REPUBLIC OF TUNISIA
MINSTRY OF AGRICALTURE
DIRECTORATE GENERAL FOR DAMS AND MAJOR HYDRAULIC WORKS

PREPARATORY SURVEY ON INTEGRATED BASIN MANAGEMENT AND FLOOD CONTROL PROJECT FOR MEJERDA RIVER IN REPUBLIC OF TUNISIA: DEVELOPMENT OF FLOOD PREVENTION MEASURES FINAL REPORT (TEMPORARY VERSION)

MARCH 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.

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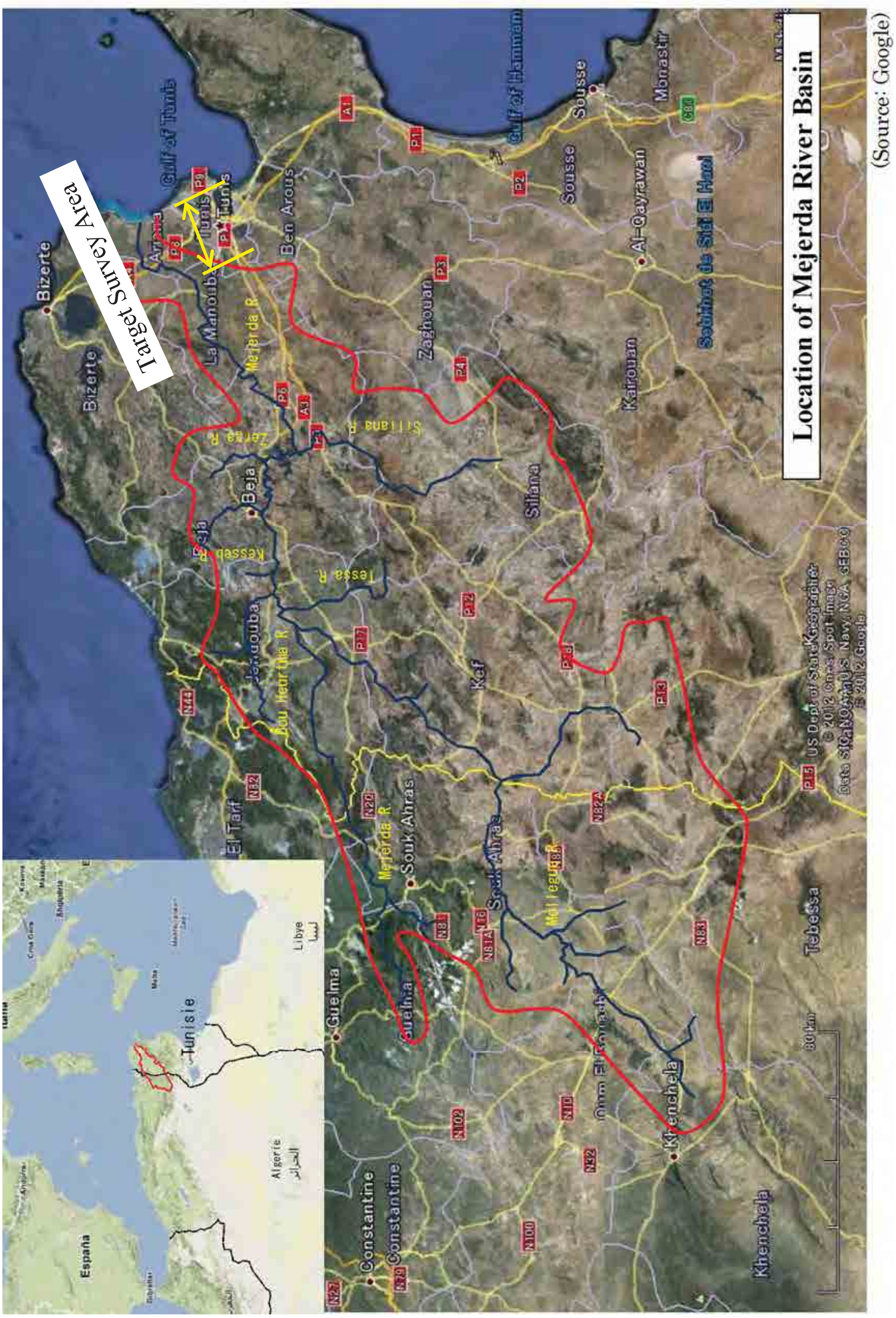
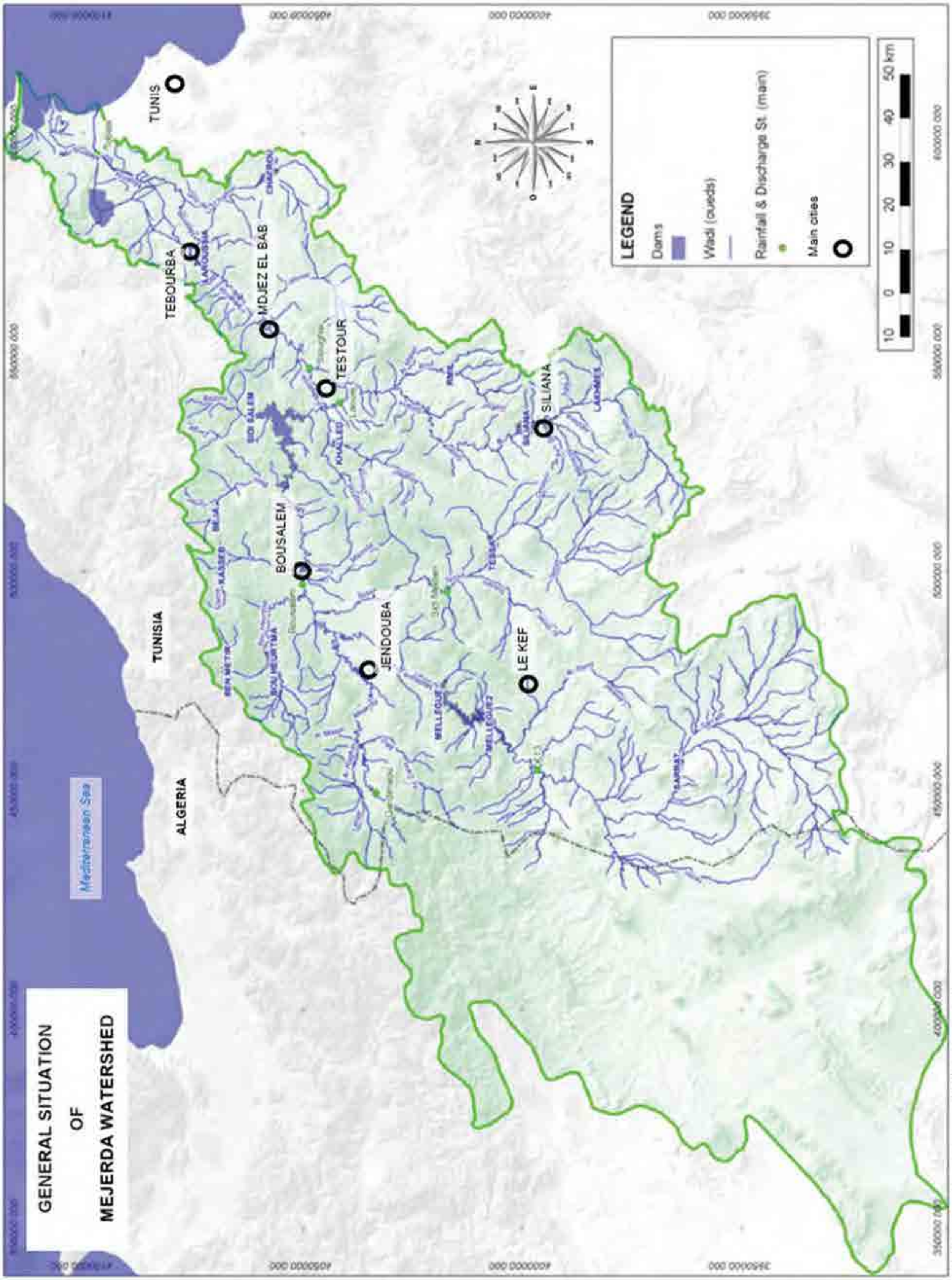
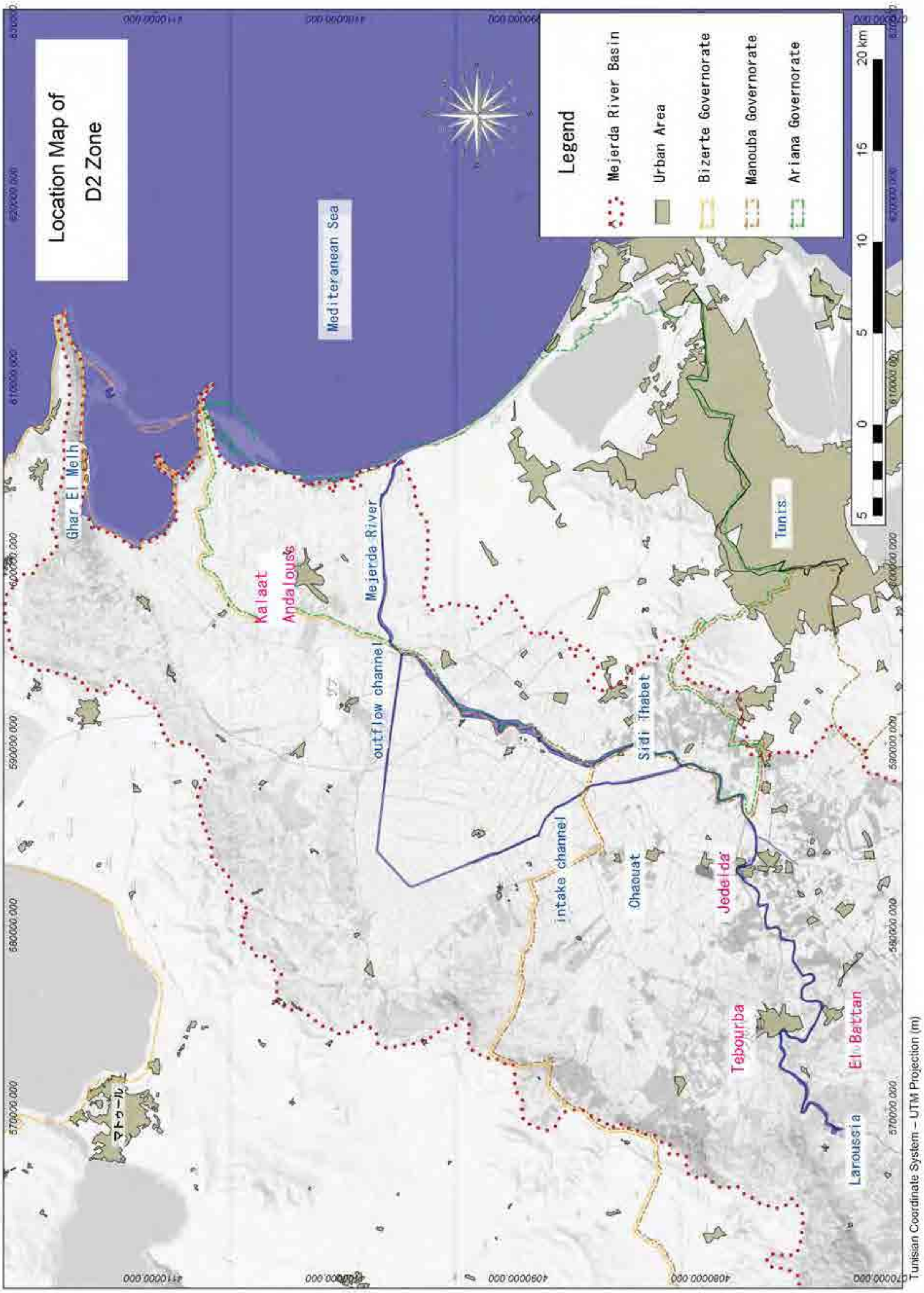


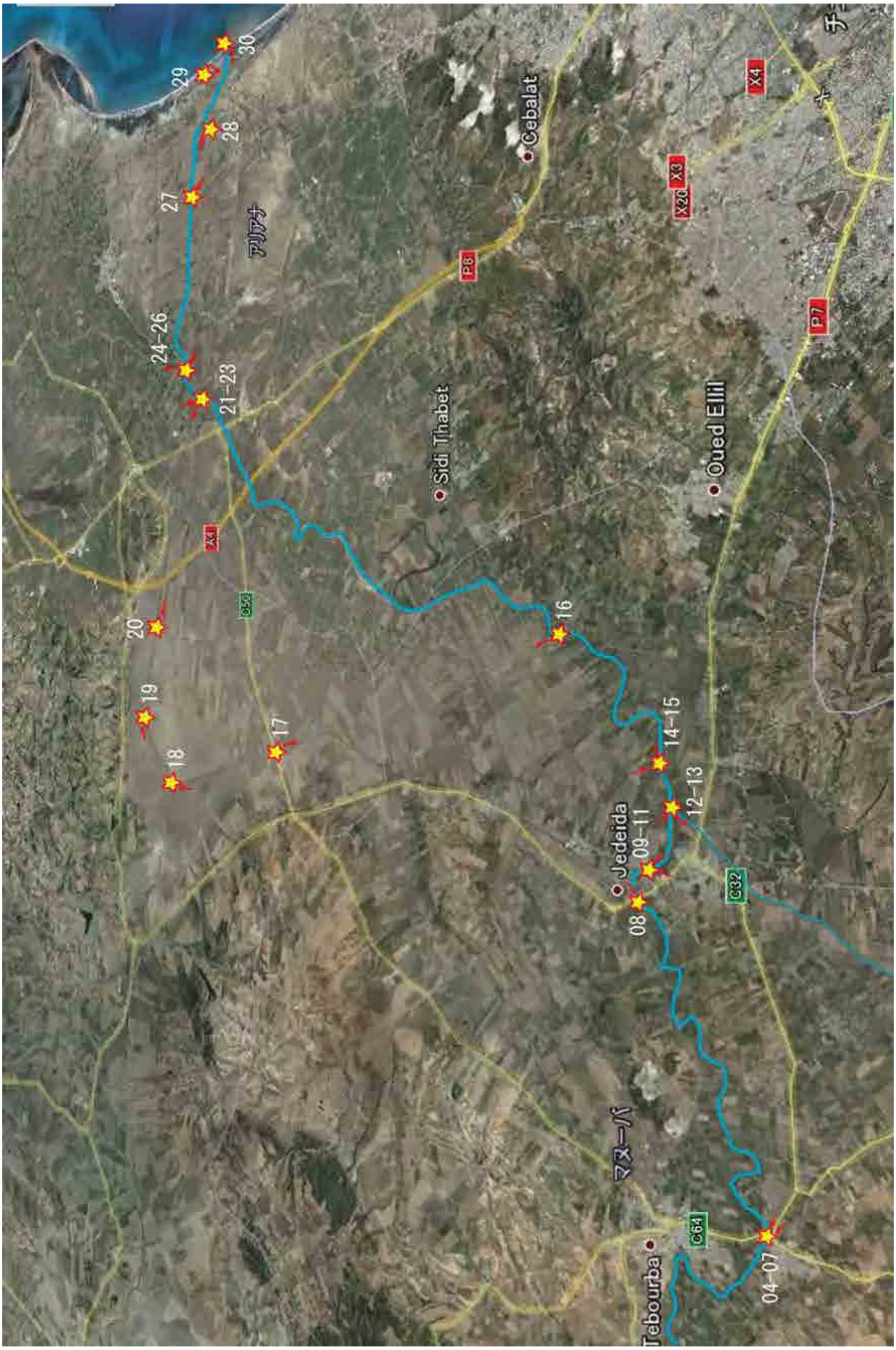
Drainage basin and survey area location map



Drainage basin overview diagram



D2-zone overview diagram


Cebalat
Sidi Thabet
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06. El Batan Bridge (2012.08)

	
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The Republic of Tunisia
Preparatory Survey on Integrated Basin Management and Flood Control Project for Mejerda River: Development of Flood Prevention Measures

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Abbreviation and Terms

Abbreviation

Abbreviation	**French**	**English**
ANGED (MEn)	Agence Nationale de Gestion des Déchets	National Agency for Waste Management
ANPE (MEn)	Agence Nationale de Protection de l'Environnement	National Agency for the Protection of the Environment
BIRH (MA)	Bureau Inventaires et Recherches Hydrauliques	Office of Hydraulic Inventories and Research
BPEH	Bureau de Planification et des Equilibres Hydrauliques	Bureau of Water Planning and Hydraulic Equilibriums
CNE	Comité National de l'Eau	National Water Commission
CRDA (MA)	Commissariats Régionaux au Développement Agricole	Regional Offices of Agriculture Development
CTV (MA)	Cellule Territoriale de Vulgarisation	Territorial Extension Unit
DGACTA (MA)	Direction Générale de l'Aménagement et de la Conservation des Terres Agricoles	Directorate General of Planning, Management and Conservation of Agricultural Lands
DGBGTH (MA)	Direction Générale des Barrages et des Grands Travaux Hydrauliques	Directorate General for Dams and Major Hydraulic Works
DGCES (MA)	Direction Générale de la Conservation des eaux et du sol	Directorate General of Water Conservation and Soil
DGEQV (MEn)	Direction Générale de l'Environnement et de la Qualité de la Vie	Directorate General of Environment and Quality of Life
DGF (MA)	Direction Générale des Forêts	Directorate General of Forests
DGGREE (MA)	Direction Générale du Génie Rural et de l'Exploitation des Eaux	Directorate General of Rural Engineering and Water Exploitation
DGPA (MA)	Direction Générale de la Pêche et de l'Aquaculture	Directorate General of Fishing and Aquaculture
DGRE (MA)	Direction Générale des Ressources en Eau	Directorate General of Water Resources
DHER (MA)	Direction de l'Hydraulique et de l'Equipement Rural	Directorate of Hydraulics and Rural Equipment
DSE (MA)	Direction du Développement Socio–Economique	Socio–Economic Development Department
DSP	Direction du Sylvopastoralisme	Sylvopastoralism Department
DVPPA	Division pour la Vulgarisation et la Promotion de la Production Agricole	Division for Extension and the Promotion of Agricultural Production
ERI	Eco–Ressources International	Eco–Resources International
ESIER	Ecole Supérieure des Ingénieurs de l'Equipement Rural	Rural Equipment Engineering School
INAT (MA)	Institut National Agronomique de Tunisie	National Institute of Agronomy of Tunisia
INM (MT)	Institut National de la Météorologie	National Institute of Meteorology
INS (MDCI)	Institut National de la Statistique	National Institute of Statistics
IRESA (MA)	Institut National de la Recherche Agronomique de Tunisie	National Institute of Agronomical Research of Tunisia

Abbreviation	**French**	**English**
MA	Ministère de l'Agriculture	Ministry of Agriculture
MDEAF	Ministère des Domaines de l'Etat et des Affairres Foncières	Ministry of State Domains and Land Affairs
MEn	Ministère de l'Environnement	Ministry of Environment
MEq	Ministère de l'Equipement	Ministry of Equipment
MF	Ministère des Finances	Ministry of Finance
MDCI	Ministère du Développement et de la Coopération Internationale	Ministry of Development and International Cooperation
MICI	Ministère de l'Investissement et de la Coopération Internationale	Ministry of Investment and International Cooperation
MT	Ministère des Transport	Ministry of Transport
ONAS (ME)	Office National de l'Assainissement	National Sewerage Board
ONPC	Office National de la Protection Civile	National Protection Civil Office
OTC (ME)	Office de la Topographie et du Cadastre	Topography and Cadastral Office
SECADENORD	Société d'Exploitation du Canal et des Adductions des Eaux du Nord	North Water Canal, Adductions and System Management Company
SNCFT	Société Nationale des Chemins de Fer Tunisiens	Tunisian Railways
SONEDE (MA)	Société Nationale d'Exploitation et de Distribution des Eaux	National Water Distribution Utility
ULAP	Union Locale des Agriculteurs et des Pêcheurs	Local Union of Farmers and Fishers

2– Other organizations		
Abbreviation	**French**	**English**
AAO	Association Amis des Oiseaux	Friends of the Birds Association
AfDB	Banque africaine de développement (BAfD)	African Development Bank
AFD	Agence Française de Développement	French Development Agency
ANRH (Algeria)	Agence Nationale des Ressources Hydrauliques	National Agency of Water Resources
BEI	Banque Européenne d'Investissement	European Investment Bank
EU	Union Européenne	European Union
GETU	Géotechnique Tunisie	Tunisia Geo-technology
GIZ	Agence Allemande de Coopération Internationale	German Agency for International Cooperation
IBRD	Banque internationale pour la reconstruction et le développement	International Bank for Reconstruction and Development
JBIC	Banque Japonaise de Coopération Internationale	Japan Bank for International Cooperation
JICA	Agence Japonaise de Coopération Internationale	Japan International Cooperation Agency

2– Other organizations		
Abbreviation	**French**	**English**
NEPAD	Nouveau Partenariat pour le Développement de l'Afrique	The New Partnership for Africa's Development
UNDP	Programme des Nations Unies pour le Développement	United Nations Development Program
FAO	Organisation pour l’alimentation et l’agriculture	Food and Agriculture Organization
UNESCO	Organisation des Nations Unies pour l’Education, la Science et la Culture	United Nations Educational, Scientific and Cultural Organization
WB	La Banque Mondiale	The World Bank

3– Other		
Abbreviation	**French**	**English**
APS	Avant Projet Sommaire	Basic Design
BM	Bassin de la Mejerda	Mejerda River Basin
EIA	Etude d’Impact sur l’Environnement	Environmental Impact Assessment
EIRR	Taux Interne de Rentabilité Economique	Economic Internal Rate of Return
F/S	Etude de Faisabilité	Feasibility Study
FFWS	Système de prévision des inondations et d'alerte	Flood Forecasting and Warning System
FFWRS	Système de prévision des inondations, d’alerte et de réponse	Flood Forecasting, Warning And Response System
GEOSS	Système mondial des systèmes d'observation de la Terre	Global Earth Observation System of Systems
GIC	Groupement d’Intérêt Collectif	Collective Interest Group
GIS	Système d’Information Géographique	Geographic Information System
GDP	Produit intérieur brut (PIB)	Gross Domestic Product
GFAS	Système d’alerte des inondations mondial	Global Flood Alert System
GPRS	General Packet Radio Service	General Packet Radio Service
GSM	Groupe Spécial Mobile	Global System for Mobile Communications
HWL	Niveau des Plus Hautes Eaux	High Water Level
IEE	Examen Initial sur l’Environnement	Initial Environmental Examination
IFAS	Système intégré d’analyse des inondations	Integrated Flood Analysis System
ITS	Services des Technologies de l’Information	Information Technologies Services
IWRM	Gestion Intégrée des Ressources en Eau	Integrated Water Resources Management
JORT	Journal Officiel de la République Tunisienne	Official Journal of the Republic of Tunisia
MDGs	Objectifs du Millénaire pour le Développement	Millennium Development Goals
M/P	Plan Directeur	Master Plan
NGO	Organisation Non Gouvernementale	Non–governmental Organization

3– Other		
Abbreviation	**French**	**English**
NWL	Retenue Normale	Normal Water Level
O&M	Exploitation et Maintenance	Operation and Maintenance
OMB	Bassin de la Mejerda	Mejerda River Basin
ORSEC	Organisation de la Réponse de SÉcurité Civile	Civil Security Response Organization
PHD	Domaine Public Hydraulique	Public Hydraulic Domain
SMAG	Salaire Minimum Agricole Garanti	Guaranteed Minimum Agriculture Wage
SMIG	Salaire Minimum Interprofessionnel Garanti	Guaranteed Minimum Wage
SMS	Short Message Service	Short Message Service
STEG	Société tunisienne de l'électricité et du gaz	Tunisian Society of Electricity and Gas
SYCOHTRAC	SYstèm de COllecte des mesures Hydrologiques en Temps Rèel et Annonce des Crues des oueds tunisiens	Real-time Hydrological Information Collecting Measurement and Flood Announcement System in Wadis
TICAD	Conférence Internationale de Tokyo pour le Développement de l'Afrique	Tokyo International Conference on African Development
TND	Dinars tunisiens	Tunisian Dinar
TOR	Termes de Référence	Terms of Reference
ZICO	Zone Importante pour la Conservation des Oiseaux	Important Bird Area

Terms

Terms	**Description**
Garaet	Low swamp
Gouvernorat (in French), Governorate (in English)	Unit of local government under the government of Tunisia
Sebkha *or* sebkhat	Area which becomes swamp except for during the dry season

Alphabetic Names of Tunisian Areas

Alphabet	Arabic	Alphabet	Arabic
Ain Ghelal	عين غلال	Kairouan	قيروان
Ariana	اريانة	Kalaat El Andalous	قلعة الاندلس
Bach Hamba	باش حامبة	Kasseb	كساب
Barbara	بربارة	Lakhmes	لخميس
Bejaoua	بيجاوة	Laroussia	لاروسيا
Ben Metir	بن مطير	Manouba	منوبة
Besbassia	بسباسية	Mejerda	مجردة
Bizerte	بنزرت	Mejez El Bab	مجاز الباب
Borj Ettoumi	برج التومي	Mellegue	ملاق
Bou Heurtma	بو هرطمة	Mellila	مليلة
Bou Salem	بوسالم	Mongi Slim	المنجي سليم
Cap Bon	الوطن القبلي	Ouenza	وانزة
Chafrou	شافرو	Rmil	رميل
Chaouat	شعواط	Sahel	ساحل
Chorfech	شرفش	Sejnane	سجنين
Djebel Chakir	جبل شاكر	Sfax	صفاقس
El Battan	البطان	Sidi Bahroun	سيدي بحرون
El Henna	الحنا	Sidi El Barrack	سيدي البراق
El Herri	الحري	Sidi Othman	سيدي عثمان
El Mabtouh	المبطوح	Sidi Salem	خزان سيدي سالم
Ellil	الليل	Sidi Smail	سيدي اسماعيل
Garaet El Mabtouh	قرعة المبطوح	Sidi Thabet	سيدي ثابت
Ghar el Melh Lake	بحيرة غور الملح	Siliana	سليانة
Ghardimaou	غار دماء	Slouguia	سلوقية
Ghezala Dam	غزالة	Souani	السواني
Henchir Tobias	هنشير طوبياس	Sousse	سوسة
Hir Tobias	هير طوبياس	Tebourba	طبربة
Ichkeul	اشكل	Utique	اوتيك
Jedeida(Jedaida)	الجديدة	Zerga	زرقة
Joumine	جومين	Zouitina	زويتنة

Exchange rate (Investigation common subjects, FY2012-Yen Loan Project, November 6th, 2012):

1.0 TND (Tunisian dinar) = JPY 49.0

1.0 US$ = JPY 79.0

Chapter 1. GENERAL

1.1 Background and purpose of the survey

1.1.1 Background

The Mejerda River is an international river through Algeria and Tunisia with a total channel length of 460 km and a basin area of 23,700 sq. km. With 312 km of the channel length (68%) and 15,830 sq. km. (67%) of the basin area within Tunisian territory, it is the largest basin area in the country. In the northern part of Tunisia where the river runs through, the rainy season is from September to March. Frequent flooding during this period has obstructed land use in the flood plain of the lower basin.

The Sidi Salem Dam was constructed in 1981 as part of the flood control measures in the lower basin. In the 22 years since its construction, there has been no flooding downstream from the dam. With a relative abundance of rainfall and fertile lands in Tunisia over this period, agricultural development boomed and grew into a driving force for the economy of the lower basin. In 2003, however, discharged water from the dam caused a seriously damaging flood. It caused severe damage with submerging duration of more than a month, 6 deaths and 27,000 evacuees, damaging field crops and houses and blocking area access. Further floods caused by discharges from Sidi Salem Dam in 2004, 2005, 2009 and 2012 have resulted in similar socioeconomic damage and increased poverty. These factors are impeding the continuous development that Tunisia has achieved. The area is in urgent need of comprehensive flood measures as existing flood safeguards are low standard.

Upon request from the Tunisia government to improve these conditions, JICA conducted the Preparatory Survey on Integrated Basin Management and Flood Control Project for Mejerda River: Development of Flood Prevention Measures (hereinafter referred to as the “Development Survey”) over 26 months from 2006 to 2008. As a result of the Development Survey, they devised a master plan for integrated basin management focused on preventing flooding of the Mejerda River. The master plan comprised levees, flood control basins and other structural measures, as well as non-structural measures, including flood forecasting warning system, flood fighting and evacuation system, organization skill building, and land use restriction management in the flood plain. In 2009, the Tunisia government then requested a feasibility survey (FS) for the project proposed in the Development Survey. JICA responded by conducting the Preparatory Survey on Integrated Basin Management and Flood Control Project for Mejerda River (hereinafter the “Preparatory Survey”) from September 2010 to May 2012. To collect basic information and review basic countermeasures, the Preparatory Survey focused on the lowest basin, Zone D2. This area was regarded in the master plan as that with the biggest economic effect.

1.1.2 Purpose

Based on the Preparatory Survey and the Climate Change Impact Analysis separately conducted by JICA, we will conduct a feasibility survey for the Integrated Basin Management and Flood Control Project for Mejerda River in order to facilitate implementation of the Project. This survey is to complement and complete the findings of the Preparatory Survey.

1.2 Basic Framework of the Survey

1.2.1 Study Area

In the master plan, the study areas divided the lower basin of the Mejerda River into zones D2, D1, U2, U1, and M as shown in the figure below. The study area for this survey is the lowest basin of the Mejerda River, Zone D2. With its position between Laroussia Dam and the estuary, Zone D2 was prioritized in the master plan as being the most in need of project implementation. Zone D2 spans three prefectures of Ariana, Manouba and Bizerte.

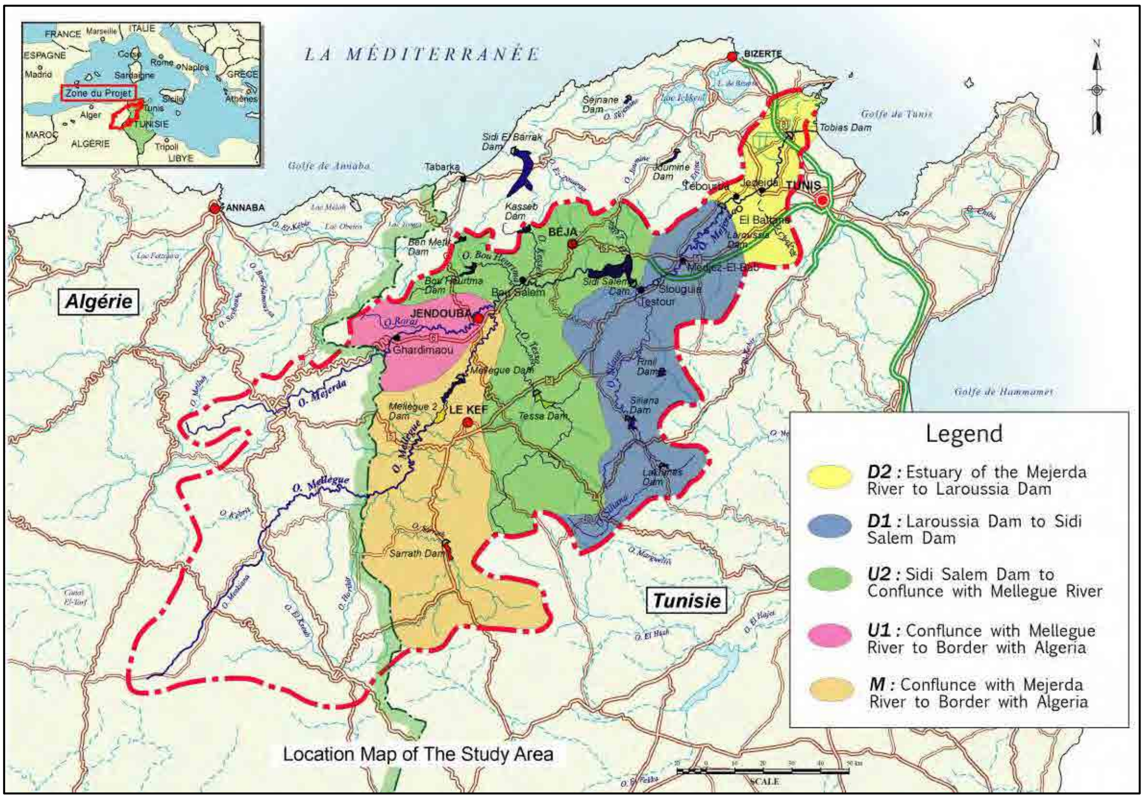


Figure 1-1: Basin divisions

1.2.2 Summary of Actions, Outputs and Goals

The survey will be conducted based on the items given in the Scope of Works (SW) for the feasibility study agreed upon with Tunisia in 2010. The master plan and Preparatory Survey will be reviewed in order to avoid any overlap between the collected documentation and survey content. Survey actions, outputs and goals are summarized below.

