CHAPTER 3 HYDROLOGICAL MODELING

3.1 Introduction

An integrated and distributed MIKE SHE hydrological model is used to evaluate rainfall-runoff process in the Madarsoo River basin. The model is able to analyze impacts of watershed management practices, land use, soil types, topographic features, flow regulation structures, etc. over the basin on river flows. For this, MIKE SHE model was coupled with MIKE 11 river modeling system to simulate flows in the river system. Inflows and hydrodynamic processes in rivers are taken into consideration for model development. The model computes river flows taking account of overland flow, interflow and base-flow.

An integrated and distributed hydrological model MIKE SHE was set up for the Madarsoo River basin for the following reasons:

(1) To generate probable or design discharges precisely in the river system to assist on flood control master plan development,

(2) To analyze the impacts of watershed management practices and biological measures of flood mitigation by quantifying river flows under these circumstances, and

(3) To analyze the impact of incorporation of flood regulation structures like dam in the river system to reduce peak flows.

3.2 MIKE SHE

MIKE SHE is an integrated hydrological model because all components of hydrological cycle (precipitation, evapotranspiration, surface flow, infiltration, groundwater flow, etc.) are incorporated into the model. Similarly, and it is also a distributed model because the model can handle spatial and temporal distributions of parameters. Therefore, MIKE SHE is an integrated and physically based distributed model. It consists of a number of components called modules, where each module represents a particular flow process. The modules of MIKE SHE used in this study are: overland flow, river flow, unsaturated-zone flow, saturated-zone flow, and evapotranspiration modules. As mentioned above, MIKE SHE evaluates the rainfall-runoff process in the basin in a fully distributed and integrated manner, and generates river flows considering overland flow, interflow and base-flow (Figure 3.1).

Overland Flow

It occurs when rainfall intensity exceeds infiltration rate of soils, which causes water stagnation on surface. The ponded water starts flow overland routed down gradient to river system. The overland flow is estimated in MIKE SHE by diffusive wave approximation of Saint Venant equations. Let horizontal plane coordinates are (x,y), ground surface level be z(x,y), flow depth be h(x,y), flow velocities in the x- and y-directions be u(x,y) and v(x,y), respectively, and q(x,y) be the net input to overland flow (net rainfall less infiltration). Then the conservation of mass gives:

$$\frac{\partial h}{\partial t} + \frac{\partial (uh)}{\partial x} + \frac{\partial (vh)}{\partial y} = q \qquad (1)$$

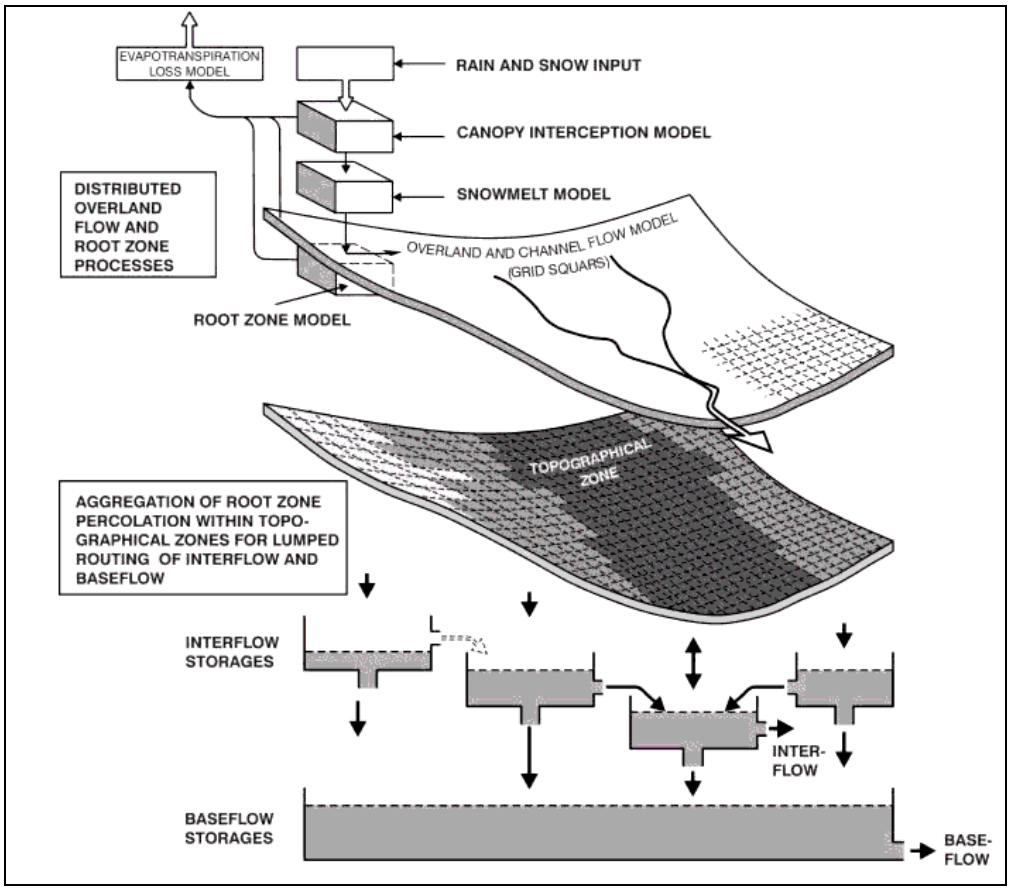

Figure 3.1 Conceptual MIKE SHE Model

The momentum equations are:

$$S_{fx} = S_{ox} - \frac{\partial h}{\partial x} - \frac{u}{g}\frac{\partial u}{\partial x} - \frac{1}{g}\frac{\partial u}{\partial t} - \frac{qu}{gh} \tag{2}$$

$$S_{fy} = S_{oy} - \frac{\partial h}{\partial x} - \frac{v}{g}\frac{\partial v}{\partial y} - \frac{1}{g}\frac{\partial v}{\partial t} - \frac{qv}{gh} \tag{3}$$

where, S_{fx} and S_{fy} are the friction slopes in x- and y-directions, respectively. S_o is the surface slope. The dynamic solution of the two-dimensional St. Venant equations is numerically challenging. Therefore, it is common to reduce the complexity of the problem by dropping the last three terms of the momentum equations. Thereby, ignoring momentum loss is ignored due to local and convective acceleration and lateral inflows perpendicular to the flow direction. This is known as the diffusive wave approximation, which is implemented in MIKE SHE. Hence, a Strickler/Manning-type law for each friction slope is used with Strickler coefficients K_x and K_y in x- and y-directions.

$$S_{fx} = \frac{u^2}{K_x^2 h^{4/3}} \tag{4}$$

$$S_{fy} = \frac{v^2}{K_y^2 h^{4/3}} \tag{5}$$

The governing equations (Eqs. 1, 2 & 3) are solved with initial and boundary conditions to get a fully dynamic description of shallow two-dimensional overland flow. For initially dry land surface, initial conditions are: h(x,y,0) = 0; u(x,y,0) = 0; and v(x,y,0) = 0; and boundary conditions applied on watershed boundary are: u = 0 and v = 0.

River Flow

To enable estimation of total river flow from overland flow, inter flow and groundwater flow, it is necessary to use the river model together with the hydrological model in a fully coupled mode. This is done through an explicit coupling between the MIKE SHE and MIKE 11 models where the two models run simultaneously and exchanges information in each time step. This coupling estimates one-dimensional river flows and water levels using fully dynamic Saint Venant equation. The conservation of mass can be expressed as:

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q \tag{6}$$

The momentum equation is:

$$\frac{\partial Q}{\partial t} + \frac{\partial (Q^2 / A)}{\partial x} + gA(\frac{\partial h}{dx} + S_f) = 0 \tag{7}$$

where, Q is discharge, A is cross-section area of flow, h is water surface elevation, q is lateral inflow, g is acceleration due to gravity, t is time elapsed, x is longitudinal distance and S_f is friction slope. The friction slope S_f can be expressed in the following form using Manning's equation.

$$S_f = \frac{n^2 \mid Q \mid Q}{A^2 R^{4/3}} \tag{8}$$

The governing equations (Eqs. 6 & 7) are solved with initial and boundary conditions to estimate one-dimensional river flows and water levels in the river system.

Unsaturated-Zone Flow

The unsaturated flow is considered to occur in vertical direction in soil profile. The driving force for transport of water in the unsaturated zone is the gradient of the hydraulic head (h), which includes a gravitational component (z) and pressure component (ψ).

$$h = z + \psi \tag{9}$$

The volumetric flux in soil profile is estimated by Darcy's equation.

$$q = -K(\theta)\frac{\partial h}{\partial z} \tag{10}$$

where q is water flux, h is hydraulic head, K(Θ) is unsaturated hydraulic conductivity. Assuming that the soil matrix is incompressible and the soil water has a constant density, the continuity equation is considered as written below.

$$\frac{\partial \theta}{\partial t} = -\frac{\partial q}{\partial z} - S(z) \tag{11}$$

where Θ is volumetric water content and S is root extraction sink term.

Saturated-Zone Flow

The governing three-dimensional saturated flow equation in saturated porous media is considered as presented below.

$$\frac{\partial}{\partial x}\left(K_x \frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_y \frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_z \frac{\partial h}{\partial z}\right)-Q=S\frac{\partial h}{\partial t} \qquad (12)$$

where, K_x, K_y, and K_z are hydraulic conductivities on x, y and z directions, Q is source or sink term, h is hydraulic head and S is specific storage coefficient.

Evapotranspiration

Evapotranspiration is one of the main components in the water balance, and it often contributes to water loss in a considerable amount of the total rainfall. The evapotranspiration is estimated based on empirically derived by Kristensen and Jensen's equation (1975). However, in this study already computed monthly reference evapotranspiration rate is input in the model to calculate actual crop evapotranspiration based on soil moisture content, root distribution and leaf area index.

3.3 Model Application

The developed MIKE SHE hydrological model is used in design flow estimation in the Madarsoo River to assist on the flood control master plan development.

3.3.1 Study Area

Study area is the Madarsoo River basin of which drainage area is about 2,300 km^2. The Madarsoo River originates from the north side on the Alborz Mountains and runs from the east to the west through northern part of the country, and merge with the Gorgan River that finally empties into the Caspian Sea. The length of the Madarsoo River is about 142 km. The mean annual rainfall in the middle part of basin (at Tangrah) is 695 mm, but the upper part of the river basin has quite lower rainfall. The elevation of the basin ranges from 79 m to 2,474 m from the mean sea level (MSL).

3.3.2 Data Requirements

Primary data requirements of the model are basin boundary map, topographic map and rainfall data. As mentioned earlier, various modules are used to develop MIKE SHE hydrological model so that data requirements of one module differs from other. Basically data requirements of used modules are presented in Table 3.1.

Table 3.1 Data Requirements for the Model

Module	Data Requirements
Overland Flow	Manning's roughness coefficient, Detention storage, Initial water depth, Rainfall, DEM, Land use
River Flow	River network data, River cross-sectional data
Unsaturated Zone Flow	Soil map, Soil physical properties like: Hydraulic conductivities, Water contents at saturation, Field capacity and wilting points
Saturated Zone Flow	Storage coefficient, Specific yields, Hydraulic conductivities
Evapotranspiration	Evaporation, Crop coefficients, Leaf area index (LAI), Rooting depth (RD)

Topographic Data

The topographic map of the study area is produced in a 30 m x 30 m grid resolution. This degree of resolution is sufficient for the hydrological modeling. The DEM of the study area was developed by the National Cartographic Center (NCC). The elevation of the study area varies from 79 to 2,474 m as mentioned above. The lowest elevations (79-100 m) are found around the Golestan Dam, or the outlet of the Madarsoo River. The elevation of the basin increases as we go to middle (800-1,000 m) and upper parts (2,000-2,474 m) of the basin (Figure 3.2).

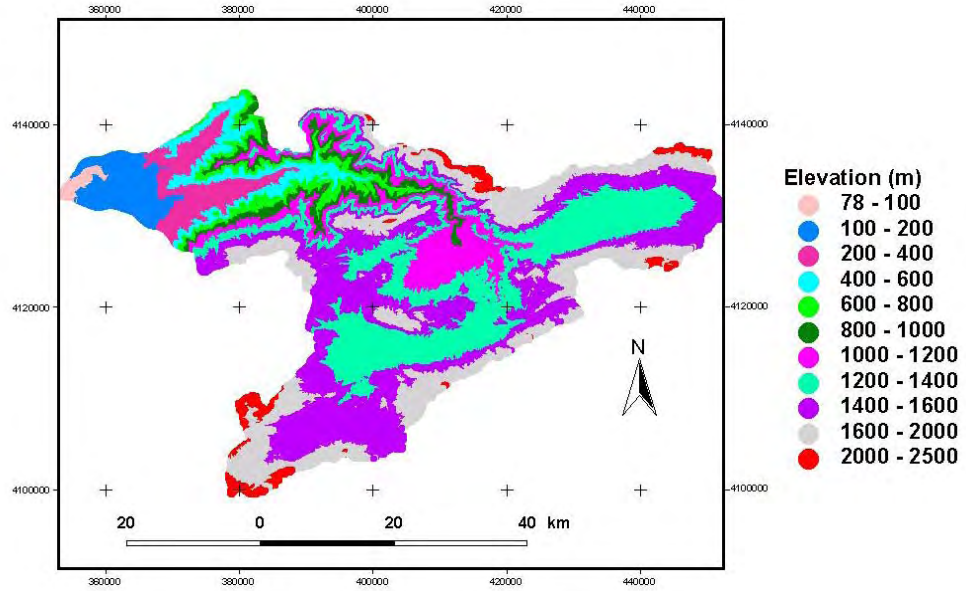

Figure 3.2 DEM of Madarsoo River Basin

Climatic Data

The rainfall, snowfall, air temperature and evaporation data are major climatic information needed for the model. However, rainfalls and already computed reference evapotranspiration data are used in the model. Historical records show mostly floods occur in dry and hot season, for instance, 2001, 2002 and 2005 floods were occurred in August at that time we cannot expect any remnant of snow in the mountain area, so snowfall is not taken into consideration in model. Almost all snow over the mountain melts by early June.

(1) Rainfall data

Daily point rainfall data of stations in and around the basin are not used as such in the model. At first 2-day sub-basin rainfalls are estimated considering spatial rainfall

distribution pattern of 2001 and 2005 flood events. These estimated 2-day sub-basin rainfalls are used to calibrate and verify the model. Similarly, probable 2-day sub-basin rainfalls are also estimated for 25-, 50- and 100-year return periods considering spatial rainfall distribution patterns of 1988, 1992, 2001, 2002 and 2005 flood events. These probable 2-day sub-basin rainfalls are used in the calibrated model to generate probable or design discharges in the river system considering 9 hours time distribution pattern of rainfall (see Hydrology in Chapter 2 of this report for details on estimation of sub-basin rainfalls and its time distribution).

(2) Evapotranspiration Data

Reference evapotranspiration is the basis for determination of actual crop evapotranspiration. The reference evapotranspiration is defined as the evapotranspiration rate from a reference surface, not short of water. The monthly estimated reference evapotranspiration data are being used in the model (Figure 3.3) to compute actual crop evapotranspiration. Monthly evapotranspiration data are sufficient to use in the model, because variations in daily evapotranspiration data cannot be expected much within a month. The maximum value of monthly evapotranspiration is found in June (154 mm) and the lowest in December (26 mm).

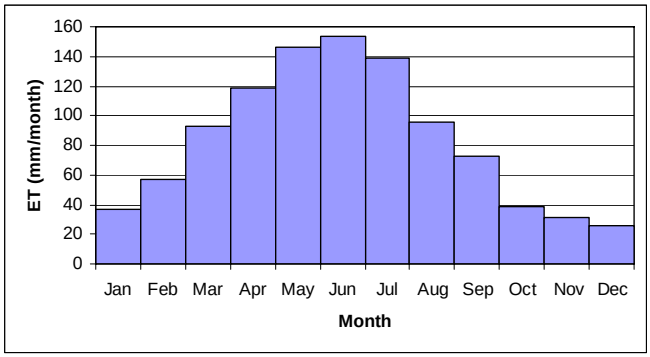

Figure 3.3 Mean Monthly Evapotranspiration in the Basin

Land Use Data

Land use information is important for estimation of actual evapotranspiration by the Kristensen and Jensen formulation and to decide Manning's roughness coefficient to estimate overland flow. The temporal and spatial variation in land use can be handled in the MIKE SHE modeling. The land use map of the Madarsoo River basin used in the model was developed in 2004; and the map was made available from GIS database developed in this study. The Madarsoo River basin is divided into 14 land use classes (Figure 3.4). The dominant land use classes are: Range and Forest. The rangeland covers about 48% of the basin area, whereas forest covers about 29% of the basin area. Based on the land use classes, parameters like leaf area index (LAI), rooting depth (RD) and canopy interception (Cint) are determined. The parameters used for model calibration for different land use classes are presented in Table 3.2.

