Republic of Tunisia
Ministry of Agriculture, Hydraulic Resources and Fishery

Republic of Tunisia
The Preparatory Survey on Sidi Salem Multi-Purpose Dam Comprehensive Sedimentation Management Project

Final Report

Volume II

October 2023

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD
NIPPON KOEI CO., LTD
JAPAN WATER AGENCY

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Abbreviations

1. Tunisian Government

Abbreviations/Acronyms	**English**	**French**
ANGED (MEn)	National Agency for Waste Management	Agence Nationale de Gestion des Déchets
ANPE (MEn)	National Agency for the Protection of the Environment	Agence Nationale de Protection de l'Environnement
CNE	National Water Commission	Comité National de l'Eau
CRC	Commision of Recognition and Conciliation	Commission de Reconnaissance et de Conciliation
CRDA (MoA)	Regional Offices of Agriculture Development	Commissariats Régionaux au Développement Agricole
DGACTA (MoA)	Directorate General of Planning, Management and Conservation of Agricultural Lands	Direction Générale de l'Aménagement et de la Conservation des Terres Agricoles
DGBGTH (MoA)	Directorate General for Dams and Major Hydraulic Works	Direction Générale des Barrages et des Grands Travaux Hydrauliques
DGCES (MoA)	Directorate General of Water Conservation and Soil	Direction Générale de la Conservation des Eaux et du Sol
DGEQV (MEn)	Directorate General of Environment and Quality of Life	Direction Générale de l'Environnement et de la Qualité de la Vie
DGF (MoA)	Directorate General of Forests	Direction Générale des Forêts
DGGREE (MoA)	Directorate General of Rural Engineering and Water Exploitation	Direction Générale du Génie Rural et de l'Exploitation des Eaux
DGPA (MoA)	Directorate General of Fishing and Aquaculture	Direction Générale de la Pêche et de l'Aquaculture
DGPC(MEq)	Directrate General of Roads and Bridges	Directeur Général des Ponts et Chaussées
DGRE (MoA)	Directorate General of Water Resources	Direction Générale des Ressources en Eau
INAT (MoA)	National Institute of Agronomy of Tunisia	Institut National Agronomique de Tunisie
INM (MT)	National Institute of Meteorology	Institut National de la Météorologie
INP(MCSP)	National Herritage Institute	Institut National du Patrimoine
INS (MEP)	National Institute of Statistics	Institut National de la Statistique

Abbreviations/Acronyms	**English**	**French**
MCSP	Ministry of Culture and Heritage Preservation	Ministère de la Culture et de la Sauvegarde du Patrimoine
MdA	Ministry of Agriculture	Ministère de l'Agriculture
MDEAF	Ministry of State Domains and Land Affairs	Ministère des Domaines de l'Etat et des Affairres Foncières
MdP	Ministry of Heritage	Ministère du Patrimoine
MEn	Ministry of Environment	Ministère de l'Environnement
MEP	Ministry of Economy and Planning	Ministère de l'Economie et de la Planification
MEq	Ministry of Equipment	Ministère de l'Equipement
MF	Ministry of Finance	Ministère des Finances
MT	Ministry of Transport	Ministère des Transport
ONAS (MEn)	National Sewerage Board	Office National de l'Assainissement
ONPC	National Protection Civil Office	Office National de la Protection Civile
OTC (MEn)	Topography and Cadastral Office	Office de la Topographie et du Cadastre
SECADENORD	North Water Canal, Adductions and System Management Company	Société d'Exploitation du Canal et des Adductions des Eaux du Nord
SNCFT	Tunisian Railways	Société Nationale des Chemins de Fer Tunisiens
SONEDE (MoA)	National Water Distribution Utility	Société Nationale d'Exploitation et de Distribution des Eaux
ULAP	Local Union of Farmers and Fishers	Union Locale des Agriculteurs et des Pêcheurs

2. International Donner

Abbreviation	**English**	**French**
EU	European Union	Union Européenne
JICA	Japan International Cooperation Agency	Agence Japonaise de Coopération Internationale
KfW	German Reconstruction Finance Corporation	Kreditanstalt für Wiederaufbau
UNESCO	United Nations Educational, Scientific and Cultural Organization	Organisation des Nations Unies pour l'Education, la Science et la Culture
WB	The World Bank	La Banque Mondiale

3. Others

Abbreviation	**English**	**French**
AR	Artificial Regeneration	La Régénération Artificielle
BOD	Biochemical Oxygen Demand	Demande biochimique en oxygène
COD	Chemical Oxygen Demand	Demande chimique en oxygène
D/D	Detail Design	Conception détaillée
DCP	Dynamic Cone Penetration	Pénétration dynamique du cône
EIA	Environmental Impact Assessment	Etude d'Impact sur l'Environnement
EIRR	Economic Internal Rate of Return	Taux Interne de Rentabilité Economique
EL	Elevation	Élévation
F/S	Feasibility Study	Etude de Faisabilité
FFWS	Flood Forecasting and Warning System	Système de prévision des inondations et d'alerte
FR	Final Report	Rapport final
GCM	General Circulation Model	Modèle de circulation générale
GDP	Gross Domestic Product	Produit intérieur brut (PIB)
GEOSS	Global Earth Observation System of Systems	Système mondial des systèmes d'observation de la Terre
GEV	Generalized Extreme Value	Généralisée de la valeur extrême
GIS	Geographic Information System	Système d'Information Géographique
GPRS	General Packet Radio Service	General Packet Radio Service
GSM	Global System for Mobile Communications	Groupe Spécial Mobile
HWL	High Water Level	Niveau des Plus Hautes Eaux
IPCC AR5	Intergovernmental Panel on Climate Change Annual Report 5	Groupe d'experts intergouvernemental sur l'évolution du climat - Rapport annuel 5
ITR	Interim Report	Rapport intérimaire
JPY	Japanese Yen	Yen Japonais
M/P	Master Plan	Plan Directeur
NATM	New Austrian Tunneling Method	Nouvelle méthode autrichienne de creusement de tunnels
NWL	Normal Water Level	Retenue Normale
O&M	Operation and Maintenance	Exploitation et Maintenance
ORSEC	Civil Security Response Organization	Organisation de la Réponse de SÉcurité Civile
PMF	Provable Maximum Flood	Crue Maximale Probable
PMP	Portable Maximum Precipitation	Précipitations Maximales Probables
PMU	Project Management Unit	Unité de gestion de projet
RCP	Representative Concentration Pathways	Voies de Concentration Représentatives

Abbreviation	**English**	**French**
SAPI	Special Assistance for Project Implementation for Mejerda Flood Control Project	Assistance spéciale pour la mise en œuvre du projet de lutte contre les inondations de Mejerda
SMS	Short Message Service	Short Message Service
SS	Suspended solids	Matières solides en suspension
STEG	Tunisian Society of Electricity and Gas	Société tunisienne de l'électricité et du gaz
STORAPIL	Company of Transport of Hydrocarbon by Pipe-Line	Société de Transport d'Hydrocarbure par Pipe-Line
SYCOHTRAC	Real-time Hydrological Information Collecting Measurement and Flood Announcement System in Wadis	SYstèm de COllecte des mesures Hydrologiques en Temps Rèel et Annonce des Crues des oueds tunisiens
TELECOM	Tunisia Telecom	Tunisie Télécom
TND	Tunisian Dinar	Dinars tunisiens
TOR	Terms of Reference	Termes de Référence
USCS	Unified Soil Classification System	Système unifié de classification des sols
VAT	Value Added Tax	Taxe sur la valeur ajoutée
WFDEI	WATCH Forcing Data methodology applied to ERA-Interim data	méthodologie WATCH Forcing Data appliquée aux données ERA-Interim
ZICO	Important Bird Area	Zone Importante pour la Conservation des Oiseaux

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CHAPTER 16 BRIDGE

16.1 Outline

In this chapter, the indispensable countermeasures for targeted 11 existing bridges in target basin "D1 Zone" are developed based on the river improvement plan on Chapter 11 and results of data collection survey and visual inspection. In addition, the plan for new bridges to be constructed in connection with the shortcut channels planned as part of the river improvement plan is described.

In this survey, the planned river cross-sectional based on the 10-year probability of design discharge in Chapter 9 was applied to the target 11 existing bridges shown in Figure 16-1, and the presence of obstruction to the river flow was confirmed. In consequence, based on the historical value and the soundness of the bridges, this survey suggested that the countermeasures shown in Table 16-1 are implemented in two road bridges and two aqueducts. These bridges are old, deteriorated, damaged and are coming to the end of their useful life. In addition, it is difficult to assess the structural stability of the bridge itself against the effects of live loads and flooding, as there are no existing drawings or design documents. In the preparatory survey for the D2 Zone in previous years, the extension of existing bridges and the raising of girders were considered as countermeasures. However, these countermeasures were not considered in this study, based on the experience that the managing authority of each bridge instructed to review the policy at the detailed design phase.

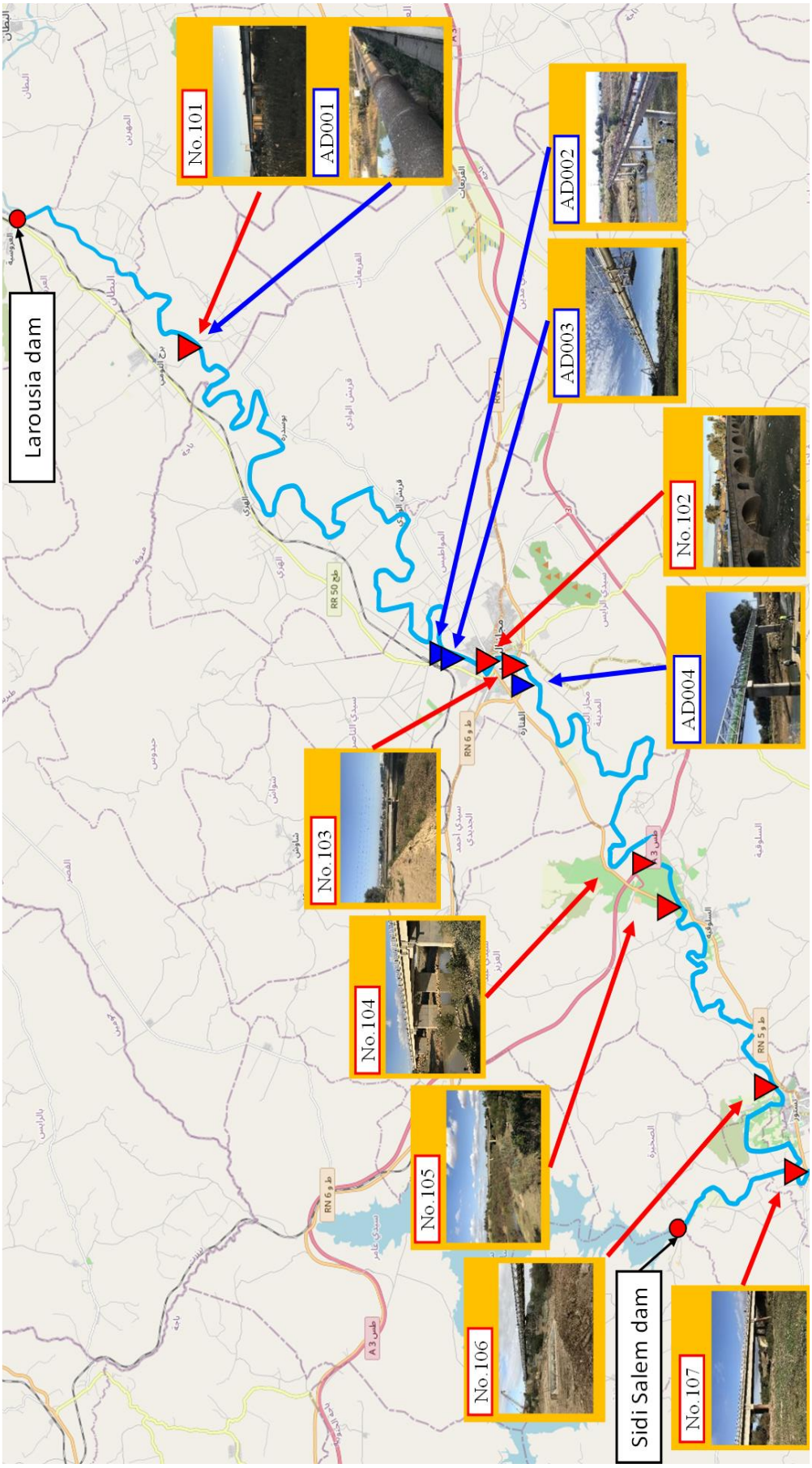
Table 16-1 Bridges in Need of Improvement and their Details

Bridge ID	Bridge Name	Use	Route Name (Function)	River		Countermeasure
				Name	Distance (km)	
No.101	Unknown	Road Bridge	RL531	Medjerda	74.933	Reconstruction to 170m concrete bridge with 5 spans (Not applicable to this project as MOE is already planned)
No.102	P. Andarrous Bridge	Road Bridge	RN5	Medjerda	109.051	No measure for the existing bridge, and Mejez Diversion Channel (Tunnel) is newly constructed under the existing road on the right bank side to compensate for the lack of design discharge.
AD001	Unknown	Aqueduct	(Water supply)	Medjerda	74.933	Reconstruction to 150m steel truss bridge with 5 spans
AD002	Unknown	Aqueduct	(Irrigation)	Medjerda	107.013	Reconstruction to 90m steel truss bridge with 3 spans

Source: JICA Study Team

Four shortcut channels are planned between El Heri and Mejez el Bab in order to stabilize the channel alignment by straightening and to control sedimentation. They will intersect with existing roads at seven locations. All of the intersecting roads are agricultural roads with low traffic volume and used by local residents. Bridges will be newly constructed on all the roads to secure the current functions, but from the viewpoint of the importance of the roads and cost reduction, the type is submergible bridge to allow temporary closure during floods. The structure type of the submergible bridge is multiple box culvert, based on the experience of its use in Tunisia and in the D2 Zone.

The details of the study results are described below. In addition, the design criteria for road bridge and aqueduct is outlined.



Source: JICA Study Team

Figure 16-1 Location of Target Bridge

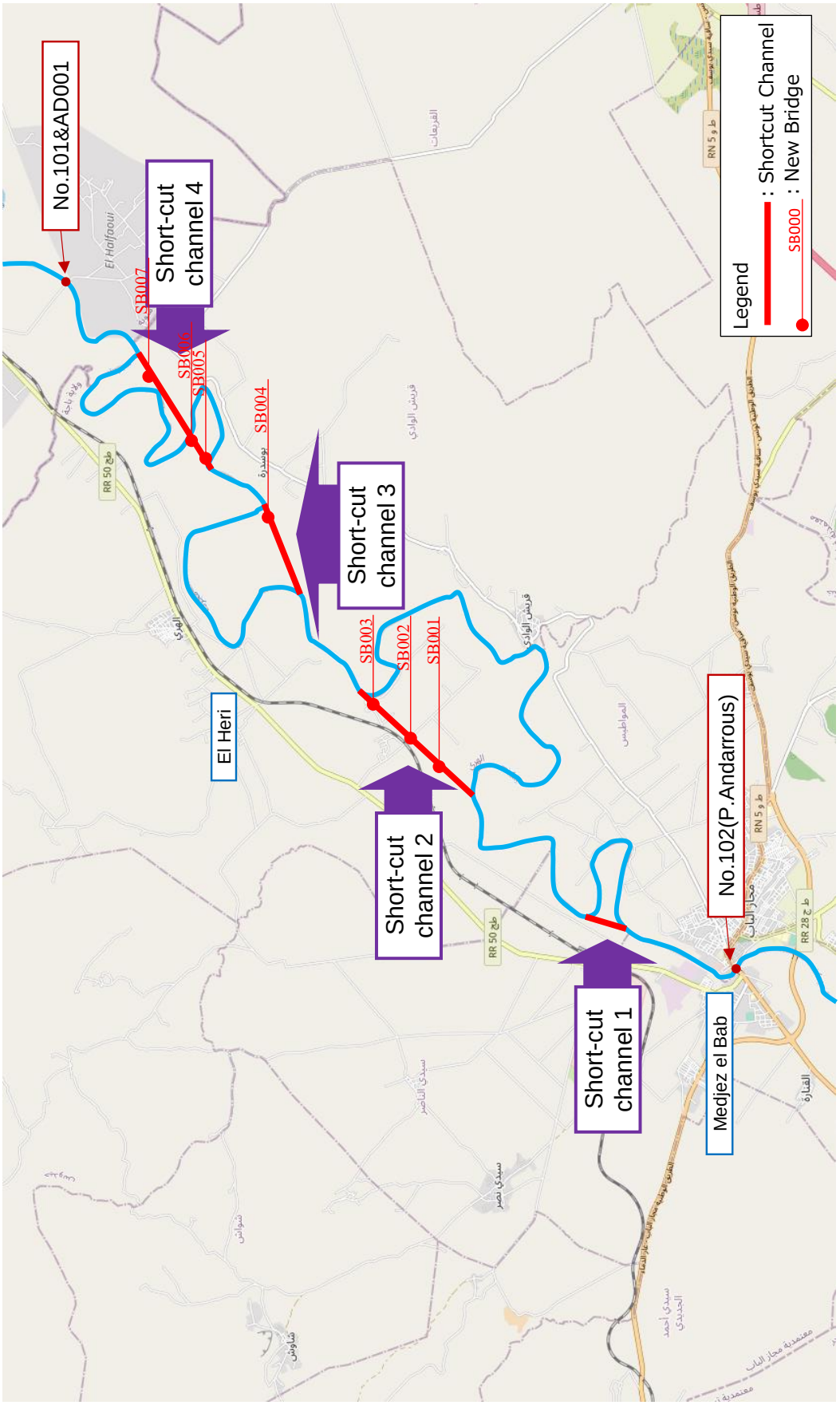


Figure 16-2 Location of Shortcut Channels and New Bridges

Source: JICA Study Team

16.2 Condition of Existing Bridges

16.2.1 Existing Bridges in Target Basin

(1) List of Existing Bridge

There are 11 bridges (7 road bridges and 4 aqueducts) in D1 Zone, as shown in Table 16-2.

Table 16-2 Existing Bridges in D1 Zone

Bridge ID	Coordinate Latitude / Longitude (deg)	Bridge type	Route Name (Function)	River		Length (m)	Width (m)
				Name	Distance (km)		
No.101	36.74296 / 9.72646	Road	RL531*	Medjerda	74.933	158	4.7
No.102	36.64902 / 9.60629	Road	RN5*	Medjerda	109.051	100	8.2
No.103	36.64055 / 9.60876	Road	RN5	Medjerda	110.121	115	8.0
No.104	36.59681 / 9.53961	Road	A3*	Medjerda	126.695	150	13
No.105	36.58938 / 9.51952	Road	RN5	Medjerda	128.900	135	7.4
No.106	36.55752 / 9.45012	Road	RR131*	Medjerda	139.877	115.5	7.6
No.107	36.54781 / 9.41845	Road	RN5	Siliana	1.200	105	7.2
AD001	36.74296 / 9.72646	Aqueduct	Water supply	Medjerda	74.933	158	4.7
AD002	36.66389 / 9.61268	Aqueduct	Irrigation	Medjerda	107.013	60	1.6
AD003	36.65894 / 9.61024	Aqueduct	Water supply	Medjerda	108.209	60	1.5
AD004	36.63631 / 9.60223	Aqueduct	Irrigation	Medjerda	110.922	90	2.5

** A: Highway, RN: National road, RR: Regional road, RL: Local road*

Source: JICA Study Team

(2) Bridge Management Authority

The target bridges are managed by authorities shown in Table 16-3.

Table 16-3 Management Authorities of Target Bridges

Authority Name	Bridge type	Target bridge
DGPC*1	Road bridge (RN・RR・RL)	No.101, No.103, No.105, No.106, No.107
TUNISIE AUTOROUTES	Highway	No.104
CRDA*2	Aqueduct for agriculture	AD002, AD004
SONEDE*3	Aqueduct for water supply	AD001, AD003
INP*4	Historic bridge	No.102

**1 : Directeur Général des Ponts et Chaussées*

**2 : Commissariat Régional de Développement Agricole*

**3 : Société Nationale d'Exploitation et de Distribution des Eaux*

**4 : Institut National du Patrimoine*

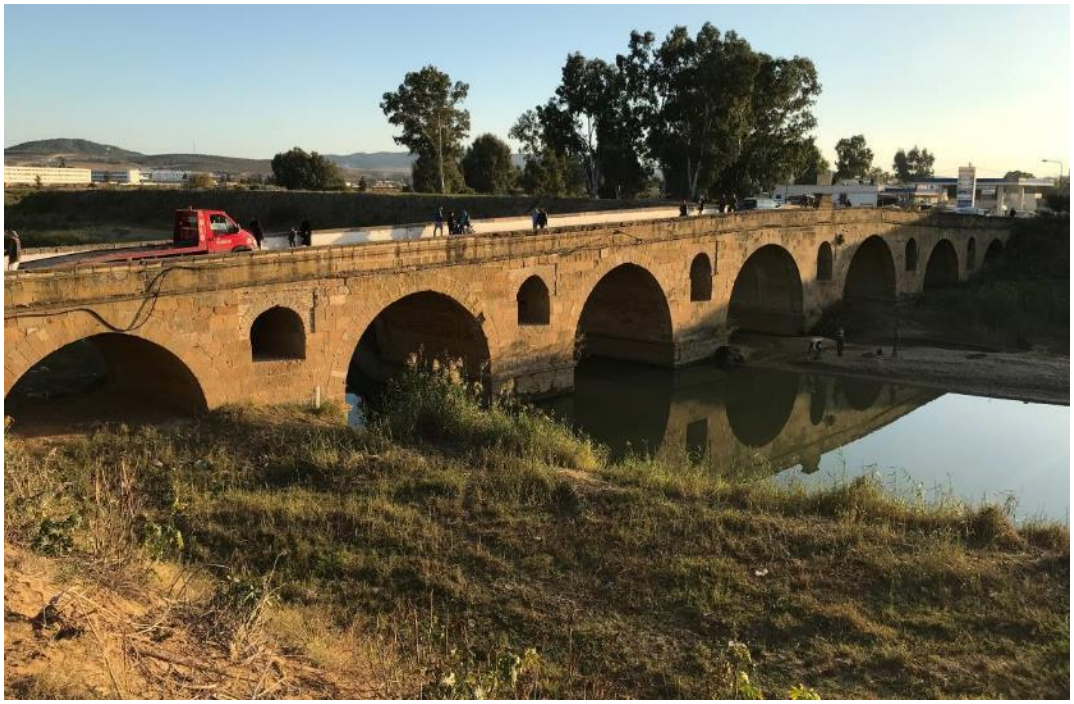
Source: JICA Study Team

(3) Cultural Heritage Designation System

There is designation system of cultural heritage in Tunisia. In D1 area, P. Andalous Bridge, located in Mejez El Bab, has been registered (refer Appendix "Bridge" and Figure 16-3).

The purposes of this system are to regulate the construction around the designated heritage, to protect its historic value and to inform the general public. The classification has been determined by the low for cultural heritage (34-94) in Tunisia since 24 February 1994. Construction around the heritage is determined in Chapter 2 "About protection". Its details are shown as below.

- Article 9: Construction within the boundary of cultural site requires permission in advance
- Article 10: (…) Deadline for Response to permission application is two months.
- Article 12: All construction work requires chemical technology verification by authorized department of Ministry of Culture and Heritage Conservation.



Source: JICA Study Team

Figure 16-3 P. Andalous Bridge

16.2.2 Bridge Survey

(1) Data Collection Survey

The drawings and relevant information about target bridges were collected. The status of the collection is shown in Table 16-4. Some of collected drawings are shown in this chapter, though all collections can be seen in Appendix. However, it was found that some drawings of historic bridges and old bridges have been disappeared.

Table 16-4 Status of Data Collection

Bridge ID	Collected information	Existing drawing
No.101	Replacement plan	Design drawing
No.102	Designated Cultural Heritage	Disappeared
No.103		Disappeared
No.104		General View
No.105		Disappeared
No.106	Under construction Installment plan of underground pipeline on upstream	As build drawing
No.107		Disappeared
AD001		Longitudinal profile of pipe
AD002	Not in service due to aging	Longitudinal profile of pipe
AD003		Longitudinal profile of pipe
AD004	Constructed in 2018	As build drawing

Source: JICA Study Team

(2) Bridge Attachment and Surrounding Underground Pipe

The collection of relevant information such as attached pipes and surrounding underground pipes of the target bridges was carried out. The status of the collection of drawings is shown in Table 16-5. The gas pipeline laying plan obtained from STEG is shown in Figure 16-4.

Table 16-5 Summary of Information and Drawing Collection

Type of utility	Company	Collected information	Collected drawing
Sanitation	ONAS*1	● No pipe attached on target bridges	---
Hydrocarbon	SOTRAPIL*2	Ditto	---
Electricity	STEG*3	Ditto	---
Telecom	TELECOM*4	Ditto	---
Gas	STEG*3	● No pipe attached on target bridges ● There is a plan to bury a gas pipe across the Medjerda River near Road Bridge No. 103.	Plan for laying underground gas pipeline

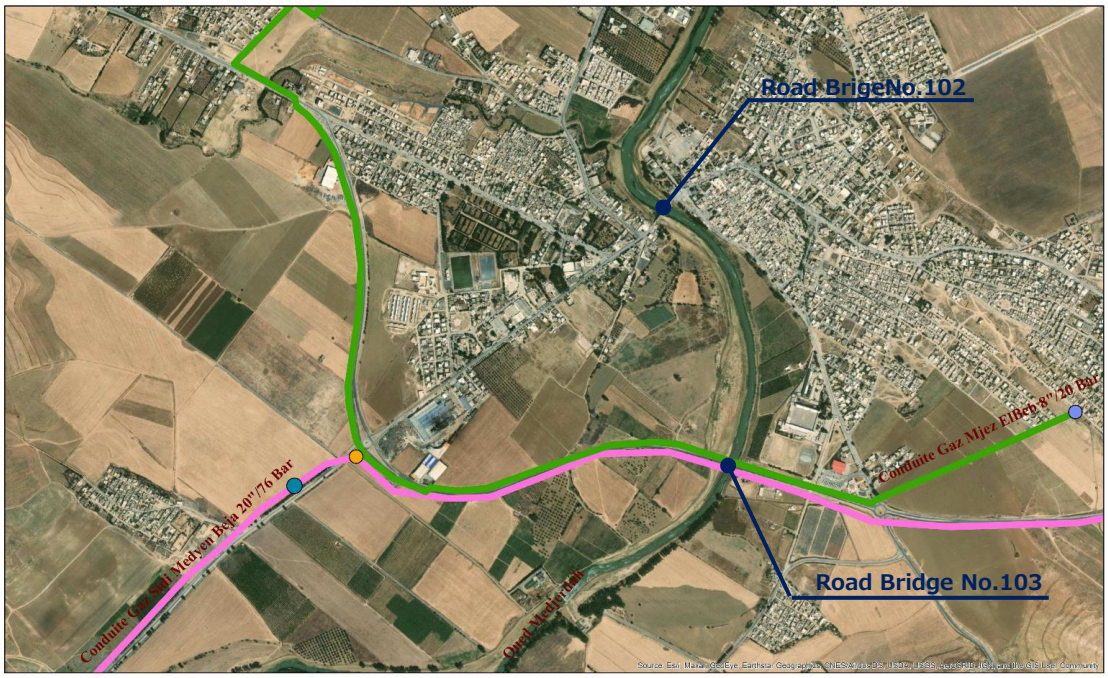
*1：L'Office national de l'assainissement

*2：Société de Transport d'Hydrocarbure par Pipe-Line

*3：La Société tunisienne de l'électricité et du gaz

*4：Tunisie Télécom

Source: JICA Study Team



Source: Additions to materials received from STEG

Figure 16-4 Plan for Laying Underground Gas Pipeline

(3) Visual Inspection

The soundness of targeted 11 existing bridges were evaluated through the visual inspection. The result of the inspection is summarized in Table 16-6. The inspection sheets can be seen in Appendix.

Table 16-6 Soundness Evaluation of Existing Bridges

Bridge ID	Bridge type	Soundness	Damage Status
No.101	RC I-girder	Severely damaged*	・ Serious surface cracking ・ Serious concrete degradation ・ Efflorescence on surface
No.102	Masonry	Damaged*	・ Stone spalling ・ Surface cracking
No.103	PC girder	Sound*	・ No remarkable damage
No.104	PC girder	Damaged*	・ Damage on road surface and expansion device
No.105	PC girder	Damaged*	・ Deterioration on deck and substructure
No.106	PC girder		・ Under Construction
No.107	PC girder	Sound*	・ No remarkable damage on bridge structure
AD001	RC U-girder	Severely damaged*	・ Serious surface cracking ・ Leakage
AD002	Steel girder	Severely damaged*	・ Rusty slab ・ Bridge rail damaged by flood
AD003	Cable Stayed	Damaged*	・ Surface cracking on substructure ・ Deterioration on superstructure ・ Sag of pipeline (central part)
AD004	Steel truss	Sound*	・ No remarkable damage

******Sound**: no remarkable damage, **Damaged:** repairable damage, Severely damaged: unrepairable damage*

Source: JICA Study Team

16.2.3 Evaluation of Hydraulics Characteristics

The effect of target bridges on the flood flow was evaluated on the planned cross section and High Water Level (H.W.L) of the river channel determined based on hydraulic analysis. The evaluation points are shown below, which are same as applied in D2 Zone. There are further points to evaluate in Japan, such as impediment ratio of river flow and the regulation related to the span arrangement of the bridge, however, they are not referred to in similar regulation in Tunisia.

- Evaluation point

  Evaluation-1: Bridge length satisfies planned width of river

  Evaluation-2: Elevation of girder bottom exceeds H.W.L
- Evaluation procedure

  The bridge satisfies neither evaluation-1 nor -2: NG (Need countermeasure)

  The bridge satisfies either evaluation-1 or -2: NG (Need countermeasure)

  The bridge satisfies both evaluation-1 and -2: OK (If the existing bridge is sound or has repairable damage, no countermeasures are needed.)

The judgment results are shown in Table 16-7 through

Table 16-12. In the current river cross section, four bridges, No.102, AD002, AD003 and AD004, are obstructive to flood flow. After the river improvement described below, all the results are satisfactory. However, countermeasures to reduce the design discharge has implemented for No. 102. Since the Siliana River, a tributary of the Medjerda River, is outside the scope of this project, the hydraulic characterization of No. 107 will not be carried out.

Table 16-7 Result of Hydraulic Evaluation1 (Current River Cross Section)

Bridge ID	Evaluation -1*			
	Bridge length (m)	Comparison	River width (H.W.L position) (m)	Judgement
No.101	158	>	157.8	OK
No.102	100	-	N/A	OK
No.103	115	<	122.2	NG
No.104	150	>	105.8	OK
No.105	135	>	121.0	OK
No.106	115.5	>	103.1	OK
No.107	105			
AD001	158	>	157.8	OK
AD002	60	**N/A**	**N/A**	**NG**
AD003	78	**N/A**	**N/A**	**NG**
AD004	90	**N/A**	**N/A**	**NG**

**1: River width and design high water level are based on the analysis results for the current cross section.*
**2: N/A means that the water level exceeds the inland elevation and the river width cannot be calculated.*
Source: JICA Study Team

Table 16-8 Result of Hydraulic Evaluation2 (Current River Cross Section)

Bridge ID	Evaluation -2*			
	Elevation of girder bottom (m)	Comparison	Designed H.W.L (m)	Judgement
No.101	43.85	>	42.7	OK
No.102	51.73	<	**54.8**	**NG**
No.103	54.10	<	**54.9**	**NG**
No.104	66.68	>	61.0	OK
No.105	65.80	>	61.7	OK
No.106	69.91	>	66.9	OK
No.107				
AD001	43.85		42.7	OK
AD002	50.73	<	**54.4**	**NG**
AD003	53.92	<	**54.6**	**NG**
AD004	56.89	>	55.1	OK

Table 16-9 Result of Hydraulic Comprehensive Evaluation (Current River Cross Section)

Bridge ID	River		Evaluation 1	Evaluation 2	Judgement
	Name	Distance (km)			
No.101	Medjerda	74.933	OK	OK	OK
No.102	Medjerda	109.051	OK	NG	**NG**
No.103	Medjerda	110.121	NG	NG	**NG**
No.104	Medjerda	126.695	OK	OK	OK
No.105	Medjerda	128.900	OK	OK	OK
No.106	Medjerda	139.877	OK	OK	OK
No.107	Siliana	1.200			
AD001	Medjerda	74.933	OK	OK	OK
AD002	Medjerda	107.013	NG	OK	**NG**
AD003	Medjerda	108.209	NG	NG	**NG**
AD004	Medjerda	110.922	NG	NG	**NG**

Table 16-10 Result of Hydraulic Evaluation1 (After Countermeasures)

Bridge ID	Evaluation -1*			
	Bridge length (m)	Comparison	River width (H.W.L position) (m)	Judgement
No.101	158	>	86.9	OK
No.102	100	>	**96.1**	OK
No.103	115	>	**84.5**	OK
No.104	150	>	99.5	OK
No.105	135	>	100.7	OK
No.106	115.5	>	98.0	OK
No.107	105			
AD001	158	>	86.9	OK
AD002	60	≒	**60.3**	OK
AD003	78	>	**69.1**	OK
AD004	90	=	**90.0**	OK

Table 16-11 Result of Hydraulic Evaluation2 (After Countermeasures)

Bridge ID	Evaluation -2*			
	Elevation of girder bottom (m)	Comparison	Designed H.W.L (m)	Judgement
No.101	43.85	>	40.25	OK
No.102	51.73	>	**50.30**	OK
No.103	54.10	>	**51.40**	OK
No.104	66.68	>	59.41	OK
No.105	65.80	>	60.13	OK
No.106	69.91		65.38	OK
No.107				
AD001	43.85	>	40.25	OK
AD002	50.73	>	**49.52**	OK
AD003	53.92	>	**49.85**	OK
AD004	56.89	>	**52.48**	OK

Table 16-12 Result of Hydraulic Comprehensive Evaluation (After Countermeasures)

Bridge ID	River		Evaluation 1	Evaluation 2	Judgement
	Name	Distance (km)			
No.101	Medjerda	74.933	OK	OK	OK
No.102	Medjerda	109.051	OK	OK	OK*1
No.103	Medjerda	110.121	OK	OK	OK*3
No.104	Medjerda	126.695	OK	OK	OK
No.105	Medjerda	128.900	OK	OK	OK
No.106	Medjerda	139.877	OK	OK	OK
No.107	Siliana	1.200			
AD001	Medjerda	74.933	OK		OK
AD002	Medjerda	107.013	OK	OK	OK*2
AD003	Medjerda	108.209	OK	OK	OK*2
AD004	Medjerda	110.922	OK	OK	OK*2

**1: Countermeasures to reduce the design discharge has implemented*
**2: River channel excavation has carried out.*
**3: Design H.W.L can be lowered by the measures in No.102*
Source: JICA Study Team

16.2.4 Judgement of Necessity of Countermeasure on Existing Bridges

The results as mentioned 16.2.2 and 16.2.3 indicate that two road bridges and two aqueducts require countermeasures (Refer to Table 16-13). However, with regards to No. 102 "P. Andalous Bridge" the measure is considered separately from others because repairing directly is restricted by the heritage designation policy.

The design flow in No. 102 is considered as below. (The detail is described in Section 11.5)

1) In the vicinity of bridges No.102 to No.103, the current flow capacity was increased from 400m3/s to 600m3/s by the river improvement of the D1 zone with channel widening, riverbed excavation, shortcuts, etc., and as result the water level in case of design discharge was reduced compared to the level before the improvement.

2) In addition, the installation of a bypass tunnel, dropouts, and revetments to protect Bridge No. 102 Historic Bridge has reduced the design discharge through Bridge No. 102 from the current 600 m3/s to 400 m3/s. As a result, the water level near bridges No.102 and 103 have also decreased.

Table 16-13 Judgement of Necessity of Measure

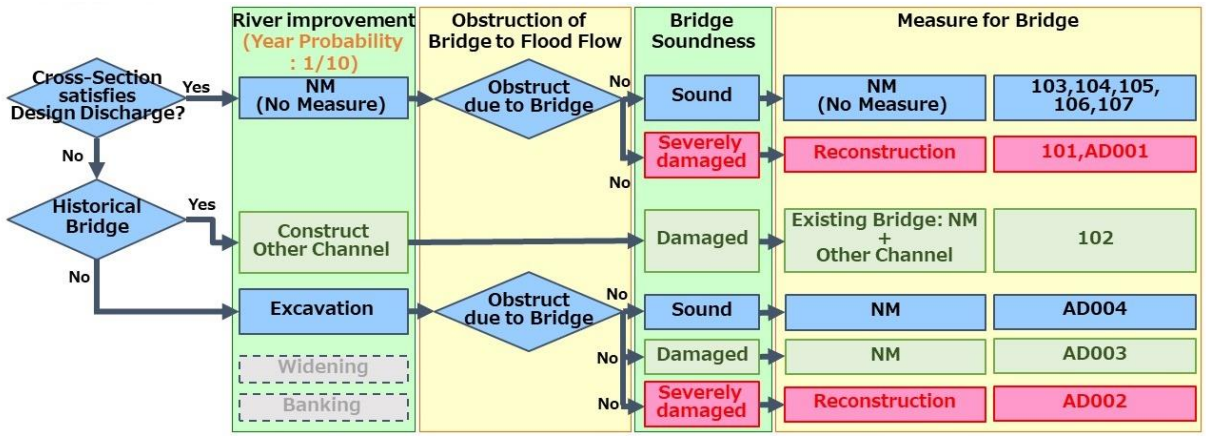
Bridge ID	Type	River		Soundness of Bridge Structure	Hydraulic Evaluation	Need for Bridge Countermeasure
		Name	Distance (km)			
No.101	Road	Medjerda	74.933	Severely damaged		Countermeasure Required (Out of scope for this project as MOE is already planned for replacement.)
No.102*1	Road	Medjerda	109.051	Damaged	OK with separate measures	Countermeasure Required*2
No.103	Road	Medjerda	110.121	Sound		
No.104	Road	Medjerda	126.695	Damaged		
No.105	Road	Medjerda	128.900	Damaged		
No.106	Road	Medjerda	139.877			
No.107	Road	Siliana	1.200	Sound		
AD001	Aqueduct	Medjerda	74.933	Severely damaged		Countermeasure Required
AD002	Aqueduct	Medjerda	107.013	Severely damaged		Countermeasure Required
AD003	Aqueduct	Medjerda	108.209	Damaged		
AD004	Aqueduct	Medjerda	110.922	Sound		

*1: Historical Bridge
*2: It is difficult to reconstruct the bridge itself due to its historical nature, therefore other measures are required.
Source: JICA Study Team

16.3 Bridge Countermeasure Policy

16.3.1 Judgement of Required Countermeasure

Selection flowchart to determine the countermeasure was developed based on river analysis, river improvement plan and the results of field survey. The extension and raising the elevation of girder were requested not to apply as the countermeasure due to the concerns about structural safety of targeted bridges lacking existing drawings and the quality control by local construction company as a results of the discussion with MOE on the detail design phase of D2 Zone. Bridge countermeasure in D1 Zone basically applies the replacement as well as D2 Zone.



Source: JICA Study Team

Figure 16-5 Selection Flowchart for Determination of Bridge Repair Policy

The bridges which require the countermeasures according to the flowchart are shown in Table 16-14.

Table 16-14 List and Repair Policy of the Target Bridges Requiring the Measure

Bridge ID	Use	Bridge Soundness	Countermeasure
No.101	Road bridge	Severely damaged	Out of scope for this project as MOE is already planned for replacement.
No.102	Road bridge	Damaged	No measure for the historical bridge, and another channel is newly constructed to compensate for the lack of design discharge.
AD001	Aqueduct	Severely damaged	Reconstruction due to bridge damage
AD002	Aqueduct	Severely damaged	Reconstruction due to bridge damage

Source: JICA Study Team

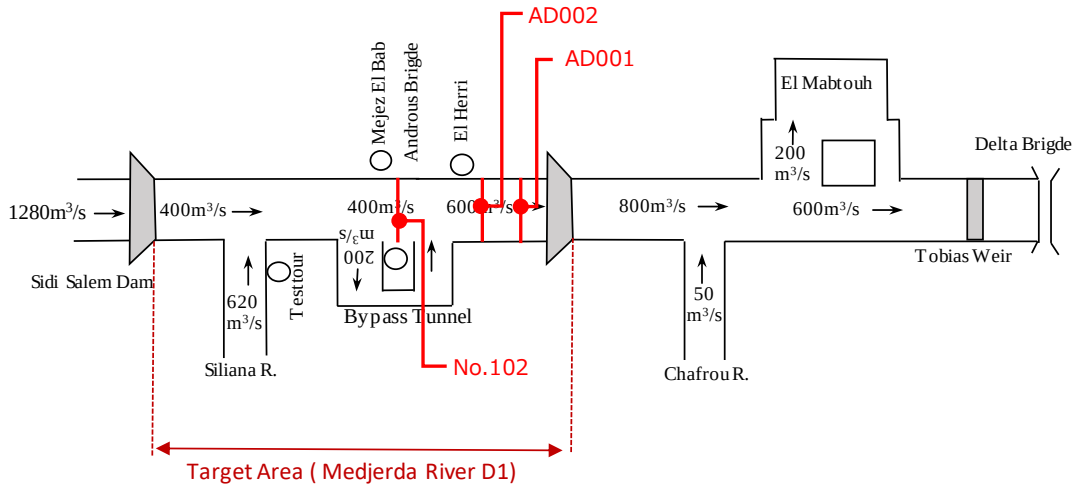
(1) Overview

The strategy of bridge repair methods is outlined in Table 16-15.

Table 16-15 Summary of Countermeasure for Existing Bridges

Item	Details
Targeted Zone	● D1 zone (From Larousia Dam to Sidi Salem Dam) ● Section Length: Approximately 83km
Design Discharge	● Q=600m^3/sec ● Return Period: 10 years
Improvement method of river	● Excavation of river channel
Purpose of bridge repair	● Assuring safety of user regarding damage of existing bridge ● Assuring discharge capacity of the Medjerda river at the location of bridge
Improved target bridge	● No. 102, P. Andarrous Bridge (Historical Bridge) ● AD001, Aqueduct (for water supply) ● AD002, Aqueduct (for agriculture)

Source: JICA Study Team



Source: JICA Study Team

Figure 16-6 Overview of Planned River and Location of the Bridge

16.3.2 Road Bridge No. 101 and Aqueduct AD001

(1) Outline

Road Bridge No. 101 is the bridge located on local road RL531 near the Pref. boundary between Manouba and Beja. This road has two lane used for bus line and relatively less traffic. However, the bridge has only one lane and its road width is about 3.1m. Therefore, bridge section creates traffic bottleneck since cars on the both side of the bridge are not able to pass each other on the bridge (refer to Figure 16-7).

Road Bridge No.101 and Aqueduct AD001 are adjoining. The both bridges are made of concrete and have 7 spans, and its lengths are both 170m. They have separated independent superstructure and piers, while its foundations are unseparated. As the results of field survey, the both bridges have been severely deteriorating. No. 101 has many bumps on its road surface and cracks on the side surface of its girder. Also, the cracks in direction of bridge axis on the surface of its undersurface were detected, which indicates that the bridge perhaps lacks the load bearing capacity against live loads. The survey also detected the cracks and white deposits due to water leakage in the AD001. Thus, it is necessary to replace them early because of the problem on the structure and the service.

MOE managing No. 101 have been proceeding with replacement plan of the bridge, while SONEDE managing AD001 haven't developed the replacement plan. Therefore, replacement of AD001 is planned in this project, whereas replacement of No.101 is out of scope of this project.

Source: JICA Study Team

Figure 16-7 Appearances of No.001 & AD001 and its Deterioration

(2) Replacement Plan of Road Bridge No. 101

Design note shows general view of No.101 for replacement planned by MOE. The new bridge will be constructed about 70 m upstream from the existing bridge. The bridge length and span arrangement on the drawing were determined based on design discharge 3500m^3/s (unknown return period) which exceeds design discharge 600 m^3/s based on 10-years return period developed in this project. Because the land use around the bridges is agricultural land and no restriction on the decision of bridge type, I-Shaped PC Girder (5x33.5m), which is standard type in Tunisia, has been applied in view of financial efficiency. A pile foundation has been applied. This is appropriate since depth of bearing layer is GL-15m according to the borehole log, BP-6 according to the geological survey in this feasibility survey written in previous chapter. Refer to Appendix for details on bridge specifications.

< Main Specification of New Bridge>

- Length (Span arrangement): 167.3m(33.4m+3x33.5m+33.4m)
- Superstructure Type: PC-I Girder
- Substructure Type: Reinforced Concrete
- Foundation Type: Pile Foundation

(3) Replacement Plan of Aqueduct AD001

The general view of replacement is shown in Appendix. The bridge was planned as a separate bridge from the road bridge No.101 after the replacement because of the different management authority. The location of the new bridge was downstream side of the existing bridge to minimize the pipe relocation, and to allow enough space for construction. The bridge type is a steel truss bridge of the same type as Aqueduct AD004, which was recently constructed with the support of JICA. The specifications are shown below. Refer to Appendix for details on bridge specifications.

< Main Specification of New Bridge>

- Length (Span arrangement): 150.0m (5x30.0m)
- Superstructure Type: Steel Truss
- Substructure Type: Reinforced Concrete
- Foundation Type: Pile Foundation

16.3.3 Countermeasures for Road Bridge No.102 (Historic Bridge)

The countermeasure for Road Bridge No. 102 is the diversion channel (tunnel) written in previous chapter.

16.3.4 Aqueduct AD002

(1) Outline

This aqueduct is for agriculture constructed in 1950s and not in service (refer to Figure 16-8). Although there is corridor on the bridge for maintenance and passing, there are very few pedestrians since the surrounding area is not a residential area. The ground mainly consists of cohesive soil. There is embankment around the bridge which seems to be constructed recently. The revetment was not observed around the bridge.

This aqueduct structure consists of steel H-shaped beams and wood slab, and its length is 60m with 7 spans. Its substructure applies single RC pole and beam seat made of shape steel is installed at the top to support the main girder. Aged deterioration has been detected such as rusting on the surface of superstructure and destruction of part of wood slab.

The pipeline is located at lower height than surrounding embankment and the bridge handrail is severely deformed possibly due to flood. This is obvious that this aqueduct will interfere with flood flow. On the other hand, the management agency is planning to resume the use of this aqueduct. Therefore, this aqueduct is planned to be replaced instead of removal in this study.

Figure 16-8 Appearance of AD002

(2) Bridge replacement plan

General View of replacement is shown in Design note. The location of the bridge was chosen in consideration of the land use in the surrounding area, upstream of the existing bridge where there is no need to land acquisition and where there is enough space for construction. The bridge type is a steel truss bridge of the same type as AD004, which was recently constructed with the support of JICA. The specifications are shown below. Refer to Appendix for details on bridge specifications.

<Bridge specifications>

Bridge length (span arrangement): 90.0m (3x30.0m)

Type of superstructure: Steel truss bridge

Type of Substructure and Foundation: RC Piers and Pile Foundation

16.4 Planning of New Bridges over the Shortcut Channels

16.4.1 Current Condition of the Existing Roads Intersecting the Planned Shortcut Channels

As mentioned above, four shortcut channels are planned to be constructed in the meandering area between El Heri and Mejez el Bab in order to stabilise the channel alignment by straightening it and to control sedimentation. Therefore, new bridges are planned to be constructed at seven locations where the shortcut channels intersect the existing roads to secure traffic functions. The location of new bridges and the specifications of the existing roads are shown in Figure 16-2, Table 16-16 and Figure 16-9. Refer to Appendix for details on bridge specifications.

Table 16-16 Location of New Bridges and Specifications of Existing Roads

Shortcut Channel	Bridge ID	Coordinates (Latitude, Longitude)	Road classification	Road Width (m)
Shortcut 2	SB001	36.68993,9.64358	Farm Road	6.2
	SB002	36.69402,9.64755	Ditto	6.0
	SB003	36.69982,9.65348	Ditto	4.5
Shortcut 3	SB004	36.71163,9.67396	Ditto	5.0
	SB005	36.71293,9.67946	Ditto	3.5
	SB006	36.71491,9.68715	Ditto	6.0
Shortcut 4	SB007	36.73118,9.71059	Ditto	4.0

Source: JICA Study Team

Source: JICA Study Team

Figure 16-9 Current Status of Existing Road Intersecting the Planned Shortcut Channels

16.4.2 Bridge Plan

(1) Outline

The summary of the proposed bridges planned for this study is shown in Table 16-17.

Table 16-17 Summary of Proposed Bridges

Item	Details
Targeted Channel	● Shortcut Channel 2,3 and 4
Design Discharge	● Q=600m^3/sec (10-years return period)
Purpose of New Bridge Construction	● Securing the function of existing roads for the installation of shortcut channels
Number of Bridges	● 7 Bridges
Type of Bridge	● Multiple box culvert type submersible bridge

Source: JICA Study Team

(2) Bridge Type

The existing roads where the seven new bridges are planned are all farm roads with no residential areas in the vicinity, and their users are limited to farmers along the roads. Therefore, in consideration of the importance of the route and the frequency of use, a submerged bridge, which allows temporary closure of the road during floods, is applied in order to reduce costs. As a result, the length of the new bridge is approx. 20m over the major bed, which can significantly reduce the size of the bridge from approx. 45m over the entire channel. The submersible bridge is planned to be constructed as a multiple box culvert, which has been applied in the D2 Zone.

(3) Bridge Plan

The general view is shown in Design note. The width of the bridge is planned to be 5 m, which is equivalent to the current road width. The length of the bridge is planned to be long enough to span the major bed to allow for temporary closure during floods.

Appendix summarizes the summary of the bridge construction profile and basic condition to design the proposed bridges.

CHAPTER 17 NON-STRUCTURAL MEASURE

Non-public

CHAPTER 18 CONSIDERATION OF COMPREHENSIVE WATERSHED SEDIMENT MANAGEMENT PLAN

18.1 Overview

Sediment dynamics in the Medjerda River Basin are affected over a wide area, from the upper reaches, each dam area, the river, and the estuary/coastal area. Thus, for-wide runoff watershed sediment management, it is necessary to implement comprehensive watershed sediment management for the entire basin from the headwaters to the coast through prevention of disasters caused by sediment transport, appropriate development and management of rivers and dams, and basin conservation measures, taking into account the characteristics of each area.

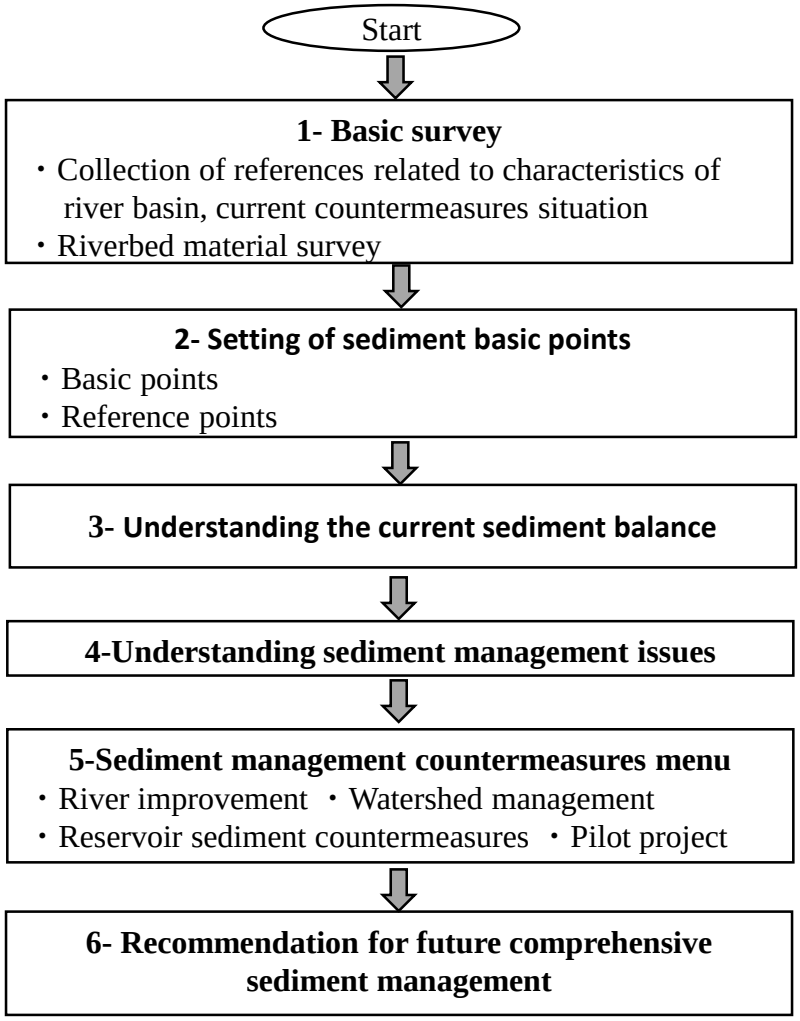
The Ministry of Agriculture has been implementing forestation and agricultural land conservation measures through the national budget and donor funds. In particular, the Directorate General of Forests of the Ministry of Agriculture has been implementing afforestation and community development projects (comprehensive afforestation projects) in four areas in northwestern Tunisia with Japanese yen loans since 2008. They include the forest establishment, biodiversity conservation, and activities to improve the living environment of local residents, and has been promoting afforestation in designated forest areas.

This chapter summarizes the characteristics of each area in the Medjerda River Basin and issues related to comprehensive watershed sediment management, and examines the following items to clarify the need for a future management plan.

- ✓Consideration of watershed sediment balance
- ✓Current status and issue about watershed sediment production
- ✓Current status of watershed Sediment conservation by Tunisian government
- ✓Proposal for the comprehensive watershed sediment management plan
- ✓Case consideration of the watershed sediment conservation countermeasure
- ✓Proposal for the Pilot Project

The examination procedure for a comprehensive watershed sediment management plan is shown in Figure 18 1. This study is a case study in the initial phase of the project.

It will be reviewed based on the results of the pilot watershed to be implemented in this project.



Source: JICA Study Team

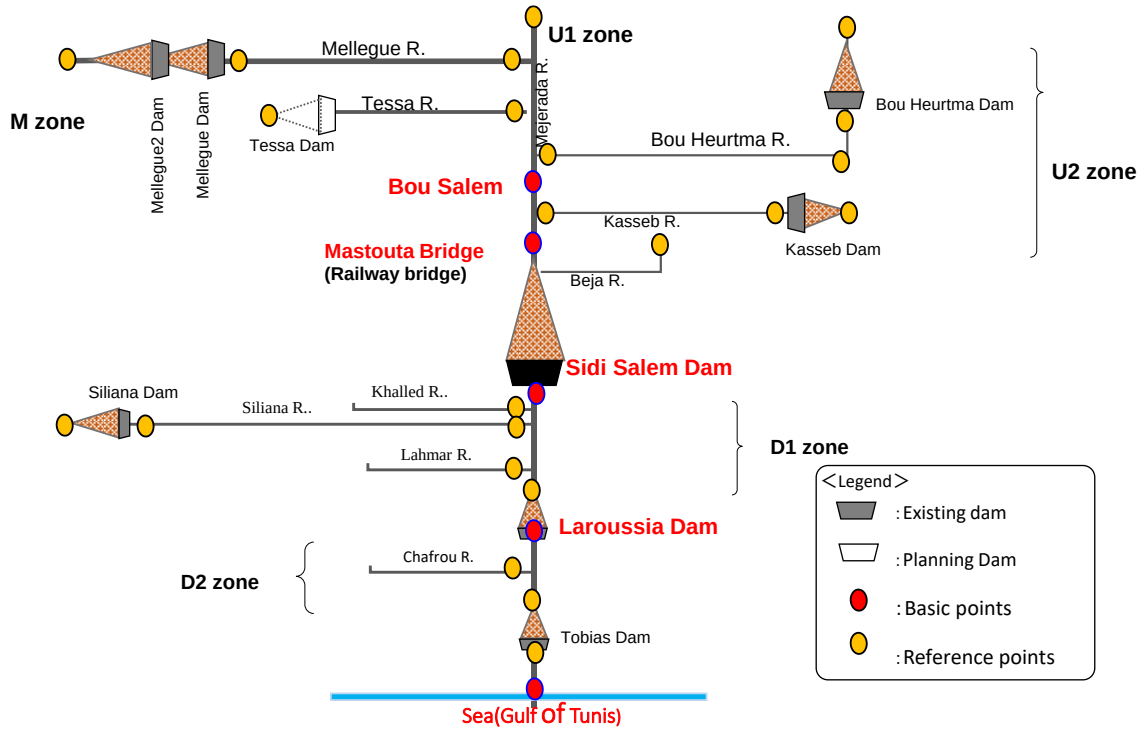
Figure 18-1 Examine for the comprehensive sediment sediment management

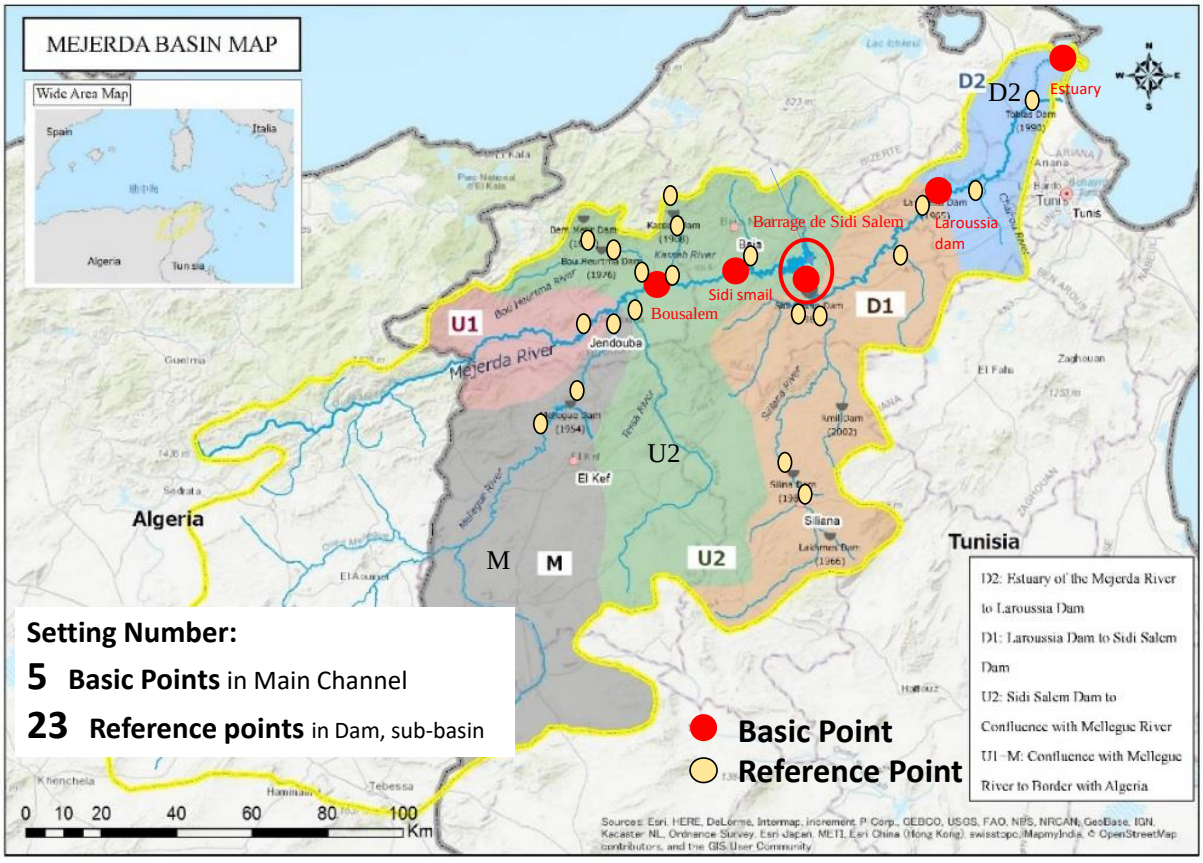
18.2 Study on Sediment Balance of River Basin

18.2.1 Calculation of Sediment Production

(1) Setting of Reference Points for Sediment Control

Medjerda River Basin is divided into U1, M, U2, D1 and D2 zones from the upstream side. The locations of sediment control reference points and basic points for the entire basin are shown in Figure 18-2. Two reference points were set at Bousalem town and Mastouta bridge in the U2 Zone, and three reference points were set at immediately downstream of Sidi Salem dam, Larrousia dam and estuary in the D1 and D2 Zones, taking into account the amount of sediment inflow at the dam sites, the status of river bed variations in the river channel, and future monitoring indicators. In addition, 23 locations at the confluence with existing dams and tributary rivers were used as basic points.





Source: JICA Study Team

Figure 18-2 Location Map of Reference Points for Sediment Control

(2) Estimation of Sediment Production Volume of River Basin by USLE

The USLE method, which is commonly used for predicting the amount of soil loss, was used to calculate the potential sediment production volume. This equation is an empirical formula for calculating the annual mean soil loss associated with agricultural land, and is a method for estimating the annual mean discharge per hectare using six factors. USLE equation is as follows,

A= R*K*LS*C*P

Where,

A: Estimated annual soil loss (tons/ha/year)

R: Rainfall and runoff factor

K: Soil erodibility factor

LS: Slope length-gradient factor

P: Support practice factor

C: crop/vegetation and management factor

Data on rainfall, topography, soil, land use, and conservation work distribution in the river basin were organized using GIS, and the parameters for each factor were selected to estimate the annual soil loss volume by river basin. The results of the selection of parameters for each factor and the calculation results are shown below.

Rainfall and Runoff Factor (R)

The rainfall and runoff factor (R) is calculated based on the rainfall observation data in the watershed. In this study, a commonly used formula was used as follows.

$R = 38.5+0.35*P$

P = Annual mean rainfall (mm/year)

Since the Medjerda River spans two countries, Tunisia and Algeria, rainfall data within Algeria was not available. Therefore, it was necessary to use the global rainfall erosion index data provided by the European Soil Data Centre (ESDAC).

The basin-wide rainfall and runoff factor (R) is high in the upstream and northwestern area of the Sidi Salem dam reservoir, as shown in Figure 18-3. Soil erosion due to rainfall is likely to be high in these areas.

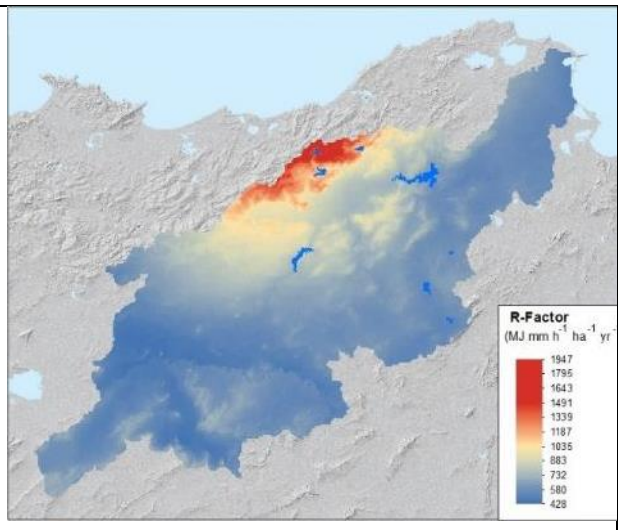


Figure 18-3 Distribution of Rainfall and Runoff Factor (R)

Soil Erodibility Factor (K)

Soil erodibility factor (K) are generally obtained by three methods: calculating from the measured values in the test field, estimating by means of a calculation chart, and determining from an estimation formula.