Table 1-1: Actions, Outputs and Goals

Overall goal	To eliminate flood damage in the lower Mejerda River basin by implementing the Project. To reduce barriers to economic development by improving social stability in the study area and help to both improve the socioeconomic situation and eliminate poverty in Tunisia.
Project purpose	To design a project plan and make technical preparation for implementation of the project

Outputs	1) Proposals for appropriate scale, content, and methods for implementing the Project 2) Confirmation of the necessity and effects of the Project
Actions	The following actions will be taken in order to conduct the feasibility survey: 1) Review the relevance and background of the Project 2) Understand the current situation and project content through additional data collection and field study 3) Prepare an environmental impact assessment report, including mitigation of environmental social impacts and a monitoring plan 4) Assist in creating a resident relocation plan 5) Devise flood control measures which account for climate changes 6) Devise consulting service details for the Project 7) Formulate an implementation schedule for the Project 8) Confirm implementation and maintenance schemes for the Project 9) Review the Project EIRR and propose operational effect indicators 10) Collect additional information and data 11) Provide assistance necessary to open a stakeholder's meeting

1.2.3 Consultant Group Organization and Work Schedule

The name, assigned area, dispatch period and task within the team for each consultant participating in the field study are shown below. 16 consultants will participate in the field study, and it will take about nine months from the start of preparatory work to presentation of the final report. The work schedule is as divided below:

① Mid July to July 29, 2012: Preparatory works in Japan, making of an inception report
② July 30 to September 15: Field study
③ August 20 to October 28: Domestic analysis, arrangement, and preparation of a draft final report
④ November 4 to 11: Interim on-site explanation of the draft final report
⑤ Late January 2013: On-site explanation of the draft final report
⑥ Late March 2013: Final report submission

Consultation minutes of meeting and a government-based study team member list and study schedule made according to the work schedule are attached to the documentation package.

Table 1-2: Study team organization and work schedule

Items		Name	2012 July	August	September	October	November	December	2013 January	February	March
[Assignment]											
＜Japanes Experts＞											
1	Team Leader/ Channel Planning	Junji Yokokura	30	19	2 15		4 11		■		
2	Hydrology	Tadafumi Sato	30	19			4 11				
3	Geography, Geology and Geotechnique	Hisashi Oura	30	19							
4	Hydraulic Analysis	Masahiro Kitano		2 19							
5	Basin Management/ Flood Control Planning	Toru Takahashi		2	15				■		
6	Bridge Design	Hitoshi Ito		27	9				■		
7	River Structure Design 1	Tamotsu Shingu		30	13		4 11				
8	River Structure Design 2	Masakazu Yatoge		27	13		■		■		
9	Assistance for Bridge Design/Cost Estimate	Hiroshi Nakata		27	14						
10	Economic & Financial Analys/Organization	Hidetoshi Kanamura		2	11						
11	Flood Conrol Economy 1	Kinuyo Fukuda		23	15				■		
12	Flood Conrol Economy 2	Yoshio Yabe		10 19							
13	Environment/ Social Consideration 1	Nobuyuki Iijima		27	15						
14	Environment/ Social Consideration 2	Yui Matsuo		2	15				■		
15	Project Coordination/Flood Control Planning	Ru Ying		2	15				■		
16	Project Coordination	Akira Someya	30	19							
＜Employed in Japan＞											
	Interpreter 1	Gentaro Suzuki	30		15		4 11				
	Interpreter 2	Norihiko Iguchi					■		■		
＜Employed in Tunisia＞											
	Interpreter 2			■	■						
	Interpreter 3			■							
	Employees (3 members)			■	■						
[Work Places and timing of report presentation]											
	Works in Japan 1		■	IC/R							
	Field study		■	■	■		DF/R(1st)				
	Works in Japan 2			■	■	■					
	DFR interim report						■		DF/R(2nd)		
	Works in Japan 3							■	■		F/R
	DFR explanation								■		
	Works in Japan 4									■	■
			7	8	9	10	11	12	1	2	3

■ Field Study

1.2.4 Tunisian Implementing Structure

The implementing agencies for the survey on the Tunisian side are the Ministry of Development and International Cooperation and Ministry of Agriculture. The direct counterpart agency for the survey is the General Directorate of Dams and Large Hydraulic Works of the Ministry of Agriculture. Within the Tunisian government, a technical committee was established for the survey by Ministry of Agriculture Ordinance No. 3436, November 26, 2010. A steering committee was also established on the same day by Director-General of Large Hydraulic Works Notice No. 4516. Both committees are comprised of the same members, with each given below.

Chairman:

Director-General of Dams and Large Hydraulic Works, Ministry of Agriculture: DGBGTH (Directeur Générale des Barrages et des Grands Travaux Hydrauliques, Ministère de l'Agriculture)

Members:

1) Representative from the Ministry of Environment: Un représentant du Ministère de l'Environnement
2) Representative from the National Institute of Meteorology, Ministry of Transport: INM (Institut National de la Météorologie, Ministère des Transports)
3) Representative from the Ministry of Equipment: Ministère de l'Equipement
4) Director-General of Water Resources, Ministry of Agriculture: DGRE (Directeur Générale des Ressources en Eau, Ministère de l'Agriculture)

5) Director-General of Land Conservation, Ministry of Agriculture, or his delegate: DGACTA (Directeur Générale de l'Aménagement et de la Conservation des Terres Agricoles, Ministère de l'Agriculture) ou son représentant
6) Director-General of Agricultural Research and Development, Ministry of Agriculture: Directeur Générale de la Recherche et du Développement Agricole, Ministère de l'Agriculture
7) Director-General of Forestry, Ministry of Agriculture, or representative: DGF (Directeur Général des Forêts, Ministère de l'Agriculture) ou son représentant
8) Director of Ariana CRDA: Directeur du CRDA Ariana
9) Director of Manouba CRDA: Directeur du CRDA Manouba
10) Director of Bizerte CRDA: Directeur du CRDA Bizerte
    (CRDA = Regional District Department of Agricultural Development: Commissariat Régional au Développement Agricole)
11) Director of Dam Operations, General Directorate of Dams and Large Hydraulic Works, Ministry of Agriculture: Directeur de l'Exploitation des Barrages, DGBGTH, Ministère de l'Agriculture

Secretariat:
Director of Water Mobilization Surveys, General Directorate of Dams and Large Hydraulic Works, Ministry of Agriculture: Directeur des Etudes de Mobilisation des Eaux, DGBGTH, Ministère de l'Agriculture

The chairman can summon members other than those mentioned above if their participation in committee actions is thought to be of benefit.

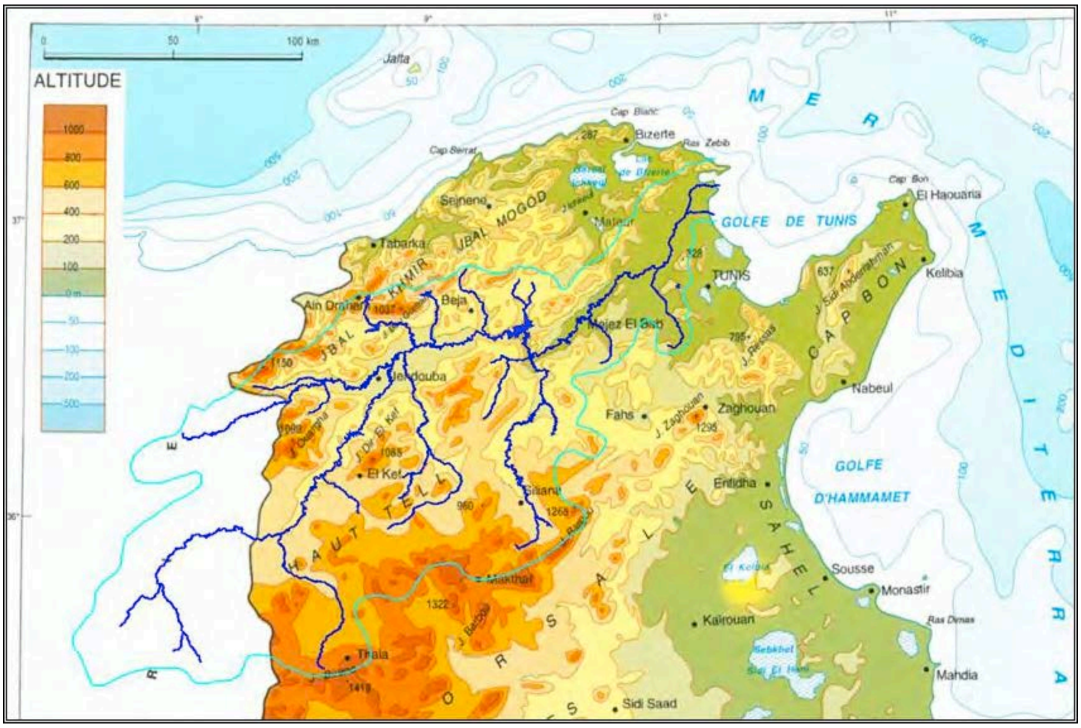
Chapter 2. AN OVERVIEW OF THE BASIN AND FLOOD DAMAGE

2.1 Overview of the Basin

2.1.1 Topography, Geology, and Soil

(1) Topography

The Mejerda is an international river that originates in the northeastern section of the Atlas Mountains and flows from northeastern Algeria down to northern Tunisia before finally settling in the Gulf of Tunis. The river's flow channel is 460 kilometers, and its basin covers 23,700Km^2. Of this, 312 kilometers of the channel length and 15,830Km^2 of the area lie on Tunisian soil, making it Tunisia's longest river. An expanse of arable land lies within the basin, with the river serving as a major water supply for both agriculture and cities, including Tunis. The regional topography for the Tunisian side of the Mejerda river basin is shown in the illustration below.



Source: Data from the National Institute of Meteorology

Figure 2-1: Topography of the Mejerda River Basin (Tunisia)

The survey area (Zone D2) exhibits the topographical features shown in the diagram below. There are mountains and plains from the Laroussia Dam to downstream of Tebourba. Downstream of Jedeida is a plain that was formed by coastline regression during the postglacial period. Downstream of Jedeida, the Mejerda has both its banks elevated, mostly with natural dikes, though the elevation tends to be lower in the surrounding lowland floodplains. Zone D2 contains 64.97 Kilometers of the river.

Table 2-1: Topographical Features of the Mejerda River Survey Area (Zone D2)

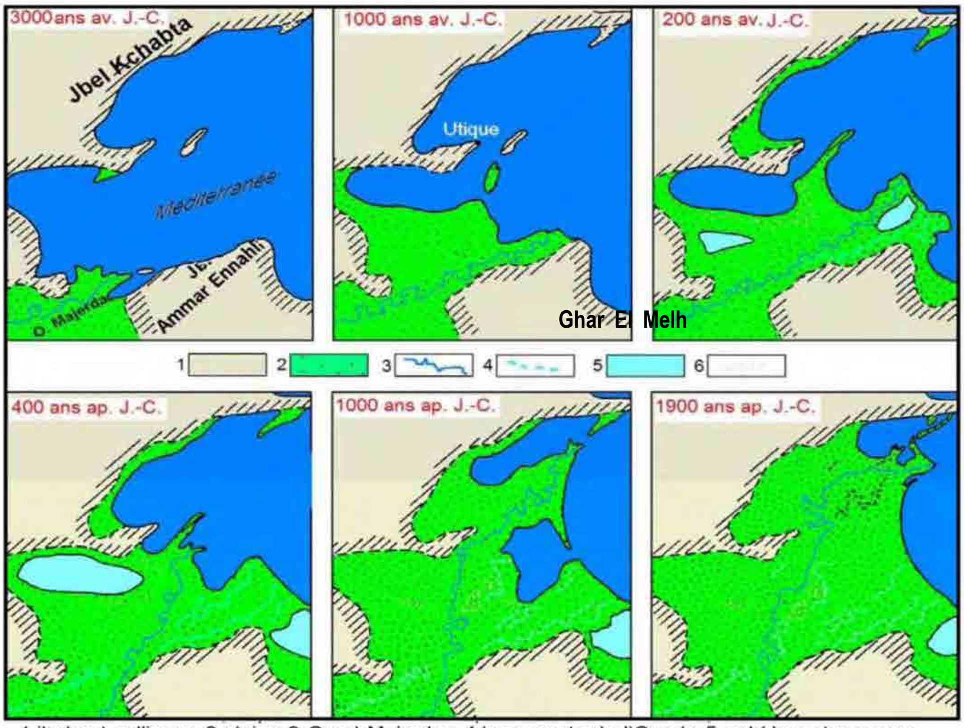
Section	Around the Mejerda River	Lowlands/Plains	Surrounding Mountains/Hills
Laroussia dam to	The Mejerda River cuts through the	The lowlands are 2-3 km wide,	Area is mountainous, with

downstream of Tebourba	lowlands that lie between the mountains.	with an elevation of 20-60 m.	Atlas Mountains at the edge of the northeastern section
From downstream of Tebourba through Jedeida to Tobias Barrage	Both the natural and man-made dikes are somewhat high, with several areas of low elevation in the surrounding floodplains. The lowlands widen to the north.	The lowlands extend from the exit of the mountain lowlands to the coastal plains. The Mejerda River flows down the southern side, while lowlands extend to the north. (Elevation is 6-20m. El Mabtouh lowlands have an elevation of 4-6m)	A mountainous expanse and hills remain in the area, with elevation of 36m near Kalâat el-Andalous and 26m near the port building.
Tobias Barrage to river mouth	Man-made diversion channels are now a part of the current river. The Tobias Barrage diverts the amount of water necessary for the old river. The old river has high natural and man-made dikes, while the area's floodplains sit at a lower elevation.	A wide coastal plain. A lagoon sits on the coast to the north. (Elevation of 0-6m, lowlands on the left bank 0-4m)	No mountains or hills.

An explanation of the formulation process used will help to better understand the topographical features of Zone D2. According to archaeological evidence, the process of coastal regression on the Gulf of Utica is estimated to have occurred as shown in the illustration below. The Gulf of Utica was formed after the ice age from a coastline transgression that occurred approximately 6,000 years ago. From that time on, river sediment from the Mejerda River has gradually filled in the northern part of the gulf.

Later, with the southern part of the gulf filled in by the ancient times, the gulf would remain like this from the Middles Ages up to the present day. Ghar El Mehl Lagoon is the last vestige of what was once the Gulf of Utica.

Topographical survey data and a coordinate system are shown in Data 2.1 and Data 2.2 below.



(Source: Preparatory Survey Report, Original Text: Paskoff R. & Trousset P. (1992) - L'ancienne Baie d'Utique : du témoignage des textes à celui des images satellitaires ; Revue MAPPE MONDE, no. 1)

Figure 2-2: Chronology of the Coastline Regression of the Gulf of Tunis (Utica)

(2) Geology and Soil

1) The Mejerda River is primarily located over a broad tectonic belt called the Diapir Zone. Within the belt's boundaries exists a thrust fault that pushes up from the northwest to the southeast. In that space, a geologic fold has developed that extends from the southwest to the northeast. The ridge lines of mountains and hills here tend to anticline. The geological features of the Mejerda River Basin are a distribution of sedimentary rock including limestone, dolomite, tuffite, sandstone, shale, and evaporite in mountains and hills formed during the Triassic period Mesozoic era, the Cretacious period, the Paleocene epoch Cenozoic era, the Eocene epoch, the Oligocene epoch, the Miocene epoch, and the Pilocene epoch, as well as sand, clay, and other sedimentary layers in the lowlands formed during the Pleistocene epoch and Holocene epoch of the Quaternary period. The limited distribution of pre-Mesozoic calareous rocks are the only hard rocks targeted for aggregate mining.
2) There has been no earthquake damage in Tunisia since 1980 (see Prevention Web data). References document earthquakes of M7 or higher in 412, 856, and 1724 AD.
3) The soil analysis performed in the preparatory study showed that the ground of the Mejerda River's Zone D2 was formed of silty clay, sandy clay, muddy clay, and sand. The area downstream of the Jedeida railroad bridge mostly consists of the three varieties of aforementioned clays, with the rare thin layer of sand between. Upstream of the Jedeida bridge, sand layers are estimated to be thicker. At Jedeida Bridge,

bedrock (weathered sections of sandstone and sandstone interbedded with shale) has also been confirmed at depths of more than 13 m. Over 90% of the clay rates as CH (clay of high plasticity) under the Unified Soil Classification System (USCS). The sand is 50% SM (silty sand), with the remainder SP (poorly graded sands) and a combination thereof.

4) A continuous soft layer (clay-like soil with an N value of less than 4, with a bore head loading test confirming a creep load of less than bar, a pressure limit of less than 10bar, and a deformation modulus of less than 100bar) has been confirmed from the highway bridge to Kalâat el-Andalous Bridge. Lying under the top layer of soil starting at a depth of 5m, this layer is shown to be 15-27m thick, tending to be even thicker downstream. In the El Mabtouh retarding basin, the depth of upstream of the central section has been confirmed at 10-20m. The layer is estimated to continue to thin as it continues upstream close to the Tobias Bridge, eventually disappearing altogether. Downstream of the Tobias Bridge, between the Kalâat el-Andalous bridge riverbed and the left bank, the 1 to 2-meter-thick surface layer sits directly below. Removing the top soil would bring this weak layer to the surface.

5) As will be discussed later, the excavated slopes where the river widens are a gradient of 1:2 (height 1: horizontal distance 2) and have been planned as small steps five meters high and three meters wide. As calculated from the lowest safety factor of the circular slip of an eight-meter tall excavated slope, excluding the weak layer, the safety factor of the sandy clay and silty clay was still high at even the lowest sheer strength received during the soil analyses of the preparatory study. Excavation at the surface of the water during the dry season has remained stable. When slope height is changed to five meters, safety factor calculations show even abrupt excavations at the surface of the water during the dry season to be safe except on the weak and sandy layers. Examining stability on the circular slip of dikes and embankments (heights of three and five meters, surface of ten meters, and a gradient of 1:2) under the assumption that the weak layer sits just below the surface reveals embankments to be unstable at heights of seven meters or higher.

6) Summarizing examination results on the amount of settlement and settlement time in the event that dikes or banks are added in locations where the weak layer is thick,
   i) Kalâat el-Andalous Bridge, 88.4 cm of settlement, with settlement time of 309months (90% consolidation)
   ii) GP8 overpass: 45.3 cm of settlement, with settlement time of 246 months (90% consolidation)

   (note: trapezoid embankments with height of five meters, surface of ten meters, and underside of 30 meters, traffic load 1tf/m^2 (9.8kN/m^2); calculations made based on the water supply of both surfaces and by normally consolidating the settlement amount and time perpendicular to the trapezoid center (applying the Osterburg Influence coefficient)

7) A supporting layer capable of serving as the foundation for structures (clay layer with an N value of 20 or higher) has not been confirmed at either the Kalâat el-Andalous Bridge or the El Mabtouh retarding basin. Confirmation at a deeper level will be required if a pile foundation is needed for either bridge repair or installation.

8) Visits to Ariana and Tebourba quarries revealed both to be potential supply sites for the structural aggregate required. However, the quarries near the survey site primarily quarry tuffite, with only partial

operations dedicated to limestone. Tuffite tends to show a lot of wear, be somewhat soft, and break easily. If higher strength materials are required, they will either need to be acquired from a quarry with harder limestone or a stricter level of quality control toward the aggregate used will be required.

More details on the information above can be found in Data 2.3 (Geology) and 2.4 (Soil).

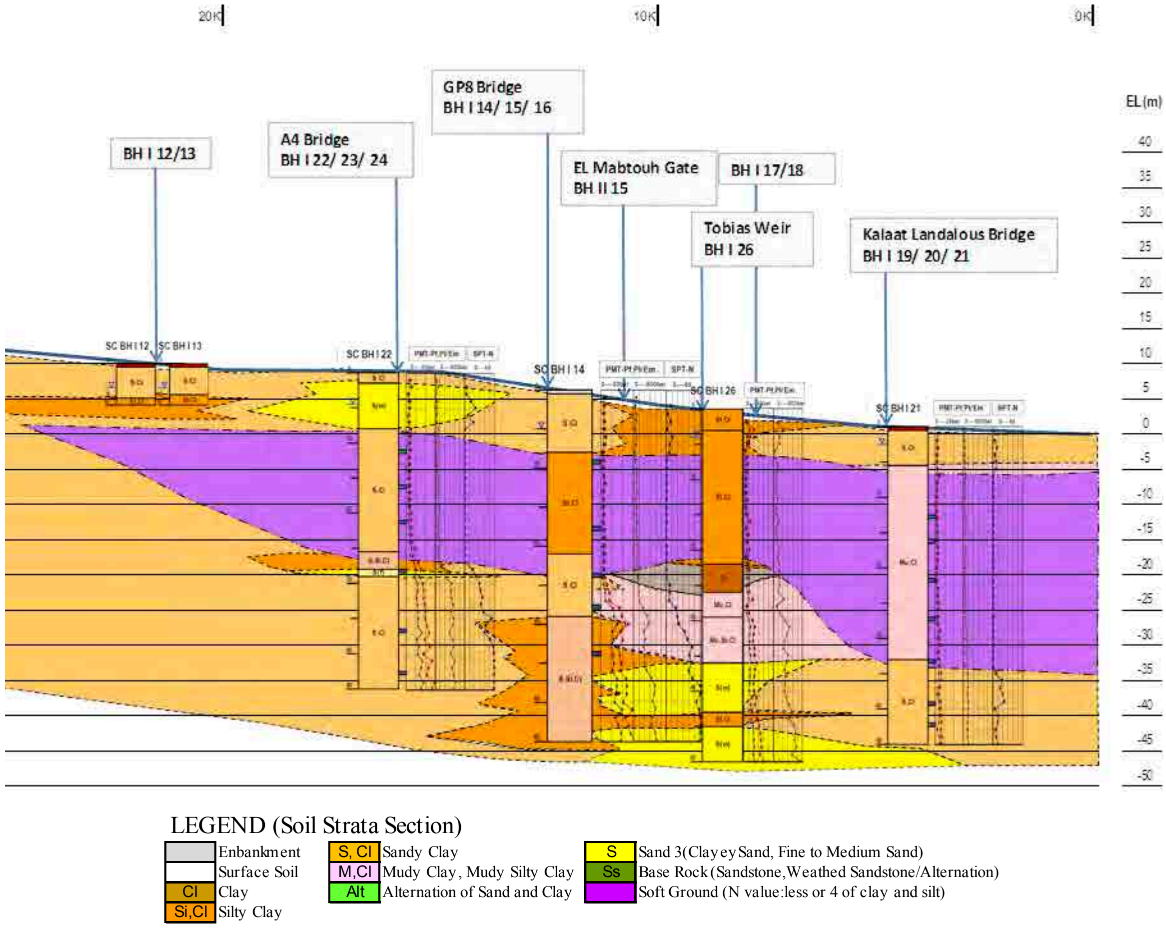


Figure 2-3: Vertical cross-section of downstream main Mejerda River riverside area (showing soft layer)

2.1.2 Weather and Hydrology

(1) Weather Overview

Tunisia sits on the northern African coast of the Mediterranean Sea. The majority of southern Tunisia, which is home to the Sahara desert, is compromised of arid desert and steppe climates, while northern Tunisia has a Mediterranean climate.

Summer peaks around July, with subtropical anticyclones from the south dominant and weather that is hot and dry. In winter, which peaks around January, and the seasonal turning point, the subtropical high-pressure systems retreat south, leading to a warmer climate. During this period, due to the influence of weather fronts and air masses, the weather in northern Tunisia, including the survey area, destabilizes and frequent rainfall is observed. Heading south, the strength of the desert climate causes a reduction in average annual rainfall and an increase in average annual temperature.

(2) Weather

The northern part of Tunisia, including the survey area, features a climate that is hot and dry in the summer and warm and moist in the winter. Temperature, evapotranspiration, and daylight hours all peak between July and August, with humidity and precipitation lowest at this time.

The annual average temperature of the survey area is generally between 17 and 20˚C. The monthly average in July and August is between 27 and 29˚C, with the highest temperatures of those months averaging between 33 and 34˚C.

The annual average relative humidity is between 60 and 68%, peaking in the rainy season in December and January at between 75 and 85% and at its lowest in July and August at between 49 and 60%. Additionally, the average annual amount of potential evaporation is between 1,300 and 1,800 mm.

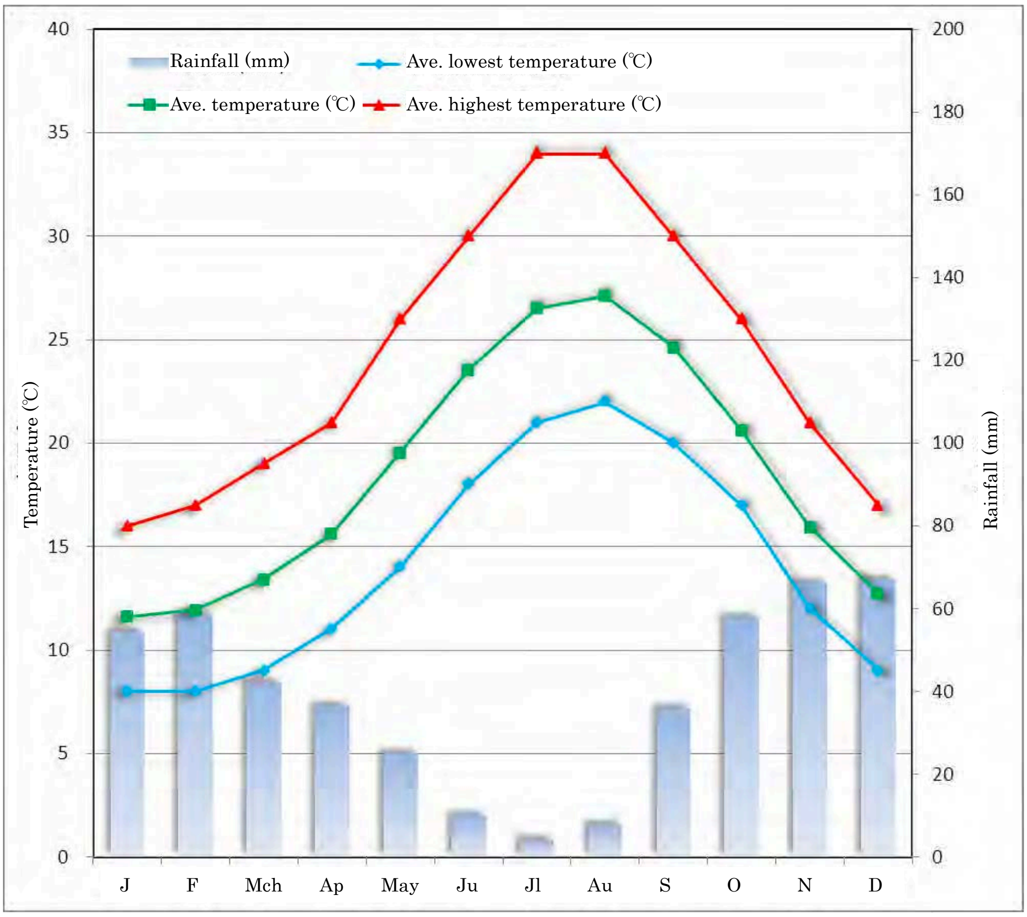


Figure 2-4: Annual average temperature and precipitation in Tunis

(3) Precipitation

The major causes of rainfall in Tunisia are as follows:

1) There are weather disturbances that occur in the North Atlantic and move into the Mediterranean Sea as well as those that occur in the western Mediterranean Sea. These are responsible for approximately two-thirds of all rainfall in Tunisia.

2) Weather disturbances also occur in the eastern Mediterranean Sea including the Cyprus region. These are responsible for approximately 11% of all rainfall. These are often observed in fall and tend to bring about comparatively strong rains.
3) Weather disturbances from the northern Sahara move from the southwest to the east and northeast. These dry air masses pass through Tunisia and stagnate over the Mediterranean Sea, causing torrential rainfall in the eastern part of the country.

The degree of variation in rainfall between seasons and regions in Tunisia is very high. The annual average rainfall of the mountainous area of Kumil in the northwestern edge of the country reaches 1,500 mm. This decreases further south, with the annual average of Tunisia's southern tip measuring in at under 100 mm. As shown in the illustration (map) below, the Mejerda basin exhibits a large regional bias in terms of precipitation. This regional difference is particularly stark between the months of October and April. As shown in the figure (graph) below, the monthly average precipitation increases greatly between October and April in the north of the survey area on the left bank of the Mejerda basin, with a particularly prominent peak noticeable between December and January. Meanwhile, month-to-month variations in average precipitation are not as prominent in the southern section on the right bank of the Mejerda basin as in the north over the course of the year. The average annual precipitation of the survey area is generally between 400 and 500 mm.