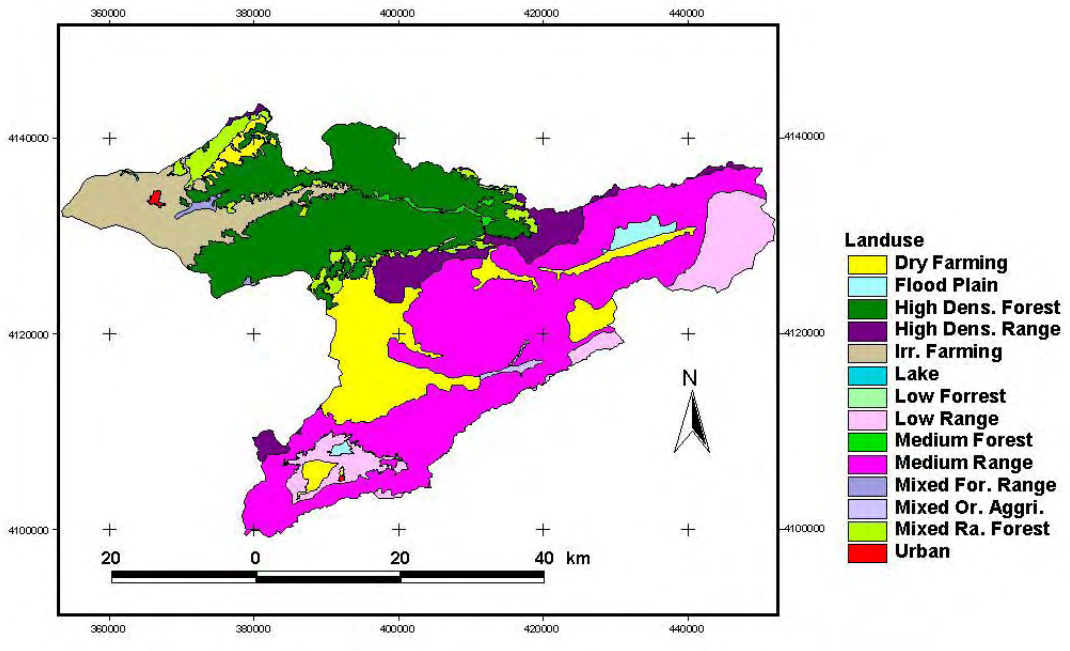

Figure 3.4 Existing Land Use Map of Madarsoo River Basin

Table 3.2 Model Parameters by Land Use Class

Land use	LAI	Root Depth (mm)	Canopy Interception (mm)
Irrigated Farming	3.0	750	0.05
Dry Farming	2.0	250	0.05
High Density Forest	5.0	1400	0.10
Medium Density Forest	3.0	1400	0.05
Low Density Forest	2.0	1400	0.05
Orchard	3.0	1400	0.05
High Density Range	1.5	250	0.05
Medium Density Range	1.3	250	0.05
Low Density Range	1.0	250	0.05
Mix of Forest and Range	3.0	1000	0.05
Mix of Orchard and Agriculture	3.0	1000	0.05
Mix of Range and Forest	3.0	1400	0.05
Urban	0.1	100	0.05
Flood Plain	0.5	200	0.05

Soil Properties Data

Soil map used in the model was made available in the GIS database prepared in this study and was originally developed by the National Geological Survey in Iran. The soil map represents the dominant soil type in the upper 30 cm of the soil column. Inside the study area there are 18 soil classes (Figure 3.5). The dominant soil types are limestone and rocky outcrops with medium to hard texture. Although infiltration capacity is low over the hill slopes, a bit higher infiltration capacity exists on the lower plateaus where the soil depth is deeper. In the lower areas of the basin some alluvial deposits exist with higher infiltration capacity. A brief description of each of soil types is presented in Table 3.3.

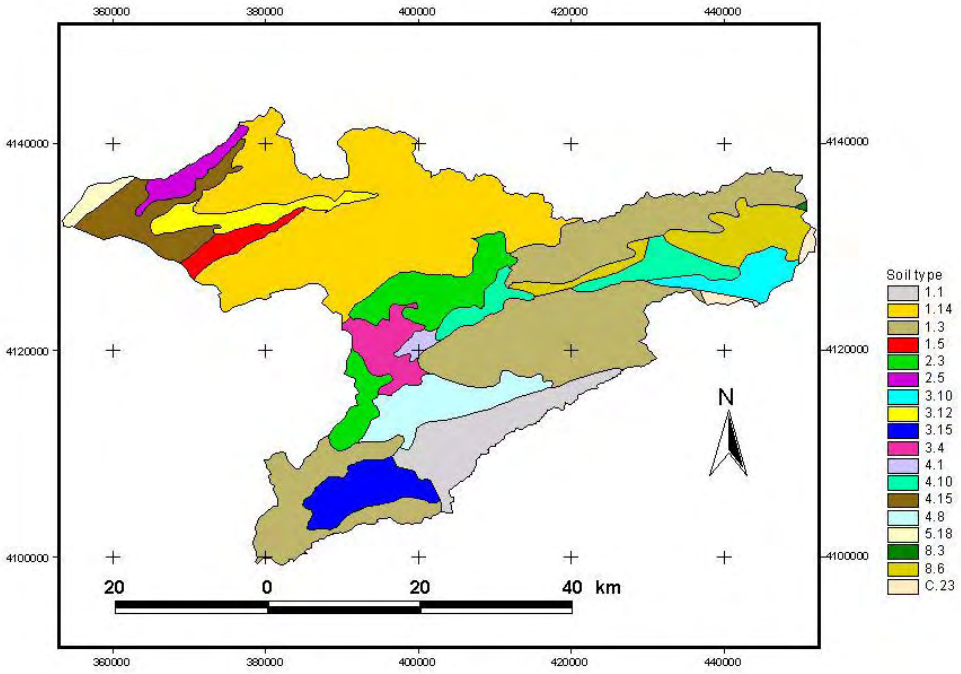

Figure 3.5 Soil Map of Madarsoo River Basin

Table 3.3 Soil Types and its Description

Soil Code	Description
C23	-
1.10	Limestone, sandstone and hard rocks, shallow soil.
1.14	Limestone, sandstone and hard rocks, shallow soil.
1.30	Limestone, shallow ground cover.
1.50	Limestone, shallow ground cover.
2.30	Limestone, sand stone and rocky outcrops.
2.50	Limestone, sand stone and rocky outcrops.
3.10	Plateaus, calcareous material, shallow to deep soil depth.
3.12	Plateaus, calcareous material, shallow to deep soil depth.
3.15	Plateaus, calcareous material, shallow to deep soil depth.
3.40	Plateaus, pebbles, medium texture.
4.00	Calcareous depositions, deep to very deep soil.
4.10	Calcareous depositions, deep to very deep soil.
4.15	Calcareous depositions, deep to very deep soil.
5.18	Alluvial deposits, deep soil.
8.30	Pebbles, medium texture.
8.60	Pebbles, medium texture.

For unsaturated zone flow computations some soil physical parameters are needed. All the necessary data were not available from the concern offices. Therefore, some soil physical parameters are based on literature and experiences. The soil physical properties like infiltration capacity; and volumetric soil water content at saturation, field capacity and wilting points are needed for the model. The field capacity denotes the moisture content left after the soil has been drained by gravity. The difference between full saturation and field capacity is the infiltration potential of the soil. The wilting point denotes the lowest moisture content from where the plants can extract water from the soil. The moisture content below the wilting point is inaccessible. The soil physical parameters used in the model are presented in Table 3.4.

Table 3.4 Soil Physical Parameters

Soil Code	Infiltration capacity [m/s]	Θs	Θfc	Θwp
C23	9.00E-06	0.40	0.20	0.11
1.10	9.00E-06	0.40	0.20	0.11
1.14	8.00E-06	0.39	0.23	0.11
1.30	1.00E-05	0.41	0.20	0.11
1.50	1.00E-05	0.41	0.20	0.11
2.30	1.00E-05	0.41	0.20	0.11
2.50	1.00E-05	0.41	0.20	0.11
3.10	1.09E-05	0.42	0.21	0.10
3.12	1.09E-05	0.42	0.21	0.10
3.15	1.09E-05	0.42	0.21	0.10
3.40	1.10E-05	0.42	0.21	0.12
4.00	1.09E-05	0.42	0.21	0.10
4.10	1.09E-05	0.42	0.21	0.10
4.15	1.09E-05	0.42	0.21	0.10
5.18	1.20E-05	0.43	0.22	0.12
8.30	1.50E-05	0.45	0.23	0.13
8.60	1.50E-05	0.45	0.23	0.13

River Network and Catchment Data

The river network comprises of the Madarsoo River and its tributaries. From hydrological modeling point of view mainstream as well as inclusion of all tributaries in the river network is important for precise estimation of river flows. There were no surveyed cross sections available for the tributaries so that cross sections have been extracted from 30 meter DEM. Therefore, there might be slight discrepancies between actual cross-sections and extracted cross-sections from the DEM. However, purpose of inclusion of tributaries is to simulate water flow towards the mainstream, and for this purpose the extracted cross sections from the DEM has been considered adequate. The total basin area of the Madarsoo River is about 2,340 km^2; and total length of the river is about 142 km. The river network of the Madarsoo River basin and its catchments are presented in Figure 3.6.

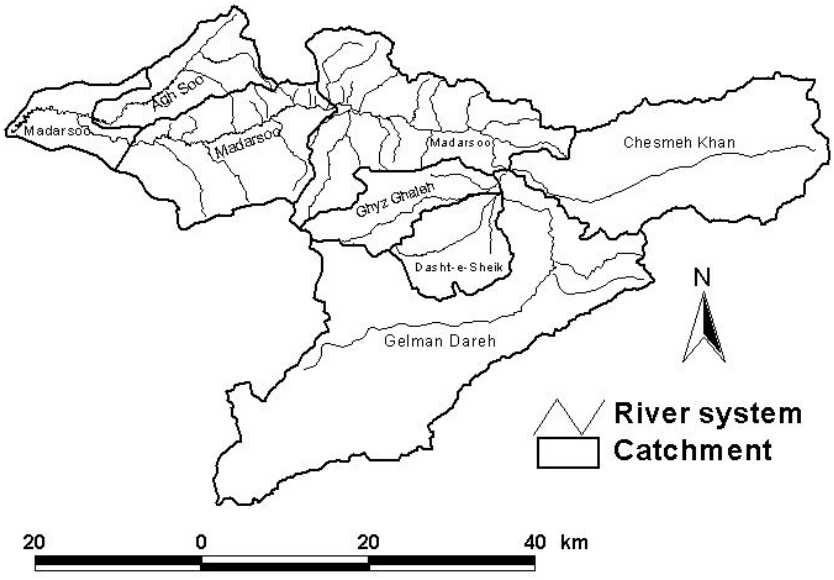

Figure 3.6 River Network of Madarsoo River Basin

Interflow Catchment Data

Saturated zone flow is defined using lumped linear reservoir approach. Therefore, interflow catchments in the model are defined equal to sub-basin areas. So, there is one interflow

reservoir for each sub-basin. It is possible to sub-divide the interflow catchments on a sub-basin scale, but it is considered to be sufficient with one interflow reservoir for each sub-basin. The interflow reservoir parameters required are: specific yield, initial depth, bottom depth, interflow time constant, threshold depth, and percolation time constant. The interflow reservoir parameters used in the model are presented in Table 3.5.

Table 3.5 Interflow Reservoir Parameters

Sub-Basin	Name	Specific Yield	Initial Depth (m)	Bottom Depth (m)	Threshold Depth (m)	Interflow Time Constant (d)	Percolation Time Constant (d)
1	Nardin	0.2	3.00	3.03	3.00	1.4	1.2
2	Chesmeh Khan	0.3	3.00	3.03	3.00	1.4	1.0
3	Dasht-e-Shiekh	0.3	3.00	3.03	3.00	0.5	1.4
4	Ghyz Ghale	0.3	4.00	4.03	4.00	0.9	1.1
5	Tangrah	0.3	1.00	1.03	1.00	0.9	1.4
6	Dar Abad	0.3	2.00	2.03	2.00	1.2	1.2
7	Agh Soo	0.3	1.00	1.03	1.00	1.1	1.8
8	Golestan Dam	0.3	4.00	4.03	4.00	1.4	1.4

Baseflow Catchment Data

Three baseflow reservoirs are used in the model. Numbers of the baseflow reservoirs are decided based on geography of the basin. One each baseflow reservoir is defined for upper, middle and lower parts of the basin. On the upper part of the basin, soil allows some infiltration of rainfall to be stored in the baseflow reservoir; and contributes considerably in baseflow. On the middle part (Tangrah or No. 5 sub-basin), there is very little scope for infiltration (because of hard rocks) and the baseflow contribution is expected insignificant. On the lower parts of the basin, soil is deeper and some baseflow occurs. Baseflow reservoir parameters used in the model are presented in Table 3.6.

Table 3.6 Baseflow Reservoir Parameters

Item	Upper Part of the Basin	Middle Part of the Basin	Lower Part of the Basin
Fraction of percolation to reservoir	0.9	0.8	0.75
Fraction of pumping from reservoir	0.1	0.2	0.25
Specific yield	0.4	0.3	0.5
Time constant for baseflow (d)	100	50	100
Dead storage fraction	0.05	0.01	0.05
UZ feedback fraction	1	0.5	1
Initial Depth (m)	10	3	10
Threshold depth for baseflow (m)	10	3	10
Threshold depth for pumping (m)	10	3	10
Depth to bottom of reservoir (m)	10	3	10

3.3.3 Discretization of the Basin

MIKE SHE hydrological model is developed with a detailed description of hydrodynamic processes in river system and landscape of surface. For overland flow estimation, the model uses a finite difference approach where numerical calculations are done within numerical cells or grids of a given dimension. Within a grid each parameter is assigned with single value. Therefore, use of smaller grid size in model enables a higher degree of details to be included but it increases numerical calculation time. Taking account of these situations, 250 m x 250 m grids are used in the model to perform numerical computations. Altogether 39,087 grids are used for overland flow computation in the basin. For sub-surface flow computation, lumped linear reservoir approach is used so that one interflow reservoir is defined for each sub-basin.

Similarly, for baseflow estimation the model adopts linear reservoir approach, and therefore three (3) reservoirs are specified for upper, middle and lower parts of the basin.

3.4 Model Configuration

3.4.1 Model Calibration

The purpose of calibration is to achieve an acceptable agreement between measured and model estimated values by adjusting model parameters within the acceptable range because describing physical processes in nature by means of mathematical equations is a difficult job. Therefore, the model is calibrated with adjusting model parameters to get best-fit estimations with observed ones. In this project, MIKE SHE hydrological model is calibrated with taking reference of observed hourly discharges in the Madarsoo River at Dasht Bridge during the 2005 flood event. The hourly discharges at the bridge were estimated based on online water levels and Broad Crested Weir formula. However, the more hydrological stations available in the basin for using observed data of those stations as references in the model calibration the better model parameters can be established at sub-basin level. Calibration results show peak flow as well as shape of hydrographs of observed and MIKE SHE simulated flows are matching quite well. Peak flow simulated by model is 744 m^3/s where as observed is 725 m^3/s at Dasht Bridge in the 2005 flood event (Figure 3.7). Slight shift between observed and model simulated hydrographs is due to not aligned time distribution pattern of rainfall. Simulated peak flows in river system by model for the 2005 flood event are: 430 m^3/s in Gelman Dareh; 127 m^3/s in Dasht-e-Sheikh; 165 m^3/s in Ghiz Ghale; 43 m^3/s in Chesmeh Khan; 1,060 m^3/s at Tangrah (Figure 3.8).

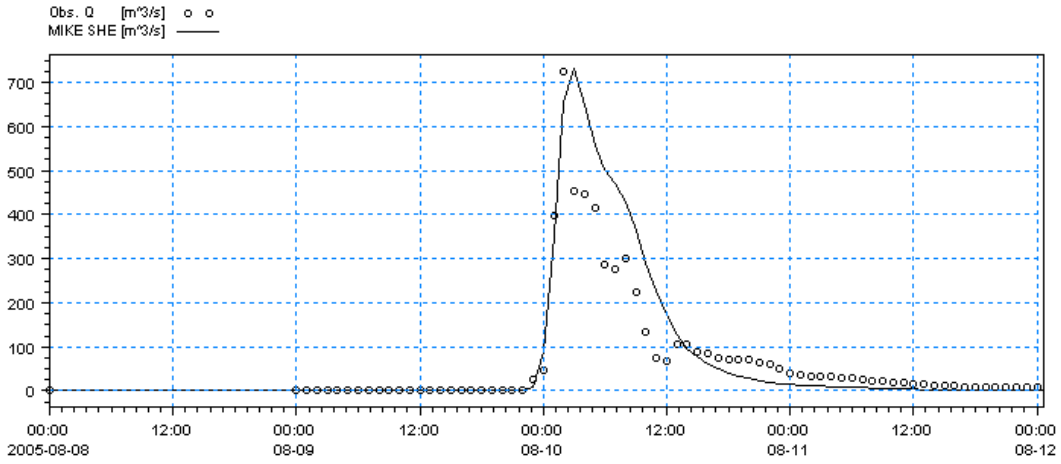

Figure 3.7 Observed and model simulated discharges at Dasht Bridge (10 August 2005)

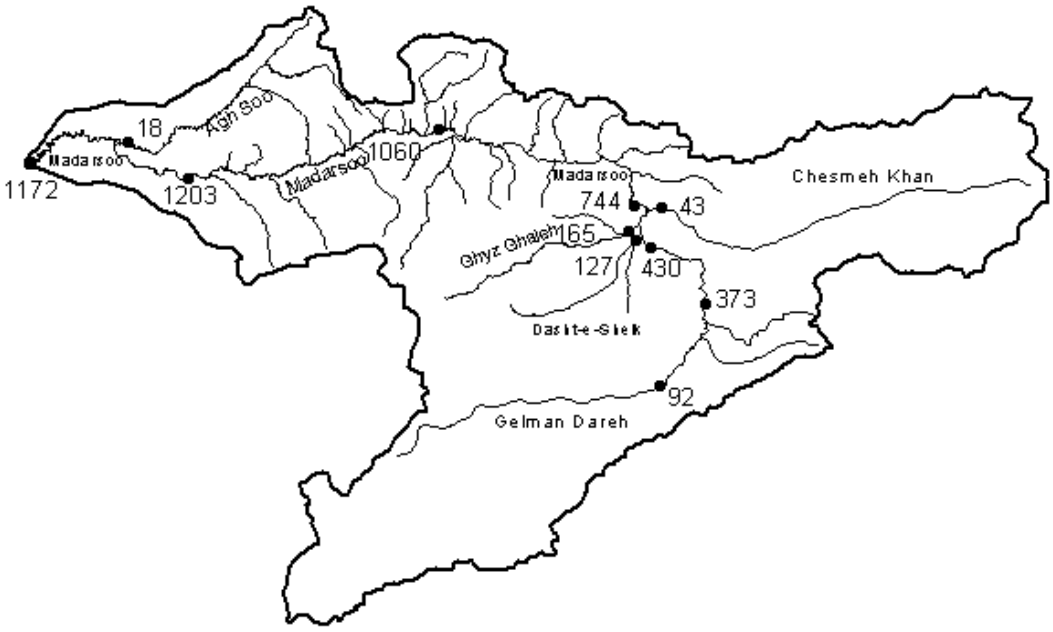

Figure 3.8 Peak Flows Simulated by Model in River System (10 August 2005)

Parameters Optimization

Parameters were optimized in calibration process to get best-fit river flow generation with the observed flows. The optimized values of parameters are presented in previous section. Some of the optimized parameters were:

Infiltration rate: It controls percolation of water from upper soil surface to sub-soil.