However, all of these methods require field data and the determination of factors is not easy. Therefore, in this study, the factors were calculated based on the estimating equation proposed by Williams (1995) and the FAO Soil data.

$K = f_{csand} * f_{cl\text{-}si} * f_{orgc} * f_{hisand}$

Where, (Williams Method)

f_{csand} : Coefficient representing the rate of coarse sand contained in the soil (sand content)

$f_{cl\text{-}si}$: Coefficient representing the rate of clay and fine-grained silt contained in the soil

f_{orgc} : Coefficient representing the amount of organic carbon contained in soil

f_{hisand} : Coefficient representing soils with extremely high sand content

Each factor is obtained from the following equation.

$$f_{csand} = \left(0.2 + 0.3 \cdot \exp\left[-0.256 \cdot m_s \cdot \left(1 - \frac{m_{silt}}{100}\right)\right]\right)$$

$$f_{cl-si} = \left(\frac{m_{silt}}{m_c + m_{silt}}\right)^{0.3}$$

$$f_{orgc} = \left(1 - \frac{0.0256 \cdot orgC}{orgC + \exp\left[3.72 - 2.95 \cdot orgC\right]}\right)$$

$$f_{hisand} = \left(1 - \frac{0.7 \cdot \left(1 - \frac{m_s}{100}\right)}{\left(1 - \frac{m_s}{100}\right) + \exp\left[-5.51 + 22.9 \cdot \left(1 - \frac{m_s}{100}\right)\right]}\right)$$

Where, m_s is the percent sand content (0.05-2.0 mm diameter particles),
m_{silt} is the percent silt content (0.002-0.05 mm diameter particles),
m_c is the percent clay content (<0.002mm diameter particles), and
$_{org}C$ is the percent organic carbon content of the layer (%).

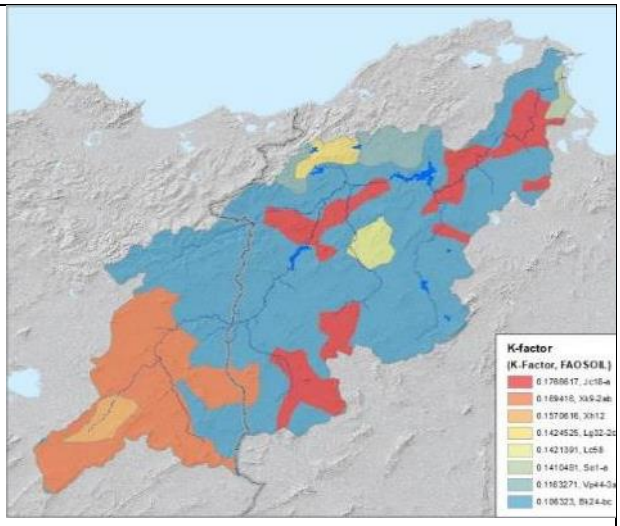


Figure 18-4 Distribution of Soil Erodibility Factor (K)

As shown in Figure 18-4, the soil erodibility factor (K) is higher in the southwestern area of the river basin, which is mainly located in Algeria, indicating that the soil erosion potential is higher in this area.

Slope Length-gradient Factor (LS)

Slope length-gradient factor is calculated as the product of the slope length factor L and the slope factor S. In this case, the slope length-gradient factor (LS) is calculated using DEM data and the following equation (Moore and Burch equation, 1986).

$LS = (Flow\ Accumulation * cell\ size / 22.13)^{0.4} * (sin\beta/0.0896)^{1.3}$

Flow Accumulation: Number of cells contributing in cells/pixel

β : Inclination angle (degrees)

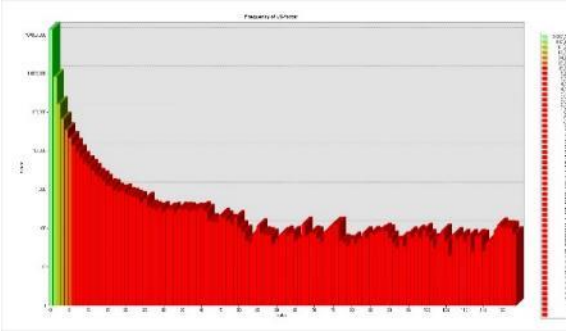


Figure 18-5 Distribution of Slope Length-gradient Factor (LS)

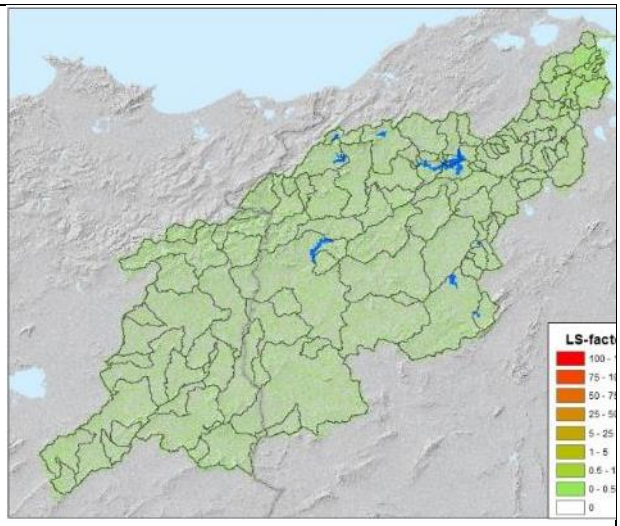


Figure 18-6 Distribution of Slope Length-gradient Factor (LS)

The slope length-gradient factor (LS) for the entire watershed are shown in Figure 18-6. Most of the factors are distributed as low as 5 or less, with a few high factors concentrated mainly along the river channel.

Crop/vegetation and Management Factor (C) and Support Practice Factor (P)

Crop/vegetation and management factor (C) represents the degree of land cover by the crop. Support practice factor (P) is determined by the method of cultivation, such as the direction of ridging and contour cropping in the agricultural work. For the crop/vegetation and management factor (C), the land use data obtained from the GIS map was used as a base information. A constant value of 1 was applied to the support Practice Factor (P) for the analysis because detailed information on land management methods was not available.

Table 18-1 Crop/vegetation and Management Factor (C) and Support Practice Factor (P)

Land Use	Factor	
	C	P
Uncultivated/ Bareland	0.75	1
Cultivated	0.45	
Built up	0.10	
Forest/ Tree cover	0.003	
Water	0.0	

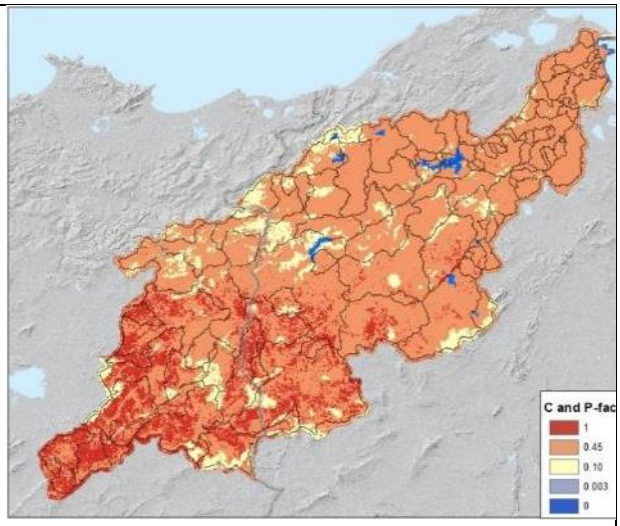


Figure 18-7 Distribution of Crop/vegetation and Management Factor (C) and Support Practice Factor (P)

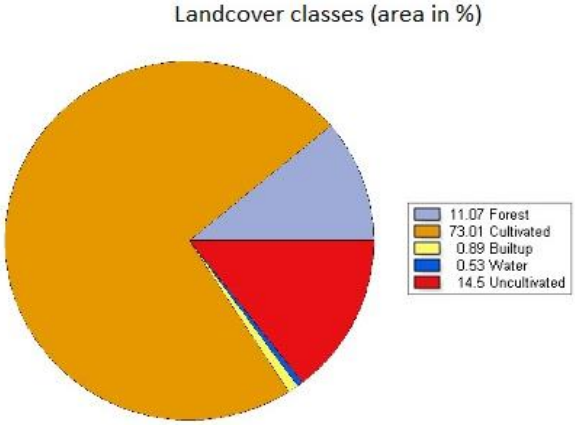


Figure 18-8 Ratio of Land Use

(3) Setting of the Erosion Rank and Calculation Results

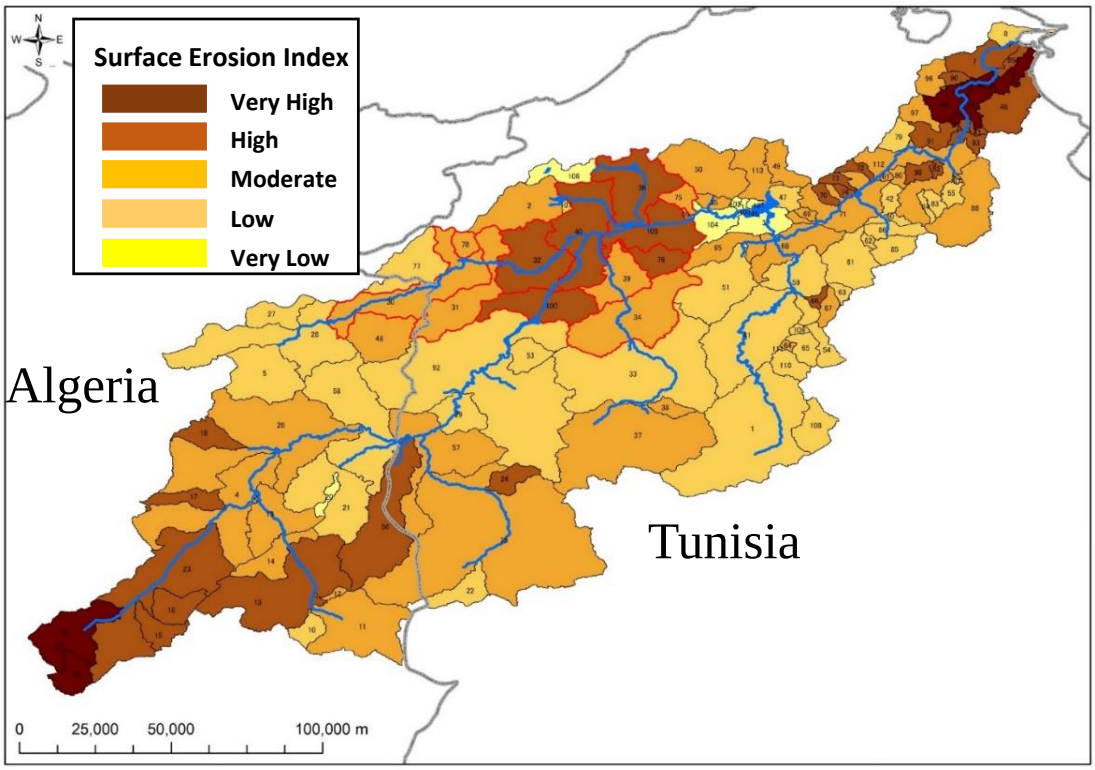
Dividing the watershed zone into 113 blocks, each sediment production are classified by 5 surface erosion rank classification shown in Table 18-2. The distribution is shown in Figure 18-9

The number of distributions for each surface erosion rank is shown in Figure 18 10. The calculated annual sediment production for each block is shown in Table 18-3.

Table 18-2 Surface Erosion Rank Classification

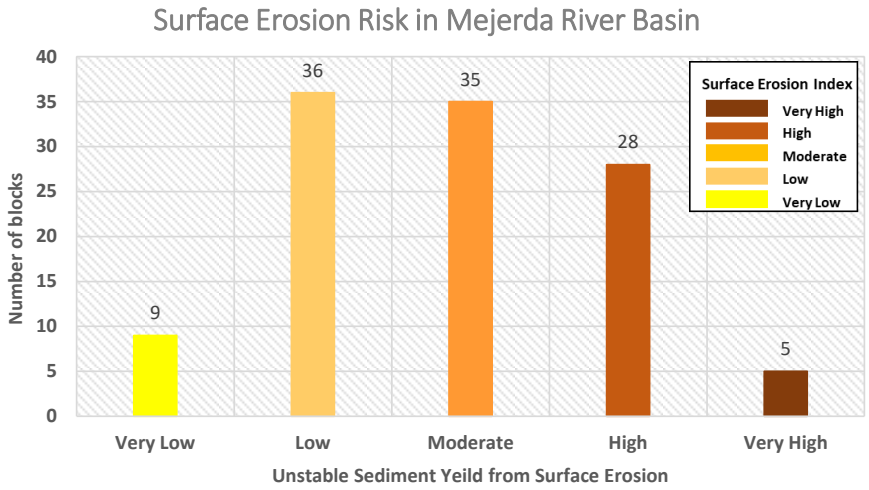
Rank Level	Degree of Surface Erosion	Annual Sediment Production (metric tons/ha/year)
Level 5	Very High	72.01-104.92
Level 4	High	54.01-72.00
Level 3	Moderate	38.01-54.00
Level 2	Low	25.01-38.00
Level 1	Very Low	8.99-25.00

Estimation results show that in the Medjerda River Basin, the amount of soil erosion is high in the blocks located in the eastern, northern, and southwestern parts of the basin. The northern region (U2 zone) is an area with a lot of agricultural land, with high rainfall and steep topographical slopes, indicating a high erosion rate.



Source: JICA study team

Figure 18-9 Distribution of Annual Sediment Production by River Basin



Source: JICA study team

Figure 18-10 Number of blocks of surface erosion risk ranks in the Medjerda River Basin

Table 18-3 Amount of Annual Sediment Production by River Basin

Sub-Basin ID	Area of sub-Basin in GIS(ha)	Soil Loss (metric tons/ha/year)	Total Soil Loss in Sub-Basin (metric tons/year)
1	89,827.92	27.38	2,459,549
2	25,495.83	53.77	1,370,905
3	10,530.90	23.39	246,353
4	52,729.47	52.96	2,792,344
5	29,842.47	29.76	888,178
6	9,440.30	83.18	785,285
7	13,638.29	59.05	805,402
8	6,450.54	26.43	170,475
9	28,569.24	87.18	2,490,783
10	6,497.37	35.78	232,488
11	42,311.88	38.91	1,646,492
12	1,437.75	48.6	69,872
13	64,998.09	58.18	3,781,792
14	13,912.83	51.09	710,854
15	9,954.54	71.17	708,423
16	11,778.21	63.82	751,662
17	9,588.15	65.72	630,113
18	23,811.21	42.53	1,012,629
19	10,595.79	70.15	743,341
20	3,160.53	21.22	67,076
21	38,580.93	33.08	1,276,439
22	11,376.18	31.13	354,109
23	73,249.83	61.77	4,524,545
24	8,110.71	56.82	460,864
25	174,103.74	51.71	9,003,298
26	89,098.47	48.68	4,337,571
27	11,576.16	31.17	360,810
28	52,297.92	30.71	1,605,852
29	13,754.34	30.48	419,281
30	42,578.82	46.39	1,975,165
31	30,744.54	42.84	1,317,173
32	33,920.64	58.16	1,972,850
33	87,387.48	36.02	3,147,544
34	47,084.22	45.1	2,123,406
35	3,647.61	49.19	179,422
36	33,756.39	63.98	2,159,773
37	82,314.63	46.46	3,824,418
38	4,686.30	38.7	181,339
39	18,764.19	42.71	801,330
40	42,654.60	64.3	2,742,533
41	55,247.49	28.41	1,569,815
42	4,387.05	34.03	149,313
43	1,135.44	70.65	80,222
44	9,983.79	88.85	887,075

Sub-Basin ID	Area of sub-Basin in GIS(ha)	Soil Loss (metric tons/ha/year)	Total Soil Loss in Sub-Basin (metric tons/year)
45	454.59	8.99	4,088
46	18,942.77	59.66	1,130,069
47	6,010.38	30.81	185,190
48	22,802.58	40.08	913,997
49	9,491.31	42.29	401,388
50	28,805.13	50.76	1,462,137
51	31,716.90	37.74	1,196,882
52	10,826.19	89.9	973,259
53	9,096.21	36.08	328,185
54	6,486.57	31.21	202,452
55	4,002.75	37.08	148,431
56	49,542.93	59.23	2,934,512
57	47,257.20	42.8	2,022,795
58	56,081.52	37.17	2,084,605
59	22,113.90	34.2	756,364
60	2,790.99	27.86	77,750
61	19,925.19	32.81	653,756
62	1,324.35	35.86	47,497
63	2,428.29	30.02	72,902
64	1,030.41	43.21	44,529
65	6,426.63	30.3	194,755
66	2,036.07	61.52	125,257
67	4,573.89	44.71	204,482
68	20,944.80	39.68	831,077
69	1,752.21	42.73	74,876
70	2,755.35	61	168,074
71	26,687.52	39.92	1,065,489
72	3,077.91	55.91	172,085
73	2,682.45	60.19	161,453
74	1,801.62	58.62	105,618
75	5,464.53	47.93	261,919
76	11,236.95	57.32	644,150
77	23,476.95	37.13	871,808
78	4,930.11	40.63	200,313
79	6,188.76	30.97	191,650
80	2,326.95	45.01	104,726
81	913.05	48.93	44,676
82	1,508.13	64.02	96,547
83	3,113.10	34.61	107,732
84	1,823.67	34.78	63,425
85	8,443.80	32.54	274,730
86	6,719.58	26.76	179,822
87	346.59	35.59	12,336
88	29,314.35	45.29	1,327,610
89	2,835.66	55.28	156,746

Sub-Basin ID	Area of sub-Basin in GIS(ha)	Soil Loss (metric tons/ha/year)	Total Soil Loss in Sub-Basin (metric tons/year)
90	2,822.04	70.09	197,794
91	9,150.30	68.1	623,171
92	156,621.51	37.02	5,798,527
93	4,345.11	69.02	299,915
94	7,504.20	77.6	582,334
95	13,257.45	40.23	533,403
96	7,246.44	44.48	322,326
97	6,458.85	46.97	303,362
98	4,122.36	64.47	265,768
99	573.66	38.01	21,803
100	25,341.48	59.51	1,508,074
101	2,081.97	13.44	27,990
102	1,094.85	21.92	24,003
103	706.59	17.48	12,350
104	10,954.26	23.27	254,905
105	26,529.21	57.52	1,526,079
106	9,752.94	11.86	115,652
107	1,107.18	34.67	38,388
108	12,581.19	25.26	317,765
109	1,346.22	27.87	37,520
110	6,899.58	30.84	212,787
111	130.23	24.5	3,190
112	31,260.60	42.45	1,327,025
113	14,333.94	39.74	569,702
		Total	**106,024,140**

Source: JICA Study Team

(4) Verification of sediment production by actual sediment volume of existing dams

The annual sediment production estimated by the USLE equation was compared and verified using the actual sediment production of four existing dams (25 years from 1975-2000).

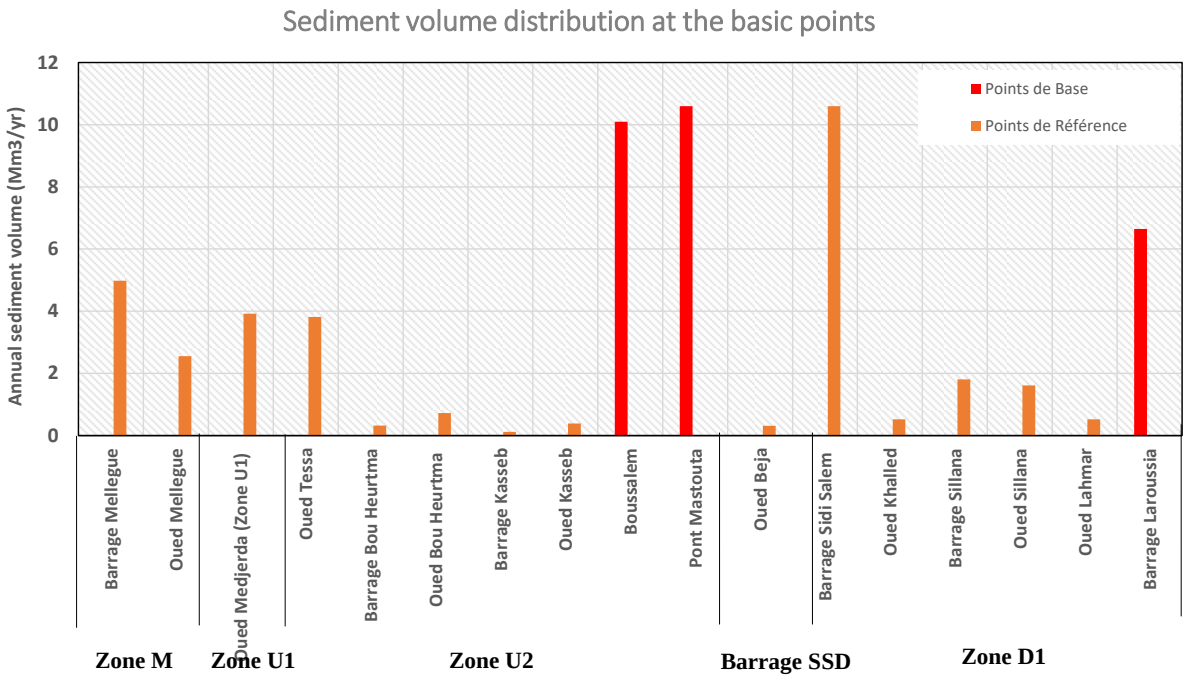
The verification results are shown in Table 18-4. In the calculation results, by applying 16 % in Mellegue dam with a large basin area to M Zone, 105% in Siliana dam with a medium basin area to Siliana dam river basin, and 30% in Bou Huertma and Kaseb dams with a small basin to U1, D1 and D2 Zones, respectively, the sediment production in each Zone are verified.

Using the above verification results, the annual sediment inflow at the major reference points is summarized in Figure 18-11. At the existing dam sites such as Sidi Salem Dam, Larrousia Dam, and Mellegue Dam, the inflow sediment volume is significantly high. In particular, at the reference point of Sidi Salem dam, the annual sediment volume reached is more than 10Million m^3. In addition, at the reference points of Bousalem and Sidi smail cities in the U2 Zone, an annual sediment volume of little under 10 Million m^3 is reached, similar to the Sidi Salem dam.

Table 18-4 Verification Results of Sediment Production by Actual Sediment Volume of Existing Dams

Verify the annual potential soil loss by actual sediment volume in dams						Applying Zone
Dam name	Dam basin	Annual dam inflow sediment volume by USLE method V1	Recorded inflow sediment		Inflow sediment ratio (V2/V1)	
			Recorded inflow sediment V2	Recorded period		
	(km^2)	(m^3/yr)	(m^3/yr)	Period	(%)	
Mellegue Dam	10,138	31,206,587	4,980,000	1975-2000	**16%**	**M Zone**
Bou Heurtma Dam	370	982,469	317,972	1975-2000	**30%**	**U1,U2 Zone D1,D2 Zone**
Kaseb Dam	95	377,478	117,048	1975-2000		
Siliana Dam	1,013	1,717,584	1,805,556	1975-2000	**105%**	**Siliana dam basin**

Source: JICA Study Team



Source: JICA Study Team

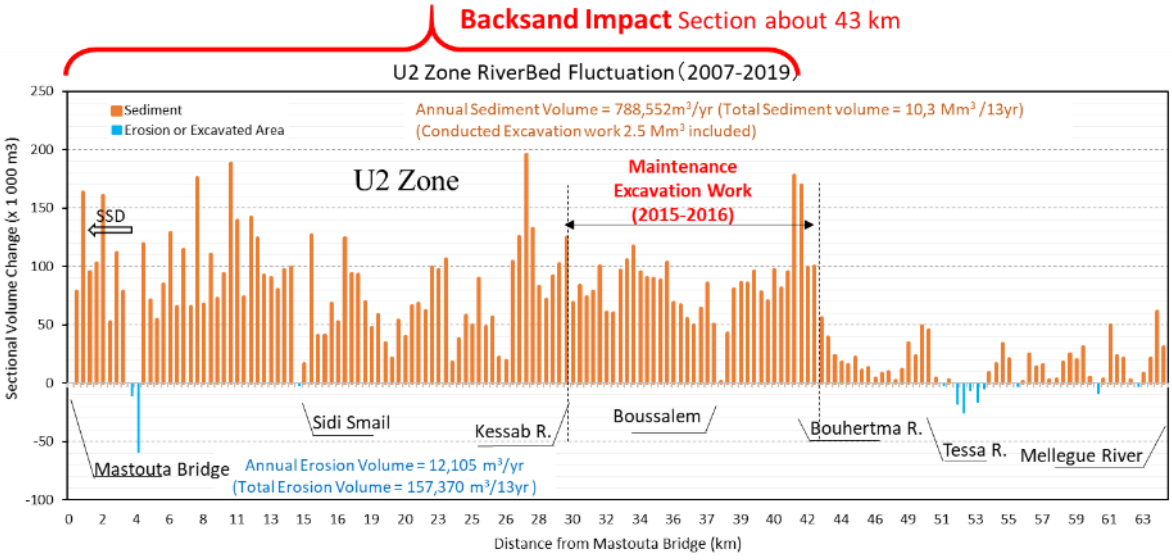
Figure 18-11 Annual Inflow Sediment at Major Reference Points and Basic Points

(5) Analysis of Current Sediment Balance

The riverbed variations in the channel section of U2 Zone were calculated from the difference between the 2007 and 2020 river cross-section data. The characteristics of the river bed variability in the U2 Zone are as below. The Tunisian government conducts maintenance excavation projects in the main river channel around major cities when major flooding occurs. The number of such projects has been several times, but the excavation is not for the purpose of planned river channel cross-sections maintenance but rather for emergency temporary measures.

【Riverbed Fluctuation in U2 Zone】

- The amount of sedimentation in all the sections during the last 13 years (2007-2020) was about 800,000 m^3/year.
- In the section from Mastouta Bridge to Bousalem town, there is significant sediment accumulation due to the back sand caused by the sedimentation shoulders of the Sidi Salem Dam Reservoir. By contrast, in the upstream section from Bousalem town, the amount of sedimentation is low.
- According to the local government hearing, river channel excavation was conducted in 2015-2016 for maintenance purposes, however, as this was a short-term measure, no fundamental measures were taken and sedimentation volume remains high.



Source: JICA study team

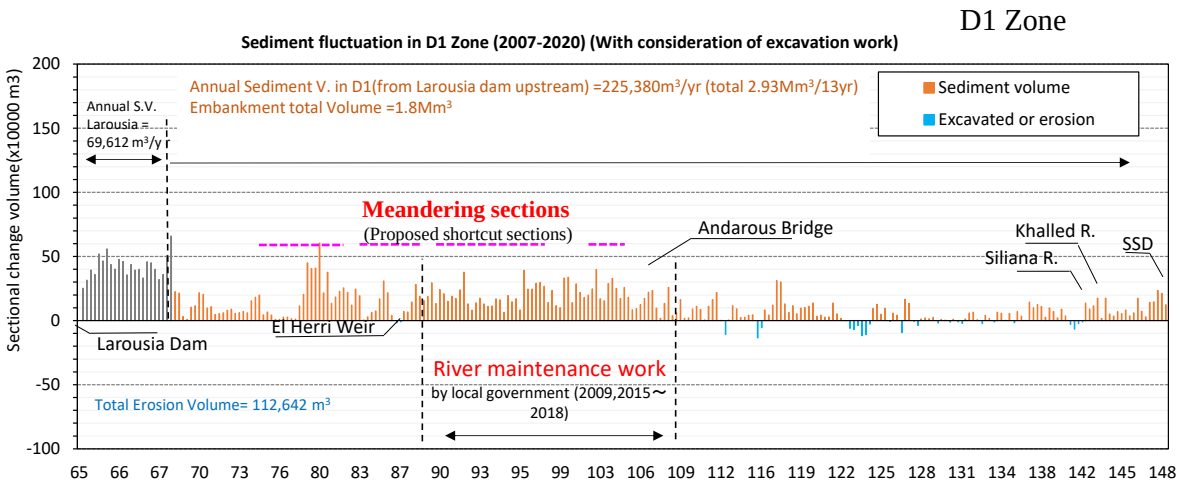
Figure 18-12 Riverbed Variations in River Channel of U2 Section (2007-2019)

【Riverbed Fluctuation in D1 Zone】

Figure 18-13 shows the amount of riverbed variation in the river channel of D1 Zone. The characteristics of the D1 Zone are as below.

- The amount of sedimentation during the last 13 years (2007-2019) is about 2.93Million m^3.
- The sedimentation in the downstream of Androus historical bridge is significant, accounting for about 160,000 m^3/year and 50 % of the total; the annual sedimentation at Larrousia Dam is about 70,000 m^3/year.
- According to the local government hearing, in 2009 and 2015-2018, river channel excavation was

conducted mainly near the Androus Historical Bridge for the purpose of maintaining the river channel, however, since it was a short-term measure, the sedimentation rate is still high.



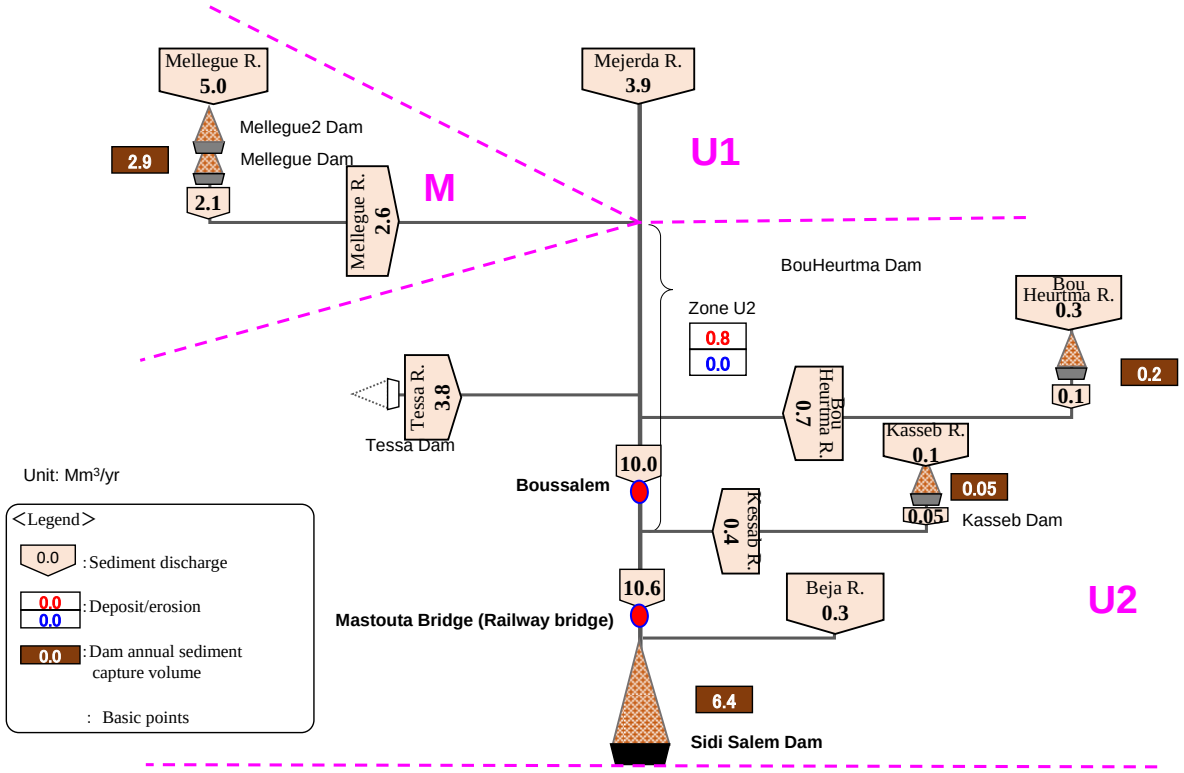
Source: JICA Study Team

Figure 18-13 Riverbed Variations in River Channel of D1 Zone (2007-2019)

18.2.2 Analysis of Future Sediment Balance

The sediment balance map of the upstream area of Sidi Salem Dam is shown in Figure 18-14, and the sediment balance of the downstream area of Sidi Salem Dam is shown in Figure 18-15. The sediment balance for the Medjerda River basin was as follows.

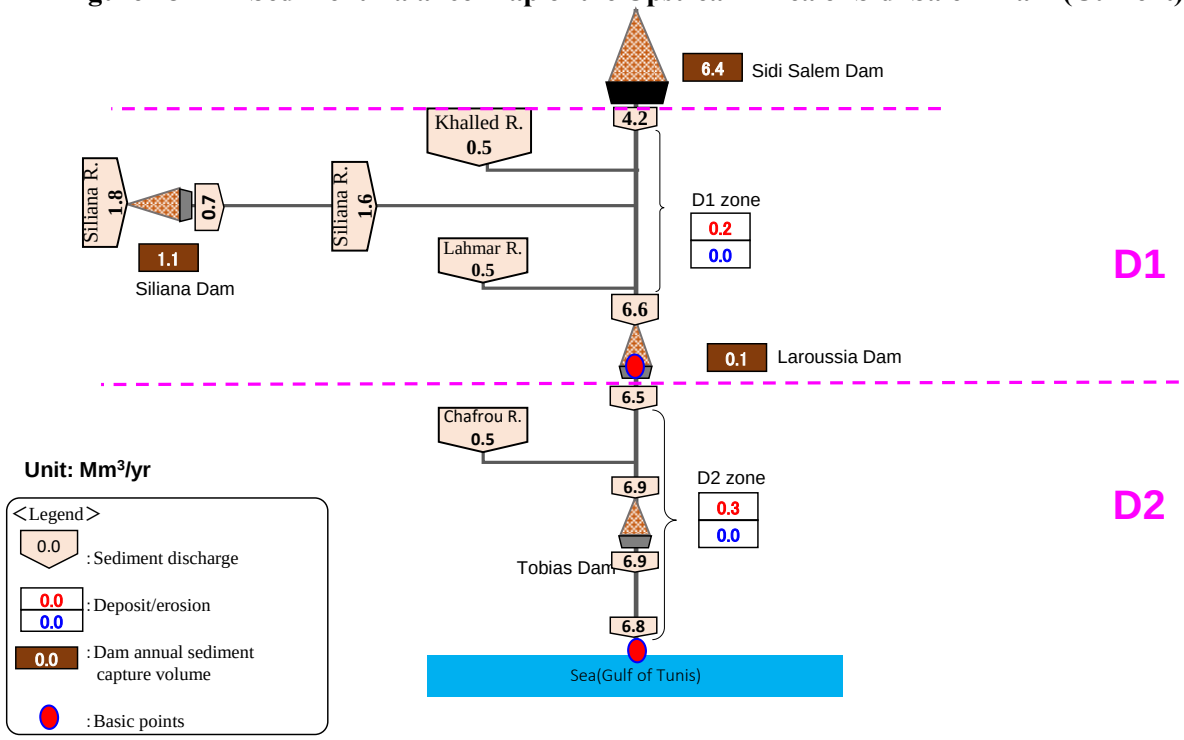
- The mean annual sediment inflow to the Sidi Salem Dam was 10.6Million m^3/year at the reference point of Mastatou Bridge. The main sources of sediment supply were the Mellegue River (2.6Million m^3/year), Tessa River (3.8Million m^3/year), and the main river (U1 Zone) (3.9Million m^3/year). Sedimentation in the U2 Section was 0.8Million m^3/year.
- The main sources of sediment supply in D1 Zone are Sidi Salem Dam (4.2Million m^3/year) and Siliana River (1.6Million m^3/year).
- The annual sediment inflow at the reference point of Larrousia Dam was about 6.6 Million m^3/year, and the annual channel sedimentation at the D1 section was as low as 0.2 Million m^3/year, indicating that most of the sediment passed through the river channel.
- The reached sediment volume at the reference point of estuary was estimated to be 6.8Million m^3/year.



Sediment Balance in Upstream Sidi Salem Dam (Enlarge view)

Source: JICA Study Team

Figure 18-14 Sediment Balance Map of the Upstream Area of Sidi Salem Dam (Current)



Sediment Balance in Downstream of Sidi Salem Dam (Enlarge view)

Source: JICA Study Team

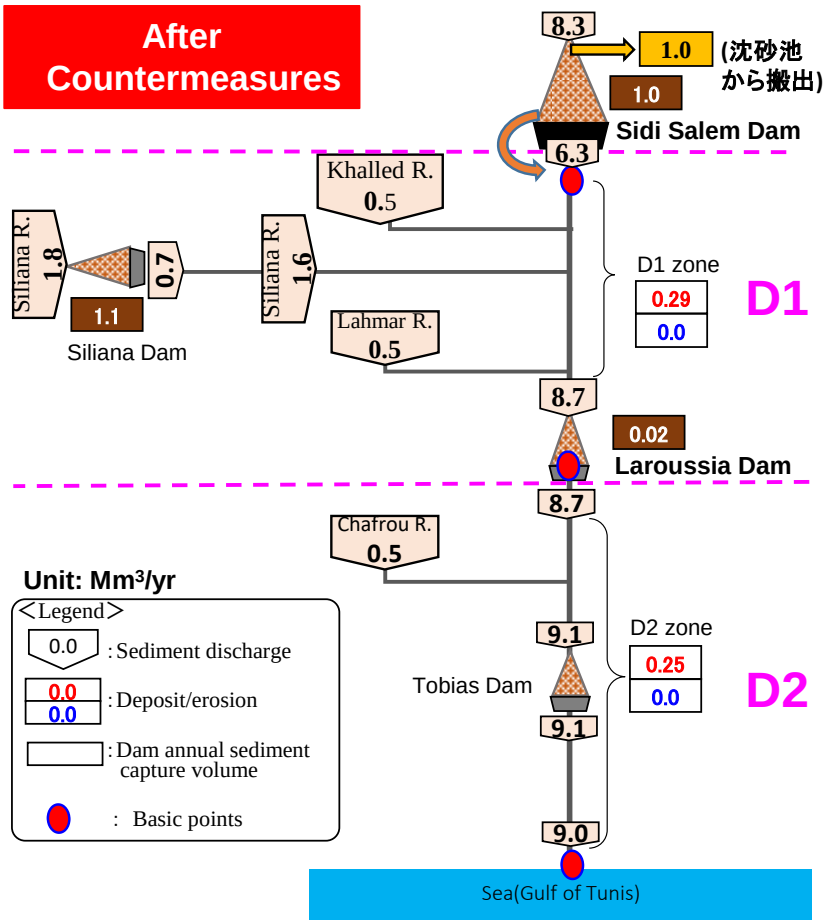
Figure 18-15 Sediment Balance Map of the Downstream Area of Sidi Salem Dam (Current)

18.2.3 Future Sediment Balance after River Improvement

The results of the analysis of the future sediment balance are shown in Figure 18-16, and described as below.

Comparison of Sediment Balance between before and after Countermeasure is shown in Table 18-5.

- The annual sediment discharge from the Sidi Salem Dam after the sediment control measures increases from 4.2Million m^3/year to 6.3Million m^3/year compared to that before the measures. However, most of the sediment discharged from the dam is predicted to pass through the D1 section, because most of them are clay with small grain size and the tractive power of the river channel will be increased due to the increased flow capacity by the river improvement of the downstream channel.
- The future annual passing sediment volume at the reference point of Larrousia Dam is predicted to increase from 6.6Million m^3/year to about 8.7Million m^3/year compared to that before the measures.
- The amount of sediment passing through the reference point at estuary is predicted to increase from 6.8Million m^3/year to about 9.0Million m^3/year compared to that before the measures.



Countermeasures in the downstream of SSD:
1)River improvement work in D1 Zone with shortcut
2)Sidi Salem Dam sediment countermeasures

Source: JICA Study Team

Figure 18-16 Sediment Balance Map of the Downstream Area of Sidi Salem Dam (after Sediment Control Measures)

Table 18-5 Comparison of Sediment Balance between before and after Countermeasure

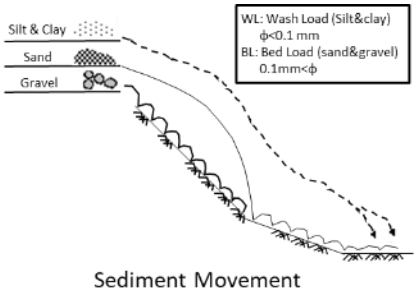
Zone	Basic points	Sediment volume (Mm^3/yr)	
		Current	With project
M	Barrage Mellegue Inflow	4.980	4.980
	Barrage Mellegue Discharge	2.080	2.080
	Residual Basin	0.474	0.355
	Oued Mellegue	2.554	2.435
U1	Oued Medjerda (Zone U1)	3.920	2.933
U2	Oued Tessa	3.816	2.857
	Barrage Bou Heurtma Inflow	0.318	0.318
	Barrage Bou Heurtma Discharge	0.127	0.127
	Bou Heurtma Residual Basin	0.596	0.447
	Oued Bou Heurtma	0.723	0.574
	Barrage Kasseb Inflow	0.117	0.117
	Barrage Kasseb Discharge	0.047	0.047
	Kasseb Residual Basin	0.339	0.254
	Oued Kasseb	0.386	0.300
	Boussalem	10.099	8.012
	Pont Mastouta	10.600	8.312
Sidi Salem Dam	Oued Beja	0.307	0.307
	Barrage Sidi Salem Downstream	4.200	6.300
D1	Oued Khalled	0.521	0.521
	Barrage Sillana Inflow	1.806	1.806
	Barrage Sillana Discharge	0.722	0.722
	Sillana Residual Basin	0.887	0.887
	Oued Sillana	1.609	1.609
	Oued Lahmar	0.516	0.516
	Barrage Laroussia	6.642	8.657
D2	Oued Chafrou	0.509	0.509
	Barrage Tobias	6.900	9.066
	Estuary	6.800	8.966

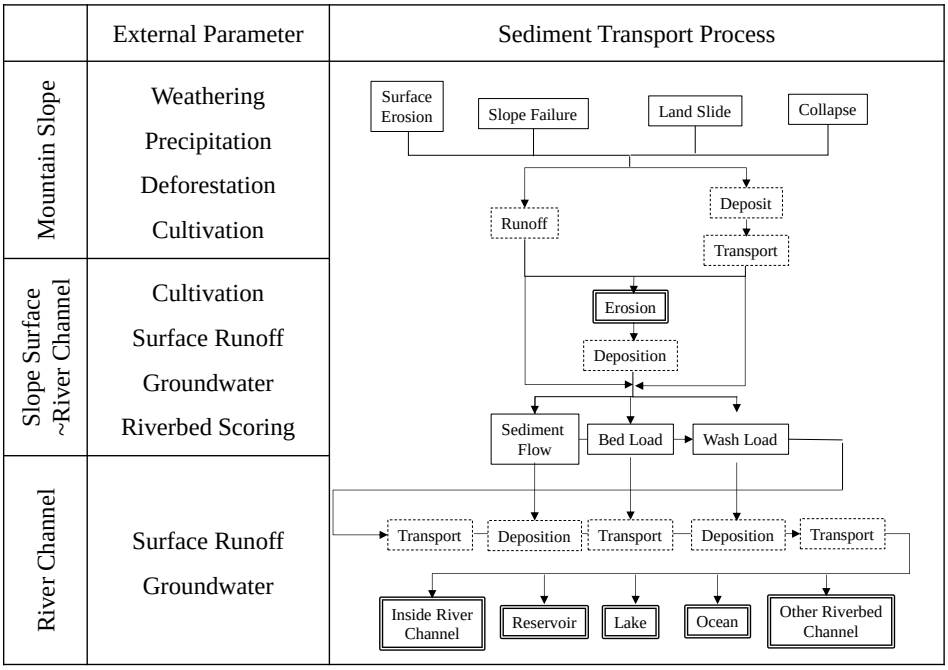
Source: JICA Study Team

18.3 Sediment Transport in the River Basin

Generally, sediment transport means a phenomenon that sediments generated in mountains and hills are supplied through river channels and deposited. Characteristics of sediment transport in the Medjerda River basin are illustrated in Figure 18-17.

In mountainous areas where the upper streams run, a large volume of sediments is produced by surface weathering on hill slopes, devastating slope failures and surface erosions on forests, landslides, soil erosions on farmlands and so on. Those sediments are sent to the downstream as surface water flows in rain, and then cause alluvial fan sedimentation at the ends of valleys. In addition, those sediments are transported to the further downstream and form alluvial plains mainly consisting of sand and mud. Furthermore, as those sediments repeatedly are eroded and are deposited in the river channels, they reach the sea where they are deposited and drifted to form the coastal topography, such as the coastline.





Source: JICA Study Team

Figure 18-17 Sediment Production and Transport in Medjerda River Basin

18.3.1 Overview of Topography and Geology

The topography, geology and characteristics of erosions and sediment productions in the Medjerda River basin are summarized according to each zone in Table 18-6.

Table 18-6 Topography, Geology and Characteristics of Erosions and Sediment Productions in Each Zone of Medjerda River Basin

Zone	Topography	Geology	Characteristics of erosions and sediment productions
M	・Hilly topography is scattered and gentle slopes are widely distributed ・The land is wholly devastated and rarely has vegetation.	The geology consists mainly of layers of the Mesozoic Cretaceous period, while Triassic period layers located between them.	・Fine materials are generated in devastated land by surface weathering of bedrocks in layers of the Triassic or Cretaceous periods. ・It is possible that those fine material move as rain causes surface water flowing and gully erosions, and that they are transferred to downstream through the main river.
U1	・The part of Medjerda River in Algeria flows between hilly topography. ・There are gentle slopes spreading on both of the sides of upstream banks in Tunisia ・The slopes on hilly topography rarely have vegetation and some of them are devastated land. ・Some toes of the hilly slopes are undercut slopes, as Medjerda River meanders. It is eroding and causing failures in the areas.	・In the western parts of hilly areas, the major layers consist of those of the Mesozoic Cretaceous period. ・In the eastern parts of the hilly areas, the majority layers established in Pliocene and Miocene periods in Neogene period of Cenozoic era. ・The gentle slopes consist of a structural basin of bedrocks and unconsolidated sediments (alluvium) in Quaternary period.	・It is possible that fine material constituting unconsolidated sediments (alluvium) along rivers and sediments on river beds are transferred to the downstream ・It is possible that fine material are produced as bedrocks on hilly slopes are eroded by the river and transferred to the downstream. ・In addition, it is possible that fine fractions are generated through surface weathering on bedrocks in wasteland are eroded by the river and transferred to the downstream
U2	・Both of the sides of banks of the Medjerda River mainstream consist of wide gentle slopes. ・On both of the sides of banks of the tributaries' upper streams in the north and south, hilly typography is distributed ・There are gentle slopes distributed between hilly areas along a right tributary, Tessa River. Some parts of the hilly topography rarely has vegetation.	・The slopes nearby the mainstream of Medjerda River consist of unconsolidated sediments (alluvium) in Quaternary period, which is similar to U1. ・The hilly topography along those slopes mainly consists of layers of Pliocene and Miocene periods in Neogene period of Cenozoic era. ・The slopes along Tessa River also mainly consist of alluvium ・The Topology on the hill consists of the geology in Mesozoic Cretaceous period.	・Alluvium along the mainstream of Medjerda River and nearby Tessa River constitute terrace alluviums that widely spread. ・It is possible that those sediments are laterally eroded and transferred to the downstream. ・It was found that gravel layers in alluvium and rounded gravel originated from gravel, which generated bedrocks formed in the further past time changed into by erosions and transports, were exposed by erosions.
D1	・The mainstream of Medjerda River runs on gentle slopes. ・Hilly topography is distributed in the northern and southern parts of the slopes. ・Along Siliana River, a right tributary, hilly topography with comparatively low elevation is distributed nearby the upper and middle streams, while gentle slopes are distributed nearby the downstream joining with Medjerda River.	・The major part of the hilly topography along both Medjerda River and Siliana River consists of layers of Pliocene and Miocene periods in Neogene period of Cenozoic era. ・The gentle slopes made of unconsolidated sediments (alluvium) in Quaternary period. ・It was found that gravel layers were located between alluviums in a geological boring survey nearby Historical bridge.	D1 is similar to U2 in terms of these items.
D2	The topography consists of gentle slopes and flat areas.	・The zone mainly consists of unconsolidated sediments (alluvium) in Quaternary period.	It is possible that unconsolidated sediments (alluvium) along rivers and sediments on river beds are eroded and transferred to the downstream.

		・The major sediments are fine: sand, silt and clay.	

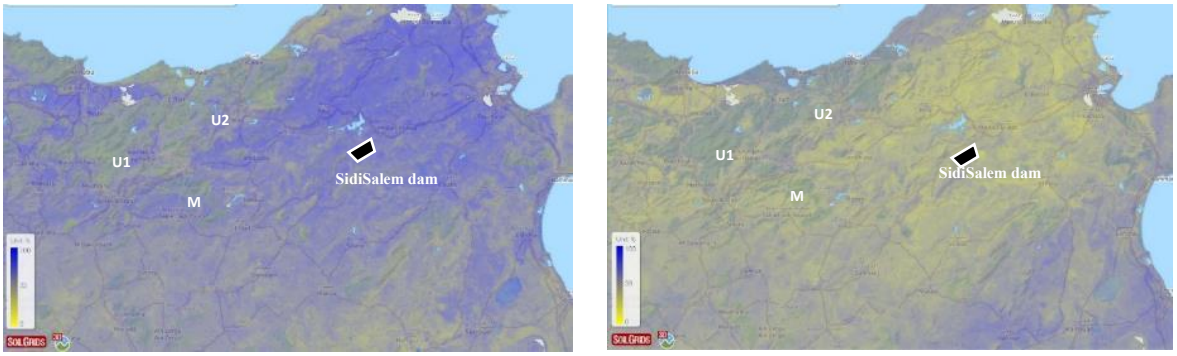
Source: JICA Study Team

18.3.2 Soil

A distribution map of the sand and clay content of soils in the Medjerda River Basin is shown in Figure 18-18. On average, the Medjerda River watershed has a clay (grain size of 2 μm or less) content of about 50% or more and a sand content of about 20% or less. This indicates that the surface layer is mainly composed of weathered soil such as clay and silt with small grain size.

In the northern area upstream of the dam (U2 zone) and in the Tessa and Mellegue tributary river basins, the sand content is greater than in the area immediately upstream and downstream of the Sidi Salem dam, and thus the area is more markedly prone to soil erosion due to its higher crushability and porosity.

The results of the fluvial material survey in the Sidi Salem Dam reservoir and in the rivers also confirm that the grain size of the soil in the reservoir and in the downstream river channel is also mainly composed of clay and silt, with fine sand, which is a coarser grain size in the Tessa, Mellegue and Siliana branches of the river.



Source：SoilGrids global digital soil mapping system

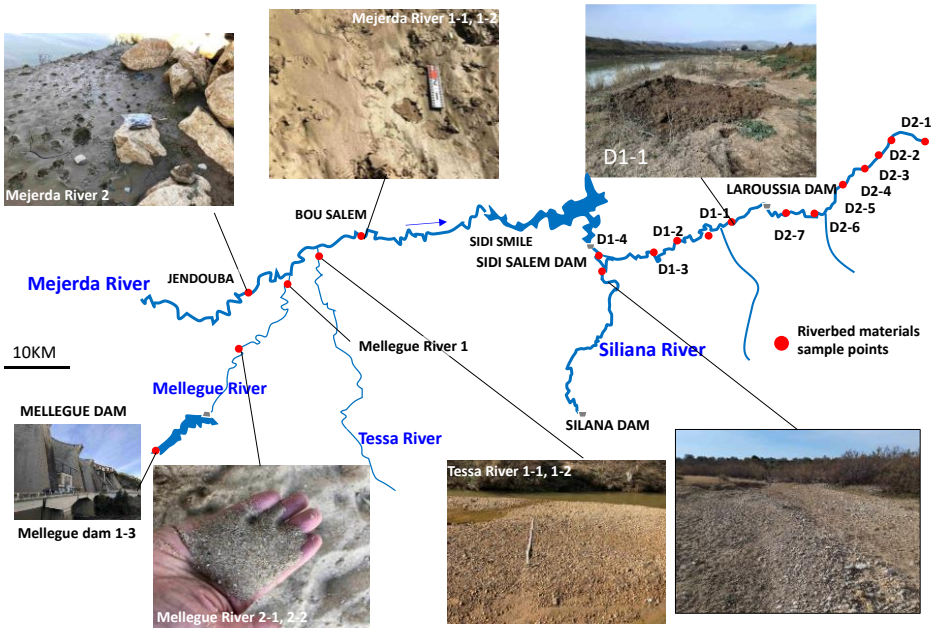
Figure 18-18 Distribution Map of Clay (Left) and Sand (Right) Contents of Soil in Medjerda River Basin

18.3.3 Characteristic of Riverbed

A riverbed material survey in the Medjerda River and tributaries was conducted in January 2020 to characterize the riverbed material in the Medjerda River. A location map of the grain size distribution survey sites in the Medjerda River, tributaries, and Sidi Salem Dam sediments is shown in Figure 18-19. Based on the results of this survey, the grain size characteristics targeted in the Medjerda River basin are summarized below.

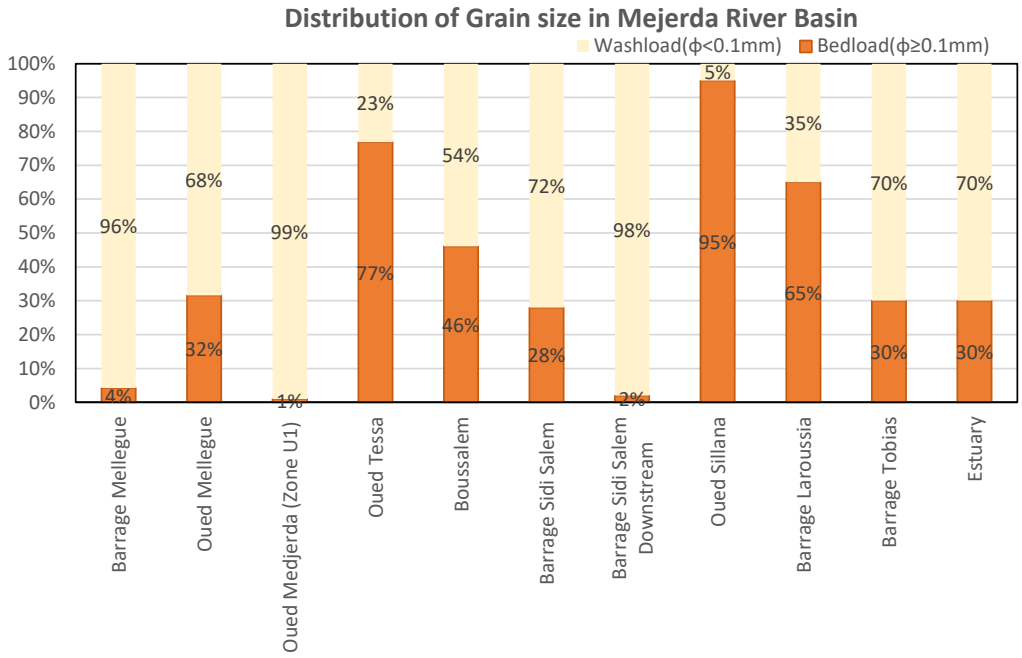
- The grain size group in the Medjerda River Basin is set up as a wash load (φ<0.1 mm, clay/silt) and a bedload (φ>0.1 mm: sand/gravel). Bedloads have larger grain size than washloads and are repeatedly transported and deposited. Washloads, on the other hand, are those in which fine particles tend to flow downstream while mixing with river water.
- In the upstream of the Sidi Salem Dam, the major grain size groups that make up the riverbed are smaller; in the U1 zone, the grain size groups consist of washloads; in the U2 zone, the bedload is provided from the Tessa and Mellegue rivers, resulting in relatively larger grain size groups.
- In the D1 zone, bedload is provided from the Siliana River, resulting in larger grain size groups. This bedload is deposited within the D1 zone river channel and its volume decreases as one moves to the D2 zone. (See Figure 18-20)

Zone	Characteristics of Riverbed Material Distribution
U1	The grain size distribution in the main river is a washload of clay and silt less than 0.1 mm (φ<0.1 mm) at 2 site of Medjerda River. The sand content (φ > 0.1 mm) is confirmed to be low.
M Mellegue Tributary River	At Mellegue River sites 2-1 and 2-2, fine sand greater than 0.1 mm accounts for about 30%, and washroad occupancy less than 0.1 mm accounts for about 70%. The fine sand is thought to be discharged downstream due to large-scale riverbank erosion in the channel section downstream of the Mellegue Dam.
U2 Tessa Tributary River	The grain size distribution is dominated (80%) by sands and gravels larger than 0.1 mm, indicating that they are the source of riverbed material for the U2 Zone main river channel.
U2	In the main river, the percentage of fine sand greater than 0.1 mm (φ > 0.1 mm) increased compared to the upstream U1 zone.
Reservoir of Sidi Salem Dam	The sediment load accounted for about 30% of the fine sand greater than 0.1 mm and about 70% of the washload occupancy of less than 0.1 mm.
D1	Upstream at D1-4, clay/silt less than 0.1 mm dominates; downstream of D1-3, the proportion of fine sand (φ > 0.1 mm) is increasing. Between D1-3 and D1-4, fine sand (φ > 0.1 mm) predominates, suggesting that the Siliana River is the source of riverbed material for D1 and D2.
D2	Compared to the upstream D1 zone, the clay/silt content is higher and the percentage of fine sand (φ > 0.1 mm) is decreasing.



Source: JICA Study Team

Figure 18-19 Location of Riverbed Survey in Medjerda River Basin (January, 2020)



Grain Size Group	U 1	Mellegue	Tessa	U2	SSD	Siliana	D1	D2
Washload (φ<0.1 mm): Clay/Silt	○	○	—	△	○	—	△	○
Bedload (φ>0.1 mm): Sand and Gravel	—	△	○	△	△	○	△	—

○：Mainly Existing；△：Partially Existing；—：Tiny Existing

Source: JICA Study Team

Figure 18-20 Grain Size Distribution in Medjerda River Basin

18.4 Current Situation of River Basin Conservation

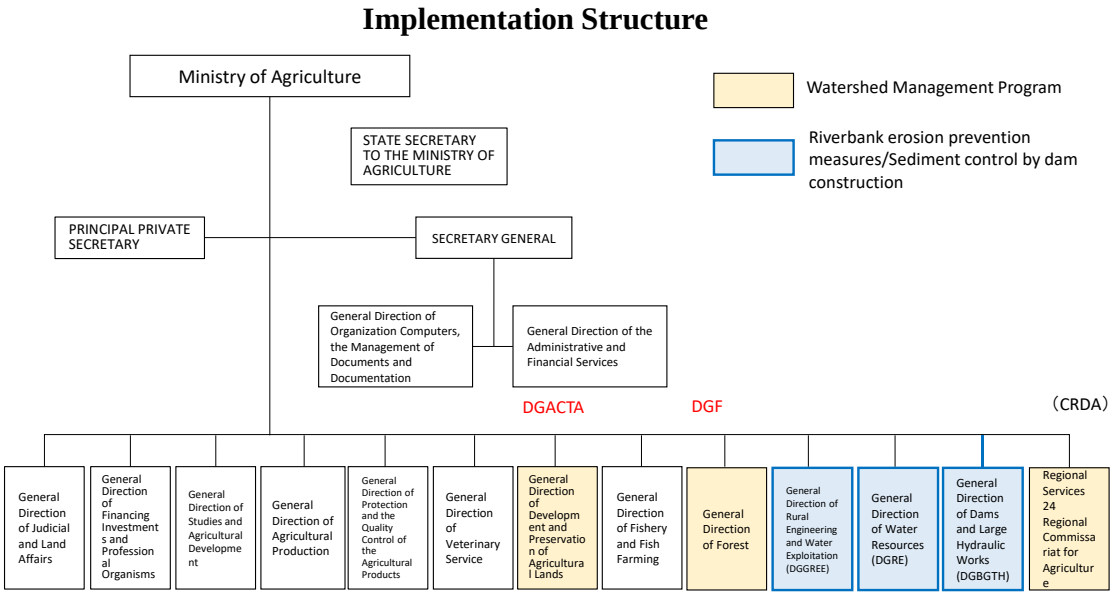
Erosions on soil surface and destructions of vegetation have been more and more rapidly deteriorating in the Medjerda River basin, because of cultivation, grazing in forests and disorderly deforestation for household uses and slash-and-burn agriculture. In addition, severe gully erosions have been happening on cultivated slopes that are fragile against heavy rain's eroding. The majority of the peasants borrows small parts of land on clayey and sharp slopes and raises grains in the river basin, in which mechanized agriculture is also witnessed. Those erosions on land surface are leading sedimentation on rivers and reservoirs. Those sediments are degrading capacity of river flows and water supply of reservoirs.

18.4.1 Effort of Related Organizations

Organizations related to river basin conservation are depicted in the figure 18-21.

Organizations responsible for water resource management and agricultural land development are affiliated to the Ministry of Agriculture. At the ministry, the DGBGTH plays key roles in river improvements and structural measures against sedimentation on dam reservoirs. The DGRE has responsibility for the non-structural measures including setting and managing of observation network and data gathering in terms of water resources. The DGACTA is engaged in formulations of plans and policies about development and conservation of agricultural land. The DGF is responsible for forestry actions.

Following decentralized policies of the government, the Ministry of Agriculture outsources all operations and activities related to regional agriculture to the CRDAs in each prefecture (the total number of prefectures is 24), while sending staff to them. Those organizations' activities are related to agricultural productions, natural resources, vegetation, forest areas and economic things.



Source: JICA Study Team

Figure 18-21 Main Organizations Related to Comprehensive Sediment Management Project for Medjerda River Basin

(1) Efforts of DGACTA

The DGACTA formulated an action plan toward 2030 based on the Strategy for planning and conservation of agriculture land by 2050. That plan's objective is to accomplish sustainable and productive development of agriculture with consideration on management of natural resources and climate change. Four core components constitute the plan: conservation and enhancement of agricultural

soils through rain-providing agriculture such as wet rice cultivation, utilizations of water resources, sustainable management of natural resources and adaptations to climate change.

According to interviews to DGACTA, it was estimated that 110 million TNDs were necessary to conduct the action plan overall: 107 million TNDs for executing the plan and 3 million TNDs for operational management. Budgets for operational management (3 million TNDs) and investment (77 million TNDs) are planned to be allocated from the national budget, while those for the rest part are expected to be secured by foreign donors.

An example of recent erosion prevention measures was a case against gully erosion in upper streams of Siliana River by the DGACTA and CRDA. Its plans and designs were created by technical engineer of the CRDA, and five groundsills with 5 meter heights were constructed in a river channel the width of which was 10 to 15 meters. (See Figure 18-22)

Figure 18-22 Case of Erosion Prevention Measures against Gully Erosion in Upsream of Siliana River

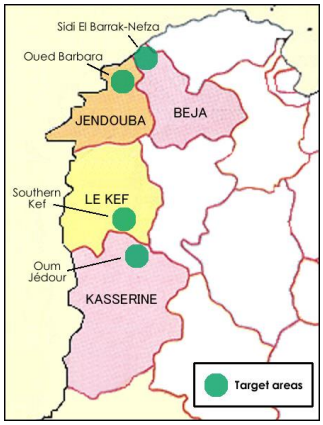
(2) Efforts of DGF

Governmental organizations responsible for forest management are the DGF, CRDA and Arrondissement de Forêt.