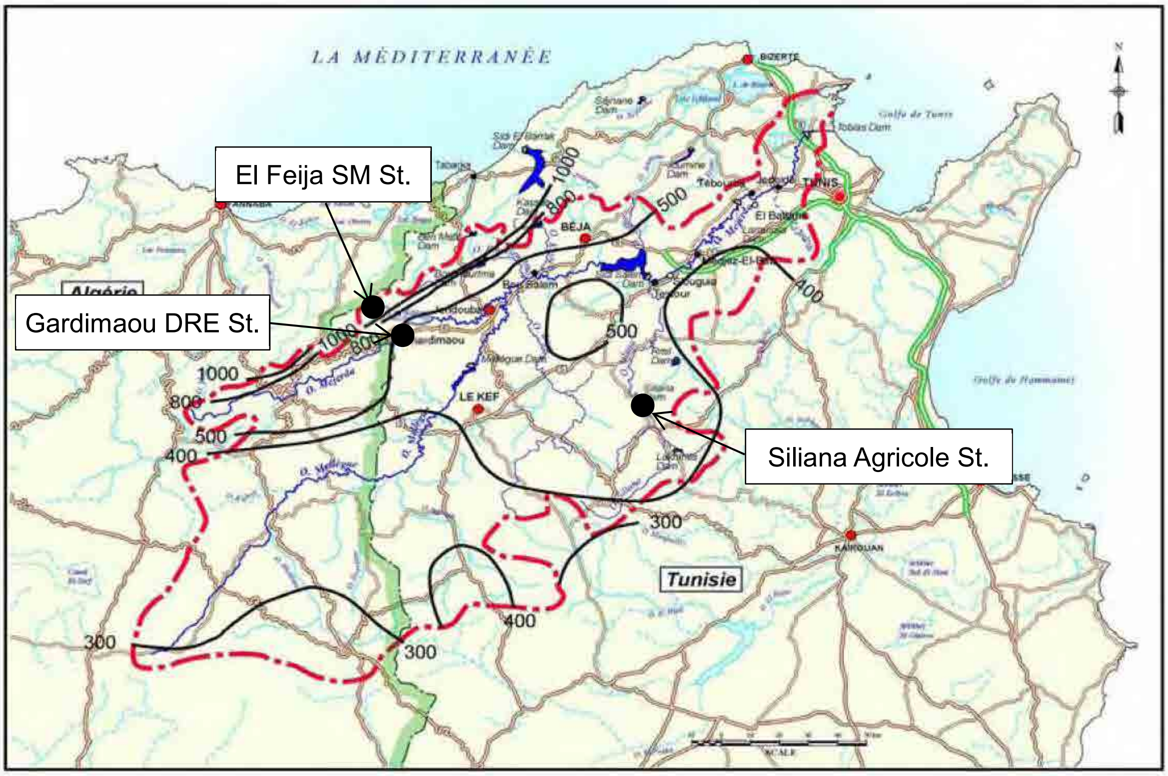


Figure 2-5: Isopluvial map in the Mejerda basin (average annual precipitation)

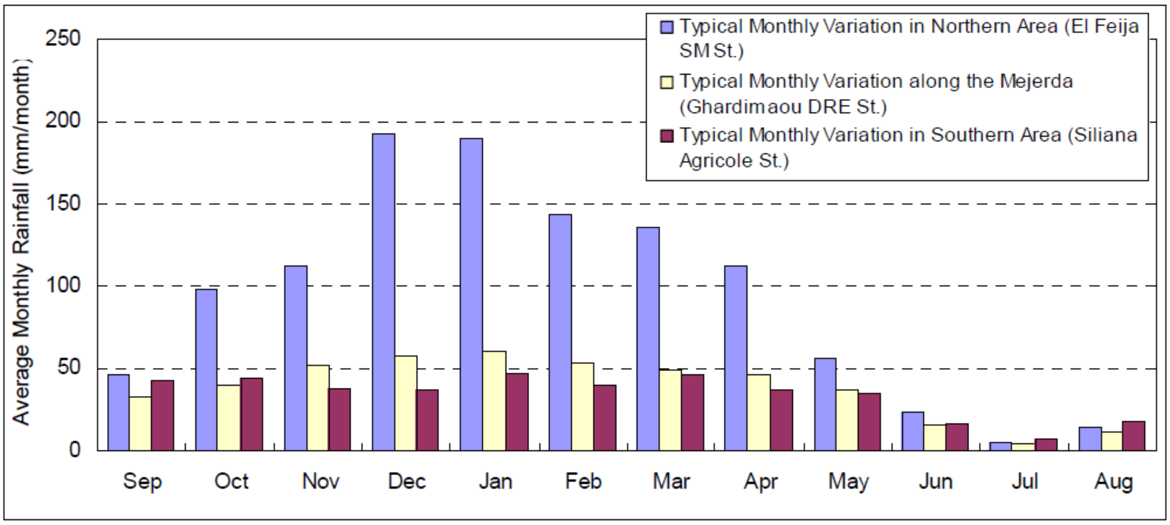


Figure 2-6: Regional differences in average monthly precipitation

2.1.3 Flood controls and irrigation facilities

Tunisia is a country lacking in water resources, with huge fluctuations in terms of rainfall both regionally and seasonally. Annual rainfall in the north is about 1,500mm, while annual rainfall in desert area of the south falls below 50mm. This is indicative of the huge variability of rainfall depending on the region. Total annual rainfall is not sufficient enough to provide a stable source of water for agriculture throughout the year as well as to meet other demands.

Therefore, water demand has been met by constructing dams and reservoirs and accumulating surface runoff. Reservoirs and water conveyance facilities have been constructed in northern Tunisia over the years to collect water and help fill the gaps between years of abundant water and years of shortages. More facilities are currently being planned and constructed to accumulate as much surface runoff as possible.

There are currently nine active dams in the Mejerda basin, with six more either in planning or under construction. An overview of the location of each is shown below. Additionally, Laroussia Dam is an intake facility that serves to convey water to the Cap Bon Canal. The Tobias Barrage also functions as an intake facility.

Table 2-2: Characteristics of Mejerda basin dams

Dam	Catchment area (Km^2)	Maximum reservoir capacity (millions m^3)
Sidi Salem	18,191	959.5
Mellegue 2*	10,100	334.0
Bou Heurtma	390	164.0
Mellegue	10,309	147.5
Siliana	1,040	125.1
Tessa*	1,420	125.0
Kasseb	101	92.6
Ben Metir	103	73.4
Sarrath*	1,850	48.5
Beja*	72	46.0
Khalled*	303	37.0
Chafrou*	217	14.0
Lakhmes	127	8.4
Rmil	232	6.0

Note: * = Under construction or in design/planning

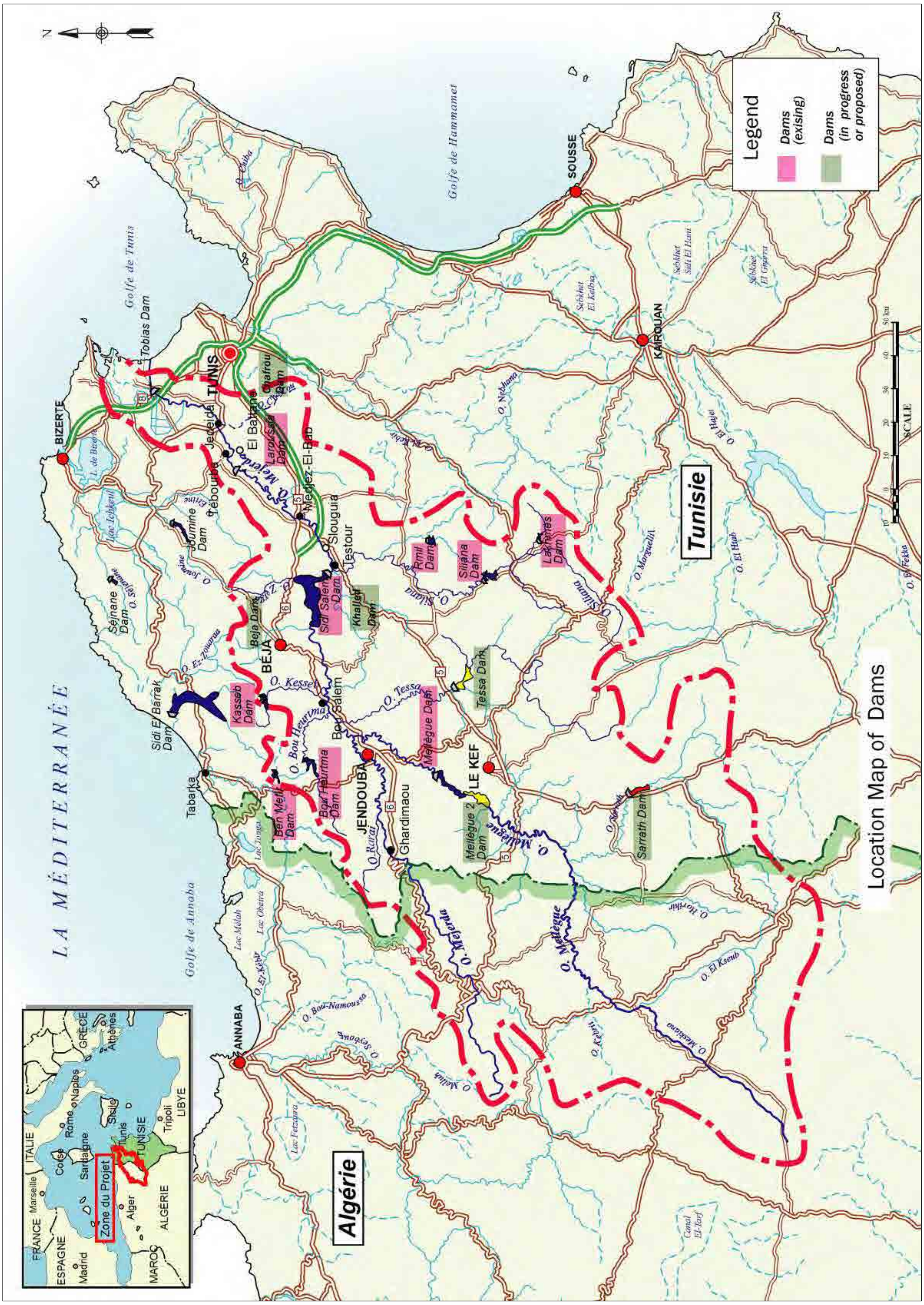


Figure 2-7: Locations of Mejerda basin dams in Tunisia

The illustration below shows the arrangement of dams, diversion weirs, tributaries, major hydrological stations, and cities.

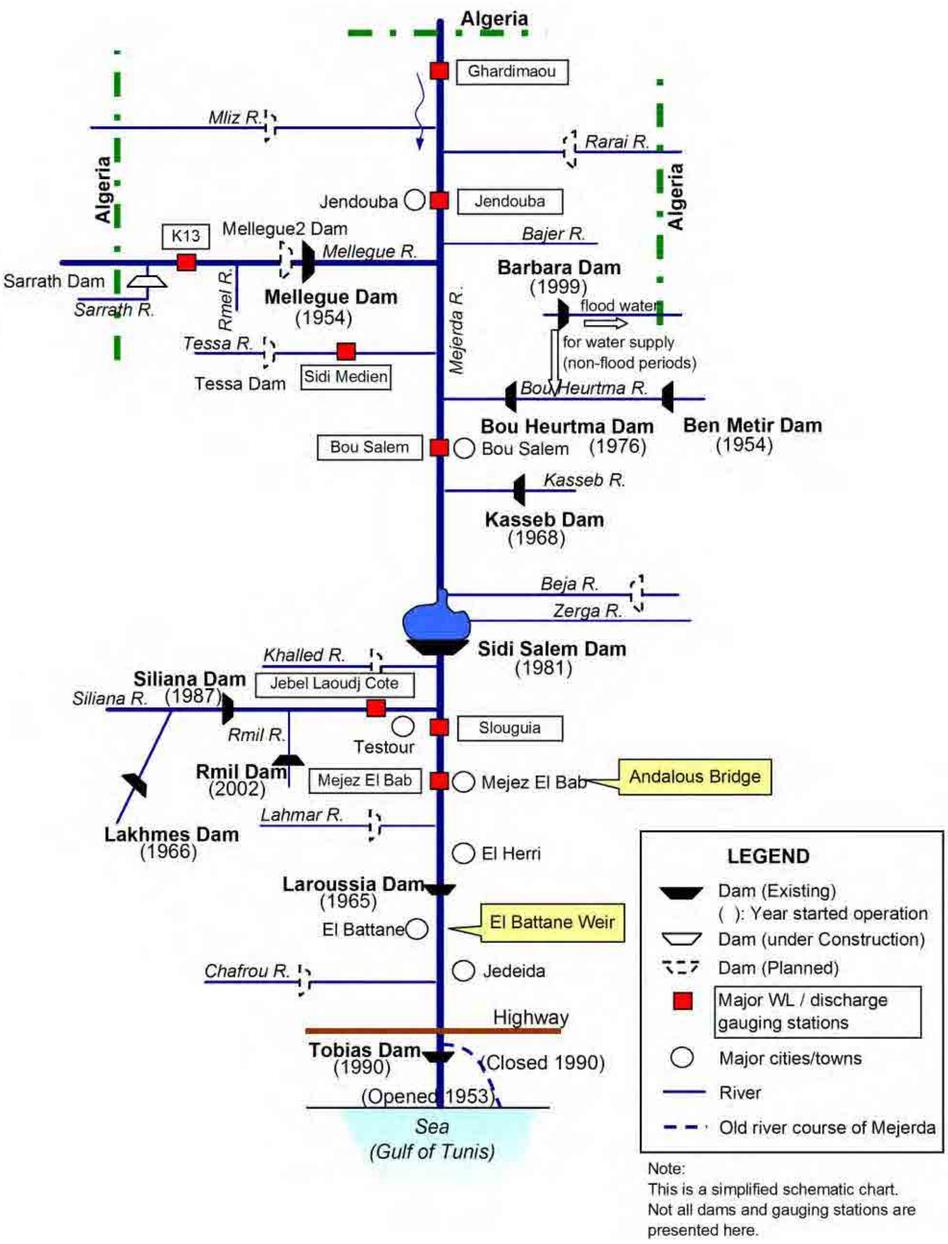


Figure 2-8: Layout of major stream gaging stations, tributaries, dams, and cities

2.1.4 Socioeconomics

(1) Population and population density

According to the 2004 national census, the population and population density of Tunisia and the Mejerda basin are as follows. Three-fourths of the total population of Tunisia lives in the northern region, which accounts for 30% of the country's territory. The Mejerda basin accounts for 9.8% of the country's territory and 13.4% of the country's total population. In terms of the country on a whole, populations tend to be concentrated along the main Mejerda River. Within the Majerda River basin, the population density is high at the alluvial plain near the river mouth, just as it is in the governorates of Manouba (201-220 people/Km^2) and Ariana (161-180 people/Km^2). Both governorates are located within Zone D2.

National population	9,910,872 (approx. 9.91 million)
National population density	61.1 persons/Km^2
National population growth rate	1.10%
National urban population ratio	64.8%
Population of the Mejerda basin	Approx. 1,330,000 (13.4% of total population)
Population density of the Mejerda basin	84.0 persons/Km^2

Source: 2004 National Census

(2) Economy

1) Agriculture

In the ten years between 1997 and 2006, agriculture dropped from making up 14.2% to 11.3% of Tunisia's total GDP. During the same period, agriculture grew at an annual rate of 2.2%, falling from the 3.1% observed between 1990 and 1997. A breakdown of number of laborers in the 2004 National Census shows 48.9% in service, 19.4% in manufacturing, and 14.5% in non-manufacturing. Comparatively, agriculture accounts for no more than 16.2%. However, the Mejerda basin plays an important role in domestic agricultural production, with agriculture serving as the basin's economic base. A summary of this is as follows.

Area of the Mejerda basin	15,830 Km^2 (9.8% of total national area)
Area of basin upland field (non-irrigated)	10,392Km^2 (65.6% of total basin area)
Area of basin farmland (irrigated)	1,489 Km^2 (9.4% of total basin area)
Agricultural produce and livestock Wheat production	1,627,000 tons (51% of total national production)
Barley production	465,000 tons (34% of total national production)
Beef production	45.4% of total national production
Goat meat production	45.2% of total national production
Poultry production	51.9% of total national production
Basin cork production	75.7% of total national production

Source: National Bureau of Statistics

2) Manufacturing and Service

As mentioned above, the 2004 National Census shows that, in a breakdown of the national workforce, service accounts for 48.9% and manufacturing accounts for 19.4%. Manufacturing grew at an annual average of 3.8% in the ten years between 2000 and 2009 and accounted for 29% of the national GDP during that period. Service grew at a high 5.8% during the same period and accounted for 61.4% of GDP as of 2006.

The current state of manufacturing and service companies in the governorates of Manouba and Ariana are organized in the following table. Being located in the outskirts the capital and country's best harbor in

Tunis, export-oriented companies account for half of all enterprises in both governorates. Protecting these companies from flood damage is in the best interest of the national economy.

	Manouba	Ariana
Total companies	186	240
Export-oriented companies	92	111
Breakdown of companies	Textiles, clothing and leather, food processing (dairy, apples, pears), and electric machinery with a focus on auto parts	Textiles, clothing and leather, agro-processing, electronics, pharmaceuticals, computers and telecommunication

Source: Tunisia Foreign Investment Promotion Agency

2.2 Overview of Zone D2

2.2.1 River channel

Zone D2, the Mejerda's lowest basin, is an approximately 65-km section that runs from Laroussia Dam to the river mouth. In the upstream section of Zone D2 between Laroussia Dam and Jedeida, the river flows through an embedded channel among a belt of gently sloping hills. Excavations downstream of Laroussia Dam are more than 10 meters deep, with the depth gradually decreasing on its way to Jedeida. The central section between Jedeida and Tobias flows through alluvial plains. The Chafrou River merges with the right bank of the Mejerda in this section. At present, there is also a section with dikes of about two meters, but it is an essentially compound river channel comprised of a low flow channel (water route) and a flood channel. Within the river channel,

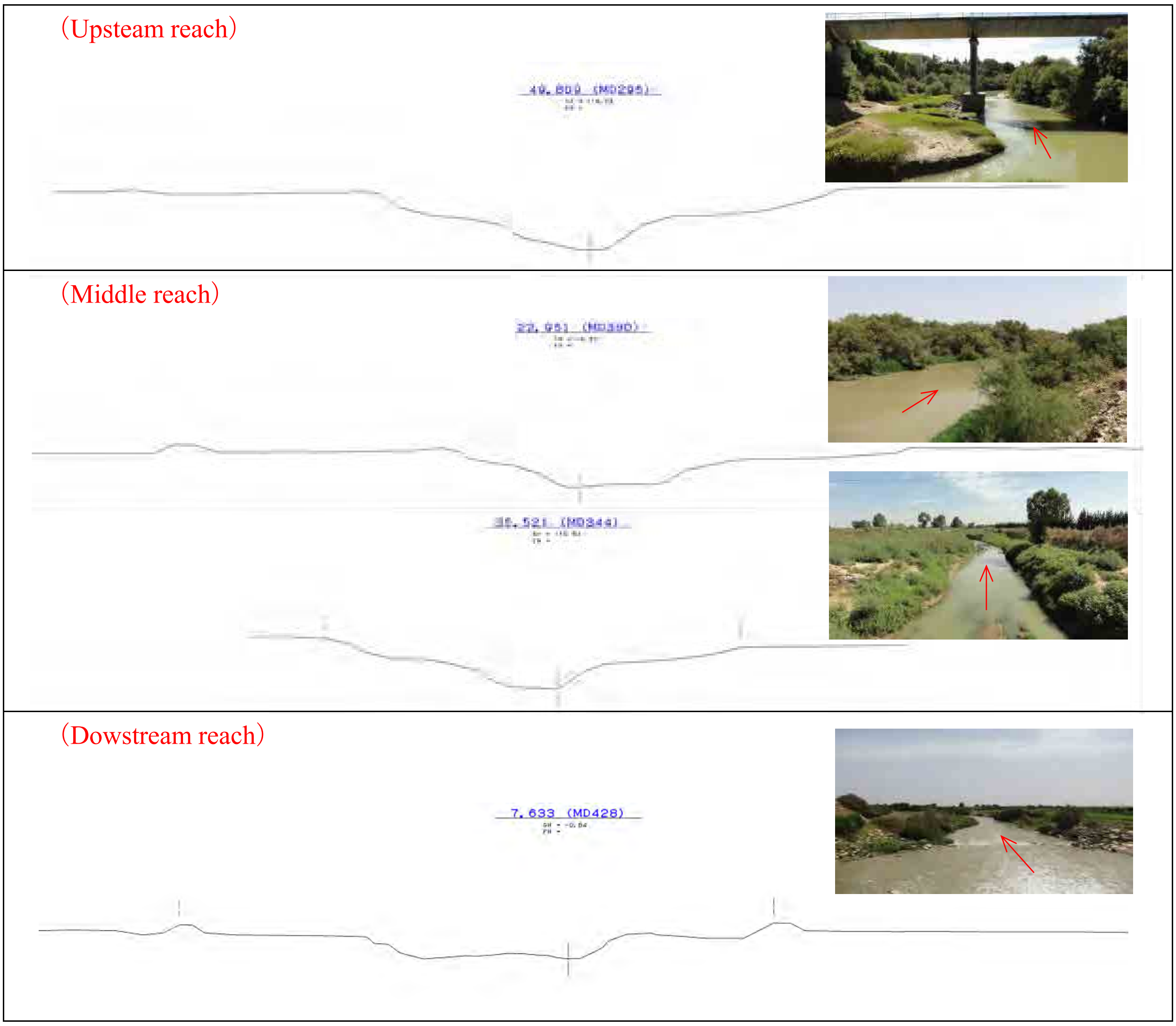


Figure 2-9: Typical cross sections of river channel

a flourishing growth of tamarix trees is visible. Downstream of Tobias Barrage, the channel is excavated in a straight line on flat terrain and continues like this until it reaches the river mouth. Both sides of the channel are banked, with two lines of embankments on the right bank. No closure has been observed at the river mouth. Typical cross sections for Zone D2 are shown in the above illustration. Detailed pictures showing the state of the river channel have been included in Data 2.5.

2.2.2 Facilities on the river channel

(1) Dams

Overviews of the Laroussia and Tobias Barrages are provided below.

1) Laroussia Dam

Laroussia Dam is located approximately 65Km from the Mejerda River mouth. It is designed to have a reservoir capacity of 2,000,000m^3 and includes intake and power generation facilities. Its primary functions are as follows:

i. Pumping stations have been installed on the left bank just upstream from the dam to provide water to the Chouigui irrigated district.

ii. Hydroelectric gates have been installed on the dam's left bank, generating 4MW/h.

iii. Three water-discharging sluice gates have been installed on the dam's right bank.

iv. Intake facilities have been installed on the right bank immediately upstream of the dam, with a maximum water conveyance capacity to Mejerda low valley of 13 m^3/sec. and maximum water conveyance to Mejerda Cap Bon of 16 m^3/sec.

Detailed pictures have been included in Data 2.6.

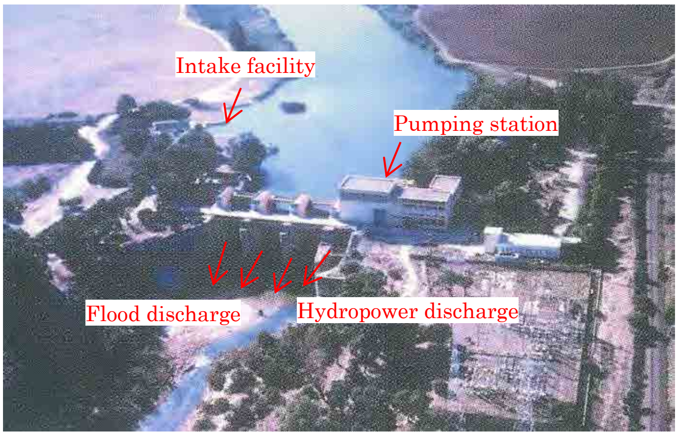


Figure 2-10: Left: Panoramic view of Laroussia dam/Right: Panoramic view of the area downstream

2) Tobias Barrage

Tobias Barrage was constructed 11 km from the Mejerda. Two tumble gates (width: 15.0 meters, height: 2.0 meters) have been installed on the left bank of the Tobias dam. When the water is calm, the gates are raised to maintain water intake levels. A fixed dam (width: 35.0 meters) has been installed on the right bank. Pumping stations have been installed as intake facilities directly upstream of the Tobias Barrage on the left bank. Detailed pictures and general structural drawings of the dam have been included in Data 2.6.

Figure 2-11: Left: Two tumble gates (in front) and the fixed dam/Right: Pumping station intake facilities directly upstream on the left bank

(2) Bridges

As shown in the diagram below, there are currently 29 bridges in Zone D2. Pictures of representative bridge confirmed during the field survey and factors which effecting each bridge have been included in

Data 2.7.

Table 2-3: Existing bridges

No.	Bridge Name	Channel		Route	Remarks
		Name	Distance		
1	K.LANDAOUS BRIDGE	Medjerda	4.664	Rue Sadok Belhadi	
2	TOBIAS BRIDGE	Medjerda	10.828	MC50	
3	TOBIAS OLD BRIDGE	Medjerda	10.836	MC50	Discrepancy between locations of new bridge and bridge pier
4	GP8 BRIDGE OVER OUED MEJERDA	Medjerda	13.728	GP8	
5	A4 MOTORWAY BRIDGE	Medjerda	16.017	MOTORWAY A4	
6	FOOTBRIDGE	Medjerda		Sidewalk	Wooden Suspension Bridge
7	WATER PIPE BRIDGE	Medjerda	34.440	Water supply	
8	JEDEIDA RAILWAY OLD BRIDGE	Medjerda	37.848	RAILWAY	Discrepancy between locations of new bridge and bridge pier
9	JEDEIDA RAILWAY BRIDGE	Medjerda	37.834	RAILWAY	Signs of afflux on beams during flooding
10	JEDEIDA BRIDGE	Medjerda	41.071	RVE507	
11	JEDEIDA OLD BRIDGE	Medjerda	41.091	RVE507	Historical bridge, narrowing of the river channel
12	JEDEIDA BRIDGE ON GP7	Medjerda	41.926	GP7	
13	EL BATTAN BRIDGE	Medjerda	53.111	MC64	Historical bridge
14	TEBOURBA IRRIGATION CANALS BRIDGE	Medjerda	56.899	IRRIGATION CANALS	
15	GP7 BRIDGE ON CHAFUROU	Chafurou		GP7	Bridge abutment installed on flood channel
16	GP7 OLD BRIDGE ON CHAFUROU	Chafurou		GP7	Discrepancy between locations of new bridge and bridge pier
17	EL H'BIBIA BRIDGE	Chafurou		Local Road	
18	Bridge on the local road	Driving		Local Road	
19	FARM BRIDGE ON Driving CHANNEL	Driving		Farm Road	Small Farm Road Bridge
20	FARM BRIDGE ON Driving CHANNEL	Driving		Farm Road	Small Farm Road Bridge
21	FARM BRIDGE	Driving		Farm Road	Small Farm Road Bridge
22	MC50 EL MABTOUH BRIDGE	Driving		MC50	
23	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road	Small Farm Road Bridge
24	A4 BRIDGE OVER Mabtouh	Mabtouh		MOTORWAY A4	
25	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road	Small Farm Road Bridge
26	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road	Small Farm Road Bridge
27	GP8 BRIDGE AND ROAD OVER Mabtouh	Mabtouh		GP8	
28	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road	Small Farm Road Bridge
29	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road	Small Farm Road Bridge

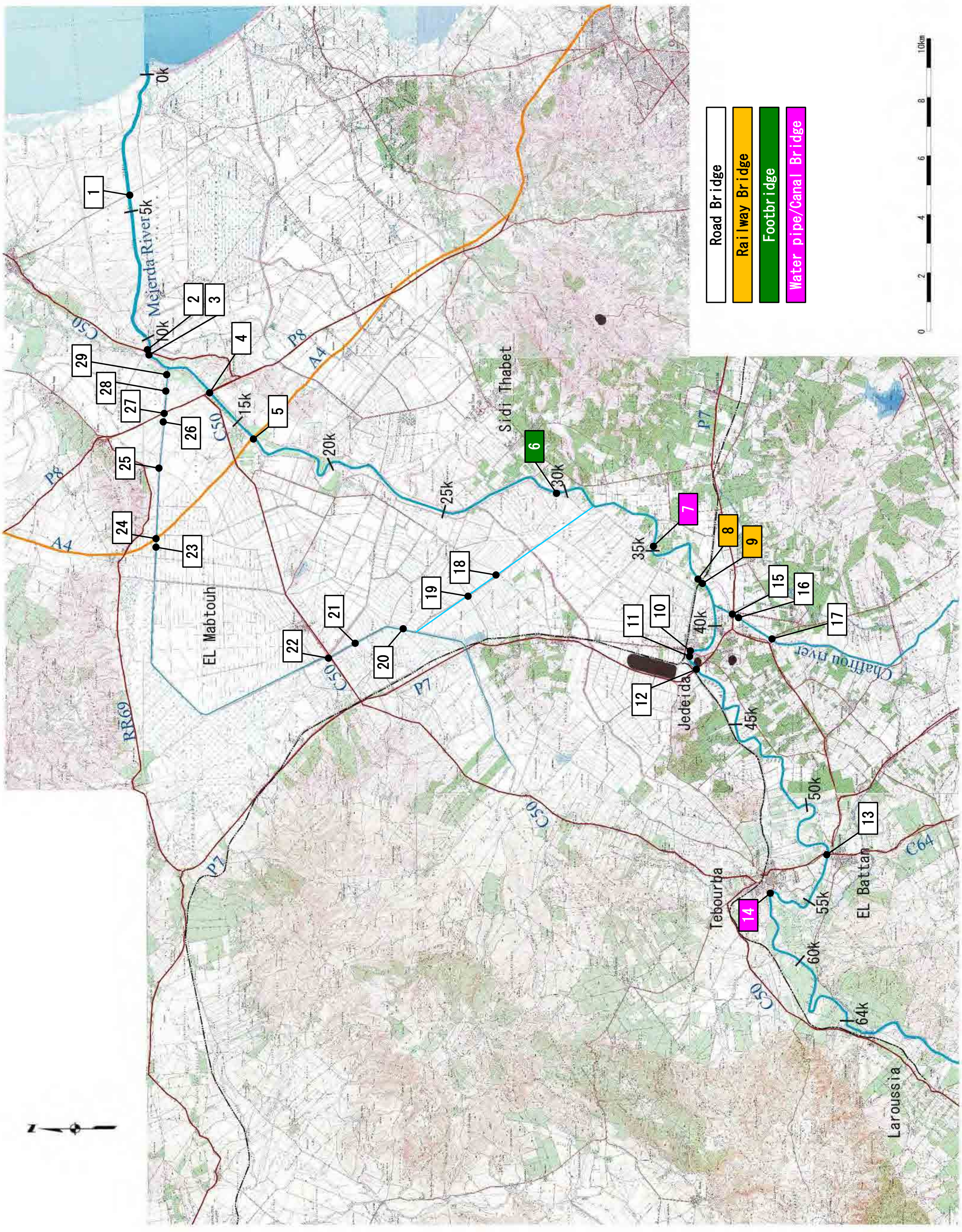


Figure 2-12: Current bridge placement

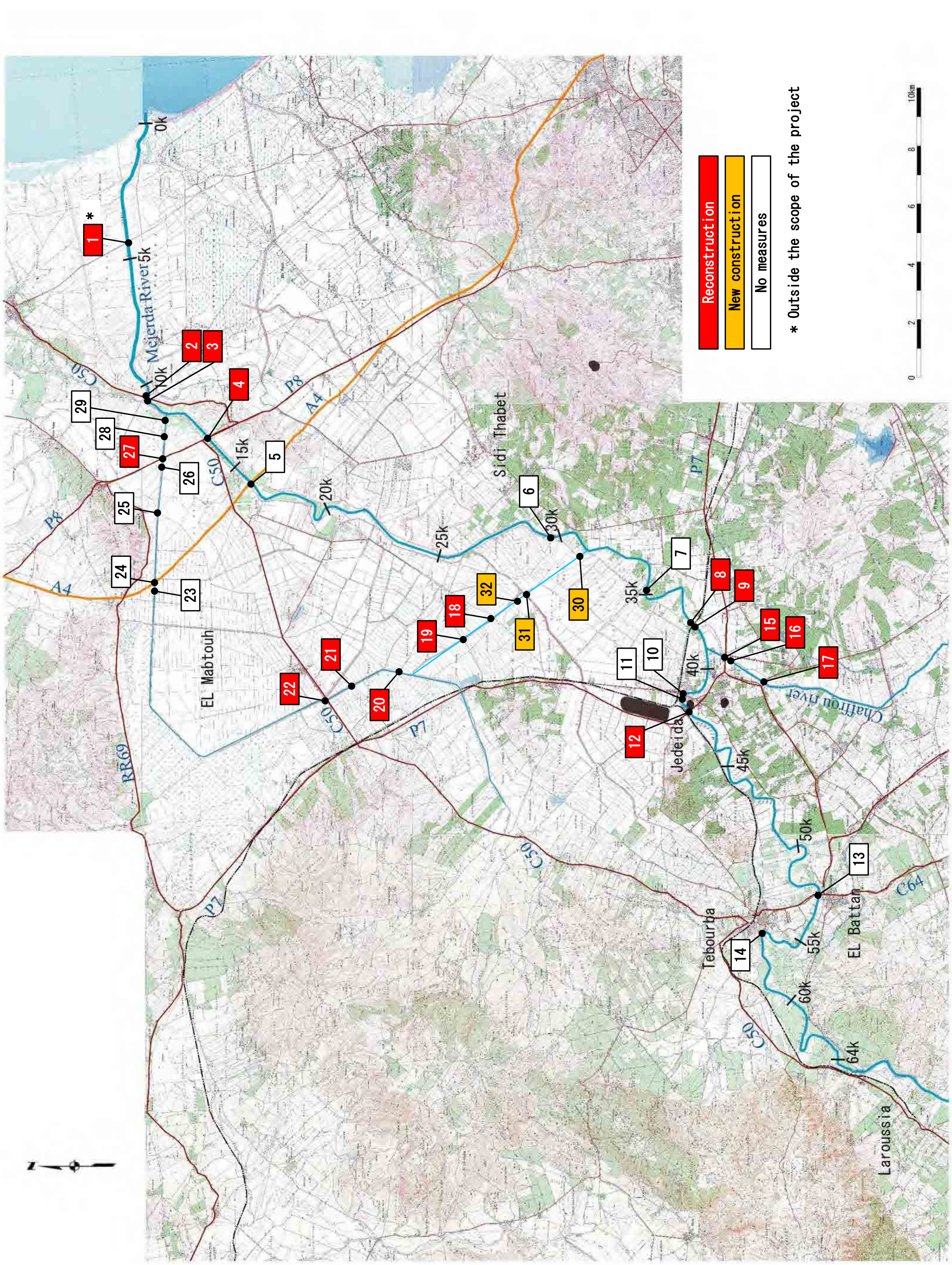
Because a widening of the river channel is assumed for river improvements, structural alterations like suspensions, raises, and bridge elongations will be necessary to compensate for functions in terms of bridges that are currently in service on-site.