Interflow time constant: It is used to control shape of flood hydrograph, small values of time constant gives fast response (steep hydrograph) to rainfall, while large values of time constant gives slow response to rainfall, thereby, gives a much more widened hydrograph.

Percolation time constant: It controls water percolation to the baseflow reservoir. Lower percolation time constant gives lower peak and widens the hydrograph as water is allowed to percolate faster and will be stored in the baseflow reservoir.

Baseflow time constant: It controls the percolation of water from baseflow reservoir to rivers.

Overland roughness coefficient: Smooth surface allows more water to flow down gradient as overland flow, whereas a rough surface allows more water to infiltrate. Therefore, roughness coefficient is closely related to the land use.

3.4.2 Model Verification

The estimated hourly discharges at Tangrah and estimated hourly inflows into the Golestan Dam from the Madarsoo River in the 2001 flood are used for model verification.

Tangrah Station's Discharges as Reference

The hourly discharges at Tangrah station were estimated for the 2001 flood event. The estimated discharges seem not so bad, because the estimated discharges at station were cross checked with inflows into the Golestan Dam during the flood event and also cross checked

with computing runoff coefficient. Therefore, the estimated hourly discharges at the station are taken as reference for model verification. Result shows shape of estimated and model generated discharge hydrographs are matching quite well to each other. The slight discrepancies between estimated and model generated peak flows is due to including some error in estimated discharge, and slight shift between estimated and model generated discharge hydrographs is due to not aligned time distribution pattern of rainfall (Figure 3.9). Result shows estimated peak discharge is 1,650 m^3/s where as model generated is 1,873 m^3/s.

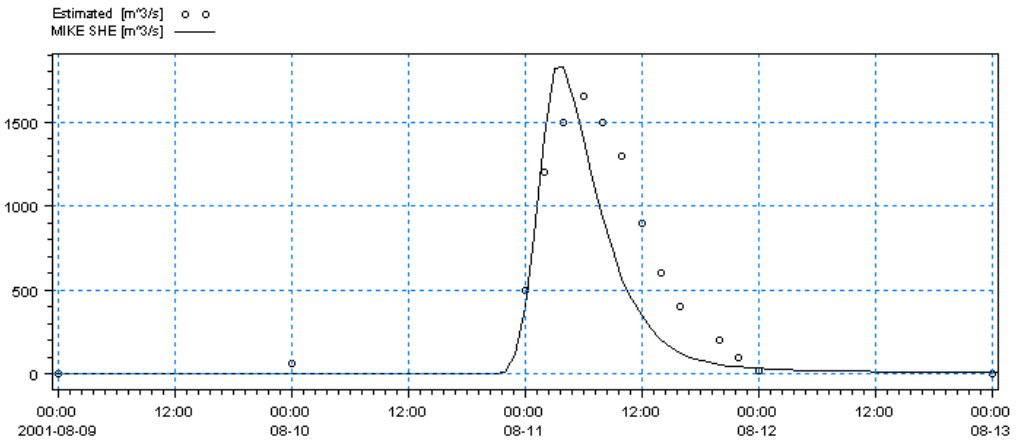

Figure 3.9 Estimated and MIKE SHE Generated Flows at Tangrah (11 August 2001)

Golestan Dam Reservoir Inflows as Reference

Hourly inflows into the Golestan Dam reservoir from the Madarsoo River were estimated for the 2001 flood event from reservoir storage curve and water levels changes in the reservoir. The estimated inflows into the reservoir were crosschecked with discharges at Tangrah (Madarsoo River), Galikesh (Oghan River) and Hojigoushan (Gorgan River). The estimated hourly inflows into the Golestan Dam reservoir from the Madarsoo River were also taken as reference for model verification. Result shows that estimated (from reservoir storage curve) and model generated peak inflows into the reservoir as well as shape of hydrographs are matching well to each other. The estimated peak inflow is 2,116 m^3/s whereas peak inflow generated by MIKE SHE model is 2,095 m^3/s (Figure 3.10). As mentioned above, slight shift between the estimated and model generated hydrographs is due to not aligned time distribution pattern of rainfalls.

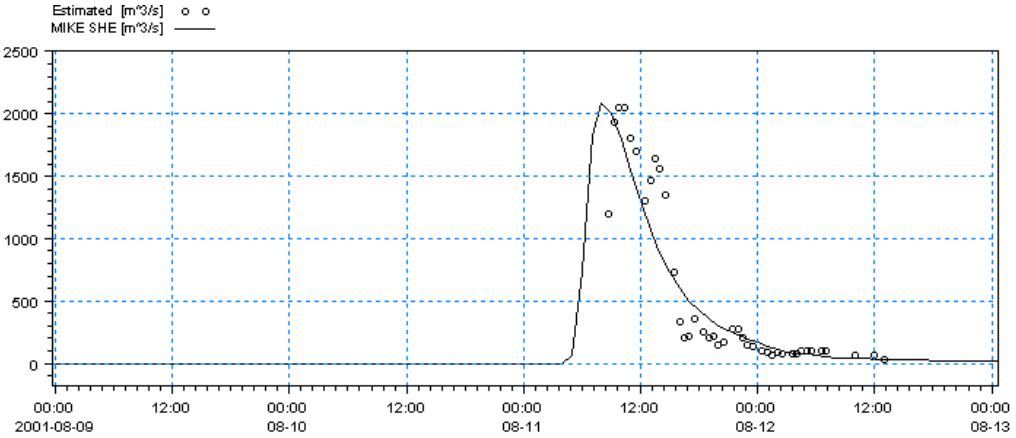

Figure 3.10 Estimated and MIKE SHE Generated Inflows into Golestan Dam Reservoir from Madarsoo River (11 August 2001)

MIKE SHE generated peak flows in river system during the 2001 flood event are presented in Figure 3.11. The model simulated peak flows in the river system are: 654 m^3/s in Gelman Dareh; 226 m^3/s in Dasht-e-Sheikh; 289 m^3/s in Ghiz Ghale; 60 m^3/s in Cheshmeh Khan; 1,266 m^3/s at the entrance of Golestan Forest, 1,873 m^3/s at Tangrah; 2,195 m^3/s at Dar Abad; 2,095 m^3/s at Golestan Dam.

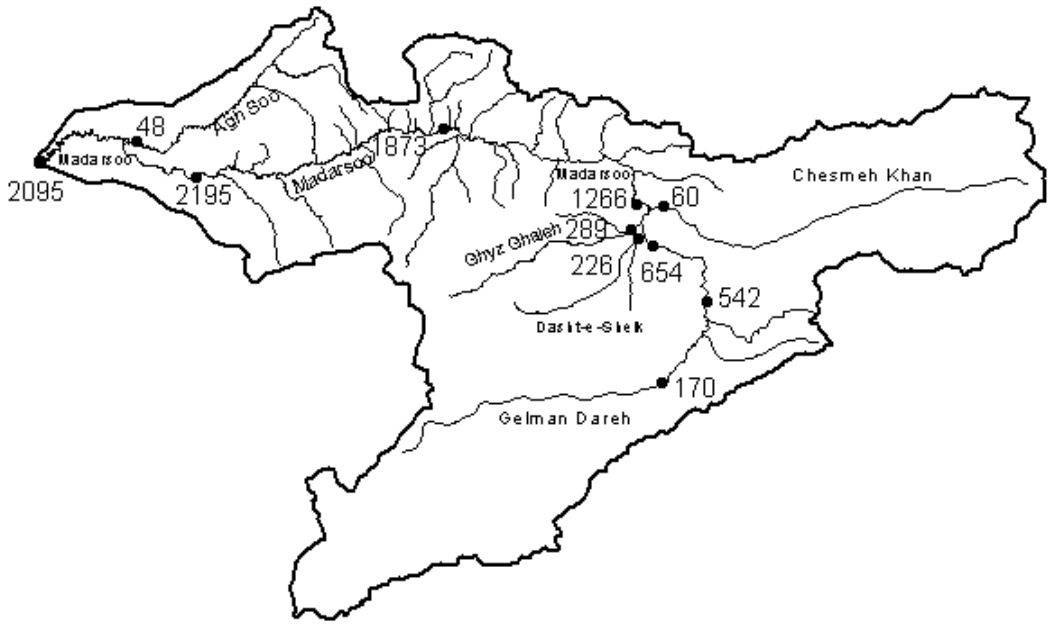

Figure 3.11 Peak Flows Simulated by Model in River System (11 August 2001)

CHAPTER 4 SIMULATION ON SCENARIOS

4.1 Probable River-Flows with Present Land Use (without Projects)

Probable discharges are generated at three probability levels i.e. 25-, 50- and 100-year return periods considering rainfall distribution patterns over sub-basins as in the past 5 major flood events occurred in 1988, 1992, 2001, 2002 and 2005.

4.1.1 Probable River-Flows for 25-year Return Period

River-flows are generated for 25-year return period probability level considering rainfall distribution pattern over sub-basins as in the 1988, 1992, 2001, 2002 and 2005 flood events. MIKE SHE generated peak river flows at Tangrah with the 1988, 1992, 2001, 2002 and 2005 flood types representing rainfall distribution patterns over the sub-basins are: 1,092, 856, 1,336, 989 and 1,060 m^3/s, respectively (Figure 4.1). The highest peak discharge at Tangrah is estimated with the 2001 flood type rainfall, which is followed by the 1988 flood type rainfall in the basin.

Similarly, probable peak flows for 25-year return period, with the past 5 major flood type rainfalls, along the mainstream, from Upper Gelman Dareh to Golestan Dam entrance in the Madarsoo, are presented in graphical (Figure 4.2) as well as tabular (Table 4.1) forms. Peak flows generated with the 2001 flood type rainfalls are higher at all points along the mainstream. However, the peak discharge of 2001 flood type as presented in Figure 4.2 is deemed to be too sharp and large. Further the 1988 flood type as the next largest discharge has not enough rainfall records. Therefore, it is suggested to select the 2005 flood type as a 25-year design flood for the flood control master plan development. In addition, rainfall records of hourly rainfall as well as daily rainfall were observed only in the 2005 Flood.

The cover ratio of the 2005 flood, which is represented as simple exceedance probability, ranges from 50 to 75 % in entire stretches of the Madarsoo River as illustrated in Figure 4.2.

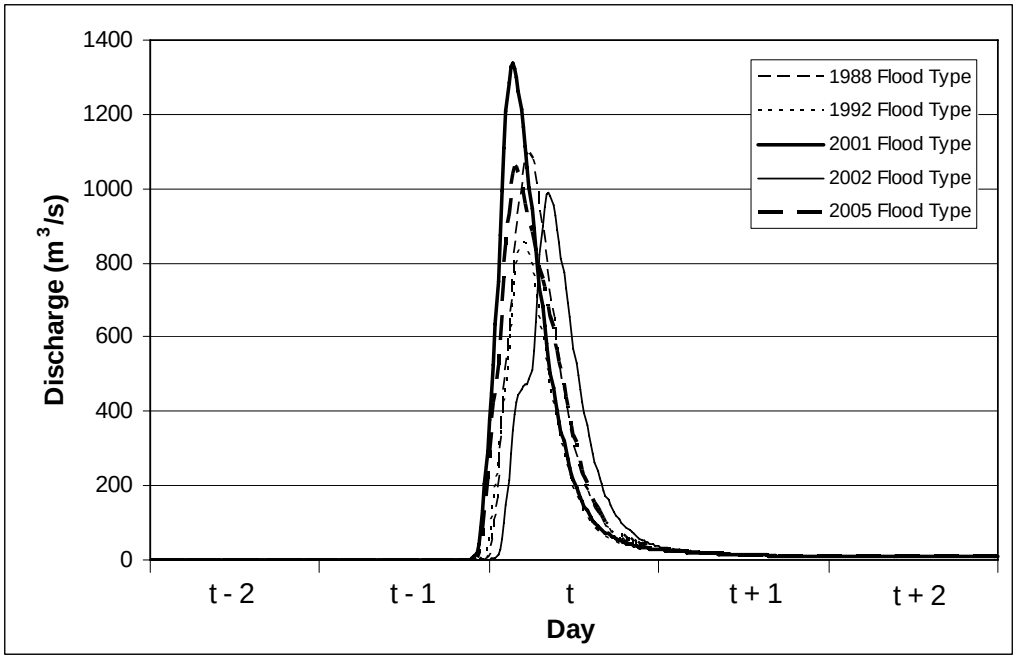

Figure 4.1 Probable Discharge Hydrograph at Tangrah (25-year Return Period)

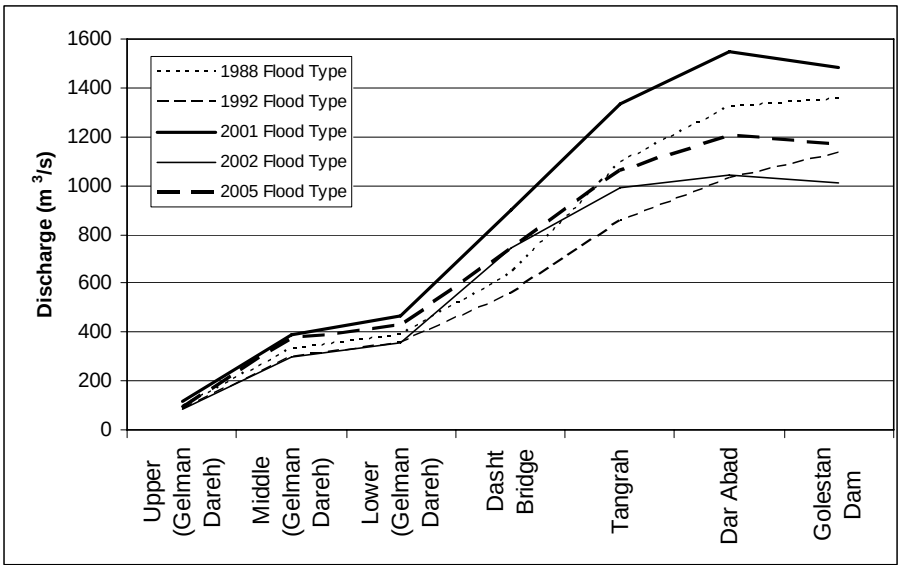

Figure 4.2 Probable Peak Flows along the Mainstream (25-year Return Period)

Table 4.1 Probable Peak River-Flows without Project (25-year Return Period)

Location	River	Design discharges (m^3/s) with various floods types rainfalls distributions				
		1988 - flood type	1992 - flood type	2001 - flood type	2002 - flood type	2005 - flood type
Upper	Gelman Dareh	94	83	116	84	92
Middle	Gelman Dareh	328	297	390	298	373
Lower	Gelman Dareh	391	354	468	355	430
Dasht	Dasht - e - Sheikh	20	39	168	133	127
Dasht	Ghyz Ghaleh	233	155	214	252	165
U/S of Confluence	Chesmeh Khan	0	12	28	0	43
Dasht Bridge	Madarsoo	642	557	898	744	744
Tangrah	Madarsoo	1092	856	1336	989	1060
Dar Abad	Madarsoo	1323	1028	1548	1043	1203
U/S of Confluence	Agh Soo	90	128	29	35	18
Golestan Dam	Madarsoo	1356	1135	1481	1013	1172

Further, probable peak discharges, with 25-year return period and the 2005 flood type rainfall, in river system are: 92 m^3/s in Gelman Dareh (Upper Part); 373 m^3/s in Gelman Dareh (Middle Part); 430 m^3/s in Gelman Dareh (Lower Part); 127 m^3/s in Dasht-e-Shiekh; 165 m^3/s in Ghyz Ghale; 43 m^3/s in Chesmeh Khan; 744 m^3/s in Madarsoo (Dasht Bridge); 1,060 m^3/s in Madarsoo (Tangrah); 1,203 m^3/s in Madarsoo (Dar Abad); 18 m^3/s in Agh Soo and 1,172 m^3/s in Madarsoo (Golestan Dam) as presented in Figure 4.3.