One of their recent activities was, for instance, a project of reforestation and local development (a comprehensive reforestation project: maintenance of forests, conservation of biodiversity and improvement of local habitants' living environment) conducted in four regions in the northwest of Tunisia (Oued Barbara in Jendouba Governorate, Sidi El Barrak-Nefza in Béja Governorate, Oum Jedour in Kasserine and a southern part of Kef Governorate) in 2008, which Japanese ODA loan was allocated to.

The ex-post evaluation of the project reported that it was intended to prevent soil erosion, expand forests as reforestation and improve economic and social conditions of the local habitants' living and had positive effects on improvement of the natural environment.

The forests that were the target of Japanese ODA loan project in 2008 and maintained are shown in Figure 18-23.



Project sites

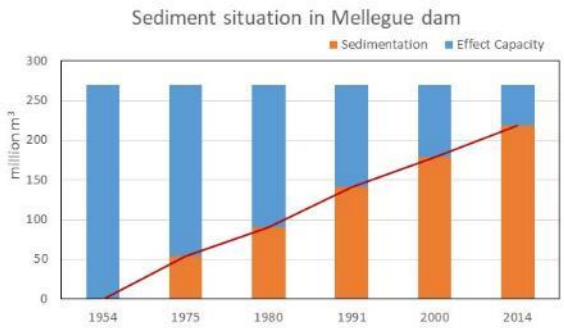
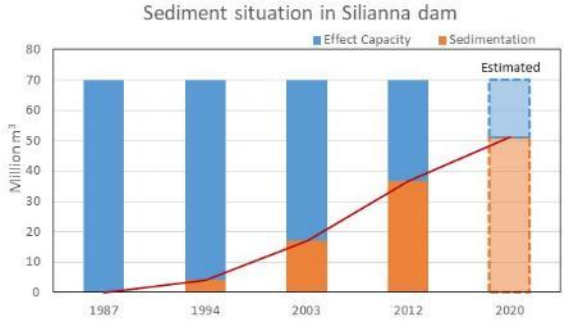
Forest maintained by Japanese loan project (Béja region)

Source: JICA Comprehensive reforestation project II (TS-P33)

Figure 18-23 Project Sites and Maintained Forest

18.4.2 Current Condition and Projection of Sedimentation on Existing Dams

The accumulated volumes of sediments on two major dam reservoirs in the Medjerda River Basin are illustrated on Figure 18-24. Since sedimentation have been happening on those dams, as sediments flow from upstream, those capacities of water supply have declined. Thus, it is an urgent issue to implement the countermeasure for the sedimentation on reservoirs at the Mellegue Dam and Siliana Dam as well as Sidi Salem Dam.

Mellegue Dam Operation 1954～ Initial Capacity approx. 270 Mm^3 Sediment volume approx. 219 Mm^3(2014) Annual Sediment V approx. 5.0Mm^3 Lost capacity approx. 81% in 60 years  	**Siliana Dam** Operation 1987～ Initial Capacity approx. 70 Mm^3 Sediment volume approx. 36.6 Mm^3(2012) Annual Sediment V approx. 1.8 Mm^3 Lost capacity approx. 52% in 25 years 

Source: JICA Study team

Figure 18-24 Accumulated Volume of Sediment on Existing Dams

(1) Current Situation of Mellegue Dam

The Mellegue Dam was established over 60 years ago. Its sedimentation rate in 2014 was 81 percent, which overwhelmed assumed one and the effective storage capacity was only about 20 percent. The rising volume of sediments on the dam reservoir has severe negative effects on safety of the dam.

Results of interviews to managers of the dam indicated that irregular vibrations at the dike body were observed and it was unstable when floods happened. The capacity of the dam's sediment discharge facility, which was established in the same time of the construction of the dam itself, is low comparatively to the volume of annual inflow of sediments (5 million m^3). Moreover, the existing sediment discharge gates of the dam are filled with sediments and do not work.

The survey of riverbed materials in previous section suggested that the sediments needs to be flushed out from the dam because most of them consist of a washload

Leakage of the Mellegue dam dikes

Spillway Gate Aging

Source: JICA Study Team

Figure 18-25 Condition in Field Survey at Mellegue Dam

(2) Current Situation of Siliana Dam

Siliana Dam was established over 30 years ago. Its sedimentation rate in 2012 was 52 percent, which is equivalent to the half of the effective storage capacity. The sedimentation is going on to some extent.

In the upstream of the dam, sediment production is significant due to surface soil erosion on degraded slopes, riverbank erosion and gully erosion in the inflowing tributary rivers, and watershed conservation measures are needed.

18.4.3 Issue for each River Basin

The issues in each basin zone due to the characteristics of the sediment environment vary depending on the characteristics of the watersheds upstream and downstream of the existing dam. Table 18-7 summarizes the issues for them.

Table 18-7 Current Situation and Issue for Each Zone

Zone	Current Situation and Issues for Sediment Management
U1	•**Sediment Production:** The annual sediment production is as high as 3.9 Million m^3/year, which accounts for 40% of the sediment inflow from the Sidi Salem Dam. •**Mountain Area:** Sediment production is high due to valley bank erosion on hillslope areas, forest devastation slope failure and surface erosion, landslides, and soil erosion on agricultural land. However, the upstream of the U1 zone are difficult to control because they belong to Algeria. •**River Area:** The riverbed sediments are composed mostly of fine-sediment produced by surface weathering in devastated areas. •**Monitoring:** Observation and monitoring related to sediment transport, and forecasting and evaluation of the impact on ecosystems have not been conducted.
M 、U2 Mellegue Tributary and Tessa Tributary	•**Sediment Production:** The annual sediment production from Zone M and Zone U2 is 2.6 Million m^3/year and 3.8 Million m^3/year, respectively, accounting for 60% of the sediment inflow from the Sidi Salem Dam. •**Mountain Area:** Watershed conservation measures are necessary because of the large amount of sediment production due to valley bank erosion on hillsides, forest devastation slope failure and surface erosion, landslides, and soil erosion on agricultural lands. •**River Area:** Bank erosion in the Tessa and Mellegue Rivers is observed to be high, and riverbank erosion prevention measures are needed. Temporary excavation to maintain the river channel is being carried out in some sections of the main river. •**Mellegue Dam Area: :** Sediment in the reservoir exceeds storage capacity by 80%. There are concerns about the stability of the dam as it is aging. Inflow sediment grain size is mostly washload of clay and silt. •**Tessa Area: :** The sediment balance will vary in the future with the construction of the Tessa Dam. •**Monitoring:** Observation and monitoring related to sediment transport, and prediction and evaluation of the impact on ecosystems have not been conducted.
Sidi Salem Dam Reservoir	•**Sedimentation Situation: :** The amount of sediment inflow is 10.6 Million m^3/year. Of this amount, 6.4 Million m^3/year (about 60%) is deposited in the reservoir and sedimentation is in progress. •**Future Prediction** : The amount of sediment in 100 years will be approximately 510 Million m^3, and approximately 50% of the total storage capacity of 960 Million m^3 will be filled with sediment. It will result in the loss of the current water utilization and flood control functions, making sediment control measures an urgent necessity.

D1	•**Mountain Area:** : Watershed conservation measures are necessary because of the large amount of sediment production due to valley bank erosion on hillsides, forest devastation slope failure/surface erosion, landslides, and soil erosion on agricultural lands. •**River Area** : Riverbed sediments are dominated by sand deposits larger than 0.1 mm. Since much bank erosion of the Siliana Tributary has been observed, measures to prevent riverbank erosion are necessary. Emergency excavation to maintain the river channel is being conducted in some main river sections. •**Dam Area:** : Deposition at Siliana Dam sediments is in progress, with a sedimentation rate of 52% as of 2012, which accounts for about half of the storage capacity. Since the inflow sediment is from sand and gravel (bedload) produced by upstream valley erosion, measures to control sediment inflow are needed. In addition, sediment from the Siliana River is affecting the sediment in the existing Larousia Weir reservoir. •**Monitoring: :** Observation and monitoring related to sediment transport, and prediction and evaluation of the impact on ecosystems have not been conducted.
D2	•**Mountain Area** : Watershed conservation measures are necessary because of the large amount of sediment production due to valley bank erosion on hillsides, forest devastation slope failure/surface erosion, landslides, and soil erosion on agricultural lands. •**River Area:** : The riverbed sediments are mostly fine-grained sediments less than 0.1 mm. •**Tobias Dam** : Sedimentation in the reservoir is progressing and needs to be controlled. •**Riverbank Area:** : Observation of sediment transport and environmental monitoring for ecosystem in the protected areas of the Ghar el Merh Lagoon and the Medjerda River delta at the mouth of the estuary.

Source: JICA Study Team

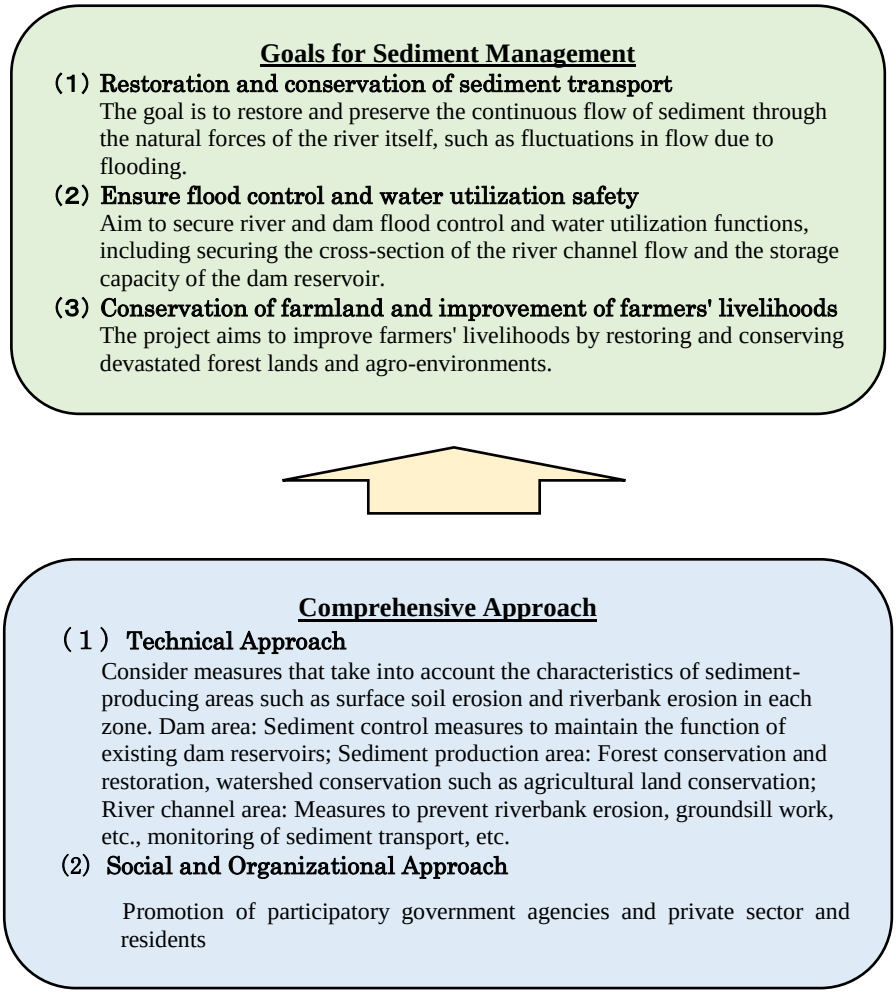
18.5 Establishment of Comprehensive Watershed Sediment Management Plan

18.5.1 Necessity of Sediment Management Plan

The Government of Tunisia's National Strategy for Agricultural Land Development Planning to 2050 and Implementation Action Plan to 2030 aim to sustain sustainable and prosperous agricultural lands, taking into account natural resource management and climate change. The basin-wide comprehensive sediment management plan will contribute to achieving the goals of the National Strategy for Agricultural Land Development Plan by targeting (1) restoration and conservation of sediment transport, (2) flood control and water security, and (3) farmland conservation and improvement of farmers' livelihoods, from both technical and social and organizational approaches from water and soil conservation and agricultural production.

18.5.2 Sediment Management Plan Goals and Comprehensive Approach

Goals and approach for sediment management plan in Medjerda River Basinare shown in Figure 18-26.



Source: JICA Study Team

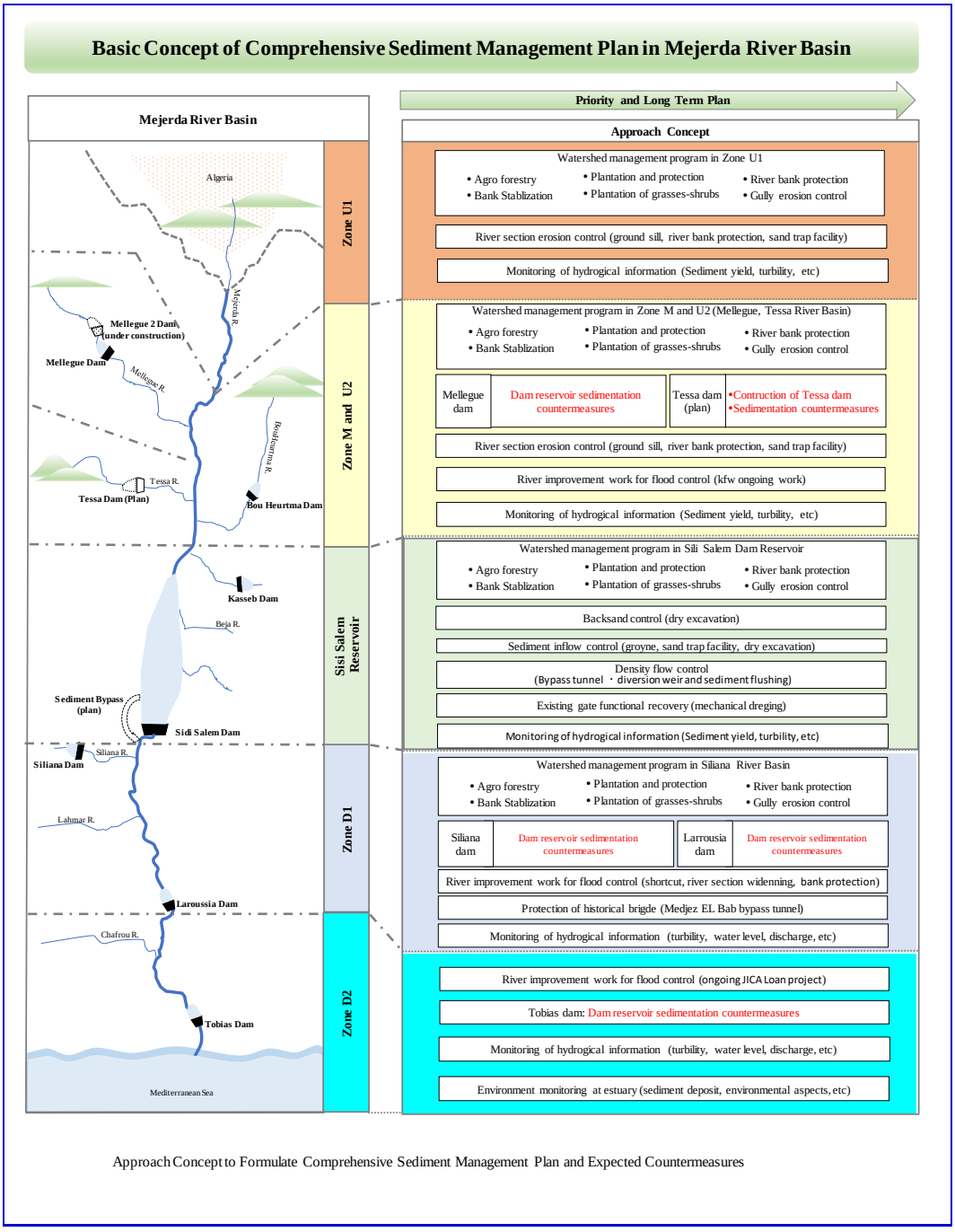
Figure 18-26 Goals and Approach for Sediment Management Plan in Medjerda River Basin

18.5.3 Priority Measures and Long-term Measures for Each Watershed Zone (Draft)

In considering the necessary measures for each watershed zone, we propose the following menu of priority countermeasures and a proposed menu of long-term countermeasures.

Since the menu of countermeasures varies depending on the topography and land use of the zone, they are summarized for each zone as shown in Figure 18-27. These countermeasures are one of the proposals at this stage, and must be developed through detailed investigation and analysis in the future.

Each of the proposed countermeasure menus is described below.



Source: JICA Study Team

Figure 18-27 Basic Strategy for the Comprehensive Watershed Sediment Management Plan for the Medjerda River Basin (Draft)

(1) Watershed Conservation Countermeasure (Watershed Management Program)

Considering the topography and geological conditions in agricultural lands and devastated slopes in the watershed, we propose forestry agricultural measures with soil conservation effects, afforestation and protection, agroforestry countermeasures by planting shrubs, changing crop patterns, etc., gully erosion control countermeasures, and stream erosion control countermeasures.

(a) Countermeasure for Agricultural Slope

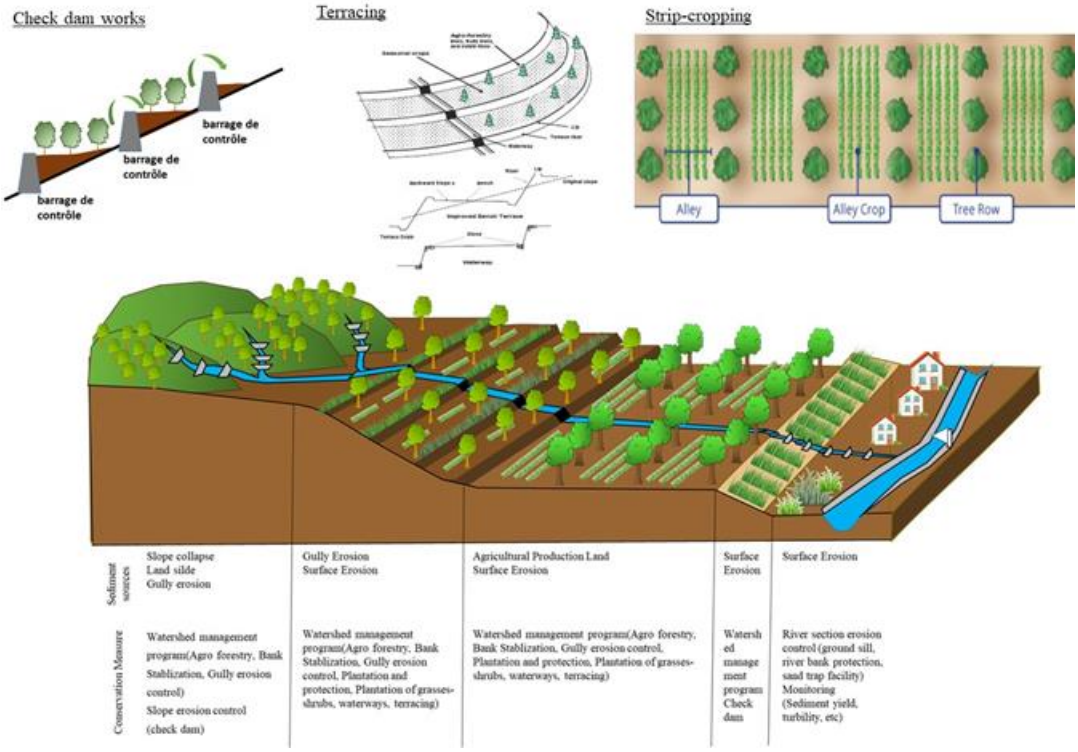
Countermeasures for soil and water conservation in agricultural lands can be broadly classified into agronomic measures, soil management, and structural measures (mechanical methods).

Agronomic measures are vegetative measures that include forests, agroforestry, contour strip cultivation, cropping patterns and farming methods, etc., and are applied to all agricultural land.

Soil conservation measures (soil management) may include conventional tillage, conservation tillage, ridge plowing, and other methods that minimize the extent of soil disturbance and the degree of soil breaking necessary to reduce problems associated with tillage.

Structural measures include gully erosion control and surface soil erosion prevention through the installation of permanent and semi-permanent structures such as terracing of fields, stone masonry works, check dams, frame retaining walls, and channel works. This measure is applied in areas where slopes are high and the risk of surface soil erosion is high.

The measure for agricultural slopes are summarized in Figure 18-28.



Source: JICA Study Team

Figure 18-28 Summary of Agricultural Slope Countermeasures

(b) Agroforestry Measure

Agroforestry measures are land management systems that involve the cultivation of trees and shrubs simultaneously with crop and livestock production on the same land. It is an new technology for effective soil and water conservation. It consists of a wide range of practices for controlling soil erosion, developing sustainable agricultural production systems, mitigating environmental pollution, and improving agricultural economics.

Agroforestry is generally known to reduce soil erosion by up to 10%. Target trees should be selected according to the intention of the farmland owner, such as fruit trees.

(c) Terracing

Terracing can be combined with agroforestry measures to achieve soil erosion control in a short period of time, and terrace improvement and creation will be carried out on field land and field land within villages. The vegetated soil erosion control targets are terrace benches, terrace slopes, and rips. The selection of grass and tree species/varieties to be introduced into the plan should be based on the farmers' intentions, taking into account economic feasibility.

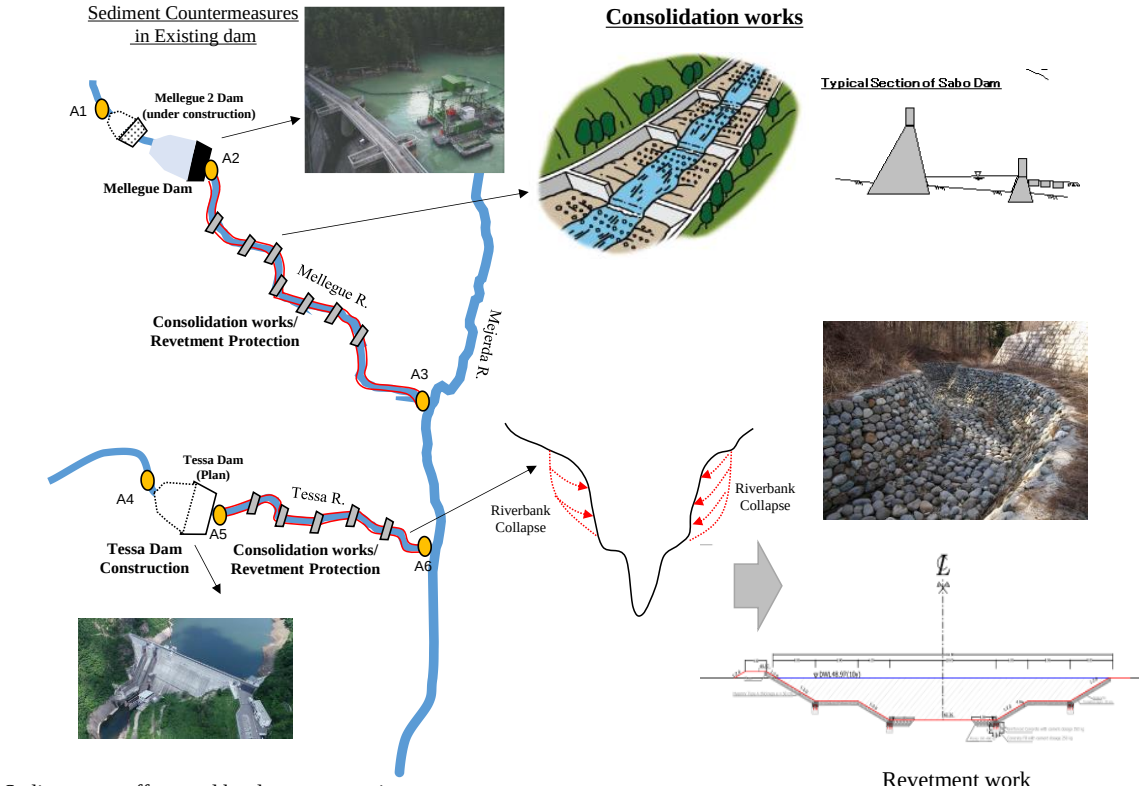
(d) Gully Erosion Measure

Gully erosion control is effective in streams and channels where gully erosion has developed, and is a fast construction method that requires little maintenance. Stone Masonry check dams and iron wire cage check dams, which can be procured locally at low cost, have been constructed by the Ministry of Agriculture.

(2) Countermeasure for Erosion inside Rivers

Figure 18-29 shows countermeasures for riverbank erosion and sediment production inside rivers. The effect of them are summarized below

According to the results of the field survey, the Mellegue, Tessa, and Siliana rivers have very high sediment production due to riverbank erosion because no measures to prevent riverbank erosion have been implemented. Therefore, it is suggested that groundsill works, revetment works, sand traps, etc. be constructed to improve channel stabilization.



Source: JICA Study Team

Figure 18-29 Countermeasures for Riverbank Erosion and Sediment Production inside Rivers

(3) Countermeasure for Sediment Production by Dam Construction

For watersheds where dams are planned to be constructed, countermeasures for the sediment production by dam construction are proposed to prevent sediment run-off disasters as well as flood disasters in the downstream areas.

In particular, in the Tessa River basin, where a dam is planned to be constructed, it is necessary to construct the dam as soon as possible to reduce sediment production from the upstream area. It is important to include long-term sediment control measures when constructing the dam.

(4) Countermeasure against Sedimentation in Existing Dams

For existing dams whose functions such as water utilization and flood control are deteriorating due to the progression of sedimentation, sediment control measures including inflow sediment control measures and sand discharge measures will be established and implemented.

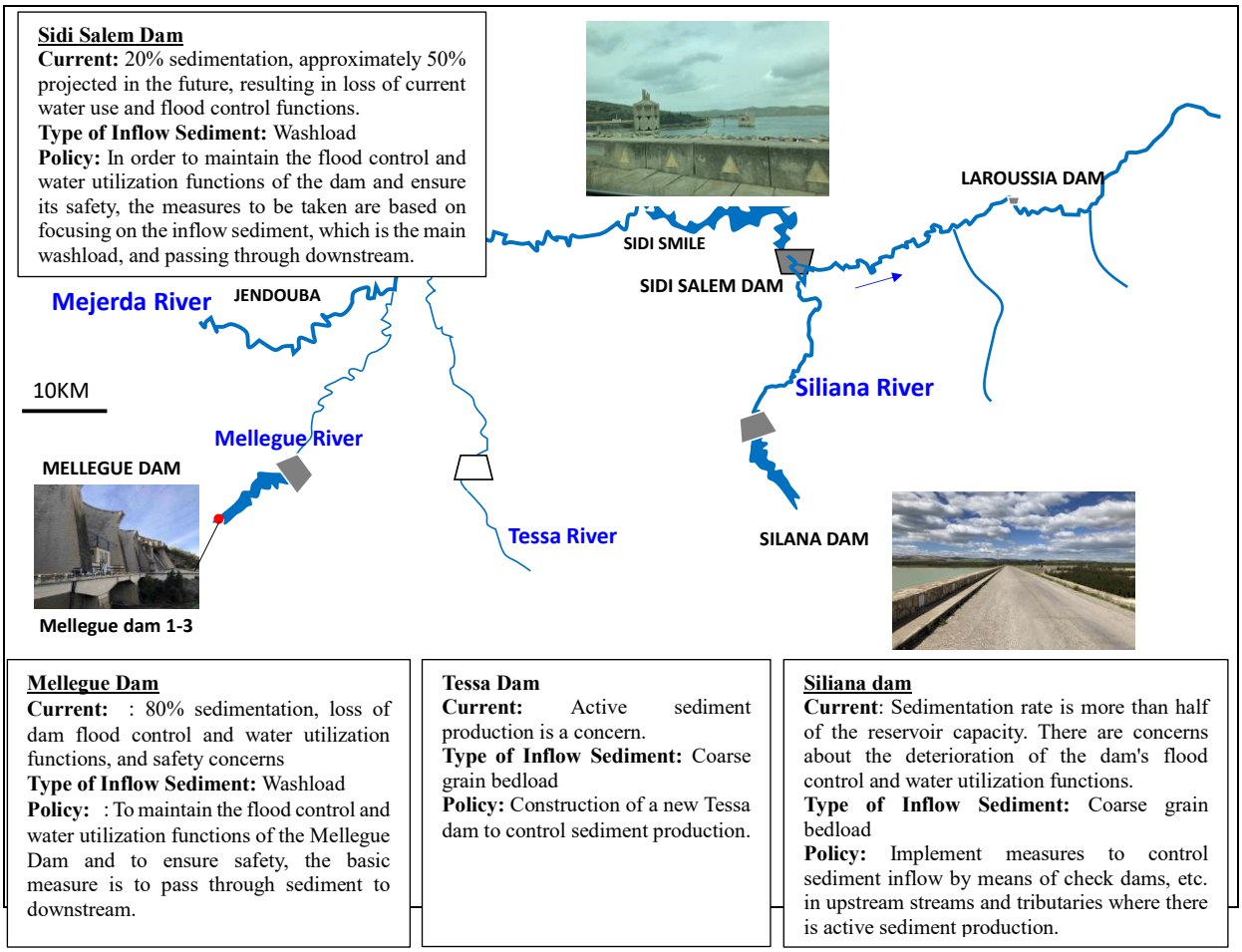


Figure 18-30 Sedimentation Countermeasure in Existing Dams

(5) Observation and Monitoring for Hydrology and Sediment Transport

Long-term observation of hydrologic data such as turbidity, water level, and flow rate is important for evaluating sediment management and reviewing plans.

In promoting comprehensive sediment management, it is important to evaluate sediment transport due to measures on a watershed-wide and reference point basis, as well as to continue to conduct research on sediment transport, review the plan, and revise it as appropriate.

Assumed observation and monitoring items are listed in Table 18-8.

Table 18-8 List of Necessary Observation and Monitoring Items

Sediment Transport	Water Level and Flow Rate
	Turbidity
	Sedimentation in Reservoirs
	Sedimentation in River Channel
	Riverbed Material
	Sediment Amount at the Reference points
Ecosystem	Distribution and population of representative organisms in each zone and environmental conservation area

Source; JICA Study Team

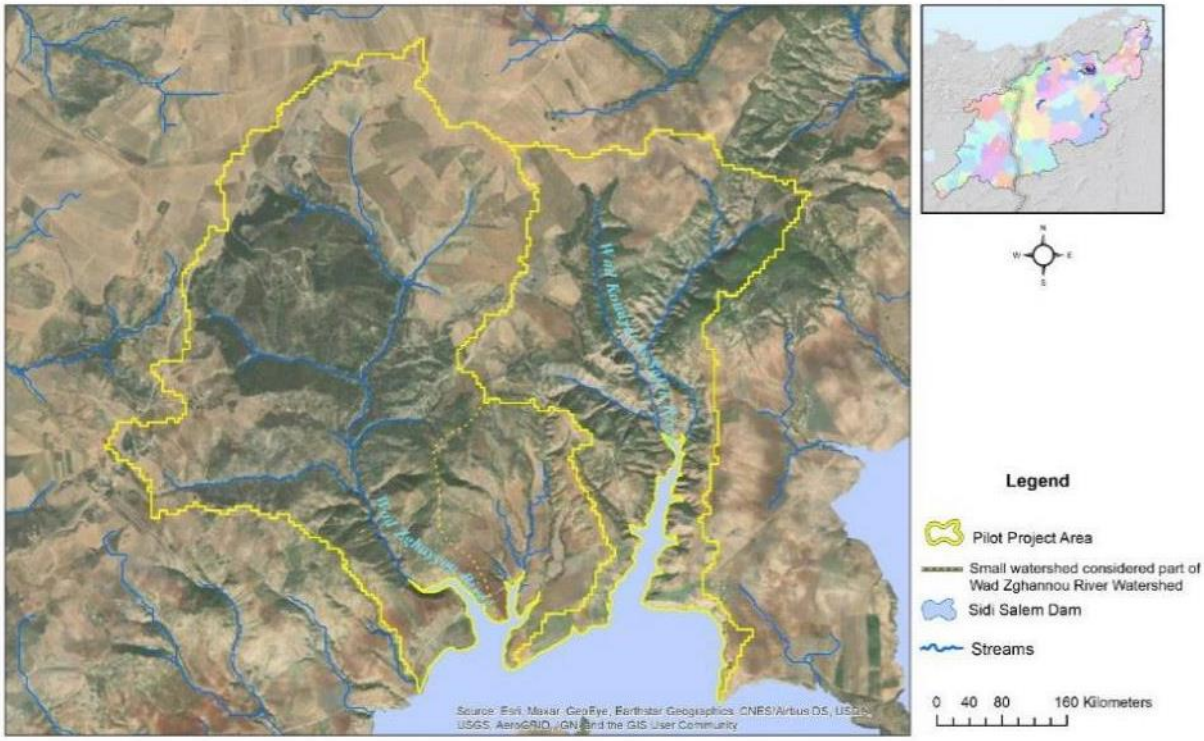
18.6 Proposal of Pilot Project for Basin Conservation Measures

18.6.1 Necessity of Pilot Project

A pilot project for watershed conservation measures will be implemented by selecting a small watershed in the upstream area of the Sidi Salem Dam Reservoir where devastation has developed. This pilot project is expected to produce the following benefits: collaboration with relevant departments within the Ministry of Agriculture, information sharing with farmland owners and the establishment of a future implementation system, increased awareness among government and residents, and technology transfer, which will be horizontally developed throughout the watershed.

18.6.2 Summary of Pilot Project Area

Considering the vastness of the entire Medjerda river basin, it was felt necessary to prepare a watershed management plan for small pilot watersheds, that were selected based on the preliminary USLE based analysis, land cover composition and vicinity to the Sidi Salem dam. The two watersheds selected as the pilot project area are (1) Wad Zghayyou River and (2) Wad Koudyat as Safra River. Since in-between the two selected pilot watersheds there is a small micro-watershed, thus, for maintaining contiguous area coverage it is also included and considered as part of Wad Zghayyon river watershed for the pilot project.



Source : JICA Study Team

Figure 18-31 Pilot Project Area

Table 18-9 Description of Target River Basin

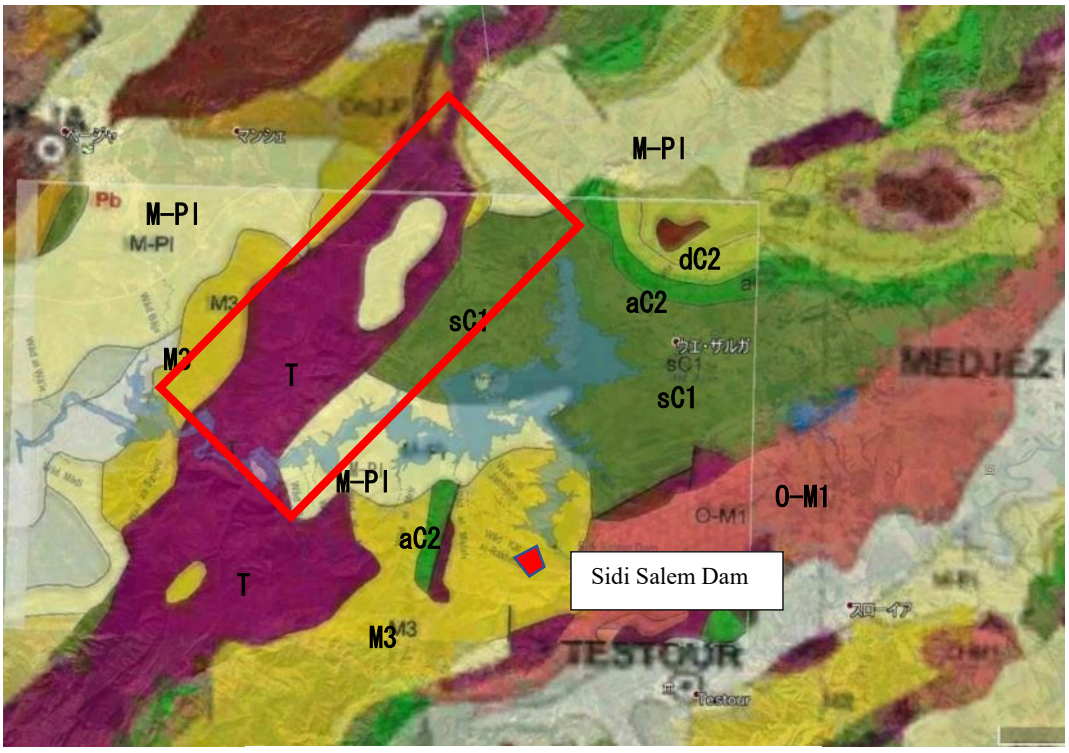
River	Catchment Area (km^2)	Slope	River Channel Length (km)
Wad Zghayyou	9.3	1/20	5.0
Wad Koudyat as Safra	4.9	1/23	3.8

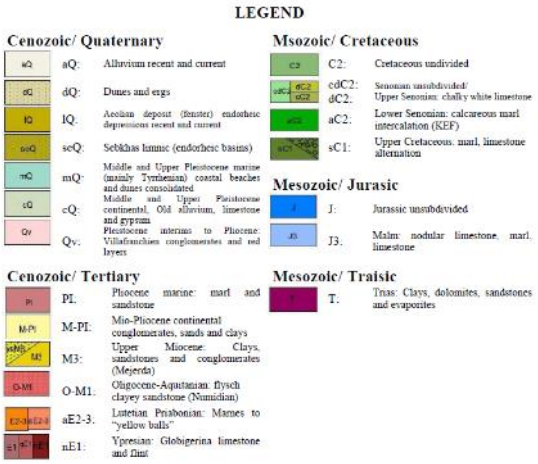
18.6.3 Outline of Geological Setting and Topography

(1) Geological Outline of the Pilot Area

The outline of geology around the pilot area of the basin conservation measures is shown in Figure 18-32, and the geological stratigraphy is shown in Table 18-10.

In the surrounding geology, the Mesozoic Triassic to Cretaceous strata are distributed as bedrock. Moreover, the Miocene to Pliocene of the Cenozoic Neogene (partly the Paleogene) is distributed above them, and the geological distribution of each is considered as shown in Figure 18-32.





Source: Former preparatory survey report, Origin: Geological Map of Tunisia 1/500,000（Office National des Mines (ONM), Editing in this report, added information by JICA Study Team

Figure 18-32 Geological Outline Surrounding the Sidi Salem Dam Reservoir

Table 18-10 Geological Stratigraphy around the Reservoir

Geological Age		Symbol	Name of	Description
Cenozoic	Quaternary	**Qdt**	detritus	Secondary sediments distributed under the slope topography. Properties depend on the host rock. It is unconsolidated and the tightness is bad. The distribution is generally thin.
		Qsdd	Sediments in the Sidi Salem Dam reservoir	Fine-grained, soft deposits accumulated in the dam reservoir by the construction of Sidi Salem Dam
		Qal	Alluvium	It is distributed in the bed of small and medium rivers. The distribution is generally small and the thickness is thin.
	Neogene	**M-Pl**	Sandstone/Shale/ Conglomerate	It is considered to be a sediment formed from Miocene to Pliocene. Mainly sandstone, consisting of shale, mudstone and conglomerate. Widely distributed on the right and left banks of the reservoir.
		M3	Sandstone/Conglomerate/ Marl	It is considered to be a sediment formed in the Miocene. It is composed of sandstone and sediment (male) in which clay and carbonate are mixed.
	Paleogene	**O-M1**	Shale/ Sandstone	It is considered to be a sediment formed in the Paleogene. Sediment mainly composed of shale and sandstone.
Mesozoic	Cretaceous	**s C1/ aC2**	Sandstone/ Mudstone/ Limestone	Marine sediments mainly composed of sandstone, limestone and mudstone. It is distributed on the east side of the reservoir.
	Triassic	**T**	Sandstone/ Slate	It consists of sedimentary rocks and carbonate-rich sediments. It is distributed upstream and downstream of the reservoir. On the downstream side of the reservoir, rock fragments show characteristic red to reddish brown. It is composed of sandstone and slate.

Source: Added to the geological legend of carte_geologique_500_000.pdf based on the field survey results of the JICA Study Team.

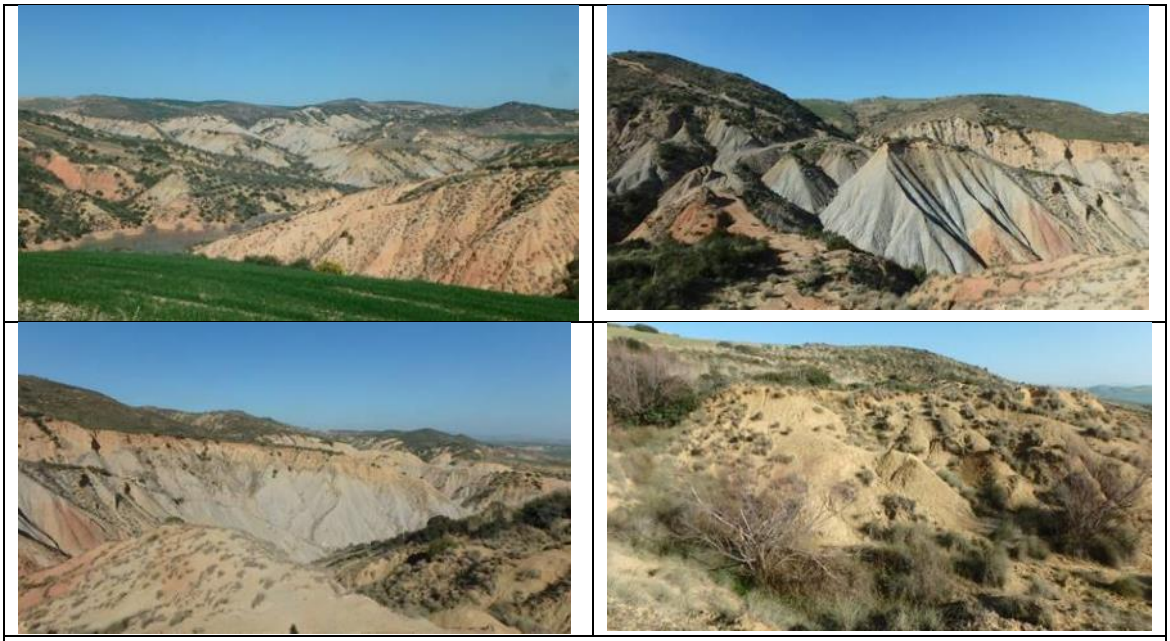
(2) Situation of the Left Bank of the Sidi Salem Dam Reservoir

1) Survey Area and Topographic Outline

Topography of the study area is shown in the Figure 18-33.

The topographical features of the study area are as follows.

- In the degraded land, there are steep slopes, and vegetation is generally poor.
- In the hills, there are some slopes that are loose or gentler than steep cliffs, and steep cliffs. On these slopes, fine particles are likely to flow out due to surface collapse and erosion. On the other hand, vegetation and sparse vegetation are observed on medium slopes, but it is also presumed that fine particles are likely to flow out due to surface erosion due to rainfall.



The Mesozoic Triassic strata are sheared, and the Neogene strata are weathered,
In both cases, the slope forms a steep cliff, and it is presumed that there is a large amount of sediment runoff due to surface erosion.

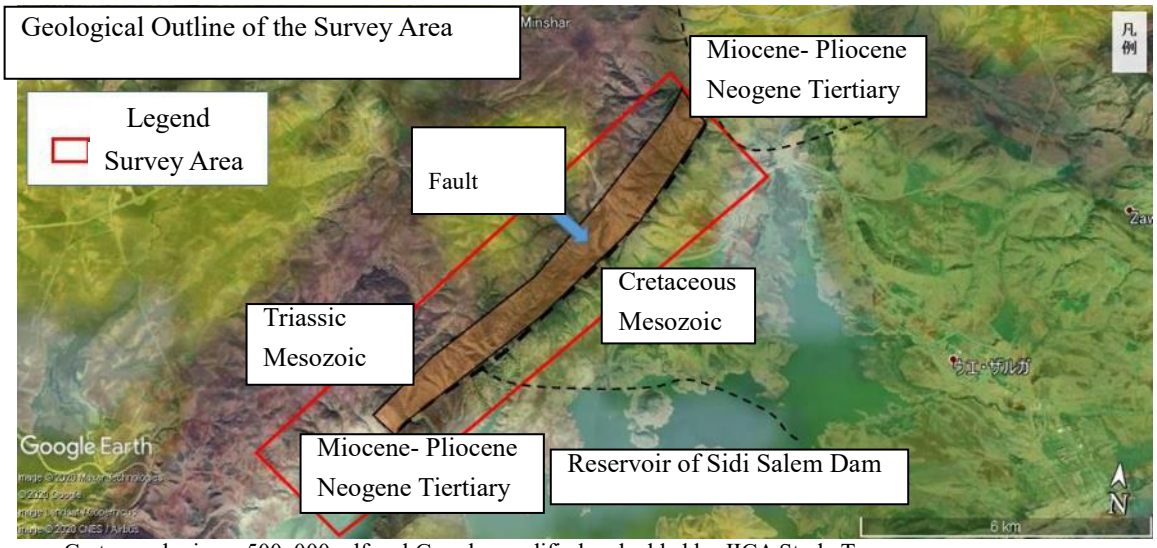
Source : JICA Study Team

Figure 18-33 Topographical Feature of the Devastated Areas in the Left side Bank of the Sidi Salem Dam Reservoir

2) Geology of the Surve Area

The geological condition confirmed by the site survey results is shown in the Figure 18-34.

As described in 5.2.2.1 Geological overview, the geology of the area is mainly consisted on the Triassic of the Mesozoic as basement rock and the geology formed in the Miocene to Pliocene of the Cenozoic. According to the results of the field survey, basement rocks with extremely high-angled bedding plane and Neogene formations with almost horizontal bedding plane are distributed in close proximity, therefore it is assumed that both are in contact with fault or unconformity. The basement rock forms a wide fracture zone.



Source : Carte_geologique_500_000.pdf and Google, modified and added by JICA Study Team

Figure 18-34 Geological Condition of the Devastated Areas in the Left side Bank of the Sidi Salem Dam Reservoir

The following points can be mentioned as geological features both of Mesozoic and Neogene layer.

- The strata formed in the Triassic of the Mesozoic era are mainly composed of sandstone, slate and conglomerate.
- The Cenozoic Miocene to Pliocene strata mainly consist of sandstone, shale and conglomerate.
- The Mesozoic Triassic strata are in the form of fault fracture zones, although hard parts can be seen in the degraded areas and outcrops along the tributaries.
- The Neogene Miocene to Pliocene strata have relatively good consolidation in the fresh zone. However, the surface area is softened due to weathering. In particular, the shale area and the fine-grained matrix portion of sandstone and conglomerate tend to be fine-grained particles such as silt or clay.

The stratum formed in the Triassic of the Mesozoic is a fault fracture zone.
Sediment is slightly thicker on the riverbed.

Source : JICA Study Team

Figure 18-35 Rock Condition around the Fault Line

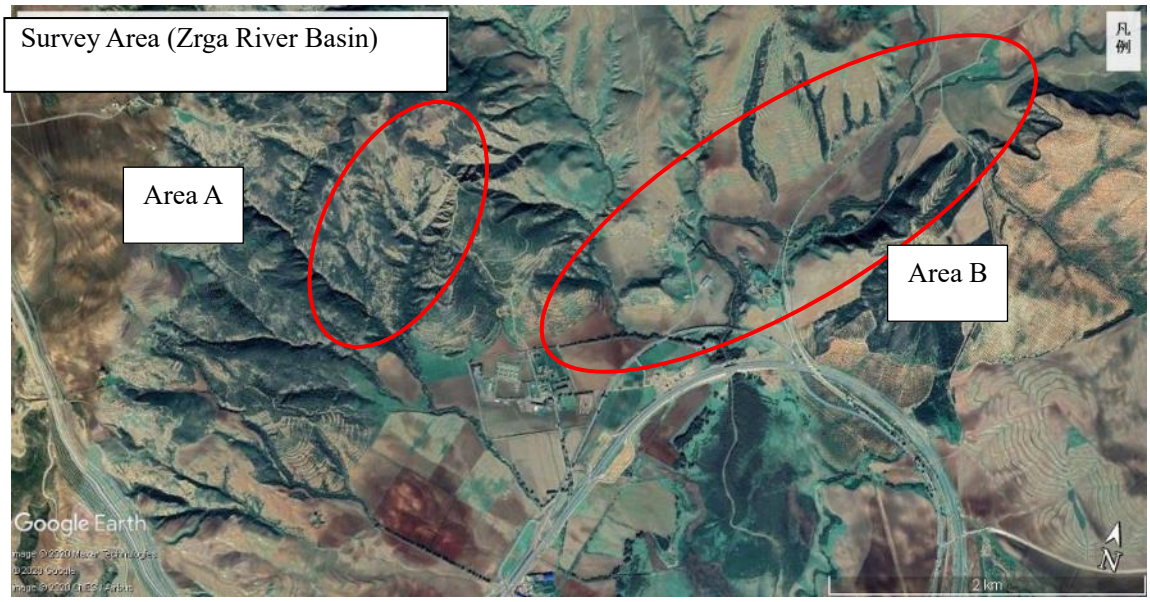
(3) Situation in the Downstream of the Zarga River Basin

1) Survey Area and Topographic Outline

The topography of the survey area is shown in Figure 18-35.

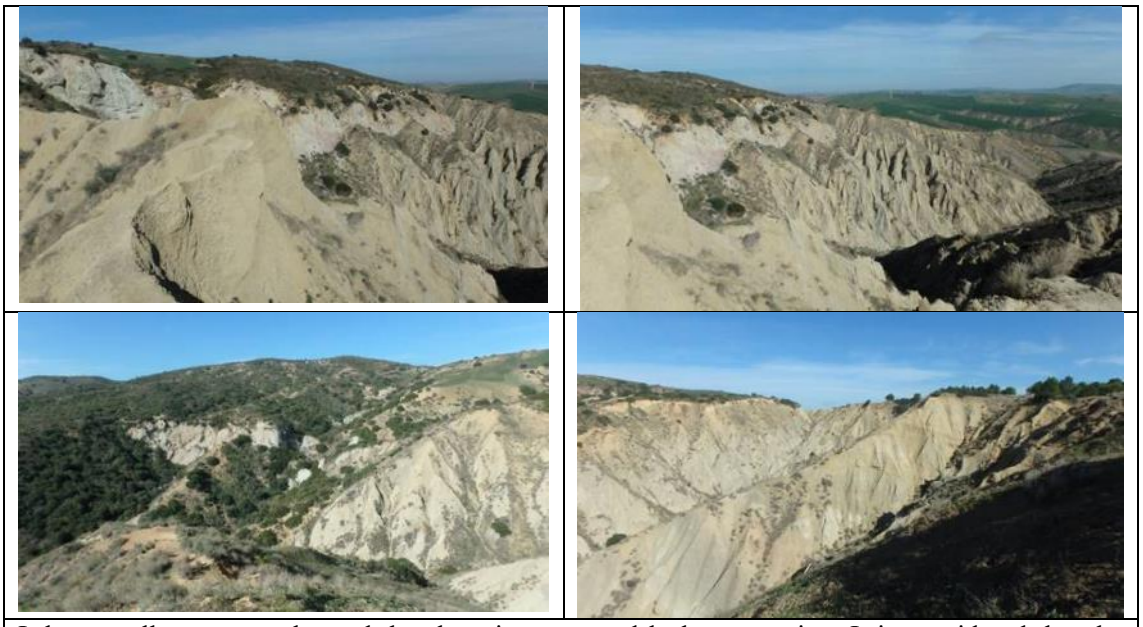
The topographical features of the survey area are as follows.

- In Area A, the terrain along the stream forms a steep slope, and vegetation is generally poor. Also, those steep slopes have been eroded on the surface and are generally bare lands. On these slopes, fine particles are likely to flow out due to surface collapse and erosion. On the other hand, vegetation and sparse vegetation are observed on medium slopes, but it is presumed that fine grains are likely to flow out due to surface erosion due to rainfall.
- Area B forms a flat land along the valley. The slopes along the valleys are relatively gentle on the whole, but some slopes along the current rivers form relatively steep slopes. Some of these slopes have become attack slopes due to the present rivers, and some slope collapses are observed here and there. In addition, the slope that was the attack slope in the past also forms a steep slope. It is presumed that these slopes discharge fine grains due to the increase in river water caused by rainfall and the accompanying slope erosion.



Source : JICA Study Team

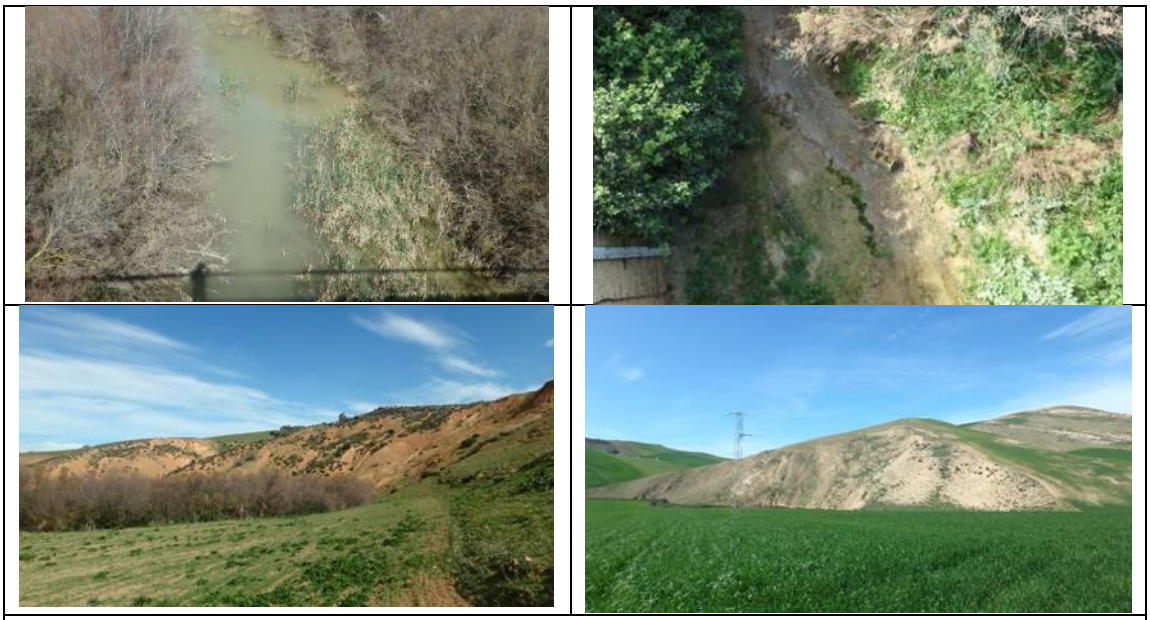
Figure 18-36 Topographical Feature of the Devastated Areas along the Zarga River



It has a valley topography and the slope is steep, and lacks vegetation. It is considered that the production and runoff of sediment containing a large amount of fine particles are significant.
According to the existing geological map described below, the upper photo shows sedimentary rocks formed in the Cenozoic Neogene, and the lower photo shows strata formed in the Mesozoic Cretaceous. Both show sheared appearance.

Source : JICA Study Team

Figure 18-37 Topographical Feature of the Devastated Areas along the Zarga River (Area A)



In general, the topography and slope of the Cenozoic Neogene strata are relatively gentle. However, some landslides are found here and there. Turbidity is observed in the river near the railway bridge, but there is currently no turbidity in the river in the tributary. It is considered that there is little outflow of sediment containing fine grains under normal conditions, and production / runoff occurs during rainfall.

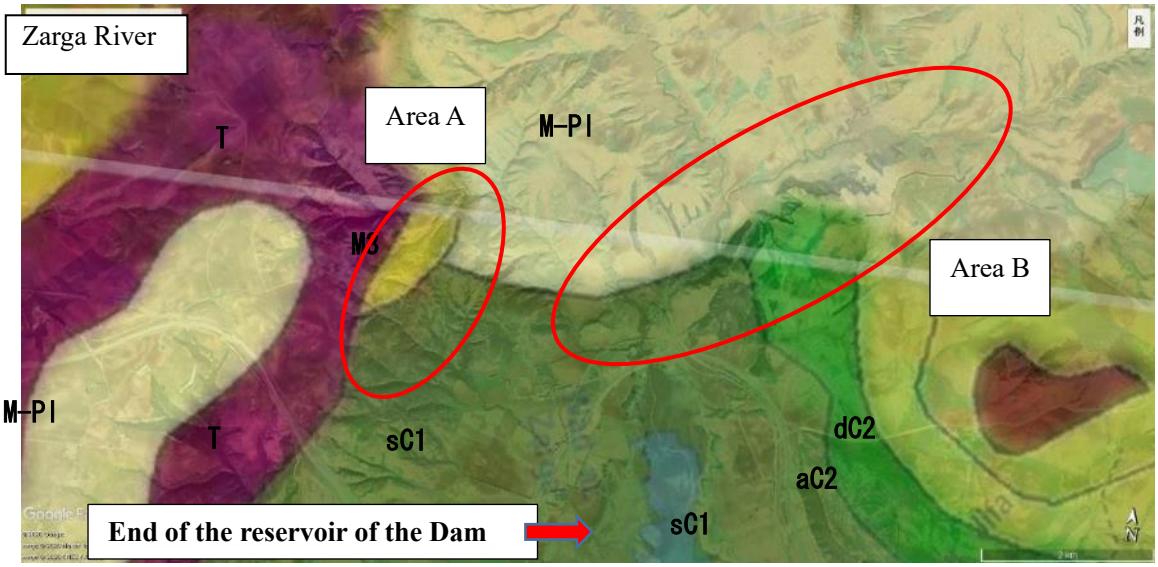
Source : JICA Study Team

Figure 18-38 Topographical Feature of the Devastated Areas along the Zarga River (Area B)

2) Geology of the Survey Area

The geological condition is shown in the Figure 18-39.

The geology of the area is that the Mesozoic Cretaceous layer is covered by the Neogene Cenozoic layer with unconformity, and downstream side of the reservoir is consisted on the Cretaceous layer and upstream of it is consisted on the Neogene layer. The Area A is located on the northward extension of the fault shear zone found in the devastated area on the left bank of the Sidi Salem Dam, so there is a possibility the geological boundary is a fault.



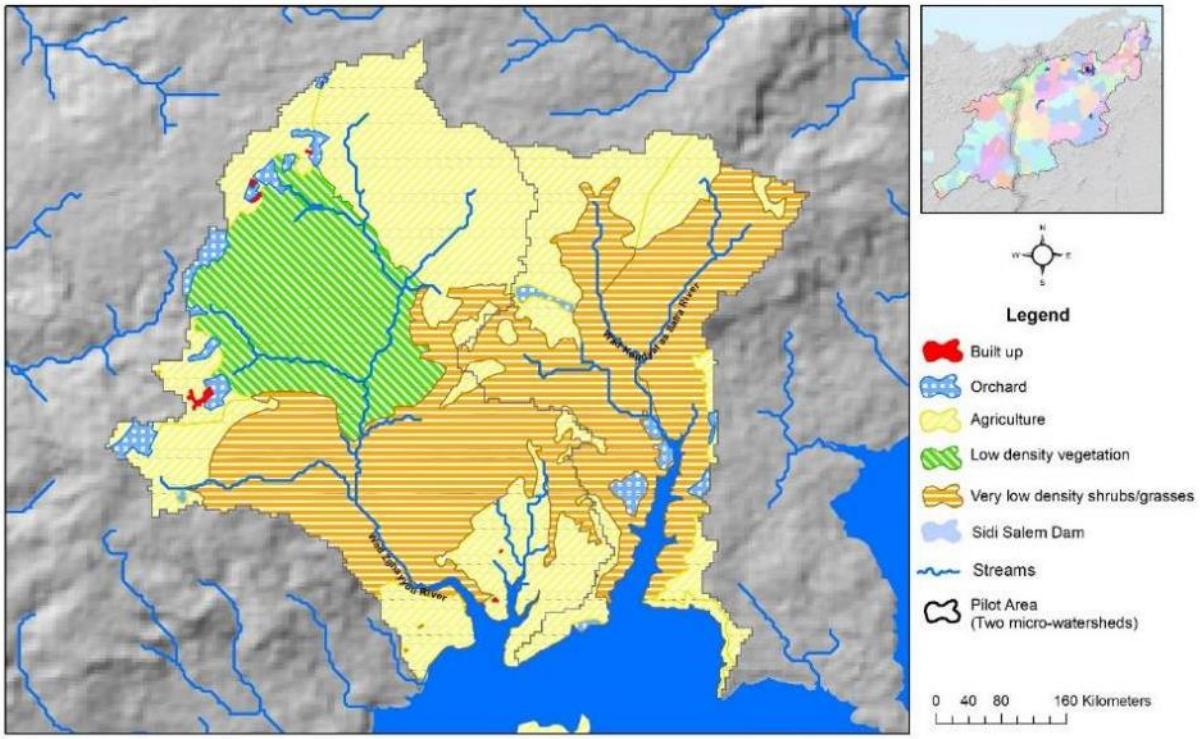
Source: Carte_geologique_500_000.pdf and Google, modified and added by JICA Study Team
Note) Geological name of figure refer to Table 5-2

Figure 18-39 Geological Condition of the Devastated Areas along the Zarga

18.6.4 Physical setup

(1) Land cover

Majorly the area in the selected micro-watersheds is under 4 dominant land cover classes, viz. very low-density shrubs/grasses (41.43%), low density vegetation (15.82%), Agriculture (39.74%), and Orchards (2.88%) (Table 18-11).



Source : JICA Study Team

Figure 18-40 Board Land Cover Map of the Pilot Site

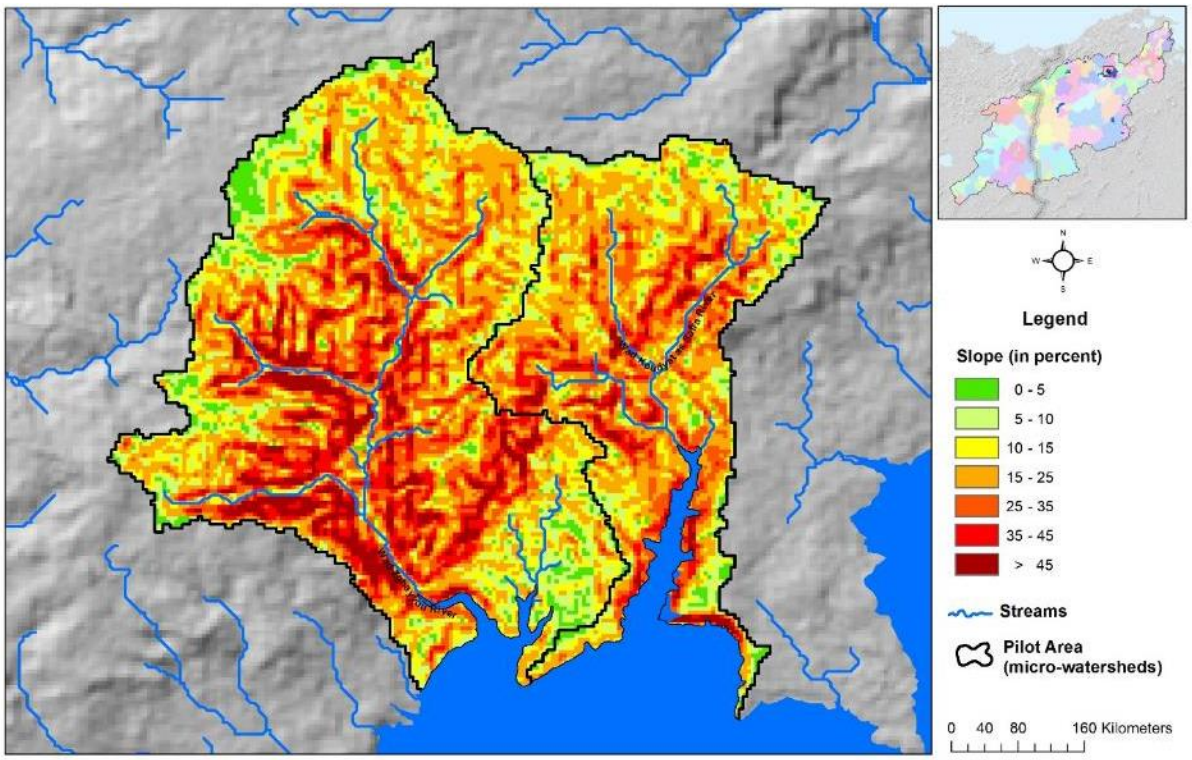
Table 18-11 Area under Different Land Cover Classes

Land Cover classes	Wad Zghayyou River watershed (1)		Wad Koudyat as Safra River watershed (2)		Total Area (1 and 2)	
	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)
Built up	1.99	0.19%	0.04	0.01%	2.03	0.13%
Orchards	27.32	2.63%	18.21	3.34%	45.53	2.88%
Agriculture	441.12	42.47%	188.27	34.55%	629.39	39.74%
Low density vegetation	250.6	24.13%	NIL	0.00%	250.6	15.82%
Very low-density shrubs/grasses	317.72	30.59%	338.33	62.10%	656.05	41.43%
Total	**1038.75**	100.00%	**544.85**	100.00%	**1583.6**	**100.00%**

Source : JICA Study Team

(2) Slope

In the watersheds the slopes are very steep and around 64.92% area falls under strongly sloping to steeply sloping categories whereas 16.13% area falls under very steeply sloping category (Table 18-12).