Displayed below is a list of bridges expected to be altered as a result of the upcoming river improvements. From among the 29 existing bridges, 15 will need to be altered and three new bridges constructed. Note that the K. Landaous Bridge located at the lowest reaches of the river will also require alterations as the river channel is improved. However, it is expected to be included among another road project and therefore, falls outside the jurisdiction of this project.

Table 2-4: List of bridges expected to be altered or constructed due to river improvements

No.	Bridge Name	Channel		Route	Reconstruction	Construction
		Name	Distance			
1	K.LANDAOUS BRIDGE	Medjerda	4.664	Rue Sadok Belhadi	Yes *	
2	TOBIAS BRIDGE	Medjerda	10.828	MC50	Yes	
3	TOBIAS OLD BRIDGE	Medjerda	10.836	MC50	Yes	
4	GP8 BRIDGE OVER OUED MEJERDA	Medjerda	13.728	GP8	Yes	
5	A4 MOTORWAY BRIDGE	Medjerda	16.017	MOTORWAY A4		
6	FOOTBRIDGE	Medjerda		Sidewalk		
7	WATER PIPE BRIDGE	Medjerda	34.440	Water supply		
8	JEDEIDA RAILWAY OLD BRIDGE	Medjerda	37.848	RAILWAY	Yes	
9	JEDEIDA RAILWAY BRIDGE	Medjerda	37.834	RAILWAY	Yes	
10	JEDEIDA BRIDGE	Medjerda	41.071	RVE507		
11	JEDEIDA OLD BRIDGE	Medjerda	41.091	RVE507		
12	JEDEIDA BRIDGE ON GP7	Medjerda	41.926	GP7	Yes	
13	EL BATTAN BRIDGE	Medjerda	53.111	MC64		
14	TEBOURBA IRRIGATION CANALS BRIDGE	Medjerda	56.899	IRRIGATION CANALS		
15	GP7 BRIDGE ON CHAFUROU	Chafurou		GP7	Yes	
16	GP7 OLD BRIDGE ON CHAFUROU	Chafurou		GP7	Yes	
17	EL H'BIBIA BRIDGE	Chafurou		Local Road	Yes	
18	Bridge on the local road	Driving		Local Road	Yes	
19	FARM BRIDGE ON Driving CHANNEL	Driving		Farm Road	Yes	
20	FARM BRIDGE ON Driving CHANNEL	Driving		Farm Road	Yes	
21	FARM BRIDGE	Driving		Farm Road	Yes	
22	MC50 EL MABTOUH BRIDGE	Driving		MC50	Yes	
23	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road		
24	A4 BRIDGE OVER Mabtouh	Mabtouh		MOTORWAY A4		
25	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road		
26	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road		
27	GP8 BRIDGE AND ROAD OVER Mabtouh	Mabtouh		GP8	Yes	
28	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road		
29	FARM BRIDGE ON Oued Mabtouh	Mabtouh		Farm Road		
30	FARM BRIDGE(NEW)	Driving		Farm Road		Yes
31	FARM BRIDGE(NEW)	Driving		Farm Road		Yes
32	FARM BRIDGE(NEW)	Driving		Farm Road		Yes

* Outside the scope of the project


Reconstruction
New construction
No measures
* Outside the scope of the project
Mejerda River
Chafrou river
Sidi Thabet
EL Mabtouh
Jedeida
Tebourba
EL Battan
Laroussia
0k
5k
10k
15k
20k
25k
30k
35k
40k
45k
50k
55k
60k
64k
P7
P8
A4
C50
C64
RR69

(3) Existing sluicing outlets on the main river

This field survey was conducted based on a list from the Ministry of Agriculture showing the existing sluicing outlets along the main river. The specifications and location of these outlets, including those not able to be confirmed in the field, are arranged in the table and figure below. A widening of the river channel is assumed in the river improvements to be described below. It will be necessary to maintain the functionality of sluicing outlets that are currently in service on-site. Therefore, existing outlets will be demolished in favor of new ones. However, no structural alterations are deemed necessary for outlets that could not be confirmed on-site and outlets that have been confirmed but are currently not in use. Sluicing gates expected to require modification as a result of the upcoming river channel improvement are shown in the table below. Note that the intake sluicing gate at Tobias Barrage that is located furthest downstream is a larger facility and will be used as-is. A record of the results of the field study is included in Data 2.9.

Table 2-5: Sluicing gates requiring alterations due to upcoming river channel improvements

No.	Name	Accumulative distance(km)	On-site confirmation	Alterations required	Internal water area (km^2)	Cross section, application and land use of existing facilities
1	P71 Left	52.2	×	-	1.44	
2	P84 Left	48.8	×	-	3.95	
3	P110 Left	42.9	Yes	×	0.85	
3-1	P110 Left-2	L 41.7	Yes	Yes		500Φ/drainage/cities, etc.
4	P84 Right	R 48.8	Yes	Yes	3.47	Approx. 800Φ assumed / drainage / farmland
5	P105 Right	R 44.4	Yes	Yes	2.58	-
6	P110 Right	42.9	×	-	1.85	
7	P116 Right	R 41.7	Yes	Yes	0.20	Approx. 800Φ assumed / drainage / cities, etc.
8	P119 Right	38.6	Yes	×	0.42	
9	P132 Right	36.5	×	-	26.26	
10	P146 Right	R 33.7	Yes	Yes	6.72	2Box-3.2mBx1.2mH/drainage/farmland
11	P160 Right	R 30.8	Yes	Yes	18.42	U-1.04m×0.8mH (Drainage)/farmland
11-a	P160 Right	R 30.2	Yes	Yes		U-1.0m×1.0mH (drainage assumed)/farmland
12	P169 Right	R 28.4	Yes	Yes	7.01	2Box-2.2mB×1.2mH / drainage
13	PoMejCher Right	23.7	Yes	×	19.71	
14	PA4Mejam Left	L 16.7	Yes	Yes	0.70	Approx. 800Φ assumed / drainage / farmland
15	PA4Mejav Left	L 15.7	Yes	×	0.80	
16	PoMejProt Right	12.9	Yes	×	7.65	
17	PoMejTobias Right	10.7	Yes	×	0.40	
18	PTobias Left	10.6	Yes	x	0.63	Present facilities to be used as-is / intake / farmland

Notes:

- L and R in front of the distance mark in the distance column of the above table indicate either left bank or right bank. Source of internal water area: JICA Study Team

- ○ on the on-site confirmation column represents facilities confirmed during the field study, and x represents facilities that remain unconfirmed.
- － on the alterations required column represents facilities that were not able to be confirmed on location and thus, the necessity of alterations to them cannot be determined as of yet. × represents facilities that have been confirmed on location but do not require alterations (besides removal) because they are currently not in service. The facilities represented by ○ are those that are currently in use and require structural alterations.

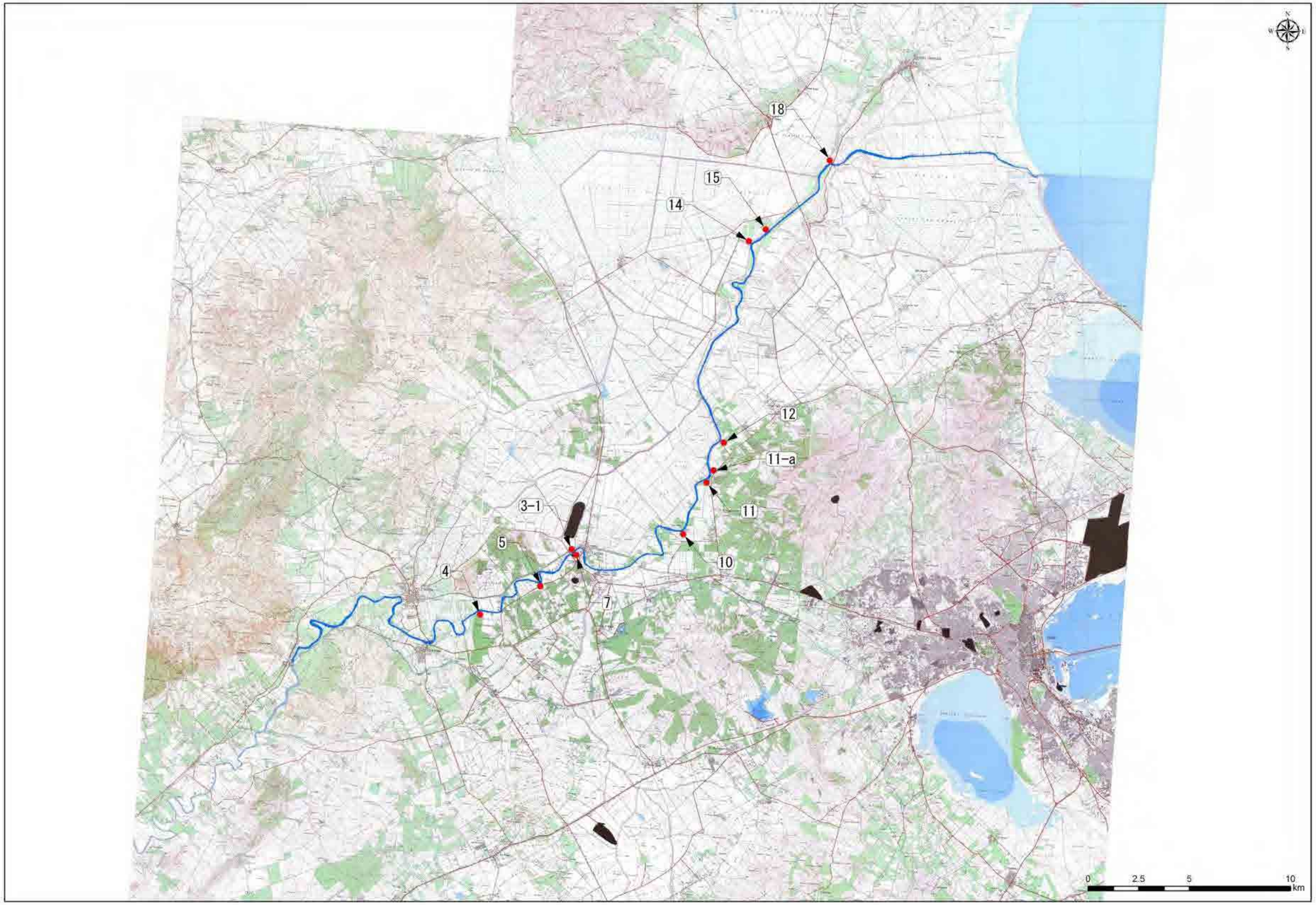


Figure 2-14: Location of sluicing gates expected to require alterations due to upcoming river channel improvement

(4) Hydraulic structures of the El Mabtouh retarding basin

In addition to information on position and structure, a list of districts planned for the El Mabtouh retarding basin is arranged in the following table and figure. Pictures of each structure are included in Data 2.8.

Table 2-6: Llist of major facilities in El Mabtouh area and Chaffrou river

No	Name	Function
1	Inlet channel	Receive water from Zone and discharge
2	Overflow dike	Flood overflow from Zone 3 to Zone 2
3	Control Gate for overflow	Adjustment of flood overflow from Zone 3 to Zone 2
4	Fuse dike	Emergent discharge of flood from Zone 3 to Zone 1
5	Flow control gate	Discharge of standing water from Zone 3 to Zone 1 and from Zone 2 to Zone 1
6	Box culvert crossing the highway	Water discharge from Zones 1 through 3 near highway crossing point
7	Box culvert crossing the highway	Water discharge from Zones 1 at the location of outlet channel crossing highway
8	Outlet channel crossing the road	Water discharge from Zones 1 through 3 near general road crossing point
9	Outlet gate (1) to Mejerda river	Outlet adjustment at Mejerda river meeting point
10	Outlet gate (2) to Mejerda river	Outlet adjustment at Mejerda river meeting point
11	Drain Culverts/ Flap gates along the channel	Water discharge from Zones 1 and 2 to inlet and outlet channels

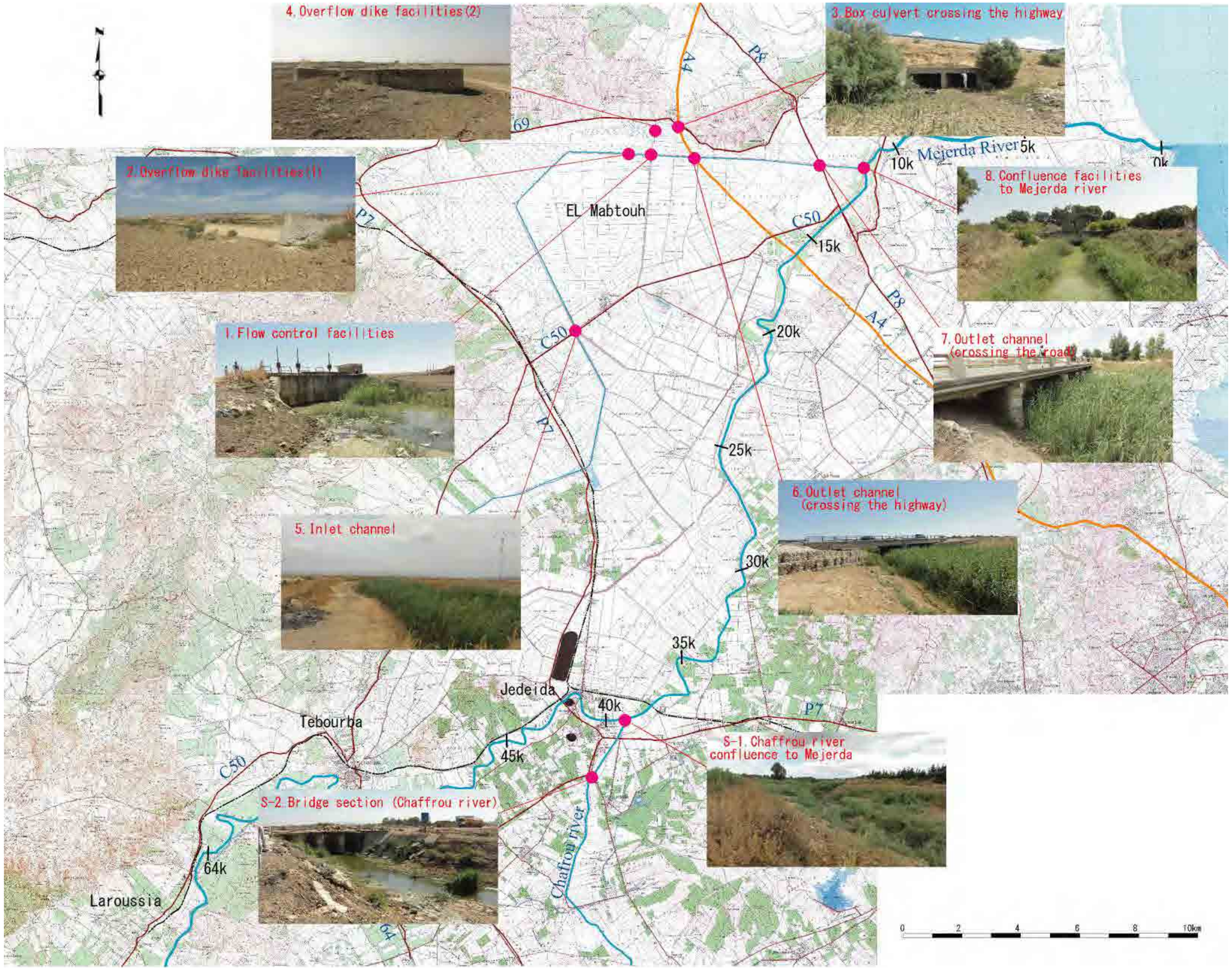


Figure 2-15: El Mabtouh retarding basin and Chaffrou river major facilities

2.3 Flood damage situation

2.3.1 Hydrological characteristics of major floods

Floods that have occurred in the Mejerda basin since 1900 and the peak flow rates at major observation stations are as follows.

Table 2-7: Past floods in Mejerda basin

Flood	Peak Discharge(m^3/s)						
	Mellegue(K13)	Ghardimaou	Jendouba	Bou Salem	Slouguia	Mejez Elbab	Jedeida
Feb 1907	-	-	1,610	-	-	-	-
Feb 1928	-	-	-	1,220	-	-	-
Mar 1929	-	-	-	1,760	-	-	-
Dec 1932	-	-	-	2,060	-	2,250	-
Jan 1940	-	-	-	1,780	-	-	-
Oct 1947	-	-	-	1,700	-	1,280	-
Nov 1948	-	-	-	851	-	891	-
Jan 1952	-	-	-	904	-	981	-
Mar 1959	-	-	-	1,140	-	1,490	-
Sep 1969	4,480	-	-	1,485	-	1,440	-
Mar 1973	-	2,370	2,420	3,180	-	-	-
1976	-	1,013	970	-	-	-	-
1981	Sidi Salem Dam Completed						
Dec 1984	600	570	750	900	-	-	-
Jul 1989	-	-	-	-	470	-	-
May 2000	4,480	736	327	977	-	-	-
Jan 2003	2,600	1,090	1,070	1,020	744	730	-
Jan 2004	2,480	1,470	1,024	889	-	-	-
Jan 2005	-	838	616	529	-	224	-
Apr 2009	-	-	-	-	365	262	-
Feb 2012	-	-	-	-	-	-	324

As discussed above, the Mejerda basin has experienced many floods up until now. The hydrological characteristics observed during major floods in recent years are mentioned below.

(1) Flood of March 1973 (Occurred in March 1973)
(2) Flood of May 2000 (Occurred in May 2000)
(3) Flood of January 2003 (Occurred between January and February 2003)
(4) Flood of January 2004 (Occurred between December 2003 and February 2004)
(5) Flood of January 2005 (Occurred between January and March 2005)
(6) Flood of April 2009 (Occurred in April 2009)
(7) Flood of February 2012 (Occurred between February and March 2012)

As mentioned above, heavy floods in the Mejerda basin occur during the rainy season from December to May. The heavy rainfall between December and January is thought to be a cause of this. However, in a basin that is relatively small such as this one, the torrential downpours of spring and fall also cause flooding. The following hydrological characteristics are thought to be connected to these phenomena.

1) Heavy floods from left bank tributaries and the Mejerda itself (Ghardimaou observation station) tend to occur between December and February in tandem with the dramatic increase in precipitation on the Mejerda basin's left bank during the rainy season.
2) The right bank's tributary area tends to experience heavy rainfall from fall through spring.
3) The right bank tributaries tend to generate floods exhibiting sharp hydrographs.

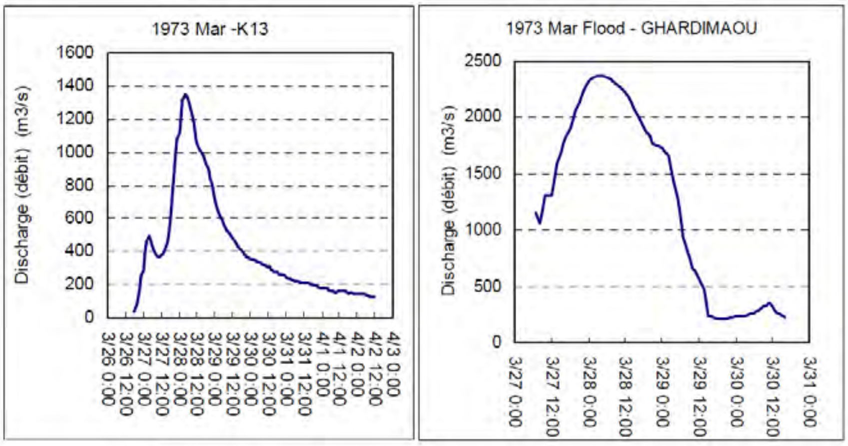
The peak inflow into the Algerian side of the main Mejerda River and into the Mellègue River coupled with the occurrence of heavy rainfall on the Tunisian side of the basin are thought to have contributed to the occurrence of devastating floods in March 1973 and January 2003.

For more information on the placement of dams, rivers, observation stations, and major cities mentioned in the following sentences, see Mejerda Basin Locations and Zone D2 Overview.

(1) Hydrological characteristics of the flood of March 1973

The flood of March 1973 was a large-scale flood that occurred across the whole of the Mejerda. As of 1973, the Sidi Salem Dam had not yet been constructed. The furthest downstream portion of the main river had two river mouths: one from the original river channel and one from a diversion channel in Tobias.

The time distribution of rainfall, inflow waveform from Algeria, and waveform of the flood on the main river featured a large single peak. The sudden inflow from Algeria coupled with the large-scale rainfall that covered the entire basin led to heavy flooding throughout the whole of the Mejerda basin. At numerous locations, the flow rate exceeded the flow capacity of the river channel, causing each to reach the point of large-scale flooding. Nevertheless, rainfall and high water level in this flood did not continue for long, with the flood itself lasting no more than a week.



(a) K13 (Mellegue) (b) Ghardimaou (Mejerda)

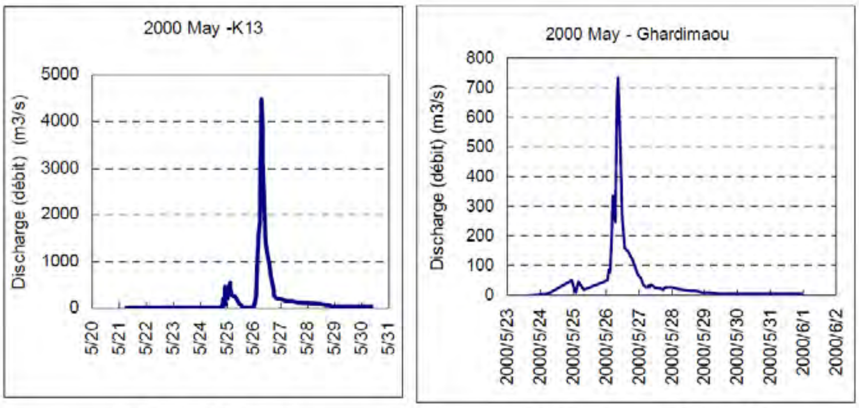
Figure 2-16: Hydrograph of March 1973 flood

(2) Hydrological features of the flood of May 2000

In the flood of May 2000, flooding only occurred upstream of the Mejerda. This flood was characterized hydrologically by the following:

1) Historically the largest inflow into the Mellègue River (at K13 flow rate observation station) and an inflow waveform that exhibited a single, sharp peak
2) Regionally uneven distribution of rainfall

Though the maximum flow rate at the K13 observation station is estimated to have reached a 90th-year probability scale, inflow into the main river of the Mejerda at the Gardimaou observation station was somewhere between a 5th and 10th-year scale. Rainfall within the area targeted for the study is concentrated on the Mellègue River, Tessa River, and Rarai River basins. Because it was near the start of the dry season when the flooding occurred, the Mellègue dam had high stores of water supply. Therefore, when the flood flowed in from upstream, it was forced to discharge the water. Water amounts discharged by Mellègue dam exceeded the flow capacity of the river channel downstream, thus causing flooding. However, the flood control functions of the Sidi Salem Dam contained the flooding to the area upstream of the dam only.



(a) K13 (Mellegue) (b) Ghardimaou (Mejerda)

Figure 2-17: Hydrograph of May 2000 flood

(3) Hydrological characteristics of the flood of January 2003

2003The flood of January 2003 is characterized hydrologically as follows:

1) Flood inflow waveforms for both Gardimaou observation station and K13 observation station show multiple peaks
2) Multiple peaks of rainfall

The maximum flow rate at the Gardimaou observation station located upstream of the main Mejerda River was at about a 20th-year scale, but the flood's total inflow (four peaks in 30 days for a total of 197,000,000m^3) puts the frequency of occurrence at about a 70th-year scale.

Comparing the flood of May 2000 with the flood of January 2003 helps explain the characteristics of the latter. As in the figure below, the maximum inflows into the Sidi Salem reservoir during the floods of May 2000 and January 2003 were virtually the same. However, whereas the flood of May 2000 peaked only once, the flood of January 2003 had four consecutive peaks. This led to a flood volume of over five times that of the flood of May 2000, making a safe downstream discharge from the Sidi Salem dam impossible.

Table 2-8: Inflow and discharge at Sidi Salem Dam during March 2003 and May 2000 floods

Flood	Maximum Inflow (m^3/s)	Total inflow (Mm^3)	Maximum Outflow (m^3/s)	Peak
May 2000	1,022	157	52	1
Jan 2003	1,065	827	740	4

The flow rate waveforms at the Bou Salem and Slouguia observation stations at the time of the flood, as well as water storage levels at the Sidi Salem Dam, are displayed in the figure below. The flow rate waveform at Bou Salem and the flow rate waveform at Slouguia are roughly proportionate to the inflow into the Sidi Salem reservoir and time variations of discharge from Sidi Salem Dam, respectively.

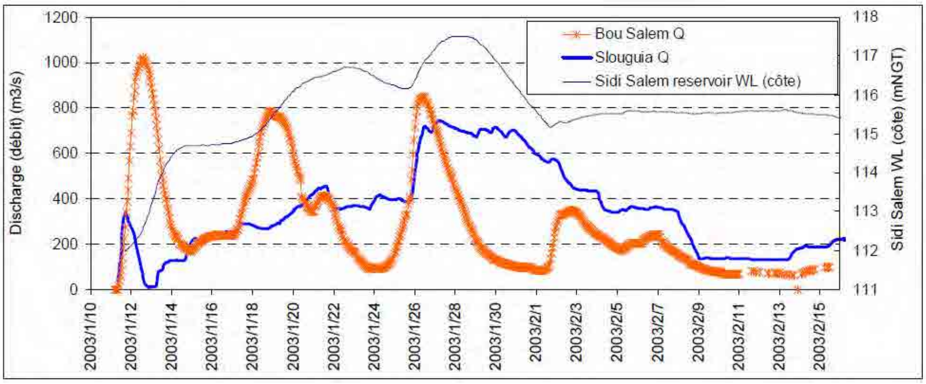


Figure 2-18: Flood of January 2003 – Sidi Salem Dam inflow, discharge, and water storage levels

The first peak observed on January 11th at Slouguia happened because of discharge from the Siliana River basin, which merges into the Mejerda downstream of the Sidi Salem Dam. This is why the Sidi Salem dam was unable to suppress it. After that, the first and second flood peaks from upstream reached the reservoir. The dam's flood control functions enabled it to restrain the discharge to between 300 and 400 m^3/sec., until the arrival of the third peak increased discharge to 740m^3/sec. The arrival of the comparatively smaller fourth peak caused delays in the reduction of discharge.

Peaks in the flow of the flood occurring multiple times like this served to prolong the period of flooding both upstream and downstream of the Sidi Salem dam. The period of flooding was particularly long downstream and continued for more than a month in some places.

(4) Hydrological characteristics of the flood of January 2004 (4) and January 2005 (5)

Both these floods were characterized hydrologically by the following:

1) The Gardimou observation station shows multiple peaks within its flood inflow waveform
2) Multiple peaks of rainfall

Daily rainfall, the Sidi Salem reservoir's water level, and discharge from November 2003 to March 2004 are shown in the figure below. During the flood of January 2004, the discharge peak at Sidi Salem dam was observed on January 6, 2004. Despite this, no large rains were observed around this particular date. Rather, heavy rainfall occurred from December 10 to 13, 2003. The average rainfall over six days in the basin upstream of the Sidi Salem dam is proportionate to a 50th-year probability. The impact of this rainfall was that, when the water level raised to where it is normally full, the inflow caused by smaller- and middle-sized rains from December 29 to January 3 forced water to be discharged to maintain the level at which it is normally full. This is why there is variation between the periods of occurrence for the rainfall peak and the discharge peak. Despite no rainfall in areas downstream, the water level of the river channel rose, resulting in a flood. The same phenomenon was also observed during the flood of 2005.

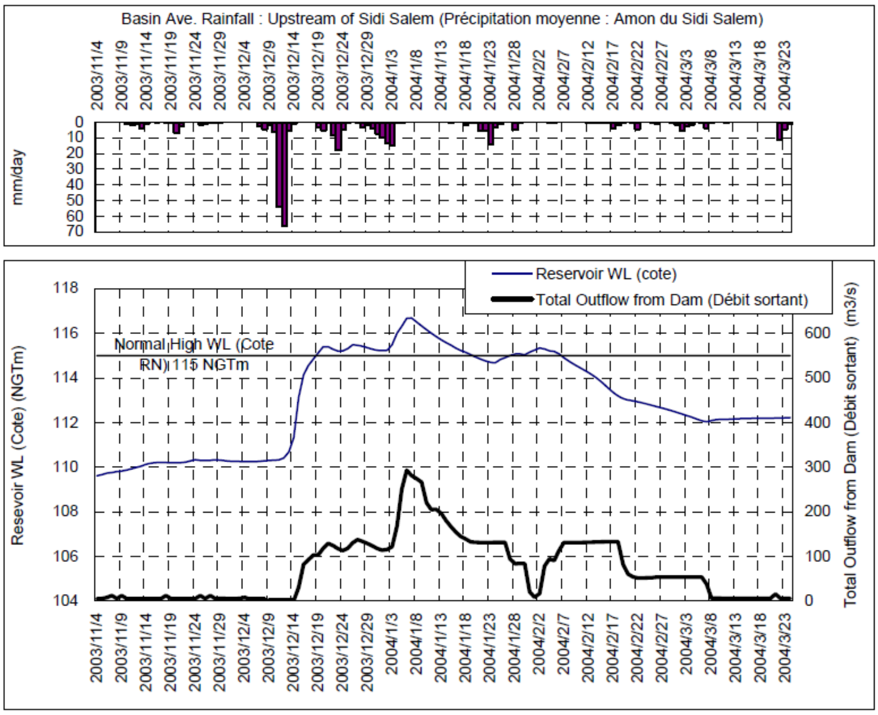


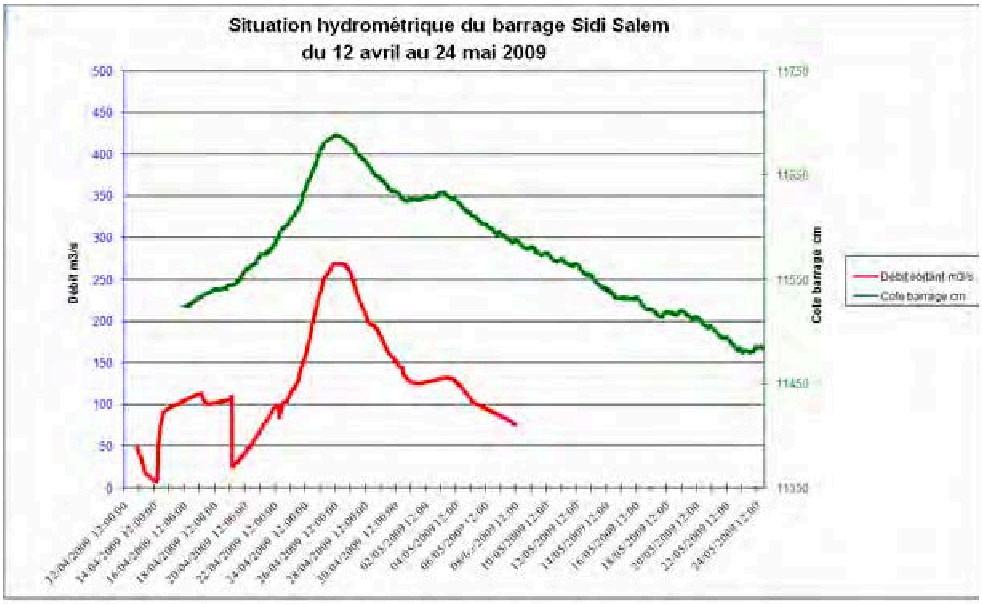
Figure 2-19: Flood of January 2004 – Water storage level and discharge at Sidi Salem dam

(6) Hydrological characteristics of the flood of April 2009

The flood of April 2009 occurred due to four consecutive rainfalls: April 2-5, April 8-9, April 13-18, and April 18-22. Throughout the whole of April, the total rainfall observed came to approximately 100mm (Jedeida 104mm, Tebourba 112mm). Rainfall between April 2 and 5 occurred in the south of El Bataan, while rainfall on other days occurred throughout the catchment area.