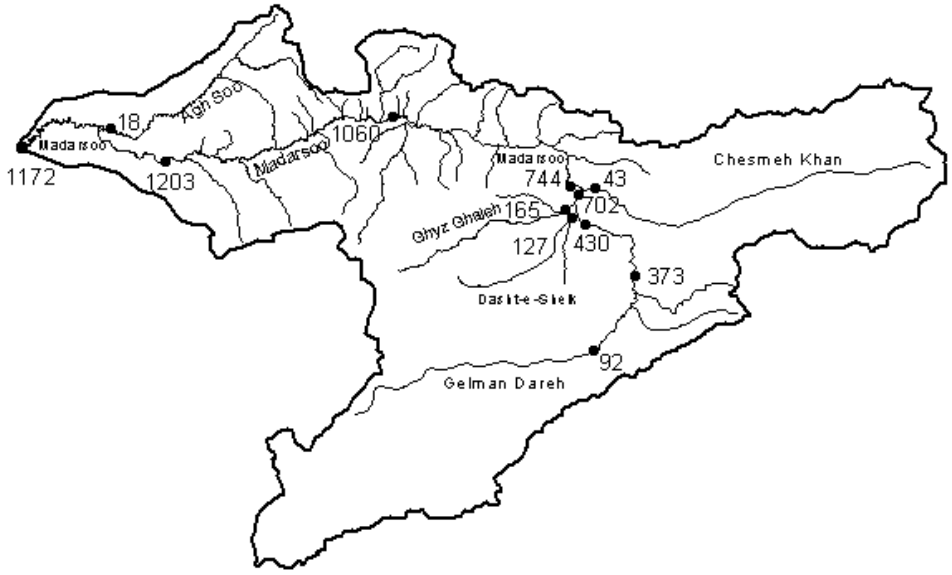

Figure 4.3 Probable Peak Flows in River System (25-year Return Period; 2005 Flood Type)

4.1.2 Probable Rive- Flows for 50-year Return Period

River-flows are generated for 50-year return period probability level considering rainfall distribution patterns of the 1988, 1992, 2001, 2002 and 2005 flood events. Model generated peak river-flows at Tangrah with the 1988, 1992, 2001, 2002 and 2005 flood type rainfalls are: 1,503, 1,196, 1,811, 1,315 and 1,522 m^3/s, respectively (Figure 4.4). The highest peak discharge at Tangrah is estimated with the 2001 flood type rainfall, which is followed by the 2005 flood type rainfall in the basin.

As in above, probable peak flows for 50-year return period, with the past 5 major flood type rainfalls, along the mainstream, from upper Gelman Dareh to Golestan Dam entrance in the Madarsoo, are presented in graphical (Figure 4.5) as well as tabular (Table 4.2) forms. As in the previous case, peak river-flows generated with the 2001 flood type rainfalls are higher at all points along the mainstream.

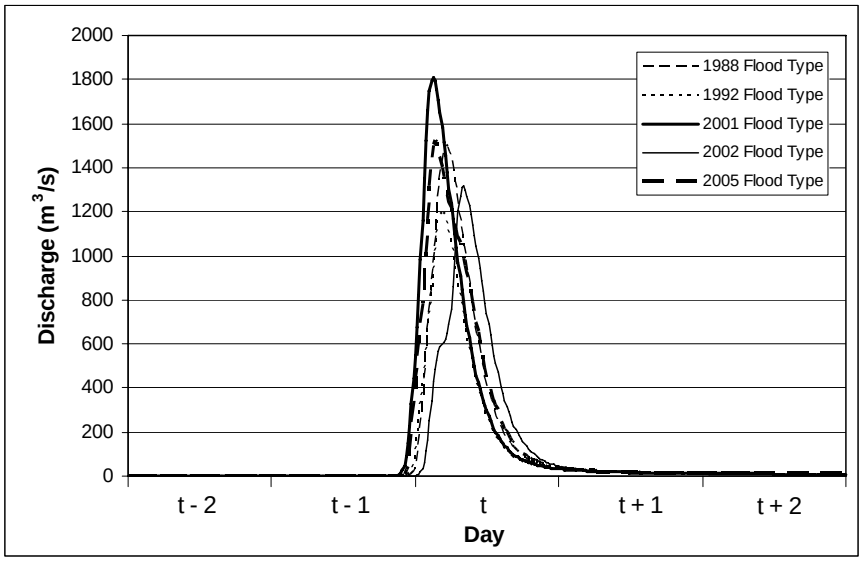

Figure 4.4 Probable Discharge Hydrograph at Tangrah (50-year Return Period)

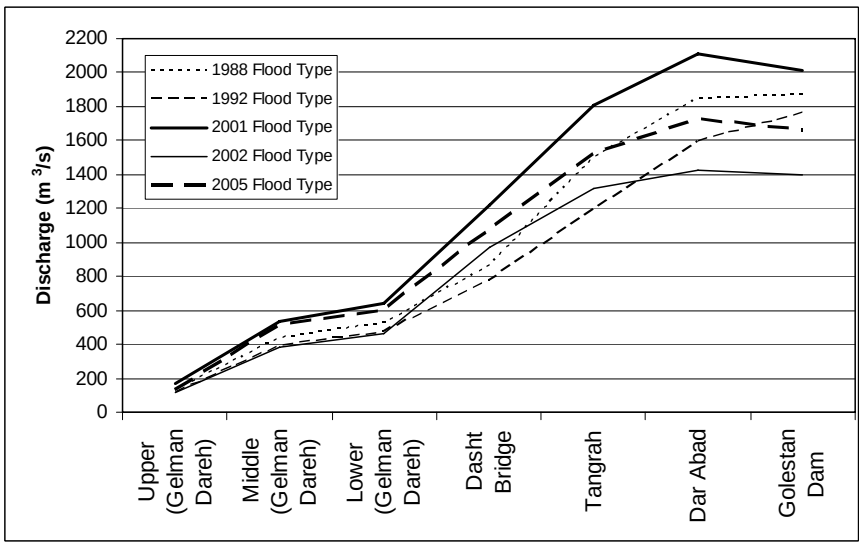

Figure 4.5 Probable Peak Flows along the Mainstream (50-year Return Period)

Table 4.2 Probable Peak River-Flows without Project (50-year Return Period)

Location	River	Design discharges (m^3/s) with various floods types rainfalls distributions				
		1988 - flood type	1992 - flood type	2001 - flood type	2002 - flood type	2005 - flood type
Upper	Gelman Dareh	134	117	167	115	133
Middle	Gelman Dareh	433	393	531	384	520
Lower	Gelman Dareh	524	473	641	462	607
Dasht	Dasht - e - Sheikh	35	61	218	176	175
Dasht	Ghyz Ghaleh	299	206	275	320	225
U/S of Confluence	Chesmeh Khan	0	27	51	0	83
Dasht Bridge	Madarsoo	867	777	1222	969	1076
Tangrah	Madarsoo	1503	1196	1811	1315	1522
Dar Abad	Madarsoo	1842	1592	2113	1429	1726
U/S of Confluence	Agh Soo	125	151	48	54	32
Golestan Dam	Madarsoo	1866	1764	2017	1399	1667

Further, probable peak discharges, with 50-year return period and the 2005 flood type rainfall, in river system are: 133 m^3/s in Gelman Dareh (upper part); 520 m^3/s in Gelman Dareh (middle part); 607 m^3/s in Gelman Dareh (lower part); 175 m^3/s in Dasht-e-Sheikh; 225 m^3/s

in Ghyz Ghale; 83 m^3/s in Chesmeh Khan; 1,076 m^3/s in Madarsoo (Dasht Bridge); 1,522 m^3/s in Madarsoo (Tangrah); 1,726 m^3/s in Madarsoo (Dar Abad); 32 m^3/s in Agh Soo and 1,667 m^3/s in Madarsoo (Golestan Dam) as presented in Figure 4.6.

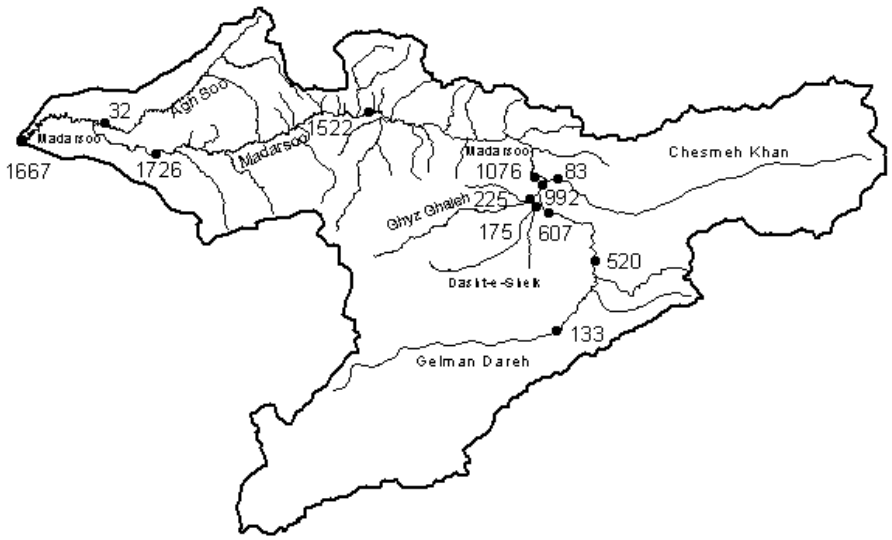

Figure 4.6 Probable Peak Flows in River System (50-year Return Period; 2005 Flood Type)

4.1.3 Probable River-Flows for 100-year Return Period

The river-flows are generated for 100-year return period. Model generated peak flows at Tangrah with The 1988, 1992, 2001, 2002 and 2005 flood type rainfall distribution patterns are: 1,967, 1,623, 2,318, 1,736 and 2,021 m^3/s, respectively (Figure 4.7). The highest peak discharge at Tangrah is estimated with the 2001 flood type rainfall and followed by the 2005 flood type rainfall.

Probable peak flows for 100-years return period, with the past 5 major flood type rainfalls, along the mainstream, from Upper Gelman Dareh to Golestan Dam entrance in the Madarsoo, are analyzed and presented in graphical (Figure 4.8) as well as tabular (Table 4.3) forms. It has been found that peak river flows generated with the 2001 flood type rainfalls is higher between Upper Gelman Dareh to Tangrah along the mainstream. But, at lower part of mainstream (Dar Abad – Golestan Dam) peak flows generated with the 1988 flood type rainfall is higher along the mainstream.

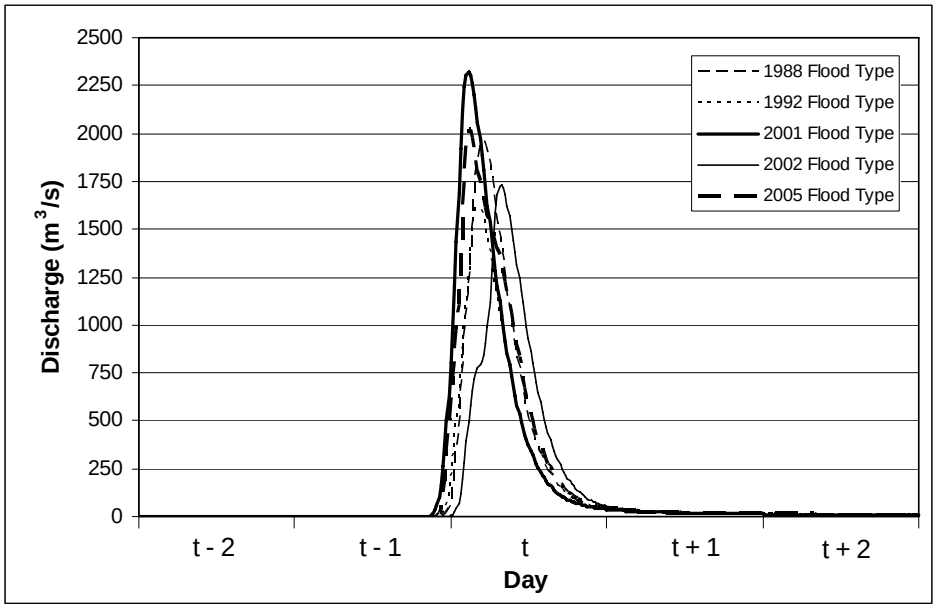

Figure 4.7 Probable Discharge Hydrograph at Tangrah (100-year Return Period)

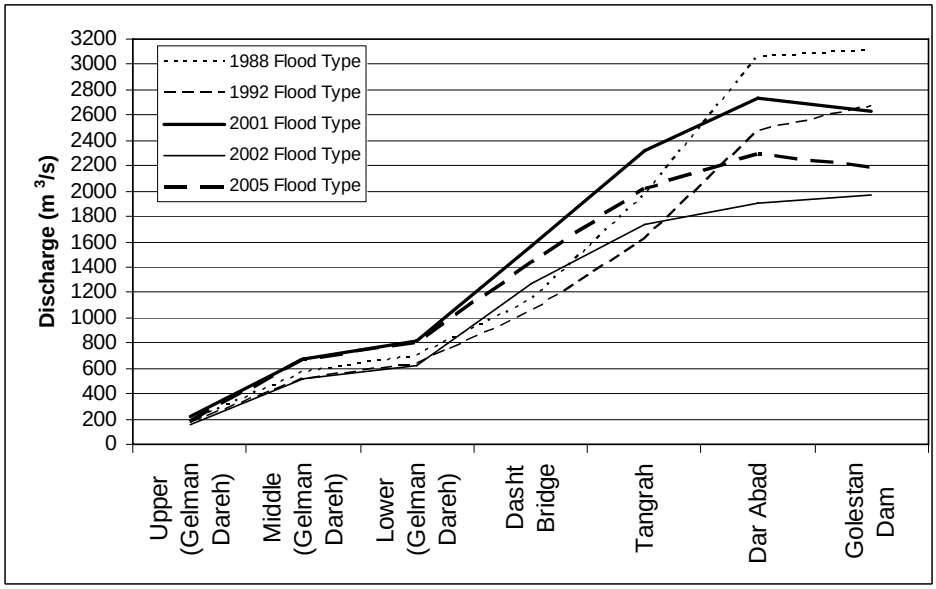

Figure 4.8 Probable Peak Flows along the Mainstream (100-year Return Period)

Table 4.3 Probable Peak River-Flows without Project (100-year Return Period)

Location	River	Design discharges (m^3/s) with various floods types rainfalls distributions				
		1988 - flood type	1992 - flood type	2001 - flood type	2002 - flood type	2005 - flood type
Upper	Gelman Dareh	180	163	218	116	180
Middle	Gelman Dareh	572	523	670	514	670
Lower	Gelman Dareh	694	632	812	623	806
Dasht	Dasht - e - Sheikh	54	82	274	223	222
Dasht	Ghyz Ghaleh	379	263	349	403	291
U/S of Confluence	Chesmeh Khan	0	53	90	0	127
Dasht Bridge	Madarsoo	1141	1052	1571	1274	1437
Tangrah	Madarsoo	1967	1623	2318	1736	2021
Dar Abad	Madarsoo	3056	2474	2740	1908	2289
U/S of Confluence	Agh Soo	165	239	69	78	46
Golestan Dam	Madarsoo	3110	2671	2629	1966	2193

Moreover, probable peak discharges, with 100-year return period and the 2005 flood type rainfall, in river system are: 180 m^3/s in Gelman Dareh (upper part); 670 m^3/s in Gelman

Dareh (middle part); 806 m^3/s in Gelman Dareh (lower part); 222 m^3/s in Dasht-e-Sheikh; 291 m^3/s in Ghyz Ghale; 127 m^3/s in Chesmeh Khan; 1,437 m^3/s in Madarsoo (Dasht Bridge); 2,021 m^3/s in Madarsoo (Tangrah); 2,289 m^3/s in Madarsoo (Dar Abad); 46 m^3/s in Agh Soo and 2,193 m^3/s in Madarsoo (Golestan Dam) as presented in Figure 4.9.

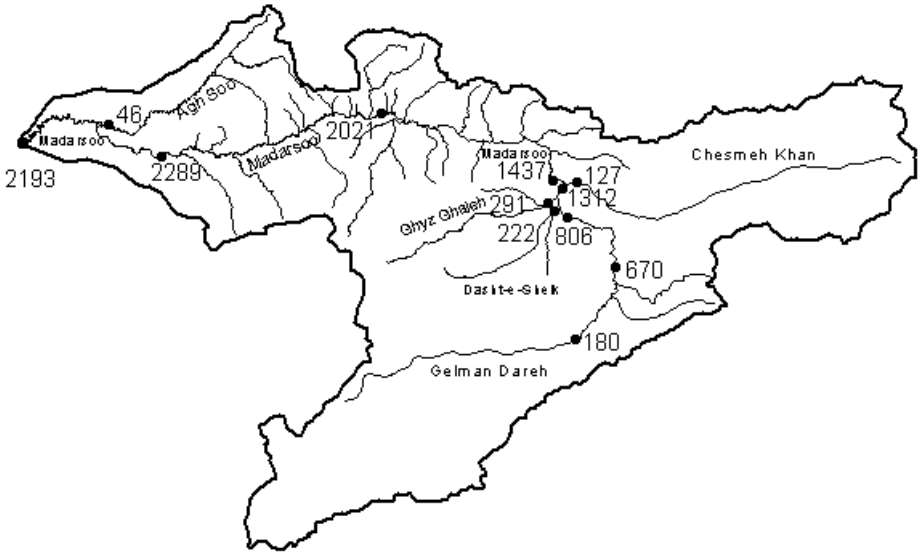

Figure 4.9 Probable Peak Flows in River System (100-year Return Period; 2005 Flood Type)

4.2 Probable River-Flows with Watershed Management Projects

The impact of watershed management practices like terracing, banqueting and furrow constructions and saplings plantation are analyzed. For this, area coverage of planned watershed management project in different sub-basins was collected (Table. 4.4). Coverage of the planned watershed management project were input in MIKE SHE hydrological model; and model parameters were adjusted accordingly for the areas and then generated flows in river system of basin. Manning's roughness coefficient, detention storage, infiltration rate, LAI, interflow and percolation time constants were adjusted in the model for planned watershed management project areas to generate river flows for 25-, 50- and 100-year return periods.