Source : JICA Study Team

Figure 18-41 Slope Map of the Pilot Site

Table 18-12 Area under Different Slope Categories

Slope category	Slope	Wad Zghayyou River watershed		Wad Koudyat as Safra River watershed		Total Area (both watersheds)	
	(%)	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)
Gently Sloping	0-5	65	6.23%	27	5.01%	92	5.81%
Moderately Sloping	5-10	138	13.31%	70	12.82%	208	13.14%
Strongly Sloping	10-15	167	16.12%	88	16.07%	255	16.10%
	15-25	291	28.01%	199	36.50%	490	30.93%
Steeply Sloping	25-35	182	17.52%	101	18.60%	283	17.89%
Very Steeply Sloping	35-45	108	10.43%	42	7.63%	150	9.47%
	> 45 %	87	8.39%	18	3.37%	105	6.66%
Total		**1038.75**	100.00%	**544.85**	100.00%	**1583.60**	100.00%

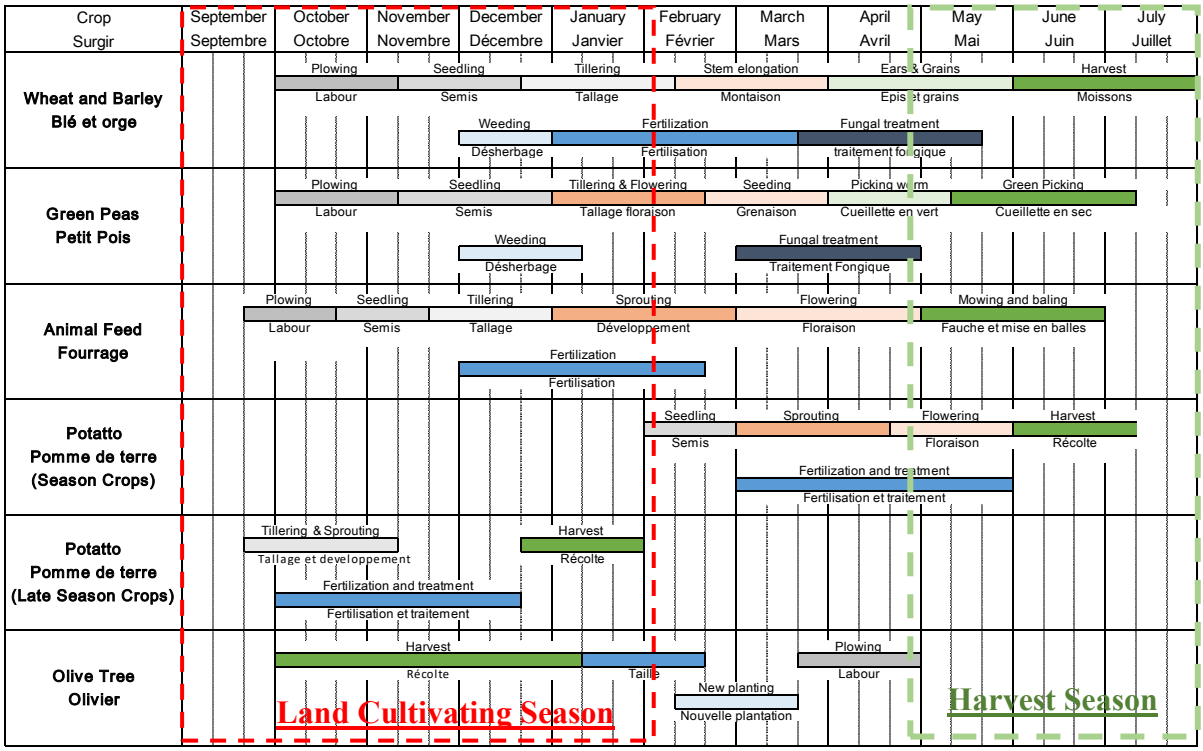
Source : JICA Study Team

In the pilot area the main region of vulnerability to high erosion are very low-density shrubs/grasses cover on predominantly very steep slopes as well as agriculture areas located on moderately sloping to steeply sloping terrain.

18.6.5 Agricultural Cycle

The farmland is used primarily for cattle feeding, olive groves, and grain (wheat), and farmers are distributed throughout the area. Based on interviews with farmers in the area, the main agricultural crop patterns around the reservoir are shown in Figure 18-41.

Crop harvesting is concentrated in the dry season from May to July, and crops are rarely grown during the rainy season (flood season), resulting in the devastation of farmlands and the development of a surface erosion process caused by rainfall.



Source: JICA Study Team

Figure 18-42 Agricultural Crop Pattern around Sidi Salem Dam Reservoir

18.6.6 Identification of Major Issues and their Probable Causes

Some of the major issues identified during the site visit and after analyzing the available information/ data in the pilot project area are discussed below:

(1) Soil erosion

Soil erosion is high due to the following reasons:

a. Considering the terrain and slope condition, which ranges from moderately sloping to steeply sloping terrain, usage of heavy mechanized tillage equipment for agriculture makes top soil vulnerable to erosion.

Cultivation/ploughing up to Dam's water level

Deep Tillage

Source : JICA Study Team

Figure 18-43 Potential High Erosion Areas

b. Deep tillage as well as in many cases along the slope direction is not a sustainable agriculture practice that makes the soil highly vulnerable to erosion and ultimately reduces soil fertility in the long run.
c. Highly dissected hills with steep slopes devoid of vegetation cover is one of the potential causes of soil erosion and siltation of dam and is a big challenge to manage.
d. Gully formations in the high slopes due to velocity of rainwater leads to heavy sediment flow and further widening of the gullies along the channels.
e. Bank erosion along the Sidi Salem dam/ Reservoir is another cause of soil erosion and slope failure.

(2) Poverty

In the upstream of Sidi Salem dam mostly farmers are poor as agriculture is predominantly rainfed.

Agriculture on high slopes – high vulnerability to erosion

Bank Erosion – Under cutting

Bald dissected hill slopes susceptible to erosion

Low density vegetal cover inside Govt. Land

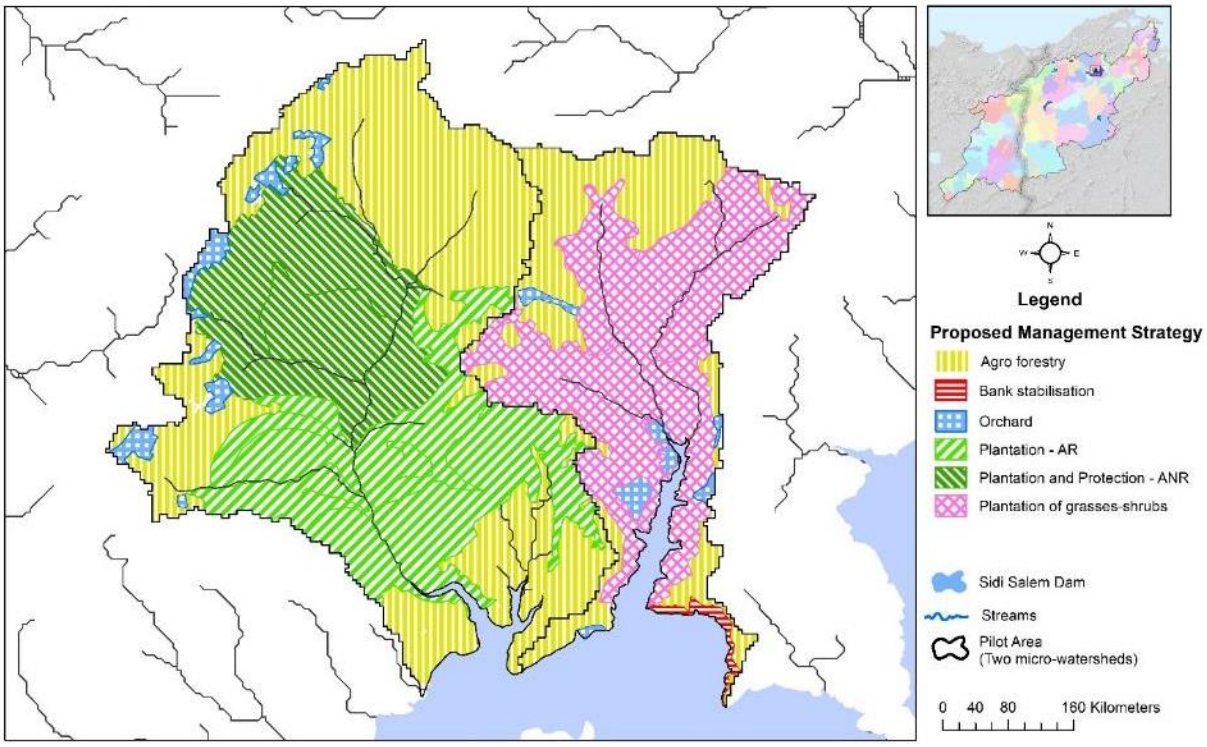
Source : JICA Study Team

Figure 18-44 Different Terrain Condition with Varying Degree of Vulnerability to Erosion

18.6.7 Watershed Management Strategy and Proposed Counter Measures

The two major objectives kept in mind before formulating the watershed management strategy are:

1. Soil management through erosion prevention and control measures
2. Livelihood enhancement and sustainability of agriculture.



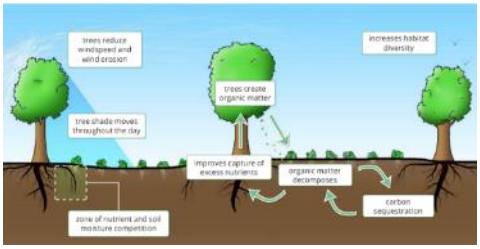
Source: JICA Study Team

Figure 18-45 Watershed Management - Proposed Strategy/ plan

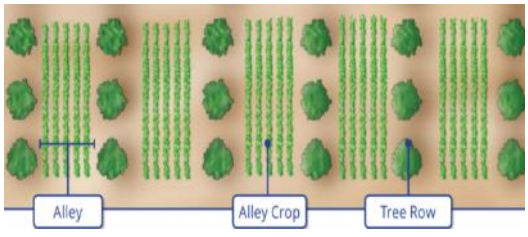
The key management strategies proposed are based on the current land use, land capability and present land ownership:

(1) Agroforestry

In the present agriculture land on the northern and southern parts of the watershed, agroforestry is proposed as an alternative to present practice of agriculture considering the terrain condition, which are primarily comprising of moderately sloping to steep slopes, in order to reduce vulnerability to soil erosion. Also, agroforestry would help in generating additional income to the farmers through plantation of horticulture fruit bearing species/ medicinal value species/ tree species that provide soil nutrition and protection. Also, as an alternative, strip cropping may also be used as another agronomic method with alternate strips of grain and forage crop.



Benefits of Allay cropping

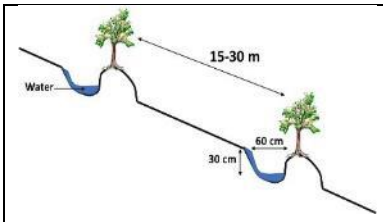


Alley cropping (an Agroforestry practice)

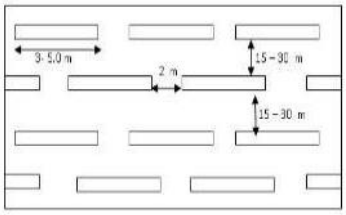
Source: Compiled by JICA Study Team

Figure 18-46 Agroforestry/ Allay Cropping

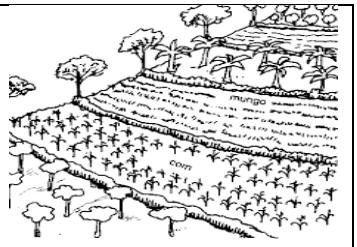
As a counter measure to high vulnerability to erosion it is suggested to go for Staggered Contour Trenching (suitable for 10 - 25% slopes) with plantation of horticulture trees species (as part of agroforestry model) in a strip along the contours in the present agricultural land in northern part. On the other hand, Contour Bunds (suitable for < 10% slopes) are proposed with plantation of horticulture tree species in a strip along contours on the bunds in relatively gentle slopes in the southern part of the pilot area (refer Figure 18-47).



Staggered Contour Trenching profile



Perspective view – Staggered Contour trenching



Bunds along contour lines

Source: Compiled by JICA Study Team

Figure 18-47 Contour Trenching and Contour Bunding

(2) Orchards:

In the present Orchard areas, cover crop in between the tree species is suggested as a counter measure to check erosion as well as to control pests, weeds and diseases.

(3) Plantation:

a. Artificial Regeneration (AR):

Artificial Regeneration is a plantation model suitable for degraded forest land and is also known as reforestation. It is done to fill the bare areas within the forest land. AR with fast growing suitable species is recommended for central and south-west part of the watershed having very-low density shrubs/grasses.

b. Assisted Natural Regeneration with enrichment planting (ANR):

Assisted natural regeneration (ANR) is a simple, low-cost forest restoration method that can effectively convert deforested lands of degraded vegetation to more productive forests. It is most effectively utilized at the landscape level in restoring the protective functions of forests for watershed protection and soil conservation. Through enrichment planting introduction of valuable species to degraded forest would be achieved without elimination of valuable species which are already existing in the areas.

c. Plantation of grasses-shrubs through Hydroseeding:

The central and north-eastern part of the pilot area is mostly devoid of vegetal cover and over that it is extremely rugged with steep slopes. It is recommended that grasses and shrubs plantation is suitable for these areas to protect it from erosion. Considering the difficult terrain condition, a method called hydroseeding is suggested where slurry of water, wood fiber mulch, seed and fertilizer is premixed and is sprayed on the slopes from a truck/ air[1].

[1] . https://www.youtube.com/watch?v=kQhspskm5DU

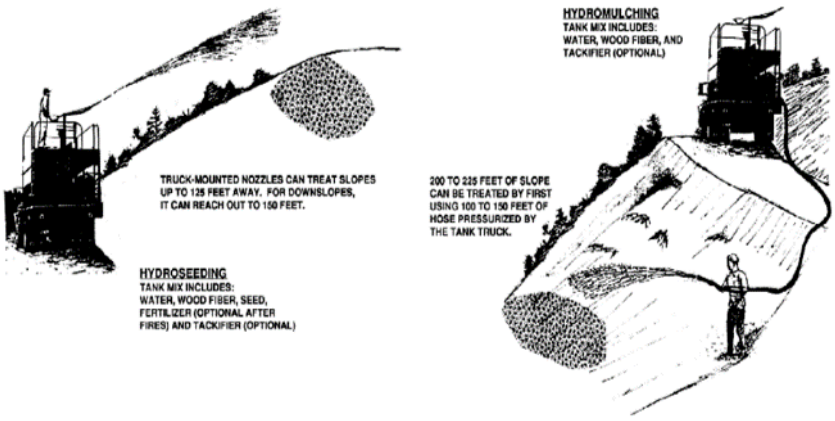


Figure 18-48 Hydro Seeding and Hydro Mulching

(4) Bank stabilization:

The fragile sloping banks of the reservoir in the south-eastern part of the watershed demand bank stabilization measures and hydro seeding is recommended as a counter measure for the same.

(5) Proposal of Construction Method for the Countermeasure against Erosion and for the Prevention of Sediment Outflow

1) Basic Policy

In the upstream area of Sidi Salem Dam, there are concerns about the impact on surrounding farm land and the progress of sedimentation in the reservoir which are due to coastal erosion. Therefore, countermeasures against coastal erosion and sedimentation will be implemented integrally by constructing sabo facilities in the upstream area and transporting the excavated sediment from the dam reservoir by dump trucks and belt conveyors.

2) Countermeasure Work Method

The outline of countermeasure works and the layout plan of sabo facilities are shown in Figure 18-49 ~ Figure 18-51.

Construction of 20 sabo facilities on the Wad Zghayyou River and 25 sabo facilities on the Wad Koudyat as Safra River is planned within the pilot area.

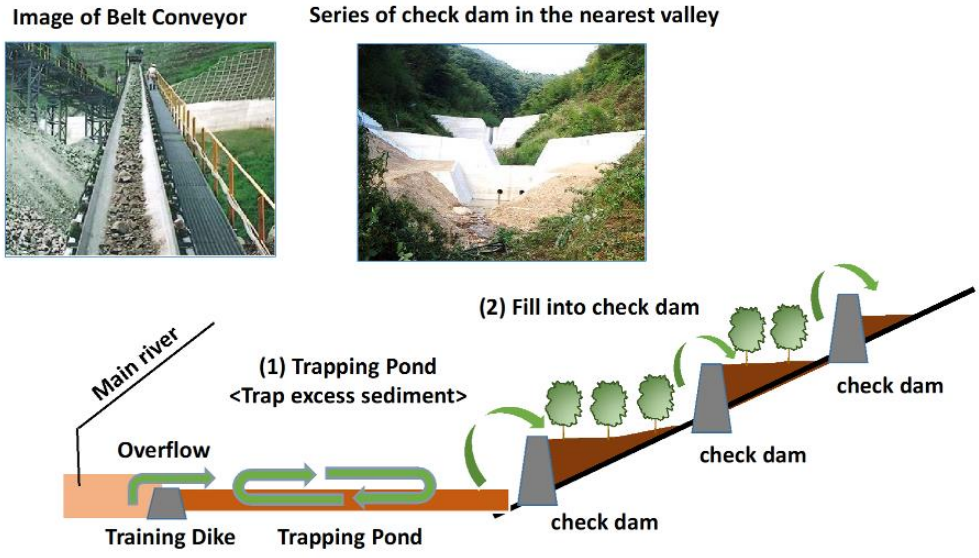


Figure 18-49 Countermeasure Works against Coastal Erosion and Sedimentation

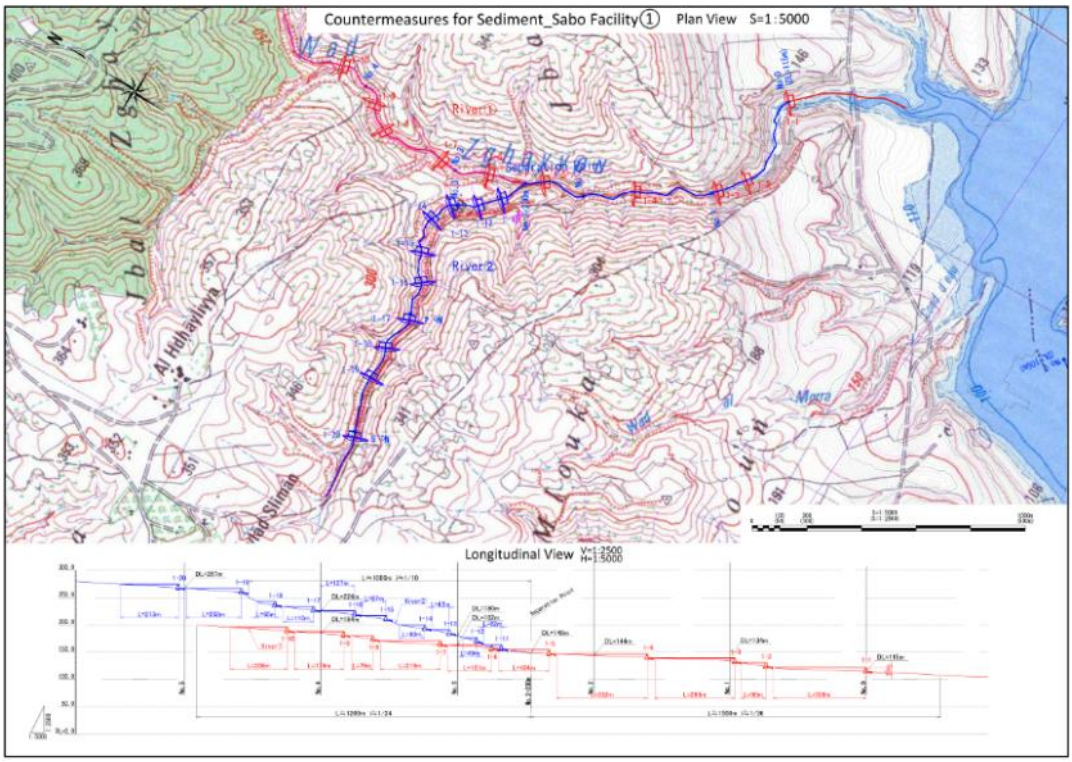


Figure 18-50 Sabo Facilities Layout Plan (1) Wad Zghayyou River

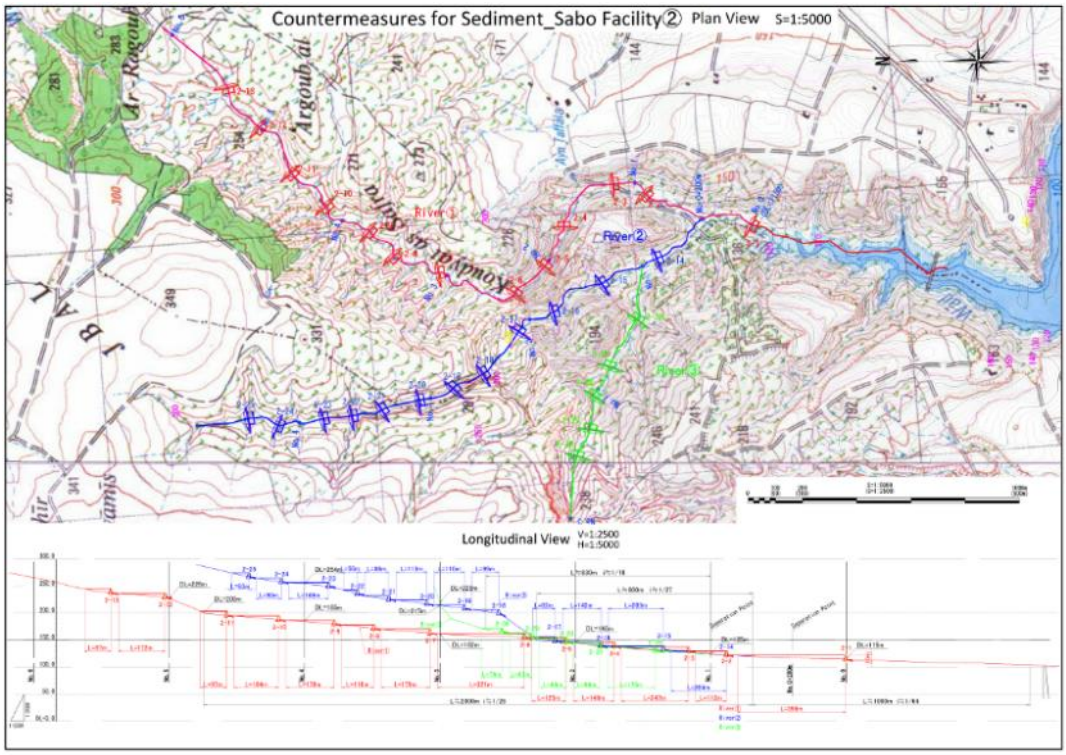


Figure 18-51 Sabo Facilities Layout Plan (2) Wad Koudyat as Safra River

18.6.8 Watershed Management Action Plan

Specific issues and their management strategy are described in detail in Table 18-13 below:

Table 18-13 Key Issues and Proposed Management Strategy for Pilot Area

Area Category	Major Issues	Causes	Proposed management strategy	Counter Measure Type	Qty	Unit	Unit Cost	Total cost
Government Owned Land								
Wadis in the watershed	Soil Erosion	Surface run-off of rainwater through steep Gullies leads to erosion in the wadis	-Series of Check dams/ Sabo dams to be construction in the identified vulnerable Wadis to check the surface flow of rain water as well as to hold/check the flow of sediments down to the reservoir. Check dams will also help in holding the moisture content for longer period and will help in groundwater recharging as well as help in growth of vegetation, that would help in stabilization of steep slopes of the wadis. (Altogether, 50 Check dams/Sabo are planned (20 on the Wad Zghayyou River and 30 on the Wad Koudyat as Safra River.) -Along the vegetated gullies natural vegetation must not be disturbed and should be kept intact.	Series of check dams	50	No.		
Central and north-Eastern part of the Pilot area covered with very low-density shrubs/grasses	-do-	Highly dissected steep bald slopes vulnerable to very high erosion	-Considering steep bald slopes in highly rugged terrain Hydroseeding technique is proposed for stabilizing the slopes by increasing the vegetal growth. - Hydroseeding technique is referred to applying a slurry of water, wood fiber mulch, seed and fertilizer to prevent soil erosion and it provides a conducive environment to plant growth. Hydro seeding can be done using a truck.	Hydroseeding	245	Ha.		
Central and south-west part of the pilot area covered with very low-	-do-	Very Low-density Vegetative cover	- Plantation (Artificial Regeneration)– Considering the very low vegetative cover it is highly recommended to take up plantation activities by planting economically and ecologically valuable fast growing native tree	Plantation-AR	174	Ha.		

Area Category	Major Issues	Causes	Proposed management strategy	Counter Measure Type	Qty	Unit	Unit Cost	Total cost
density shrubs/grasses			species.					
Western part of the pilot area covered with low-density vegetation	-do-	Low density vegetative cover	-Assisted Natural Regeneration (ANR) with Enrichment plantation in the patches that do not have enough tree cover to establish and enhance tree canopy cover. It will complement natural regeneration in restoration of economically, ecologically and socially valuable tree species. The vegetated cover would help in reducing rainwater surface runoff and helps in water absorption.	ANR with enrichment planting	56	Ha.		
Private Land (Agriculture/ Orchards)								
South-eastern part of the watershed	Bank Erosion/ slope failure	Slopes devoid of vegetation	Hydroseeding on narrow slopes is recommended	Hydroseeding	7	Ha.		
Agricultural Area on Moderate to Steep slopes mostly in the northern and southern part of the pilot area	Poverty	Mostly Rainfed Agriculture in Upstream of Sidi Salem dam	-Plantation in the upper reaches of the watershed and adoption of agroforestry technique would ensure lifesaving retention of rainwater moisture for longer duration as well as check erosion of fertile top soil.	Capacity Building/ Awareness creation/ Training (Agroforestry and Alley cropping)	10[2]	No.		
-do-	-do-	Overdependence on low value crops grown only during rainy	-Plantation of Olive, Pomegranate, Almond etc. fruits bearing trees/shrubs and grasses/ legumes along the contour trenches in hedge row planting is recommended. This would be useful for the					

[2] Number of Trainings covering practical aspects in the field for 10-15 farmers each once in a month for during first 6 months. And then once in a quarter for 1 year.

Area Category	Major Issues	Causes	Proposed management strategy	Counter Measure Type	Qty	Unit	Unit Cost	Total cost
		season	farmers as an additional source of income and would also help in reducing splash erosion in the upstream and also act as break in slope for surface run-off.					
-do-	-Soil Erosion	-Very Deep ploughing/tillage operation for land preparation. -In many places Ploughing also done in the direction of slope	- Land Tillage must always be done along the contour lines and not across the contour line. These contour lines create a water break which reduces the formation of rills and gullies during times of heavy precipitation and also allows time for the water to settle into the soil. -Awareness among farmers to reduce usage of very heavy mechanized tools and avoid very deep tillage on high slopes is recommended.	Capacity Building/ Awareness creation/ Training (Erosion control measures)	10	No.		
-do-	-do	-Lack of farm level erosion control measures on steep slopes	- Staggered Contour Trenches are proposed for farm lands along with plantation of fruit bearing trees/shrubs along the trenches as part of agroforestry model on medium to high slopes in the northern upstream areas of the watershed. -Contour Bunds are proposed for farm lands along with plantation of fruit bearing trees/shrubs under agroforestry along the bunds in the southern downstream areas.					
-do-	-Susceptibility to Loss of soil fertility due to top soil erosion	-Deficiency of agronomic measures	-Practicing Inter cropping/ alley cropping (agroforestry) between the contour trenches or rows of trees would significantly reduce the top soil erosion and helpful in maintaining soil fertility. -Crop rotation would help in maintaining soil nutrients and crop yield. -Mulching would help in reducing evaporation,	Capacity Building/ Awareness creation/ Training (Agronomic measures on Soil fertility)	10	No.		

Area Category	Major Issues	Causes	Proposed management strategy	Counter Measure Type	Qty	Unit	Unit Cost	Total cost
			retaining moisture, reducing soil erosion, suppressing weed growth and providing plant nutrients as the material decomposes					
Area under Orchards in the watershed	-Susceptibility to soil erosion and soil fertility loss.	Lack of soil conservation and overall management in Orchards	- Cover crop is a good technique to manage soil erosion, soil fertility, soil quality, water, weeds, pests, diseases etc., in orchards. To avoid competition for water between the cover crop and the tree species, an alternative method involves one or two hoeings during the hot period. -Awareness creation among Orchard owners to adopt cover crops technique by planting suitable species in the open space between rows of tree species.					
Pilot project area	Lack of quantitative data on soil erosion	-Lack of monitoring mechanism of soil erosion	-Establish Erosion measurement plots for long term monitoring of the sediment yield/erosion before and after intervention.	Setting up soil erosion recording station	2	No.		

Source : JICA Study Team

* Prioritized counter measures

The priority areas and suggested counter measures are depicted in Figure 18-52.

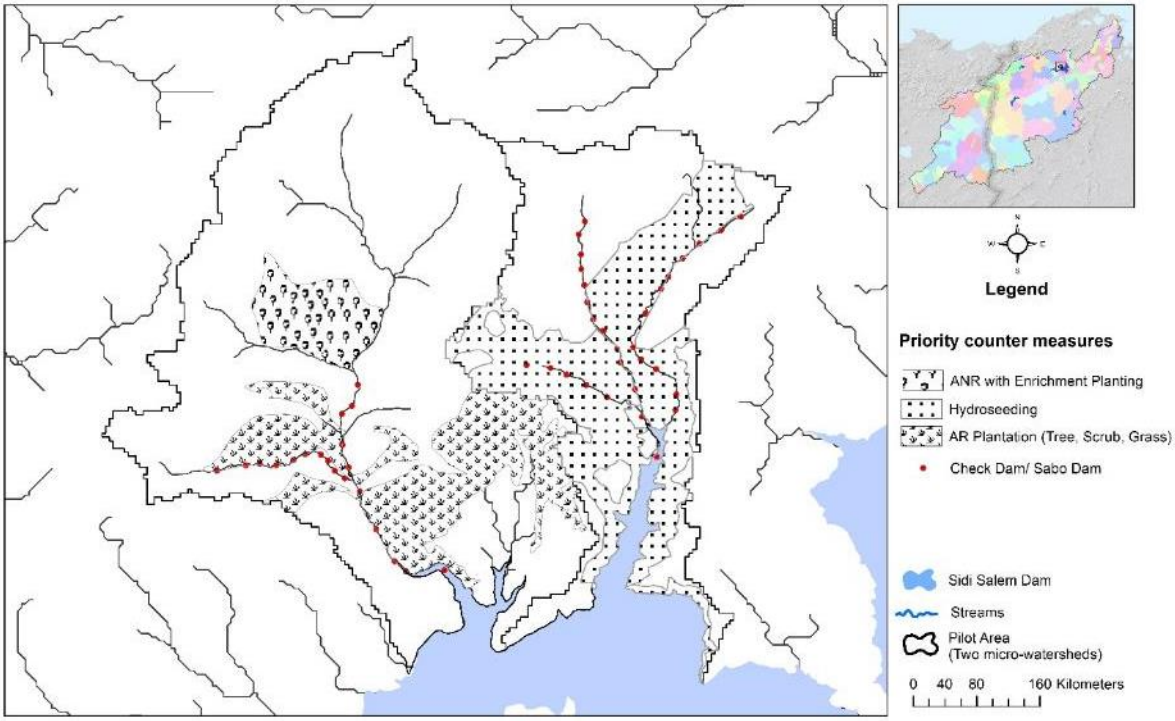
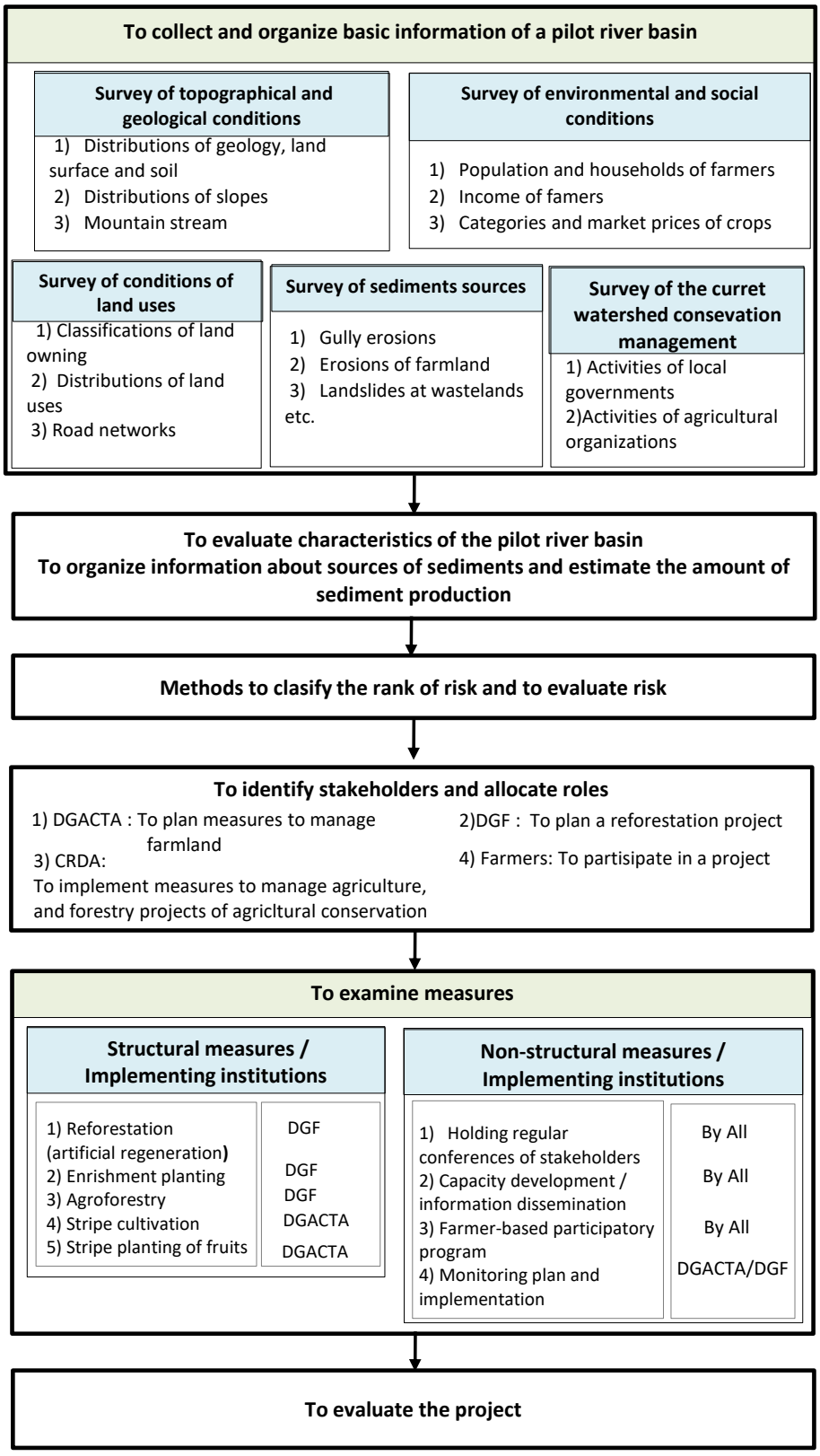


Figure 18-52 Prioritized Areas and Counter Measures

18.6.9 Implementation Schedule for Pilot Project

Figure 18-53 and Figure 18-54 show the implementation flow and schedule (draft) of the pilot project. In this pilot project, risk assessment, structural and non-structural measures based on watershed characteristics such as natural and socioeconomic conditions will be considered for the purpose of agricultural land and soil conservation, etc. in the pilot watershed. In addition, the project will identify stakeholders and organize the division of roles related to the implementation of these measures. The implementation schedule of this project is approximately 6 years from the survey to collect basic information on watershed characteristics, construction of countermeasures, and monitoring of the effects of the countermeasures.



Source: JICA Study Team

Figure 18-53 Implementation Flow (Draft) for Watershed Conservation at Pilot Area

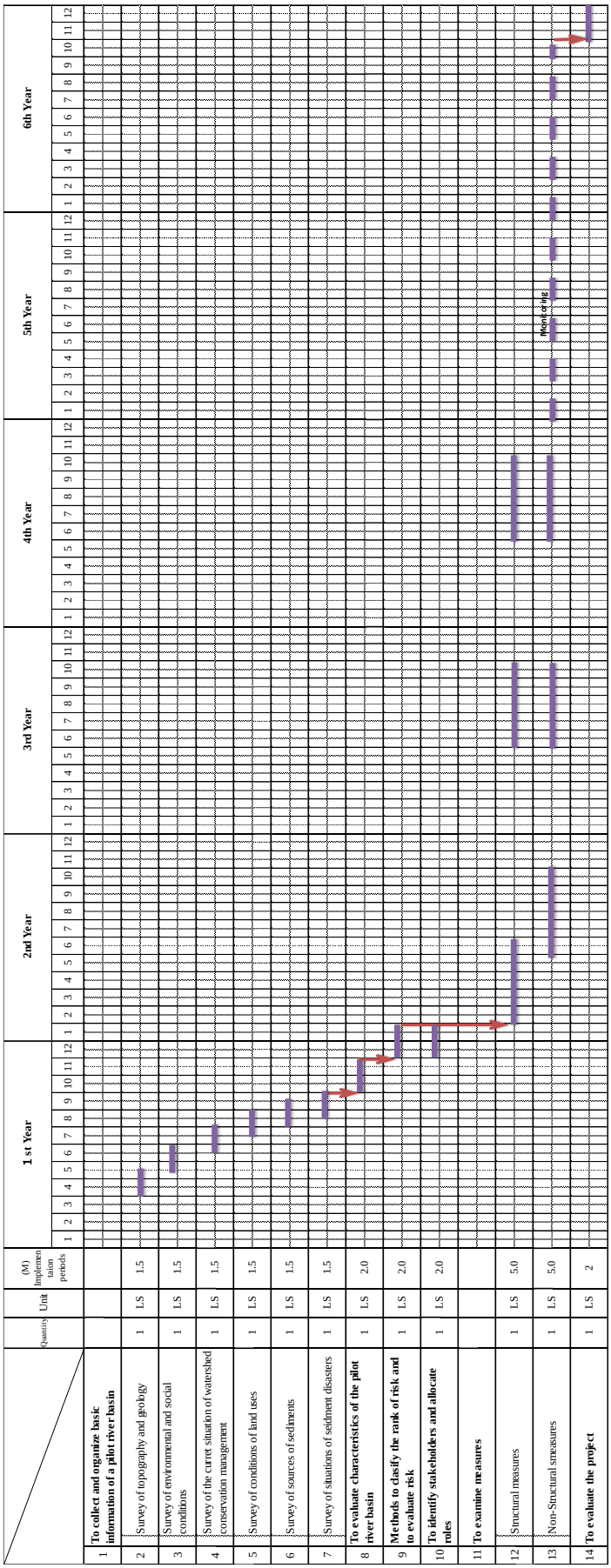


Figure 18-54 Implementation Schedule (Draft) for Watershed Conservation at Pilot Area

CHAPTER 19 ENVIRONMENTAL CONSIDERATION

19.1 Laws and Regulation for Environmental and Social Consideration

19.1.1 Laws and Regulation for Environmental and Social Consideration

(1) Law No. 88-91 dated August 2, 1998 (Amendment Law No. 92-115 dated November 30, 1992)

This Decree No. 88-91 is the law concerning the establishment of the Agence Nationale de Protection de l'Environnement (ANPE), and the first law in Tunisia that EIA implementation guidelines for projects in all sectors that lead to environmental destruction and pollution.

(2) Law No. 362-91 dated March 31, 1991

The law sets out the research required to evaluate and review the content of the EIA report in order to determine the environmental impact of the project in the short, medium and long term. Annex-1 (Categories A and B) and 2, which are annexes to the law, list the projects that are required to prepare and submit an EIA report.

Category A: The ANPE will decide on a petition of objection regarding the implementation of facilities and projects within 21 working days of receiving an EIA report of facilities and projects. If a petition of objection is not made by the ANPE within this period, it will be considered as an implicit approval of implementation.

Category B: The ANPE will decide on a petition of objection regarding the implementation of facilities and projects within three working months of receiving an EIA report of facilities and projects. If a petition of objection is not made by the ANPE within this period, it will be considered as an implicit approval of implementation.

Regarding projects that are not in categories A / B and where the negative impact of the project is very small, the mandatory to implement the project on the basis of a technical specification (Cahier discharges) signed between the proprietor and ANPE instead of the EIA.

(3) Law No. 2005-19911 dated July 11, 2005

The law amends the above-mentioned Law No. 362-91 of 31 March 1991. Article 6 of the same law provides the following minimum requirements for the content of an EIA report
Detailed Description of Projects and Facilities

The elements of the Project area and the nature of the Project/facilities that cause environmental impacts

Analysis of direct/indirect impacts, particularly on the natural environment, endangered species, protected areas (including impacts on old-growth forests, archaeological sites, and national parks, etc.)

Details of environmental mitigation measures implemented by the employer

Prepare a detailed Environment Management Plan (EMP)

Guidelines for the implementation of the environmental assessment have been prepared by ANPE. The EIA study, including the development of TORs, has been conducted by the implementing agencies in consultation with ANPE and in accordance with the guidelines.

Based on the above situation, the ANPE will ultimately decide whether the project can be implemented or not. The approval of the EIA report by the ANPE is a prerequisite for the implementation of the Project by the implementing agency (in the case of the Project, DGBGTH).The figure below shows the general EIA procedure.

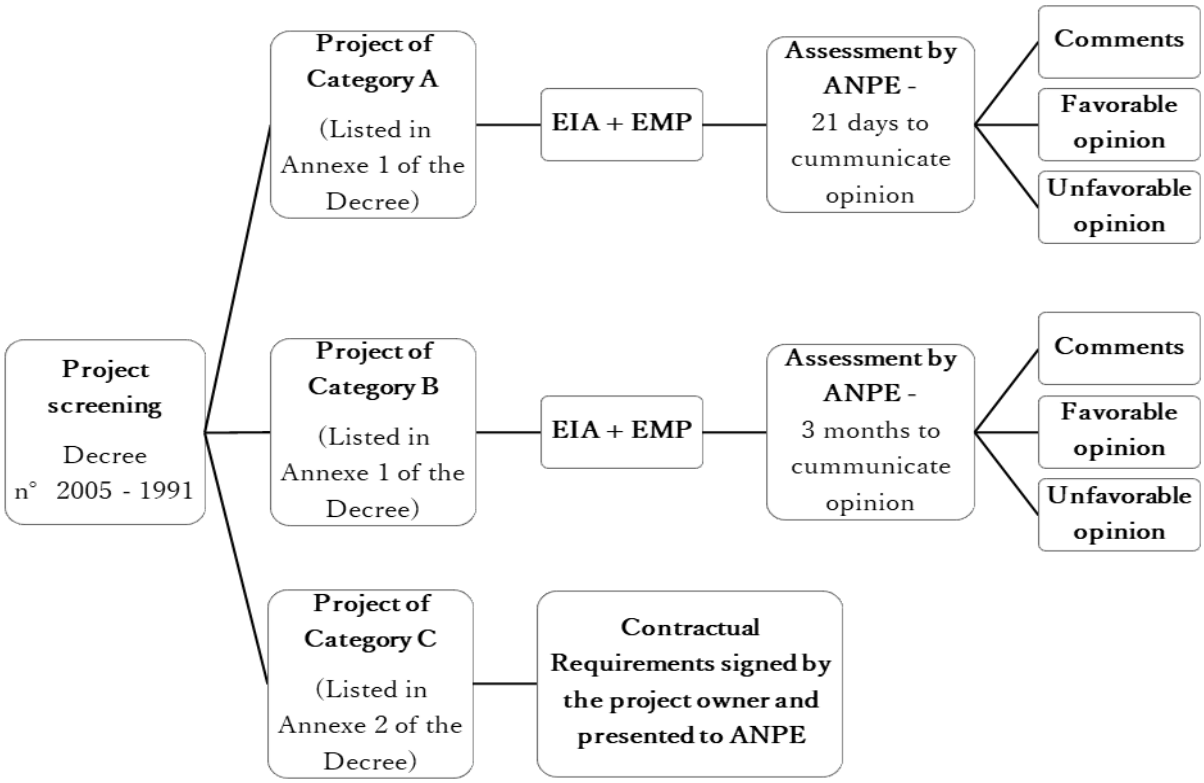


Figure 19-1 EIA process in Tunisia

(4) Need for EIA for the Project

The components of the Project, "Flood Control Project", "Sediment Dredging Project" and "River Rehabilitation Project" are not listed in the ANNEX-1 and ANNEX-2 projects to be implemented in the EIA of Decree No. 362-51. Therefore, according to national legislation, no EIA or environmental permit is required for the activities planned under the Project. The implementation of the Project and associated subprojects does not require the formal submission of an EIA to the ANPE, which is responsible for environmental permitting.However, according to interview with ANPE in January 2020, ANPE commented that ANPE and DGBGTH will need to discuss the need to conduct EIAs on a case-by-case basis, based on the scale and impact of the Project, and their comments remain unchanged as of March 2022.ANPE and DGBGTH will need to discuss the Project plan once it has been outlined.

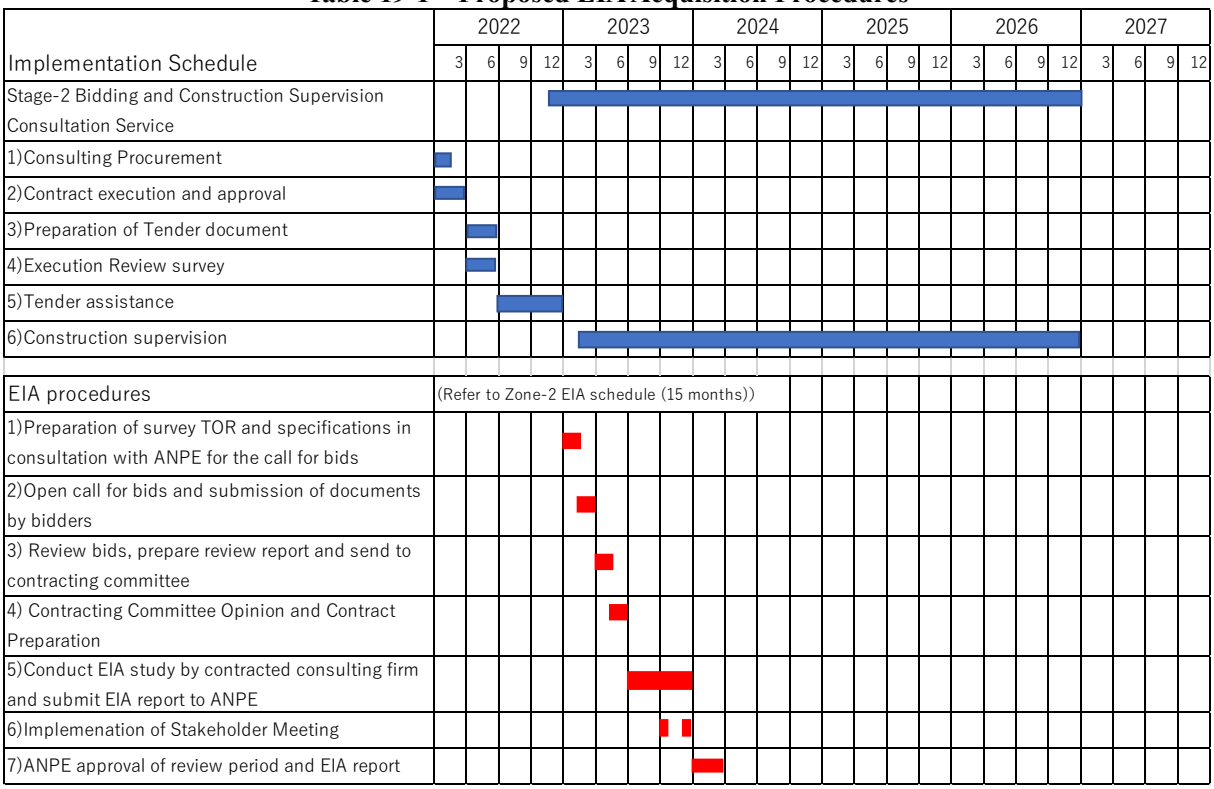
It should also be noted that national laws/regulations relating to EIA and environmental licensing is currently under revision. The laws/regulations to be revised may set up entirely new processes for environmental and social impact assessment (e.g. screening, public consultation, managing the application of environmental and social management plans (ESMPs)), in line with World Bank procedures and requirements. As of March 2022, the laws/regulations had not yet been revised.

DGBGTH is cautious about holding discussions with ANPE at a stage when the project has not been finalized, saying it is premature. The DGBGTH will determine the appropriate time for final consultation.

(5) Anticipated EIA Schedule

Based on the above, if ANPE determines that an EIA is required for the Project, the anticipated EIA procedure schedule is shown in the table below. The acquisition of EIA procedure is expected to begin in January 2023 and is expected to take 15 months.

Table 19-1 Proposed EIA Acquisition Procedures



Source:JICA Study Team

19.1.2 Environmental Standard

(1) Water Quality Standard（Tunisian Standards NT 106.02, 1989）

Water quality standards that are applied when discharging wastewater from facilities such as factories to public water bodies such as rivers and seas are specified in "Tunisia Standard 106.02, 1989".

Table 19-2 Tunisian National Water Discharge Standards

Parameter	Unit	Public Waters	Public River	Public Health	IFC EHS Guidelines*1
A - TSS, BOD, COD					
TSS	mg/l	30 40 if maximum daily load does not exceed 15 kg/d 50 in case of lagoon-based WWTP with a maximum daily load that don't exceed 15 kg/d		400	50
Biochemical Oxygen Demand (BOD)	mg NO_2/l	30 40 if maximum daily load does not exceed 15 kg/d 50 in case of lagoon-based WWTP with a maximum daily load that does not exceed 15 kg/d		400	30
Chemical Oxygen Demand (COD)	mg NO_2/l	125 160 if maximum daily load does not exceed 50 kg/d		1000	125
B - Nitrogen and Phosphorus					
Nitrates	mg NO_3/l	90	50	90	(Total Nitrogen) 10
Nitrites	mg NO_2/l	5	0.5	10	
Kjeldahl nitrogen	mg N/l	30	5	100	-

Parameter	Unit	Public Waters	Public River	Public Health	IFC EHS Guidelines*1
Total phosphorus	mg/l	2	2	10	2
C - Other Parameters					
Temperature	°C	35	25	35	-
Colour	mg/l Platinum-cobalt scale	100	70	To set as appropriate	-
pH		6.5<pH<8.5	6.5<pH<8.5	6.5<pH<9	6.5<pH<9
Settleable solids	ml/l after 2h	0.3	0.3	-	-
Chloride	mg/l	-	700	700	-
Conductivity	µS/cm	-	5000	5000	-
Active chlorine	mg Cl_2/l	0.6	0.6	1	-
Chlorine dioxide	mg/l	0.2	0.2	0.5	-
Active bromine	mg/l	0.2	0.2	1	-
Sulphate	mg/l	1000	600	500	-
Magnesium	mg/l	2000	300	300	-
Calcium	mg/l	-	500	-	-
Potassium	mg/l	1000	50	50	-
Sodium	mg/l	-	700	1000	-
iron + aluminum	mg/l	5	5	10	-
Sulphide	mg/l	2	1	3	-
dissolved fluorides	mg/l	3	3	3	-
Phenol index	mg/l	0.5	0.5	1	-
Saponifiable fats and oils	mg/l	10	10	30	-
Total aliphatic hydrocarbons	mg/l	10	2	10	-
Anionic Detergents - Alkyl Benzene Sulfonate	mg/l	2	1	5	-
Boron	mg/l	20	2.4	2.4	-
Copper	mg/l	2	2	2	-
Tin	mg/l	2	2	2	-
Manganese	mg/l	1	1	1	-
Zinc	mg/l	5	5	5	-
Cobalt	mg/l	0.5	0.5	0.5	-
Barium	mg/l	10	0.7	10	-
Silver	mg/l	0.1	0.1	0.1	-
Arsenic	mg/l	0.1	0.1	0.1	-
Cadmium	mg/l	0.01	0.01	0.1	-
Cyanide	mg/l	0.1	0.1	0.5	-
Hexavalent chromium	mg/l	0.1	0.05	0.5	-
Trivalent chromium	mg/l	0.5	0.5	0.1	-
Antimony	mg/l	0.1	0.1	0.2	-
Nickel	mg/l	1	0.2	1	-
Selenium	mg/l	0.5	0.05	1	-
Mercury	mg/l	0.005	0.005	0.01	-

Parameter	Unit	Public Waters	Public River	Public Health	IFC EHS Guidelines*1
Lead	mg/l	0.5	0.1	1	-
Titanium	mg/l	1	1	2	-
Halogenated organic compounds	mg/l	1	1	1	-
D - Microbiological Parameters					
Fecal coliform	MNP/100ml	2000	2000	-	-
Fecal streptococci		1000	1000		-
salmonella		Absence	Absence	-	-
Cholera vibrios		Absence	Absence	-	-
Eggs of intestinal nematodes	arithmetic mean	< 1/1000 ml	< 1/1000 ml	-	-

Note：Environmental, Health, and Safety (EHS) Guidelines GENERAL EHS GUIDELINES: ENVIRONMENTAL WASTEWATER AND AMBIENT WATER QUALIT （IFC）
Source:JICA Study Team

(2) Noise and Vibration

Regarding noise standards, the rules are established by each local government level. Background noise standard value and a temporarily allowable noise limit value (E dB (A): dB value that can be added to the standard value) that is applied during construction phase are defined.

These regulations for the target area are currently being collected. There is no standard for vibration.

(3) Air Quality

Regarding air quality, “Decree No. 2007-34 dated June 4, 2007” stipulates procedures for air quality management to prevent, limit and reduce air pollution and its adverse effects on human health and the environment.

In “Government Ordinance No. 2018-447 dated May 18, 2018” defines air quality item limits and warning thresholds. In “Government Order 2018-928” dated November 7, 2018 and Government Order 2519 dated September 28, 2010, abolition and supplementary order”, the limit values for the sources of air pollutants from fixed sources were defined.

JST plan to obtain the regulation value information in the future.

Table 19-3 Limit Value and Alert Value of Air Pollution[1]

Air Quality Survey Items		Limit values	Margin of tolerance in 2020	Alert thresholds	WHO Ambient Air Quality Guidelines (mg/m^3)
Nitrogen dioxide $NO_2(\mu g/m^3)$	Hourly average	200	30	400 $\mu g/m^3$ exceeded for 3 consecutive hours	200
	Annual average	40	30		40
Sulfur dioxide SO_2 ($\mu g/m^3$)	Hourly average	350	30	500 $\mu g/m^3$ exceeded for 3 consecutive hours	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	Daily average over the year	125	30		500

[1] Adapted from The governmental decree n° 2018-447, dated 18 May 2018, defines the limit values and alert thresholds for ambient air quality.

Air Quality Survey Items		Limit values	Margin of tolerance in 2020	Alert thresholds	WHO Ambient Air Quality Guidelines (mg/m^3)
Particulate Matter PM_{10} ($\mu g/m^3$)	Daily average over the year	50	10	150 $\mu g/m^3$ exceeded for 3 consecutive hours	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
	Annual average	40	6		70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3
Particulate Matter $PM_{2.5}$ ($\mu g/m^3$)	Daily average over the year	35	5		75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
	Annual average	20	1		35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
Ozone O_3 ($\mu g/m^3$)	Daily maximum of the average over 8 continuous hours	120	30		160 (Interim target-1) 100 (guideline)
Carbon monoxide CO (mg/m^3)	Maximum daily average for 8 continuous hours	10	-		-
	Maximum daily average for 1 hour	40	-		-
Benzene C_6H_6 ($\mu g/m^3$)	Annual average	5	1		-
Lead Pb ($\mu g/m^3$)	Annual average	0.5	-		-
Arsenic As (ng/m^3)	Annual average	6 (*)	-		-
Cadmium Cd (ng/m^3)	Annual average	5 (*)	-		-
Nikel Ni (ng/m^3)	Annual average	20 (*)	-		-
Hydrogen sulfides H_2S ($\mu g/m^3$)	Hourly average	200	-		-
Benzo(a)pyrene (ng/m^3)	Annual average	1 (*)	-		-

(*)calculated by reference to the total content of suspended particles whose diameter is less than or equal to 10 micrometers (PM10)

19.1.3 Other environmental laws/legislation

Other environmental laws/legislation is listed below.

(1) Water Resource

The water resource management is governed by the Waters Code promulgated by law no°75-16 of March 31th 1975. The provisions of this code are intended to prevent and manage water pollution in order to meet or reconcile the requirements of the drinking water supply; public health; agriculture, industry, and all other human activities of general interest; and the biological life of the receiving environment.

It's important to note that the Waters Code has been revised but not yet published. It is expected that the new code will bring significant changes in the national water related regulations starting by the management of water resources.

(2) Cultural Heritage

The Archaeological, Historic and Traditional Arts Code (law n° 94-35 of February 24th 1994) defines the regulatory provisions for the safeguarding and protection of the archaeological, historical or traditional and cultural heritage integrated into the public domain of the State.

The article 68 stipulates that in case of accidental discoveries of movable or immovable remains, concerning prehistoric or historical periods, arts or traditions, the author of the discovery shall immediately inform the competent services of the Ministry responsible of patrimony or the closest territorial authorities so that they in turn inform the services concerned within a period not exceeding 5 days.

The law n°88-44 of May 19th 1988 sets provisions on the protection of cultural assets with specific value including archaeological remains, set of buildings with a specific archaeological, historical, artistic or scientific value, sites of human or natural origin, handwritten and printed documents, property of artistic interest, archives.

The Law n° 86-35 of May 9th 1986 relating to the protection of archeological assets, historical monuments and natural and urban sites sets safeguarding provisions. It stipulates that the assets, monuments and natural and urban sites inventoried by the authorities in charge of archaeology are classified by decree that defines a protection perimeter.

(3) Labour and Working Conditions

Tunisia has adopted a large legal arsenal regarding working conditions under numerous ratified international conventions.

The Labour Code sets detailed provisions in line with international conventions on:

Labour contracts (Book I) including provisions on conclusion and termination of contracts, obligation of employees, subcontractor workforce and collective agreements

Work process (Book II) including provisions on work conditions (minimum work age and admission to work, maternity protection, night work for women and children, special works, work duration, weekly rest period and statutory holidays, days off and paid leave) on salary and on occupational Health and Safety

Employee representation (Book III)

Labour inspection (Book IV)

Labour disputes (Book V)

Penalties (Book VI)

Special provisions (Book VII) including provisions on professional unions, foreign workers, occupational medicine, dangerous, insalubrious and inconvenient institutions, surveillance and sanitary police, work clothes, national commission of social dialogue, professional training, general conditions of agricultural workers employment, employment of women and children in agriculture, settlement of collective labour conflicts, control of collective redundancies, etc.

(4) Occupational Health and safety

The Labour Code includes a chapter on occupational health and safety. According to article 152-2, every employer is required to take the necessary and appropriate measures for the protection of workers and the prevention of occupational hazards. He must, in particular: (i) ensure the protection of workers health in the workplace; (ii) ensure adequate conditions and work environment; (iii) protect workers from the risks inherent in machinery, equipments and products used; (iv) provide adequate means of collective and individual protection and introduce workers to their use; (v) inform and educate workers about the risks of the tasks they perform.

Occupational health and safety are regulated by numerous other legal texts such as:

Law n° 2002-24 of February 27th 2002 modifying law n° 96-101 of November 18th 1996, related to the social protection of the workers

Law n ° 57-73 of December 11, 1957, modified by the law n ° 94-28 of February 21st, 1994 governing the repair system of the damages resulting from work-related accidents and occupational diseases.

Order of the Ministries of Social Affairs and Public Health of January 10th 1995 relating to the revision of the tables of occupational diseases, amended by subsequent orders including the order of March 29th 2018.

Law n°95-56 of June 28th 1995 establishing a special scheme for the compensation of injuries resulting work-related accidents and occupational diseases in the public sector.

According to decree n°2000-1989 of September 12th 2000, laying down the categories of companies required to designate an Occupational Safety manager and the conditions he must fulfill, companies that have to designate an Occupational Safety manager are the following:

establishments listed as dangerous, insalubrious and inconvenient

any industrial company employing at least 500 workers

construction sites employing at least 20 workers

Therefore, every construction and public works company shall designate a technical officer as an Occupational Safety Manager, in every construction site employing at least 20 workers. The person responsible for occupational safety must have acquired occupational safety training or have pursued a training cycle in this field.

(5) Information disclosure and engagement with stakeholders

(a) Public relation and access to information

The Decree n° 93-1549 of July 26th, 1993 requires that an "office of relations with the citizen" is established in each Ministry and each governorate. These offices are meant to assist citizens in resolving difficulties they encounter in their relations with public administration and to facilitate access to administrative services.

According to Decree n°2001-420 of February 13th, 2001 on the organization of the Ministry of Agriculture, and in particular its Article 7, the office of Public Relations, which is attached to the Agriculture Minister's office, has the following mandate:

To welcome citizens, to receive and discuss their grievances and requests with the relevant services to find appropriate solutions, to respond to citizens directly or by correspondence.

To inform citizens, directly, by correspondence or by phone, about the administrative procedures and channels for granting the various administrative services.

To identify, through an in-depth analysis of citizens' requests, the difficulties in the administrative procedures and propose measures to overcome them.

