become decreased in the downstream. After that, the natural dam is suddenly destroyed by floodwater energy and has a few abrupt wave happen. This phenomenon is very dangerous in the viewpoint of disaster prevention.
		Imlil: Rheraya	Inhabitants, Tourists, Vehicles, Houses, Road	
		Upstream of N'fis, Zat and R'dat Rivers	Mainly farmland (Damages are hardly reported)	
	Tributary	Tighazrit: Ourika	Road, Houses	Debris flow from tributaries some time form natural dams in main river course, causing enormous flood damages. Road damages are also very severe.
		Wirgane: N'fis	Road, Bridge	
		Imigdal: N'fis	Road, Farmland	
		Tasaft: N'fis	Road	
		Tighadwine: Zat	Inhabitants, Houses	
		Zerkten: R'dat	Road	
		Tazlyada: R'dat	Inhabitants, Houses, Road	
Flood Flow (Main River)	Narrow River Course	Aghbalou: Ourika	Road	The roads usually pass near riverbed. Floods damage the houses along the roads and the roads themselves.
		Ourmes: Ourika	Inhabitants, Tourists, Houses, Road	
		Tazitount: Ourika	Road	
		Tahannaout: Rheraya	Road, Hydro-station	
		Some parts: Rheraya	Road	
		Algu: R'dat	Inhabitants, Houses	
		Aguelmous: Issyl	Bridge	
	Wide River Course	Asni: Rheraya	Bridge, Houses	Casualties are hardly reported. Some tourists staying in riverbed at M. Brahim died but presently it was prohibited to stay in riverbed. All the farmland could not be necessarily protected against flood.
		M. Brahim: Rheraya	Tourist, Houses, Road	
		Mid/Down stream of N'fis, R'dat and Zat Rivers	Mainly farmland	
	Marrakech Urban Area	Sidi Youssef Ben Ali: Issyl	Houses, Inhabitants, Road, Bridge	Flood causes the lost of city function.
		Remparts Road: Issyl	Houses, Road, Bridges	
Inundation (Poor drainage)		Tassoltante: Issyl	Houses, Road, Farmland	Less casualties but large effect to road traffic and villages
		Mid/Upstream: Issyl	Houses, Farmland	