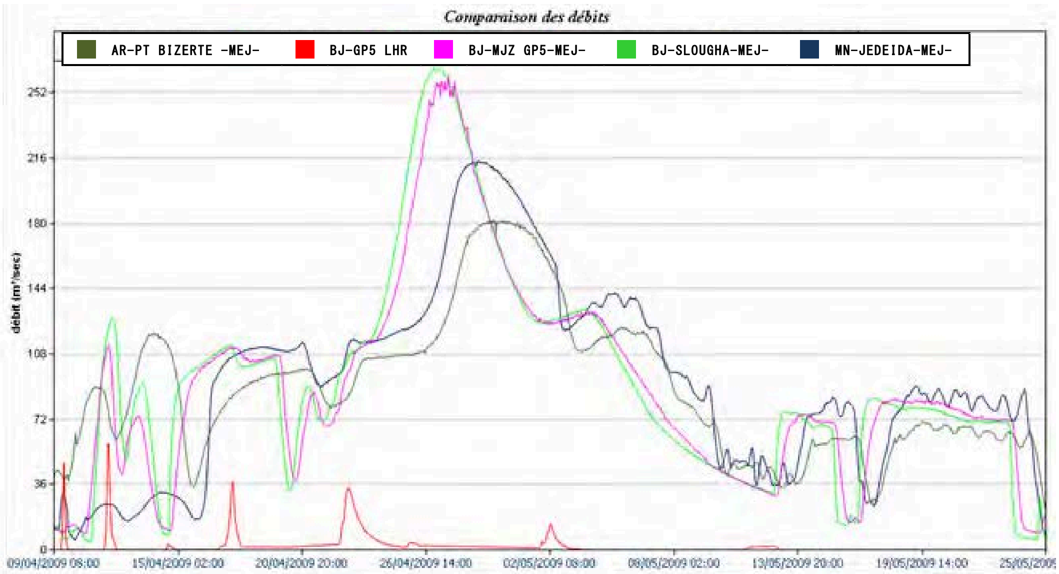
The DGRE states that this level of rain occurs once every two to five years.

Multiple inflow peaks occurred at the Sidi Salem Dam. The first peak inflow was 182m^3/sec. At this time, the water level of the reservoir was relatively high and being discharged at a rate of 90m^3/sec. The storage level would exceed 116 mNGT after the next inflow peak, reaching a maximum discharge of 269m^3/sec.



Source: DGRE

Figure 2-20: Flood of April 2009 – Discharge and water storage level of Sidi Salem Dam

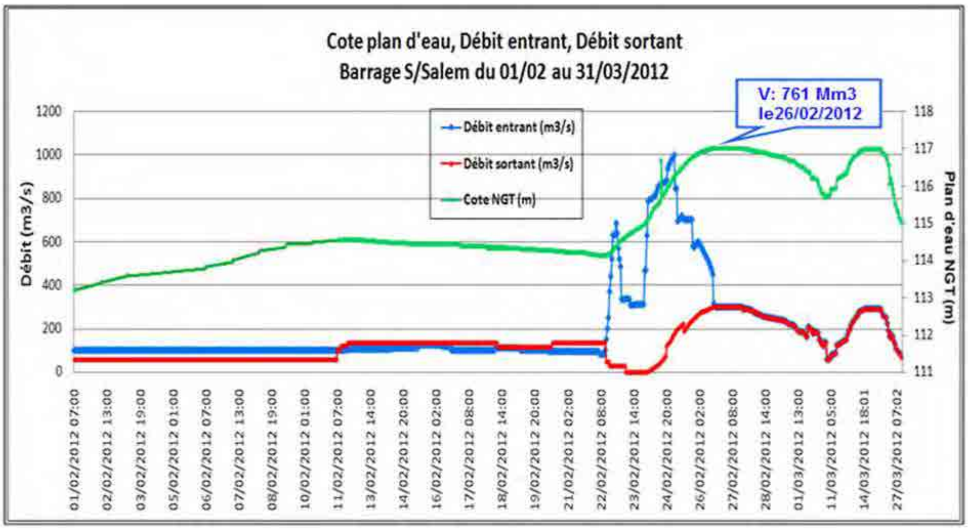


Source: DGRE

Figure 2-21: Flood of April 2009 – Hydrographs of major observation stations

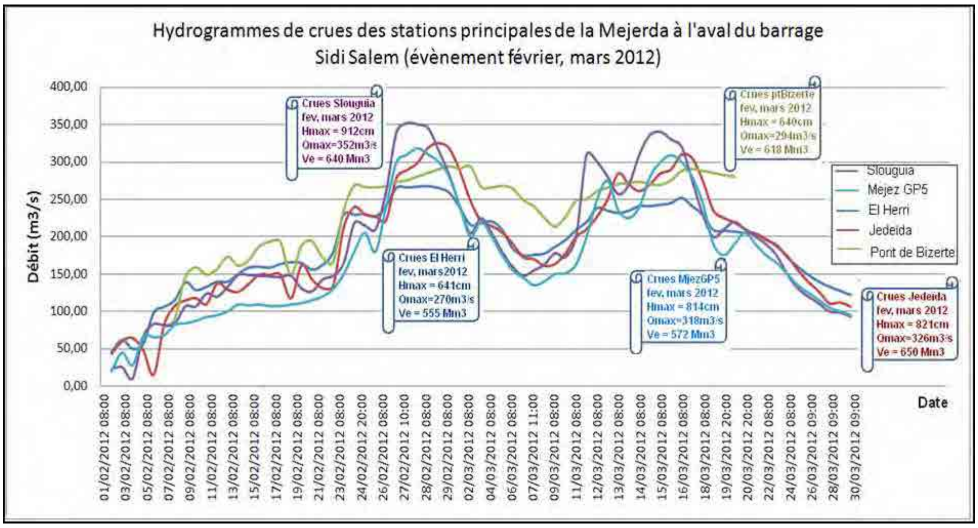
(7) Hydrological characteristics of the flood of February 2012

The flood of February 2012 was caused by rainfall that lasted from February 22 to 23. This rainfall mainly occurred over the mid and downstream areas of the Mejerda basin and the branch area of the Siliana River basin. Two peak inflows occurred at Sidi Salem Dam. The first inflow peak of approximately 700m^3/sec. went almost completely without discharge. The second inflow peak of approximately 1,000m^3/sec. caused the stored water level to rise. After exceeding 116 NGTm, the discharge gradually increased to a maximum discharge of 299 m^3/sec. between February 26 and 27.



Source: DGRE

Figure 2-22: Flood of February 2012 – Sidi Salem Dam inflow, discharge, and water storage levels



Source: DGRE

Figure 2-23: Flood of February 2012 – Hydrographs of major observation stations

2.3.2 Summary of past floods

The table below provides an overview of the major floods mentioned above.

Table 2-9: Overview of major floods

No.	Flood name	Overview of flood and damage caused
1	Flood of March 1973	A major flood in the Mejerda that was large in scale and caused damage throughout the whole of the river basin. The Sidi Salem dam did not yet exist at this time. The Mejerda also had two passages at the river mouth (the old river channel and the Tobias diversion channel). Characteristic of this flood was its large, climactic peak rainfall, inflow, and discharge. The rainfall and high water levels did not continue for long during this flood. It lasted less than a week in length.
2	Flood of May 2000	This flood caused serious flooding in the Mellègue basin and the upstream

		section of the Mejerda basin. Characteristic of this flood was the following: - A climactic inflow of heavy flooding into the Mellègue River (K13) from the Algerian side - Localized heavy downpours on the upstream section of the Mejerda basin The Sidi Salem dam had already been constructed by this time. Its flood control functions saved the downstream section of the Mejerda from flood damage.
3	Flood of January 2003	A flood that caused extensive, widespread damage between January and February 2003. Characteristic of this flood was the following: - Multiple large peak inflows at the Gardimaou observation station on the main Mejerda River as well as at the K13 observation station on the Mellègue River. - Multiple large peak rainfalls The inflow of the flood of January 2003 exhibited multiple large peaks. Unlike the flood of May 2005, it brought about long-term flooding downstream and upstream of the Sidi Salem dam and along the whole of the Mejerda. In particular, downstream areas suffered from flooding for over a month. 60% of all households were damaged and six individuals turned up dead.
4	Flood of January 2004	Multiple medium-scale floods occurred. Discharge of the Sidi Salem dam was required to maintain normal levels. This discharge caused a flood that would inflict damage downstream. Characteristic of this flood was the following: - Multiple medium-scale peak discharges were observed at Gardimaou observation station - Multiple peak rainfalls
5	Flood of 2005	
6	Flood of April 2009	Discharge of the Sidi Salem dam and dike break led to a flood that caused flood damage in irrigated farmland and at irrigated facilities. Characteristic of this flood was the following: - Covered mountain flood at Gardimaou observation station and Ragay observation station. - Localized heavy downpours in the Manouba and Ariana governorates on the downstream section of the Mejerda basin.
7	Flood of 2012	This flood caused large-scale flood damage in the vicinity of Jedeida. Characteristic of this flood was the following: - Covered mountain flood at the Jedeida observation station. The flooded area of the Mejerda was 2,216 ha, while flooded agricultural areas of Jedeida came to 700 ha.

A record of floods that have occurred since 1900 is shown below.

Table 2-10: Record of floods that have occurred since 1990

No.	Flood	Flood record	Notes
1	Flood of February 1907	Water rose for 14 days. The volume of the flood was approximately 3.55Mm^3, while a peak flow rate of 1,610m^3/sec. was recorded at Jendouba. The flood caused damage at Majaz el Bab.	
2	Flood of February 1928	Peak flow rate of 1,220m^3/sec. at Bou Salem	
3	Flood of March 1929	Peak flow rate of 1,760 m^3/sec. at Bou Salem	
4	Flood of December 1931	The strongest flood in 60 years of observation. The 11 days yielded a flood volume of 3.36Mm^3. Peak flow rate of 2,060m^3/sec. at Bou Salem and 2,250m^3/sec. at Majaz el Bab.	
5	Flood of January 1940	Peak flow rate of 1,780m^3/sec. at Bou Salem	
6	Flood of October 1947	Peak flow rate of 1,700m^3/sec. at Bou Salem and 1,280m^3/sec. at Majaz el Bab	
7	Flood of November 1948	Peak flow rate of 851m^3/sec. at Bou Salem and 891m^3/sec. at Majaz el Bab	

8	Flood of January 1952	Peak flow rate of 904m^3/sec. at Bou Salem and 981m^3/sec. at Majaz el Bab	
9	Flood of March 1959	Peak flow rate of 1,140m^3/sec. at Bou Salem and 1,490m^3/sec. at Majaz el Bab	
10	Flood of September 1969	Peak flow rate of 1,485 m^3/sec. at Bou Salem, 1,440m^3/sec. at Majaz el Bab, and 4,480 m^3/sec. at Mellegue (K13)	
11	Flood of March 1973	Peak flow rate of 2,370m^3/sec. at Gardimaou, 3,180m^3/sec. at Bou Salem, and 2,420 m^3/sec. at Jendouba	
12	Flood of 1976	Peak flow rate of 1,013m^3/sec. at Gardimaou and 970m^3/sec. at Jendouba	
13	Flood of December 1984	Peak flow rate of 900 m^3/sec. at Bou Salem, 750m^3/sec. at Jendouba, 570m^3/sec. at Gardiaou, and over 600m^3/sec. at Mellègue (K13)	1981: Sidi Salem dam is constructed
14	Flood of July 1989	Peak flow rate of 940m^3/sec. at Siliana-Rawaju observation station, 470 m^3/sec. at Slouguia, and 600 m^3/sec. at Rmil observation station	
15	Flood of May 2000	Peak flow rate of 4,480m^3/sec. at Mellègue (K13), 736m^3/sec. at Gardimaou, 977 m^3/sec. at Bou Salem, and 327 m^3/sec. at Jendouba	
16	Flood from between January and February 2003	Peak flow rate of 2,600m^3/s at Mellègue (K13), 1,090m^3/sec. at Gardimaou, 1,020m^3/sec. at Bou Salem, over 1,070m^3/sec. at Jendouba, 744 m^3/sec. at Slouguia, and 730m^3/sec. at Majaz el Bab	
17	Flood from December 2003 until February 2004	Peak flow rate of 2,480m^3/sec. at Mellègue (K13), 1,470 m^3/sec. at Gardimaou, 889 m^3/sec. at Bou Salem, and 1,024 m^3/sec. at Jendouba	
18	Flood from January to March 2005	Peak flow rate of 224m^3/sec. at Majaz el Bab, 838m^3/sec. at Gardimaou, 529 m^3/sec. at Bou Salem, and 616 m^3/sec. at Jendouba	
19	Flood from April to May 2009	Peak flow rate of 265m3/sec. at Slouguia and 262 m3/sec. at Majaz el Bab	
20	Flood from February to March 2012	Peak flow rate of 324m^3/sec. at Jedeida	

Chapter 3. Current State of Flood Control Measures

3.1 Flood Control Policy and Organization Structure

3.1.1 Policy

The Tunisian government devised a 12th Five-Year Socio-Economic Development Plan (2010-2014) to follow its 11th Five-Year Socio-Economic Development Plan (2007-2011). According to the Ministry of Development and International Cooperation, the 12th five-year plan is under review following the Jasmine Revolution of January 2011 (as of December 2012). However, the government has made it clear that there will be no policy changes regarding this Project in Tunisia, even in the wake of the overthrow of the Ben Ali administration. The Islamist Ennahada party became the leading party of the Tunisian constituent assembly by capturing 90 of 217 seats in the election held on October 23, 2011. Principal members of the party then released a statement on October 27 that confirmed that there was hardly any change among government officials and that the objectives of existing policies would be carried over.

Below is a brief summary of the 11th and 12th five-year plans:

(1) 11th Five-Year SEDP (2007-2011)

This plan was devised on the strength of bright prospects based on GDP growth of 4.5% in 2006 and sought to thrust Tunisia into the global economy through exports and new technology while focusing on employment and other social capital. GNP was expected to grow an average of 6.1% per year. Mitigating flood damage was one crucial element of the plan.

(2) 12th Five-Year SEDP (2010-2014)

This plan supplanted the 11th five-year plan in 2010. It includes new financial processes based on new priority issues and EU rules. This plan was drafted with the effects of the global financial crisis of 2008 in mind, including actual GNP growth of 4.6% from 2007 to 2009 as compared to expected growth of 5.5%. Critical areas of the development plan are environmental, investment and enterprise, trade policy, domestic commerce and competition policy, financial policy, sector-specific policy, human resources development, social development, sustainable development, improving administrative organization and state-owned companies, regional development and statistical studies.

Sector-specific policy is broken down into the industries of agriculture and fishing, manufacturing, non-manufacturing, transportation, tourism, information and communications technology (ICT), commerce and industrial arts. This plan includes the following items concerning flood control measures:

1) Optimize coordination between stakeholders to integrate management, particularly in regions hosting major projects.
2) Programs aimed at maintaining and stabilizing natural resources to preserve the environment and ensure sustainable development will comprise 1.25% of GNP (water, anti-desertification measures, etc.).

The following is written on page 95 in direct relation to flood control measures:

Basin management, dam preservation, aquifer recharge and urban flood protection measures demand more effort toward erosion control measures, preserving fertile soil and improving productivity.

3.1.2 Legal Framework

All legislation related to water resources management and established under French colonial rule

(1881-1956) was updated in 1975 as “Water Code” to define the authority of all operators and users in the water resources sector and conserve water resources and distribute them fairly. The Water Code has been further updated since 1975. Some of its articles were revised and new articles on socioeconomic development were added, shifting water demand and important environmental issues for the conservation of natural resources. The Water Code was most recently updated in 2010. Below are descriptions of each of the nine chapters that make up the Water Code:

Chapter	Description	Chapter	Description	Chapter	Description
1	Public Waters	4	Duties	7	Contamination and Flooding
2	Public Water Conservation, Policy	5	Authorized Use of Public Waters	8	Irrigation Associations
3	Water Rights	6	User Duties	9	Justice and Penal Regulations

Following are the descriptions of regulations relating to floods in Articles 140 through 152 from Chapter 7, Article 2 (Flood Control Measures):

1) A regulation giving Tunisia the authority to implement flood control studies, research and construction
2) A restriction against conduct that obstructs flood protection in river channels
3) A regulation on fines for damages to flood protection dikes
4) Items related to implementation of agricultural land drainage projects

The Soil and Water Conservation Law (1995) and the Forest Code (1993) serve as the basic legislation for integrated water resources management (IWRM).

The organization structure for flood and other disaster management was based largely on the following laws and decrees. These laws and decrees set forth procedures for devising plans, procuring materials and equipment, securing personnel and other structural organization, as well as implementing activities to mitigate damage from fires, earthquakes, storms and terrorism in addition to floods.

a) Law No. 39-1991 on disaster management, disaster measures and rescue organization (8 June 1991)

Below are descriptions of the 16 articles in this law set forth to provide basic disaster management guidelines at national and regional levels:

Article	Description
1	Definition of Disaster
2	National and Regional Disaster Management Planning
3	National and Regional Disaster Commissions
4	Coordination Between the Ministry of the Interior and Governors of Each Governorate
5	Comprehensive Statistics on Equipment and Personnel Available for Disaster Management
6	Enforcement Orders for National and Regional Disaster Management Planning
7-15	Recruiting Personnel and Equipment During Disasters
16	Abolishing Past Regulations

b) Decree No. 942-1993 on National and Regional Disaster Management Planning and Disaster Committees (26 April 1993) and Decree No. 2723-2004 on amendments to Decree No. 942-1993 (21

December 2004)

Followings are the descriptions of the 16 articles in these decrees set forth on national and regional disaster management planning and disaster commissions;

Article	Description
1	Procedures for Implementing National and Regional Disaster Management Planning and Disaster Commissions
2	Planning Consideration Points
3	Devising and Approving Plans
4	Shaping Regional and National Plans
5	Authorizing and Referring Regional Plans to the National Disaster Commission
6	Types of Disasters
7	Specific Progressive Projects
8	Beginning Implementation
9	Prior Meetings with Contractors
10	Granting Authority
11	Commands to Complete Measures
12	National Disaster Commission Members
13	National Disaster Commission Meetings
14	Regional Disaster Commission Members
15	Regional Disaster Commission Meetings
16	Implementing These Decrees

3.1.3 Administrative Framework

The Ministry of Agriculture has jurisdiction over flood control measures in rural areas and agricultural lands, while the Ministry of Equipment presides over those of urban areas. Administrative boundaries of urban and rural areas have been clearly established.

The following structural and non-structural measures are carried out by both ministries:

1) River projects
2) Dam projects
3) Gathering hydrological information and predicting floods
4) Flood evacuation and rescue operations
5) River channel maintenance
6) Regulating land use in public waters

The figure below shows administrative boundaries of urban and rural areas in Zone D2. The Ministry of Agriculture is the leading authority since agricultural lands make up most of the target area for this Project. However, the Ministry of Equipment serves on technical and steering committees since the target area also includes some urban areas.

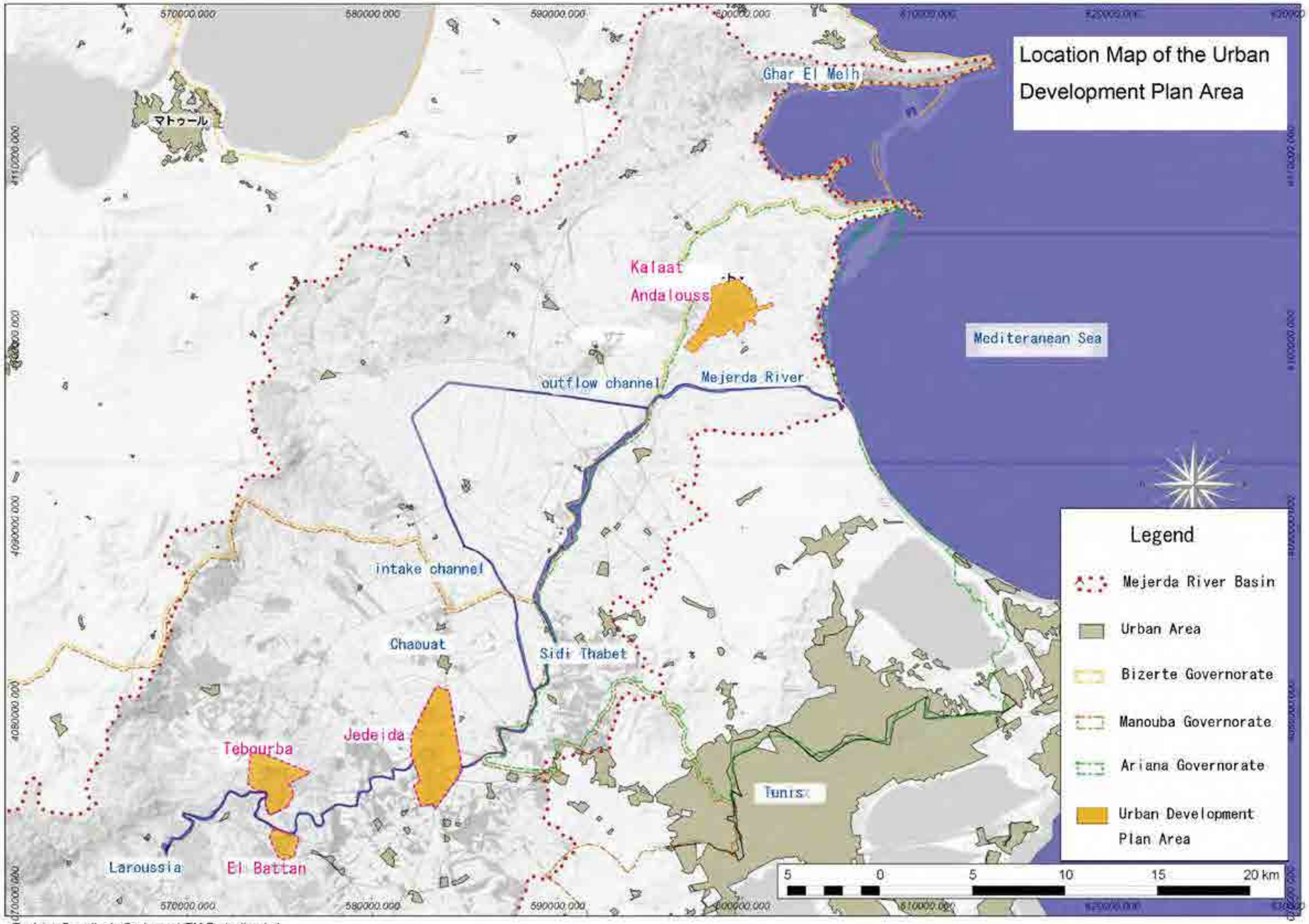


Figure 3-1 Location Map of the Urban Development Plan Area

3.1.4 Administrative Agencies

(1) Ministry of Agriculture

The Ministry of Agriculture and Environment was established in January 2011 by the merger of the Ministry of Agriculture, Water Resources and Fisheries and the Ministry of Environment. Organizational changes in December 2011 split them apart into the original ministries again, and each stood independently of the other. Finally, in June 2012, the name of the Ministry of Agriculture, Water Resources and Fisheries was changed to "Ministry of Agriculture." Below is the Ministry of Agriculture organization chart:

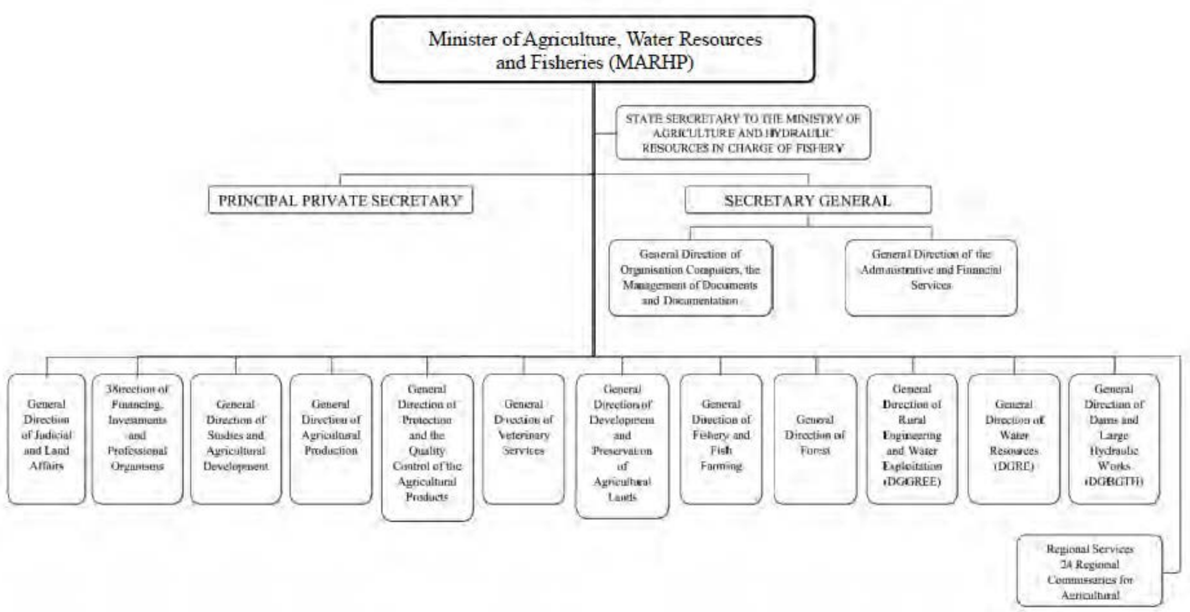


Figure 3-2 Ministry of Agriculture Organization Chart

The Ministry of Agriculture is responsible for water resources management according to Decree No. 2001-419, Article 2 (revised February 13, 2001, Official Journal of the Tunisian Republic (JORT)). In terms of flood control measures, the Ministry of Agriculture has jurisdiction over rural areas and agricultural lands. Below are the main duties of the Ministry of Agriculture as set forth in the aforementioned decree:

1) Devise strategic plans to spur agricultural development, propose development plans as part of the national development plan and monitor their implementation.
2) Determine and monitor the implementation of procedures for self-sufficiency and stabilizing food supply.
3) Stimulate the agricultural sector and improve technical standards for all involved through academic research, practical experiments, training and promotion.
4) Conserve and encourage the practical use of natural resources.
5) Devise and implement plans and projects to encourage irrigated agriculture.
6) Protect water, soil and agricultural lands by encouraging the conservation and development of forest resources.
7) Devise plans for the practical use of water resources, use water resources to fill domestic demand, develop unconventional water resources and manage them economically.
8) Upgrade infrastructure related to agricultural water use and management, water and soil conservation, natural river improvement and agricultural land conservation.

1) Central Ministry of Agriculture Agencies

The General Directorate of Dams and Large Hydraulic Works (DGBGTH) and the General Directorate of Water Resources (DGRE) at the Ministry Headquarters fulfill important roles related to flooding.

(a) General Directorate of Dams and Large Hydraulic Works (DGBGTH)

DGBGTH has jurisdiction over dams and large-scale hydraulic facilities and has the authority to:

1) Implement hydrological studies of water resources
2) Devise master plans to develop surface water resources
3) Implement studies on water resource usage
4) Implement studies of dam and reservoir facilities
5) Implement studies to devise large-scale plans for water resource usage (large dams, channels, etc.)
6) Operate and maintain dams
7) Devise and implement plans for large-scale projects to protect rural areas and agricultural lands from flood damage
8) Act as the coordinating authority for all activities related to flood prevention measures and disaster management in rural areas
9) Monitor drought management systems

DGBGTH serves as the direct implementing authority during the implementation of this Project. DGBGTH worked with an annual budget of TND 84 million in 2008, 101 million in 2009 and 102.5 million in 2010, an increase of 22% over two years.

There are 819 workers (as of interviews in October 2011) organized as shown on the table and figure below. The budget and personnel appear to be sufficient to implement and manage this Project.