The organic law n° 2016-22 of March 24th, 2016 related to the right of access to information lays downs provisions on transparency of public administration in relation to proactive publication of information and on-demand access to information.

(b) Public consultations for projects implementation

A government Decree (n°2018-328 of March 29th, 2018) sets out the general provisions on public consultations. These provisions are only applicable to public policies, programmes and projects and by public institutions. It is important to note that the current EIA regulation doesn't require public consultation or information disclosure. However, the expected revision will set provisions on public consultations within the framework of ESA/ESIA studies, in line with World Bank policies.

19.1.4 International environmental guidelines applicable to the project

(1) World Bank

The World Bank's environmental and social policy, known as the Safeguards Policy, is a mechanism for addressing environmental and social issues in project design, implementation and operation, and provides a framework for community consultation and information disclosure. Examples include conducting environmental and social impact assessments, consulting affected communities on potential project impacts, and restoring livelihoods of displaced people. In August 2016, the World Bank adopted a new environmental and social policy called the Environmental and Social Framework (ESF). From 1 October 2018 onwards, the ESF will apply to all new World Bank investment project loans. The ESF consists of 11 operational policies.

(2) JICA Guidelines for Environmental and Social Considerations（April, 2010）

JICA promulgated the new Guidelines for Environmental and Social Considerations of the Japan International Cooperation Agency (hereinafter referred to as the 'JICA Guidelines') on 1 April 2010. was promulgated and came into force as of 1 July 2010. The Outline of Objection Procedure was also promulgated at the same time.

The Guidelines are intended to encourage counterparties to implement appropriate environmental and social considerations and to ensure appropriate implementation of JICA Guidelines support and confirmation by indicating JICA's responsibilities and procedures for environmental and social considerations and the requirements for counterparties and others. In this way, JICA strives to ensure transparency, predictability and accountability of JICA's environmental and social considerations support and verification. The project is being considered for adaptation as a yen loan project, in which case it will need to meet the outline required by the JICA Guidelines on Environmental and Social Considerations.

The latest version of the JICA Guidelines was issued in January 2022, but this applies to projects requested after 1 April 2022, so the April 2010 version applies to the Project.

The table below shows a comparison of JICA guidelines and domestic laws, and the policy for resolving differences in the Project.

Table 19-4 Comparison of JICA Guidelines and Domestic Laws and Policy for Eliminating Differences

Items	Subject matter	JICA Guidelines.	partner country system
Basic matter	In implementing a project, the environmental and social impacts of the project should be investigated and reviewed as early as possible in the planning stage and alternatives and mitigation measures to avoid or minimise them should be considered, and the results should be reflected in the project plan. (JICA Guidelines, Annex 1.1)	When implementing the development of a project under Decree No. 2005-1991, the project proponent is required to conduct an environmental impact assessment and approve an environmental permit from ANPE.	There are no gaps. According to national law, the activities planned for the Project do not require an EIA or environmental permit. However, based on interviews with ANPE, it is necessary to consider the need for conducting EIA on an individual basis based on the scale and impact of the project, etc. Therefore, ANPE and DGBGTH plan to hold discussions once the outline of the plan is determined.
Disclosure of information	The Environmental Assessment Report (may have a different name in some schemes) must be written in an official or widely used language in the country where the project is being implemented. It	In accordance with the NEA, EIA will be open to the public for 30 working days; the	There are gaps. Considering the scale of this project in the EIA procedure in Chu country, we propose to DGBGTH to implement

Items	Subject matter	JICA Guidelines.	partner country system
	must also be written in a language and style that can be understood by the local population when it is presented. The environmental assessment report must be publicly available in the country where the project is implemented, including to local residents and other stakeholders, and must be accessible to local residents and other stakeholders at all times, and copies must be available for acquisition. (JICA Guidelines, Appendix 2)	final EIA report will be made available to the public in three languages (Sinhala, Tamil and English) and placed in easily accessible locations, including relevant sector offices and local authorities. Comments and questions from stakeholders and the public need to be addressed by the project implementer before the final conditional permit is granted.	the information disclosure at an appropriate time in the EIA procedure.
Public consultation	In particular, for projects that are considered to have a significant impact on the environment, it is necessary that information is made publicly available and that the results are reflected in the project content after sufficient consultation with local residents and other stakeholders, from an early stage, such as when alternatives to the project plan are being considered. (JICA Guidelines, Annex 1 , Social Agreement.1) In preparing an environmental assessment report, sufficient information must be made available to the public in advance, consultations must be held with local residents and other stakeholders, and consultation records and other documents must be prepared. Consultations with local residents and other stakeholders should be carried out as necessary throughout the project preparation and implementation period, but especially during the selection of environmental impact assessment items and drafting. (JICA Guidelines, Annex 2. Environmental Assessment Report required for Category A)	Ditto	There are gaps. Considering the scale of the project, it is proposed to DGBGTH that stakeholder consultations and public briefings be conducted at an appropriate time during the EIA process.
Items subject to environmental assessment	The range of impacts to be investigated and considered in relation to environmental and social considerations includes human health and safety and impacts on the natural environment (including transboundary or global environmental impacts) through air, water, soil, waste, accidents, water use, climate change, ecosystems and biota, and social considerations of matters such as those listed below. Population displacement, including involuntary resettlement; local economy, including employment and livelihoods; land use and local resource use; social organisation, including social capital and local decision-making bodies; existing social infrastructure and social services; socially vulnerable groups such as the poor and indigenous peoples; equity in damage and	Decree No. 2005-1991 requires the protection of the natural environment. Land acquisition and resettlement are approved by Law No. 85 of August 11, 1976, as amended by Law No. 26 of April 14, 2003.	There are gaps. The relevant decrees and guidelines do not list impact items to be verified. Therefore, it is proposed that when DGBGTH conducts an EIA, it should comply with the JICA guidelines and include social impact items such as "vulnerable groups," "gender," "children's rights," "infectious diseases," etc., which are not often examined in general EIAs in Tunisia, in the scope of evaluation.

Items	Subject matter	JICA Guidelines.	partner country system
	benefit sharing and in the development process; gender Includes children's rights, cultural heritage, conflicts of interest in the region, infectious diseases such as HIV/AIDS, and the working environment occupational safety. (JICA Guidelines, Annex 1. Scope of impacts to be considered1) The impacts to be investigated and considered include not only the direct and immediate impacts of the project, but also, to the extent considered reasonable, derivative and secondary impacts, cumulative impacts and the impacts of an inseparable part of the project. In addition, impacts over the life cycle of the project should be considered. (JICA Guidelines, Annex 1, Scope of impacts to be considered.2)		
Monitoring	Efforts should be made to publicise the monitoring results to local stakeholders involved in the project. (JICA Guidelines, Annex 1, Monitoring.3) In the event of specific indications from third parties, etc., that environmental and social considerations are not sufficient, etc., a forum should be established with sufficient information disclosure for stakeholders involved in the project to discuss and consider countermeasures, and efforts should be made to agree on procedures to resolve the problem. (JICA Guidelines, Annex 1, Monitoring.4)	The monitoring is required by Decree No. 2005-1991. However, detailed conditions, such as frequency, are not indicated.	There are no major gaps. However, at this time, there is no dedicated environmental section or environmental staff within the DGBGTH's Research Bureau, and thus no experience in conducting environmental impact assessments and monitoring. On the other hand, since experience will be gained prior to the Project in the yen loan project currently being implemented in the downstream D2 zone. JST request that the response be based on these experiences to DGBGTH.
Ecosystems and biota	Projects must not involve significant conversion or significant degradation of important natural habitats or important forests. Projects must, as a rule, be implemented outside areas specifically designated by the Government for nature or cultural heritage protection by law or otherwise.	Decree No. 2005-1991 requires the protection of the natural environment.	There are no major gaps The Project will not alter important natural habitats or forests.
Indigenous People	Every effort must be made to avoid impacts of the project on indigenous peoples by considering all possible means. If avoidance is not possible after such consideration, effective measures for indigenous peoples must be taken to minimize impacts and compensate for losses.	Consideration for indigenous peoples is not included during the EIA process.	There are gaps. This project does not anticipate any impact on indigenous peoples and is therefore not included in the scope of the project.

Source :JST

19.1.5 Organization for environmental management

(1) Ministry of Environment

The Ministry of the Environment is the body that takes all measures that may improve the quality and effectiveness of the State's actions in the field of the environment and the measures that may be required.

The Ministry of the Environment is responsible for formulating and implementing policies and environmental standards related to sustainable environmental management in Tunisia. It is an organization that takes all measures that may improve the quality and effectiveness of national action in the field of environment and, where appropriate, may be needed.

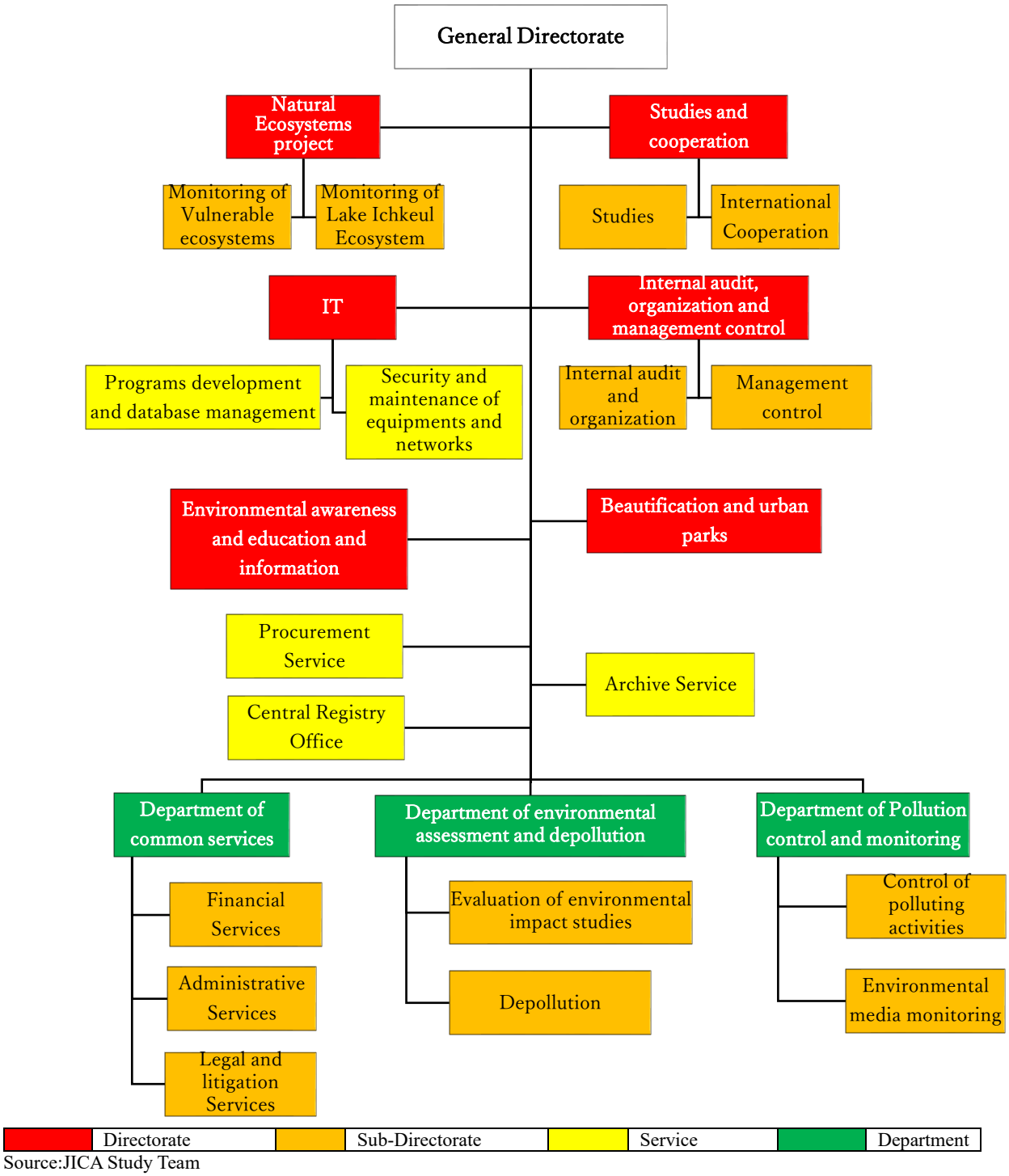
(2) National Agency for Environmental Protection：ANPE

ANPE is a sub-agency of the Ministry of Environment and is the responsible and approving body for a series of procedures related to EIAs under Law No. 88-91 of August 2, 1998. If the implementing agency is required to carry out EIA procedures when carrying out development projects in the Tunisia, depending on the type and size of the project, the implementing agency should prepare/evaluate the EIA report accordance with the TOR prescribed by ANPE for each project.

ANPE is also required to carry out technical, legal, administrative, training, research and outreach activities for environmental management for sustainable development. The organizational chart of ANPE is shown on the next page.

(3) National Agency for Waste Management：ANGed

ANGed is the implementing agency responsible for waste management in all of Tunisia under Decree No. 2005-2317 dated August 22, 2005. It is the agency responsible for developing and implementing policies and standards for waste management, including the National Waste Management Plan.



Source:JICA Study Team

Figure 19-2 Organization Chart of ANPE

19.2 Environmental Protected Area in Tunisia

(1) Protected Area

The provisions of the Tunisian State's protected areas (including the international ordinances that are registered) include the following;

The Ramsar Convention

As of 2020, 41 wetlands of international importance (Ramsar Wetlands) have been designated as wetlands of international importance (Ramsar Wetlands) with a surface area of 840,363 hectares.

Environmentally Sensitive Areas under the National Environmental Concern Management Plan (Ministry of Environment)

Game reserve

(2) Protected Area in the Project Area

The above mentioned protected areas are not located in the Project area. However, a part of the Mejelda River basin in Zone D2, downstream of the Project area, is registered as a Ramsar Wetland. Although the protected area is located sufficiently far from the project area, the indirect impacts in the downstream area by the Project should be analyzed.

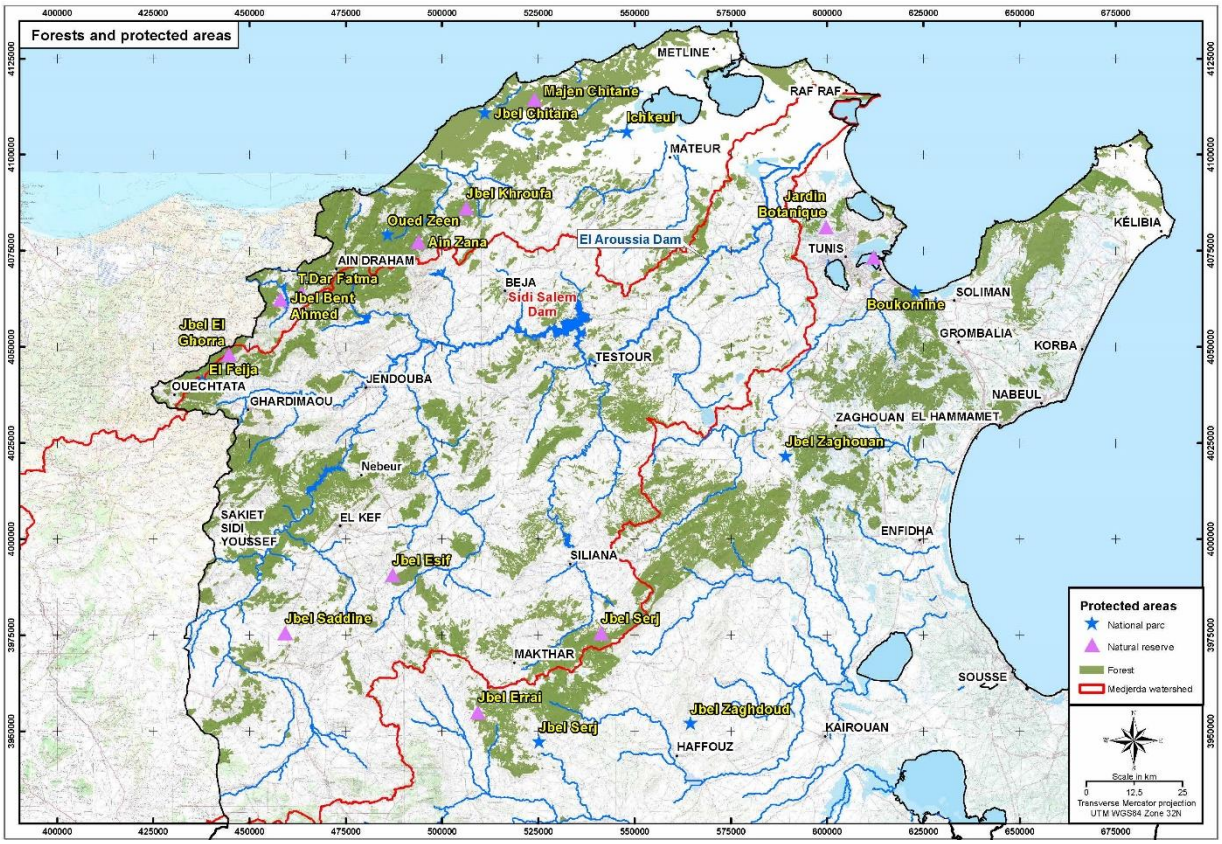


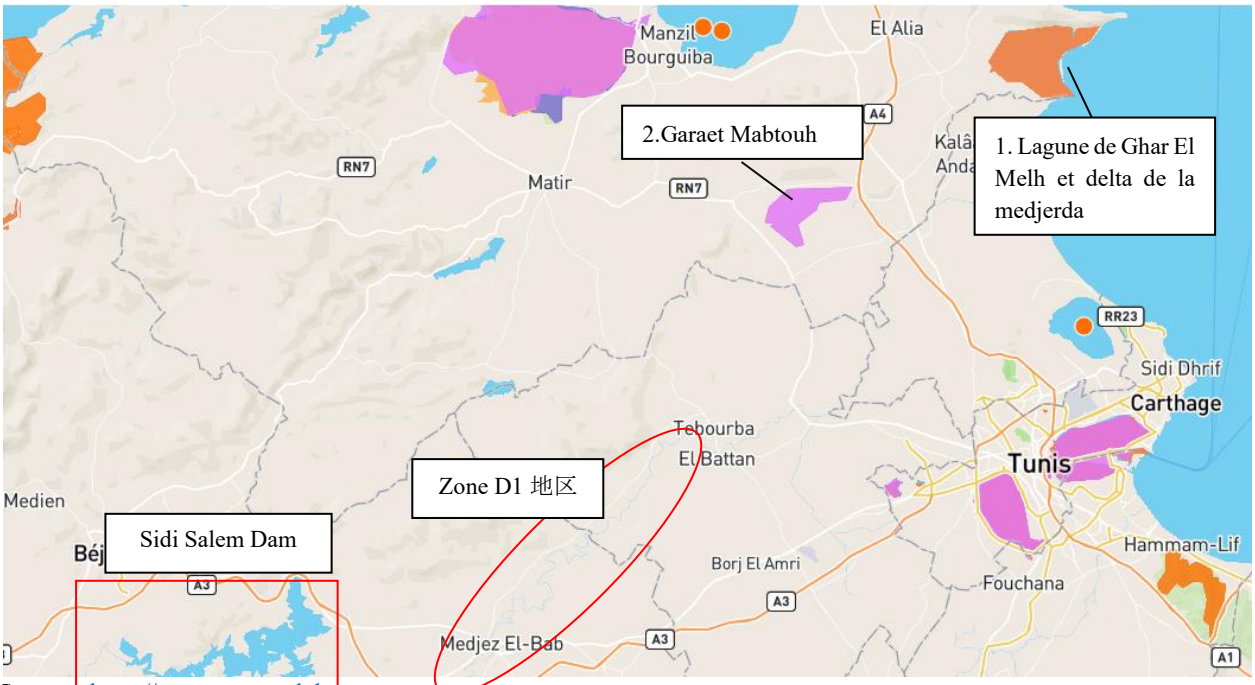
Figure 19-3 Protected Forests and Protected Areas in Medjerda Watershed

(3) Other Protected Areas in the Project Area

Key Biodiversity Areas (KBA)/Important Bird Areas (IBA) are the most important areas for bird conservation in the world, as defined by Bird Life International, an international NGO. 46 areas have been designated in Tunisia.

Although not located within the project area, the area around the mouth of the Medjerda River basin in Zone D2 downstream of the project area has been designated as "Lagune de Ghar El Melh et delta de la medjerda" (Ghar El Melh Lagoon on the Medjerda River), an area of 101.68 km2 , the area is

registered under the Ramsar Convention. This protected area is sufficiently distant from the Project area that impacts are expected to be limited. Indirect downstream impacts should be considered as necessary during the preparation of future EIAs. Garaet Mabtouh has been designated as an IBA as the closest KBAs/IBAs to the project area; Garaet Mabtouh is a freshwater wetland in the lower reaches of the Medjerda River.According to Bird Life International web site, the entire floodplain used to be a magnificent wetland, but now most of it has been reclaimed for agriculture, and Garaet Mabtouh is the only place still inundated. No impacts are anticipated in the downstream project area (Zone-1), as it is located approximately 22 km northeast of Tebourba, the lowest point of the project area, and in a different watershed. The location map of KBAs/IBAs is shown in Figure 19 4.

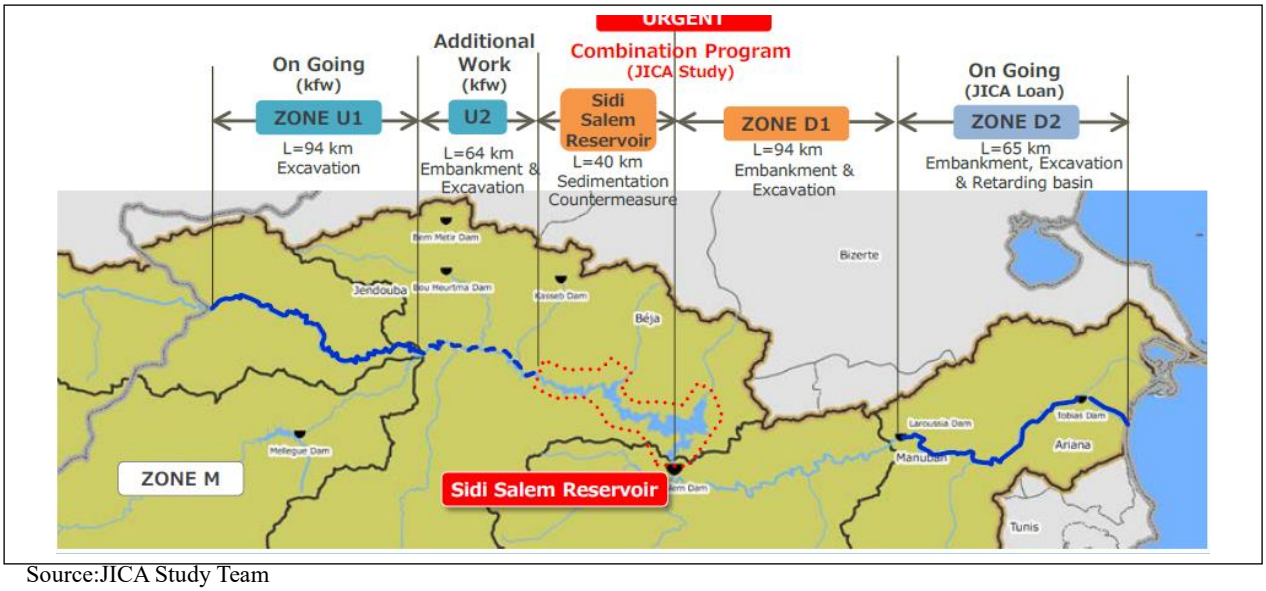


Source：https://www.protectedplanet.net

Figure 19-4　Location of KBAs/IBAs in Medjerda Basin

19.3 Current States of the Social-Natural Environment in the Target Area

The study area was divided into three zones: the upstream area of the dam (U2), the area around the Sidi Salem Dam, and the downstream Zone D1, as shown below. Zone D2, where the other ICA loan project is currently underway, is not included in the scope of the study. However, the area is downstream area of the Project and is included as a reference area for each item.



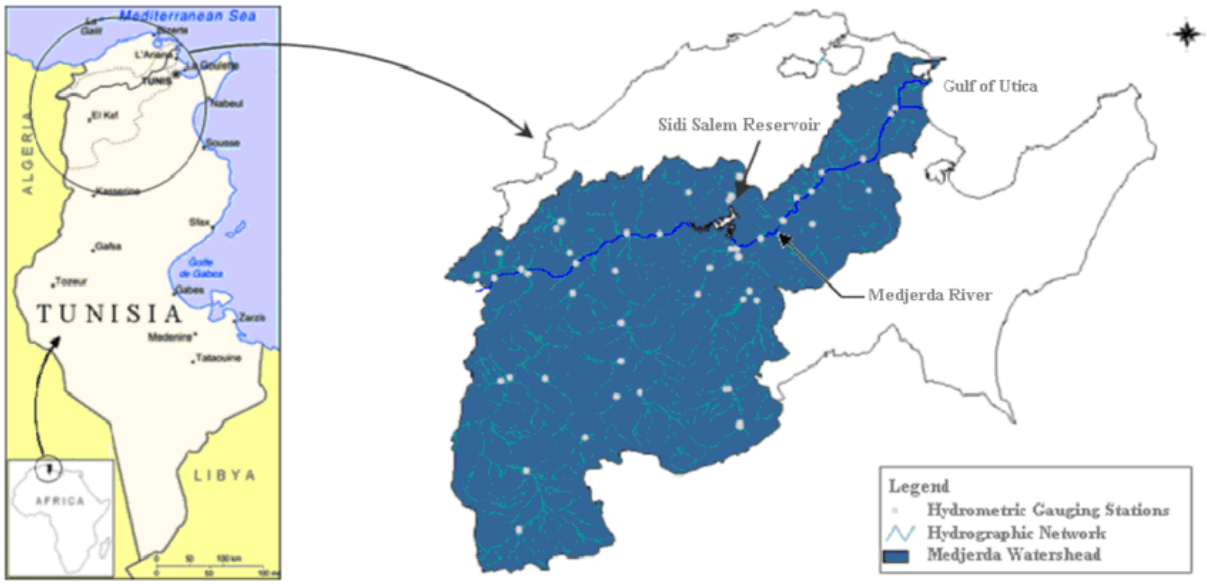
Source:JICA Study Team

Figure 19-5 Study Area

The Medjerda watershed, Tunisia's main hydrological basin, covers an area of approximately 23 000 km2 shared with Algeria. The watershed begins in eastern Algeria (near Souk Ahras) and extends over 16 400 km2 in Tunisia (10% of the country's surface area) where it stretches from the North-West to the North-East, while covering six Governorates: Jendouba, Beja, Kef, Siliana, Ariana and Mannouba which are mainely rural and agricultural governorates. This basin cuts Tunisia in its diagonal according to a Southwest / Northeast orientation and is part of Tellian region, located between the two major orographic axes: the Dorsal in the south and the Kroumirie-Mogôds in the North.

The Medjerda watershed is considered as the country's "water tower" since it provides most of the surface water and supplies nearly 38% of the Tunisian population. Many dams (Sidi Salem, Mallègue, Béni M'tir, Kasseb, Laroussia, Lakhmess, Bouhertma, etc.) have been built on the various tributaries of Oued Medjerda. They occupy a prominent place in the strategy water resources mobilization and in the development of the agricultural sector. In fact, many civilizations settled along the Medjerda valley making it an important axis of development.

The project area belongs to the upper and middle reaches of the Medjerda River, extending from Sidi Salem Dam to Laaroussia Dam and corresponding to the D1 region.



Source:JICA Study Team

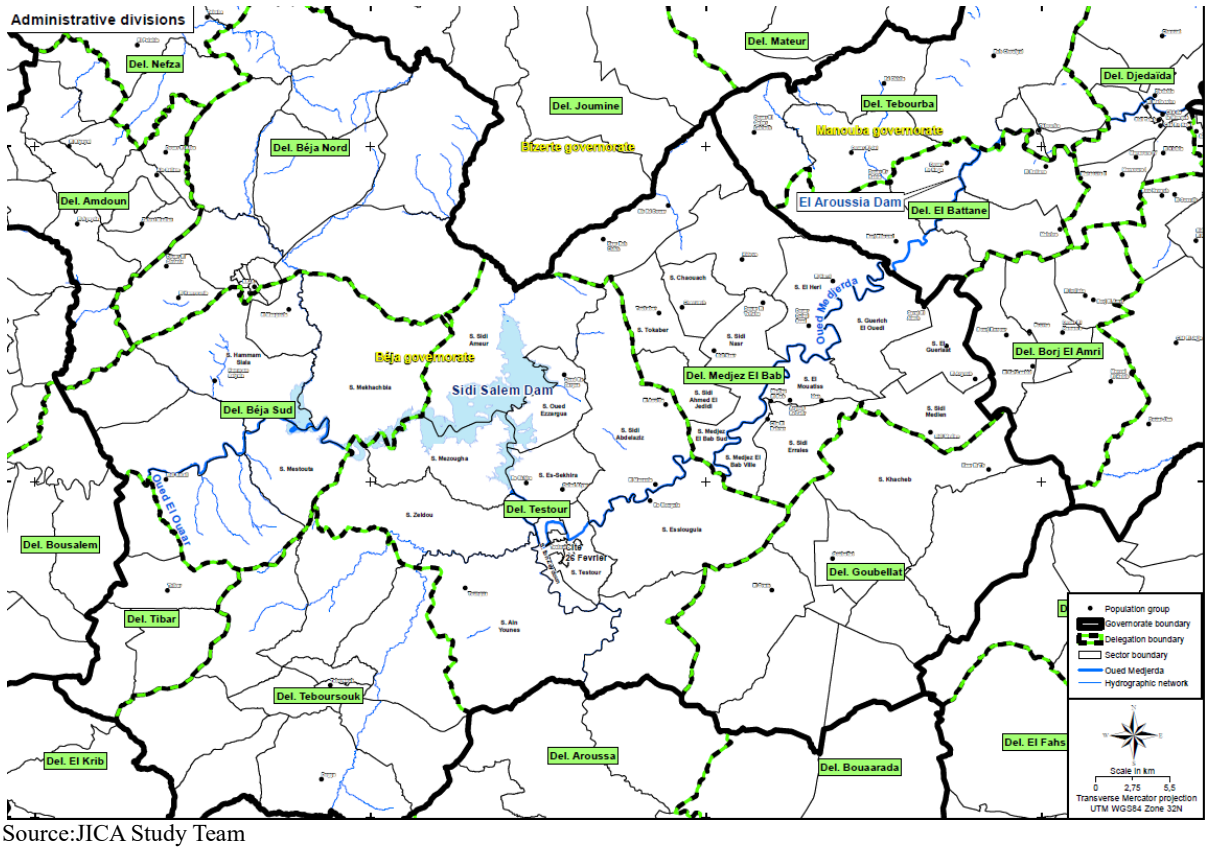
Figure 19-6 Medjerda Watershed

19.3.1 Current Status of Social Environment

(1) Population

(a) Administrative Divisions

The administrative division of the Project area is two provinces, Beja and Manouba. The Project implementation area is divided into four districts(subdivision of the province): (Tesour, Mejez el Bab and Beja Sud districts in Beja province, and El Battane district in Manouba province).



Source:JICA Study Team

Figure 19-7 Administrative Divisions in Project Area

(b) Population

According to official data from the last General Population and Housing Census performed in 2014 by the National Institute of Statistics (INS), 132 440 people among which 49.67% are women in the 4 districts of the project site. There are 33,357 households in the area, corresponding to a ratio of nearly 4 people per household. The Mejez el Bab district is the most populated, followed by Beja Sud, Testour and finally El Battan.

Table 19-5 Population, Gender Ratio and Number of Households in Project（2014）

Province	District	Population (2014)			Households
		Total	Male	Female	
Beja	Beja Sud	38,101	19,022 (49.9%)	19,079 (50.1%)	10,084
	Testour	33,613	16,992(50.6%)	16,621 (49.4%)	8,291
	Mejez el Bab	41,749	21,011(50.3%)	20,738 (49.7%)	10 ,415
Manouba	El Battane	18,977	9,628(50.7%)	9,349 (49.3%)	4,567
Total		132,440	66,653 (50.3%)	65,787 (49.7%)	33,357

Source:JICA Study Team

(c) Illiteracy Rate

Illiteracy rates are high for populations aged 60 and over and are higher for women in this age range reaching 94%.

On the contrary, illiteracy rates are low for the young population aged between 15 and 29 and are comprised between 3.89% for men and 5.62% for women with a value of 4.76% for all the population at the national level.

At the Provinces level, Beja shows illiteracy rates higher than national values while these rates are much lower for Manouba Province.

Testour District, from Beja Province, shows the most high illiteracy rates in the project area with values of 31.19% for all populations, 23.34% for men and 39.15% for women.

Table 19-6 Illiteracy Rate in the Project Area（2014）

	Illiteracy rates (%)	Aged over 10	Aged 15 to 29	Aged 60 and over
Total Population	Beja Province	29.17	5.96	
	Béja Sud District	24.67	4.48	
	Testour District	31.19	8.25	
	Mdjez Elbeb District	24	5.9	
	Manouba Province	16.63	2.03	
	El Battane District	22.85	4.02	
	Tunisia	19.27	4.76	81.6
Men	Beja Province	21.43	5.23	
	Béja Sud District	17.01	3.33	
	Testour District	23.34	8.45	
	Mdjez Elbeb District	17.55	5.99	
	Manouba Province	10.93	1.8	
	El Battane District	15.32	2.89	
	Tunisia	12.81	3.89	68.8
Women	Beja Province	36.79	6.71	
	Béja Sud District	32.16	5.61	
	Testour District	39.15	8.04	
	Mdjez Elbeb District	30.46	5.82	

	Manouba Province	22.41	2.27	
	El Battane District	30.56	5.19	
	Tunisia	25.58	5.62	94.0

Source:JICA Study Team

(d) Education Level

The table below shows the school attendance level in the project implementation area. In terms of education level, 80.66% of Tunisian population is educated, either at primary, the secondary or higher levels. Beja Province shows lower rates of education than the national level while these rates are higher in Manouba Province.

Most of the studied population is educated at secondary level except for the Testour District.

Table 19-7 Education Level in Project Area（2014）

Area	Division	Education Level(%)			
		Preschooler	Primary	Secondary	Higher education
Tunisia	Total	19.3	32.0	36.6	12.1
Beja Province		29.3	30.8	32.1	7.8
Béja Sud District		24.7	28.4	36.2	10.8
Testour District		31.3	31.0	30.8	6.9
Mdjez Elbeb District		24.1	31.8	35.3	8.9
Manouba		16.7	32.1	39.7	11.5
El Battane District		22.9	35.3	35.5	6.3
Tunisia	Male	12.9	34.9	40.3	12.0
BejaProvince		21.5	35.4	35.8	7.3
Béja Sud District		17.0	32.7	40.0	10.2
Testour District		23.4	35.0	34.8	6.8
Mdjez Elbeb District		17.6	35.3	38.8	8.3
ManoubaProvince		11.0	34.6	43.6	10.8
El Battane District		15.4	38.7	40.4	5.6
Tunisia	Female	25.7	29.2	32.9	12.2
BejaProvince		36.9	26.3	28.5	8.2
Béja Sud District		32.2	24.1	32.4	11.3
Testour District		39.2	27.0	26.7	7.1
Mdjez Elbeb District		30.6	28.3	31.8	9.4
Manouba Province		22.5	29.5	35.8	12.3
El Battane District		30.6	31.9	30.6	7.0

Source:JICA Study Team

(2) Vulnerable Population

Population vulnerability is assessed according to poverty, unemployment, disabilities prevalence and characteristics of the population aged 60 and over based on available data from INS. Data is presented either by district or Province and is compared to national values.

(a) Poverty Level

The poverty headcount ratio is the proportion of the population living at less than $5.50 a day at international prices in 2011. The poverty headcount ratio in Tunisia in 2015 was 17.50%, down 12.9% from 2010. However, since the revolution in January 2011, there have been frequent labor disputes and roadblocks for improved treatment and employment by citizens. Tunisia's economy is stagnant due to the deterioration of corporate production activities, which suggests the same in the Project area.

(b) Unemployment Rates

Unemployment rates are considered high in the project area with values that are higher than at the national level, except for the Mejez el Bab District. Unemployment rates are higher for women that for men in the different districts and provinces as well as at the national level.

The Mejez el Bab district shows the lowest unemployment rates for both men and women even though unemployment rates are still much higher for women than for men.

Table 19-8 The Non-employment Rate in the Project Area（%）

Area	Total	Male (%)	Female (%)
Beja Province	17.8	13.6	29.4
Béja Sud District	17.0	13.2	25.6
Testour District	18.5	13.9	33.1
Mdjez El Bab District	13.2	9.9	21.6
Manouba Province	17.3	13.6	25.3
El Battane District	17.8	13.8	30.2
Tunisia	14.8	11.4	22.5

Source:JICA Study Team

(c) Disabilities

Beja Province show little higher prevalence of disabilities occurrence among its population. The population with disabilities represents 2.4% while this ratio is of 2% for Manouba Province and 2.2% at national level.

Table 19-9 Population with disabilities (2014)

	Population with disabilities		Nature of disabilities (%)						
			Multiple difficulties	Commu-nication	Self care	Concen-tration	Walking	Hearing	Vision
Beja Province	7 171	2.4%	33.2	4.0	5.3	5.1	15.5	6.0	30.9
Manouba Province	7 648	2.0%	28.3	5.6	5.2	5.9	17.3	6.2	31.5
Tunisia	241 240	2.2%	32.4	5.1	4.8	5.0	17.7	6.0	29.0

Source:JICA Study Team

(d) Population aged 60 and over

Population aged 60 and over-represents 14.5% in Beja Province and 10.9% in Manouba Province while it is 11.4% at the national scale.

Only 52.3% of the population aged 60 and over in Beja Province have income. These rates are higher in Manouba Province and at the national level and are respectively 62.1% and 62.9%.

Table 19-10 Characteristics of population aged 60 and over (2014)

	Population aged 60 and over		With disabilities (%)	With income (%)	Illiteracy rates (%)
Beja Province	44 000	14.5%	7.4%	52.3%	-
Manouba Province	41 400	10.9%	6.9%	62.1%	-
Tunisia	1 249 600	11.4%	8.0%	62.9%	81.6

Source:JICA Study Team

(3) Livelihood and Local Economy

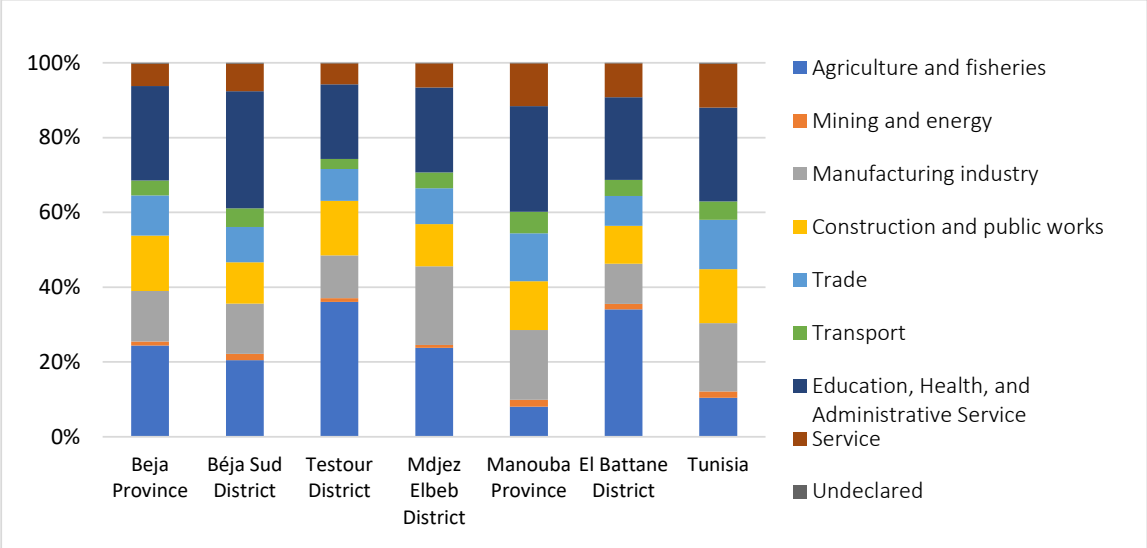
The main industries in the project area are education, health and administrative services in both Baja and Manouba provinces. Agriculture and fisheries are the major industries in the three districts of Testour, Mdjez Elbeb and El Battane Districts.

Freshwater fishing is practised in the study area, particularly in Sidi Salem dam reservoir. The number of fishermen is estimated to be 160 according to a survey performed in 2017. These fishermen are using 80 rowing boats, practising artisanal and selective fishing, while using fishing nets, longlines and traps. There are 3 attachment points in the Béja Sud District and 5 in the Testour District. Fishermen are organized into two organizations: the Mkachbia group and the Sidi Salem dam-Testour group.

Table 19-11 Distribution (%) of Employees Aged 15 and over According to Activity Sectors(2014)

	Agriculture and fisheries	Mining and energy	Manufacturing industry	Construction and public works	Trade	Transport	Education, Health, and Administrative Service	Service	Undeclared
Beja Province	24.4	1.1	13.5	14.9	10.7	4.0	**25.3**	6.0	0.2
Béja Sud District	20.5	1.7	13.4	11.1	9.4	5.0	**31.3**	7.4	0.2
Testour District	**36.1**	1.0	11.4	14.6	8.5	2.7	20.0	5.6	0.1
Mdjez Elbeb District	**23.8**	0.8	21.0	11.3	9.6	4.2	22.7	6.5	0.1
Manouba Province	8.1	1.8	18.7	13.1	12.8	5.8	**28.3**	11.5	0.1
El Battane District	**34.1**	1.5	10.7	10.2	8.0	4.3	22.1	9.1	0.1
Tunisia	10.5	1.7	18.3	14.5	13.2	4.9	**25.2**	11.8	0.2

Source:JICA Study Team



Source:JICA Study Team

Figure 19-8 Distribution (%) of employees aged 15 and over according to activity sectors (2014)

(4) Public Health

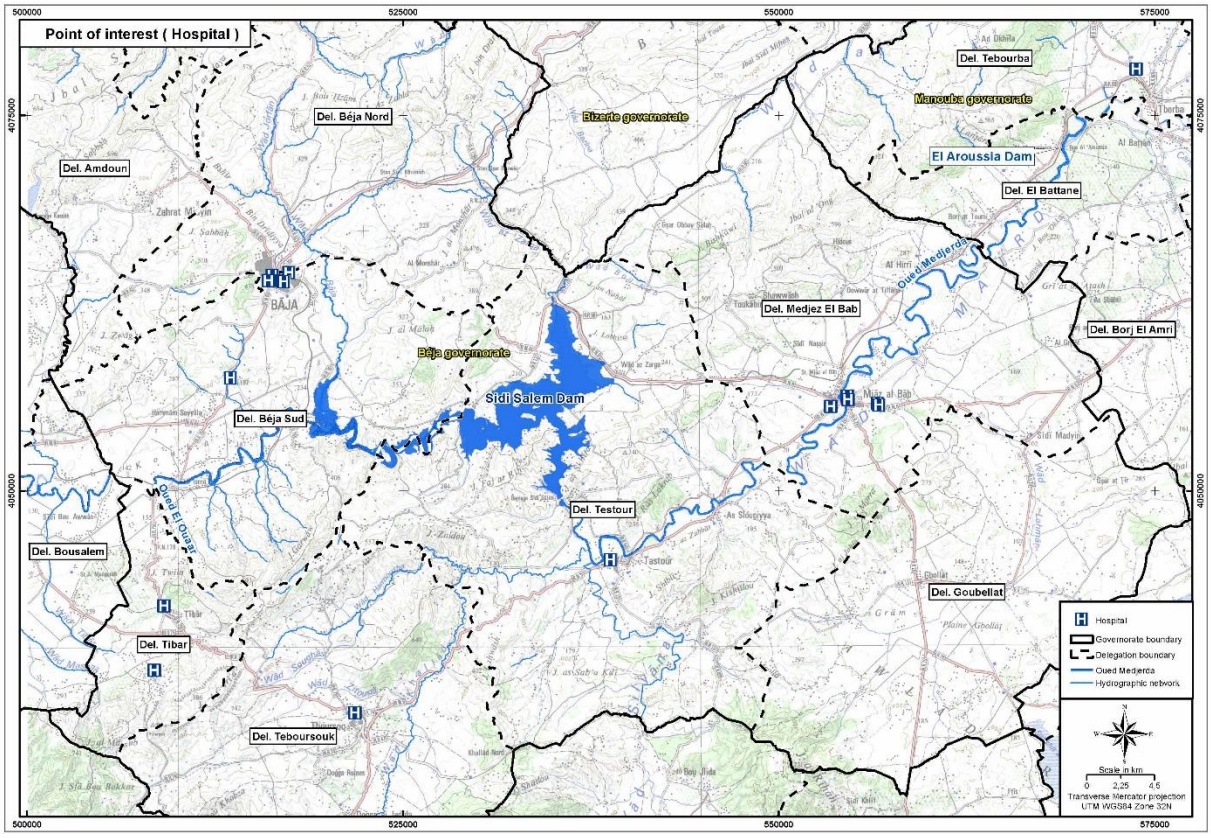
(a) Hospital and Primary Health Center

As medical facilities in the project area, 2 hospitals and 36 primary care centers are located in 4 districts, which is not a high level medical system. In Tunisia, hyperlipidemia, hypercholesterolemia, hypertension, etc. are major diseases.

Table 19-12 Medical Institution in the Study Area（2014）

Area	Hospital	Primary Health Center
BejaProvince	7	92
Béja Sud District	0	10
Testour District	1	9
Mdjez Elbeb District	1	12
Manouba Province	3	41
El Battane District	0	5

Source:JICA Study Team



Source:JICA Study Team

Figure 19-9 Location of Public Hospitals in Project Site

(5) Waste Management

(a) Solid Waste Management

Within the project area, two managed landfill sites are located in the Study area, 5 ha in Beja Sud area District and 3.7 ha in Mejez el Bab District.

As of June 2020, the two landfill sites have already exceeded their capacity and it is necessary to close the site as planned by the Waste Management Agency (ANGeD). However, plans for new landfill sites have not yet been considered.

In addition, unauthorized dumping of domestic waste in the Medjerda River and the waterways of the basin is not adequately controlled.

Table 19-13 Controlled landfills in the project area (2019)

Designation	Location /District	Area (ha)	Amount of stored waste (tonnes)	Status
Beja	Beja Sud	5	21 848	Overloaded, Sites to be closed and cleared
Mejez el Bab	Mejez el Bab	3.7	5 375	

Source:JICA Study Team

(b) Wastewater Management

There are 4 wastewater treatment plants (WWTP) in the project area as listed in the table below. The Oued Zargua WWTP is a rural facility with a very low treatment capacity.
The WWTP of Beja, dating from 1994, is the most important facility in the project area in terms of capacity. The 4 existing facilities totalize a wastewater treatment capacity of nearly 20 000 m^3/day.

Table 19-14 Wastewater treatment plants in the project area (2018)

District	Location / District	Operation date	Hydraulic capacity (m^3/day)	Treatment capacity (kg BOD_5/day)
Beja	Beja	1994	14,000	7,800
Mejez el Bab	Mejez el Bab	1994	4,500	2,000
Oued Zargua	Mejez el Bab	2003	30	12
Testour	Testour	2004	1,180	720

Source:JICA Study Team

(6) Schools

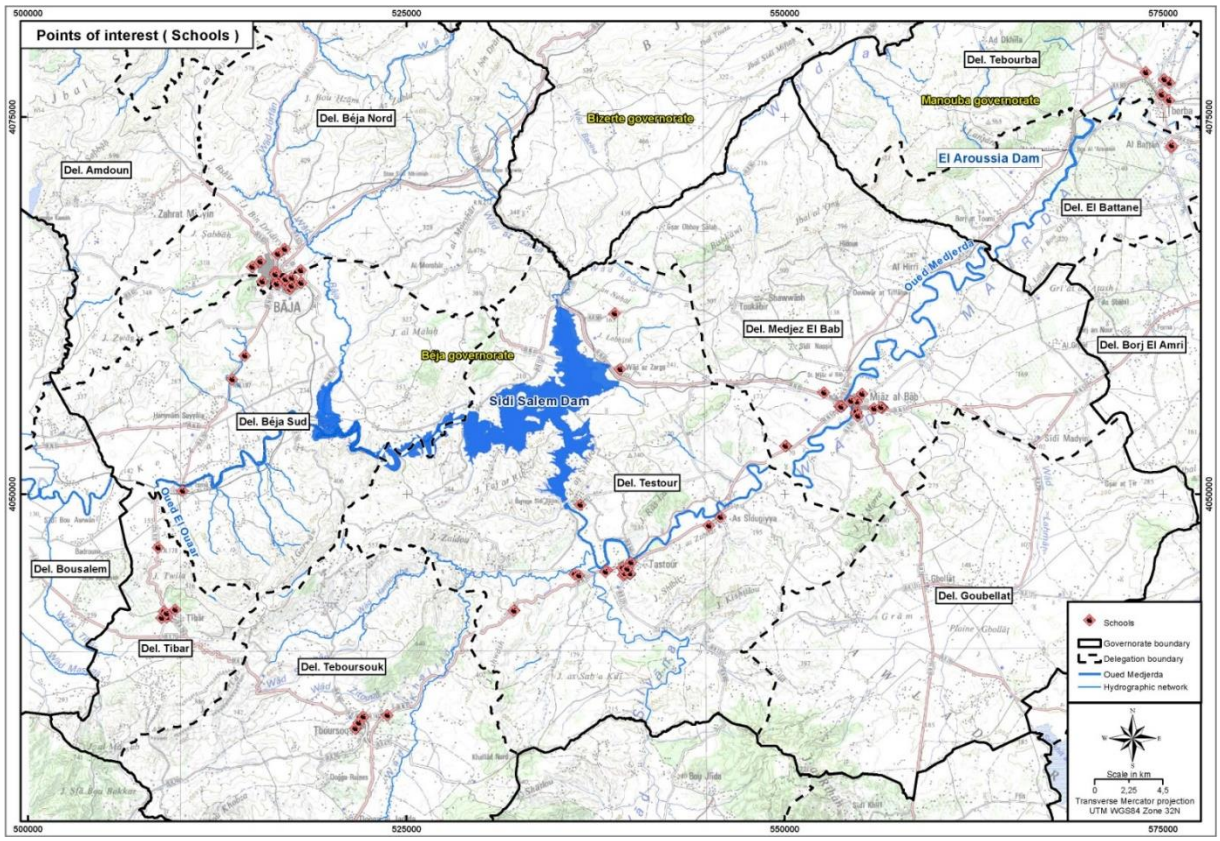
The project area is well covered in terms of education infrastructure.

Knowing that the majority of population groups are located near the Medjerda banks (and in the Medjerda floodplain according to existing simulations), an important number of schools could also be impacted by Medjerda flooding in the Testour and Mejez el Bab districts.

Table 19-15 Number of Schools Located in the Project Area

School District	Primary school	Middle school	Secondary school	University
Béja Sud	13	6	4	-
Testour	20	4	2	-
Mdjez El Beb	18	4	4	1
El Battane	8	2		-

Source:JICA Study Team



Source:JICA Study Team

Figure 19-10 Location of Schools in the Project Area

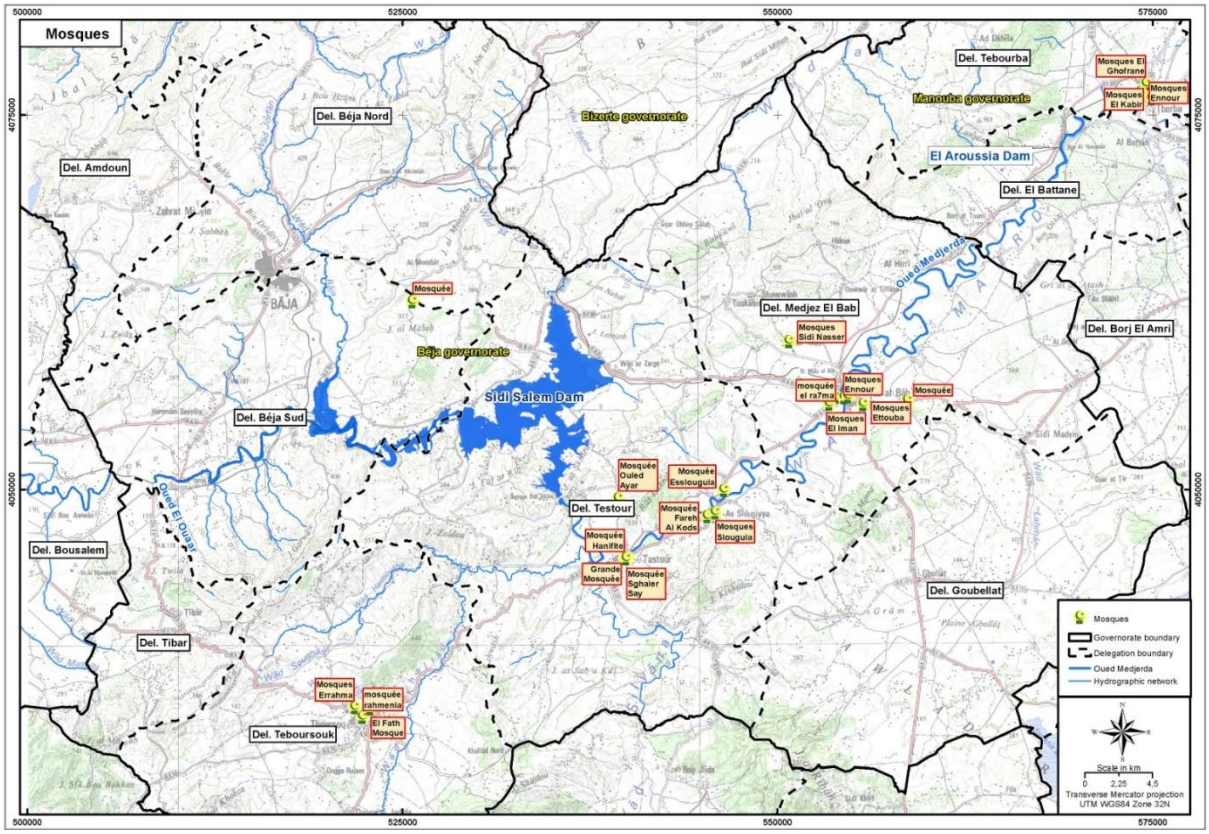
(7) Religious Buildings

The Mosques of the project area of influence are located in the populated area of the Testour and Mejez el Bab districts. Among these mosques, 2 are listed protected monuments: Mesjed of Bab-Teboursouk in Testour and the Great Mosque of Mejez el Bab.

Table 19-16 Number of schools located in the Project Area

District	Number of Mosques
Béja Sud	15
Testour	14
Mdjez El Beb	19
El Battane	9

Source:JICA Study Team

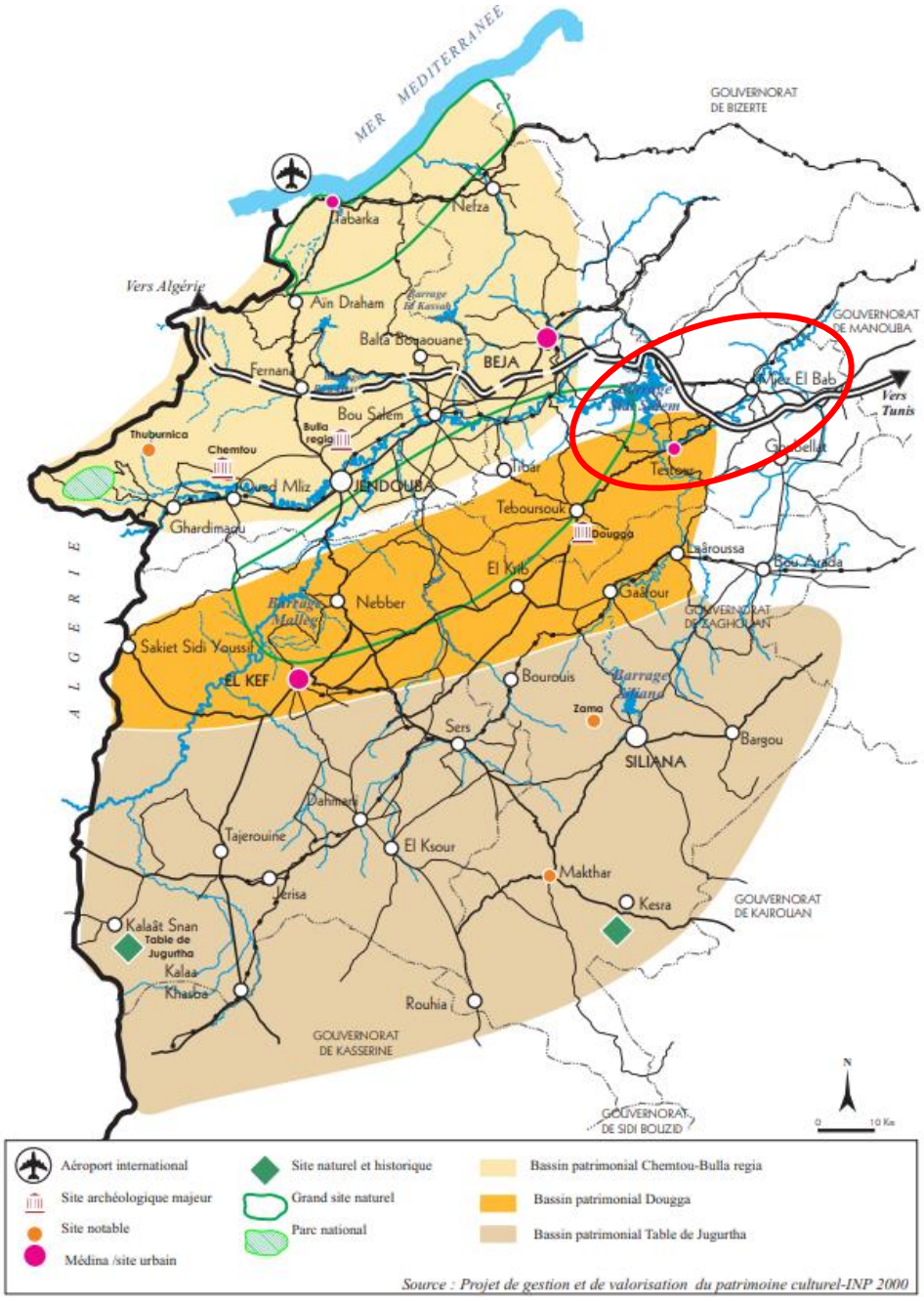


Source:JICA Study Team

Figure 19-11 Location of Mosques in the Project Area

(8) Historical sites and monuments

The project area in Beja Governorate is located near a historical region known for its multiple archaeological sites called the heritage basin of Dougga as shown by the following map. Therefore, besides the inventoried monuments, there are chances of archaeological objects discoveries during construction works.



Source:JICA Study Team

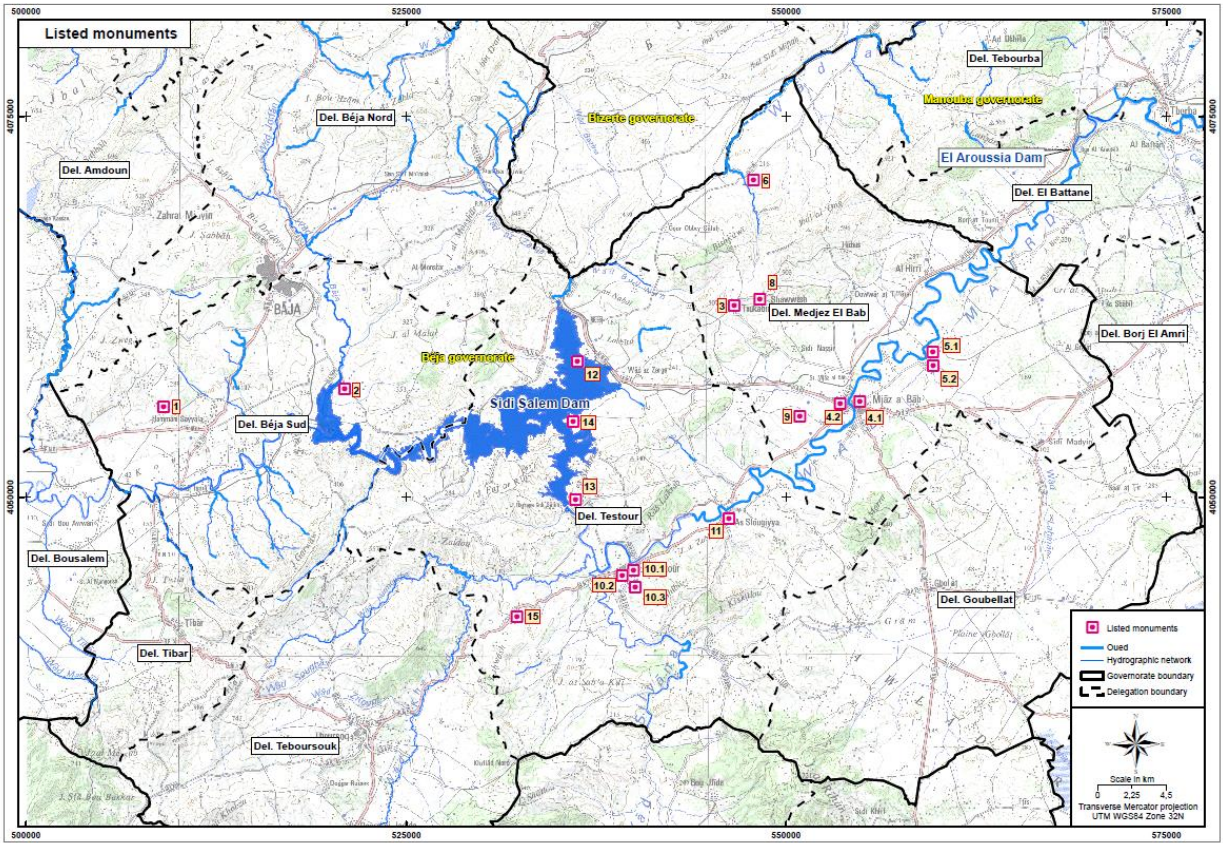
Figure 19-12 Heritage Basins of the Northwest Region of Tunisia

The following table present a list of the protected monuments listed in the project area in the Beja Sud, Testour and Mejez el Bab districts. There are no protected monuments in the project area of influence included in the El Battan District.