Table 4.4 Coverage of Planned Watershed Management Projects

Item	Dasht-e-Shiekh	Ghyz Ghale	Tangrah	Chesmeh Khan
Terracing (Ha)	120	125	200	
Banquet (Ha)	1360	180	1740	145
Furrow (Ha)	2850		2650	
Plantation (Ha)		25	150	

Results show considerable impact of planned watershed management project in peak river flow reduction. For instance, peak flows of the Dasht-e-Sheikh River with and without planned watershed management project are: 85 and 127 m^3/s (25-year return period); 119 and 175 m^3/s (50-year return period); 151 and 222 m^3/s (100-year return period). Therefore, about 33% of Dasht-e-Sheikh River peak flow can be reduced because of planned watershed management project in the Dasht-e-Sheikh River basin (Table 4.5 and Figure 4.10).

Table 4.5 Impact on Peak River-Flows by Watershed Management Project

Location	River	Peak River Flow (m^3/s)		% of Peak Flow Reduction by Watershed Management Project
		Without Project (Existing Landuse)	With Watershed Management Project	
A. For 25 Year Return Period				
Dasht	Dasht-e-Shiekh	127	85	33
Dasht	Ghyz Ghale	165	157	5
Dasht Bridge	Madarsoo	744	696	6
Tangrah	Madarsoo	1060	1003	5
Dar Abad	Madarsoo	1203	1089	9
Golestan Dam	Madarsoo	1172	1060	10
B. For 50 Year Return Period				
Dasht	Dasht-e-Shiekh	175	119	32
Dasht	Ghyz Ghale	225	215	4
Dasht Bridge	Madarsoo	1076	1006	7
Tangrah	Madarsoo	1522	1430	6
Dar Abad	Madarsoo	1726	1554	10
Golestan Dam	Madarsoo	1667	1509	9
C. For 100 Year Return Period				
Dasht	Dasht-e-Shiekh	222	151	32
Dasht	Ghyz Ghale	291	278	4
Dasht Bridge	Madarsoo	1437	1344	6
Tangrah	Madarsoo	2021	1896	6
Dar Abad	Madarsoo	2289	2049	10
Golestan Dam	Madarsoo	2193	1982	10

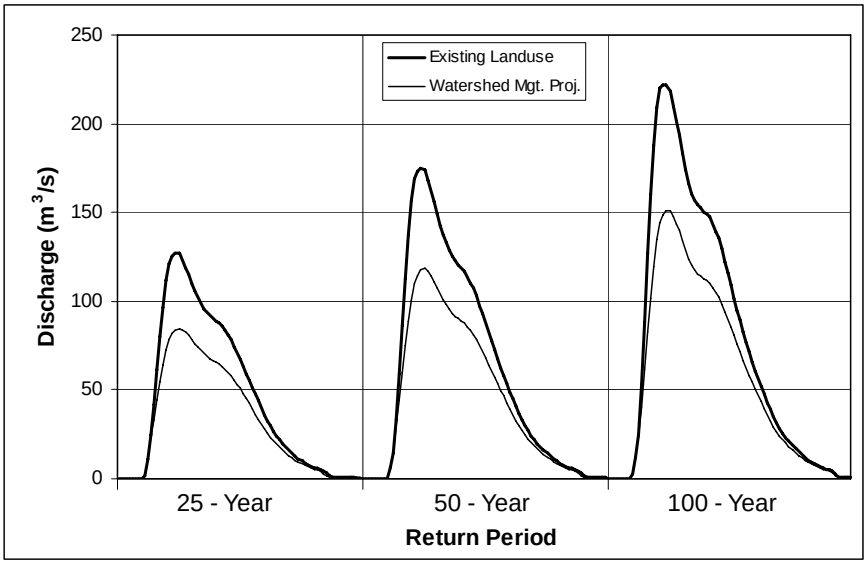

Figure 4.10 Impact Assessment of Watershed Management Project in Dasht-e-Sheikh

Similarly, impact of planned watershed management project around Tangrah is clearly shown with considerable reduction in peak flows at Dar Abad as compared to without project. Peak flows in the Madarsoo River at Dar Abad with and without planned watershed management project are: 1,089 and 1,203 m^3/s (25-year return period); 1,554 and 1,726 m^3/s (50-year return period); 2,049 and 2,289 m^3/s (100-year return period). Therefore, about 9 % of the Madarsoo River peak flow can be reduced at Dar Abad because of planed watershed management project at upstream part of river basin (Table 4.5).

Peak flows, with planned watershed management project in basin, generated by the model in river system for 25 year return period are: 85 m^3/s in the Dasht-e-Sheikh; 157 m^3/s in the

Ghyz Ghale; and in the Madarsoo 696 m^3/s at Dasht Bridge; 1,003 m^3/s at Tangrah; 1,089 m^3/s at Dar Abad; and 1,060 m^3/s at Golestan Dam (Figure 4.11). On the similar manner, peak flows in river system, with planned watershed management project in basin, generated by the model for 50- and 100-year return periods are also presented in Figure 4.12 and Figure 4.13, respectively.

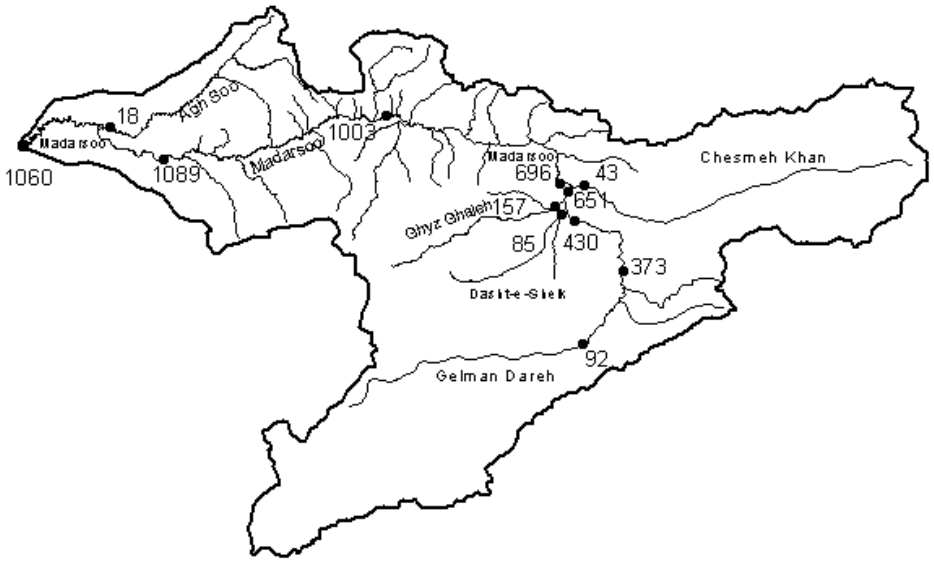

Figure 4.11 Probable Peak Flows in River System with Watershed Management Project (25-year return period; 2005 flood type)

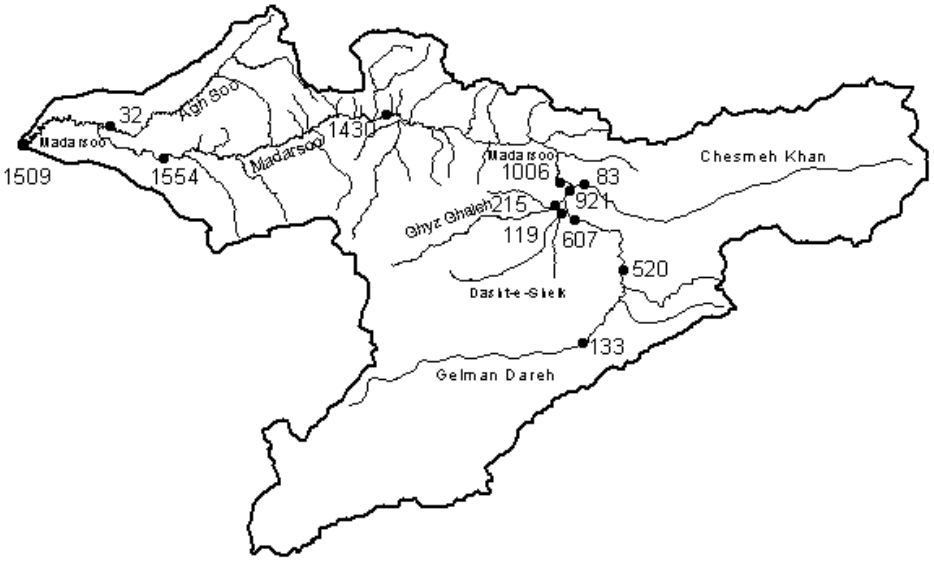

Figure 4.12 Probable Peak Flows in River System with Watershed Management Project (50-year return period; 2005 flood type)

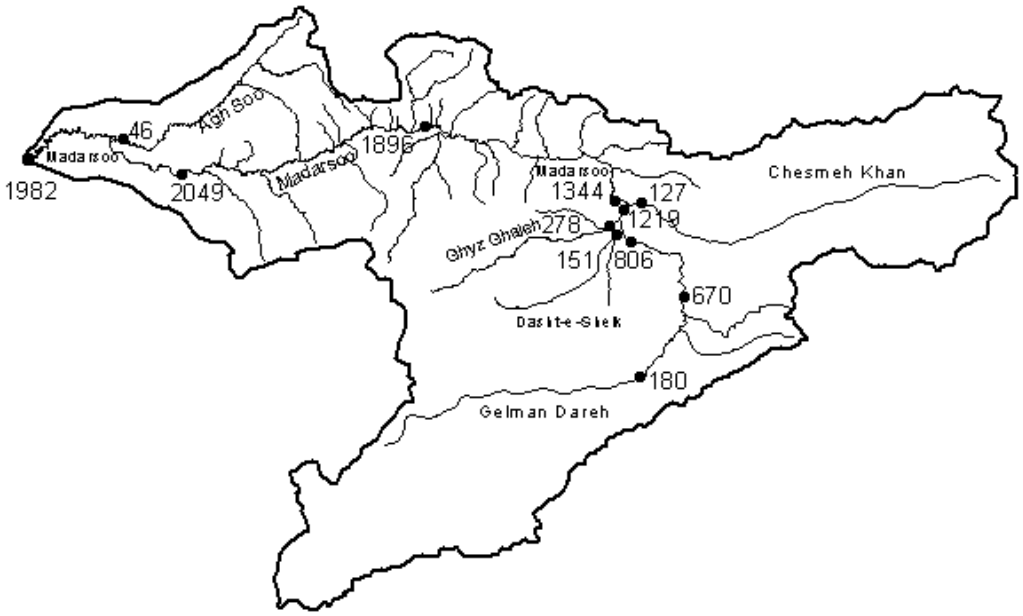

Figure 4.13 Probable Peak Flows in River System with Watershed Management Project (100-year return period; 2005 flood type)

4.3 Impact Assessment of Planned Dam in Ghyz Ghale River

The impact of planned flood control dam in Ghyz Ghale River on flood regulation is analyzed. For this, a flood control dam is incorporated in the river network at downstream of existing broken dam. The profile view of flood control and sediment control dams in the river network is presented (Figure 4.14). A sediment control dam (SCD) is planned at 600 m upstream of the flood control dam (FCD).

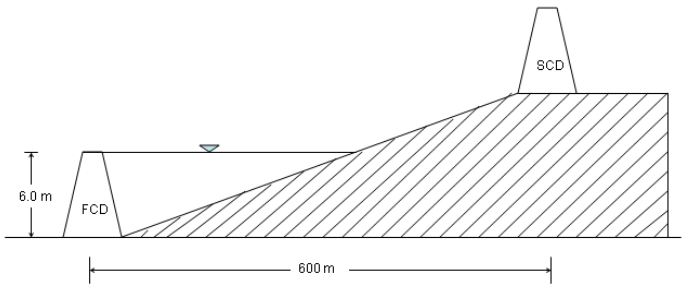

Figure 4.14 Profile View of Flood Control and Sediment Control Dams

4.3.1 Fixation of Dam Dimensions

At first, 6 m height is fixed for flood control dam spillway. Because, it is not possible to make dam taller than 6 m at that location of Ghyz Ghale River from geographical and geological point of view. The maximum feasible height of the dam is taken into consideration to get the maximum dam storage capacity so as to assess potential impact of the dam on flood regulation. For fixing gate width of the flood control dam, inflow into the dam reservoir during the 25-year flood with planned watershed management projects, was taken into consideration. The dam width is so fixed that there will be no overflow of floodwater from spillway in case of 25-year flood with the planned watershed management projects; all

floodwater passes through dam gate being water level equal to dam spillway height. Floodwater overflow from the spillway occurs only in cases of 50- and 100-floods with the planned watershed management projects. The set condition was satisfied with 4.1 m gate width of the flood control dam (Table 4.6).

Table 4.6 Gate and Spillway Discharges at Various Gate Widths of Flood Control Dam

Dam Height (m)	Gate Width (m)	Maximum Gate Discharge (m^3/s)	Spillway Discharge (m^3/s)	Total Outflow from Flood Control Dam (m^3/s)	Inflow from Sediment Control Dam (m^3/s)
6.0	3.5	72.9	14.1	87.0	95.0
	4.0	80.4	1.7	82.1	95.0
	4.1	81.2	0.0	81.2	95.0
	4.5	83.0	0.0	83.0	95.0

4.3.2 Dam Impact Assessment

With 4.1 m wide gate of flood control dam, it can reduce peak flow only by13.8 m^3/s (Table 4.6 and Figure 4.15). This small reduction of peak flow by the flood control dam does not have any impact on flood regulation. Therefore, flood control dam construction over Ghyz Ghale River, at 600 m downstream of existing broken dam, cannot give considerable impact on flood regulation. This is mainly due to having very small dam reservoir capacity to store floodwater. The maximum reservoir storage capacity at 6 m dam height is about 282,000 m^3 (Figure 4.16). It is also verified with computing the storage volume of floodwater in dam reservoir considering the differences in inflows into the reservoir from the sediment control dam (SCD) and outflows from the flood control dam (FCD) taking 25-year return period of the 2005 type flood. This computation also shows exactly the same storage capacity of the dam reservoir. From calculation it shows about 248,000 m^3 floodwater inflow from the sediment control dam can be stored in the dam reservoir (Figure 4.17). The less amount 34,000 m^3 of storage volume comes from lateral inflows into the dam reservoir.