Table 3-1 DGBGTH Personnel Chart

	Hydrological Studies	Large Hydraulic Works	Dam Operations	Large Dams
Managing Engineers	1	1		
Chief Engineers	2		3	2
Senior Technicians	7	3	13	16
Construction Technicians			5	1
Senior Engineers	2	3	9	19
Engineers	5	2	9	8
Technical Assistants	4	1	6	7
Clerical Assistants	1	3	2	1
Managers	2	2	16	7
Administrative Staff	3	2	2	5
Clerical Workers	2	2	3	3
Contractors	14	4	85	122
Workers	18	37	171	88
Drivers	6	2	25	16
Security	2	1	32	11
Total	69	63	381	306

Source: DGBGTH (October 2011 interview)

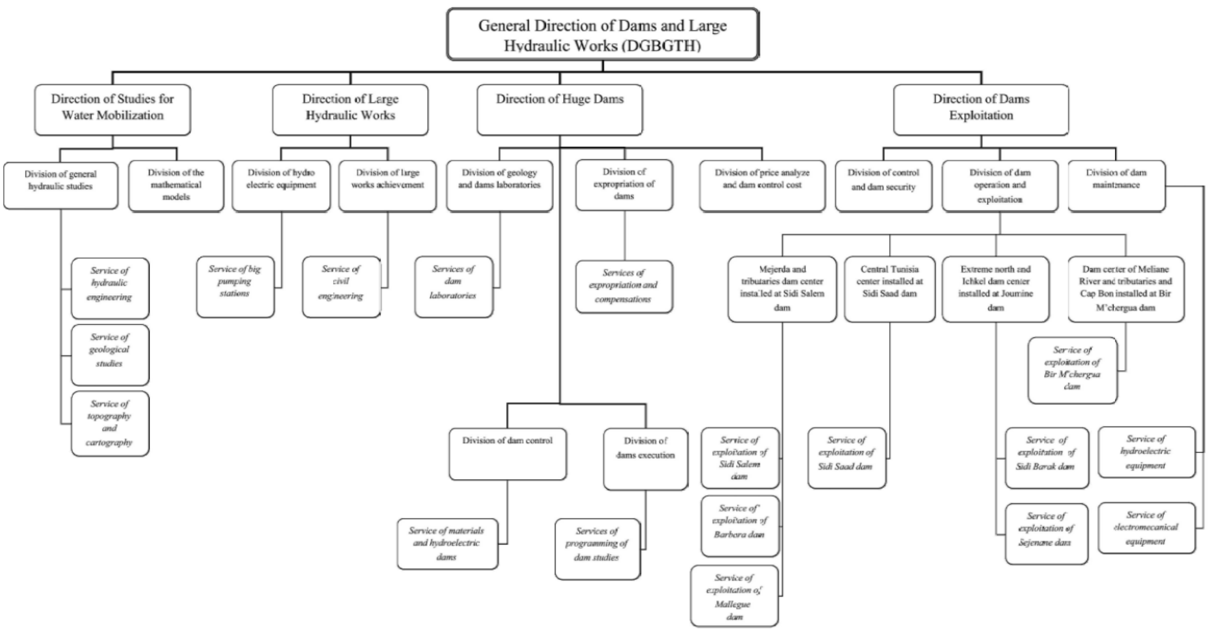


Figure 3-3 General Directorate of Dams and Large Hydraulic Works (DGBGTH) Organization

Chart

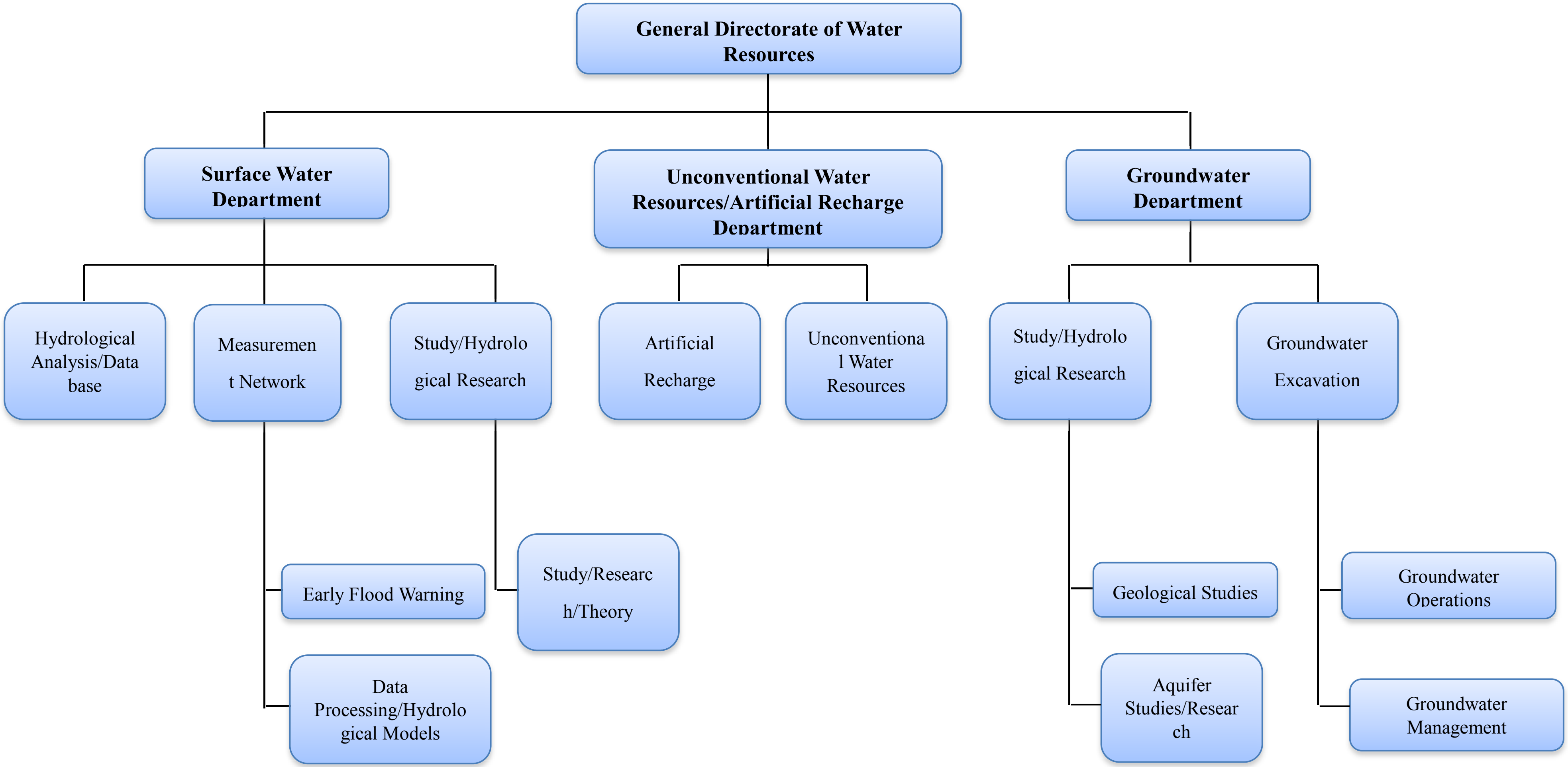
(b) General Directorate of Water Resources (DGRE)

This agency establishes, manages and collects data for a water resources monitoring network. It has jurisdiction over early flood warning systems. DGRE has the authority to:

1) Evaluate water resources and implement both basic and detailed studies on overall water budgets
2) Define general and specific methods for managing water resources in line with supply and demand
3) Conduct research and experiments on conventional and unconventional uses of water resources
4) Investigate plan proposals, use and development of water resources from all aspects and finalize plans

Below is the DGRE organization chart:

Figure 3-4 General Directorate of Water Resources (DGRE) Organization Chart



(c) Other Agencies/Affiliates

Below are other agencies and affiliates within the Ministry of Agriculture:

1) General Directorate of Rural Engineering and Water Exploitation (DGGREE): water use in rural areas
2) General Directorate of Planning, Management and Conservation of Agricultural Lands (DGACTA): geological research on hydrology with respect to evaluation and conservation of natural resources
3) Bureau of Water Planning and Hydraulic Equilibriums (BPEH): a bureau under direct control of the Minister's Secretariat, has a close relationship with national authorities on water resources management, builds and manages a massive database

2) Regional District Departments of Agricultural Development (CRDA)

CRDAs were established based on Law No. 89-44 (enacted March 1989, amended October 1992 and October 1994 (JORT)). In line with government policy on decentralization, the Ministry of Agriculture has commissioned the CRDAs in each of the 24 governorates with all activities related to agriculture in those regions. The nature of those activities ranges from agricultural production and natural resources to vegetation and forest areas and economic aspects.

CRDAs oversee agricultural activities in their governorate and administer agriculture in technical, political, legal and financial terms. They also manage river channels. Workers are centrally dispatched to each CRDA. CRDAs have technical and administrative sections that implement activities on the governorate level. There are 24 CRDAs in Tunisia, with the following three being directly involved in this Survey:

1) CRDA Ariana
2) CRDA Bizerte
3) CRDA Manouba

(2) Ministry of Equipment

Flood control measures are defined as the main role of the Ministry of Equipment in Decree No. 1413-88 (July 22, 1988) and its amended version. The Ministry of Equipment has the following responsibilities concerning flood control measures:

1) Studying urban flood control projects, devising plans, monitoring construction
2) Maintenance inspections of structures for urban flood control measures
3) Construction of bypasses on *wadi*[1] and other rivers to manage rainwater during the rainy season
4) Reviewing and improving profiles of *wadi* in urban areas
5) River improvement, dike construction

The Ministry of Equipment will build a rainwater drainage network consisting of conduits and drainage channels to discharge rainwater into *wadi* and the ocean, draining urban areas as outlined in the aforementioned TOR. A public wastewater corporation will be commissioned to build and manage civil

[1] wadi: dry rivers

structures. The responsibilities of the Ministry of Equipment are traceable to the fact that most flood control projects are initially implemented in urban areas (particularly in the capital city of Tunisia). This is how the Ministry of Equipment gained expert knowledge of flood control measures. Of the nine general directorates and agencies within the ministry, the Urban Hydrology Department (DHU) is in charge of planning, management, studying/monitoring and maintaining facilities related to urban flood protection. As of September 2011, a total of 162 projects are being implemented in 150 municipalities at a total cost of TND 220 million.

In addition to bridges and other river-crossing structures, the Ministry of Equipment also manages and presides over dirt quarries and disposal areas and is intimately involved in the implementation of this Project.

(3) National Water Committee (CNE)

The Water Code grants a level of authority regarding Tunisia's water resources to CNE. CNE serves as an advisory organization that investigates and assesses all aspects of water management, including dam management during times of flooding, and water use planning.

The Minister of Agriculture serves as the head of CNE, and the membership of CNE is made up of representatives from each ministry that deals with water resources management: the Ministry of Justice, the Ministry of the Interior, the Ministry of Finances, the Ministry of Equipment, the Ministry of Development and International Cooperation, the Ministry of Public Health, the Ministry of Industry, the Ministry of Energy and Small Businesses, the Ministry of Communication Technologies and the Ministry of Transport (Decree No. 78-419, 15 April 1978). Regional agencies and committees will participate when matters for discussion involve their regions.

(4) National Institute of Meteorology (INM)

The INM was established in 1974 under the authority of the Ministry of Communication Technologies and the Ministry of Transport (Law No. 101-74 (JORT)). This agency is responsible for forecasting and observing weather. It manages a weather observation network that includes a central weather station, agricultural weather stations, rain gauges, marine observation stations and aviation weather observation stations.

3.2 Summary of Past Flood Control Projects

3.2.1 River Projects

Below is a summary of river projects that were part of flood control measures on the Mejerda River. It is a compilation based on past documents.

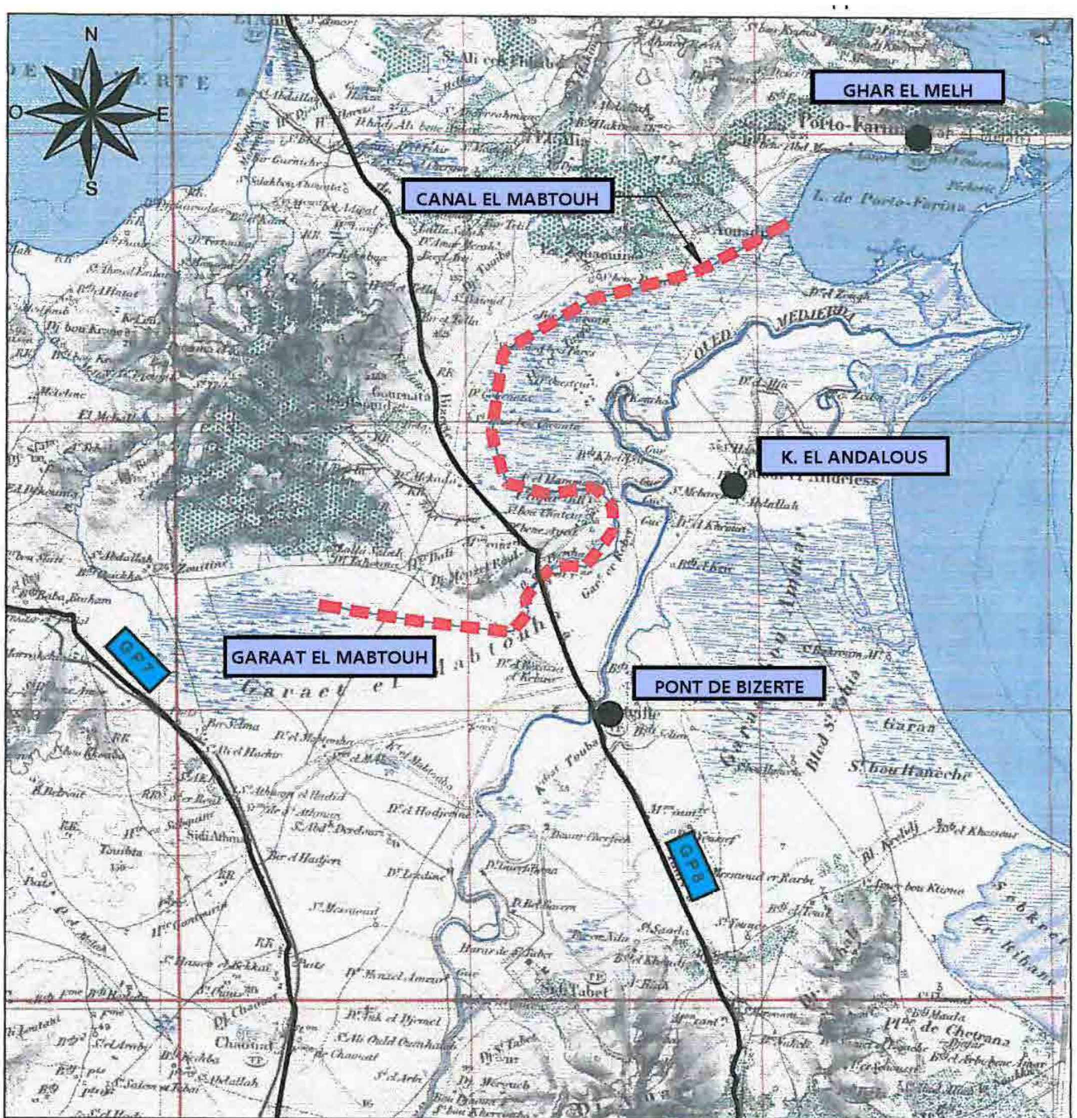
Table 3-2 Summary of Past River Projects

Project Name	Year Commenced	Purpose & Description of the Project
1.Drainage Channel Construction Project	1909	Drainage for lowland areas in El Mabtouh Plain 1) Construction of Trapezoidal Channel (L=30km) 2) Channel Construction along the MejerdaRiver (L=0.95km)

2.Lowland Areas Development Plan in Mejerda River	1952	Lower to water level and improvement of the flow capacity 1)Short-cut of curved reach and removal of bridge at Protville 2)Short-cut of curved reach at Menzel Reached 3)Improvement of older structures at Jedaid and El Battan 4)Construction of dykes 5)Construction of diversion channel
3. Irrigation and Drainage Project in Galaat Andalous – Ras Djebel	1994	1) Improvement of Tobias Barrage (Movable Barrage) 2) Pipe irrigation by pumps (irrigated area: 11,675 ha)

Source : Project D'irrigation et de Drainage Galaat Andlous-Ras Djebel Rapport Final (MA,1992.6)

The first project on the table above sought to drain the El Mabtouh wetlands, and in 1909, the Public Works Department built a 30-kilometer trapezoidal channel with channel bottom width of four meters, slope gradient of 1/1 and longitudinal gradient of 0.15m/km (1/6666). A 950-meter channel was also built along the left bank of the Mejerda River. The broken red line on the map below shows the drainage route from the El Mabtouh wetlands to Ghar El Melh lagoon (Porto Farina).



EXTRAIT DE LA CARTE BIZERTE 1/200 000 ANNEE 1928

Source: Collection B Bouvet

Figure 3-5 Drainage Channel Route

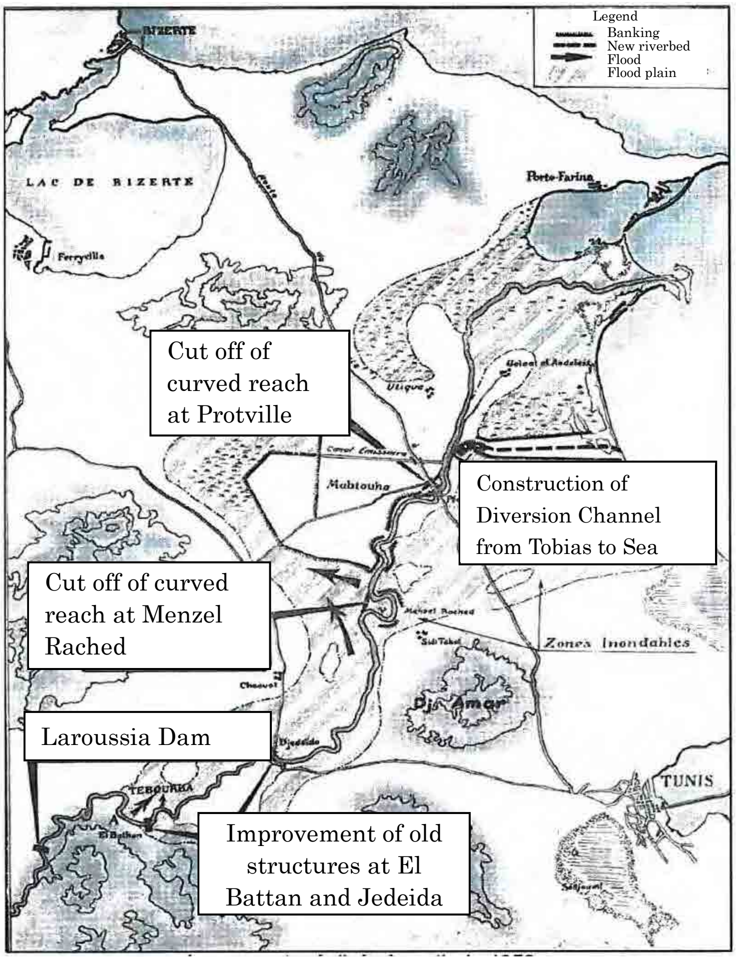
Following the flood of December 1931, the Mejerda River Lowlands Area Development Plan, the second project on the table above, was implemented to lower the design high water level, improve down flow capacity and reduce the frequency of flooding. The following projects were implemented under this plan:

1) Removing a curved reach and bridge in Protville
2) Bypassing a curved reach in Menzel Rached
3) Improving old structures in Jedeida and El Battan
4) Building dikes to improve flow capacity
5) Building a diversion channel (current river channel from Tobias Barrage to the river mouth)

Since this was a large-scale project, it was implemented in several segments to align it with each year's budget and allow for observations of the results of each year's work so that the work done the following year could reflect the observations. The first work done on the curved reach in Protville began in 1952.

Tobias Barrage was built to ensure intake levels for irrigated areas, and it was improved and made into a movable barrage in the 1990s as part of the third project on the table above. Tobias Movable Barrage plays an extremely vital role in controlling the flow of the lower Mejerda River. The diversion channel (current river channel) was completed in the 1950s and the movable barrage in the 1990s. The movable barrage improvement altered the course of the Mejerda River into the path it follows today. The old course has been converted into an irrigation channel.

The figure below is an overview of the second and third projects from the table above.



Source: Collection B Bouvet

Figure 3-6 Overview of Post-1952 Construction on the Lower Mejerda River

3.2.2 Dam Projects

(1) Summary of Dam Projects in the Basin

Structural flood control measures in the Mejerda River Basin consist of dams in addition to channels and dikes. Dam projects on the Mejerda River mainly develop water to be used for agriculture, drinking and power generation, but dams such as the Mellegue and Sidi Salem also serve to control flooding. Below are eight dams capable of controlling flooding in the Mejerda Basin:

Table 3-3 Summary of Dam Projects (Flood Control)

Dam	River	Year	C. Area (km2)	Normal Water Level(m)		Surcharge WL & Flood Control Volume			
				El (m)	Volume (Mm3)	El (m)	Volume (Mm3)	Flood Volume (Mm3)	ERD (mm)
Sidi Salem	Mejerda	1981	18,191	115.0	674.0	119.5	959.5	285.5	15.7
Mellegue	Mellegue	1954	10,309	260.0	44.4	269.0	147.5	103.1	10.0
Bou Heurtma	Bou Heurtma	1976	390	221.0	117.5	226.0	164.0	46.5	119.2
Silliana	Silliana	1987	1,040	388.5	70.0	395.5	125.1	55.1	53.0
Kasseb	Kasseb	1968	101	292.0	81.9	294.4	92.6	10.7	105.9
Ben Metir	Bou Heurtma	1954	103	435.1	57.2	440.0	73.4	16.2	157.3
Lakhmes	Silliana	1966	127	517.0	7.2	521.1	8.4	1.2	9.4
Rmil	Rmil	2002	232	285.0	4.0	288.0	6.0	2.0	8.6
Total (8 Dams)								520.3	

Note: ERD (Equivalent Rainfall Depth, mm) = Flood Control Volume/Catchment Area

The eight dams offer a total flood control volume of 520 million m^3. The Sidi Salem and Mellegue Dams combine for 388 million m^3, 75% of the total volume.

(2) Sidi Salem Dam Overview

Sidi Salem Dam is a multi-purpose fill dam with power generation, water supply and flood control capabilities. It was completed and put into operation in 1981. It is 345 meters long, 73 meters high and has a total volume of 4.5 million m^3. It can generate 30,000 kW of power. The dam is located about 150 kilometers upstream of the river mouth, and its rate of discharge during floods helps mitigate flood damage in Zone D2.

Below are figures that show the plan, longitudinal section for dam body and longitudinal section for outlets of Sidi Salem Dam.

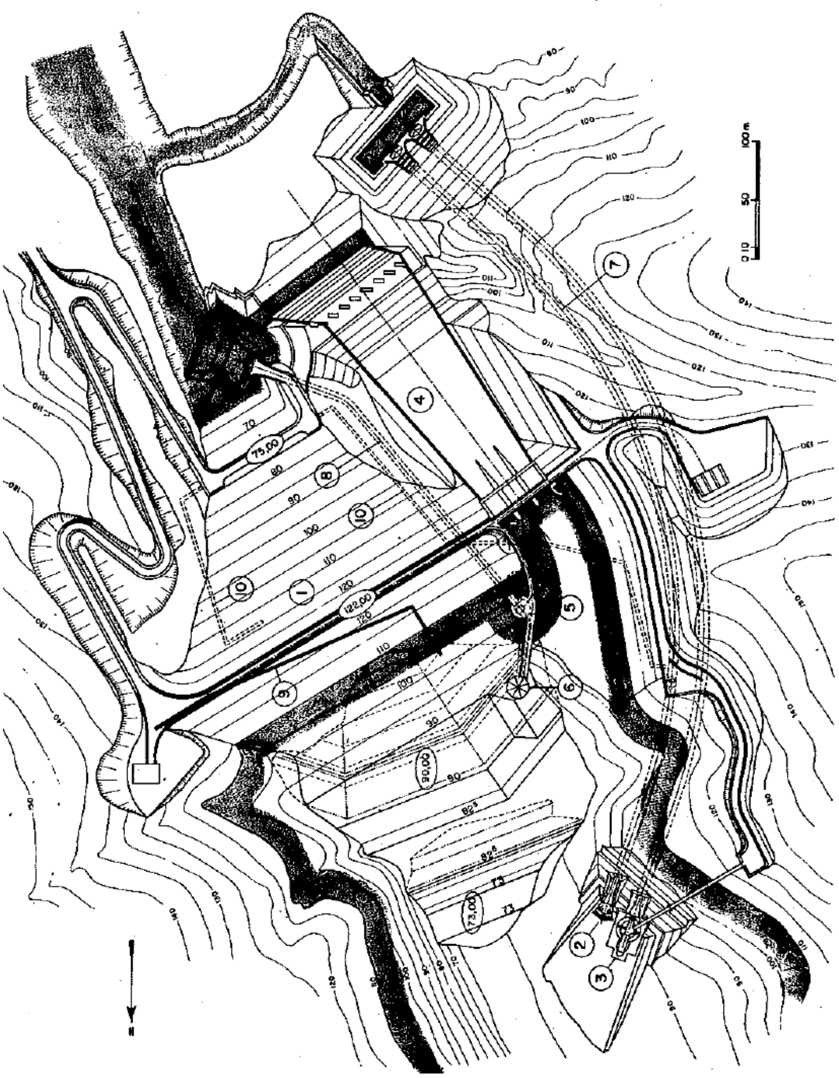
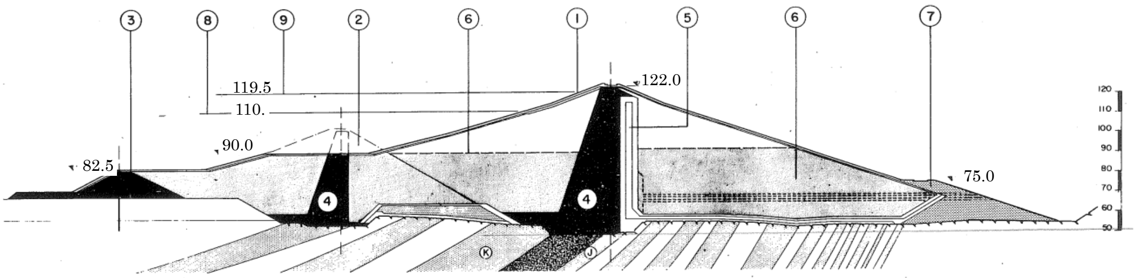


Figure 3-7 Sidi Salem Dam Plan



1. Digue
2. Batardeau
3. Prébatardeau
4. Noyau étanche
5. Filtre et drain
6. Recharges
7. Gros enrochements
8. Niveau de retenue normale RN
9. Niveau des plus hautes eaux exceptiponnelles PHEE

1 — الحاجز
2 — الحاجز الامامي
3 — ما قبل الحاجز الامامي
4 — نواة مانعة للرشح
5 — مصفاة ومصرّف
6 — اعادة مركومات
7 — حجارة ذات الحجم الكبير
8 — المستوى العادي للمياه بالحوض
9 — المستوى الاقصى للمياه الاستثنائية

Figure 3-8 Longitudinal Section for Dam Body, Sidi Salem Dam

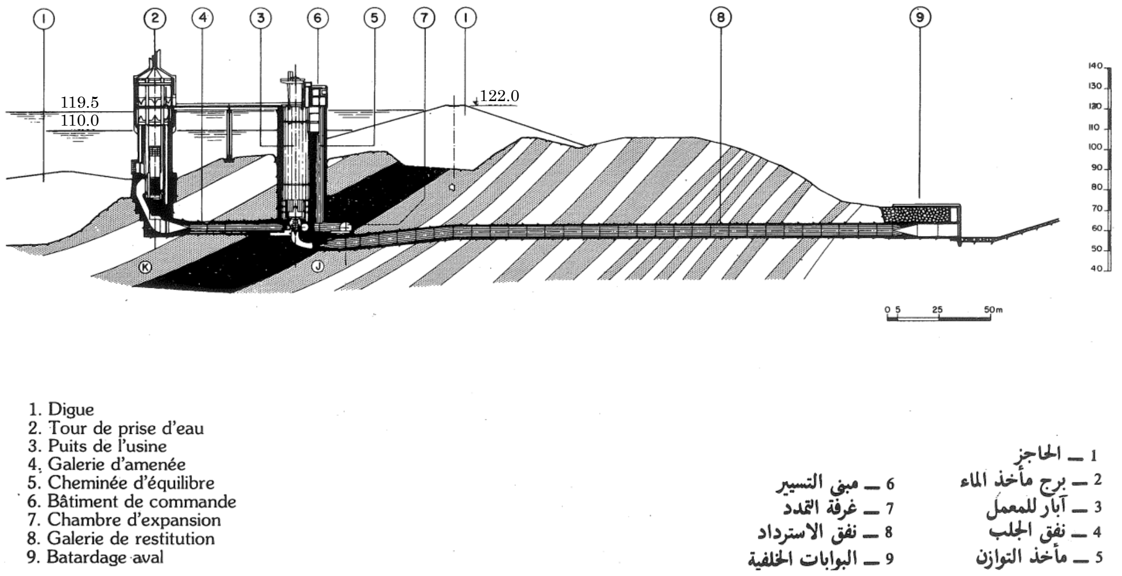


Figure 3-9 Longitudinal Section for Outlets, Sidi Salem Dam

3.2.3 Hydrological Information Gathering System and Flood Prediction

(1) Hydrological Information Gathering System

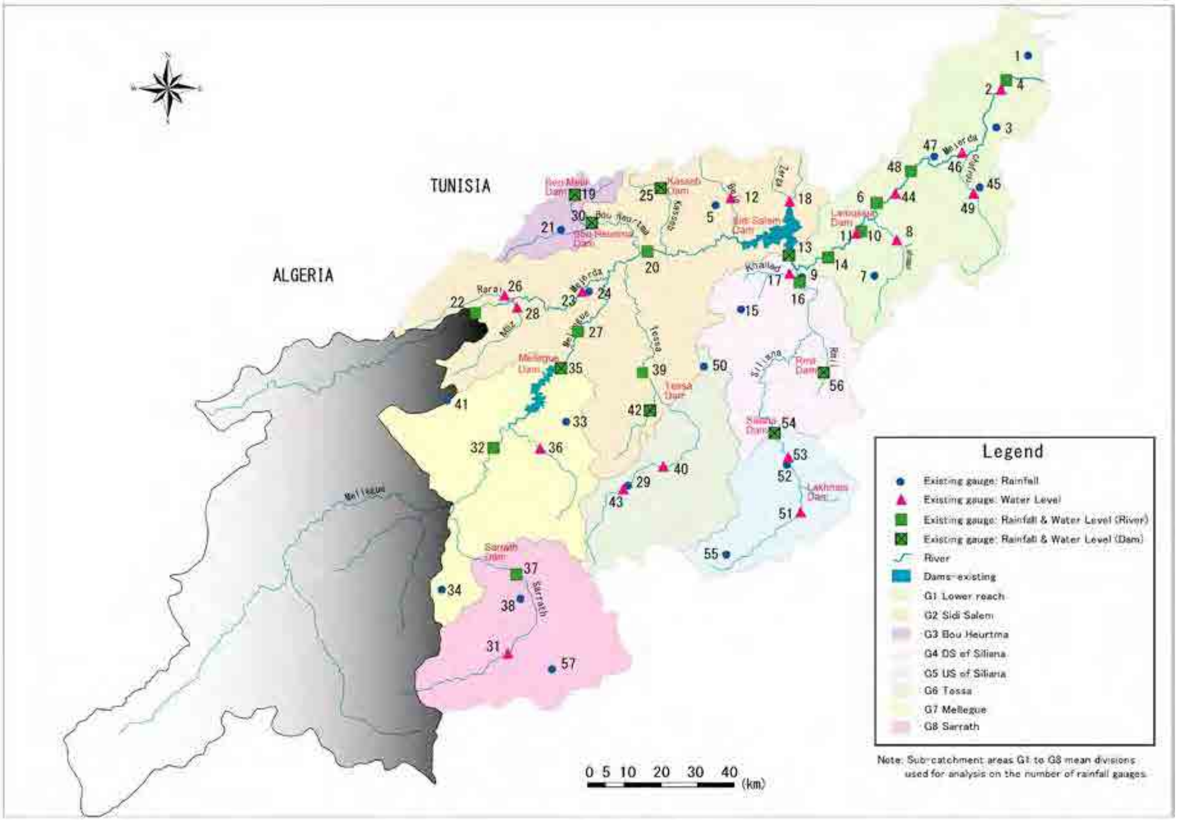
DGRE improved its system for gathering rainfall, total flow and other hydrological information about the Mejerda River in 2007 with technical and financial aid from the French Development Agency (AFD). It is worth noting that DGBGTH gathers and manages information about dams (rainfall, inflow, outflow, reservoir levels, etc.) separately.

The DGRE hydrological information gathering system is called SYCOHTRAC (SYstèm de COllecte des mesures Hydrologiques en Temps Rèel et Annonce des Crues des oueds tunisiens) and is made up of 75 observation stations located on the rivers of Tunisia. The Mejerda River Basin has 57 of those observation stations. Observation data is updated every day at 7:00 a.m., and it is possible to observe and gather data at 15-minute intervals during floods. There are 39 rain gauges and 37 water level observation stations, but only 30 rain gauges and 22 water level observation stations are operating as of September 2012.