Table 19-17 List of Protected Monuments in the Project Area

District	Site designation	Monument designation	Protection date by decree	Site / monument designation in map
Beja sud.	Ksar el-Hadid.	Fountain	1892/03/24	1
	Beja Gare.	Tiberius Bridge (Tarjan Bridge)	1892/03/24	2
Mejez el Bab.	Toukabeur.	Sextilius Celsus Arch	1894/03/19	3
		Basin	1894/03/19	
		Tanks	1894/03/19	
		Mausoleum	1894/03/19	
		Half-buried gate	1894/03/19	
		Gate with three monoliths	1894/03/19	
		Thermal baths	1894/03/19	
	Mejez el Bab.	Mosque	1915/03/03	4.1
		Bridge (on Medjerda river)	1920/05/03	4.2
	Kirche el Oued.	Staircase and door near the mosque	1894/03/19	5.1
		Bridge	1894/03/19	5.2
	Henchir Dourat.	Punic Mausoleum	1901/12/05	6
	Glat Sebbag.	Remains	1894/03/19	7
	Chaouach.	Water tower	1894/03/19	8
		Tank	1912/13/03	
		Byzantin enclosure	1894/03/19	
		Byzantin enclosure	1912/13/03	
		Monumental gate	1894/03/19	
	Henchir el Aouilia.	Mausoleum	1928/16/11	9
	Testour.	Great mosque	1915/03/03	10.1
		Mesjed of Bab-Teboursouk	1915/03/03	10.2
		Zaouïa of Sidi Naceur	1915/03/03	10.3
	Slouguia.	Mausoleum	1891/12/23	11
	Oued Zarga.	Bridge	1894/03/19	12
	Henchir Skhira.	Basins	1894/03/19	13
		Fountain	1894/03/19	
	Beja el Kedima.	Watchtower	1894/03/19	14
	Aïn Tounga.	«Great temple»	1891/12/23	15
		«Small temple»	1894/03/19	
		Arch A	1891/12/23	
		Arch B	1891/12/23	
		Christian basilica	1891/12/23	
		Tanks	1894/03/19	
		Byzantin fort	1891/12/23	

Source:JICA Study Team

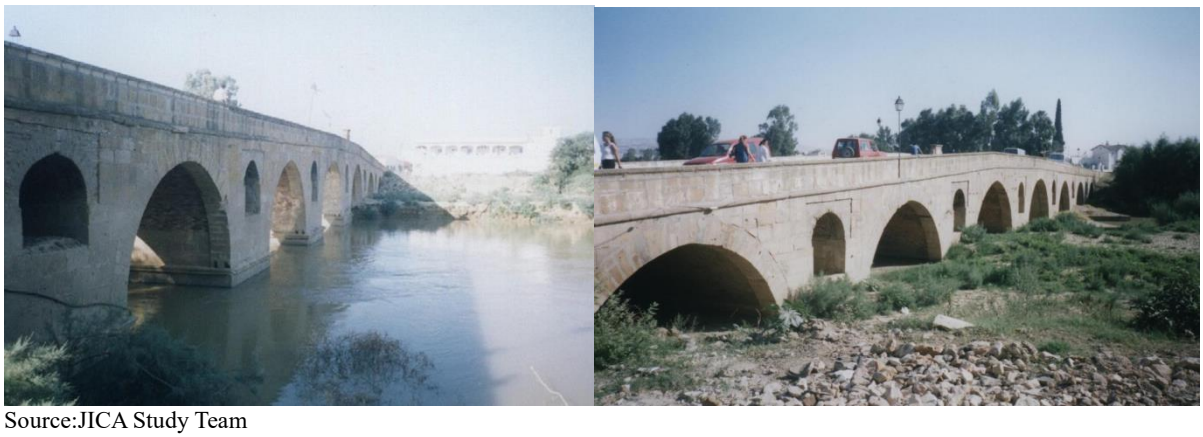


Source:JICA Study Team

Figure 19-13 Historical and Cultural Heritages in the Study Area

Many historical cultural properties are located in the Project implementation area, and historical structures are concentrated especially in the Mejez el Bab area. In the Project plan as of June 2020, the historical cultural property most likely to be affected by the construction is the Mejez el Bab Bridge (Pont de Mejez el Bab) on the Medjerda River as shown below. The structure is a stone bridge with eight arches, built in 1677 and still functions as a bridge.

Since the Project site is centered within the river channel, these cultural properties are not located in the project area, and no specific cultural properties that will be affected by the Project activities.



Source:JICA Study Team

Figure 19-14 Existing Status of Pont de Mejez el Bab

(9) Land Use

The land use map of the project site is shown in below. The project area is mostly occupied by agricultural lands (field crops and grove).

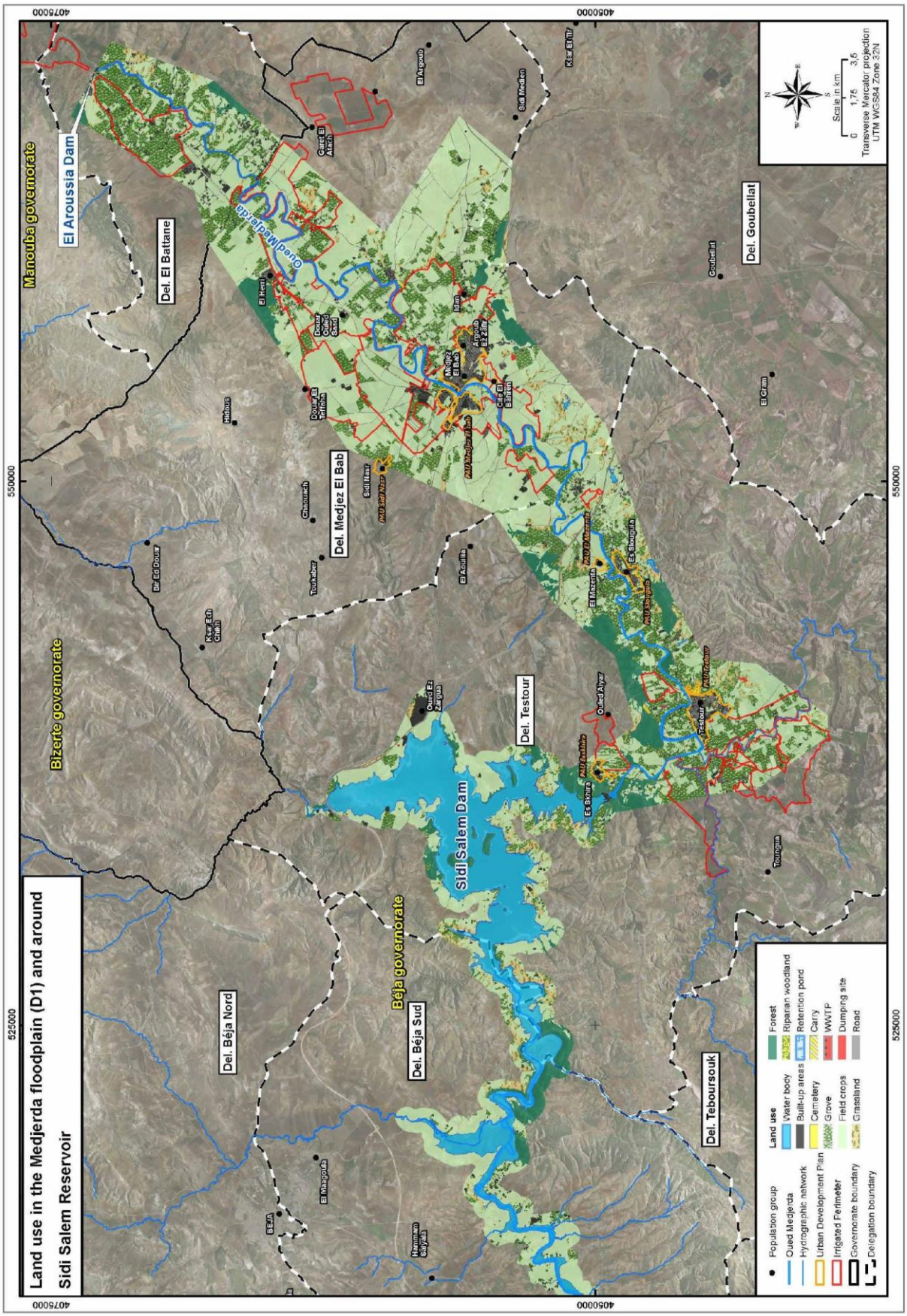


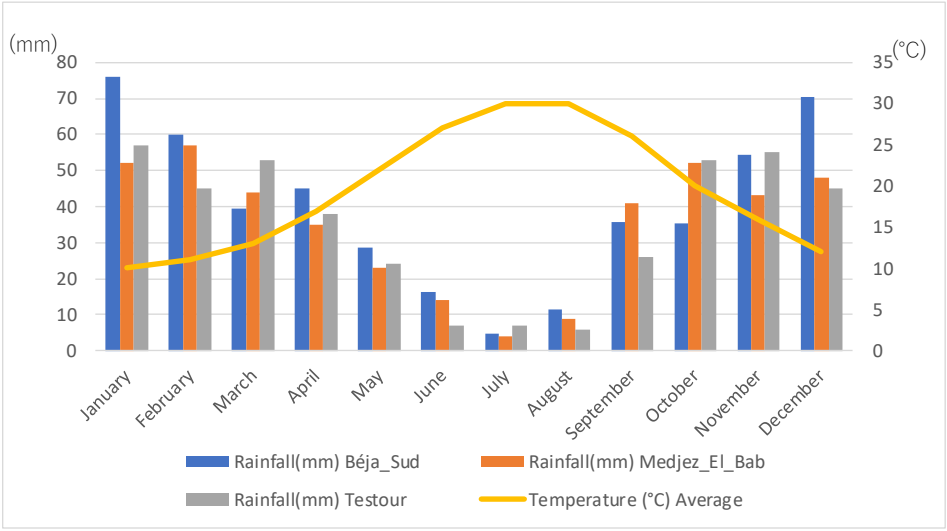
Figure 19-15 Land Use Map

19.3.2 Current State of the Natural Environment

(1) Climate

(a) Rainfall and Temperature

The Ministry of Agriculture has set up an observatory in country to continuously measure temperature and precipitation. Three observatories in Tesour District, Mejez el Bab District and Beja Sud District are located in the Project area. The 50-year average of precipitation and temperature is shown in the figure below. (http://www.agridata.tn/fr/dataset/moyenne-des-precipitations-beja).



Source：Ministry of Agriculture

Figure 19-16 Precipitation and Temperature in the Project Area（50-year average）

(b) Winds

The most dominant winds in the study area are generally northwesterly. These are cold, dry winds. The winter period is characterized by westerly winds, which are cold. The summer period is characterized by hot winds from the South (usually Sirocco).

(2) Flood

Over the past ten decades, the Medjerda has experienced several significant floods including those of 1907, 1929, 1931, 1936, 1940, 1947, 1952, 1959, 1969, 1973, 2000 and more recently 2003, 2009 and 2012. The middle valley experienced several major flood events. The following table shows the flows recorded during the most catastrophic flood of March 1973 and the more recent floods of January 2003 and February 2012.

It should be noted that the strongest flood ever known on the Medjerda is that of March 1973 causing the death of more than 100 people. More recently, the January 2003 flood led to the submersion of the town of Mejez el Bab with a maximum flow equal to 730 m^3 / s. Finally, the recent flood of February 2012 caused an increase in the water level of the Laâroussia reservoir, which imposed gradual and increasing releases. These releases caused overflows downstream covering several areas (El Battan, Béjaoua, Jedeida, Chaouat, etc.). In fact, the water flooded around 700 ha of agricultural land located near the banks of the Oued.

Table 19-18 Peak flows of Medjerda river basin recorded during floods

	Sidi Salem	Slouguia	Mejez el Bab	Laaroussia
	Maximum flow (m^3/s)			
Flood of 1973	3 180	3 550	3 300	-
Flood of 2003	1 417	744	730	400
Flood of 2012	300	353	250	240

Source:JICA Study Team

(3) Air Quality, Noise and Vibration

(a) Air Quality

ANPE have been set up atmospheric observation stations in urban centers nationwide for continuous observation. The data is available on the website (http://www.anpe.nat.tn/Fr/ air_132_200). These data have not been updated since January 2016. The observation stations are not located near the project area.

Figure 19-17 Air quality monitoring station

(b) Noise and Vibration

There is no regular observation of noise and vibration in Tunisia.

(4) Topography

The Medjerda watershed is characterized by the diversity of its topography: plains, hills, Jbels, slopes and elongated and narrow depressions.

The maximum altitude of the region reaches 1419 m at Jbel Berino in the South West of the Watershed, in the upper valley.

Gradually from the North West, the Medjerda valley narrows and the altitudes drop (195 m at Gardimaou, 143 m at Jendouba) to reach a few meters in the lower valley (5 to 20 m at Gaârat Mabtouha) and finally the marine zero on the coastal fringe in the Gulf of Tunis.

This diversity enhances the climatic nuances in the region.

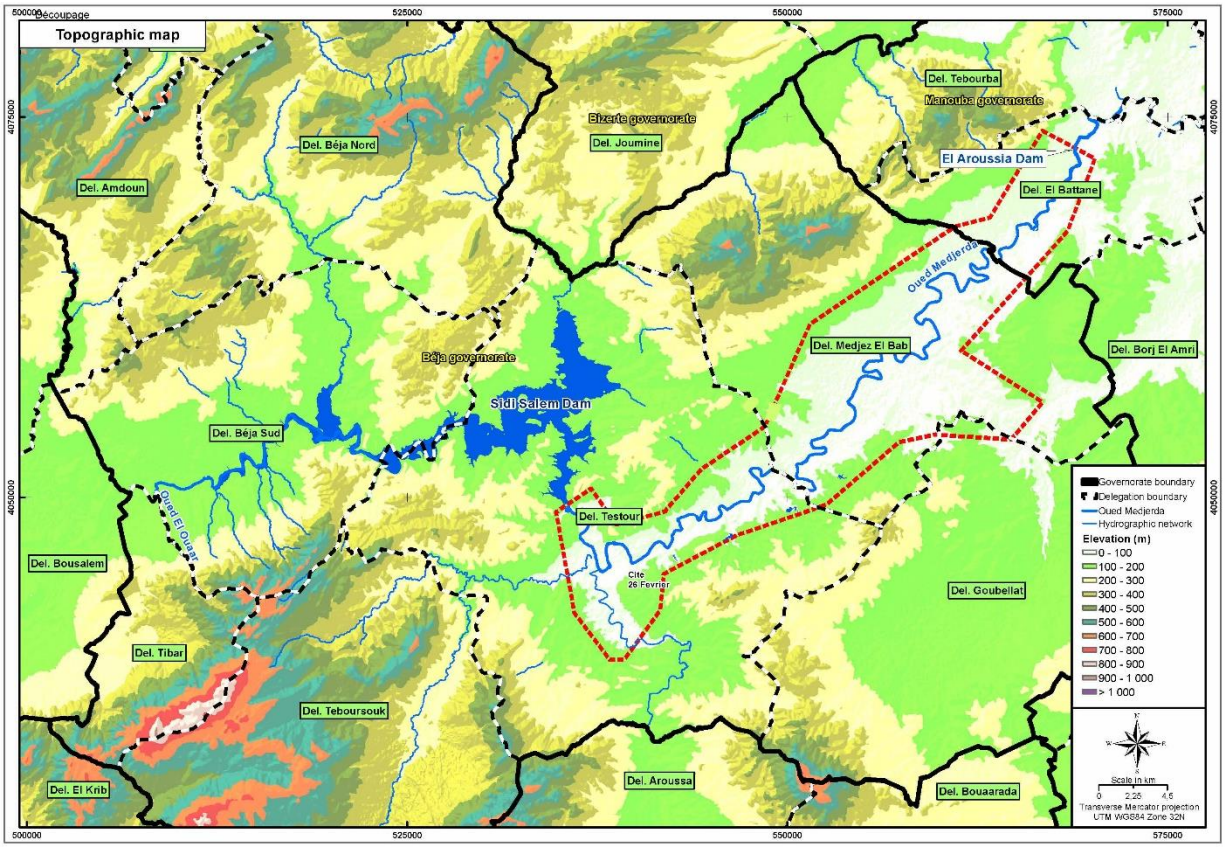
The general south-west / north-east orientation of the major relief axes favors the increase in rainfall on the northern slopes (windward slopes) and hinders its penetration deep inland. The absence, on the other hand, of significant relief to the North-East of the Ridge facilitates, in summer, the progression of warm southerly winds to the north. Besides, the partitioning of the relief in the Medjerda watershed multiplies the local climates.

The Medjerda watershed is subdivided into three units considered fairly homogeneous both in terms of hydrography and in terms of topographic units:

Table 19-19 Topographical features of the Medjerda River basin in the project area

Topographic classification	Trend
The Medjerda upper valley	It corresponds to the highest part of the Medjerda watershed and ends upstream of Béja. It includes the sub-watershed of the Oued Mallègue and Oued Tessa, with a topography of undulating plateaus, located at an altitude of 600m to 800m. They are dominated by isolated and elongated chains (Jebel Berino 1419m, Jebel Dir-Kef 1084m and Jbel Takrouna 955m) or perched tables (Kalaât Es-nam 1271m). There is also an elongated plain along Oued Medjerda in the form of a corridor from Gardimaou to Bou Salem for about 65 km. The region is also marked by the presence of low-lying plains and is interspersed with depressions and transverse topographic corridors.
The Medjerda middle valley, which represents the project area (Sidi Salem Dam - D1)	Represents a slightly mountainous region formed by a succession of small plains connected to each other by sections of very deep valleys. It ends in the town of El Aroussia where Oued Dkhila, Oued Lahmer and Oued Siliana constitute its most important tributaries. It is characterized by a steep topography and a very marked northwest exposure. This part represents the crossing point of the large tributaries of the Medjerda, from where we find the largest dam in the country (Sidi Salem). Going from upstream to downstream, the relief softens; the plains become more and more frequent and their extensions widen considerably. The study area considered, between the two dams Sidi Salem and Laâroussia is characterized by a slight longitudinal slope and a wide major bed with a slope varying from 0.5 to 1%, and extensive plains in particular around the reach going from Mejez el Bab to the Laâroussia dam. The region is characterized by low slopes favoring the phenomenon of sedimentation causing a fattening of the bed of the Oued.
The Medjerda lower valley,	It is located between the Trajan Bridge and the sea. The region represents a plain which crosses land less than 100m. It is surrounded by a set of Jbels of low altitude around 300m: Jbel Nahli, Jbel Ammar and Jbel Ennadhour. This section doesn't include large tributaries. It is characterized by a homogeneous, flat topography, marked by the presence of wetlands (Garâat, Sebkhat, swamps) with an opening onto the Mediterranean.

Source:JICA Study Team



Source:JICA Study Team

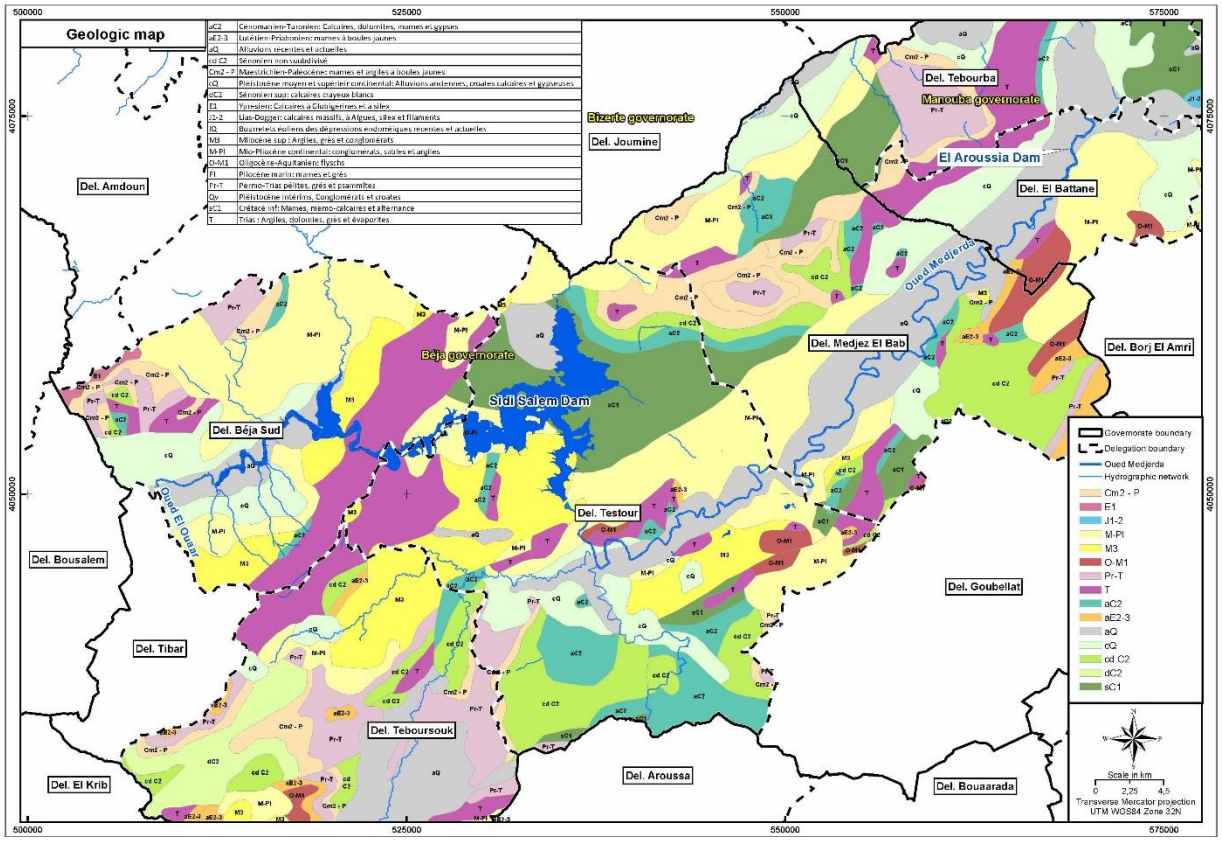
Figure 19-18 Topography Map of the Project Area

(5) Geology

Oued Medjerda crosses a succession of plains and defiles in the mountainous alignments oriented SW-NE which constitute the eastern end of the Atlas chains and of which the two important ones are the alignments of the Thibar mountains and the Teboursouk mountains. Geologically, these reliefs correspond to complex anticline bulges, outlined at the end of the Cretaceous and which were accentuated during te Alpine orogeny. The geological formations in the study area are relatively old, they mainly belong to the Secondary and Tertiary.

The site of the Sidi Salem dam is located in the defile created by the Medjerda in the alignment of Teboursouk, more exactly on the side of an anticlinal structure affecting alternations of sandstone and marl from the Miocene. Upstream of the site, there is a very regular monocline structure: the layers are parallel to the right alignment of the valley corresponding to the defile of the dam (NW-SE) and plunge on the left bank (NE). On the contrary, downstream of the dam site, there is a the complex structure of the Teboursouk alignment marked out by a Triassic diapyr on the right bank (diapyr of Oued Mellah) and the Eocene limestones of Skira on the left bank.

The middle valley, Filled with marl-sandstone sedimentation from the Miocene, is currently covered on its surface by Quaternary deposits (aQ) in which the river hollows its bed.



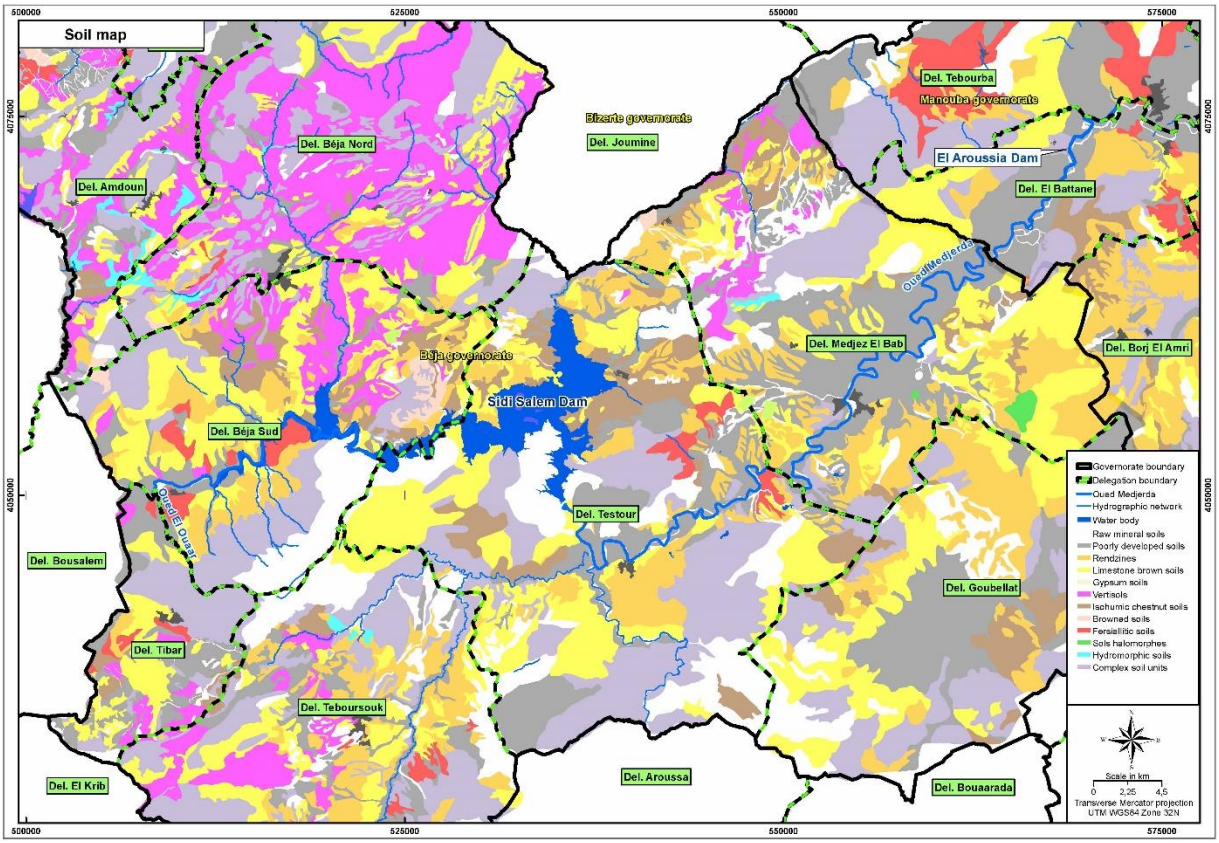
Source:JICA Study Team

Figure 19-19 Geologic Map of the Project Area

(6) Soil

In the Medjerda watershed, we can distinguish three sets of soils which are: soils of Jbels and hills, soils of foothills and soils of plains. The soil map presents a great diversity, linked at the same time to the variation of the climate, to the great variation of the lithology and to the degree of the slope. On the steep slopes and the rugged reliefs, lithosols and rendzines (rough mineral soils of erosion) are found. These are soils colonized by scrubland or degraded forest. On less steep slopes capable of retaining water and on more watered heights, calcic Cambisols develop on marl and calcareous clay. Moreover, Luvisols (acidic soils on alternating clay and sandstone) are not very thick but quite rich in organic matter and relatively stable, occupied by a forest of Zen oak and cork oak. The Medjerda valley floor is

covered by alluvial soils of variable texture and well drained. In the plains the soils benefit from their lower position to conserve more water in their lower horizons.



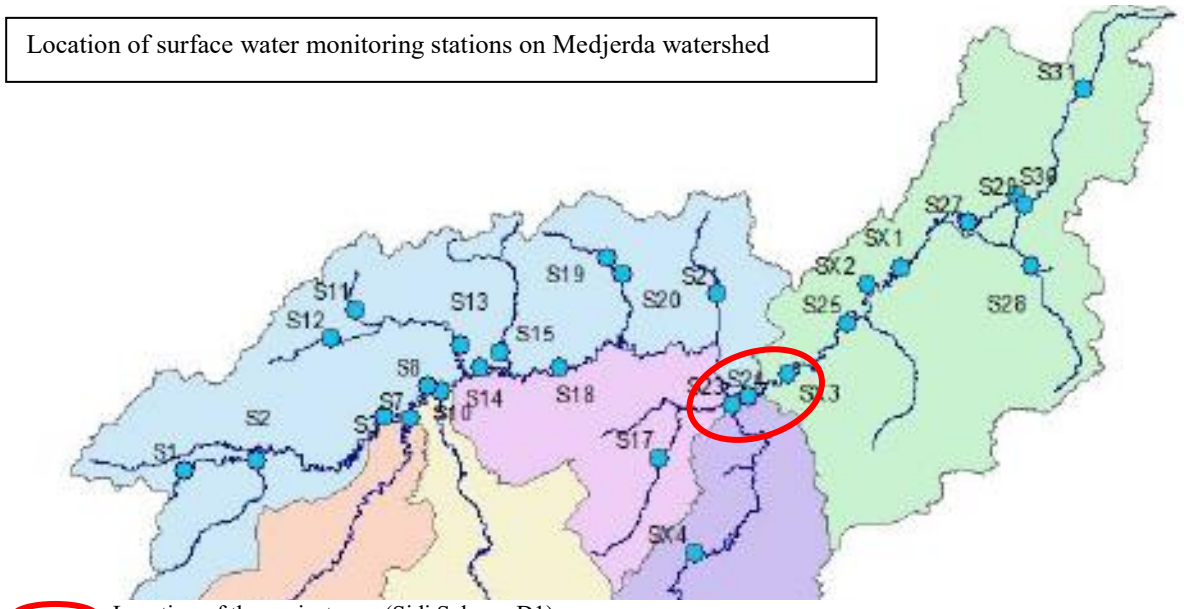
Source:JICA Study Team

Figure 19-20 Soil Map of the Project Area

(7) Water Quality

(a) Surface Water

The Ministry of the Environment regularly monitors water quality in representative rivers throughout Tunisia. The figure below shows the monitoring points of the three sites located in the D1 area downstream of Sidi Salem Dam Lake, and the table below shows the monitoring results.



S18 : Medjerda River - upstream of Sidi Salem Dam
S24 : Medjerda River - Testour
SX3 : Medjerda River – Slouguia
Source:JICA Study Team

Figure 19-21 Water Quality Monitoring Points in the Project Area on the Medjerda River

Table 19-20 Water Quality Data in the Project Area (2010 – 2018 Average)

Items \ Monitoring Point	S18	S24	SX3
T(°C)	21.3	16.7	16.1
pH	7.6	8	8.1
Dry residues (mg/)	2.1	1.56	1.42
O2 (mg/l)	6.1	5	9.1
Suspended matter (mg/l)	2700	100	51
COD (mg/l)	48	28	24
NO3 (mg/l)	13	4	6
KTN (mg/l)	1.6	2.2	
Ptot (mg/)		0.3	0.3
PO4 (mg/l)	0.1	0.9	0.8
Fe (mg/l)		0.08	0.17
Zn (mg/l)		0.09	0.14
Cd (mg/l)			
Pb (mg/l)			0.04
E. Coli (UFC/ml)	150	92	

Source:JICA Study Team

(b) Groundwater

D1 area covers 3 aquifers as shows in the following map:

The shallow aquifer of Bled Ghenima, known as the Medjerda middle valley aquifer, which extends over D1 zone. Groundwater is characterized by poor quality reflected by high

mineralisation. In fact, dry residues values are considered high and vary around an average value of 3 g/l.

The deep aquifer of Bled Ghenima which extends over Testour and Slouguia located immediately downstream of Sidi Salem Dam. Groundwater is also characterized by poor quality with an average value of 3.4 g/l of dry residues.

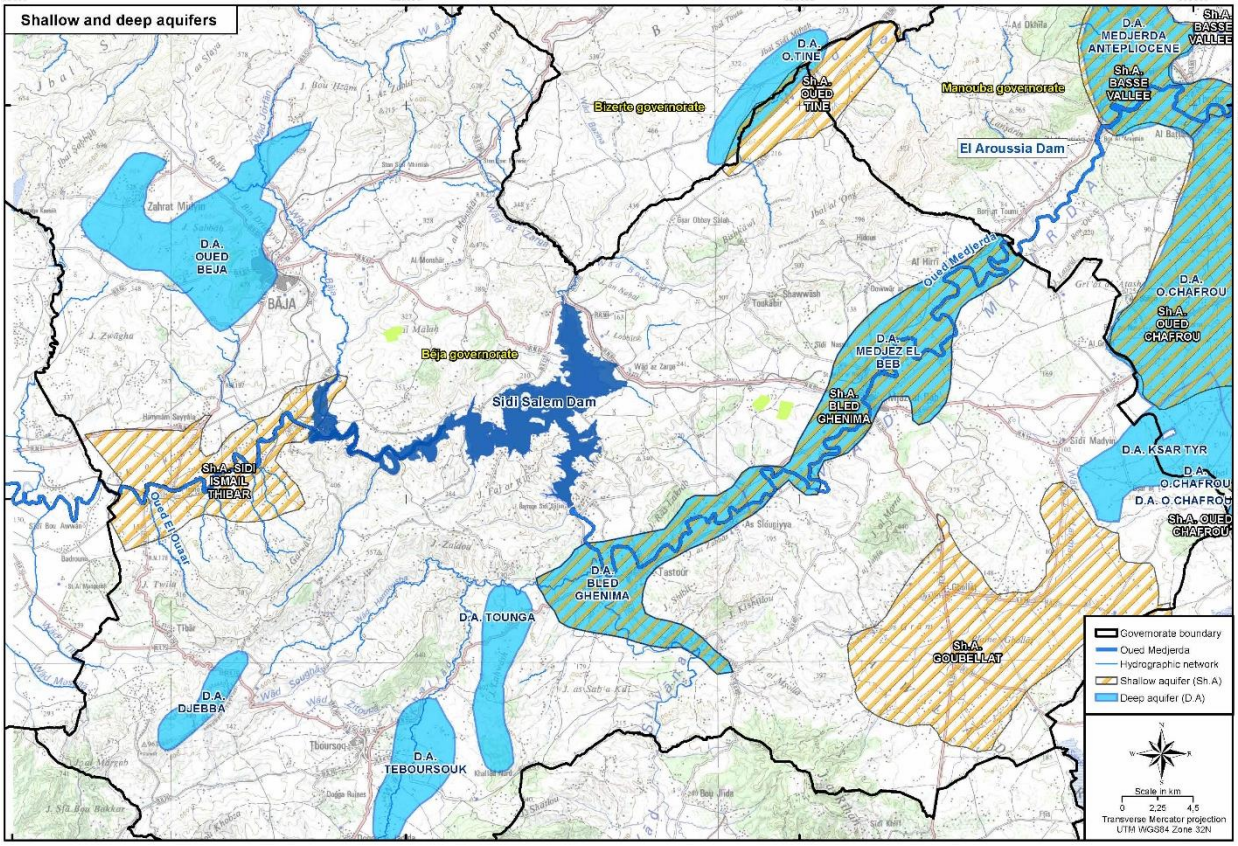
The deep aquifer of Mejez el Bab which extends over the downstream part of D1 zone. This aquifer is of good quality according to its level mineralization with an average value of 0.7 g/l of dry residues.

The deep aquifer of Bled Ghenima show signs of pollution from agricultural origin through high level of nitrates exceeding 50 mg/l.

Table 19-21 Groundwater quality in the project area (2009 - 2016)

Name of the aquifer	Medjerda Middle Valley aquifer	Plio-quaternary aquifer of Bled Ghenima	Plio-quaternary aquifer of Mejez el Bab
Nature	Shallow aquifer	Deep aquifer	Deep aquifer
Number of monitoring points	3	1	1
Quality characteristics			
Dry residues (mg/l)	3120	3364	679
Nitrates (mg/l)	36	61	17

Source:JICA Study Team



Source:JICA Study Team

Figure 19-22 Shallow and Deep Aquifers in the Project Area

(8) Flora and Fauna In Medjerda Watershed

(a) Flora

Medjerda watershed includes diverse ecosystems with various vegetal formations. The summary is shown in the following table.

Table 19-22 Description of Flora in Medjerda Watershed

Vegetation	Summary
Forest formations & ecosystems	These formations are mainly represented by the existence of cork oak (Quercus suber), zen oak (Quercus fagina), holm oak (Quercus ilex) in the Medjerda watershed located in the Kroumirie. Further South, there is Aleppo pine forest (Pinus halepensis). These forest ecosystems represent approximately 10 to 15% of the area of the Medjerda watershed and face a certain deterioration linked to anthropization.
Maquis & forest degradation ecosystems	These ecosystems are exclusively structured by Quercus coccifera (Kermes oak), Olea europaea ssp. Oleaster (Oleaster), Pistacia lentiscus (Lentisk), Ceratonia siliqua (Carob tree), Rosmarinus officinalis (Rosemary) and Filaria. These ecosystems are located in particular on the right bank of Oued Medjerda, the Tell plateaus and the Siliana mountains. On encrusted glacis. The flora is limited to taxa such as Olea europaea, Rosmarinus officinalis and Callicotome villosa. These formations cover approximately 12 to 15% of the watershed area.
Vegetation of hydro-halomorphic depressions	This type of plant formations is mainly located in the depressions commonly called Garaât and Sebkhas as well as on the banks and the edges of watercourses and temporary flow beds. The presence of this floristic category indicates the high salinity of the soil. The most representative halophilic taxa of these formations are Halocnemum strobilaceum, Arthrocnemum macrostachyum, Salsola, Suaeda, Salicornia, Sarcocornia, etc. In terms of area, these plant formations cover 5 to 10% of the total area of the Medjerda watershed.
Riparian forests	Riparian forests are the plant formations colonizing the banks of Oued Medjerda as well as its tributaries. The riparian vegetation consists of the following tree species: Tamarix africana, Dittrichia viscosa, Nerium oleander, Juncus acutus, Typha latifolia, Phragmites australis, Zizyphus lotus, Ricinus communis and Rubus ulmifolius.
Vegetation of the crop areas	These are all cultivated species, either dry or irrigated. It also includes pastoral and grassland vegetation, cereal crops, industrial crops, vegetable crops and fruit trees. These formations are dominant in the Medjerda watershed.

Source:JICA Study Team

Figure 19-23 Types of reed beds identified in the project area. (Ouni and al. 2017)

Figure 19-24 Various reed bed structures in the Project area (Ouni and al. 2017)

(b) Fauna

The Medjerda watershed is home to different animal species. The summary is shown in the following table.

Table 19-23 Description of Flora in Medjerda Watershed

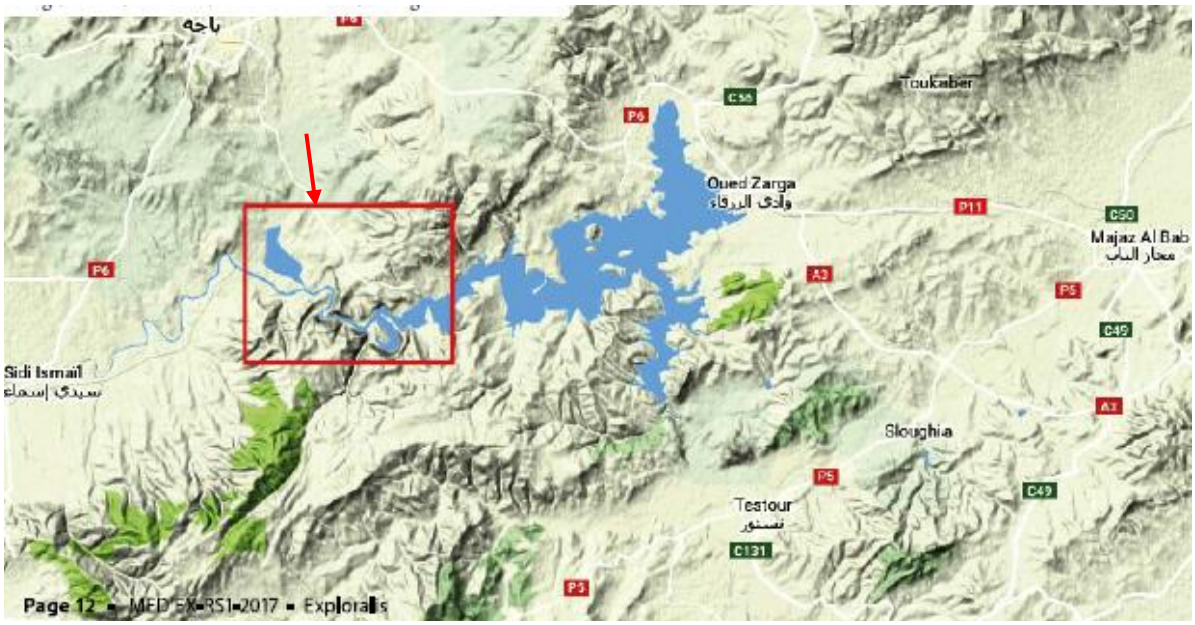
Type	Summary
Mammals	Among the main species of fauna encountered in the Medjerda watershed, a total of 25 species of mammals are inventoried. Among the most important are the Berber Deer, wild boar, jackal, fox, porcupine, lerot, gloved cat, weasel, mongoose, genet, woodland mouse, shrew, hedgehog, or the bat. Other rodent species, including rats and mice are abundant within this region. However, the strong anthropisation of the watershed is having a negative impact on the maintenance of the population and diversity of this category of animal species.
Amphibians	Two species of Amphibians are strictly located in the northwest of Tunisia, the wettest region of the country. Among the species encountered in the Medjerda watershed, the Algerian newt, the only Amphibian with a tail in the adult state, known in Northern Tunisia and the Southern tree frog is mainly located in Kroumirie.
Reptiles	They include turtles, lizards, snakes and vipers. These animals are mainly terrestrial, but some are temporarily or permanently linked to water. Within the Medjerda watershed, there are about twenty different reptile species. The land turtle, or Moorish turtle, is a species present in the Medjerda watershed. The second rare species of turtle present in Kroumirie is the leprous emyde. It is linked to water and is considered to be a bio-indicator of unpolluted water. Among the lizards, we find the common chameleon, a species rarefied by the collection. As for snakes, we find snub-nosed viper (Vipera latasti), as well as other species known to live in Kroumirie, such as the grass snake.
Birds	The Medjerda watershed is home to several species of birds, with more than 70 species. Among these species, we mention the gray cuckoo, the warbler, the common hawk, the chaffinch, the hoopoe, the owl, the woodpecker, the sparrowhawk, the wood pigeon, the booted eagle, the jay oaks, the canary, the blackbird, the common raven, the sparrow and the owl.

Type	Summary
	In addition, several migratory birds frequent the area, particularly during the winter and spring seasons, thereby taking advantage of the multiple water bodies. The Stork is very linked to this region, where it nests in several places, including the city of Testour. As far as nesting birds are concerned, most of the species common to Northern Tunisia can be seen in the Medjerda watershed. The Golden Eagle is a prestigious, protected and rare species in Tunisia, is frequent on the mountainous massifs of the region. Finally, waterfowl: duck, teal, woodcock, are in turn very common in the region. However, excessive hunting, especially illegal hunting outside the authorized period, poses a serious threat to the extinction of the target species.
Insects	It is commonly reported that Oued Medjerda and its tributaries are home to a rich spasmophilic and even thermophilic fauna. Indeed, insects are very numerous in the Medjerda watershed. Among this fauna, was reported the diptera, the hymenoptera, the orthoptera, the beetles, the lepidoptera. Chironomids are insects whose biology and ecology are linked to water bodies and rivers. So the stream of the Medjerda and its tributaries are suitable habitats for these insect species. During an inventory of these species in the region, a faunistic list of 81 taxa of Chironomidae were identified.
Cave fauna	Within the Medjerda watershed, the abundance of reliefs creates several caves or caverns. They are home to a fairly diverse cave fauna, including some species of bats. They are insectivorous and nocturnal Microchiropteran bats that are rare and fragile species because they can only live in very specific biotopes and have low fertility. There are also birds such as the ferocious buzzard, the pitchou warbler and the common raven and rare species of cave mammals such as the zorilla. As for reptiles, the presence of the hooded snake and the olive tree eremias is reported.
Ichthyological fauna	The streams and dams are reservoirs of fish fauna. Freshwater fishing which has become a profitable economic and social activity for the inhabitants of the areas bordering the Sidi Salem dam. Among the most encountered species are the catfish (Silurus), which form a genus of freshwater fish from the family Siluridae. At the level of the Medjerda, and its tributaries, as well as the dams which depend on it, there are today approximately 16 identified species of catfish, the best known of which is the catfish glane, which is a giant omnivorous fish (up to 1.5 m long on average), with a maximum weight of 250 kg, and an average lifespan of up to twenty. The breeding period is from May to July with water of 20°C. The female can lay up to 500,000 eggs. However, this species remains very threatened by pollution, in particular chemical pollution. Other species of economic interest are present in the Medjerda, and are the subject of an important fishing activity. Among these species, we mention the roach, the rotengle, the common carp, the phoxinelle of the calle, the catfish, the eel, the banded cyprino- donte, the gambusie, the marbled goby, the zander and the two species of mullet. However, the population of mullet is decreasing given the fishing effort and the lack of seeding, while the roach and rotengle populations are abundant and balanced. However, the 2 months of March and April represent the annual biological rest period.

Source:JICA Study Team

(9) Flora and Fauna in Sidi Salem Estuary

In 2018, within the project area, IUCN and domestic NGOs conducted a year-long survey of flora and fauna and ecosystems in Sidi Salem Lake and part of its upstream area as shown in the figure below. The outline of the result is shown below.



Source:JICA Study Team

Figure 19-25 Survey Area of Animal and Plant based on Existing Literature (2018)

(a) Flora

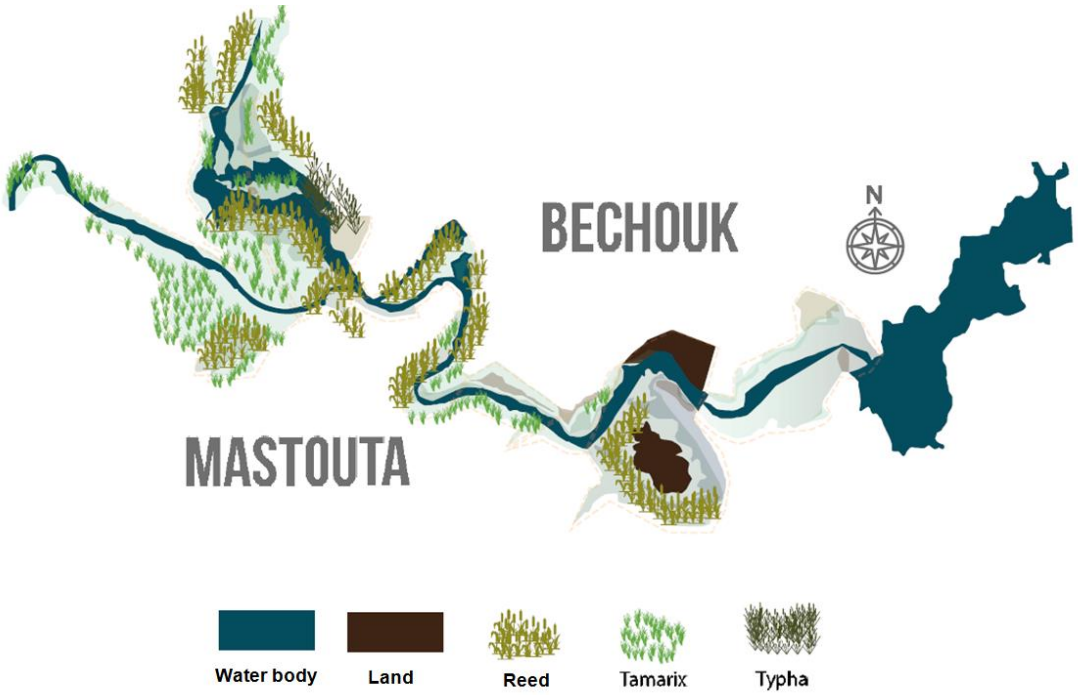
The vegetation map of the study area is shown below. A wide area along the river in the upper reaches is covered with reed trees, and the high-water channel become deciduous small forests centering on tamarisk. Also, a part of riverbeds is covered by Gama-reed bed. Reed-bed and Gama reed-bed are bog plants with high water levels. From this, it is concluded that a wide area in the upstream area is an artificial wetland due to the dam lake.

In addition, due to favourable climate and rich soils, especially on the riverbanks, the area presents a very diversified vegetation cover.

The west bank and the gypsy hills are covered by a low shrub layer, dominated by rosemary, thyme, calicotoma and cistus de Montpellier as well as fields of cereals.

The east bank is covered by a dense shrub layer, dominated by rosemary, thyme, calicotoma, cistus and acacia, as well as by a dense pine forest without undergrowth.

In the wetland, five types of reedbeds have been identified by Ouni and al. (2017) as shown by the following illustration. Their distribution is mainly conditioned by agricultural practices and by the tolerance of the plants to water level and salinity.



Source: Inventory of biodiversity in the Medjerda river, at the estuary of the artificial lake of Sidi Salem reservoir (2017)

Figure 19-26 Vegetation Map of Upper Sidi Salem Dam Lake

(b) Fauna

In the Medjerda River basin, 25 mammals including deer, wild boar, jackal, fox, porcupine, weasel, mongoose, civet family, shrew, hedgehog and bat have been confirmed. In addition, other rodents, including grassland rats, are abundant in the area. About 20 kinds of amphibians such as newts and tree frogs and reptiles such as tortoises, moor turtles and grass snakes have been confirmed.

More than 70 species of birds inhabit the same basin. Cuckoo, warbler, American warbler, finch, hoopoe, owl, woodpecker, sparrow, pigeon, black hawk, blue jay, canary, blackbird, raven, sparrow or owl have been confirmed. Storks are also a species closely related to the area and nest in several locations, including the city of Testour. Most of the common species in northern Tunisia have been confirmed to nest in the Medjerda River basin. As a rare species, golden eagles are often found in the mountainous areas of the region. In addition, many migratory birds frequently visit the area, making use of multiple waters in the area, especially during the winter and spring seasons. At present, hunting pressure, especially illegal hunting outside the permitted periods, poses a serious threat to the extinction of these species.

In addition, a cave-like ecosystem has been confirmed as a characteristic ecosystem of the same basin. There are several caves in the basin, and various cave faunas mainly inhabit small insect-eating and nocturnal small bat species. These bat species are rare species because they can live only in a very specific habitat and have low fertility, and are a species that needs attention.

19.4 Alternative Analysis

In the Chapter 11 of the Project, the planform, longitudinal profile, and cross-sectional profile of each plan were compared and examined in terms of flood control effects and future maintenance and management of each plan using inundation analysis and riverbed change analysis. In this chapter, the alternatives were compared in terms of impact on existing public infrastructure facilities, flood control effectiveness, construction period, maintenance and management, social impacts (land acquisition area and resettlement), and economic efficiency for each alternative. The concept of alternatives is shown in Table 19 24 and the results of the comparative study of alternatives are shown in Table 19 25.

As a result of the alternatives study and discussions with the local government, " Plan-3" was selected as the best alternative. The details of the study shall be described in Chapter 11.

Table 19-24 Concept of Alternatives

No	Content	Concept
Zero	Proposal not to implement the project	The project is not implemented.
Plan-1	General river improvement + bypass channel or alternative bypass channel (tunnel))	River improvement shall be based on riverbed excavation, embankment construction, and channel widening. In the vicinity of the Historic Bridge, the Mejez eL Bab Bypass Channel or the alternative Mejez eL Bab Bypass Channel (tunnel)
Plan-2	Plan-1+ drop-off construction	In addition to the Plan-1, a drop-off construction will be considered immediately downstream of the historic bridge to protect the historic bridge and to ensure the flow capacity of the Mejez eL Bab bypass channel.
Plan-3	Plan-2＋Shortcut	In addition to the Plan-2, shortcuts will be considered in the downstream section of the D1 zone. The shortcut location will be applied to four meandering sections with low flow capacity.

Source:JICA Study Team

Table 19-25 Comparative Study of Alternatives to the Proposed River Improvement Plan in the D1 Zone River Channel

Items	Contents of Alternatives	Alternatives		
		Plan-1	Plan-2	Plan-3
Main mitigation measures	Proposal not to implement the project	Excavation, embankment and channel widening Mejez el Bab bypass channel Mejez el Bab Bypass Channel - Ensuring water surface gradient is an issue.	Plan - 1 + construction of a drop-off immediately downstream of the historic bridge. Mejez el Bab bypass channel water surface gradient is an issue.	Plan - 1 + construction of a drop-off immediately downstream of the historic bridge. Mejez el Bab bypass channel water surface gradient is an issue.
Impact on existing public infrastructure facilities	In the absence of the project, flood damage in the target area will continue, resulting in extensive damage to infrastructure in the event of a flood event.	AD002、AD003 Water pipe bridge	No.102 Bridge AD002、AD003 Water pipe bridge	No need to replace bridge and water pipe bridge etc.,
Flood control effects	Individualized measures are necessary due to ongoing flood damage.	The flood damage caused by the 1/10th year plan flood can be reduced to zero.	The flood damage caused by the 1/10th year plan flood can be reduced to zero.	To be able to reduce inundation damage from 1/10-year floods to zero Effective for excess flooding No negative impact on downstream D2 zone
Maintenance	Maintenance with alternative flood control measures should be considered.	Maintenance excavation required Future sedimentation rate: Higher than the Plan-3	Maintenance excavation required Future sedimentation rate: Higher than the Plan-3	Maintenance excavation required Future sedimentation rate: Least
Social Impact (Land acquisition area, resettlement)	The social impact of flood damage is significant because it causes significant damage to the residents of the watershed, although land acquisition is not	Area of land acquisition: small Resettlement will not occur	Area of land acquisition: small(Subject land is pasture land only.) Resettlement will not occur	Area of land acquisition: small Resettlement will not occur

Items	Contents of Alternatives	Alternatives		
		Plan-1	Plan-2	Plan-3
	required. Areas with significant flood damage may be continuously habitable.			
Impact on natural environment	Not major change	The river ecosystem is affected because of the regular disturbance of the river channel.	The river ecosystem is affected because of the regular disturbance of the river channel.	The river ecosystem is affected because of the regular disturbance of the river channel.
Economic efficiency (construction ratio)	Flood damage will continue, so the risk is higher	1.0	1.1	1.0
Comprehensive evaluation	×	○	▽	◎

Source:JICA Study Team

19.5 Preliminary Scoping

Based on the results of the survey conducted during the first dispatch period (January 2020) of the environmental and social consideration specialists and the report of the locally hired environmental engineer, the scoping plan for the project plan selected above is summarized in the table below, including the reasons for evaluation, which is assumed to be associated with the implementation of the project.

Table 19-26 Result of Scoping

	Items	Evaluation			
		B	C	O	Expected Impact/Assesment (B:Before construction、C: Construction Stage、O:Operation Stage)
Physical Environment					
1	Meteorology				B/C/O: No activities are planned that will cause the item.
2	Topography/ Geography		✓		B: No activities are planned that will cause the item.
					O: River channel excavation in the upper and lower reaches of the dam lake will cause instability in the riverbank and bed. Therefore, it may cause topographic changes downstream of the excavation site.
					O: O: No activities are planned that will cause the item due to topographical stability after construction.
3	Soil erosion		✓		B: No activities are planned that will cause the item.
					C: Soil erosion has already been seen on the shore of the Dam. In addition, soil erosion is expected especially during rainfall, such as soil runoff from the construction site. It is necessary to take mitigation measures such as the construction work is concentrated in the dry season and the erosion control on existing surface and others.
					O: No activities are planned that will cause the item.
4	Hydrology		✓	✓	B: No activities are planned that will cause the item.
					C: This project involves excavation of river channels in the upstream and downstream areas of the dam for the purpose of river rehabilitation, so there is concern over the impact on hydrology. However, since the excavation location and area are not determined at this point, it will be considered in the future.
					O: There is concern about the impact on the hydrology in the downstream river channel due to the discharge of sediment during downstream flooding to prevent dam sedimentation.
5	Groundwater				B/C/O: No activities are planned that will cause the item.
6	Ecosystem/Flora and Fauna		✓	✓	B: No activities are planned that will cause the item.
					C: Abundant natural resources have been confirmed in the upstream area from Sidi Salem Dam Lake, and it is assumed that the impact on the ecosystem will be large.

	Items	Evaluation			
		B	C	O	Expected Impact/Assesment (B:Before construction、C: Construction Stage、O:Operation Stage)
					O: The continuous excavation of sediment regularly disturbs the dam lake and the river channel, which is expected to have a large impact on the ecosystem.
7	Protected areas		✓	✓	B/C/O: The Ramsar registered wetland is located at the lowest reaches of the Medjerda River. Although the Project will not directly affect on the protected area, the indirect effects of sediment discharge are expected in downstream area.
8	Coastal areas				B/C/O: No activities are planned that will cause the item.
9	Natural disasters			✓	B/C: No activities are planned that will cause the item.
					O: Due to properly management of the sedimentation, the water resources of the Sidi Salem Dam lake will be properly managed, and it will be a countermeasure against natural disasters such as drought. In addition, the Project is for flood control in the lower Medjerda River area in the future, and to be expected to mitigation measure to natural disasters.
Pollution					
10	Air pollution/Dust		✓		B: No activities are planned that will cause the item.
					C: Impact on air quality due to operation of construction machinery and movement of construction vehicles is expected, however, the impact is to be limited.
					O: No activities are planned that will cause the item.
11	Offensive Odors		✓	✓	B: No activities are planned that will cause the item.
					C/O: Depending on the condition of the sedimentation in the Dam, there is a possibility that offensive odor may be generated from the sediment temporarily accumulated on land.
12	Water Quality		✓	✓	B: No activities are planned that will cause the item.
					C: The impact on dam water quality due to upstream sand excavation, turbid water due to river excavation work, and sewage from construction sites and workers' lodgings on downstream river water quality are expected.
					O: Water quality of the dam lake due to the excavation of sediment in the dam lake, and the periodic release of sediment from the dam may affect the water quality of downstream rivers.
13	Bottom Sediment		✓		B: No activities are planned that will cause the item.
					C: Excavation and removal of sediment from the dam lake and river channel excavation of downstream rivers will be carried out, which is expected to have a large impact on bottom sediment. However, the impact on bottom sediment is limited if only excavation of high water bed is limited.
					O: No activities are planned that will cause the item.
14	Soil contamination		✓	✓	B: No activities are planned that will cause the item.
					C: It is expected that the effect of soil pollution from construction equipment and building materials at the construction site will be small. Depending on the nature of the sedimentations in the dam lake/the upstream area, which are scheduled to be removed, soil contamination may occur. Therefore, analysis of the sedimentation should be implemented.
					O: Depending on the nature of sediments in the dam lake and upstream areas where continuous removal is planned, soil contamination may occur, so sediment analysis will be required.
15	Ground subsidence				B/O: No activities are planned that will cause the item.
					C: Construction work will not effect on groundwater flow.
16	Noise and Vibration		✓		B: No activities are planned that will cause the item.
					C: Increase in noise and vibrations due to construction machines and vehicles is anticipated temporarily. Appropriate attention should be paid to villages, sensitive receptor (especially schools or hospitals) during construction work.
					O: No activities are planned that will cause the item.
17	Low Frequencies				B/C/O: No activities are planned that will cause the item.
18	Interference (Electromagnetic wave)				B/C/O: No activities are planned that will cause the item.
19	Sunshine				B/C/O: No activities are planned that will cause the item.
20					B: No activities are planned that will cause the item.

	Items	Evaluation			
		B	C	O	Expected Impact/Assesment (B:Before construction、C: Construction Stage、O:Operation Stage)
	Waste/Toxic substances		✓	✓	C: Construction surplus soil, waste materials, and garbage will be generated from construction sites and workers' camp. These waste may contain harmful substances. The sediment generated from the excavation of the river channel at D1 will be used for the fill required for the river bank, and the remaining soil will be returned to the surrounding farmland. In the F and E zones upstream of the reservoir, excavated soil and sand will be generated due to the construction of 50m wide channel works to prevent back sanding to the upstream U2. Basically, these sediments will be reused within the construction zone, but the remaining soil is planned to be embanked on the side of the reservoir.
					O: Excavating/reusing the sedimentation will be continually implemented in the future.
Social Environment					
21	Involuntary resettlement	✓	✓		B: Although the upstream area and the area around the Sidi Salem Dam lake are public land, small land acquisition will occur in order to secure the necessary land based on the downstream river improvement plan. It is necessary to prepare a land acquisition plan based on the final design and formulate an appropriate compensation policy. Land acquisition should be completed before the construction works. Resettlement will be not occurred.
					C: Future contractor may basically cause temporary land acquisition as construction yard and dormitories for construction workers.
					O:The negative impact by the Project on the item is not to be expected.。
22	Land use	✓	✓	✓	B: In case of land acquisition or resettlement is required in the downstream area, land use may be affected in and surrounding Project area.
					C: Land use changes are expected to occur on a small scale within the river improvement area. In addition, changes in land use for the construction yards and dormitories for construction workers are temporary.
					O: For proper sediment management, there is a possibility of continuous excavation of the upstream area, the dam lake, and part of the downstream area. In addition, some of the existing slopes are planned to be replanted as mitigation measure to prevent sediment runoff.
23	Usage of local resources				B/C/O: No activities are planned that will cause the item.
24	Master plan/Urban planning				B/C: No activities are planned that will cause the item.
					O: With the appropriate water resource management and flood control maintenance under the Project, it will be possible to secure stable water source, so positive impact is expected in the Project area.
25	Social institutions such as social capital and local decision-making institutions	✓	✓	✓	B: There is a possibility of impact on social institutions and local decision-making institutions due to resettlement and land acquisition.
					C: There is a possibility to impact on social institutions and local decision-making institutions due to inflow of construction worker and people from outside.
					O:No activities are planned that will cause the item.
26	Existing infrastructure and services	✓	✓	✓	B: There is a possibility of impact on existing infrastructure and services due to resettlement of community center and other public facilities.
					C: Set-up of construction yard and quarters for construction workers, and traffic congestion due to increase of construction vehicles cause impact on existing infrastructure and services temporarily.
					O: The negative impact by the Project on the surrounding area cannot be expected. The sustainable use of water resources and the effects of flood protection are expected to contribute significantly to the improvement of social services.
27	Lifestyle and livelihood	✓	✓	✓	B: There is a possibility of impact on lifestyle and livelihoods due to loss of working opportunities and decrease in income caused by resettlement and land acquisition.
					C: Positive impact on local economy is anticipated due to increase in commercial/working opportunities from the construction work.

	Items	Evaluation			
		B	C	O	Expected Impact/Assesment (B:Before construction、C: Construction Stage、O:Operation Stage)
					O: The Project will provide a more stable supply of water resources and indirectly have a positive impact on the local economy of the Project area. In the long run, it is expected that commercial/employment opportunities will increase as the local economy of the Project area grows. On the other hand, the termination of temporary employment opportunities for local workers may have a negative impact after the completion of construction work.
28	Misdistribution of benefits and damages	✓	✓	✓	B/C: In construction activities, for example, affected households need to be relocated, but nearby unaffected persons may get commercial opportunities for those involved in construction, resulting in misdistribution of damage and benefits.
					O: The positive effects of sustainable use of water sources and flood protection by the project will be equally provided.
29	Local conflict of interests	✓	✓		B/C: There is a possibility of conflict of interest in the area between the beneficiaries and the affected residents due to damage and uneven distribution of benefits before, during and during construction.
					O: No activities are planned that will cause the item.
30	Water use		✓	✓	B: No activities are planned that will cause the item.
					C: The Medjerda River is now an important water source for residents along the downstream river. Turbid water from channel excavations can affect the water use of residents in downstream rivers. ..
					O: Regular discharge of sediment may affect the water intake of downstream fields. On the other hand, by implementing the project, local people in the downstream area will be able to share water resources more stably than at present.
31	Cultural and historical heritage		✓		B: No activities are planned that will cause the item.
					C: There is no historical heritage in the dam lake and upstream areas. The downstream Beja area is a historic area where several archaeological sites are located. The Mejez el Bab Bridge on the Medjerda River is a historic bridge constructed in 1677 during the Mouradite Beys period. Depending on the downstream river improvement plan, the construction may be affected. If it is necessary to rehabilitate the river near the bridge, it is necessary to give due consideration to the planning to minimize the impact.
					O: No activities are planned that will cause the item.
32	Landscape			✓	B: No activities are planned that will cause the item.
					C/O: The landscape of the excavated area upstream of the dam is likely to change significantly.
33	Religious facilities	✓	✓	✓	B/C/O: If there is a religious facility in the project area, it may be affected by noise/vibration during construction and operation, so sufficient consideration is required. In the future, field survey should be conducted to grasp the current situation.
34	Poor		✓	✓	B: It is unlikely that the poor will be significantly negatively affected. However, depending on the river rehabilitation plan, the loss of arable land and opportunities for crop harvesting may affect the poor. It is necessary to understand it through a census survey for the preparation of RCAP for the PAP targeted for relocation and land acquisition.
					C: Poor people around the dam lake may have employment opportunities in construction and related projects.
					O: The sustainable use of water resources and flood protection will improve the surrounding living environment, which will contribute to improving the lives of the poor, who are vulnerable to society.
35	Ethnic minority /Indigenous people		✓	✓	B/C/O: Indigenous peoples' residences that require special protection have not been identified in the Project area and need to be investigated. It is possible that the national land of the Medjerda River basin is used for nomadic ethnic groups.
36	Gender		✓	✓	B: No activities are planned that will cause the item.
					C: No activities are planned that will cause the item. In addition, employment as a construction worker during construction requires consideration for gender.
					O: The sustainable use of water resources and flood protection will contribute to improving the lives of women who are vulnerable to society.