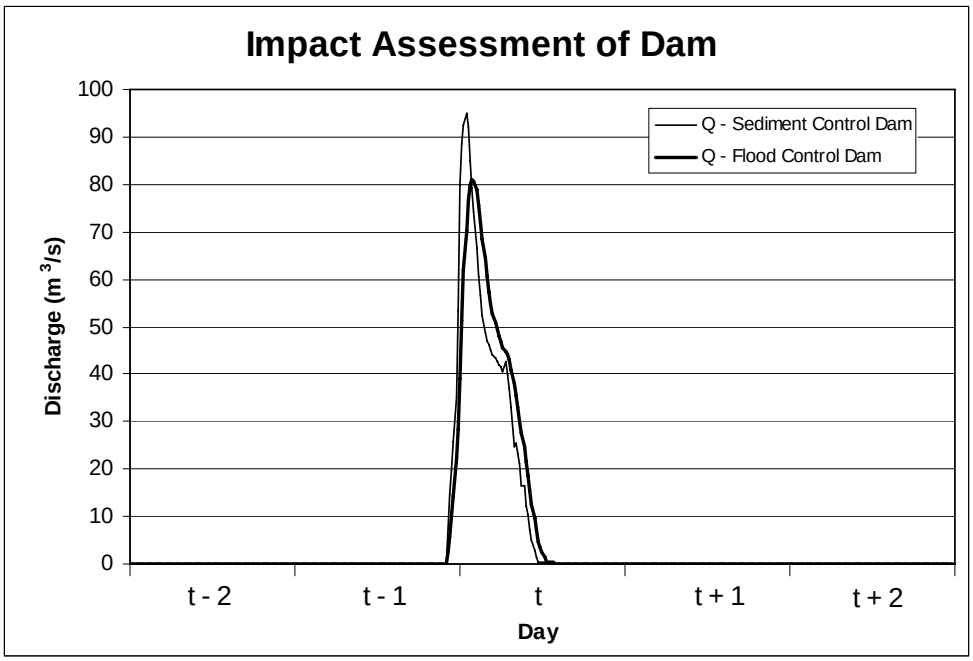

Figure 4.15 Inflow and Outflow Hydrographs of Dam Reservoir with Watershed Management Project (25-year return period; 2005 flood type)

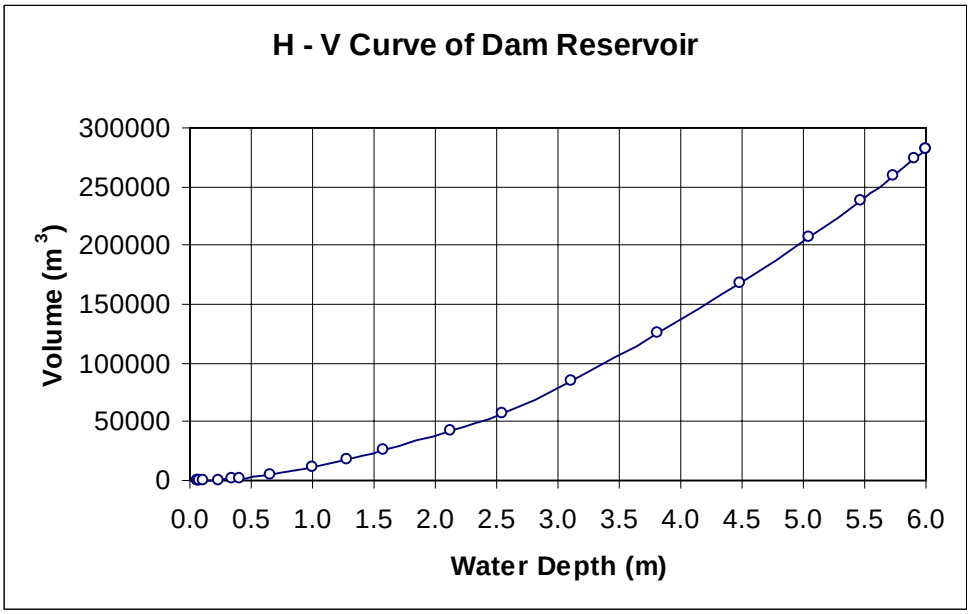

Figure 4.16 H – V Curve of Dam Reservoir

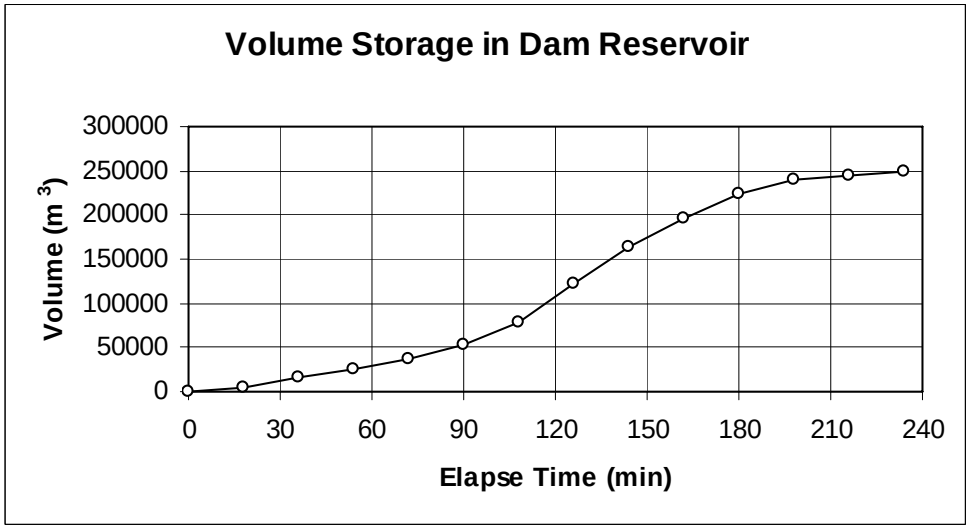

Figure 4.17 Storage Volume Computed from Inflows and Outflows of the Dam Reservoir (25-year return period; 2005 flood type)

4.4 Gelman Dareh Dam Impact Assessment

4.4.1 Introduction

A dam has been incorporated in Gelman Dareh River basin at 56°05’00’’ E and 37°16’28’’ N location to assess impact of the dam on flood regulation on downstream parts of Madarsoo River. The floodwater is fully controlled by the dam to see the impact of the dam on peak flows reduction at downstream parts of Madarsoo River. For this, MIKE SHE model is coupled with MIKE 11 river modeling system to simulate flows in the river system.

4.4.2 Probable River-Flows with Watershed Management Projects

Peak flows, with planned watershed management project in basin, generated by the model in river system for 25 year return period with 2005 flood type rainfalls are: 92 m^3/s in Gelman Dareh at upper part; 373 m^3/s in Gelman Dareh at middle part; 430 m^3/s in Gelman Dareh at Dasht; 85 m^3/s in the Dasht-e-Sheikh; 157 m^3/s in the Ghyz Ghale; and in the Madarsoo 651 m^3/s at location prior to confluence with Chesmeh Khan; 696 m^3/s at Dasht Bridge; 1,003 m^3/s at Tangrah; 1,089 m^3/s at Dar Abad; and 1,060 m^3/s at Golestan Dam (Figure 4.18).

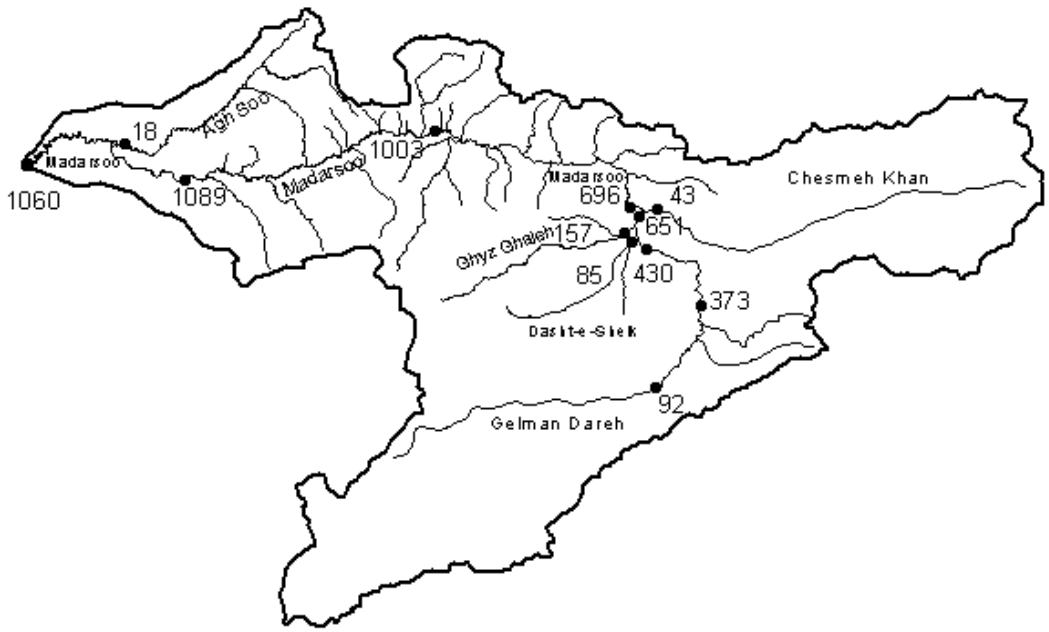

Figure 4.18 Probable Peak Flows in River System with Watershed Management Project (25-year return period; 2005 flood type)

Similarly, peak flows, with planned watershed management project in basin, generated by the model in river system for 50 year return period with 2005 flood type rainfalls are: 133 m^3/s in Gelman Dareh at Upper part; 520 m^3/s in Gelman Dareh at Middle part; 607 m^3/s in Gelman Dareh at Dasht; 119 m^3/s in the Dasht-e-Sheikh; 215 m^3/s in the Ghyz Ghale; and in the Madarsoo 921 m^3/s at location prior to confluence with Chesmeh Khan; 1,006 m^3/s at Dasht Bridge; 1,430 m^3/s at Tangrah; 1,554 m^3/s at Dar Abad; and 1,509 m^3/s at Golestan Dam (Figure 4.19).

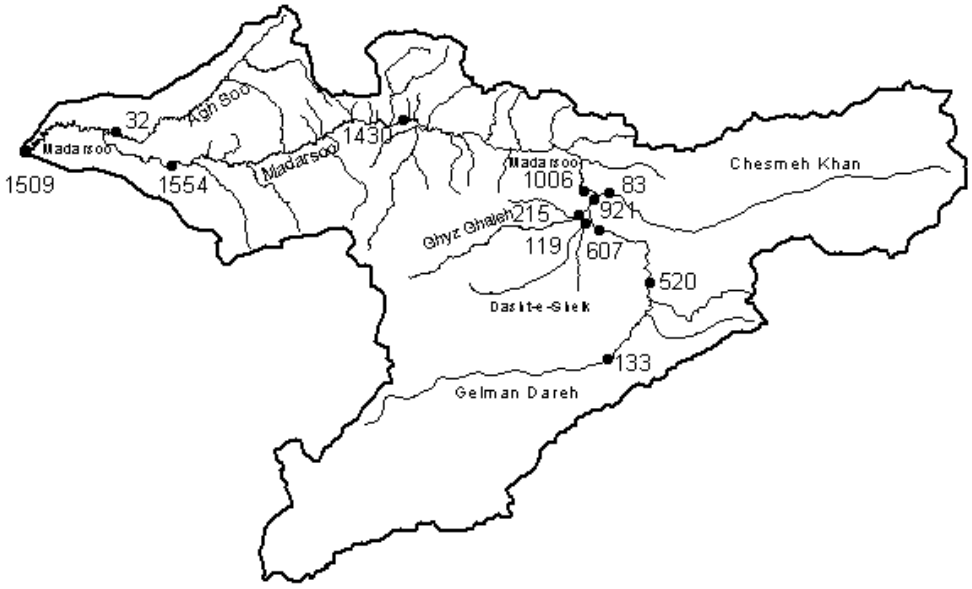

Figure 4.19 Probable Peak Flows in River System with Watershed Management Project (50-year return period; 2005 flood type)

4.4.3 Dam Impact Assessment (with 50-year Provable Flood)

Further, peak flows, with planned watershed management project in basin and flood water full control dam in Gelman Dareh River, generated by the model in river system for 50-year return period with 2005 flood type rainfalls are: 133 m^3/s in Gelman Dareh at Upper part; 520 m^3/s in Gelman Dareh at Middle part; 80 m^3/s in Gelman Dareh at Dasht; 119 m^3/s in the Dasht-e-Sheikh; 215 m^3/s in the Ghyz Ghale; and in the Madarsoo 423 m^3/s at location prior to confluence with Chesmeh Khan; 507 m^3/s at Dasht Bridge; 970 m^3/s at Tangrah; 1,117 m^3/s at Dar Abad; and 1,111 m^3/s at Golestan Dam (Figure 4.20).

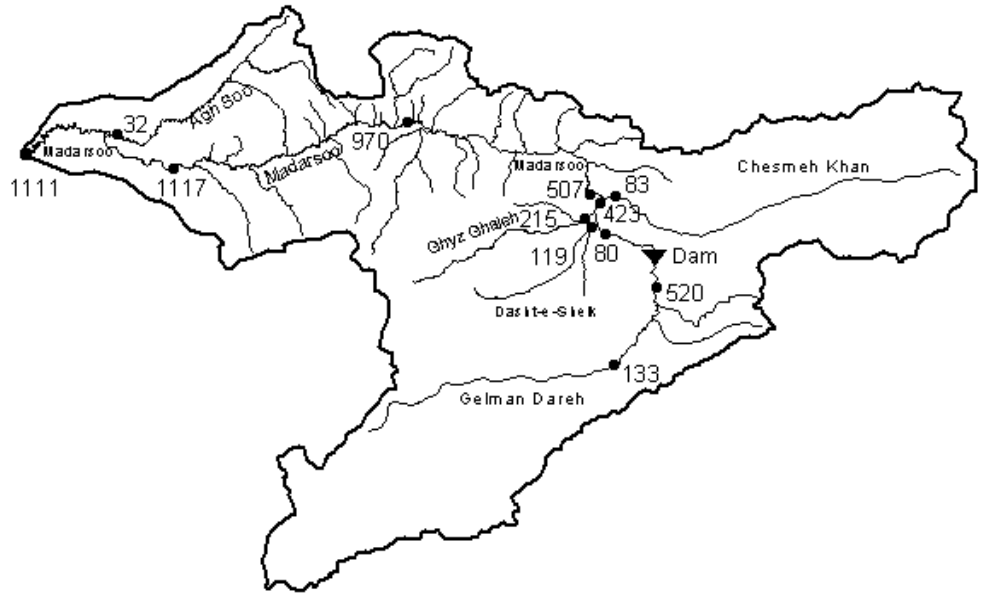

Figure 4.20 Probable Peak Flows in River System with Watershed Management Project and Dam in Gelman Dareh River (50-year return period; 2005 flood type)

Results show if the dam is constructed in Gelaman Dareh River and floodwater is fully controlled then peak flows of 50-year provable flood can be reduced to level of 25-year provable flood. Simulated peak flows in Madarsoo River for 25-year provable flood with watershed management project are: 1,003 m^3/s at Tangrah; 1,089 m^3/s at Dar Abad; and 1,060 m^3/s at Golestan Dam, while the simulated peak flows in Madarsoo River for 50-year provable flood with watershed management project and a dam (with full control of floodwater) in Gelman Dareh River are: 970 m^3/s at Tangrah; 1,117 m^3/s at Dar Abad; and 1,111 m^3/s at Golestan Dam. These figures are almost similar magnitudes so that it implies the urgent river improvement works for 25-year flood could be upgraded for 50-year safety level after construction of the Gelman Dareh Dam.

Flood Hydrographs

As a reference for dam impact assessment, flood hygrographs of Madarsoo River at Tangrah, Dar Abad and Golestan Dam are presented considering scenarios of: (1) 25-year flood with watershed management project, (2) 50-year flood with watershed management project, and (3) 50-year flood with watershed management project and full controlled dam in Gelman Dareh River (Figs. 4.21 to 4.23). As mentioned above, if the dam is constructed in Gelman Dareh River and flood water is fully controlled by the dam then peak flows of 50-year flood can be reduced to level of 25-year flood which is clearly presented in flood hydrographs.

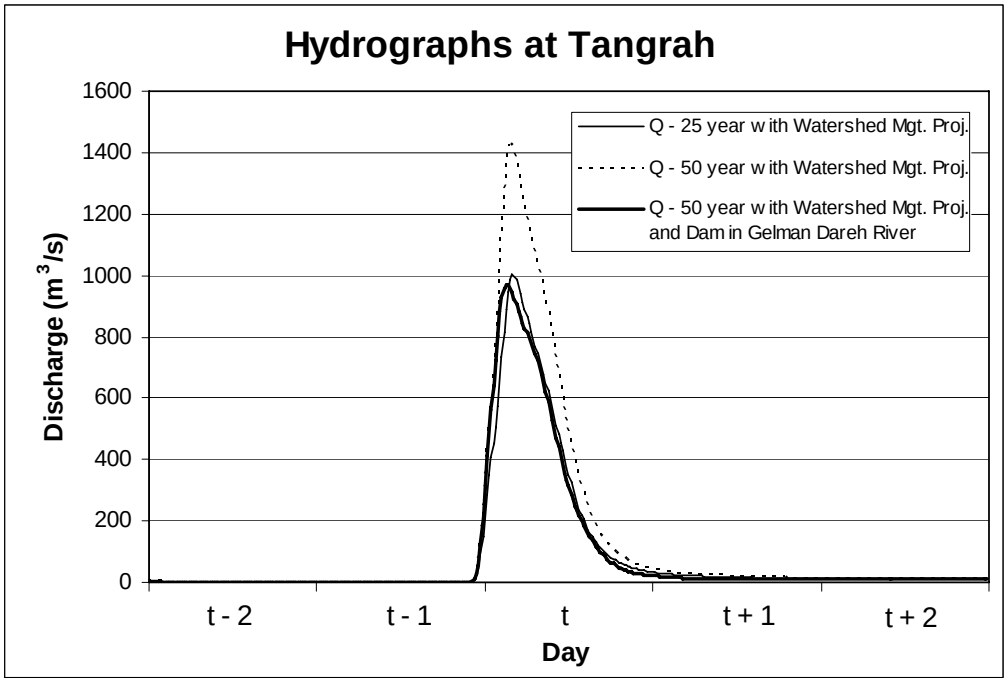

Figure 4.21 Flood Hydrographs of Madarsoo River at Tangrah (2005 flood type)