The table below shows hydrological observation stations and monitoring elements (rainfall, water level, or both) for each CRDA, and the figure below shows the locations of those observation stations.

Table 3-4 SYCOHTRAC Observation Stations and Monitoring Elements (DGRE)

CRDA	No.	Station Name	Monitoring Elements	Remarks(Dam, River)
Ariana (AR)	1	AR–KLT ANDALUS	Rainfall	
	2	AR–PT BIZERTE–MEJ	Water level	Mejerda
	3	AR–S/THABET	Rainfall	
	4	AR–TOBIAS MEJ	Rainfall and Water level	Mejerda
Beja (BJ)	5	BJ–BEJA	Rainfall	
	6	BJ–EL HERRI–MEJ	Rainfall and Water level	Mejerda
	7	BJ–GOUBELAT	Rainfall	
	8	BJ–GP5 LHR	Water level	Lajmar
	9	BJ–JBL LAOUEJ–SI	Rainfall and Water level	Siliana
	10	BJ–MJZ GP5–MEJ	Rainfall and Water level	Mejerda
	11	BJ–MJZ MORADI–MJ	Water level	Mejerda
	12	BJ–PT BEJA–BEJ	Water level	Beja
	13	BJ–S/SALEM–BGE	Rainfall and Water level	Sidi Salem Dam
	14	BJ–SLOUGHIA–MEJ	Rainfall and Water level	Mejerda
	15	BJ–TEBOURSOUK	Rainfall	
	16	BJ–TESTOUR	Rainfall	
	17	BJ–KALED AVL–KH	Water level	Khalled
	18	BJ–MKHACHBIA–AVAL	Water level	Mekhachbia
Jendouba (JD)	19	JD–BNIMTIR–BGE	Rainfall and Water level	Ben Meter Dam
	20	JD–BOUSALEM–MEJ	Rainfall and Water level	Mejerda
	21	JD–DAR FATMA	Rainfall	
	22	JD–GARDIMAOU–MEJ	Rainfall and Water level	Mejerda
	23	JD–JENDOUBA	Rainfall	
	24	JD–JENDOUBA–MEJ	Water level	Mejerda
	25	JD–KASSEB–BGE	Rainfall and Water level	Kasseb Dam
	26	JD–PLAINE RAGHAI	Water level	Raghai
	27	JD–PT GP17 MLG	Rainfall and Water level	Mellegue
	28	JD–PT GP6 MLZ	Water level	Mliz
	29	JD–S/ABID TSA	Water level	Tessa
	30	JD–BOUHERTMA–BGE	Rainfall and Water level	Bou Hertuma Dam
El Kef (KF)	31	KF–HAIDRA SRT	Water level	Sarrat
	32	KF–K13 MLG	Rainfall and Water level	Mellegue
	33	KF–KEF	Rainfall	
	34	KF–KLT SENAN	Rainfall	
	35	KF–MELLEGUE–BGE	Rainfall and Water level	Mellegue Dam
	36	KF–PT ROUTE RMEL	Water level	Rmel
	37	KF–PT RTE SARRAT	Rainfall and Water level	Sarrat
	38	KF–S/AHMED SLH	Rainfall	
	39	KF–S/MEDIEN TSA	Rainfall and Water level	Tessa
	40	KF–SERS VILLE–TSA	Water level	Tessa
	41	KF–SKT S/YOUSF	Rainfall	
	42	KF–SOUANI–BGE	Rainfall and Water level	No Data
	43	KF–ZOUARINE GARE	Rainfall	
Manouba (MN)	44	MN–BJ TOUMI–MEJ	Water level	Mejerda
	45	MN–CHAFROU	Water level	Chafrou
	46	MN–JEDEIDA–MEJ	Water level	Mejerda
	47	MN–TEBOURBA	Rainfall	
	48	MN–LAROUSIA AVAL	Rainfall and Water level	Mejerda
	49	MN–MORNAGUIA	Rainfall	
Siliana (SL)	50	SL–KRIB	Rainfall	
	51	SL–M12 OSAFA–SIL	Water level	Siliana
	52	SL–PT ROUTE–SIL	Water level	Siliana
	53	SL–SILIANA	Rainfall	
	54	SL–SILIANA–BGE	Rainfall and Water level	Siliana Dam
	55	SL–MAKTHAR	Rainfall	
	56	SL–RMIL–BGE	Rainfall and Water level	Rmil Dam
Kasserine (KS)	57	KS–TALLA	Rainfall	
Total	(57)		(Rainfall : 20) (Water level :18) (Rainfall & Water level :19)	



Source: DGRE

Figure 3-10 SYCOHTRAC Observation System on the Mejerda River (Current Arrangement)

Statistical analysis of observation stations in the part of the Mejerda Basin in Tunisian territory and their locations performed during the master plan study shows that rain gauges are required in 14 new locations.

Figure 3-10 shows these locations. The current average basin area per rain gauge across the entire basin is 410 km^2, which is well above the Japanese standard of 50 km^2. It is not likely that sufficiently accurate observations can be made, especially if rain gauges are disproportionately placed in rainy areas. The southern area of the basin likely needs new rain gauges as suggested in the master plan study.

Table 3-5 Number of Rain Gauges on the Mejerda River (Including Additional Observation Stations) and Cover Area Per Station

Name of Sub-basin	Catchment Area(km^2) (a)	Existing Stations by SYCOHTRAC (b)	Additional Raingauge proposed by MP Study (c)	Cover Area per Station (km^2) (a)/(b)
G1 :Lower Reach	2,890	11	0	260
G2 :Sidi Salem Dam	4,310	9	0	480
G3 :Bou Hertuma Dam	390	3	0	130
G4 :Down St. of Siliana Dam	1,600	4	2	400
G5 :Up St. of Silian Dam	1,020	3	4	340
G6 :Tessa Dam	1,500	2	2	750
G7 :Mellegue Dam	2,320	4	2	580
G8 :Sarrath Dam	1,800	3	4	600
Total	15,830	39	14	410

Source: Number of rain gauges proposed the master plan study is based on the Supporting Report G in Master Plan Study

Note: ( ) shows the number of existing rain gauges arranged by the Master Plan Study

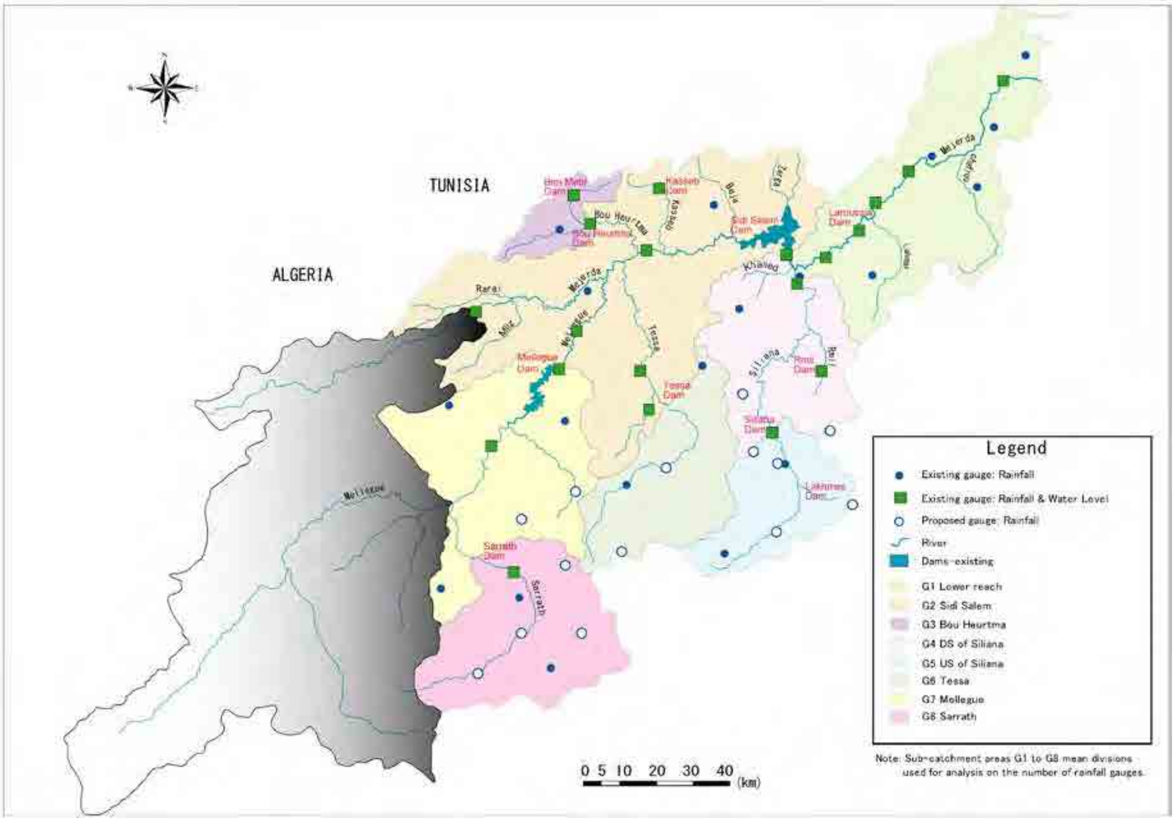


Figure 3-11 Rain Gauge System Suggested in the Master Plan Study (Current Arrangement + Proposed Expansion)

The table below shows the current arrangement of water gauges on the Mejerda River and its tributaries. There are 37 gauges in total, and they are located at dams and at most confluences of tributaries and the Mejerda River. Adding new water gauges was investigated in the master plan study, and four additional gauges were proposed. In addition, DGRE conducted an investigation in April 2007 and proposed 11 more gauges it wanted built.

Table 3-6 Mejerda River Water Gauges Current Arrangement and New Gauges

Name of River	Section (from)	Section (to)	Number of Water Gauges	
			Mejerda	Tributaries
1) Mejerda River	River Mouth	Chafrou River	2 + New 1 = 3	
Tri. Chafrou River	Mejerda	Chafrou		1 + New 1 = 2
2) Mejerda River	Chafrou	Lahmar	4	
Tri. Lahmar River	Mejerda	Lahmar		1
3) Mejerda River	Lahmar	Siliana	3	
Tri. Siliana River	Mejerda	Siliana & Khmes		5 +New1= 6
Tri. Khalled River	Mejerda	Khalled		1 +New2= 3
4) Mejerda River	Siliana	Sidi Salem Dam	1	
Tri. Zerga River	Mejerda	Zerga		1+New1=2
Tri. Beja River	Mejerda	Beja		1+New1=2
5) Mejerda River	Sidi Salem Dam	Bou Heurtuma	1+New1=2	
Tri. Kasseb River	Mejerda	Kasseb		1
Tri. Bou Heurtma River	Mejerda	Bou Heurtma		2
6) Mejerda River	Bou Herutma	Mellgue		
Tri. Tessa River	Mejerda	Tessa		4+New1=5

7) Mejerda River	Mellegue	Algeria Border	2	
Tri. Rarai River	Mejerda	Rarai		1+New1=2
Tri. Mliz River	Mejerda	Mliz		1+New1=2
Tri. Mellegue	Mejerda	Mellegue & Sarrath		5+New4=9
Total (Ex.3737+New15=52)			Ex.13+New2=15	Ex.24+New13=37

Source: Table 7.2.2 & Figure 7.2.2 (Tables & Figures, Master Plan Report, 2009)
Note: 'New' means additional gauging stations

Below are explanations for adding the water gauges shown in the table above:

Table 3-7 New Mejerda River Water Gauges

No.	Proposed Location	Explanation for Additional Installation	Proposed Study
1	Confluence Merjerda & Sarrath River	For monitoring water level at confluence of two rivers	JICA M/P Study (2009)
2	Sidi Smail	For judging of flood risk at Sidi Smail Town	Ditto
3	Sarrath Dam Site	For reservoir operation	Ditto
4	Tessa Dam Site	For reservoir operation	Ditto
5	Meeting point of P5 road and Mellegue River	For reservoir operation	DGRE Study (2007) & JICA Preparatory Survey (2012)
6	Confluence of Zerga River & Bou Nab River	For monitoring water level to the SS Dam	Ditto
7	P5 Bridge over Khalled River	For monitoring floods	Ditto
8	Lakhmes Dam	Planned Dam	Ditto
9	Chafraou Dam	Planned Dam	Ditto
10	Mliz Dam	Planned Dam	Ditto
11	Khaled Dam	Planned Dam	Ditto
12	Beja Dam	Planned Dam	Ditto
13	Eddir Dam	Planned Dam	Ditto
14	Retarding Basin	For monitoring water level to the retarding basin	Ditto
15	Mellegue 2 Dam	Planned Dam	Ditto

Source: 1) Supporting Report G (Master Plan Final Report. January, 2009)
2) Draft Final Report for Preparatory Survey (January, 2012)

The figure below shows the locations of water gauges, including new ones.

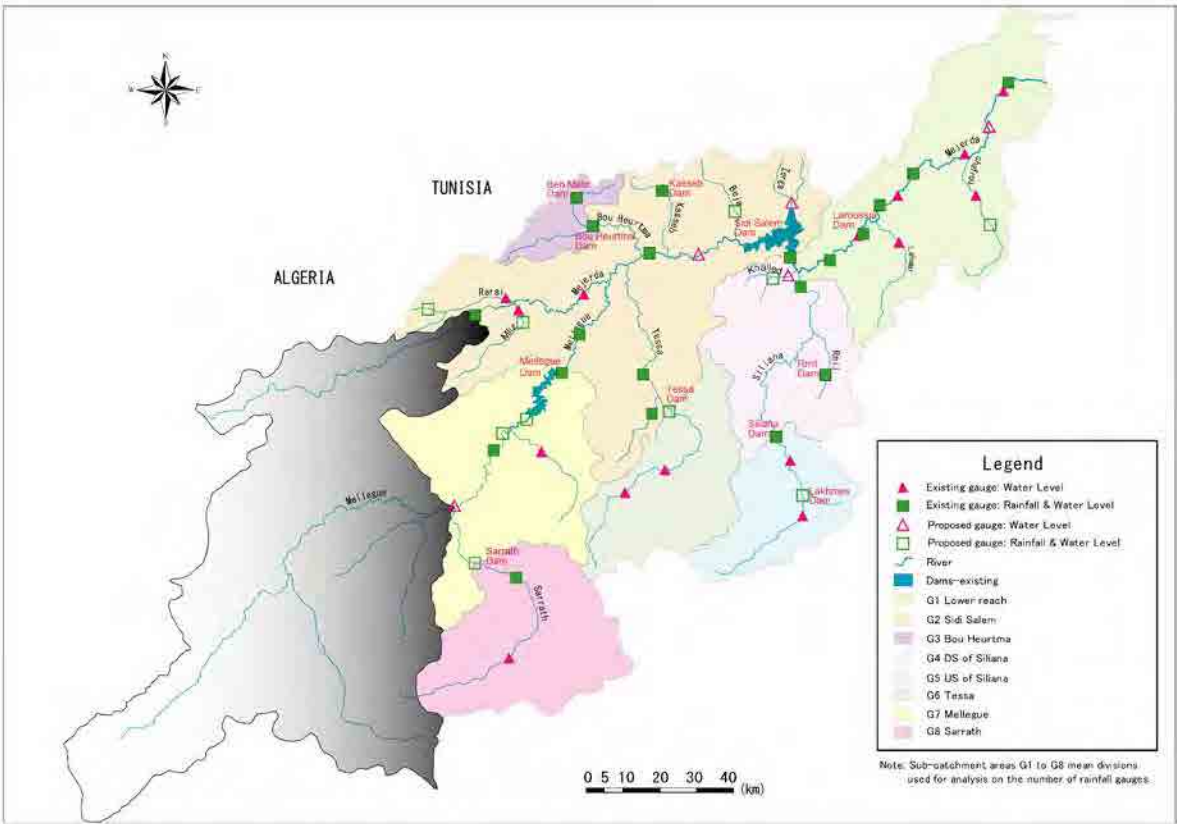


Figure 3-12 Water Level Observation System Proposed by the Master Plan and DGRE (Current Arrangement + Proposed Expansion)

(2) Flood Prediction

Flood prediction system capabilities do not include the ability to predict rainfall. The flood prediction system predicts water levels by considering propagation times to downriver areas based on the results of past water level and flow analysis from principal gauges. Below are propagation times from Sidi Salem Dam:

Table 3-8 Flood Propagation Times (From Sidi Salem Dam)

Reference Points	Slouguia	Mejes El Bab	El Battan	Jedeida	GP 8 Road	Tobias Barrage
Disatance from SS Dam (km)	22	38	97	106	132	135
Max. Propagation Time (hrs.)	4	8	23	23	31	32
Min. Propagation Time (hrs.)	6	11	29	33	44	42

Source: DGRE

According to the Surface Water Department of DGRE, the annual maintenance budget for the telemeter system (SYCOHTRAC) is TND 70,000. The Department has a separate 15-year purchasing contract with OTT France for hydrological observation equipment and currently has a three-year (2010-2012) contract for TND 300,000. Most of the hydrological observation equipment delivered by OTT France and currently in use was manufactured by OTT Germany. It is worth noting that financial aid from AFD was only provided in 2007.

(3) System Problems and Solutions

The table below summarizes an interview with the Surface Water Department of DGRE, the agency responsible for the telemeter system and early flood warnings, about the current status of problems with said systems and solutions to those problems:

Table 3-9 SYCOHTRAC System and Maintenance Problems and Solutions

System or Maintenance Problem	DGRE Solution (as of 9/2012)
1. CZMS, the company that procured and installed hydrological equipment, and DGR entered an equipment maintenance contract, but the contract relationship failed to deliver the expected results. The contract was terminated in November 2011.	Terminated the contract in November 2011. DGRE is directly managing maintenance and equipment installation.
2. Something needs to be done about system theft and destructive behavior.	The structure housing observation facilities were improved and a lock added, and solar panels were stored inside. Equipment was purchased from OTT Germany and updated in 20 locations. This solution cannot be expected to wipe out theft, but theft has decreased.
3. The dam management system and SYCOHTRAC are not compatible with each other.	a. DGRE installed observation equipment at each dam, but it is not compatible with systems related to dams and was not operating well. The plan is to investigate whether equipment can be concentrated at Sidi Salem Dam and incorporated into the DGRE system. b. It was determined that data communication system problems caused the data incompatibility. The plan is to change from a GSM system to a GPRS system. c. The GPRS system can transfer data over the Internet, enabling it to exchange and provide information to relevant authorities in addition to CRDA. d. Tunisiana is the only company that has this system, and the contract with this company will be renewed.
4. Flood information is not being relayed outside of the Ministry of Agriculture.	Flood information is provided to CRDA only via an exclusive online access system. The system uses special monitoring software, and the information is not provided to other agencies. There is also a dedicated telephone line to communicate this information. The above is governed by the contract with Tunisiana.
5. It is not possible to obtain hydrological information from the Algerian side.	The two countries deliberated over this in 2011. They agreed to exchange information, but a political change followed and negotiations have not gotten off the ground.

Source: Interview with Surface Water Department of DGRE

3.2.4 Current Status of Emergency Flood Response

(1) Current Status of Emergency Disaster Response

According to the National Civil Protection Office (NCPO), flood damage accounts for 90% of disasters in Tunisia with fires, heavy snow, droughts and other disasters accounting for less than 10%.

According to Law No. 39-1991 on Disaster Management and Organization, Disaster Management Commissions are to be formed when disasters are expected to strike, with the Minister of the Interior serving as the chair of the national commission and governors serving as chairs of governorate commissions.

The government's disaster management authority, the NCPO in the Ministry of the Interior, will serve as the standing office of the commissions and will coordinate between disaster organizations on central and regional levels. Governorates concerned with evacuation from flooding on the Mejerda River are Ariana in the lower region and Manouba and Bizerte, in which part of the retarding basin is located, in the upper region.

Below are descriptions of disaster organizations on national and regional levels.

1) National Disaster Commission

According to Decrees No. 942-1993 and No. 2723-2004, the National Disaster Commission is the highest disaster management authority, and the Minister of the Interior serves as its chair. As the table below demonstrates, this commission is comprised of the chair and 26 representatives selected from related ministries. It is worth noting that these representatives are selected in response to the type of disaster.

Table 3-10 Members of the National Disaster Commission

Organization	National Level	Regional Level
PM Office	1	
Interior	4	3
Finance	1	1
National Economy	1	1
Regional Planning and Development	1	1
Agriculture	1	1
Equipment	1	1
Land Development	1	1
Transportation	1	1
Communication	1	1
Public Health	1	1
Total	14	12

Source: Decree No. 93-942 (April, 1993)

2) Regional Disaster Commissions

Regional Disaster Commissions are set up in each governorate during disasters, and governors of each governorate serve as their chairs. These commissions are comprised of the chair and 17 representatives selected from the regional organizations of related ministries. These representatives are selected in response to the type of disaster.

3) Civil Protection Offices

Civil Protection Offices exist at the national (NCPO), governorate (Regional Civil Protection Office in Governorate) and even delegation (Delegational Civil Protection Center) levels. They cooperate with security forces, police and military forces and are in charge of evacuation and flood protection activities.

According to the NCPO, around 6,600 people, including temporary personnel summoned during disasters, can be mobilized at the central level, and 2,300 people can be mobilized at the regional level. The RCPO in Manouba, part of the survey area, can mobilize around 200 people and has also organized a rescue squad.

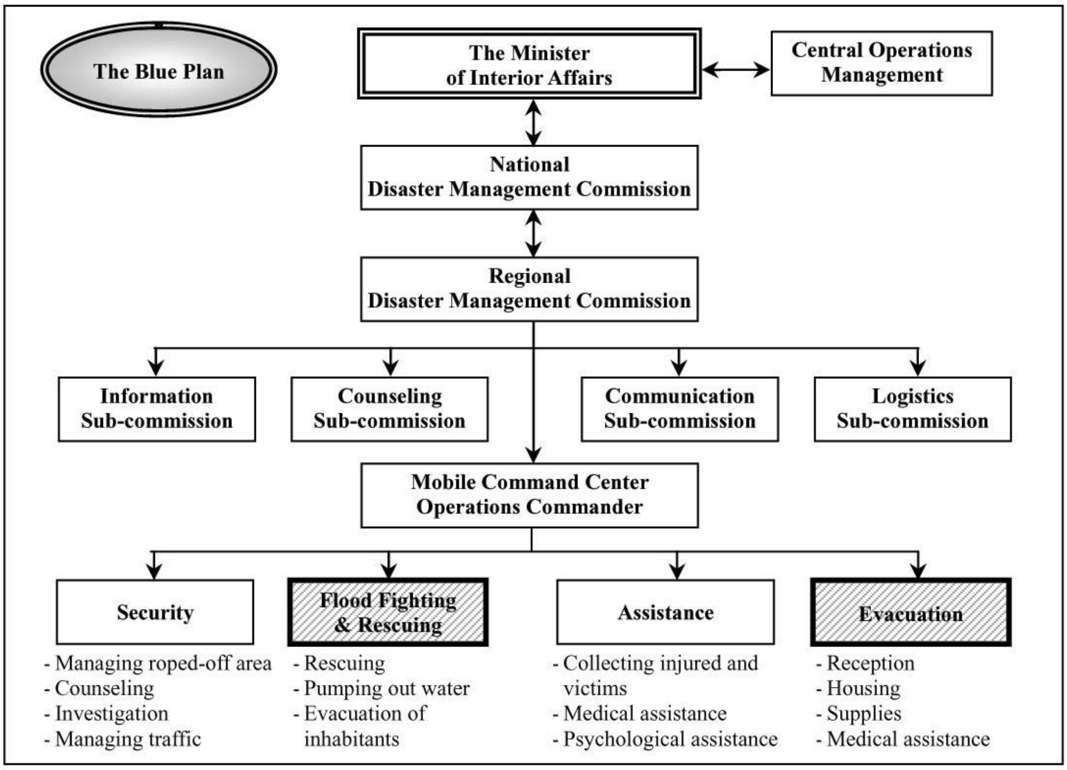
4) Citizen Volunteers, International Red Cross

Citizen volunteers assist in flood protection activities during disasters. According to Commission Regulation No. 2428-1999 on regulations for citizen volunteer participation in disaster management activities (1 November 1999), citizens 20 years of age or older who have passed citizen volunteer screening may register as citizen volunteers, and RCPOs will summon them during disasters. The NCPO revealed in an interview that, though volunteers had registered, there was a lack of experience in most governorates. Relief during floods comes from the International Federation of Red Cross and Red Crescent Societies and Arab countries (Saudi Arabia, Qatar).

(2) Disaster Management Plans

Regional Disaster Commissions work together with RCPOs in governorates to devise Disaster Management Plans based on Law No. 39-1991 and Decree No. 942-1993. National Disaster Commissions review the plans of each region, and governors approve them. Each governorate's distinct evacuation and flood protection plan includes ORSEC regional disaster management plans.

Governorate plans are devised based on guidelines that enable implementation systems and procedures employed when disasters strike to be standardized, but they are established in such a way that the specific needs of each governorate are met.



Source: NCPO & Master Plan

Figure 3-13 Disaster Management Organization and Disaster Information Communication System (Blue Plan)

Blue Plans are the parts of disaster management plans that deal with floods. Blue Plans are organized as shown in the figure above. These plans are reviewed before the rainy season to account for changes in geographical and hydrological conditions and changes caused by humans. These plans do not include flood prevention activities carried out by fire departments in Japan. These plans include:

- Organization structure
- Roles and duties of each organization
- Coordination, communication and reporting system diagrams
- Rescue orders to be given by individuals or organizations
- Rescue and evacuation drill plans
- Budgets for rescue operations
- Maps (maps that show road dangers during floods, inundation zone maps, evacuation center locations)

The maps below show inundation zones in El Battan, Jedeida and Tebourba from the Manouba Blue Plan (2011.8).

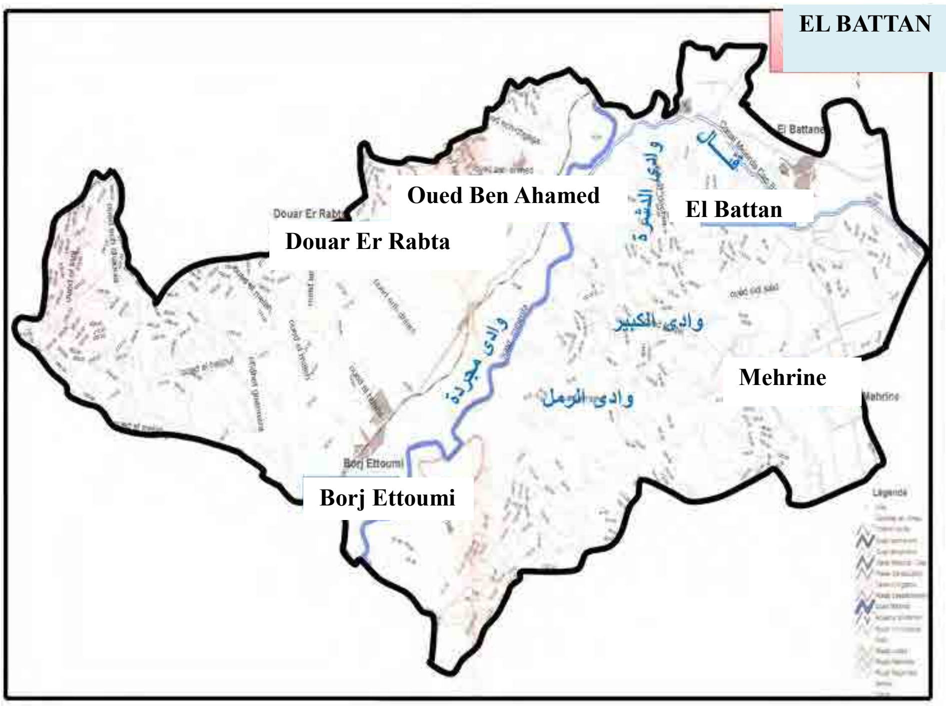


Figure 3-14 Flood Inundation Zones in El Battan Delegation (Manouba Blue Plan 2011)

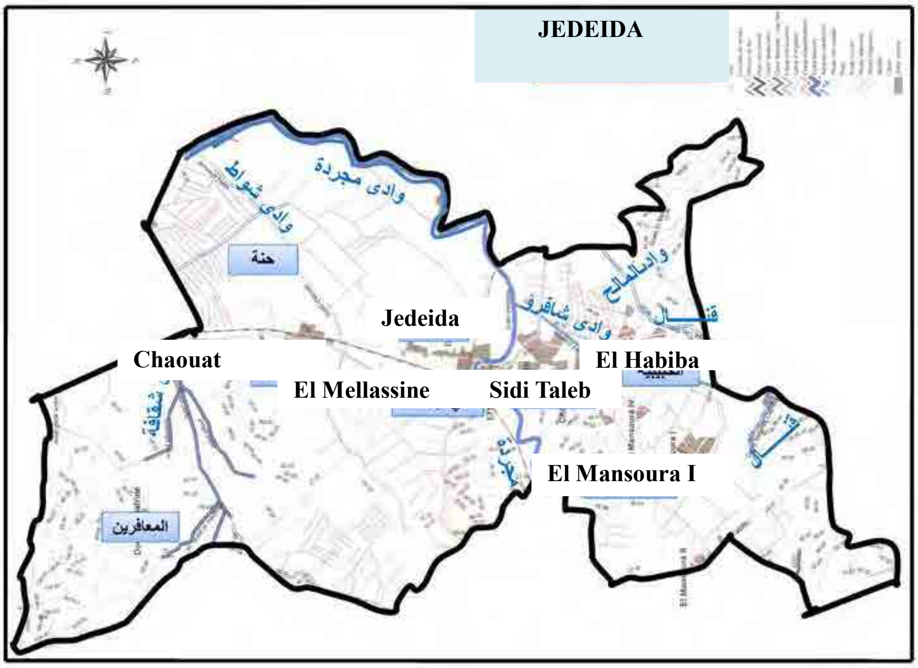


Figure 3-15 Flood Inundation Zones in Jedeida Delegation (Manouba Blue Plan 2011)

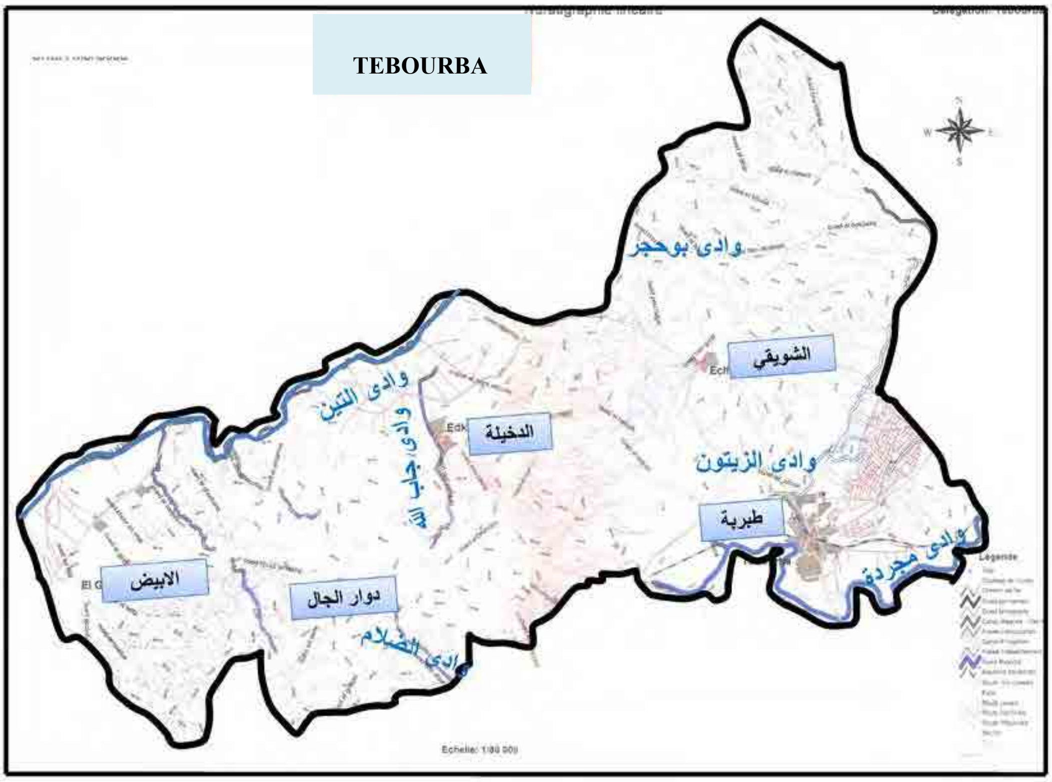


Figure 3-16 Flood Inundation Zones in Tebourba Delegation (Manouba Blue Plan, 2011)

(3) Issuing Flood Warnings

The Minister of the Interior is to issue flood warnings based on warnings and water level information provided by DGRE in the Ministry of Agriculture. A two-staged system has been set with Alert Levels and Overflow Levels as shown on the table below. The table shows warning levels at major Ministry of

Agriculture water gauges on the Mejerda River.