	Items	Evaluation			
		B	C	O	Expected Impact/Assesment (B:Before construction、C: Construction Stage、O:Operation Stage)
37	Children's rights	✓	✓	✓	B: The major impact of this project is not expected. If there is a school or children's facility in the river rehabilitation area in the downstream area, it may be subject to relocation, so the evaluation in this phase is C.
					C: The opportunity for work including construction worker due to the Project is for adults only.
					O: The sustainable use of water resources and flood protection will contribute to improving the lives of children who are vulnerable to society.
38	Risks of infectious diseases such as AIDS/HIV		✓		B:The negative impact by the Project on the item is not to be expected.。
					C: Risks of the item would increase with fixed probability due to influx of laborers into the Project area. In addition, risk of STD/STI and HIV/AIDS would increase between construction workers and local people. In southern area, people should be wary of Malaria. In addition, sufficient consideration should be given to COVID-19 infection measures during construction.
					O: No activities are planned that will cause the item.
39	Occupational health and safety (Working environment)		✓	✓	B: No activities are planned that will cause the item.
					C:Attention should be paid to the occupational safety and health of construction workers.
					O: It is necessary to pay attention to the occupational health and safety of the workers who perform maintenance and maintenance work (including sand removal work) of dam facilities.。
Others					
40	Accident		✓	✓	B: No activities are planned that will cause the item.
					C: There is a possibility of increased risks of accident due to the operation of construction machines and running of construction vehicles.
					O: There is a possibility of increased risks of accident due to regular sand removal work and others.
41	Climate Change		✓		B/O: No activities are planned that will cause the item.
					C: Emission of greenhouse gases (GHGs) would be generated from construction machinery and vehicle traffic caused by the Project. However, the impact will be limited and small-scale.

Source: EIA Study Team

B: Before Construction Stage, C: Construction Stage, O: Operation Stage

Non-public

Non-public

Non-public

Non-public

Non-public

Non-public

Non-public

Non-public

Non-public

Non-public

19.7 Environmental Mitigation Measures and the Cost

The table below shows the environmental management plan and mitigation measures proposed based on the preliminary environmental impact assessment presented above. The appropriate mitigation measures will be reviewed by the EIA procedures to be conducted by DGBGTH in the future.

Table 19-30 Proposed Environmental Management Plan and Mitigation Measures

Items	Environmental Mitigation Measures	Responsible Unit (RU)/ Implementation Unit(IU)	Cost (USD)
1. Before Construction/Construction Phase			
1.1 Before Construction			
21) Involuntary Resettlement	Based on the final project plan, DGBGTH will now prepare the land acquisition plan and develop an appropriate compensation policy. Land acquisition will begin at the time of detailed project design and will be completed by the time construction bidding begins. When preparing the land acquisition plan, DGBGTH will conduct a detailed site survey and provide appropriate explanations and compensation, including the advantages of the project after its implementation.	RU:DGBGTH IU:DGBGTH	(To be discussed)
1.2 Construction Phase			
3) Soil Erosion	Concentrate riverbed excavation work during the dry season. Conduct erosion control measures on existing erosion surfaces, etc.	RU:DGBGTH IU: Contractor	Included in construction cost
4) Hydrology	Ditto	RU:DGBGTH IU: Contractor	Included in construction cost
6) Ecosystem/Flora and Fauna	Excavate and widen the low channel (riverbed area) where fish and other species inhabit, and only in the high water bed of the main river to avoid significant impacts on fish and on birds that use the low channel as a feeding ground. A certain amount of trees will be left along the river to provide habitat for birds. (Currently, the Flora/fauna in the project area is not known, so if the habitat of valuable species is confirmed through field surveys, it will be necessary to consider the impact of each valuable species and conservation measures).	RU:DGBGTH IU: Contractor	Included in construction cost
10) Air Quality /Dust	Ensure construction areas are watered and construction equipment and vehicles are cleaned regularly. Educate construction workers and staff on energy conservation.	RU:DGBGTH IU: Contractor	Included in construction cost
12) Water Quality	Excavation work within the dam reservoir will be carried out during the dry season. To prevent turbid water concentration to a minimum during construction, a half river closure with embankment works will be implemented within the reservoir. Adopt impermeable curtains and half river closure works during construction to prevent turbid water generation due to river excavation works. In addition, appropriate sanitary facilities will be installed around the reservoir to prevent the discharge of sewage from the construction site and workers' quarters	RU:DGBGTH IU: Contractor	Included in construction cost

Items	Environmental Mitigation Measures	Responsible Unit (RU)/ Implementation Unit(IU)	Cost (USD)
	Since water from the dam lake is used for agricultural purposes, it is recommended that water quality testing be conducted at each intake facility mouth during the intake period in the dry season.		
14) Soil contamination	The EIA investigation will include analysis of the sediment. If the sediment sediment contains contaminants above a certain concentration, appropriate measures and disposal will be taken and the sediment will be disposed of according to the country's laws.	RU:DGBGTH IU: Contractor	Included in construction cost
16) Noise/Vibration	Require construction contractors to promote the use of low-noise and low-vibration construction equipment and construction vehicles and to properly care for vehicles and machinery before private use. Require construction contractors to limit construction work hours according to Chu national or international standards. Prohibit nighttime driving and construction work in principle. Require speed limits for all drivers. Observe the above when conducting construction work near villages, especially near facilities that require quietness (schools, hospitals, etc.).	RU:DGBGTH IU: Contractor	Included in construction cost
20) Waste/ Toxic substances	A large amount of excavated soil from dam lake sediment and river channel excavation, and a large amount of logs generated from cutting and cultivation of Tamarisk forest are expected to be generated. For hazardous materials generated by construction, the scope of the dumping site (waste dumping area) should be clarified prior to construction, and if the excavation area covers a large area, the materials should be taken to a disposal site for appropriate disposal. The soil and sand generated from the D1 river channel excavation will be used for the embankment required for the river embankment, and the remaining soil will be returned to the surrounding farmland.	RU:DGBGTH IU: Contractor	Included in construction cost
21) Involuntary resettlement	In the case of temporary land lease for construction yards, appropriate negotiation and restoration of the land to its present condition after use shall be conducted.	RU:DGBGTH IU: DGBGTH/Contractor	As necessary
22) Land Use	The scope of the river improvement to be altered shall be kept to a minimum.	RU:DGBGTH IU: Contractor	Included in construction cost
25) Social institutions such as social capital and local decision-making institutions	Provide regular safety and health training for construction workers. Explain the project plan and schedule to residents in the surrounding area in advance, and ensure that they are well informed.	RU:DGBGTH IU: Contractor	Included in construction cost
26) Existing infrastructure and services	Ditto	RU:DGBGTH IU: Contractor	Included in construction cost
28) Misdistribution of benefits and damages	Provide prior explanation of the project plan and schedule to residents in the surrounding area and ensure that they are fully aware of the project.	RU:DGBGTH IU: Contractor	Included in construction cost

Items	Environmental Mitigation Measures	Responsible Unit (RU)/ Implementation Unit(IU)	Cost (USD)
	Demand that builders give preference to hiring local residents as workers and staff whenever possible.		
29) Local conflict of interests	Provide prior explanation of the project plan and schedule to residents in the surrounding area and ensure that they are fully aware of the project.	RU:DGBGTH IU: Contractor	Included in construction cost
30) Water Use	To reduce the impact on water use, the excavation work will be carried out during the dry season and a half-river cutoff will be employed in the river channel. Water withdrawal and water rights will be properly managed during construction. Briefing sessions will be held with relevant stakeholders on the impacts during construction, and information will be shared in advance.	RU:DGBGTH IU: Contractor	Included in construction cost
31） Cultural and historical heritage	Since there are concerns about the effects of vibration and construction vehicle travel during construction, consideration should be given to avoid concentration of construction schedules and routes. Establish rules in advance during construction so that appropriate conservation measures can be taken if cultural properties are identified during construction.。	RU:DGBGTH IU: DGBGTH/Contractor	Included in construction cost
36）Gender	Pay due attention to the fact that this is a traditional Islamic area, and create a system that allows women workers to engage safely (install outdoor toilets exclusively for women and manage the safety system).	RU:DGBGTH IU:Contractor	Included in construction cost
37) Children ' s rights	Ensure safety education and training for drivers of construction vehicles, strict adherence to speed, etc. Specify in specifications that construction contractors should not employ school-age children as construction workers to prevent child labor.	RU:DGBGTH IU:Contractor	Included in construction cost
38) Risks of infectious diseases such as AIDS/HIV	Provide an adequate number of restrooms exclusively for construction workers and implement a hygiene training program for workers. Implement measures to prevent infection with COVID-19, such as installing hand washing stations, ensuring that masks are worn indoors, and decentralizing construction work.	RU:DGBGTH IU:Contractor	Included in construction cost
39) Occupational health and safety (Working environment)	Provide regular training on health and safety to construction workers. Raise awareness of traffic safety through education and training for drivers. Provide a bulletin board at the construction site to educate workers about safety first, provide the necessary equipment, and conduct periodic inspections. Contractors shall appoint a technical staff member as an occupational safety manager for each construction site employing 20 or more workers.	RU:DGBGTH IU:Contractor	Included in construction cost
40) Accident	Properly manage safety during construction in accordance with Tunisian labor laws as indicated in "Occupational Health and Safety." Ensure safe operation through safety training programs for construction workers.	RU:DGBGTH IU:Contractor	Included in construction cost

Items	Environmental Mitigation Measures	Responsible Unit (RU)/ Implementation Unit(IU)	Cost (USD)
	Implement appropriate environmental mitigation measures, such as the installation of sign boards indicating the construction site.		
2. Operation Phase			
4) Hydrology	Not applicated		
6) Ecosystem/Flora and Fauna	If the EIA survey confirms the presence of important species, etc., monitor the effectiveness of conservation measures for each species and consider conservation measures as necessary.	RU/IU:DGBGTH	To be consider in EIA procedure
7) Protected Area	To determine indirect impacts on protected areas, suspended sediment concentrations will be measured during the EIA and after flooding.	RU/IU:DGBGTH	To be consider in EIA procedure
12) Water Quality	Conduct periodic river water quality analysis.	RU/IU:DGBGTH	To be consider in EIA procedure
20) Waste/Toxic substances	Waste materials such as thinned wood and dredged soil will be generated, but as much as possible, they will be reused, such as returned to farmland, and the overburden will be properly disposed of. Regular maintenance of the river channel is expected to reduce the act of dumping waste into the channel by nearby residents.	RU/IU:DGBGTH	To be consider in EIA procedure
22) Land Use	Revegetation measures will be planned for some existing slopes to prevent sediment runoff.	RU/IU:DGBGTH	To be consider in EIA procedure
39) Occupational health and safety (Working environment)	Prepare safety manuals and provide education on occupational safety and health for workers engaged in maintenance and upkeep work on dam facilities (including sand removal work). Require workers to wear safety belts, life jackets, and other safety equipment during work.	RU/IU:DGBGTH	To be consider in EIA procedure
40) Accident	Prepare safety manuals and provide education on occupational safety and health for workers engaged in maintenance and upkeep work on dam facilities (including sand removal work). Require workers to wear safety belts, life jackets, and other safety equipment during work.	RU/IU:DGBGTH	To be consider in EIA procedure

Source:JICA Study Team

19.8 Environmental Monitoring Plan

The environmental monitoring plan (EMP) currently proposed by the JST is shown in the table below. It will be finalized after the implementation of the EIA procedure by DGBGTH.

Table 19-31 Environmental Monitoring Plan

Environmental Items	Monitoring Items and Methods	Location	Period	Responsible Unit (RU)/ Implementation Unit(IU)	Cost
1.Design Phase					
21) Involuntary resettlement	Check the progress of land acquisition Check the number of complaints	Shortcut area in D1 site	Quarterly	RU:DGBGTH IU:DGBGTH	To be calculated
2.Construction Phase					
3) Soil erosion	Check status of mitigation measure for erosion control	Entire construction area（ Especially upstream area）	Quarterly	RU:DGBGTH IU:Contractor	
4) Hydrology	Ditto	Ditto	Ditto	RU:DGBGTH IU:Contractor	
6) Ecosystem/Flora and Fauna	Check implementation status of mitigation measures (Construction implementation records) Habitat status of valuable and important specie（as necessary）	D1 area	As necessary	RU:DGBGTH IU:Contractor	
10) Air pollution/Dust	Check implementation status of mitigation measures (Construction implementation records)	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
12) Water Quality	Check implementation status of mitigation measures (Construction implementation records)	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
14) Soil contamination	Check implementation status of mitigation measures (Construction implementation records)	Entire construction area	One time（ Soil analysis）	RU:DGBGTH IU:Contractor	
16) Noise/Vibration	Check implementation status of mitigation measures (Construction implementation records) Check the number of complaints	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
20) Waste/Toxic substances	Check waste generation Check implementation status of mitigation measures (Construction implementation records)	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
21) Involuntary resettlement	Confirmation of the status of securing the construction yard	Downstream area of the Dam lake	Quarterly	RU:DGBGTH IU:Contractor	
22) Land Use	Check implementation status of mitigation measures	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
25) Social institutions such as social capital and local decision-making institutions	Check the number of complaints	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	

Environmental Items	Monitoring Items and Methods	Location	Period	Responsible Unit (RU)/ Implementation Unit(IU)	Cost
26) Existing infrastructure and services	Check the number of complaints	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
28) Misdistribution of benefits and damages	Check the number of complaints	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
29) Local conflict of interests	Check the number of complaints	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
30) Water Use	Check the water use status	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
31) Cultural and historical heritage	Check construction route Status of identification of buried cultural properties	Downstream area of the Dam lake	Monthly	RU:DGBGTH IU:Contractor	
36) Gender	Check number of women workers Check the facilities which pay attention gender equality	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
37) Children's rights	Check of construction implementation records	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
38) Risks of infectious diseases such as AIDS/HIV	Status of implementation of health and safety programs (number of times, participants) Status of implementation of COVID-19 measures	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
39) Occupational health and safety (Working environment)	Status of Safety and Health Program Implementation Status of safety and health measures in place	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
40) Accident	Confirmation of the number of accidents	Entire construction area	Monthly	RU:DGBGTH IU:Contractor	
3.Operation Phase					
6) Ecosystem/Flora and Fauna	Survey of flora, fauna, and ecosystems in the surrounding area (especially identification of important species)	D1 Zone	Yearly	RU/IU:DGBGTH	
7) Protected Area	Confirmation of floating sand generation (monitoring)	D1 Zone	After flooding(One time)	RU/IU:DGBGTH	
12) Water Quality	Turbidity visualization	Dame Lake Downstream	Monthly	RU/IU:DGBGTH	
20) Waste/Toxic substances	Check waste Management Status Check amount of waste generated Check of reuse status of soil and sand	Project site	Monthly	RU/IU:DGBGTH	
22) Land Use	Check progress of greening measures	Surrounding Dam lake	Monthly	RU/IU:DGBGTH	

Environmental Items	Monitoring Items and Methods	Location	Period	Responsible Unit (RU)/ Implementation Unit(IU)	Cost
39) Occupational health and safety (Working environment)	Check manual preparation status	Surrounding Dam lake	Monthly	RU/IU:DGBGTH	
40) Accident	- Check safety equipment	Scope of excavation around dam lake	Monthly	RU/IU:DGBGTH	

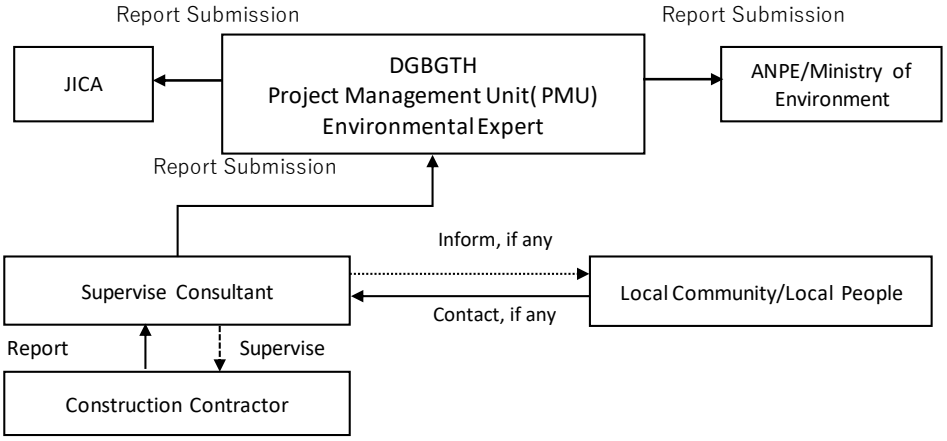
Source:JICA Study Team

19.9 Implementation Structure

Regarding the implementation structure, the JICA study team will propose the following structure to the DGBGTH and request the DGBGTH to establish the structure after the implementation of the EIA.

19.9.1 Before/During Construction

DGBGTH is the responsible agency for environmental monitoring in the project. During construction, the contractor, the construction contractor, is the implementing agency. The Construction Supervision Consultant will provide guidance, supervision, complaint handling, and reporting to DGBGTH on the environmental management implemented by the Contractor, and DGBGTH will report to JICA and MOE as necessary.

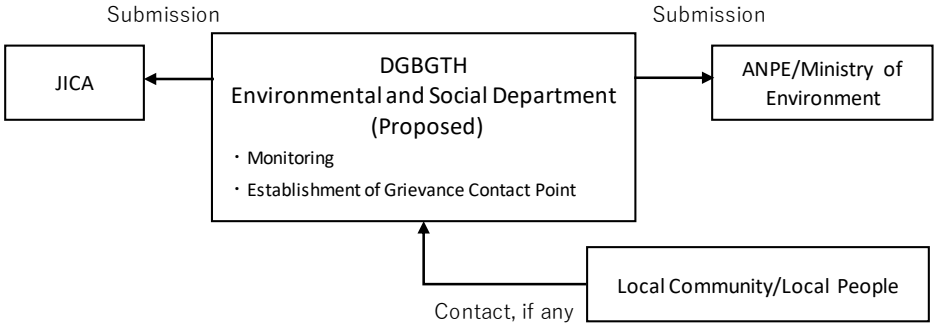


Source:JICA Study Team

Figure 19-28 Monitoring Implementation Structure in Construction Phase

19.9.2 Operation Phase

In operation phase, DGBGTH, the ordering agency of the Project, will be the responsible agency. Once in operation, an environmental management section should be set up within DGBGTH to manage the environment, conduct monitoring, handle complaints, and report to JICA. The organizational structure of the DGBGTH will be important in the phase. As of December 2022, environmental management and other tasks are not included in the DGBGTH's responsibilities, and since DGBGTH has no environmental specialist, it is recommended that a specialist be established and that DGBGTH staff training be provided. It is envisioned that actual environmental monitoring will not be carried out directly by the department, but will be budgeted and carried out by hiring an outside environmental specialist in cooperation with the Ministry of the Environment.



Source:JICA Study Team

Figure 19-29 Monitoring Implementation Structure in Operation Phase

19.10 Stakeholder Meeting

19.10.1 Outlines

Current Tunisian law does not stipulate a procedure for stakeholder consultation during the EIA procedure. However, JICA guidelines require hearing from stakeholders, and it is desirable to conduct stakeholder consultations to facilitate consensus building among the project stakeholders.

In the Project, after the completion of this study, it is planned to hold stakeholder consultations with all related organizations and local residents during the regular EIA procedures conducted by DGBGTH. During this study, a stakeholder meeting related to the project was held with the cooperation of the Ministry of Agriculture and local government related organizations.

In the upstream of the dam, the proposed project areas are all within the dam lake or on state-owned land. It is assumed that no residents directly affected by the project basically. As a reference, individual interviews were conducted with residents of residences near scattered dam lakes.

On the other hand, the river channel rehabilitation project in the D1 zone downstream of the dam was implemented, especially in the D1 zone river channel section located 40 km downstream of the Sidi Salem Dam. The current river channel in this area is narrow and has been damaged by many floods in the past. In particular, a new channel bypass is planned to be constructed in the town of El Bab, where the historical bridge, a cultural heritage site, is located, in order to properly preserve this historical bridge. DGBGTH confirmed that before starting specific basic design work, information was disclosed to the municipalities and organizations concerned on the location, scale, and construction method of the planned facilities, and they were asked to exchange opinions. In this context, in conjunction with the explanation of the project, the environmental impact of the project was also explained to gain the understanding of the local residents. The stakeholder consultations were conducted in three sessions with different participants as follows. The first and second meetings were conducted face-to-face, but the survey team participated via web conference from Japan when the meeting was held at the Corona Disaster. In April 2022, the third meeting was held with the Japanese survey team in attendance to explain in detail the scale and effectiveness of the planned facilities, as travel from Japan had been eased.

19.10.2 Stakeholder Meeting in the Upstream Area of the Dam

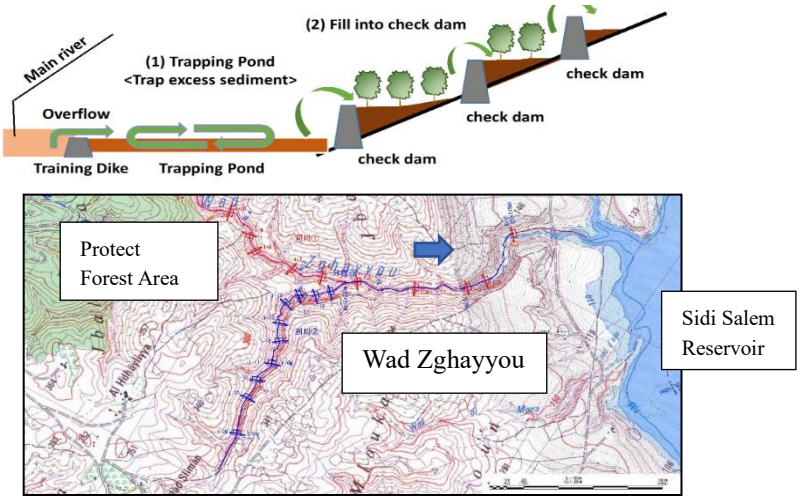
There are no villages in the area around the dam lake, which is the upper reaches of the project, and the area is dotted with farmhouses. Since all projects in the upstream area will be implemented in the dam lake and on state-owned land, it is assumed that the impact on the local residents will not be significant. The survey team conducted interviews with local residents living in the surrounding reservoirs to obtain their opinions on the project plans. The study team described the future project or the following reservoir sedimentation measures The image of sediment runoff control in the watershed used for the explanation is shown in the figure below.

1) A 100m wide and 2-3m deep river channel will be excavated upstream of the reservoir to direct turbid water generated by flooding.

2) A sediment bypass tunnel of 6 km in length will be constructed on the right bank.

3) Construction of a diversion weir to divide the reservoir in Zone D is planned.

4) Pilot projects (Wad Zghayyou and Wad Koudyat as Safra) will be implemented to protect erosion and agricultural land on the left bank of the reservoir.



Source:JICA Study Team

Figure 19-30 Image of Sediment Runoff Control in a Watershed

JICA Study Team also interviewed them about their current living conditions and sedimentation problems. Their opinions and requests are as follows.

Table 19-32 Hearing Result to Relevant People in Upper Stream Area

Items	Contents
Implementation period	December 16-17, 2022
Participants	Five（Male:five）
location	Watershed Sediment Management Pilot Candidate Area: Left Side of Reservoir Wad Zghayyou,Wad Koudyat as Safra Upper part of the reservoir: Left side of the reservoir Land owners near Sidi Salem Dam
Issues and farmers' opinions	Watershed Sediment Management Pilot Candidate Area: Left Side of Reservoir Agricultural land on the left bank of the reservoir, severe lateral and surface erosion is partially developed. The area of farmland is decreasing in the future. They are in daily trouble due to lack of crossing facilities such as bridges. Daily drinking water is groundwater, and public water supply is desired. - They would like to participate in future reservoir construction as construction workers. Upper part of the reservoir: Left side of the reservoir The water level in the reservoir has been falling and there has been no fishing activity for many years. We can see that sedimentation is progressing, especially in the upper part of the reservoir area. I am concerned that in the future the sedimentation will continue and affect the farmland around the reservoir, so I am in favor of excavation in the upper reaches of the reservoir and would like to see it returned to my farmland.

Items	Contents
	Land owners near Sidi Salem Dam Some of the landowners in the vicinity of the reservoir requested to use the valley as a dumping ground for earth and sand in order to recover some of their farmland. It was confirmed that the land could be used as a dumping ground for excavated sediment from the tunnel.

Source:JICA Study Team

Interviews with farmers confirmed that this is a necessary measure in the watershed proposed as a pilot project for sediment erosion control. It was also confirmed that they expect this countermeasure work to be implemented as soon as possible.

19.10.3 Stakeholder Meeting in the Upstream Area of the Dam

(1) First Stakeholder Meeting

The first stakeholder meeting was led by DGBGTH with the support of the heads of the prefectures, cities, and towns located within the proposed project area, and was conducted on the following schedule. The purpose was to deepen understanding of the flood control and sediment management project through explanation and discussion of the scope of the project to the relevant agencies, and a certain level of understanding was achieved.

Table 19-33 Outline of First Stakeholder Meeting

Items	Contents
Implementation period	July 25, 2020
Area and City	El Bab, a local city in the D1 River Zone
Location	Conference room in El Bab City Hall
Participants	Mayer of Mejez el Bab City Head of Maintenance Department Head of Civil Society 5 Young Engineers Member "Young Scouts 3 Young Engineer Member "Young Scouts 3" DGBGTH 1 member JICA Study team: participated via web
Explanation and opiniton	Explanation of the Medjerda Basin Flood Control Project as a whole, area covered by the project, outline of the reservoir sediment control plan, outline of the D1 river channel rehabilitation plan, project start date, construction period, land acquisition for the D1 river channel (proposal for a shortcut channel), proposal for a shortcut channel in El Bab City, confirmation of flood control conservation targets, exchange of opinions
Purpose	The purpose of the first stakeholder consultation is to gain a better understanding of the flood control and sediment management project through explanation and discussion of the scope of the project. The purpose of the stakeholder consultations is also to convene opinions regarding the goals and components of the Project and to have them confirm the location and size of the final facility. It is also to discuss issues that may arise from the Project from an environmental perspective.
Result of Discussion	During the discussions, the overall plan prepared by the survey team and the scale of the planned facilities were explained, and all parties involved agreed on the implementation of the plan. Since the subject area is also inundated during floods, the overall plan was well understood. Regarding the shortcut channel plan, the client requested that the cross-section of the planned channel be appropriately selected so that it would not come into contact with residential areas. In addition, questions were raised regarding the slope of the channel and whether sediment would accumulate in the channel. The committee also explained that there is a plan to shortcut the meandering river channel, and collected information on land use and landowner information for the planned site. The parties also confirmed that the facilities and channel widening planned by the project would reduce the risk of flood damage, and that land acquisition would be necessary for channel widening and construction

Items	Contents
	of a shortcut channel in the meandering section. Furthermore, the mayor suggested that the discussion be linked to urban planning, such as landscaping around the historic bridge, and requested that an additional meeting be held with other interested parties.

Status of First Stakeholder Meeting

Source:JICA Study Team

(2) Second Stakeholder Meeting

The second stakeholder meeting was held as a continuation of the first round, with the farmland owner, the regional construction authority (ANPE), and the regional agricultural authority (CRDA) as participants. Land acquisition related to the proposed shortcut was also explained, and it was agreed that a joint site inspection would be conducted to identify landowners and other interested parties.

Table 19-34 Outline of Second Stakeholder Meeting

Items	Contents
Implementation period	July 29, 2020
Area and City	El Bab, a local city in the D1 River Zone
Location	Conference room in El Bab City Hall
Participants	Mayor of Mejez el Bab City Head of maintenance department Director and staff in charge of civil society 5 Engineer in charge of environment 2 Young Engineers "Young Scouts 3" Local Construction Authority (ANPE) Regional Agricultural Department (CRDA) Farmland Owner Representative DGBGTH 1 person Survey team: Participation via web
Explanation and opiniton	Outline of reservoir sediment control plan, outline of D1 river channel improvement plan, project start date, construction period, land acquisition for D1 river channel (proposal for shortcut channel), proposal for shortcut channel in El Bab City, confirmation of flood control conservation targets, exchange of opinions
Purpose	Following the first stakeholder meeting, the farmland owner, the regional construction authority (ANPE), and the regional agricultural authority (CRDA) were added as participants in the discussions. The objective was to deepen understanding of the flood control and sediment management project through explanation and discussion of the scope of the Project as in the first meeting. It is also to convene opinions on the goals and components of the Project and have them confirm the location and scale of the final facility. It is also to discuss issues that may arise from the Project from an environmental perspective.
Result of Discussion	In this stakeholder, the overall plan prepared by the study team and the scale of the planned facilities were explained again. All parties agreed on the implementation of the project. Regarding the proposed shortcut of the meandering river channel, we were able to confirm the specific location of the proposed shortcut on

Items	Contents
	topographic maps and gather information on the land use status of the proposed site, and a joint inspection was to be conducted at a later date. The construction bureau explained the concept of urban planning, including the development of the landscape around the historical bridge, which was proposed by the mayor. Due to the lack of budget, the specific design has not yet been started, but it was suggested that it should be adopted in this project as much as possible. The participants exchanged opinions on the plan to develop river terraces and other revetment works in this project to match the town's landscape development. It was confirmed that the committee will discuss specific ideas during the facility design phase after the project is launched.

Status of Second Stakeholder Meeting

Source:JICA Study Team

(3) Third Stakeholder Meeting

As a result of two stakeholder meetings held during the 2020 Corona Disaster, a priority plan for reservoir sediment control, limited sediment release during downstream flooding, the scale of widening in the D1 section of the downstream river channel, the location of shortcut channels, and the scale of shortcut channel facilities within El Bab, along with planning drawings The presentation included an animation. The presentation also included a question-and-answer session with the participants, including the method of reservoir sediment control for long-term operation and the management system of irrigation intake facilities in the D1 section of the river channel.

Table 19-35 Outline of Third Stakeholder Meeting

Items	Contents
Implementation period	April 22, 2022
Area and City	El Bab, a local city in the D1 River Zone
Location	Mayor's Conference Room in El Bab City Hall
Participants	Mayor of Mejez el Bab City Head of maintenance department Director and staff in charge of civil society 5 Engineer in charge of environment 2 Survey team members 3 Japanese DGBGTH 1 member
Explanation and opiniton	Priority plan for reservoir sediment control plan, final widened channel cross section for D1 channel rehabilitation plan, project start date, construction period, outline of D1 channel shortcut channel, size of shortcut channel in El Bab City, construction method
Purpose	Following the two consultative meetings held in 2020, this study will explain the size of the facility, which was generally determined in this study, and seek to build consensus.
Result of Discussion	The consultation meeting included the results of two stakeholder meetings held during the Corona Disaster and a presentation of the priority plan for reservoir sediment control, limited sediment discharge during downstream flooding, the scale of widening in the D1 section of the downstream river channel,

Items	Contents
	the location of the shortcut channel, and the scale of facilities for the shortcut channel within El Bab City, along with drawings and an animation of the sediment control measures. The presentation included drawings and an animation of sediment control measures. For the proposed meandering channel shortcut, specific plans were presented and the scale of the facility was explained. Regarding the landscaping around the historic bridge, which was proposed by the mayor at a previous meeting of the Council, the participants were asked to confirm the image of the future river channel development, which was drawn in perspective to share the image of the plan. The construction method of the shortcut channel was also explained and confirmed to ensure safety during construction and no impact on traffic. There were no objections to the general project implementation method, and consensus was reached. The mayor commented that he hoped the project would begin construction as soon as possible.

Third Stakeholder Meeting

Source:JICA Study Team

19.10.4 Proposed Outline and Schedule for Holding New Stakeholder Meetings

(1) Date of the Meeting

After the commencement of the EIA study to be conducted by the executing agency and during the preparation of RAP.

(2) Participants whose Attendance is Particularly Desirable

Affected residents, landowners and local government officials

(3) Contents of Meeting

Description of the Project (components, objectives, sites to be acquired, etc.)

Explanation of the results of the stakeholder meetings held during the preparatory study phase due to the change in the person in charge of the project

Explanation of procedures from land acquisition to resettlement and compensation to affected residents and local governments

Confirmation of requests from affected residents and local governments

(4) Others

Resettlement will not occur, but confirmation meetings will be held with affected residents and local governments, with sufficient information prepared in advance.

Explanations during the meeting should be provided to the affected residents and local governments in an easy-to-understand manner using slides.

19.11 Action to be required in Future

The following actions are required of the DGBGTH to ensure smooth implementation of the project in the future.

19.11.1 To Consult with ANPE on EIA implementation

As mentioned above, according to domestic legislation, the activities planned under the Project do not require an EIA or environmental permit, and the implementation of the Project and related sub-projects does not require the official procedure of an EIA to the ANPE, which is responsible for environmental permits and licenses. However, when JICA Expert Team interviewed with ANPE in January 2020, ANPE responded that the Project owner should consider whether or not to conduct an EIA on a case-by-case basis based on the scale and impact of the project, so ANPE and DGBGTH will need to discuss this issue in the future. In addition, domestic legislation relating to EIA and environmental permits is currently being revised, and the timing of the start of construction will need to take into account the revised status of these laws/legislations.
As DGBGTH considers that it is premature to hold discussions with ANPE within the current FS study, it is recommended to proceed with these discussions on its own, based on the results of this FS study.

19.11.2 To Conduct EIA studies cover both of the JICA Environmental and Social Considerations Guidelines and Tunisian laws

Even if the EIA procedure for the Project is not required by national law and consultation with ANPE, if the Project is envisaged to be implemented as a yen loan project, an EIA study should be conducted in accordance with the JICA Environmental and Social Considerations Guidelines on (April 2010). As the Project is planned to involve large scale river channel excavation and is expected to have a significant impact on the water quality and aquatic ecosystem in the Medjerda River basin. Therefore, detailed field survey should be conducted before the construction phase. In addition, stakeholder meeting with the surrounding community and appropriate information disclosure are required, although not stipulated in the domestic regulations.

19.11.3 Prepare an Appropriate Land Acquisition Plan and Implement Land Acquisition

The upstream area and the area around the dam lake are government land. Some land acquisition will occur to secure the land needed for the downstream river improvement project (0.68 ha). The details of the land acquisition are presented in the next chapter, but with the cooperation of DGBGTH, seven landowners of the target land have now been identified. Individual interviews were conducted with these landowners in December 2022. They are also beneficiaries of the Project in the area, and all of them favorably to the Project and were cooperative in acquiring land for the Project. DGBGTH will need to discuss and agree on a compensation policy with them based on the land acquisition plan.
In order to secure the necessary land, a site acquisition plan covering both the country's laws and regulations/JICA guidelines must be prepared as soon as possible, and the land acquisition must be implemented.

19.11.4 Establish of Organized System to Implement Environmental and Social Considerations

In current situation, DGBGTH has not assigned a department in charge of environmental and social considerations and does not have a resident expert in environmental and social considerations. On the other hand, after this study, DGBGTH will need to proactively implement mitigation measures and environmental monitoring based on the EIA and environmental management plan in accordance with Tunisian law. For this purpose, the necessary structure should be established. A department in charge of the environment as shown in "19.9 Implementation Structure" above should be established within DGBGTH to cover the JICA guidelines and to implement environmental and social considerations.

CHAPTER 20 LAND ACQUISITION AND RESETTLEMENT

20.1 Needs for Land Acquisition and Resettlement

For the Project, the upstream sediment control area is in and around the dam reservoir. All project land is owned by the government, and the Project will occur no resettlement or land acquisition. In the downstream D1 zone, 0,62 km^2 of land acquisition is required for the shortcut and channel widening of the meandering section. The land to be acquired is pasture lands (not cultivated land, part of the floodplain), and the Project will not impact on resettlement, buildings, crops, etc.

20.2 Legal System and Implementation Conditions Regarding Land Acquisition and Resettlement in Tunisia

20.2.1 Legal System Regarding the Demarcation of Water Zones

The following government decrees have been established as the legal system pertaining to water zone demarcation and land use for public projects.

- Decree No. 75 of 16 March 1975 promulgating the Water Code (Amended by Decree No. 24 of 15March 2004.)
- Decree No. 20 of 13 April 1988 promulgating the Forest Code (Amended by Decree No. 13 of 26January 2004.)
- Decree No. 122 of 28 November 1994 promulgating the Land Development and Urban Planning Law (Created by integrating Decree No. 34 of 4 February 1976 on construction permits and Decree No. 43 of 15 August 1979 for promulgating the Urban Development Law.)

Within these legal systems, government-owned public water zones (public hydraulic domain) are set by the Water Code, Easement of Land use is set by the Forest Code.

In a broad sense, easement is the right to use the land of another person for the benefit of his or her own land. Easement in Tunisia is regarded, in particular, as the right to secure land for the benefit of the state within the scope of the law.

20.2.2 Legal System and Implementation Conditions Regarding Land Acquisition and Resident Resettlement in Tunisia

(1) Land acquisition laws/regulations

The right to property is a fundamental constitutional right protected by the Constitution, the Real Rights Code and the Code of Obligations and Contracts. The right of ownership is guaranteed; it can only be infringed in the cases and with the guarantees provided for by law and no one may be compelled to transfer his property except in the cases provided for by law and for fair compensation. Property transfer is only possible either through acquisition by amicable agreement or expropriation. Expropriation is only considered as a last resort.

Expropriation in the public interest is regulated by the law n°53-2016 of 11 July 2016 laying down expropriation procedures and conditions towards the facilitation of public projects development and through acceleration of respective procedures comparatively to the former law. More specifically:

- The declaration of expropriation may be published only after the decision of the Administrative Tribunal which confirms the public utility of the transaction.
- As soon as the State decides to expropriate, experts will be responsible for determining temporarily the amount of the compensation and the State will proceed directly to the possession.
- The criteria setting the amounts of compensation are strengthened and updated comparatively to the former regulation and an independent expert advisory office is created under the supervision of

the Ministry of State Property and Land Affairs.

- Owners may have recourse to independent experts to have a counter-expertise and resort to justice in case they object the amount of the proposed compensation.
- Economic displacement, resettlement and livelihood restoration are not covered by national legislation. Monetary compensation is only payable in cases of acquisition by amicable agreement or expropriation, while no assistance is provided to relocate people according to legislation. Besides, it is common that the State offers equivalent properties to people when this is feasible.
- Compensation of informal occupation can be very complex and the procedure of land acquisition can affect the project implementation knowing that the situation is considered on a case-by-case basis taking into account the social aspect and the social requirements of the international financial institution involved in the project funding.

The law n°53-2016 of 11 July 2016 was followed by the following application texts:

- Governmental decree n° 2017-332 of February 28, 2017, fixing the composition and the functioning of the national commission in charge of fixing the criteria determining the financial value of the buildings necessary for the realization of public projects, their components and the methods of their revision as well as their updating,
- Decree of the head of government of March 1, 2017, setting the amount of the value of property acquisitions for the benefit of the state subject to the authorization of the head of government,
- Decree of the head of government of March 13, 2017, fixing the documents of the expropriation file for reasons of public utility,
- Decree of the head of government of March 13, 2017, fixing the composition of the commission of acquisitions for the benefit of public projects and the procedures for its operation.

(2) Land ownership

The forms of land status are mainly classified into three categories, namely state land, privatized state land, and private land, and the procedure for site acquisition and compensation varies according to the situation as detailed in the table below.

The acquisition and compensation procedure is necessary in the following cases:

- state land illegally occupied,
- private land registered or in the process of registration in the land register,
- unregistered private land.
- In the following cases (4) and (5) which are other forms of land status, the procedure for changing the vocation of the land will be carried out in coordination with the Ministry of State and Land Affairs and organizations concerned:
- public lands without illegal occupation,
- privatized state lands.

Table 20-1 Procedure for sites acquisition according to land status

Legal status of land	Property / occupation situation		Acquisition procedure
State-owned Land	Land registered in the land register (under the land law promulgated on July 1, 1885	Without illegal occupation (4)	The land use change procedure is carried out by the ministries concerned, according to the classification of state lands, (hydraulic domain, forest domain, marine domain...) and the Ministry of State Domains and Land Affairs.

Legal status of land	**Property / occupation situation**		**Acquisition procedure**
	and the real rights code of February 12, 1965)	With illegal occupation (1)	Implementation of procedures for compensation or resettlement on replacement land, but these are not judicial expropriation procedures. In the event of a refusal by the occupants of the amount of compensation offered, it is likely that rapid recovery of the site will be difficult.
Privatized State lands	Exploitation of public lands - parks or dams - by the private sector, including public enterprises (5)		Request for a procedure for changing the vocation of the land to the Ministry of State Domains and Land Affairs
Private lands	Land registered in the land register (under the land law promulgated on July 1, 1885 and the real rights code of February 12, 1965)	Registered land with a revised land title (2)	A land title is issued in accordance with the property right registered in the Regional Directorate of Land Conservation and the land registration number registered in the cadastral plan of the OTC. The procedure of amicable acquisition or expropriation by judicial means is implemented. The main difficulty comes from cases of joint tenancy, for which it may be necessary to delimit the plots and the value of property between a large number of rights holders.
		Unregistered land without a revised land title (2)	An update is necessary, but it may take time.
	Land for which the cadastre registration procedure is underway (request)	Occupant with requisition certificate (2)	When the registration procedure is underway, a requisition number is assigned for the plots by the court responsible for the matter. The procedure for amicable acquisition or expropriation by judicial means is implemented according to the results of the requisition from the court responsible for the matter.
	Lands unregistered in the cadastre	Occupant with certificate of possession (2)	The certificate of possession is an administrative document given to the occupants of agricultural land installed for at least 5 years, giving them the right of pre-emption when registering in the cadastre in the future.
		Occupant with property rights (3)	The right to property is a notarial act without a land registration number. In this case, a certificate of possession is issued by the governor after the completion of the public notification period by the Regional Assessment and Coordination Commission.
		Absence of any document attesting ownership (3)	After 6 months of public notification, if a site is considered as the land of an occupant claiming the right of ownership of an unregistered plot, and no one claims the right of ownership, the site in question returns to the domain of the State.

Source:JICA Study Team

(3) Land Acquisition Flow

The general land acquisition procedural flow in the Tunisian State is shown below.

1. Identification of plots, of owners and occupants through a preliminary social / site study	
Organizations concerned: The ministry of agriculture, the General Directorate of Dams and Large Hydraulic Works (DGBGTH). The Ministry of State Domains and of Land Affairs, General Directorate of acquisitions and Delimitation, Office of Topography and Land Registry (OTC).	i) The DGBGTH sends the technical documents of the project sites consisting of site plans, location of the planned works, as well as the project summary. ii) The preliminary social / site study will be carried out by the OTC or will be entrusted to a private surveyor's office. The purpose of this work is a) to investigate residents and property directly affected by the project, and b) to calculate the costs of site acquisition and damage resulting from loss of land (crops, similar property, etc.). The following outputs will be obtained through the social study / preliminary site. - List of land titles, plots, owners (registered land) and occupants (unregistered land) - Soil characteristics of plots of land - Resettlement planning - Visualization of the project sites by using terminals determining the physical limits. iii) The preliminary social / sites study will be presented to the CRDA (Regional representation of the Ministry of Agriculture in each governorate), to the governorates and to the Department of delimitations and acquisitions (within the Ministry of State Domains and Land Affairs), and, on receipt thereof, the governor will appoint the representative of the Procurement Commission for the benefit of public projects.

2. Assessment of properties values (goods and lands) based on the expertise report	
Organizations concerned: Procurement Commission for the benefit of public projects (CAPPP)	i) The Procurement Commission for the benefit of public projects will prepare the expertise report for the appraisal concerning properties on land where acquisitions are planned. The expert report will include the land title number, the plot number, the name of the beneficiaries, the estimated value of the bare land / planted land, and fixed installations. This same commission will be in contact with the owners / occupants to prepare the appraisal report, but it will have to limit itself to collecting information and will in no case be able to conduct consultations with the residents concerning the estimated prices. The term "planted land" refers to wooded or arable land as well as standing crops, and the term "fixed installations" refers to dwellings, stables, barns, stables, and all the constructions located on the sites planned for the project. In the case of agricultural land, the price is indicated in dinars / hectare, and in the case of sites and constructions in urban areas, this is given in dinars / m2. The owners / occupiers of the land will in no case have access to the expert report. ii) The Procurement Commission for the benefit of public projects will analyze the report of the preliminary social/ sites study sent by the Sub-Directorate of expropriations and compensation to the General Directorate of site acquisition of the Ministry of State Domains.

3. Evaluation / Approval of expert report	
Organizations concerned: Ministry of State domains and Land Affairs Regional Center for Agricultural Development (CRDA), Regional Office of the Ministry of Equipment	i) The examination and approval of the expert report will be carried out by the General Directorate of Expertise of the Ministry of State Domains and Land Affairs. The estimated quotation price for bare land / planted land / fixed installations is evaluated, and the amount of compensation corresponding to the loss of means of subsistence for the owners / occupants is calculated taking into account other aspects that may affect the market price, the price at the time of purchase by the owners, the price of the production of agricultural land, the price of bare land, the price of goods. For agricultural and planted land, CRDA provides advice. Regarding fixed installations, the regional office of the Ministry of Equipment is responsible for this.

4. Consultations with the owners / the occupants and acquisition of sites

Organizations concerned: Ministry of State domains and Land Affairs Procurement Commission for the benefit of public projects (CAPPP) Expropriation Recognition and Conciliation Commission (CRC) DGBGTH	i) The Directorate General of Expertise of the Ministry of State Domains and Land Affairs submits to each Regional Evaluation and Coordination Commission of the governorates concerned the results of the preliminary social / sites study as well as the results of the assessment work after the examination of the expert report has been completed.
	❖ Case of registered land ((2) in previous table) ii) The General Directorate of Acquisitions and Delimitations convenes the owners / occupants of the land to find out their requirements relating to the amounts of compensation calculated and the procedures for the acquisition of the land. The meetings will be organized consecutively no more than 3 times, and the owners / occupants will accept or refuse the price of goods announced by the Regional Evaluation and Coordination Commission, and will write down on their request and their requirements concerning the amount of compensation and the terms. The Regional Evaluation and Coordination Commission will not have the authority to review the amount of compensation proposed by the General Expertise Department of the Ministry of State and Land Affairs. iii) The Regional Evaluation and Coordination Commission will send the request to the Acquisition and Delimitation Department, as well as one (1) copy to the site acquisition division. iv) The DGBGTH will entrust deposit the amount of compensation for the plots to the Ministry of Finance within two (2) months. v) The Regional Evaluation and Coordination Commission will develop in the two (2) months the final report based on consultations. This period may under certain conditions be extended to three (3) months. vi) The Ministry of State Domains and Land Affairs will receive the report of the Regional Evaluation and Coordination Commission and will take the decision on the acquisition of the sites. The owners may challenge the decision of the Ministry of State Domains and Land Affairs by appealing to court. vii) After the approval of the acquisition of the sites amicably, a contract of sale and purchase for administrative purposes will be signed between the owners and the Ministry of State Domains and Land Affairs. The headings of the contract in question will include the plot area, the unoccupied land of the plot, the amount of the acquisition, as well as the transfer of property rights. viii) The payment or deposit of the amount of compensation will be carried out within six (6) months from the date of preparation of the final report by the Regional Evaluation and Coordination Commission. In the event of late payment, owners or occupants may claim arrears of interest. In the case of an amicable contract, the owners will have the duty to hand over the site to the buyer immediately after the conclusion of the sale and purchase contract. The sites / buildings located in the area of the construction site will be subject to immediate recovery, but the sites / buildings outside the site area may, to the fullest extent permitted by the project, be occupied in the same conditions than before.
	❖ Case of occupied land and unregistered land ((1) and (3) in previous table) ii) Unregistered lands are generally accompanied by a certificate of possession but without official registration. It also happens that the site owner does not have any documents at his disposal. The owner being unspecified, the acquisition procedures are more complex. The Regional Evaluation and Coordination Commission will organize a public notification over a period of six (6) months through the Governorate, the delegation and the municipal administrations, and the regional office of the Ministry of State Domains and Land Affairs covering the intention of the acquisition of the sites, the list of plans of the sections and of the supposed owners. The owners will have to file an application, during the public notification period, to obtain the amount of compensation for their property. iii) The vocation change procedure will be implemented once the six (6) months of notification elapsed, in the event that there are no owners who have made a request. In the case where there are owners, procedure ii) of 【Land and registered land】 will apply.

5. Compensation for surface goods	
Organizations concerned: Procurement Commission for the benefit of public projects (CAPPP) Governorate DGBGTH	i) The governorate will convene the owners / occupants for signing the declaration of intent regarding compensation for surface goods. This declaration of intention differs from the administrative sale and purchase contract concluded with the Ministry of State Domains and Land Affairs, and constitutes a pledge on the part of the owners / occupants to the DGBGTH, which is the purchaser of the sites, recognizing the work to develop the project on the compensation sites without any dispute in exchange for the amount of compensation offered. ii) In the case of planted land and fixed installations, the DGBGTH may start the procedure for compensating surface property on the basis of the results of the expert reports transmitted by the General Directorate of Site Acquisitions of the Ministry of State Domains and Land Affairs, without waiting for the results of the site acquisition procedure. With regard to the payment of the amount of compensation, the DGBGTH will transfer the compensation for surface goods to the order of its regional offices, and, in general, payment will be made quickly after the declaration is signed by the owners / occupants. The period between the signing of the declaration of intent and the payment of the amount of compensation is not regulated. Consequently, the owners / occupants will present to the purchasers of the sites the surface goods for which the payment of the compensations has been made within six (6) months from the date of payment of the amount of the compensations. iii) In the event of a refusal on the part of the owners of the terms of the compensation, a legal expropriation procedure will be undertaken. The DGBGTH will entrust the compensation amount to the Ministry of Finance within two (2) months, and the owners will appeal to the court on the basis of a new second opinion, after having signed the declaration of intent in dispute. In this case, it is possible that the recovery of the sites will be extended longer than expected.

6. Change of vocation	
Organizations concerned: DGBGTH Ministry of State Domains and Land Affairs	i) The DGBGTH will make the request to of the Ministry of State Domains and Land Affairs for the change of vocation of the targeted lands on the basis of the list presented by the Evaluation and Coordination Commission ii) Vocation Change is the procedure for transferring the property of ordinary state property, which was land belonging to owners, in public state domains, undertaken by the Ministry of State Domains and Land Affairs at the time of the preparation of sales and purchase contracts / transfer of property rights. The contract indicated in the above will be sent to DGBGTH to pay the owner by cancelling the amount of compensation entrusted to the Ministry of Finance.

7. Publication of decrees and of declarations of interest public, expropriation of sites	
Organizations concerned: Ministry of State Domains and Land Affairs Court	i) If the owners / occupants appeal to court concerning the amount of compensation / conditions relating to surface goods or, in the case where many people claim a right of property, a procedure of expropriation by legal means will be undertaken. The Ministry of State Domains and Land Affairs will publish the decrees and proclamations of public interest for the sites in the official journal, and the land concerned will then officially revert to State domains. The expropriating party may be involved in the works / the studies immediately after the publication of the decrees. In the event that the land concerned is not surrendered by the owners / occupants after the publication of decrees and proclamations of public interest, the provision of sites for the project may be threatened by interminable legal procedures. ii) As part of the site acquisition procedure, experts at the service of the State will reassess the amount of compensation, while assessors will tackle the same task for the opposing party. iii) Regarding the amount of compensation requested in the context of the procedure of acquisition of the sites, the court will be in the obligation to take a decision within three (3) months from the first instance. iv) In the case of a new second opinion provided by the claimant, the Court of Appeal must render its verdict within three (3) months from the first instance. In addition, the Court of Cassation will deliver its judgment within three (3) months from the date of the legal action.

Source:JICA Study Team

Figure 20-1 Land Acquisition Flow

(4) Organization

1) Ministry of State Properties and Land Affairs (MDEAF)

MDEAF is the management agency that activities related to land and real estate transactions. MDEAF becomes the responsible agency and manages the land acquisition procedure performed by the business owner when land acquisition occurs in public works. In case of expropriation is required (legal land acquisition), under the supervision of the Ministry, legal land expropriation based on the Land Acquisition Act "Law No. 2003-26 dated April 14, 2003" will be implemented.

2) Commission of Recognition and Conciliation (CRC)

The CRC is a committee established in each district to coordinate a series of procedures related to legal land acquisition (Expropriation).

In addition to assessing the amount of compensation for land subject to land acquisition, it will also coordinate and mediate land acquisition and compensation procedures between business owners and landowners in public works.

Members are, with the judge of the court as chairman, composed of the prefectural governor, prefectural land and land ministry representative, prefectural GSI representative, mayor, executing agency land acquisition section representative, etc.

20.2.3 Organizations Related to Land Acquisition and Resident Resettlement in Tunisia

The legal land expropriators are the Division of Expropriation of Dams and Services of Expropriation and Compensations within the Directorate of Large Dams of the DGBGTH. From this position, they are responsible for land acquisition procedures in cooperation with the following relevant organizations.

- The Directorate General of Acquisition and Boundary Demarcation and the Directorate General for Appraisals within the Ministry of State Domains and Land Affairs (hereinafter called "Ministry of State Domains")
- Governorate branches of the Ministry of State Domains
- Office of Rural Land Conservation (a public companies set up within the Ministry of State Domains to handle registration management)
- CRDA
- Governorates and relevant districts
- Regional Commissions of Expropriation

With the Governor acting as chairperson, this commission consists of representatives from the DGBGTH, MEq, Ministry of State Domains, CRDA, and relevant districts.

- Regional Commissions of Assessment and Adjustment

With a government official acting as chairperson, this commission generally consists of about 12 people as standing and temporary members. They include the land expropriator, local representatives of the MEq, experts from the Ministry of State Domains, representatives of regional social welfare agencies, district court representatives, and CRDA representatives.

- Court of justice (involved if there are land expropriation procedures)
- Central Committee on Land Use Planning and Development

This committee consists of the major relevant directorates, the Ministry of State Domains, and the governors of governorates in Project areas. It is only involved for special cases, such as disputes between owners during land acquisition or the discovery of cultural or archeological artifacts during construction

work.

- Central Steering Committee

Study on the establishment of this committee by the Ministry of State Domains, the MEq, and the ME began following the revolution in order to facilitate land acquisition procedures through government involvement. The timing of establishment and primary activities of the committee are yet undetermined.

20.2.4 Public consultation for land acquisition

Stakeholder engagement and public consultation, where land owners will be directly affected by a project, is addressed in the Framework for Land Acquisition and Compensation (law n°53-2016 of 11 July 2016).

According to the law, stakeholders are not required to be consulted during project scoping, development or implementation. Therefore, any meetings with concerned parties are organized at the discretion of the project developer in concert with local authorities and according to decree n°2018-328 of March 29th, 2018 setting out the general provisions on public consultations.

According to law n°53-2016 of 11 July 2016, local authorities involved in land acquisition are required to:

· Once the authorization for the project has been published in the Official Journal, display publicly the list of persons who will be affected by land acquisition for 60 days at the governorate headquarters, the delegation, the commune and regional offices for state lands and land titles.

- Notify concerned land owners about the existence of the project and the consequences of the project on their property.
- Use written and audio communication methods to inform land owners about the existence of the project.
- ·Collect and transmit grievances of affected population to the administration in charge of land acquisition.

20.2.5 Grievance mechanism in land acquisition

Property or rights owners can object the amount of foreseen compensation before the publication of the Decree. A descriptive list of properties stating the names of owners and the value estimated by an appropriate expert is displayed in the headquarters of the local authorities for 60 days. The "Commission of acquisition for the benefit of public project" records objections from owners or rights owners during the 60 days of the display and investigates the objection reasons. An owner can have recourse to an expert to estimate his property and resort to justice.

20.2.6 Key Principles of JICA Policy on Involuntary Resettlement

The JICA Environmental and Social Guidelines stipulates basic policies such as consideration to minimize resettlement. The key principles of JICA policy on involuntary resettlement are shown in the figure below.

The key principle of JICA policies on involuntary resettlement is summarized below:

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV. Compensation must be based on the full replacement cost6 as much as possible.
V. Compensation and other kinds of assistance must be provided prior to displacement.
VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
XIII. Provide support for the transition period (between displacement and livelihood restoration).
XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

*1 Description of "replacement cost" is as follows.

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

Source:JICA Study Team

20.2.7 Comparison between Tunisian Law on Compensation/Resettlement with JICA/WB Environment Guidelines

The differences between the land acquisition system in Tunisia and the JICA environmental guidelines and WB OP4.12, and the planned response to this project are shown in below table. The outline of the Project plan is under consideration and no concrete discussions have been held with DGBGTH. Regarding "Corresponded to be expected in the Project," the content tentatively referred to the case of a JICA loan project that is currently being implemented in downstream area.

Table 20-2 Comparison between Tunisian Law on Compensation/Resettlement with JICA/WB Environment Guidelines

No	Requirements and Points by JICA Guideline and WB OP4.12	Law and regulation in Tunisia	Gaps between Tunisian law and JICA guidelines	Corresponded to be expected in the Project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Not Applicable	The principle has not been expressly stipulated in Tunisian law.	The optimal plan is selected not only from an environmental point of view, but also from a technical and economic point of view. Due regard to the rights of the residents, consideration will be given from the planning stage so that the loss of resettlement and livelihood means will be minimized.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Land Ownership Law (Amended by Decree No. 53 of 11 July 2016)	Common to both Tunisian land ownership law and JICA guidelines	Involuntary resettlement does not occur in the project Apply the land acquisition and compensation process in accordance with the Land Ownership Act.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Land Ownership Law (Amended by Decree No. 53 of 11 July 2016)	Common to both Tunisian law and JICA guidelines.	Affected persons who have lost their livelihoods due to this project will be compensated for the cost of reacquiring their livelihoods or recovering their livelihoods elsewhere. In addition, for buildings that require relocation, replacement costs are guaranteed based on market prices.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Land Ownership Law (Amended by Decree No. 53 of 11 July 2016)	Common to both Tunisian law and JICA guidelines. According to land ownership law, the compensation cost is set based on the price actually sold in the market desired by the seller.	Compensation for the building will be the full replacement cost based on the market price. For crops and other plants, compensation cost will be set the market price based on the potential yield lost by the business.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Land Ownership Law (Amended by Decree No. 53 of 11 July 2016)	Common to both Tunisian law and JICA guidelines. According to land ownership law, all compensation should be provided before resettlement.	All process of compensation should be provided prior to displacement.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	Not applicable	Although there is no provision for preparing a resettlement plan, generally, the resettlement policy will be prepared in advance in	Under the Project plan, no large-scale involuntary resettlement will occur. If necessary, DGBGTH will be recommended to prepare a resettlement plan in advance and make it open to the public.

No	Requirements and Points by JICA Guideline and WB OP4.12	Law and regulation in Tunisia	Gaps between Tunisian law and JICA guidelines	Corresponded to be expected in the Project
	(JICA GL)		consultation with the target people.	
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	Not Applicable	For compensation procedures following the laws, negotiations cannot be conducted with affected people in advance.	JET will recommend to DGBGTH to discuss information with the affected people and related organizations through stakeholder discussions and focus group discussions and to disclose information.
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Not Applicable	This principle has not been expressly stipulated in Tunisian law.	There are no particular problems because the language used by the target people are Arabic or French. Since the Project area is traditional Islamic area, DGBGTH is recommended to gender-sensitive when holding stakeholder meeting.
9	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Not Applicable	This principle has not been expressly stipulated in Tunisian law. Participation system for affected residents within involuntary resettlement procedures in Tunisia.	JET will recommend that DGBGTH to obtain agreement with the residents through stakeholder consultations and focus group consultations at the necessary project stage.
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Not Applicable	There is no particular system for processing grievances apart from filing a lawsuit.	A system for processing grievances as a part of the land acquisition and compensation process will be proposed to DGBGTH.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	Not Applicable	Social, land, and initial construction surveys are stipulated as land acquisition procedures, but there are no regulations regarding cut-off dates for obtaining eligibility for loss compensation.	There is no cut-off date system in Tunisia. However, due to the legal system in Tunisia, it is possible to prevent the inflow of non-regular residents and clarify the persons to be compensated.
12	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census and the PAPs who own the land practically although they don't have formal legal	Land Ownership Law (Amended by Decree No. 53 of 11 July 2016)	Unless there are claims by other land owners, rules related to the cut-off date for obtaining eligibility for loss compensation for residents without legal rights to land will also be set to match Tunisian law.	A process of land acquisition and compensation following the Land Ownership Law will be applied.

No	Requirements and Points by JICA Guideline and WB OP4.12	Law and regulation in Tunisia	Gaps between Tunisian law and JICA guidelines	Corresponded to be expected in the Project
	rights to land. (WB OP4.12 Para.11)			
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Not Applicable	No specific rules for land-based resettlement strategies for displaced persons describe in Tunisian laws. DGBGTH policy states that preference will be given to exchanging land with that having the same or larger surface area than the owned land within a 20km radius.	The DGBGTH already has experience with same type of compensation in rural districts, such as the River Improvement work in the downstream of Medjerda River (D2 Zone) under implementation. This method will be preferentially applied for this Project as well.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	Not Applicable	Although this principle during resettlement period is not clearly stated in Tunisian law, the DGBGTH applies it for resident resettlement due to large projects.	Necessary support during the resettlement period will be provided to minimize the impact on the livelihoods of resettled people.
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	Not Applicable.	No detailed rules, such as specific methods for dealing with vulnerable groups describe in Tunisian laws.	If affected people by the Project includes vulnerable groups, specific consideration and support will be given to ensure that those affected are not disadvantaged.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	Not Applicable.	Abbreviated RAP has no particular description in Tunisian laws.	Even if the people to be resettled is less than 200, DGBGTH will prepare Abbreviated RAP (draft).

Source: JICA Study Team

20.3 Proposed Policy of Land Acquisition/Resettlement by the Project (Scope of Resettlement Impact)

20.3.1 Basic policy on resettlement and land acquisition

Basically, the Project will be planned in such a way that sufficient consideration is given to avoid resettlement and land acquisition. However, due to technical and economic advantages, land acquisition will be occurred depending on the rehabilitation plan of the river downstream of the dam reservoir. In such cases, the compensation procedure will be based on Tunisian land ownership law and JICA guidelines, and will provide just and fair compensation to the owner/occupier of the subject area, regardless of whether the ownership is legal or illegal.