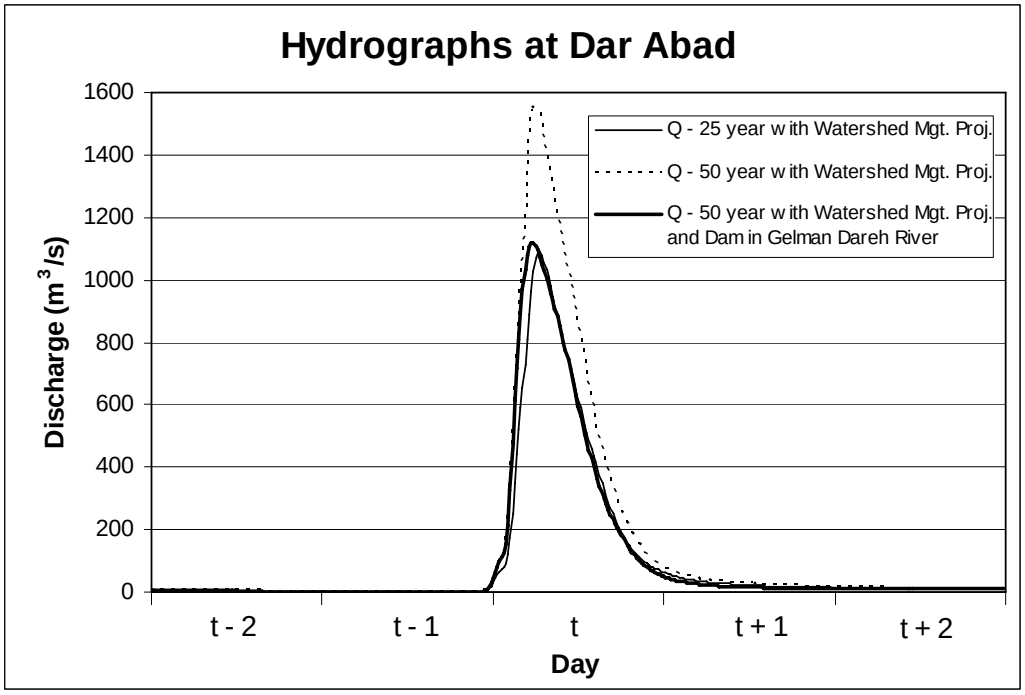

Figure 4.22 Flood Hydrographs of Madarsoo River at Dar Abad (2005 flood type)

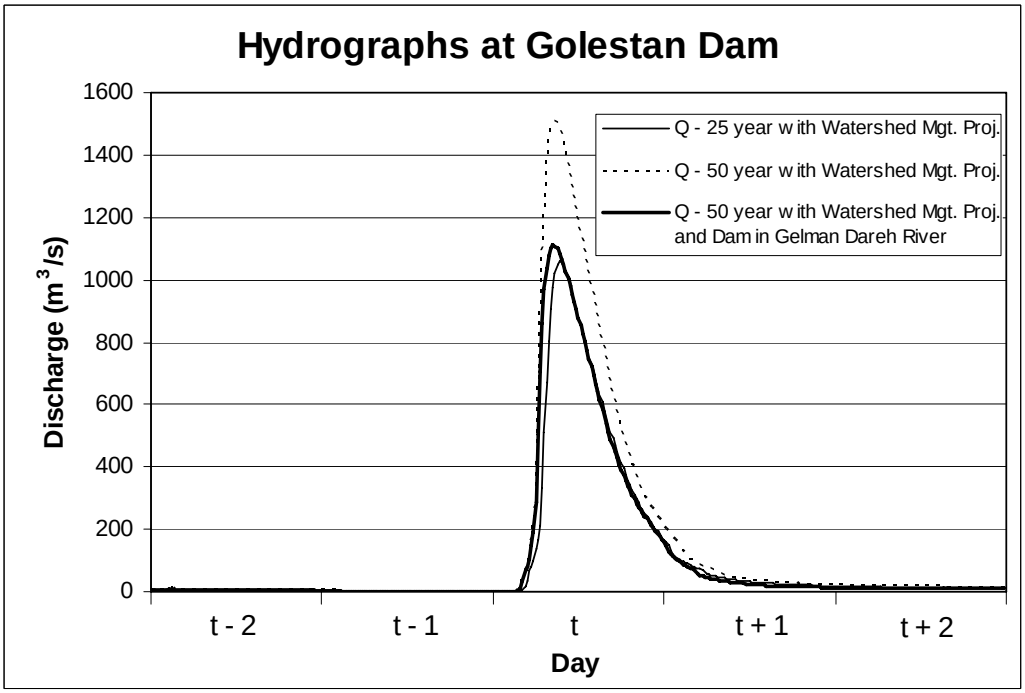

Figure 4.23 Flood Hydrographs of Madarsoo River at Golestan Dam (2005 flood type)

Dam Reservoir Storage Potential

Expected maximum water level in dam reservoir, while 50-year provable flood is fully controlled by the dam, is simulated. The maximum water level in dam reservoir is expected to reach up to 1,102.4 m; at this water level corresponding water depth in the reservoir will be 29.6 m (Figure 4.24). Further, floodwater storage potential of the dam reservoir is also investigated. The water depth and corresponding storage volume relationship (H – V Curve) of the dam reservoir is developed (Figure 4.25). The maximum floodwater storage volume will be about 15,000,000 m^3 when water depth in the reservoir reaches to 29.6 m.

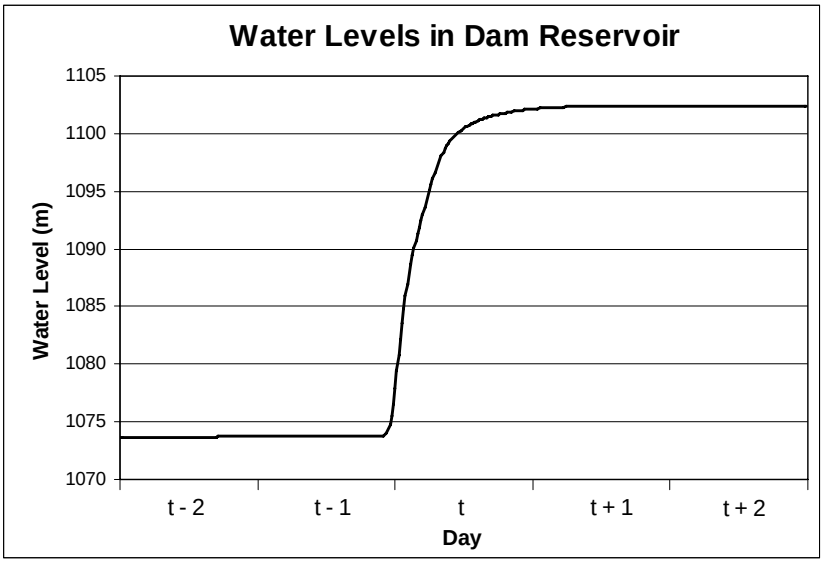

Figure 4.24 Expected Water Levels in Dam Reservoir (50-year return period; 2005 flood type)

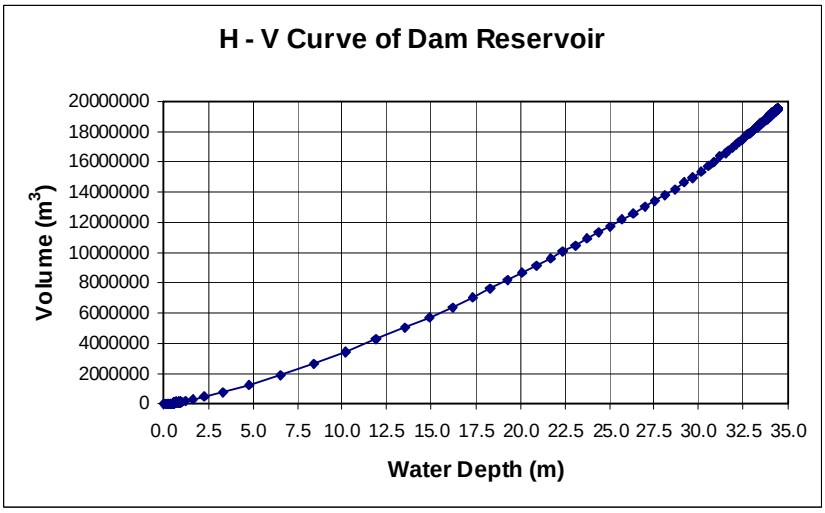

Figure 4.25 H – V Curve of Dam Reservoir

4.4.4 Dam Impact Assessment (with 100-year Provable Flood)

Flood peak flows, with planned watershed management project in basin and floodwater full control dam in Gelman Dareh River, generated by the model in river system for 100-year return period with 2005 flood type rainfalls are: 180 m^3/s in Gelman Dareh at Upper part; 670 m^3/s in Gelman Dareh at Middle part; 103 m^3/s in Gelman Dareh at Dasht; 151 m^3/s in the Dasht-e-Sheikh; 278 m^3/s in the Ghyz Ghale; and in the Madarsoo 556 m^3/s at location prior to confluence with Chesmeh Khan; 679 m^3/s at Dasht Bridge; 1,278 m^3/s at Tangrah; 1,461 m^3/s at Dar Abad; and 1,458 m^3/s at Golestan Dam (Figure 4.26).

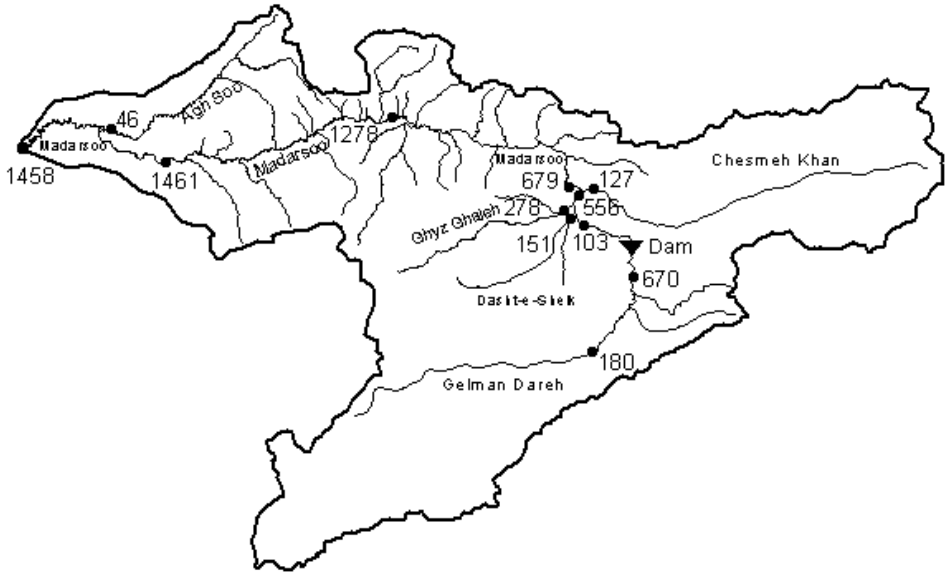

Figure 4.26 Probable Peak Flows in River System with Watershed Management Project and Dam in Gelman Dareh River (100-year return period; 2005 flood type)

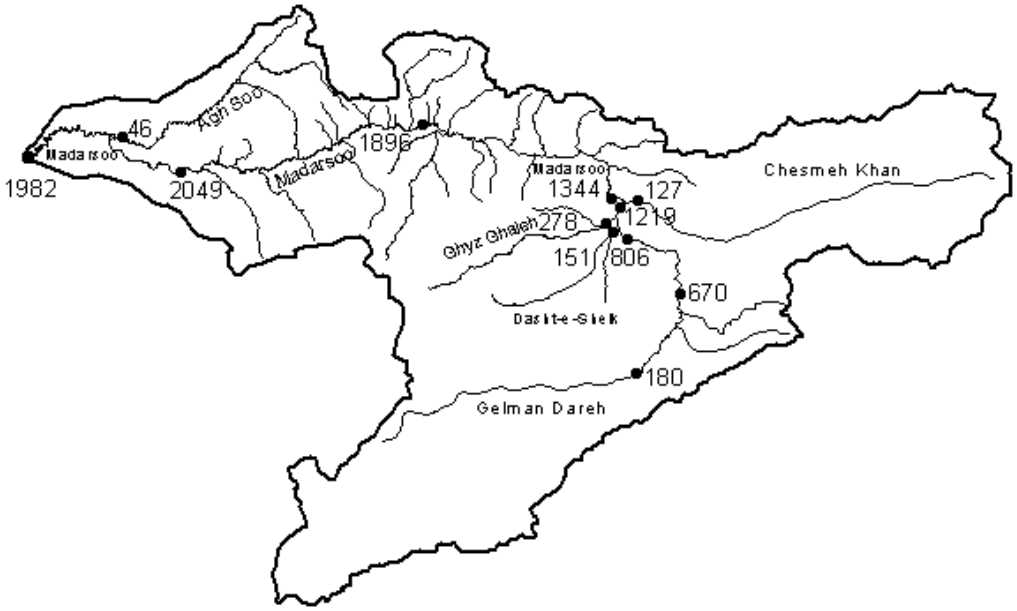

Figure 4.27 Probable Peak Flows in River System with Watershed Management Project (100-year return period; 2005 flood type)

Probable peak flows, considering watershed management project and 100-year return period, with 2005 flood type rainfall are presented in Figure 4.27. Results show if the dam is constructed in Gelaman Dareh River and floodwater is fully controlled by the dam then peak flows of 100-year flood in Madarsoo River can be reduced by 618 m^3/s at Tangrah; 588 m^3/s at Dar Abad; and 524 m^3/s at Golestan Dam.

Flood Hydrographs

For reference of dam impact assessment, flood hygrographs of Madarsoo River at Tangrah, Dar Abad and Golestan Dam are presented considering scenarios of: (1) 100-year flood with watershed management project, and (2) 100-year flood with watershed management project

and full controlled dam in Gelman Dareh River (Figs. 4.28 to 4.30). As mentioned above, if the dam is constructed in Gelman Dareh River and flood water is fully controlled by the dam then peak flows of 100-year flood can be reduced by 520 – 620 m^3/s at downstream parts of Madarsoo River which is clearly presented in flood hydrographs.

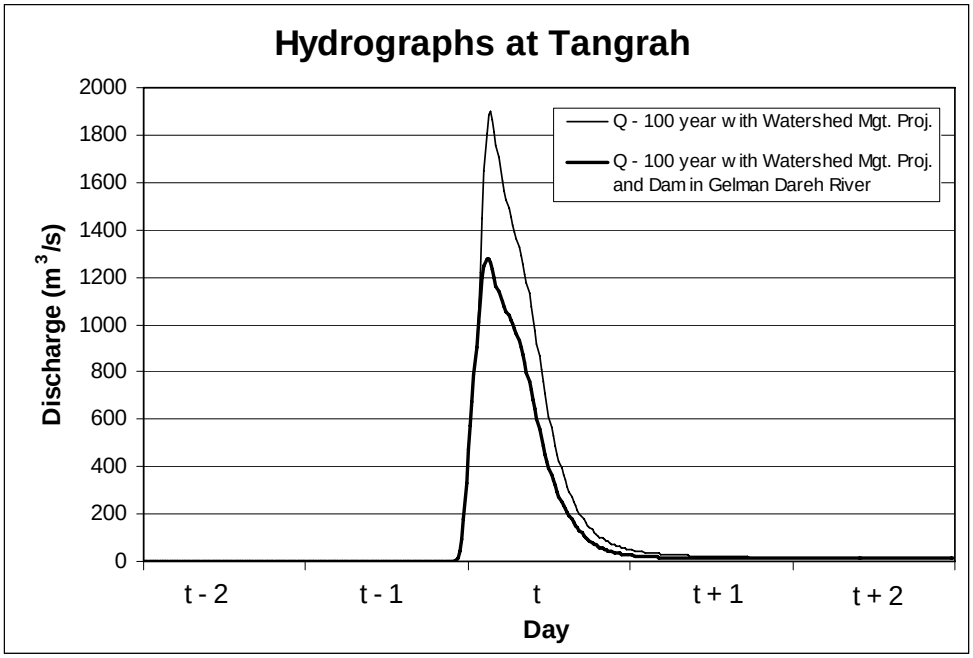

Figure 4.28 Flood Hydrographs of Madarsoo River at Tangrah (2005 flood type)

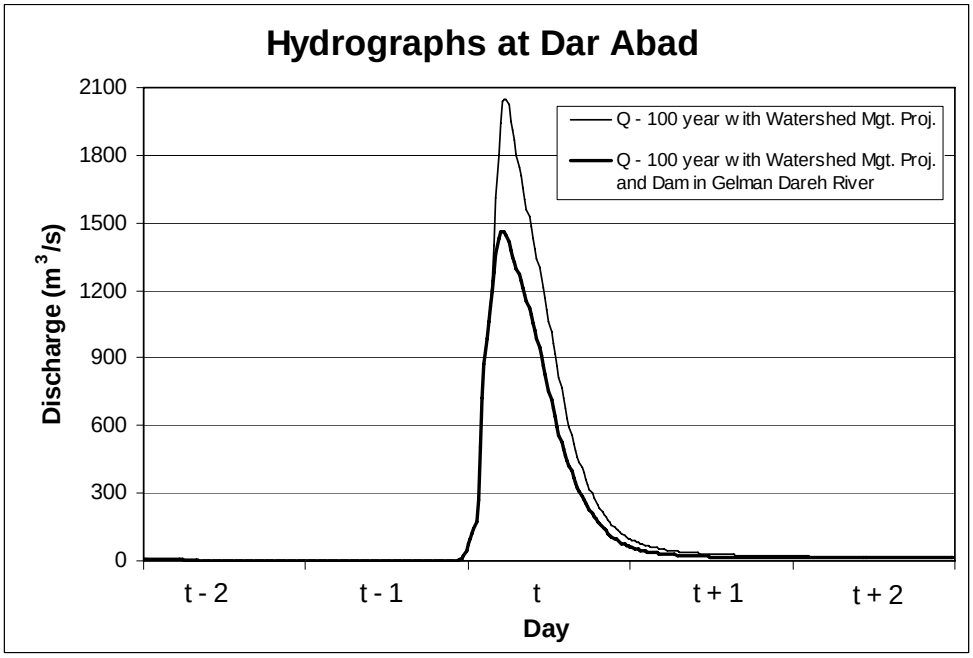

Figure 4.29 Flood Hydrographs of Madarsoo River at Dar Abad (2005 flood type)

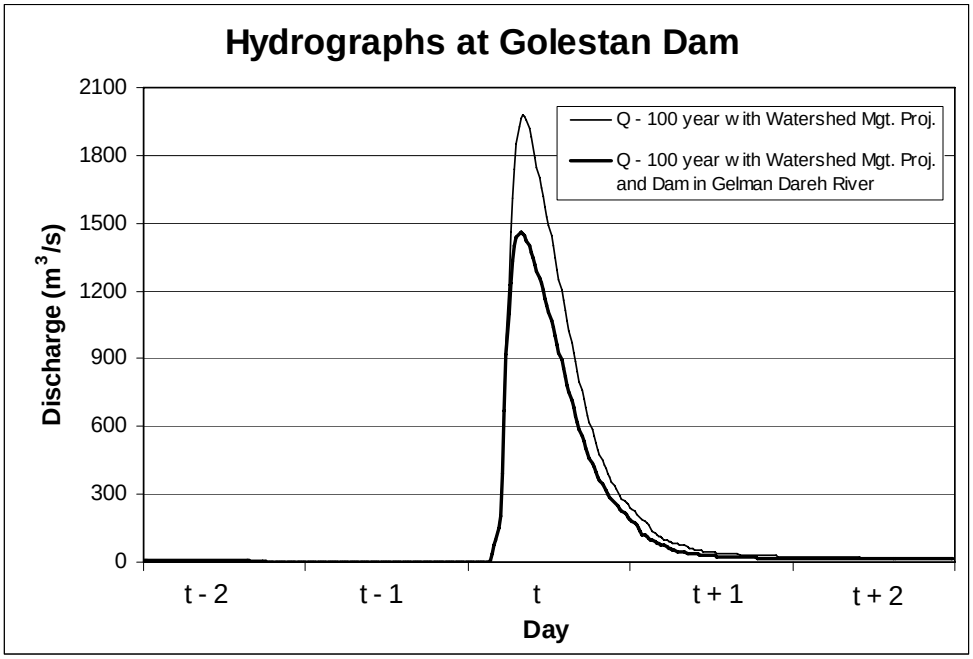

Figure 4.30 Flood Hydrographs of Madarsoo River at Golestan Dam (2005 flood type)

Dam Reservoir Storage Potential

Expected maximum water level in dam reservoir, while 100-year flood is fully controlled by the dam, is simulated. The maximum water level in dam reservoir is expected to reach up to 1,107.3 m; at this water level corresponding water depth in the reservoir will be 34.4 m (Figure 4.31). Moreover, floodwater storage potential of the dam reservoir is also investigated. The stage-volume relationship (H-V Curve) of the dam reservoir is referred to Figure 4.25. The maximum floodwater storage volume will be about 19,500,000 m^3 when water depth in the reservoir reaches to 34.4 m.