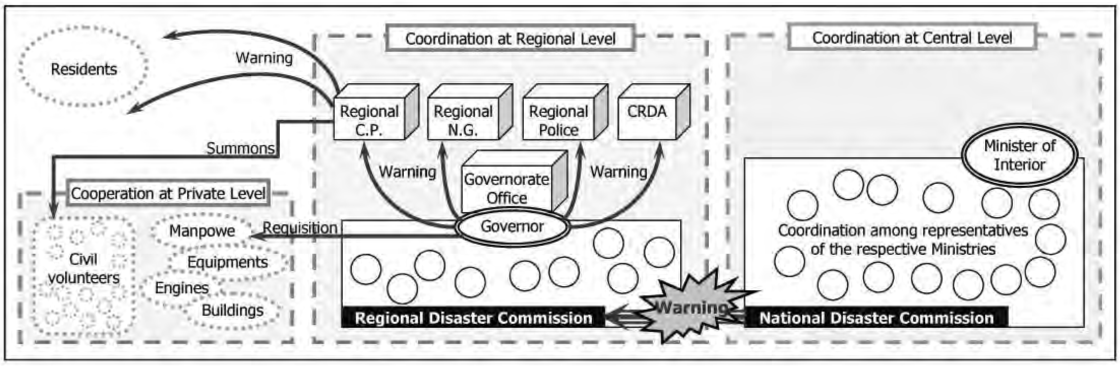
Table 3-11 Water Gauge Warning Levels

No.	Station Name	Relative CRDA	Alert Level(cm)	Overflow Level(cm)
1	Pt. Bizerte	Ariana	600	750
2	Tobias	Ariana	590	694
3	Bj Toume	Monouba	400	500
4	Jedeida	Monouba	750	820
5	Larousia	Monouba	190	-

Note: Alert and overflow levels do not correspond to the ground elevation network system.
Source: DGRE

These warnings are finally communicated to residents by Civil Protection Offices. The warnings can be relayed by telephone, facsimile and mobile phone or radio along the organizational system of communication established by Regional Disaster Management Plans.

In the First Stage, warnings issued by the Minister of the Interior are communicated to governors who serve as Regional Disaster Commission chairs. At the governorate level in the Second Stage, governors issue warnings to relevant authorities at the regional level: RCPOs, security forces and CRDAs. In the Third Stage, RCPOs patrol the river basin to relay warnings to residents.



Source) Ministry of Agriculture, NPCO

Figure 3-17 Flood Warning System Diagram (National – Governorate – Delegation – Residents)

(4) Evacuation and Evacuation Centers During Floods

Local residents evacuate to designated evacuation centers when they receive an evacuation advisory. Residents evacuate in community and family units. Civil Protection Offices and military forces work together to implement evacuations. Warnings are issued to the Jedeida Delegation in Manouba Governorate, in which flood damage is common, about two hours in advance.

Evacuation centers are set up in governorates and delegations. From upstream to downstream, evacuation centers in Manouba Governorate, located in the upriver part of Zone D2, are located in El Battan, Tebourba, Jedeida and Oued Ellil (see map below). In Ariana Governorate, located on the lower Mejerda River, evacuation centers are located in Sidi Thabet and Kalaat Andalous.

Source: Manouba Blue Plan, August, 2011

Figure 3-18 Locations of Manouba Governorate Delegations Requiring Flood Evacuation

The table below shows information about the evacuation areas in delegations on the Mejerda River in Ariana and Manouba Governorates. There are 12 evacuation centers in the two zones of Ariana with a capacity of 1,275 people. There are 19 evacuation centers in the four zones of Manouba with a capacity of 6,400 people. The mean capacity per evacuation center is around 100 in Ariana and around 340 in Manouba.

Table 3-12 Number of Mejerda River Flood Evacuation Centers and Capacities

Governorate	Related Delegations for Evacuation	Number of Evacuation Centers	Total Capacity of Evacuation Centers	Mean Capacity per Center(Persons/Center)
Ariana	2 (Kalaat Andalous, Sidi Thabet)	12	1,275	106
Manouba	4 (Oued Ellil, Tebourba, Jedaida, El Battan)	19	6,427	338

Source: Disaster Management Plan (Blue Plan) (Ariana & Manouba Governorate, August, 2011)

Evacuation centers contain mosques, schools, culture centers and sports centers. These centers can function as lodging and are fully equipped with electrical facilities and toilets. Daily necessities like water, bread, milk and blankets as well as feed for livestock are distributed. There are two national reserve stations in the Mejerda River Basin, and each governorate also has regional reserve centers.

Evacuation from Mejerda River floods typically lasts one or two weeks, but it has lasted a whole month for big floods like the one in 2003. Physiological and psychological damage brought on by long-term evacuation can have major effects on elderly people, children and other vulnerable people. Consolation payments have been made in the agricultural sector as compensation after flooding.

(5) Issues with Flood Evacuation, Flood Warnings and Communication

The table below shows issues with flood evacuation, flood warnings and communication:

Table 3-13 Issues with Flood Evacuation, Flood Warnings and Communication

Type	Issues, Problems
Evacuation, flood prevention, rescue operations	1) Some residents do not evacuate in order to prevent theft in their absence. 2) Many heads of households with livestock ignore evacuation advisories and stay behind to care for their animals 3) There are not enough materials and equipment for rescue operations. Particularly lacking are pumps for discharging water and rescue boats. 4) Long-term evacuation brings on physiological and psychological damage. 5) Preparation and persuading residents with evacuation advisories takes time.
Issuing and relaying flood warnings	1) Information about flood inundation from the Ministry of Agriculture moves too slowly. In some cases, the information does not arrive until right before the inundation. 2) Relaying evacuation information requires patrolling and visits to each household, which takes time. 3) Ninety mostly vulnerable people were once left behind in an Ariana delegation where evacuation advisories never arrived. 4) Evacuating at night is difficult because there are many power outages.

Source: Interviews with the NPCO and Manouba Governorate

3.2.5 River Channel Maintenance

CRDAs are responsible for Mejerda River channel maintenance in the administrative districts in which they have jurisdiction.

River channels were excavated and rampant vegetation in river channels removed in Manouba Governorate after the flood of 2003. From May 2004 to November 2004, the Manouba CRDA removed deciduous tamarisk shrubs proliferating along the five kilometers of river channel they excavated from a new road bridge in Jedeida to Sidi Thabet at the border with Ariana. Unfortunately, the roots left behind grew back into shrubs two to four meters high less than two years later because tamarisk are hearty and exuberant and can grow in various types of soil. Military forces used a bulldozer equipped with a ripper to remove tamarisk roots in Jedeida within a 500-meter area upstream of the road bridge. Young tamarisk roots were dug out of the ground in that case, so they were not able to grow or proliferate as fast as they had before. A 2.5-kilometer stretch of the Chafrou River channel from its confluence with the Mejerda River was also excavated in 2004.


Figure 3-19 Tamarisk Proliferation (September 2012)

Downstream of the Mejerda-Chafrou Confluence **Upstream of the Jedeida Railroad Bridge**

In September 2012, a JICA Study Team interviewed the Manouba CRDA about how it dealt with tamarisk and found that:

1) completely removing the roots kept tamarisk at bay for five years.

2) the CRDA began removing roots in 2009 over 1.5 kilometers per year for budgetary and other reasons. The CRDA's budget for root removal is TND 120,000 per year (equivalent to JPY 6 million, or about JPY 4,000 per meter).

3) the CRDA has to outsource the root removal work because it does not have the required machinery. Experience showed the CRDA that it is best to do root removal work once every three years.

3.2.6 El Mabtouh Retarding Basin Functions and Land Use Regulations

The El Mabtouh Retarding Basin is a low-lying area that has been used for salt production since ancient times. It is the entry point for runoff from the mountains located in the northern and western parts of the area and currently serves as a temporary holding area for overflow from the left bank of the Mejerda River; it is a retarding basin. A diversion channel from the retarding basin joins the Mejerda River upstream of Tobias Barrage. Gate facilities are set up at the confluence to prevent discharge and backflow on the diversion channel side, but they are broken and currently out of order.

Figure 3-20 El Mabtouh Retarding Basin Diversion Channel Confluence with Mejerda River and Gate Facilities

The retarding basin is split into three zones with inundation and discharge sequences determined for each. When organizing the summary of explanation given by BDGTH, the current situation of retarding basin management and existing facility functions are as follows;

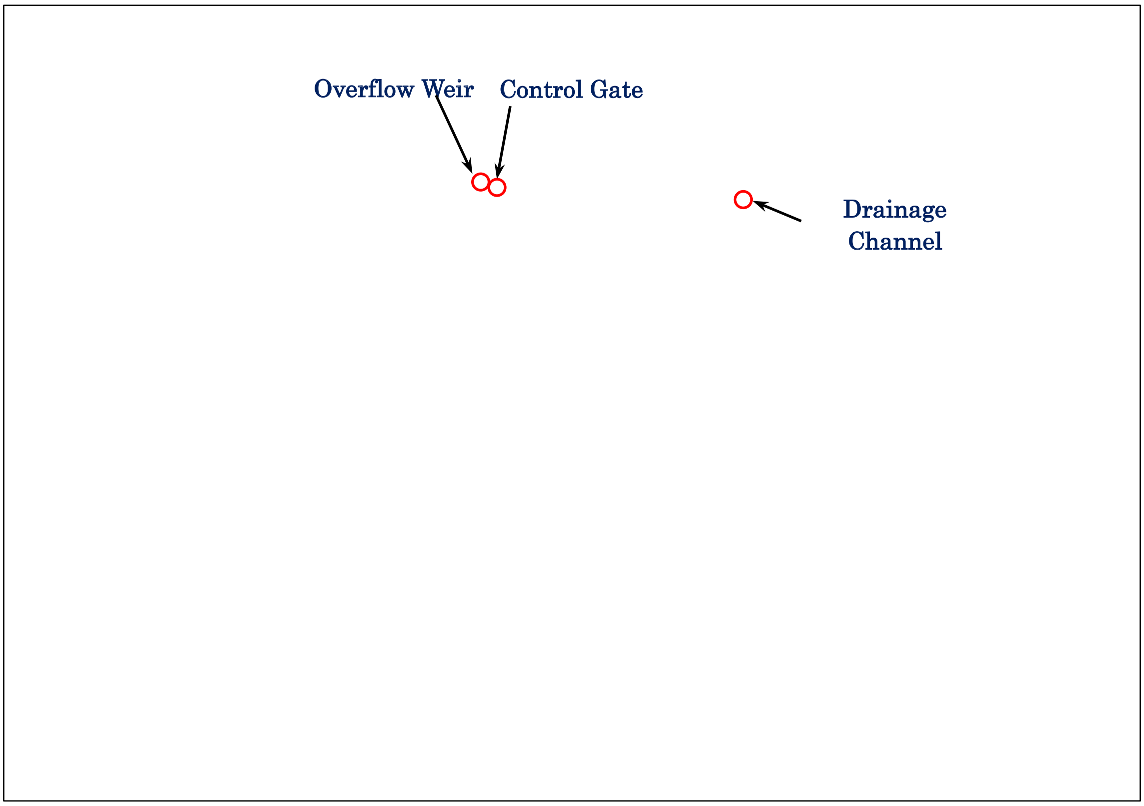


Figure 3-21 El Mabtouh Retarding Basin Diversion Channel Zones

1) Zone 3 is located on the outer (western) side of the inflow channel dike, Zone 2 is located on the inner

(eastern) side of the dike, and Zone 1 is located further east of Zone 2.

2) Zone 3 is the first inundation zone into which floodwaters flow. Floodwaters inundate Zone 3 first because there is no dike on the left bank of the inflow channel; there is only a dike on the right bank. When there is an even bigger amount of inflow, an overflow weir cut into the right bank of the inflow channel allows floodwater to spill into Zone 2 and inundate it.
3) Water from still bigger floods flows into Zone 1 from Zone 2 through a pipe under the road that connects the two zones. A gate at the end of that pipe controls inflow from Zone 2 to Zone 1.
4) Assuming the case of flood peak flowing into retarding basin with several waves, overflow weir with gate is installed adjoining to the downstream side of above mentioned overflow weir in order to make preliminary discharge from Zone 3 to Zone 2 being possible in preparation to the next wave attack even in the case of standing water level is less than designed water storage level (NGT + 9.5m).
5) If the sudden water level rising in Zone 3 is unable to be suppressed, destroy the soil weir bank (fuse bank) installed on the embankment road between Zone 3 and Zone 1 artificially to allow water passing.
6) Zone 3 exists solely for flood control; restrictions against cultivation in Zone 3 are in place. Grain crops can be grown in Zones 1 and 2 every other year.
7) Following floods, water is discharged from Zone 1 first. Water is discharged from Zone 2 after discharge from Zone 1 is complete. Water is discharged from Zone 3 last since it was designed to be a retarding basin from the start. A control gate to meet the purpose is installed in Zone 2 and Zone 3, respectively.

At the water discharge channel continuing from discharge channel and its flow rate control gate, a drainage sluiceway form Zone 2 and Zone 1 is installed which goes through underneath of the bank. A flap gate is equipped at water channel side but if the size of sluiceway is large, a box culvert is equipped instead.

The respective picture for inflow channel (installed only right dike while no dike at left side, Zone 3 side), overflow weir installed at right side of retarding basin inflow channel, overflow weir with gate, fuse weir, discharge channel (Zone 3) flow rate control gate, inside channel (Zone 2) and discharge sluiceway is shown below;

The retarding basins are divided into government-owned land and private land. As previously mentioned, grain crops can be grown only in Zones 1 and 2 every other year, and Zone 3 is dedicated for retarding basin. Since the government-owned part of Zone 2 and Zone 1 are allowed to farm with the condition of allowing flow in at flood and submerging, no compensation is required for the water immersion into farm land.

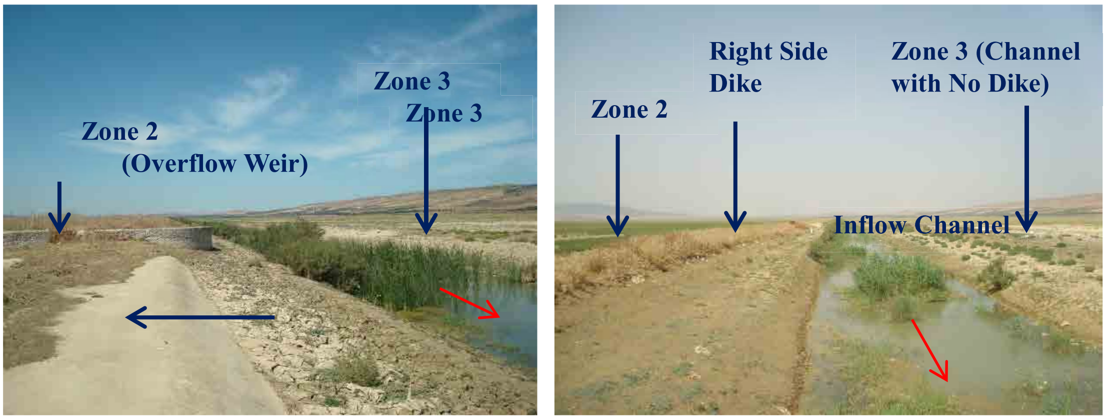


Figure 3-22 Overflow Weir (Zone 3 to Zone 2) and Dike on Right Bank of Inflow Channel

Figure 3-23 Overflow Weir (Zone 3 to Zone 2) with Gate

Figure 3-24 Fuse Dike (Zone 3 to Zone 1)

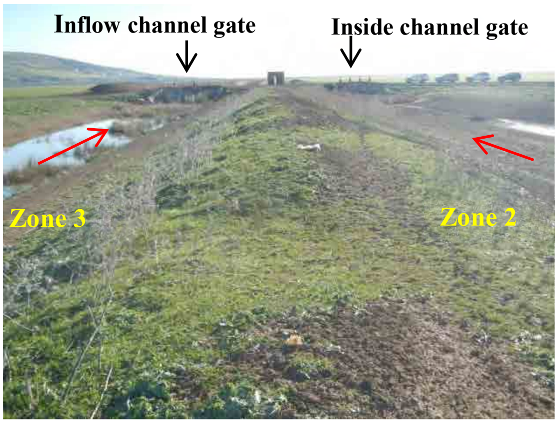


Figure 3-25 Flow Rate Control Gate

Figure 3-26 Appearance of Farmland in Zone 2

Figure 3-27 Flap Gate at Outlet of Discharge Sluiceway

Figure 3-28 Discharge Sluiceway with Box Culvert Structure

3.3 Donor Water Resources Management Activities

3.3.1 Donor Activities

(1) Flood Control

Most flood control efforts to this point have actually been funded by Tunisia itself. The African Development Bank (ADB), the World Bank and JICA are international donors who have funded past flood control projects. Below are descriptions of those efforts:

1) The African Development Bank

The ADB is currently implementing the North and West Tunis Flood Protection Study (FS). The construction period is 13 months from May 16, 2012 through June 15, 2013. The Urban Hydrology Department of the Ministry of Equipment is serving as the Tunisian government authority of this Study. The ADB report will be used to determine the relevance of project implementation and entities from which to procure funding. As shown on the map below, the target area for the ADB study is Tunis and the Mejerda River Basin downstream of Route 8, the northern part of which overlaps with the target area of this Study. This Study calls for improvement of the river channel upstream of the Kalaat Andalous Bridge, but there will be no overlap in the project implementation stage because the Ministry of Agriculture will implement that part, coordinating with the Ministry of Equipment.

It is worth noting that the Ministry of Equipment was the implementing authority on the Greater Tunis Flood Protection Study, Phase I (Etude de Protection Contre Les Inondations du Grand Tunis), a study related to the ADB study and performed in 2005. Flood control measures in Tunis city limits were investigated in that study, but the lower Mejerda River Basin was not included in the scope of that study.

Figure 3-23 North and West Tunis Flood Protection Study Area

2) JICA

Japan has continuously cooperated toward the development of Tunisia in the form of ODA loans, grant aid, and technical cooperation. Below is JICA's experience with flood control measures from that cooperation:

1. Inundation Protection Plan	Ministry of Equipment	1997 LA	JPY 3.13 billion	ODA Loan
1) Improve drainage channels and balancing reservoirs and repair existing channels to control flooding in the Enkhilet River Basin that flows through the city of Ariana in the northern part of Tunis. 2) Perform channel construction, build dikes, relocate river-crossing structures and build bridges to control flooding on the Mergeullil and Zerga Rivers on the Kairouan plain that surrounds the city of Kairouan in Central Tunisia.				
2. Greater Tunis Flood Control Project	Ministry of Equipment	2007 LA	JPY 6.808 billion	ODA Loan
1) A succession of major floods has hit Greater Tunis in recent years. In particular, the torrential rains of				

September 2003 (said to have a 100th-year probability) brought capital functions to a halt for more than two days and wrought significant damage (four people died and damages totaled JPY 45 billion). This project will improve drainage channels with the focus on the western part of Greater Tunis, in which existing drainage facilities are not capable of adequately handling the large floods of recent years, likely owing to climate change. 2) Improve facilities, provide materials and equipment.			
3. Development Study on the Integrated Basin Management and Flood Control Project in the Mejerda River	Ministry of Agriculture	2006-2008	Technical Cooperation (Development Study)
Implement a development study on flood control measures across the entire Mejerda River Basin based on this Study and devise a master plan.			

3) The World Bank

The World Bank provided reconstruction assistance after the flood in the city of Sfax in 1982. Sfax is a port city located 270 kilometers southeast of Tunis with a population of 340,000 people (as of 2005). It is the capital of Sfax Governorate and is the second largest city in Tunisia. The flood of 1982 killed 70 people, destroyed 700 homes and damaged 8,000 others. The World Bank implemented flood control measures after that flood, contributing USD 25 million of USD 48 million project funds. The project consisted of repairing dikes, improving drainage channels and helping restore neighboring municipalities.

(2) Water Use

From as early as the 1950s, foreign donors have assisted Tunisia in implementing many projects dealing with water use. These projects involved dam construction, irrigation improvement, drinkable water supply and water and wastewater facilities. International organizations, community development finance institutions, regional cooperation groups and many other agencies provided assistance. Bilateral aid also occurred. Below are prominent donors:

1) World Bank
2) German Agency for International Cooperation (GIZ)
3) French Development Agency (AFD)
4) African Development Bank (ADB)
5) European Fund (European Bank (SEI), Neighborhood Investment Facility (NIF))
6) Arab Fund for Economic and Social Development (FADES)
7) JICA
8) Other: Abu Dhabi Fund, Kuwait Fund for Arab Economic Development

According to OECD data, 20,000 hectares of Tunisian soil turn to desert every year. Countering desertification is a major policy issue in Tunisia, and many projects are being implemented. Many dams have been built in the northern and central regions of the country, in which the Mejerda River Basin is included, as part of reservoir plans, and still more are currently being built or planned. Bilateral aid from Japan, Germany, Kuwait, Libya, Russia, Saudi Arabia and France has joined international organizations in support of these projects. The documentation package contains more specific information about the nature of this aid.

3.3.2 Connection between This Project and Japanese Policy on Aid for Tunisia

Policy on aid for Tunisia released by the Japanese Ministry of Foreign Affairs has indicated the following three major issues that require attention above all others:

1) Aid to improve industry

2) Aid to develop and manage water resources

3) Aid for environmental efforts

Aid to develop and manage water resources is expected to include a water demand management project and an integrated water resources management project that effectively brings together the technical capabilities and local experience of Japanese corporations.

The Japanese government has continued to serve as a joint host of TICAD (Tokyo International Conference on African Development). It hosted TICAD I in 1993, TICAD II in 1998, TICAD III in 2003 and TICAD IV in 2008. The UN Office of the Special Advisor on Africa (OSAA) and the UN Development Programme (UNDP) are joint hosting organizations of TICAD. TICAD are held to facilitate meetings between heads of state from African nations and high-ranking officials of development partner nations, and policy and integrated guidelines for the development of African nations have been devised since the first TICAD.

TICAD IV was held in Yokohama in 2008. Participating nations investigated key aspects such as millennium development goals (MDGs) and other ways to spur economic growth, ensuring public order, advancement of peace, considerations for the environment and climate change and other matters to which a global society must respond with policy. The result of their investigations was the adoption of the Yokohama Declaration.

Though the Yokohama Declaration pays particular attention to environmental and climate change issues, participating nations emphasized the importance of health, agricultural production, reducing disaster-related risk, peace, public order and water and recognized the need to encourage the sustainable use of water resources, all vital elements for responding to needs for the development of nations. Action plans under this declaration include aid for devising natural disaster protection plans and emergency response plans based on risk assessment in regions likely to suffer from droughts, floods and other natural disasters.

This Study is intended to function as part of the feasibility study of the ODA loan project seeking to control, at minimum, flood damage in the Mejerda River Basin, and it conforms to Japanese aid policy.

3.4 Development Plans for Mejerda River Zone D2

Two privately funded development projects, Tunis Bay Finance Harbour and Tunis Telecom City, have been planned for the coastal region around the mouth of the Mejerda River. Both development projects will be implemented in Zone D2, the target area of the Mejerda River Flood Control Plan. The locations for these projects are shown in the figure above. This plan is expected to reduce flood damage for those projects.

1) Tunis Bay Financial Harbour

A private development company planned this project for the coastal region between the mouth of the

Mejerda River and Tunis. A financial center, a business center and a university will be built on 483 hectares of land. The table below shows an overview of the plan:

Table 3-14 Tunis Bay Financial Harbour Plan Overview

Owner	Tunis Bay Project Company
Funding Source	Gulf Finance House
Plan Study Implementation Consultant	HOK Planning
Lot Area	483 ha
Description	International finance center, multipurpose business center, yacht harbor, beach, golf course, commercial facilities, hospital, technology center, university, residential area, private housing complex and the water supply, energy, communications and transportation infrastructure required for the above
Implementation Schedule	Phase I: Golf course, financial center
	Phase II: Yacht harbor, markets, hotels, world center tower
	Phase III: Hotels, residences
	Phase IV: University, technology center, residential area

Source: Tunis Bay Financial Harbor, Design Phases 1 & 2, Preliminary Design, Version C, STUDY, Janvier, 2011 (does not contain specific information about construction periods or budgets)

2) Tunis Telecom City

This development project will be implemented in the coastal region about four kilometers north of the mouth of the Mejerda River. Like the Tunis Bay Financial Harbor, its plans call for improvement of urban infrastructure.

3.5 Project Necessity and Positioning

3.5.1 Project Necessity

Half of the Republic of Tunisia has a semi-arid climate, with the entire country receiving an average of just 500 millimeters of rainfall per year. The rainy season in the northern part of the country, which includes the Mejerda River, lasts from September to March, and torrential rains hit the region once every few years and cause rivers to rapidly swell with water and flood surrounding areas. Torrential rains pounded the lower Mejerda River Basin, also in northern Tunisia, in 2000, 2003, 2004, 2005, 2009 and 2012, causing major damage due to flooding and inundation.

The great flood of January 2003 killed 10 people and forced 27,000 to evacuate, inflicting tremendous social and economic loss as it damaged crops and houses and cut off transportation as it submerged the area for over one month. Most recently, heavy rains in the northwestern part of the country in February 2012 caused flooding in many regions along the Mejerda River and led to six deaths and inflicted much damage.

The IPCC Fourth Assessment Report indicated that, while total rainfall is expected to decrease in the future in the Republic of Tunisia and the rest of Northern Africa, increased water vapor content in the atmosphere caused by higher average temperatures could lead to more frequent, more intense heavy rainfall events. The fact that flooding has frequently occurred in Tunisia since 2000 means that the effects of climate change must be considered when investigating flood control measures for Tunisia.

The Mejerda flows for 312 kilometers in Tunisia and is the only river in the country that runs year-round.

Its basin is home to 13.4% of the population of Tunisia, and the population density of the basin is 84.0people/km^2, which is higher than the national average of 61.1people/km^2. The relatively plentiful rainfall and fertile agricultural lands in the basin make agriculture in the basin the key to the nation's economy. However, existing flood protection measures still depend on the outmoded solution of retaining water behind dams, and down flow capacity improvement and other river improvement projects urgently need to be implemented to move toward more comprehensive flood control measures.

This Project aims to mitigate flood damage in Zone D2, the lower Mejerda River Basin, and area that has suffered serious flood damage. Structurally, the Project will improve the river, establish a retarding basin through flow diversion and improve bridges that traverse the river and other river infrastructure; non-structurally, it will update the hydrological observation system at the Ministry of Agriculture (SYCOHTRAC), improve the operability of diversion management systems at dams, enhance flood response capacity at the Ministry of Agriculture and improve community disaster management. All things considered, this Project will contribute to the economic and industrial development of the Republic of Tunisia, and it is highly necessary.

3.5.2 Project Positioning

(1) History

The lands in the flood plain of the lower Mejerda River Basin cannot be used effectively because floods occur during the rainy season, which lasts from September to March in Northern Tunisia.

The Sidi Salem Dam was constructed in 1981 as a flood control measure for the lower basin, and it kept floods from occurring downstream for the next 22 years. Over the same period, relatively plentiful rainfall and fertile agricultural lands spurred agricultural development, and agriculture became the key to the regional economy.

However, as explained above, major flooding occurred in 2003 significantly damaged crops, homes and transportation services. The same type of flooding continued to occur afterward, inflicting social and economic loss and inhibiting sustained development in Tunisia.

Following a request from the Tunisia government to improve the situation it faced, JICA implemented the Development Study on the Integrated Basin Management and Flood Control Project in the Mejerda River (hereinafter referred to as "Development Study") from 2006 to 2008 and devised a master plan for integrated basin water management. Afterward, a feasibility study on the actualization of integrated basin management and the flood control project on the Mejerda River was implemented from September 2012 through March 2013 in Zone D2, the lowest part of the basin in which the economic effects would be the strongest according to the master plan, via the Preparatory Study on Integrated Basin Management and Flood Control Project in the Mejerda River and this Study.

(2) Disaster Management and Flood Control Policy in Tunisia and the Mejerda River Basin

Mitigating flood damage was a crucial element of the 11th five-year plan (2007-2011). Flood control measures were also a crucial element in the 12th five-year plan (2010-2014); the plan demands more effort toward basin management, dam preservation, urban flood protection, erosion control measures, fertile soil preservation and productivity improvement.

The Ennahada became the leading party after the constituent assembly election on October 23, 2011 following the Jasmine Revolution of January 2011, and the party has since made it clear that the objectives of existing policies will be carried over. The Ministry of International Development and Cooperation confirmed during this JICA Study (July through September 2012) that there would be no policy changes with respect to this Project.

(3) Connection Between This Project and Japanese Policy on Aid for Tunisia

Policy on aid for Tunisia from the Japanese Ministry of Foreign Affairs has indicated aid for water resources management as a major issue that requires attention above all others.

The Japanese government has also continued to serve as a joint host of TICAD (Tokyo International Conference on African Development). At TICAD IV, held in Yokohama in 2008, participating nations investigated knowledge and policy of the global society regarding matters such as considerations for the environment and climate change, and they adopted the Yokohama Declaration. Though the declaration pays particular attention to environmental and climate change issues, participating nations emphasized reducing disaster-related risk as a vital element for responding to needs for the development of nations. Action plans under the declaration include aid for devising natural disaster protection plans and emergency response plans based on risk assessment in regions likely to suffer from floods and other natural disasters.

This Study is intended to function as part of the feasibility study of the ODA loan project seeking to control, at minimum, flood damage in the Mejerda River Basin, and it conforms to both Japanese aid policy and the Yokohama Declaration.

(4) Overview of Related Projects

The Urban Hydrology Department of the Ministry of Equipment is implementing the North and West Tunis Flood Protection Study from May 16, 2012 through June 15, 2013 on the strength of grant aid from the African Development Bank. The scopes of the ministry’s study and this Study overlap in the Mejerda River Basin downstream of Tobias Barrage, but coordination between the Ministry of Agriculture and the Ministry of Equipment will prevent overlapping in the project implementation stage.

Two privately funded development projects, Tunis Bay Finance Harbour and Tunis Telecom City, have been planned for the coastal region around the mouth of the Mejerda River. The studies that are currently being dealt with are intending study on the Tunis city and downstream from Tunis ~ Bizerte Express Highway of Mejerda River as their target on the assumption that these and subsequent projects will facilitate the development of this region in the future.

This Project will fulfill an important role in providing flood protection for agriculture in the basin, the key to the Tunisian economy, and also for the planned economic infrastructure around the mouth of the Mejerda River.