20.3.2 Consideration of the need for resettlement and land acquisition

The area upstream and around the dam reservoir is public land. Some land acquisition will be required to secure the land needed for the downstream river improvement programme. Based on the final project plan, DGBGTH will need to prepare a site acquisition plan and formulate an appropriate compensation policy. Site acquisition should be completed before the start of construction. Although resettlement is not expected to occur in the D1 zone, the river channel widening and embankment construction will be implemented, and land acquisition will be required.

In meandering sections of existing rivers, short-cut channels need to be constructed in order to straighten the meandering sections and allow them to flow smoothly. The project envisages the construction of shortcuts at four locations, requiring a total length of 7.57 km. The lands to be acquired are shown in Figure 20-4. No house and other structures are located on the land to be acquired, and most of the land

is agricultural land, as shown in Figure 20-3. However, the site survey should be carried out when preparing the land acquisition plan prior to project implementation, and appropriate compensation should be provided.

It should be noted that the project needs to ensure conformity with existing Tunisian laws and JICA guidelines on land acquisition and compensation. Since the non-affected residents in this project are likely to be ordinary farmers and resettlement will not occur, Land acquisition shall proceed with the general procedure. Land acquisition is likely to be a critical delaying factor for the project and is therefore encouraged to be addressed at an early stage.

20.3.3 Setting Cut-off dates

The cut-off date is the date before which residents/users of the project area are classified as affected persons and become eligible for land compensation by the Project. For the project, for landowners, the cut-off date will be the date of notification in accordance with the Land Acquisition Law（décret de déclaration d'utilité publique / Loi no.85 du 11 août 1976, modifiée par la Loi no. 26 du 14 avril 2003 relative à l'acquisition de terrains pour les intérêt public）. For non-landowners, the cut-off date will be the first date of the land survey (enquête socio-foncière et travaux préliminaires) for the year in which DGBGTH plans to implement the Project. This date is disclosed by the relevant local government to each affected village, which in turn discloses it to its residents. The set of cut-off dates is intended to prevent an influx of ineligible non-residents who might take advantage of project entitlements.

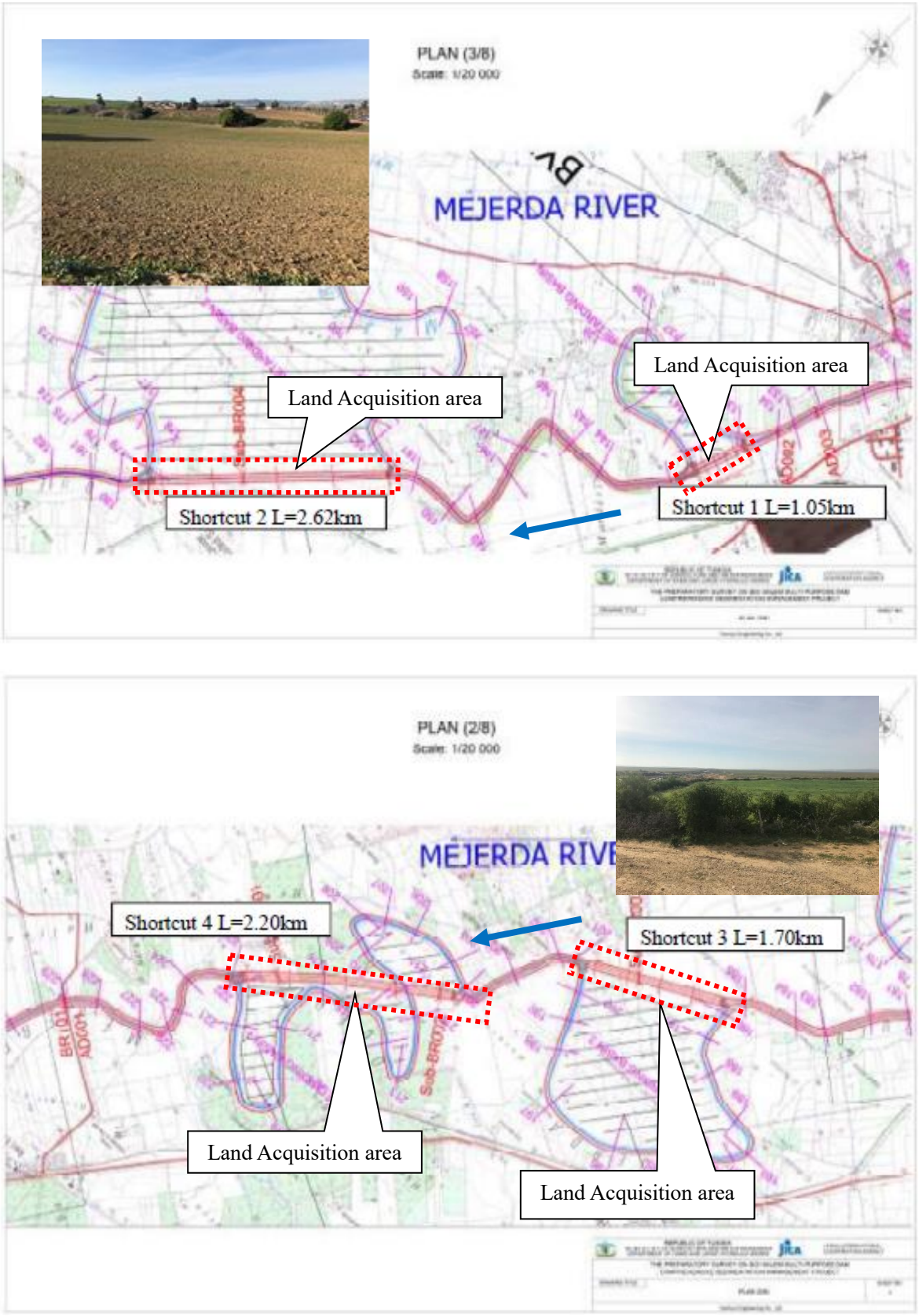
20.3.4 Landowner information in the proposed shortcut sites and interview results

With the support by the local government, JST identified information on the ownership of the farmland on the proposed shortcut site. The results of individual on-site interviews conducted in December 2022 are summarized in the table below. Area of shortcut2-4 require land acquisition from individuals, and a total of seven landowners were identified in the Project area. All of them have agreed on the land acquisition in the Project site with some conditions. From now on, DGBGTH will negotiate directly with these targeted land owners regarding the site purchase price and will acquire the land before the Project is implemented.

Table 20-3 Landowner Information in the Proposed Shortcut Site and Interview Results

Name of the land	Extension of New Waterway（km）	Land acquisition Area（km^2）	Information of land owners（Number）	Results of the Hearing Survey as of December 2022
Shortcut site 1	1.05	0.07	Government land	-
Shortcut site 2	2.62	0.17	4 persons	Three of the four agreed. The remained one agreed if irrigation water could be taken from the new canal.
Shortcut site 3	1.70	0.11	2 persons	Agreed
Shortcut site 4	2.20	0.15	1 person	Agreed
Total	7.57	0.50	7 persons	

Source: JICA Study Team



Source:JICA Study Team

Figure 20-2 Candidate sites for land acquisition (Map of location of shortcuts in meanders).

20.4 Specific Measures for Compensation and Support

20.4.1 Compensation for Losses

The Project does not occur resettlement, only land acquisition. The land to be acquired is in an exiting flood zone and is normally used as pasture land. At present, JICA survey team identified seven landowners in the target site. DGBGTH plans to conduct a detailed survey and negotiations with the landowners for the acquisition of the land. Basically, all compensation for the Project is assumed to be in cash.

20.4.2 Livelihood Restoration Program

The land targeted for land acquisition is pasture land, which is small (0.62 km^2). At present, no impact on means of livelihood is expected, livelihood restoration program will not be considered.

20.4.3 Entitlement Matrix

DGBGTH will conduct a detailed survey and negotiation on the landowners who are eligible to acquire land for the Project. The land will be divided into two types: 1) land to be acquired permanently, and 2) temporary use of land (during the construction period), all of which will be compensated in cash.

Table 20-4 Draft Entitlement Matrix for the Project

Type of Loss	Type of Affected People	Compensation Policy	Remark
Compensation for Land			
1) Land to be acquired permanently	Legal owner(s) of land	- Payment of the agreed land price (but not more than the amount calculated with reference to the market price)	- Compensation by Cash includes taxes and other expenses related to the land transaction - Compensation costs are paid in a lump sum prior to delivery
2) Temporary use of land (e.g., storage of materials during construction)	Legal owner(s) of land	- Rent fee based on land use agreements	- Temporary use of the land is not subject to acquisition, but only temporary use during the construction period. - The cost of this compensation is included in the construction contract, and the construction contractor is responsible for the procedure.

Source: JICA Study Team

20.5 Grievance Mechanisms

In line with general land acquisition, the Project also allows landowners to request an expert to estimate their property for the projected compensation amount and bring it to justice prior to the issuance of the decree. A descriptive list of the property with the owner's name and the value estimated by the appropriate expert will be posted at the local government headquarters for 60 days. The "Acquisition Committee for Public Works" will record any objections from the owner or rightful owner during this 60-day display period and investigate the reasons for the objections.

In addition to this procedure, the Project proposes to establish a grievance office within the DGBGTH as the project implementer, to take appropriate action in advance to ensure that the project does not proceed to the judicial process.

20.6 Implementation structure (identification of agencies responsible for resettlement and their responsibilities)

DGBGTH, the operator of the Project, is responsible for the implementation of land acquisition in the Project, handling of complaints, and monitoring of land acquisition. In addition, the MDEAF monitors land acquisition in public works projects, and the CRC will be involved in the land acquisition process by assessing the amount of land compensation and, if necessary, by judicial proceedings when a landowner files a grievance. The implementation structure related to land acquisition is shown in the table below.

Table 20-5 Land Acquisition Implementation System for the Project

Institution / Department	Duties
DGBGTH (Land acquisition unit centered on PMU)	1) Obtaining and organizing technical data necessary for land acquisition, and calculating the amount of compensation 2) Negotiate with the target people for land acquisition 3) Budgeting within the Ministry 4) Progress management of land acquisition, and understanding of the level of satisfaction of the affected people 5) Consideration of policies for dealing with complaints received 6) Prepare to stakeholder meetings, if required.
Ministry of State Lands and Land Projects (MDEAF)	1) In case that land acquisition is required for public works projects, the Ministry shall act as the responsible agency to manage the land acquisition procedures to be carried out by the owner of the Project. 2) In the event that legal appropriation (Expropriation) is required, legal land acquisition will be carried out under the supervision of the Ministry and in accordance with the Land Acquisition Law "Law No. 2003-26 dated April 14, 2003".
Commission of Recognition and Conciliation (CRC)	1) Assess the amount of compensation for land that is subject to land acquisition, etc. 2) Coordinate and mediate land acquisition and compensation procedures between project owners and landowners in public projects.
Local court	1) Involved in the case of judicial land acquisition procedures in the event that the project operator and landowner fail to reach an amicable agreement.

Source: JICA Study Team

20.7 Implementation Schedule

For land acquisition by DGBGTH, DGBGTH wants limited negotiations to avoid the situation, since informing residents widely in advance of the project before it is finalized would risk increasing the price of the land to be acquired. In contrast, in the case of this project, the landowners of the land to be acquired are clear, so it is assumed that it is possible to proceed with negotiations and procedures for land acquisition after explaining the project individually to each landowner without setting a cutoff date. In addition, since the area of land to be acquired in this project is small and the number of landowners to be surveyed is small, the risk of a large influx of residents who are not eligible for compensation, which is a concern in projects involving large-scale land acquisition, delaying the land acquisition process, is considered to be small. In addition, to prevent such an influx, measures such as temporary enclosures will be planned after the land acquisition.

On the other hand, JICA loans project should be widely agreed upon by society before the screening mission. Therefore, DGBGTH is required to disseminate information to landowners who are the target of land acquisition at an early stage.

The progress of land acquisition needs to be properly managed for smooth implementation of the Project. Therefore, a deadline for implementing the process of land acquisition in accordance with the progress of the Project should be organized. In considering the implementation schedule, as mentioned above, DGBGTH assumes that no overt procedures will be taken until the provision of yen loans is made public.

In addition, until the official exchange official documents are signed, internal information gathering and budget estimation will proceed, as it will be procedurally difficult to secure a budget. A schedule for land acquisition that takes these factors into account is shown in Table 20-6.

Table 20-6 Summary of Land Acquisition Implementation Schedule

Procedure \ Years	2022				2023				2024				2025				2026			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
1) Survey of land acquisition targets, calculation of rough budget																				
2) Budegerary Arrangement																				
3)Negotiations with landowners, compensation payments																				
4)Reexamine the scope of land acquisition through detailed design and acquire as necessary																				
5) Site description registration																				
6) Complaint handling and monitoring																				

Source: JICA Study Team

20.8 Costs and Financial Resources

Compensation for land acquisition will be determined and calculated in accordance with the compensation policy outlined in Section 20.4.3. As of December 2022, a survey will be conducted on the private land to be acquired for the site and an estimate will be calculated.

20.9 Stakeholder Meeting

The current land acquisition process in Tunisia does not request for stakeholder consultation procedures by law. As part of the preliminary study of environmental and social considerations for the implementation of the Project, stakeholder meetings were held three times with the cooperation of DGBGTH and relevant local government organizations. In the meetings, the occurrence of land acquisition for the shortcut locations of the Project was explained as part of the environmental and social consideration. No major opposition to the Project and the Project was welcomed because it would reduce flood damage throughout the watershed.

On the other hand, the landowners who are currently directly targeted for land acquisition have not been identified with certainty as of December 2022, but interviews with nearby residents indicate that there are approximately seven.

Therefore, the following is the implementation policy for the stakeholder meetings related to the land acquisition that is expected to be conducted in the future.

Table 20-7 Planned Stakeholder Meeting for Land Acquisition

Items	Contents
Holding period	Land acquisition planning stage
Participants	Affected residents, landowners and local government officials
Meeting agenda	✓ Description of the Project (components, objectives, sites to be acquired, etc.) ✓ Explanation of the results of the stakeholder meetings held during the preparatory study phase due to the change in the person in charge ✓ Explanation of procedures from land acquisition to resettlement and compensation to affected residents and local governments ✓ Confirmation of requests from affected residents and local governments
Others	✓ Resettlement will not occur, but confirmation meetings will be held with affected residents and local governments, with sufficient information prepared in advance. ✓ Explanations during the meeting will be provided to the affected residents and local governments in an easy-to-understand manner using slides.

Source: JICA Study Team

20.10 Monitoring Implementation Structure (Identification of the responsible agency for resettlement and its responsibilities)

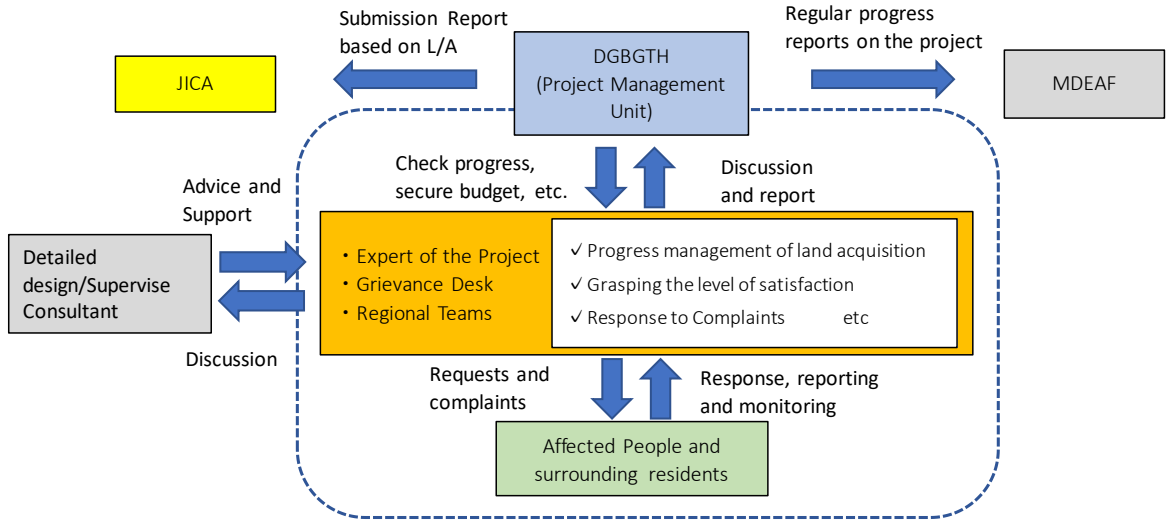
20.10.1 Monitoring of Land Acquisition Implementation

Considering the scale and content of land acquisition for the Project, only internal monitoring of land acquisition is considered appropriate. Monitoring items are expected to include the following

1) Overall Progress: The progress of the overall work will be summarized based on a comparison of the implementation schedule presented in this report with the actual progress of land acquisition.
2) Satisfaction of the affected population: Confirm and organize the level of satisfaction of the PAPs
3) Consistency with compensation policy: Based on the compensation implementation policy organized in Table 20.4 Entitlement Matrix for this project (draft) above, check and organize whether compensation is appropriately provided based on the ownership relationship of the site.
4) Appropriateness of complaint response: The contents of complaints filed during the period covered and what actions were taken shall be organized and verified. Also, verify the time taken to respond to complaints and feedback from residents who filed complaints, and if there are any problems with the complaint response system, examine areas for improvement.

20.10.2 Monitoring Implementation System

The implementation system of monitoring shall be as proposed in Figure 20-4. DGBGTH conducts monitoring, prepares periodic reports based on the monitoring results, and submits them to relevant organizations. In that case, the consultant who carries out the detailed design will be consulted, advised or supported as necessary before monitoring.



Source: JICA Study Team

Figure 20-3 Proposed Monitoring Structure

Details of the above Project Management Unit (PMU) are specified in the Implementation Plan in Chapter 25. The monitoring will be carried out by the Social and Environmental Social Officer of the PMU.

20.10.3 Number of Monitoring Conducted and Monitoring Forms

The monitoring plan for site acquisition is shown in the table below. DGBGTH, with the advice and assistance of employment consultants and related agencies, will proceed with land acquisition by conducting an overall review through the use of monitoring forms. Since there is no fixed format for the monitoring form in the local government, the form recommended for the yen loan project of Medjerda River Downstream Zone D2, which is currently under construction, will be used for the monitoring form.

Table 20-8 Planned Monitoring Plan for Land Acquisition

Purpose	Item	Location	Frequency	Responsible Organization
【Before Construction】				
Confirm consensus on project details and compensation methods.	Implementation of Stakeholder Meeting	Local government council meeting site or near the target land	When stakeholder council meetings are held	- Assessment and Implementation:. - DGBGTH Land Acquisition Section - Decision by - Ministry of State Lands and Land Projects - Monitoring of Relocation Assistance Measures: Ministry of - CRDA/DHER
Check the progress of land acquisition.	Confirm and record the number of lots and acreage for acquisition.		Before construction : 1 time	
Check the progress of the compensation payment procedure.	Record the number of persons for whom compensation has been paid.		Before construction : More than 1 time	
【During Construction】				
Check living conditions.	Record the number of complaints and their resolution.		During construction : More than 1 time	

Source: JICA Study Team

Table 20-9 Monitoring form for Preparation of Resettlement Site

Monitoring form for Preparation of Resettlement Sites **No.____**

Explanation of the land (e.g. Location, size of the area, no. of resettlement HH, etc.)	**Status (Completed (date) / not completed)**	**Details (e.g. Site selection, identification of candidate sites, discussion with PAP, Classification of the land (State-owned land / Private land (Cropland / Tree plantation / Plantation planting / Pasture / Residence and adjunct / Other)))**	**Expected Date of Completion**

Public Consultation

No.	Date	Place	Contents of the consultation / main comments and answeres
1.			
2.			

Resettlement Activities	Planned Total	Unit	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organization
			During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Preparation of RAP									
Employment of Consultants		Man-month							
Implementation of Census Survey (including Socioeconomic Survey)									
Approval of RAP			Date of Approval:						
Finalization of PAPs List		No. of PAPs							
Progress of filling the request card (if any)		No. of PAPs							
No. of PAPs who need Resettlement support		No. of PAPs							
No. of PAPs who have received Resettlement support		No. of PAPs							
Progress of signing the administrative sales contract based on discussion		No. of HHs							
Progress of Compensation Payment		No. of HHs							
Amount of Compemsation for the land in the project site		TND							
Amount of Compemsation for the properties in the project site		TND							
Transferred Compemsation payment for the land to the Finance Bureau		TND	Date of Approval:						
Transferred Compemsation payment for the properties to the Finance Bureau		TND	Date of Approval:						
Progress of Land Acquisition (All Lots)		ha							
Lot –D1-1		ha							
Lot –D1-2		ha							
Progress of Asset Replacement (All Lots)		No. of HHs							
Lot –D1-1		No. of HHs							
Lot –D1-2		No. of HHs							
Progress of Relocation of People (All Lots)		No. of HHs							
Lot –D1-1		No. of HHs							
Lot –D1-2		No. of HHs							

Source: JICA Survey Team

CHAPTER 21CONSTRUCTION PLAN OF COUNTERMEASURES FOR SEDIMENTATION IN RESERVOIR OF SIDI SALEM DAM

Non-public

CHAPTER 22 CONSTRUCTION PLAN AND CONSTRUCTION COST ESTIMATION

Non-public

CHAPTER 23 CONSTRUCTION PLAN AND CONSTRUCTION COST ESTIMATION

Non-public

CHAPTER 24 Economic Evaluation of the Project

Non-public

CHAPTER 25 PROJECT IMPLEMENTATION PLAN

25.1 Project Objectives

The project objective is to secure water storage capacity for irrigation and domestic water use and flood control by constructing sediment bypass and sediment inflow prevention measures in Sidi Salem dam and the downstream of the dam which is located in north of Tunisia. It will contribute to the stability of people life and the improvement of social and economic activity in Tunisia.

25.2 Target Area

As shown in Figure 25-1, the project will cover two areas: the Sidi Salem Dam and its 40 km long reservoir in the northern part of the Medjerda River basin, and the 83.5 km downstream river channel section (D1 zone) from the Sidi Salem Dam to the existing Larousia Dam.

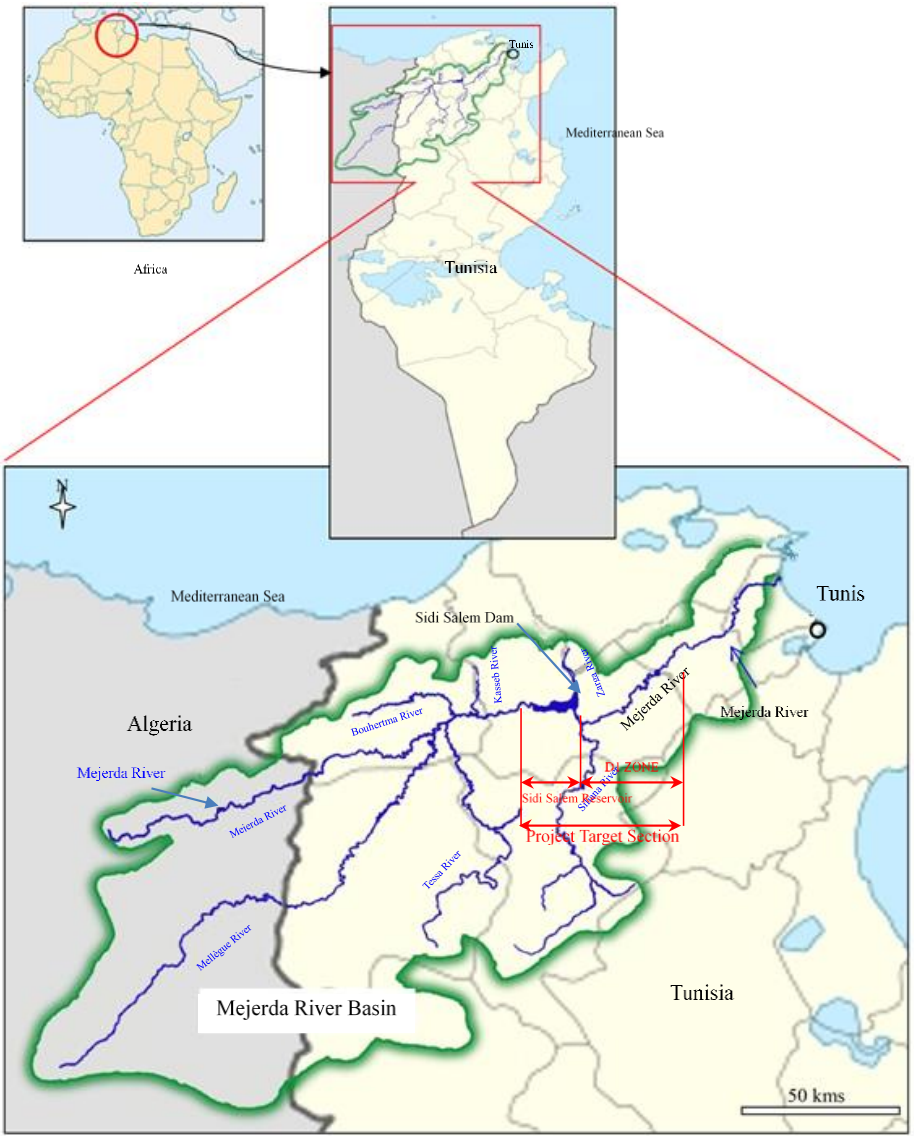


Figure 25-1 Target Area

In the upstream area of the Sidi Salem Dam reservoir, flood mitigation projects in the U1, M and U2 zones are underway with German (KfW) loan financing. In the downstream area, Zone D2, construction is ongoing with Japanese loans. The location of each project is shown in Figure 25-2.

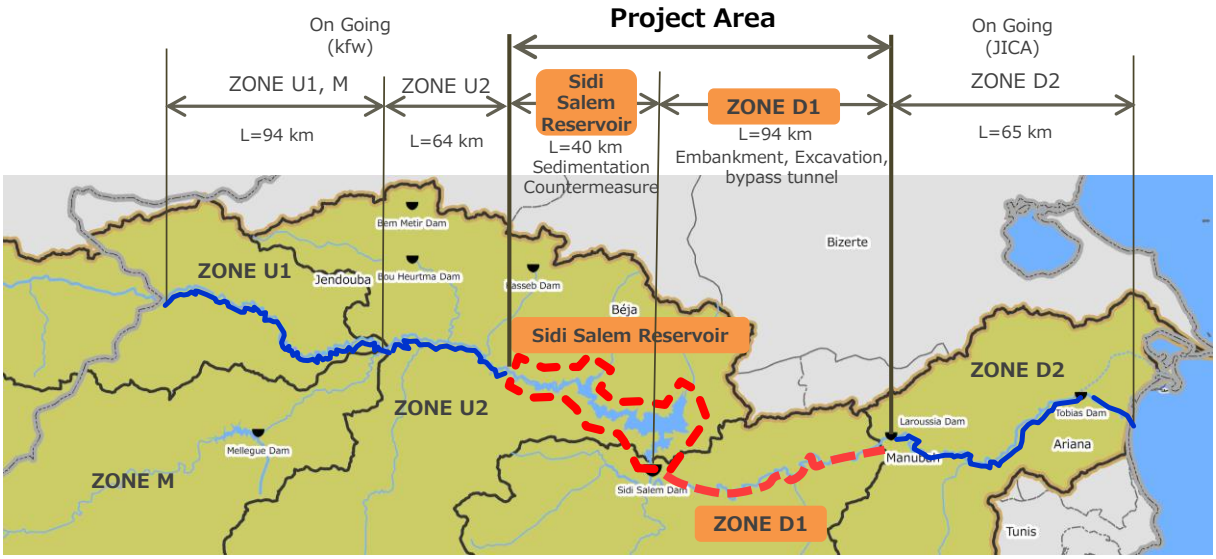


Figure 25-2 Ongoing Project Site and Location of This Project

25.3 Project Summary

25.3.1 Summary of Whole

The Sidi Salem Dam, the largest multi-purpose dam in Tunisia, has recently been facing a sediment problem in the reservoir, and based on the future forecast of sediment inflow from the upstream area of the reservoir, it is feared that if a medium-sized flood occurs within the next 10 years, the current and future water use capacity may not be secured. The future forecast of sediment inflow into the upper reservoir basin indicates that if a medium-sized flood occurs within the next 10 years, it may not be possible to secure the current and future water supply capacity.

Against this background, this project is to implement a comprehensive sediment management project in the basin, including the D1 zone downstream of the Sidi Salem Dam, based on the basic policy of countermeasures for sediment inflow, sediment deposition, and sediment discharge promotion, and from the perspective of flood control safety and environmental considerations in the sediment discharge plan.

In the D1 zone section of the river improvement project, in order to cope with excess flooding over the prescribed planned magnitude and flooding due to the effects of global warming, the river cross section is to be modified, short-cut measures in meandering sections are to be implemented, and flood control countermeasures in El Bab Town where the historic bridge is located are also to be contributed to the project. The main countermeasure works for each target area is shown in Table 25-1.

Table 25-1 Menu of Countermeasure

Target area	Main works	Priority work
1)Sediment countermeasure for Sidi Salem Dam	Density Flow Control Countermeasure for Backsand Building Dam Control System	Sediment Bypass Tunnel, Diversion Weir, Countermeasure for Backsand (setting Low Water Channel), Improvement of Spillway, Upgrade of Dam Operation
2)River Improvement Work for D1 Zone	Flood Control and Sediment Countermeasure	River Improvement Work, Diversion Channel (Tunnel) at Mejez el Bab, Shortcut in meandering section, Retarding Basin, Return of excavated sediment for farm

Non-public

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25.9 Structure of Project Implement

25.9.1 Current Organization to Implement Project

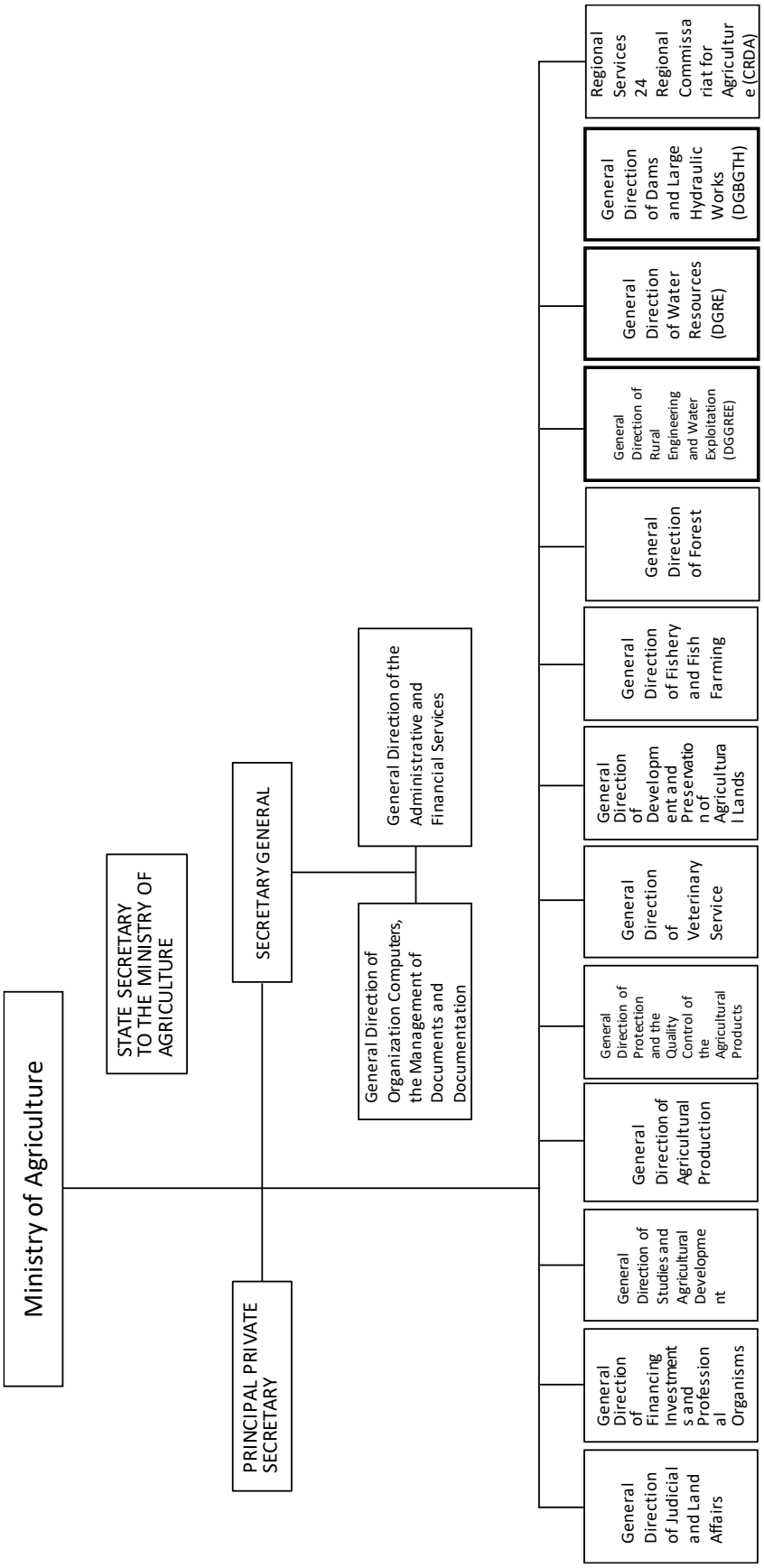
Flood management in rural areas and on agricultural lands is primarily administered by the Ministry of Agriculture. Flood management in urban areas, on the other hand, is under the control of the Ministry of Equipment. The administrative boundary between urban and rural areas is clearly defined.

Structural and non-structural measures that have been implemented by both ministries are as follows.

1) River Improvement Work
2) Dam Project
3) Data collection for hydrology and flood forecast
4) Evacuation and rescue from flood
5) River Channel Maintenance
6) Land use regulations for public watershed

(1) Ministry of Agriculture

In January 2011, the Ministry of Agriculture, Water Resources and Fisheries and the Ministry of Environment were merged to form the Ministry of Agriculture and Environment. In December 2011, the Ministry of Agriculture, Water Resources, and Fisheries was again separated through reorganization, becoming an independent Ministry of Agriculture and the Environment. The Ministry of Agriculture, Water Resources and Fisheries was renamed the Ministry of Agriculture in June 2012. The organizational chart of the Ministry of Agriculture is shown in Figure 25-8.



Source: Ministry of Agriculture

Figure 25-8 Organization system of Ministry of Agriculture

The Ministry of Agriculture is responsible for water resources management in accordance with Article 2 of Cabinet Order No. 2001-419, as amended on February 13, 2001. In flood control, the Ministry of Agriculture has jurisdiction over rural areas and agricultural lands. The main responsibilities of the Ministry of Agriculture as stipulated in the said Cabinet Order are as follows

1) Develop a strategic plan for the promotion of agricultural development, and develop a development plan as part of the National Development Plan and monitor its implementation.
2) Establish and monitor the implementation of measures to achieve food self-sufficiency and food supply security.
3) To promote the agricultural sector through academic research, applied experiments, training, and extension activities, and to improve the technical level of the parties involved.
4) Conserve water resources and promote their utilization.
5) Develop and implement plans and projects to promote irrigated agriculture.
6) Promote the conservation and development of forest resources and protect water, soil, and agricultural lands.
7) Develop water resource utilization plans, use water resources to meet domestic demand, and manage unconventional water resource development and conservation.
8) Provide infrastructure development related to agricultural water use and management, water and soil conservation, natural river maintenance, and farmland preservation.

(2) Department of this Ministry of Agriculture

The key flood-related functions in the Ministry are the Directorate General of Dams and Major Hydraulic Works (DGBGTH) and the Directorate General of Water Resources (DGRE).

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

This has jurisdiction over dams and large hydraulic facilities and has the authority as below

1) Conduct hydrological studies on water resources.
2) Develop a master plan for surface water source development.
3) Conduct surveys for the use of water resources.
4) Conduct studies on dam and reservoir construction.
5) Conduct a study to develop a large-scale plan for the use of water resources (large-scale dams, water conduits, etc.).
6) Dam operation and maintenance.
7) Develop and implement plans for large-scale projects to protect rural areas and agricultural lands from flood damage.
8) It will be the coordinating body for all activities related to flood prevention measures and disaster management in rural areas.
9) Monitor drought management systems.

The personnel structure of the DGBGTH is shown in Table 25 16. The DGBGTH has a large number of personnel, including specialized workers and operators. (Note that the number of personnel has been halved compared to 2011.)

Table 25-21 Numbers of staffs in DGBGTH

Position	Bureau of Studies for Water Mobilization	Bureau of Large Hydraulic Works	Bureau of Huge Dams	Bureau of Dam Operation	Total
Senior engineer	1		1	1	4
Chief engineer	1	3	4	10	18
Principal engineer	3	4	6	14	27
Principal technician	1	3	9	18	31
Technician	2	1	12	30	45
Assistant technician	2	1	12	22	37
Assistant administrator	2		5	12	19
Administrator	1	1	2	4	8
Clerical employees	1			1	2
Specialized worker	5	0	5	62	72
Worker	5	1	8	128	142
Driver	1	2	2	27	32
Security staff	2	1		130	133
Total	27	17	66	460	570

Source: DGBGTH (2023.1)

The budget for DGBGTH in recent years is shown in Table 25-22. In past years, ordinary expenses have been adjusted so that budgeted and actual amounts are the same.

Table 25-22 Budget for DGBGTH

Unit price: million TND

Budget type	Budget / Actual expense	2017	2018	2019	2020
Ordinary expense	Budget is same as actual expense	8,527.0	9,941.0	1,677.0	24,146.0
Investment expense	Budget	182.2	292.2	368.4	131.2
	Actual expense	119.9	258.0	105.4	130.8

Source: MoA (2021.5)

(3) Directorate General of Water Resources (DGRE)

The Directorate General of Water Resources (DGRE) is responsible for the establishment, management, and data collection of monitoring networks related to water resources. It has the following powers for floods, it is responsible for the early warning system.

1) Conduct basic and detailed studies related to water resource assessment and overall water balance.
2) Define general and individual methods for managing water resources according to demand and supply.
3) Conduct research and testing on conventional and unconventional uses of water resources.
4) The planning, use, and development of water resources will be examined from all angles and finalized into a draft plan.

The staffing structure of the DGRE is shown in Table 25-23, which is smaller than that of the DGBGTH because the DGRE's duties are to monitor and collect data, and to manage the early warning system.

Table 25-23 Numbers of staffs in DGRE

Position	Bureau of Surface water	Bureau of Groundwater	Bureau of Unconventional Water Resources and Artificial irrigation	Total
Senior engineer	1	1	2	4
Chief engineer	5	2	1	8
Principal engineer	2	4		6
Principal technician	1			1
Technician	3	2		5
Administrator	1	1		2
Worker	2			2
Total	15	10	3	28

Source: DGRE (2021.12)

The budgets for DGRE in recent years are shown in Table 25-24. Same as the number of staff, the budget is considerably smaller than that of DGBGTH.

Table 25-24 Budget for DGRE

Unit price: 1,000 TND

Budget type	Budget / Actual expense	2017	2018	2019	2020
Ordinary expense	Budget is same as actual expense	15	15	15	15
Investment expense	Budget	1,150	1,700	1,100	3,200
	Actual expense	707	438	1,744	2,137

Source: MoA (2021.5)

(4) Other Directorates and Bureau

The Ministry of Agriculture also has the following other directorates and bureau related to water resources management, water resources management and flood control.

1) Directorate General of Rural Engineering and Water Exploitation (DGGREE): : Water Use in Agricultural Areas
2) Directorate General of Planning, Management and Conservation of Agricultural Lands (DGACTA): Hydrological and hydrogeological studies on the evaluation of natural resources and their conservation
3) Secretary of State in charge of Water Resources Fishery (BPEH): A bureau under the direct control of the Minister's Secretariat, with close ties to national agencies involved in water resources management, building and managing an extensive database
4) Directorates General of Law and Land Affairs: jurisdiction over matters related to laws and lands; established in 2018

(5) Regional Offices of Agriculture Development (CRDA)

The Regional Offices of Agricultural Development (CRDAs) are established under Law No. 89-44, enacted in March 1989 and revised in October 1992 and October 1994 (Official Gazette of the Republic of Tunisia). In line with the government's decentralization policy, the Ministry of Agriculture delegates all activities related to agriculture in the regions to CRDA established in each province (24 in total). Their work covers agricultural production, natural resources, vegetation and forest areas, and economic aspects.

CRDA supervises agricultural activities in each province and carries out technical, administrative, legal, and financial agricultural administration. They are also responsible for the management of river channels. Each CRDA is staffed by central government employees. Of the 24 offices, the following three are directly involved in the study.

1) CRDA Ariana
2). CRDA Manuba

(6) Ministry of Equipment

The role of the Ministry of Equipment is defined in Cabinet Order No. 1413-88 dated July 22, 1988 and its amendments, which lists flood control as primary. The tasks performed by the Ministry of Equipment with regard to flood control are as bellow.

1) Study, planning, and monitoring of construction implementation for urban flood control projects
2) Maintenance and inspection of urban flood control structures
3) Wadi and river bypass construction to manage water volume during the rainy season
4) Review and maintenance of wadi cross sections within the city.
5) River improvement and other embankment construction

The construction of a storm water drainage network consisting of pipes and drains to drain storm water to wadis or the sea for the purpose of storm water drainage in urban and suburban areas in accordance with the above-mentioned task. The construction and management of the civil structures will be delegated The responsibilities of the Ministry of Equipment stem from the fact that most flood control projects were initially carried out in urban areas, especially in the Tunis Metropolitan Area. The Ministry of Equipment therefore has expertise in flood control. Of the nine directorates or bureaus in the ministry, the Department of Urban Hydraulics (DHU) is responsible for planning, management, research monitoring, and maintenance of urban flood protection and related facilities.

The Ministry is also responsible for the management of river crossing structures (bridges, etc.) as well as soil extraction and disposal sites, making it an agency closely related to the implementing organization of the Project.

(7) National Water Committee

The Water Law gives the National Water Committee (CNE) certain powers related to the country's water resources. The National Water Committee is an advisory body that reviews and evaluates all aspects related to water management and water use planning, including dam management during flood periods.

The National Water Committee is chaired by the Minister of Agriculture and its members include representatives of the ministries involved in water resources management: the Ministry of Justice, Ministry of Interior, Ministry of Finance, Ministry of Equipment, Ministry of Developmet International Cooperation, Ministry of Public Health, Ministry of Industry, Ministry of Energy and SMEs, Ministry of Communication Technology, and Ministry of Transport (Law No. 78-419 dated April 15, 1978). If the agenda is a matter of local relevance, the relevant local authorities also participate in the committee.

(8) National Meteorological Institute

The National Meteorological Institute (INM) was established in 1974 under the authority of the Ministry of Communications and Technology and the Ministry of Transport (Law № 101-74, Official Journal of the Republic of Tunisia). The National Meteorological Institute is responsible for weather forecasting and meteorological observation, and manages a meteorological observation network that includes general meteorological stations, agricultural meteorological stations, rainfall stations, marine meteorological stations, and aeronautical meteorological stations.

25.9.2 Project Management Unit (PMU)

Project Management Unit (PMU) shall be established for the implementation of the Project. PMU shall be an administrative organization under DGBGTH of the Ministry of Agriculture, the implementing organization of the Project. Establishment and operation of the PMU are as follows;

1) PMU establishment is done based on the Presidential Decree. Organization configuration and function are defined by the decree.
2) A committee is established with the chairman, Minister of the Ministry of Agriculture, as the observation organization of PMU.
3) Possible major personnel organization for the PMU of this project is as follows;
   a. Chief: Director-General level of the Ministry
   b. One Deputy Chief: Director-General level of the Ministry
   c. One Project Manager: Department-Manager level of the Ministry
   d. One Manager in Charge of Office Work: Department Manager level of the Ministry
4) It is under reviewing that the government owned building at Sidi Salem Dam is used as an office.
5) The proceeding of Presidential Decree for the PMU establishment will be started at the completion of the Yen loan pledge.
6) Time required for the Presidential Decree becoming effective after pledge is 6 ~ 8 months. Before that timing, DGBGTH will conduct project implementation management directly.

Organizations and functions of PMU are shown as follows;

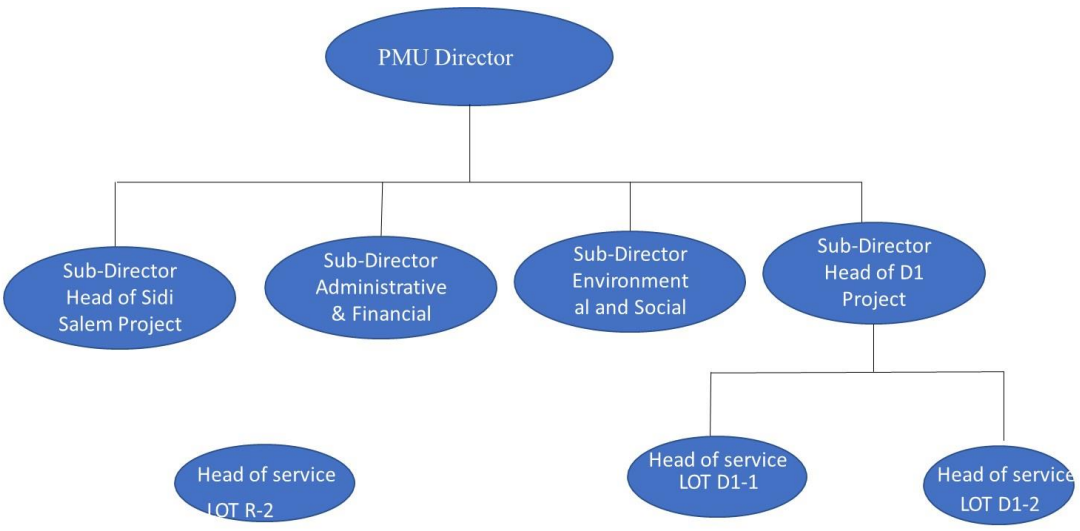


Figure 25-9 PMU Organizations and Functions

PMU will be composed of project manager, engineering staffs (river engineering, bridge superstructure, civil engineering, construction management, environment management, resident relocation) and under the office work manager, administrative staffs (PR, accounting, general-affairs) are allocated. Those workers shall be responsible for required jobs such as detailed design, bidding (selection of consultants and contractors), project implementation, implementation progress report to the relevant organizations, resident relocation, environmental management, etc. PMU shall be given authorities to approve contracts with consultants and contractors on behalf of the related organizations. Regarding project management, PMU shall be in charge of operational control and progress management of consulting services (CS) and contractors.

25.9.3 Operation and Maintenance System

Operation and maintenance are currently conducted by the local agriculture development agency (CRDA) of each governorate. The current system shall be maintained after the completion of the Project.

CRDAs, local organizations of the Ministry of Agriculture, give approval concerning various issues of engineering, administration and finance, introduce new technologies in the field of agriculture and manage major rivers.

After the completion of the Project, CRDAs and DG/DGTH shall maintain the dam facilities, river courses, channels and river structures and manage the retarding basin including the overflow weir.

The following CRDAs shall be involved in the Project.

a. CRDA Ariana: Portions of Medjerda River located in Beja Governorate
b. CRDA Manuba: Portions of Medjerda River and the retarding basin located in Beja Governorate

25.10 Proposal from This Study

25.10.1 Participatory Development

(1) Participatory Development in Watershed Conservation Measures

For the success of the proposed action plan and its implementation it is necessary to discuss with the farmers of the pilot project watershed and form a farmers group. To start with, awareness creation programs need to be organized highlighting the benefits of the proposed watershed development action plan and its recommendations for protection of fragile ecosystem of the pilot project watershed as well as to enhance livelihood development opportunities.

Table 25-25 Action Items for Capacity Building/ Awareness Creation

Action Item		Responsibility
-Capacity Building	-Discussion with local farmers / educate them about benefits and importance of adoption of appropriate erosion control measures in their watershed in general and farmland in particular. -Agriculture Extension service and awareness creation/ trainings need to be organized for the farmers on agronomic measures (including agroforestry) and recommended farming techniques. -Training on suitable alternative source of livelihood like adoption of agroforestry with (horticulture species), **Bee keeping/Apiculture** can be practiced by the farmers in addition to present agriculture to generate additional income.	Department of Agriculture
-Participatory Management	-Maintenance of check dams	Department of Agriculture/ Department of Rural development in support of FPG

(2) Participatory Development in Flood Control

In the flood control measures studied in this project, it is proposed that in the area planned for the bypass channel around the historic bridge in the El Bab urban area in Zone D1, in addition to structural measures, land use plans such as the development of parks, plazas, and olive groves will be studied, and programs aimed at promoting industry and tourism by making use of local resources will be undertaken by the local community. (See 11.8 for details.)

A water park will be developed on the high water bed to provide a place for residents to relax, and to increase residents' interest in the river. In addition, by creating a space where outdoor markets can be held on a regular basis, it is hoped that the economic activities of the local community will be stimulated.

25.10.2 Poverty Alleviation and Poverty Consideration

The challenge in the pilot watersheds for conservation measures is to generate stable income for farmers. In addition, the risk of sediment inflow into the Sidi Salem Dam Reservoir increases due to the degradation of small watersheds as a result of excessive cultivation of farmland to generate income, hence efforts to increase farmers' income are proposed in the pilot project. (See 18.6.8 for details.) The project will contribute to improving the profitability of farmers in the target area through the planting of high value-added fruits (olives, pomegranates, almonds, etc.) and soil improvement to increase productivity. Specific measures will be discussed with the Ministry of Agriculture and local residents at the implementation stage of the project.

25.10.3 Gender Considerations

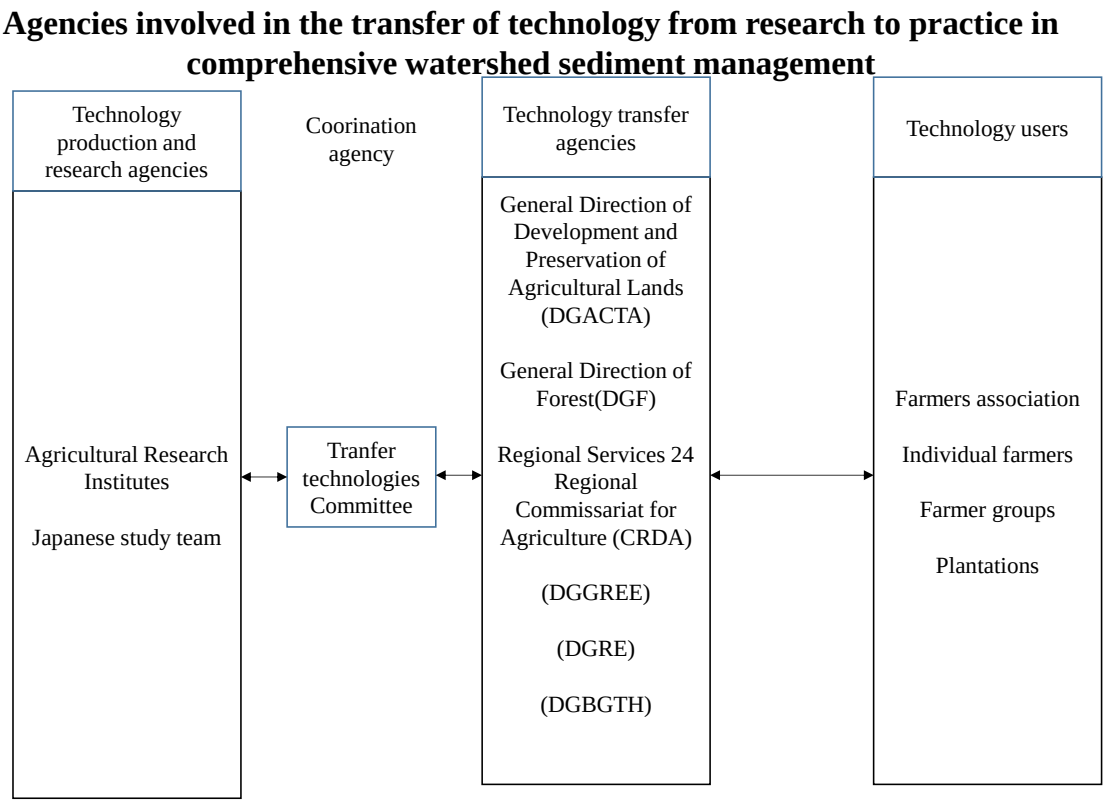
The sustainable use of water resources and flood protection will contribute to improving the livelihoods of socially vulnerable women. Since the project area is a traditional Muslim area, when conducting EIAs and project explanations, gender-sensitive briefings will be conducted. In addition, gender-sensitive employment is planned during construction, including setting a certain percentage of unskilled labor employment to be women, ensuring equal pay for equal work (no unfounded wage difference between men and women), and installing facilities for women workers (toilets, showers, changing rooms, etc.).

25.10.4 Technical Cooperation, Cooperation with Other Donors

(1) Proposal for Technical Assistance Associated with This Project

This study summarized the current status and issues related to the Integrated Sediment Management Plan for the Medjerda River Basin, as well as a policy for comprehensive sediment management measures and a schematic study of a watershed conservation pilot project. The following studies should be conducted for the future implementation of the Integrated Sediment Management Plan. The interviews with relevant organizations of the Ministry of Agriculture during this study confirmed that the Tunisian government does not have sufficient organizational structure and capacity to carry out the studies listed below, and that there is a need for capacity-building projects and planning for sediment management.

- Regarding watershed conservation measures, in order to properly assess surface soil erosion risk, watershed characteristics, etc., an inventory related to soil conservation (soil erosion, land use, soil geology, crop patterns, etc.) and an inventory related to water resources (existing development plans, rainfall, drainage works, water use, etc.) More detailed surveys should be conducted. Based on this, it will also be necessary to identify needs taking into account socioeconomic conditions, and then consider watershed conservation measures and integration of land use, etc.
- Through the implementation of the proposed pilot project in the Sidi Salem Dam Reservoir, the following effects can be obtained: establishment of an implementation system, awareness raising among government and residents, technology transfer, and successful examples, which are considered important from the perspective of horizontal development in the entire watershed.
- There is a concern that the existing dam reservoirs, such as the Sidi Salem Dam, Mellegue Dam, and Siliana Dam, may become overburdened with sediment in the future, which will lead to a reduction in water use and flood control capacity, thereby reducing dam functions. Therefore, there is an urgent need to implement measures to prevent sedimentation in the existing dam reservoirs. This is especially true of the most important Sidi Salem Dam. In addition, rather than considering individual measures for sediment control based on the characteristics of each dam, dam group sediment control measures, including upstream dams, should be considered from the perspective of comprehensive sediment control for the entire watershed.
- In order to develop a comprehensive watershed sediment management plan, it is necessary to involve management personnel, research institutions, and users from a wide variety of fields including rivers, forests, dams, weirs, and coastlines. Therefore, we propose the establishment of a promotion committee or similar body to strengthen cooperation and information sharing with related organizations. The proposed framework of the related organizations is shown in Figure 25-10.



Source: JICA Study Team

Figure 25-10 Framwork for Implementation of the Comprehensive Watershed Sediment Management Plan

(2) Consideration of Possible Collaboration with Other Donors (in the Medjerda River Basin)

Currently, river improvements in the U1 and U2 zones have been implemented in the Medjerda River basin by KfW. A summary of the project is in Figure 25 9 below: the KfW project is in the implementation phase, with the completion of the Sidi Salem Dam reservoir and D1 zone works to maximize the effectiveness of sediment countermeasures in the whole Medjerda River watershed.

Table 25-26 River Improvement Projects Underway with KfW Support

	Contents
Business name	English：Protection against floods (zone U1 + M and U2 in the Medjerda valley) French：Protection contre les inondations (zone U1 + M et U2 dans la vallée de la Medjerda)
Business Background	The project is based on the plans of the 2009 Master Plan for Flood Control developed by the Japan International Cooperation Agency (JICA) at the request of the Government of Tunisia, and the survey and detailed design of the U1, U2 and M zone river areas have been conducted since September 2019. With the results, construction bidding and construction work are to be carried out in the following four consecutive phases.
Implementation process	Phase 1: Preparation of tender documents and evaluation of offers (12 months) Phase 2: execution studies (during the works phase) Phase 3: Control and supervision of execution works Phase 4: Preparation and implementation of non-structural measures (for the entire duration of the project)
Budgetary amount	Consulting fee: 20 million TND Construction cost: 300 million TND
Remarks	As of October 2022, bidding has not yet begun. Some delays have occurred.

25.11 Performance Indicator

The implementing organization measures and documents the performance of the "operational" and “effect" indicators for mid-term review, post-project evaluation, and post-project monitoring following project completion. The project establishes operation and effect indicators for the Sidi Salem Reservoir Sediment Countermeasures and River Improvement Work in D1 Zone, respectively.

Operation and effect indicators are defined as follows, and the indicators for each target watershed are shown in Table 25-27.

Operation Indicator: Indicators that quantitatively evaluate the operational status of the project.
Effect Indicator: Indicators that quantitatively evaluate the results generated by the project.

Table 25-27 Operation and Effect Indicators of the Project

＜Sidi Salem Dam Reservoir Countermeasures＞

Operation and Effect Indicator		Reference level (In the beginning of Detail Design*)	2035 target (3 years after construction completion)
Operation Indicator	Frequency of using Sediment Bypass Tunnel	— (before tunnel construction)	Operation opportunity /The number of more than 100 m^3/s flood events (0~100%) **
Effect Indicator	Sedimentation amount in ABC Zone	Annual average sedimentation 2.2 Million m^3/y (Without project)	Annual average sedimentation 0 m^3/y ***

*Observation of water storage capacity in addition to the amount of sediment in the dam reservoir through bathymetric survey of the ABC zone.
**In principle, the target year is 2 years after construction completion. The target year will be updated in case that no more than 100 m3/s flood occurs due to the rainfall trend.
***The sedimentation inside the fence

＜River Improvement Work in D1 Zone＞

Operation and Effect Indicator		Reference level (10 year return period)	2035 target (3 years after construction completion)
Operation Indicator	Annual maximum water flow (m^3/s)	400 m3/s (Current Flow Capacity)	600 m3/s (After River Improvement Work)
Effect Indicator	Annual maximum inundation area (ha)	3696 ha	0 ha
	Annual maximum flood damage (houce)	1527 houses	0 house

*in case of no no more than 10 year return period

The base year of operation and effect indicators of the project is 2018. It is set on the basis of the results of the future projection without measurements, as shown in Figure 25-11. The results in the figure show that the sedimentation rate for the ABC zone and the DEF zone has been calculated using the forecast results; the annual average sedimentation for the ABC zone has been set at 2.2 Million m3/year based on the trend for the next 100 years into the future.

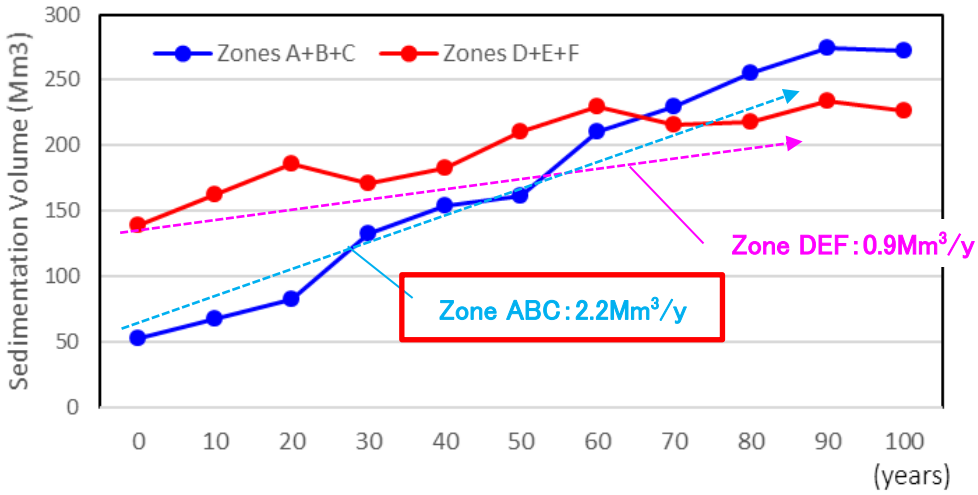


Figure 25-11The basis result of operation and effect indicators of the project (the calculation result of future sedimentation without countermeasure)

CHAPTER 26 MEETING WITH RELEVANT ORGANIZATION

26.1 Meeting

In proceeding with this project, discussions were held with the relevant organizations to explain and discuss the progress and the draft plan. The discussions with the organizations implementing organizations involved in this project are listed in Table 26 1. The minutes of the meetings are shown in the Appendix.

Table 26-1 Meetings with relevant organization

No.	Date	Meeting partner	Title	Face-to face/ online
1	2019/12/2	DGBGTH	Inception Report Meeting	Face to face
2	2019/12/4	MDICI, MoA	Inception Reort meeting	Online
3	2020/1/20	DGBGTH	Technical Meeting	Online
4	2020/1/27	DGBGTH	Introductory Meeting of JICA Advisory Team	Online
5	2020/7/15	DGBGTH	Technical Meeting of D1 shortcut alternative	Online
6	2020/7/22	DGBGTH	Techical Meeting	Online
7	2020/10/16	DGBGTH, KfW Consultants	Coodination Meting	Online
8	2021/2/19	DGBGTH, KfW Consultants	2nd Coodination Meting	Online
9	2021/4/22	DGBGTH, KfW Consultants	2nd Coordination Meeting (followup)	Online
10	2021/6/4	DGBGTH, KfW Consultants	3rd Coordination Meeting	Online
11	2021/6/18	DGBGTH, KfW Consultants	4th Coordination Meeting	Online
12	2021/12/16	DGBGTH, KfW Consultants	5th Coordination Meeting	Face-to face
13	2022/3/23	DGBGTH, KfW Consultants	6th Coordination Meeting	Face to face
14	2022/3/24	DGBGTH, DGACTA	Disscussion about Watershed Management	Face to face
15	2022/3/28	DGBGTH	Techical Meeting	Face to face
16	2022/4/4	DGForest	Discussion about the activity of DGForest	Face to face

17	2022/4/6	MDICI,, MoA	Presentation Meeting of the Project Overview Following the Submmision of the Interim Report	Face to face
18	2022/4/14	DGBGTH	Disccusion about next schedule	Face to face
19	2022/7/20	DGBGTH	Presenation of Draft Final Report	Face to face
20	2022/7/28	MDICI,, MoA	Presentation Meeting of the Project Overview Following the Submmision of the Draft Final Report	Face to face

26.2 Stakeholder Meetings

As mentioned in Chapter 19, stakeholder meetings related to the project were held in cooperation with the Ministry of Agriculture and local government-related organizations. The list of meetings is shown in Table 26 2, and the minutes of the meetings are shown in the Appendix.

Table 26-2 Stakeholder Meetings

No.	Date	Meeting partner	Title	Face-to face/ online
1	2020/7/25	Mejez el Bab city	Explanation of Flood Protection Planning concept and Collecting the various Opinions from City of Mejez el Bab	Face-to face/ online
2	2020/7/29	Mejez el Bab city	Explanation and Discussion for Flood Protection Work Plan and Proposed Short cut location of D1 River zone	Face-to face/ online
3	2022/4/8	Mejez el Bab city	Explanation and Discussion for Flood Protection Work Plan and Proposed facilities at D1 River zone	Face-to face