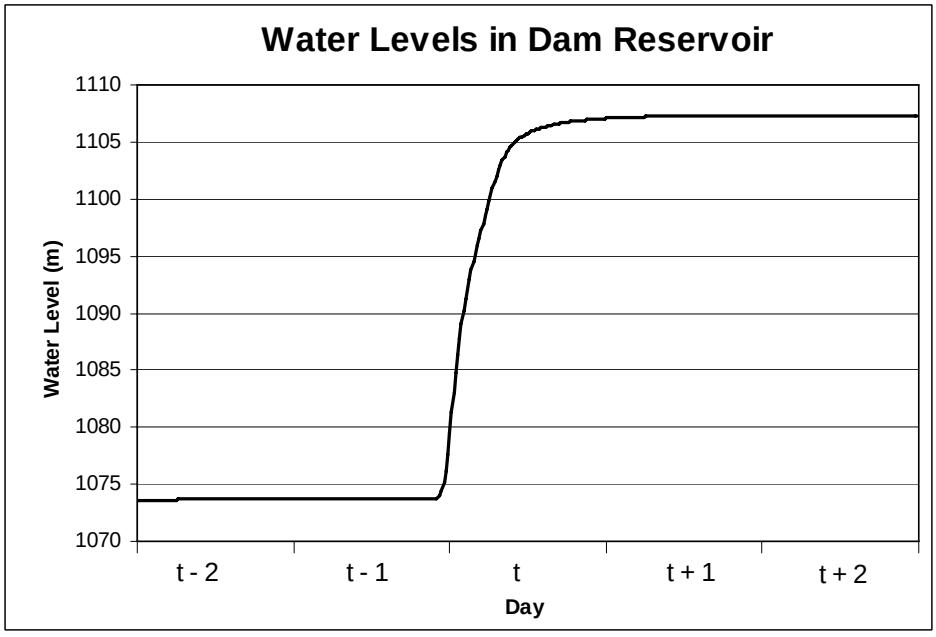

Figure 4.31 Expected Water Levels in Dam Reservoir (100-year return period; 2005 flood type)

4.5 Conclusions

The following conclusions are drawn throughout the hydrological modeling and simulation encompassing Chapters 3 and 4:

(1) MIKE SHE hydrological model is calibrated well so that simulated flows are good-fit with estimated/observed flows at Dasht Bridge (2005 Flood) and Tangrah (2001 flood), and inflows into the Golestan Dam (2001 flood). Therefore, probable (design) flows simulated by the model for 25-, 50- and 100-year return periods are considered highly reliable.

(2) Additional hydrological stations for river-flow observations in major tributaries of the Madarsoo River helps to upgrade model. Thereby more precise flows simulation in rivers can be achieved.

(3) Planned dam in Ghyz Ghale River cannot contribute considerably in flood regulation. Because only 13.8 m^3/s peak flow can be reduced by the planned dam in Ghyz Ghale River because of smaller dam reservoir storage capacity. The maximum storage capacity of the planned dam reservoir can be about 282,000 m^3.

(4) Planned watershed management project in the basin can contribute considerably in flow reduction in rivers. Because, about 33 % of peak flow in Dasht-e-Sheik River can be reduced by the project. Similarly, about 9 % of peak flow can be reduced at Dar Abad in the Madarsoo River because of the planned watershed management projects at upstream part in the basin. Therefore, implementation of the planned watershed management project could help in flood regulation to some extent.

(5) The magnitude and severity of 50-year probable flood can be reduced to the level of 25-year return period if dam is constructed over Gelman Dareh River and floodwater is fully controlled by the dam. However, it should be noted that even 25-year flood can cause severe damages in the basin. Although detailed studies on feasibility and effectiveness of the dam are necessary for making any conclusion regarding the dam, it takes long time to prepare and accumulate necessary meteo-hydrological observed records and related data.

RECOMMENDATIONS

The following recommendations are drawn from the study:

(1) Effective online weather monitoring and forecasting system aided with installation of meteorological radar at proximity of the Madarsoo River basin seems necessary to alleviate life and capital loss from natural disasters like the 2001 and 2005 floods again.

(2) Proper maintenance and operation of online water level and rainfall stations, installed in the Madarsoo River basin by Meteorological Organization (MO) and Ministry of Energy (MOE), is suggested to get real time data effectively for flood warning proposes.

(3) Investigations of aerial rainfall distribution over the basin during past floods (occurred in 1988, 1992, 2001, 2002 and 2005) show three sub-basins (Ghyz Ghale, Golestan Forest, and Lower Reaches between Tangrah and Kalale) got much rainfalls

than other sub-basins. Therefore debris flow and flood control works should more oriented on these sub-basins.

(4) Numbers of hydrological stations in Madarsoo River basin are few; therefore, expansion of the network with installing more stations in the big tributaries is advisable. Additional stations in tributaries would be useful for monitoring hydrological changes in sub-basins.

SUPPORTING REPORT I (MASTER PLAN)

PAPER V

Geomorphology

THE STUDY ON FLOOD AND DEBRIS FLOW IN THE CASPIAN COASTAL AREA FOCUSING ON THE FLOOD-HIT REGION IN GOLESTAN PROVINCE

SUPPORTING REPORT I (MASTER PLAN)

PAPER V GEOMORPHOLOGY

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CHAPTER 1 GEOMORPHOLOGICAL LAND CLASSIFICATION

1.1 Purpose and Methodology

Geomorphological Land Classification Map of the middle reaches of the Madarsoo River was made by the aerial photo interpretation to analyze the following items.

- Devastated condition,
- Condition of sediment production and movement, and
- Hazardous area by flood and debris flow.

Topographic features were interpreted using aerial photos at a scale of about 1:40,000 taken before disaster in 2001, and the results of interpretation were traced on topographic map with a 1:25,000 scale. And as the data after disaster, transition of the riverbed shape by sediment movement was interpreted using satellite imagery taken in 2004, and its result was traced on the classification map. Incidentally, shot area of satellite photos was only along mainstream of the Madarsoo, so that work coverage was limited.

1.2 Geomorphological Classification

1.2.1 Slope

Steep Slope

The steep slope area is defined in mountain and hilly areas except the following location,

- Depositional landform over 15 degree,
- Landslide terrain,
- Creep slope,
- Slope failure, and
- Cliff.

If its angle of gradient is over 25 to 35 degree, it might collapse. The area with vegetation is the surface soil, but the other with poor vegetation is the slope being composed of exposed rock or boulder and residual soil that may become the resources of rock fall.

Nick Point

Characteristics of “nick point" are the line that is connected the clearly slope-changing points, and the slope of higher area is gentler than that of lower area. Nick point is often formed as a boundary of geomorphic agent, formative date, and phenomenon of sediment movement.

In contrast to “nick point”, the line that the slope of higher area is steeper than that of lower area is called “break of slope”. Both lines are the important elements to categorize the topographic units, but “break of slope” is not drawn in Geomorphological Land Classification Map because topographical boundary line is usually equal to “break of slope”.

Cliff

Cliff is the steep slope composed of outcrop rock. The target basin is mainly composed of limestone that have strong resistibility against surface erosion so that lots of sharp cliffs are usually formed along the riverbank and valley head in progress of downcutting erosion. Collapse of bedrock and rock falling sometimes happen along the Cliff.

1.2.2 Slope Failure, Landslide

Slope Failure

"Slope Failure" is the landform that weathering bedrock and surface soils of the slope were already collapsed. In general the area that has a lot of slope failure tends to be,

- There are certain factors to collapse, and/or
- Recently the phenomenon triggering collapse were happened, for example heavy rainstorm, earthquake, and snow melting etc.

It is generally difficult to distinguish slope failure in this basin from cliff. The slope failure in the cliff might be slightly new outcrop.

Landslide

"Landslide" is the landform having following characteristics,

- Hillside slope was slide previously, and
- Gentle slope area surrounded by arc form and a horseshoe-shaped steep slope.

The arc form and horseshoe-shaped steep slope is the main scarp, and gentle slope portion under the main scarp is the landslide block. Landslide block is usually fragmentized in line with sliding, but the target basin has many rockslide blocks of which degree of fracture is low. On the other hand, there are some landslide blocks and rockslide blocks which fracturing remarkably progressed.

Landslide blocks may slide slowly, and give damages to houses and farmlands. They may also collapse extensively during earthquake or intensive rainfall. Front side of the blocks with steep slope may easily collapse due to being fragmentized.

Landslide, Creep, Glide

"Landslide, Creep, Glide" is the landform that has unclear main scarp and gentle slope, and the rock creep slope that topographic character is unclear and displacement of slope is less than landslide. Rock creep slope assumes as an initial stage of landslide. These slopes seldom move gradually like landslide, but collapse significantly during large-scale triggering impact like earthquake and intensive downpour.

1.2.3 Riverbed

Riverbed (before disaster in 2001)

This riverbed has been most drastically changed by large-scale disaster. Since the aerial photos for interpretation were taken in 1966, riverbed can be identified only in the channel segment with intensive sediment movement. Meanwhile, riverbed cannot be interpreted in the forest area where trees grow thick due to blockage of the tree crowns being larger than the riverbed width.

Riverbed (after disaster in 2001)

This riverbed is that can be interpreted by satellite imagery taken in 2004 after the 2001 disaster, and seems that enormous volume of sediment was transported by the floodwater. Even after the 2001 Flood it is also difficult to interpret the riverbed in the forest area where trees grow thick.

The shape of riverbed changed significantly after the 2001 Flood and a lot of trees along the river course are wash away by floodwater. Disappearance of vegetation along the river course is significant information of the riverbed movement in comparison with before and after disaster.

On the geomorphological land classification map, mainstream and tributaries in the middle reaches significantly changed. In particular although the mainstream that was not interpreted continuously due to tree crown's covering before disaster, continuous stream flow can be identified after disaster.

1.2.4 Floodplain, Valley Bottom Plain, Valley Flat

Floodplain, Valley Bottom Plain, Valley Flat

These topographic elements are extending over the flat area with little height from existing riverbed in valley bottom formed with sediment deposition. Now this landform keeps on being formed by stream flow. It is high possibility that debris flow and floodwater will pass, overflow, and accumulate sediment on it because of little height difference from existing riverbed.

Flood Terrace

This topography is the riverside depositional landform in mountain streams and about 5 m high above the existing riverbed. The formation date of it is near to present. It was formed through depositing sediment transported mainly by mass-movement such as flood, debris flow, landslide, and large collapse. Medium and small flood seldom overflow it because of significant height difference from existing riverbed. However floodwater in the large-scale floods scours the riverbank, and also it deposits sediment on the terrace through over-banking flooding to the terrace.

High-water Channel, Floodplain, Valley Bottom Plain

This topography is the flat area regarded as current riverbed with much vegetation and little height difference from existing riverbed. It can be interpreted in only mainstream of the Madarsoo River and large tributaries. Even middle- and small-scale floods may overflow because of little height difference from existing riverbed. The 2001 Flood extended and overflowed over this area.

1.2.5 Alluvial Fan, Alluvial Cone

New Alluvial Fan, Alluvial Cone

This topography is the presently depositing area in the shape of fan spreading from valley mouth where a river or a mountain stream appears from the mountains. Generally, the alluvial fans formed in the large rivers have gentle slope, while the fans formed in the small mountain streams have steep slope. Small-scale and steep-slope alluvial fans called alluvial cone are mainly formed with debris flow deposits. Alluvial fans are formed as the result of several river flow direction changing at the valley mouth, so-called fan apex, and flooding and river course shifting easily occur there. In the Madarsoo basin, there are a lot of alluvial fans and alluvial cones formed in the tributaries.

Old Alluvial Fan, Alluvial Cone

This topography is the alluvial fan area formed in the long past. It could be assumed that the past sediment discharge was much more intensive than the present in some era. At the downstream end of this topography, indistinct cliffs, steep slope, and unclear terraces are often seen, and also little terraced portions along the river course are seen. In addition, most of the areas are covered up partly with sediment of new alluvial fan, and therefore it is often difficult to discriminate between old and new alluvial fans.

The areas with new alluvial fan have the risk for the flooding and sediment deposition, and also old alluvial fan areas with little height from existing riverbed have similar risk.

Most of alluvial fans formed in Dasht basin are old one, and are partly covered with new sediment.

Mudflow/Debris Flow Fan

This topography is the alluvial area formed by extrusion of sediment from landslide. In this area, undulation of the surface is more distinct than that of another type of alluvial fans. Landslide terrains are formed near the entrance of valley. Typical mudflow fan in the Madarsoo basin is identified 2km upstream of Tangrah village on the right bank.

1.2.6 Terrace

Lower Terrace

Lower Terrace is the flat or gentle slope area with some height from existing riverbed. It was former floodplain, valley bottom plain, and valley flat, and afterwards riverbed shifted to lower part due to channel degradation. Generally over-banking flooding and debris flow might not encroach on this area because of high topography from existing riverbed, but the mountain streams with entrance of valley on the terrace might engender the over-banking flooding or debris flow.

Some lower terraces have little height differences of existing riverbed, and accordingly sediment deposits may cover on it during large floods. These terraces have the risk of flooding.

Higher Terrace

Higher terrace is the flat or gentle slope area with significant height differences from existing riverbed. It was former floodplain, valley bottom plain, and valley flat formed in Pleistocene epoch, and afterwards riverbed lowered due to channel downcutting. This area has much undulation than lower terrace so that some part of this area looks like hilly area. Tendency of overflow is similar to lower terrace. Furthermore higher terraces have the risk of bank collapse of their scarp or cliff because of significant height from existing riverbed.

Mudflow Terrace, Debris Flow Terrace

This topography is commonly found in landslide area. It seems to be formed with abnormal sediment accumulation originated from landslide. Generally river terraces are sloped toward the downstream, but mudflow terraces are partly sloped toward the upstream because of sediment deposition during large-scale collapse by landslide origin.

1.2.7 Mountain Slope

Colluvial Slope, Pediment

Colluvial slope is the gentle slope with sediment deposits formed at the foot of mountain and hilly areas. It was formed with collapsed sediment, sediment produced by gully erosion or surface erosion. It includes the alluvial fans of extreme small mountain streams, has gentler slope than talus, and has various formation processes.

Pediment is the smooth eroded gentle slope developed in front of mountains in arid region. Thin gravel layer generally covers its surface, and outcrop is found in some case. It looks like continuous alluvial fans along the mountain foot. It is subject to flooding and debris flow encroachment during heavy rain if there is a mountain stream along the mountain slope.

Talus (with vegetation)

Colluvial soil and fallen rocks accumulated with repose angle at the foot of mountains, and it formed Talus. This topography implies that collapsing or rock falling occurred on the mountain slope above the talus in the past. Steep sloped sediment is unsteady, so that talus deposits themselves become the source of debris flow, collapse and rock falling.

Talus (no vegetation)

Some parts of talus in the forest area have no vegetation because of continuous sediment supply from the mountain slope.

1.2.8 Uplifted Erosion Surface, Uplifted Peneplain

Uplifted Erosion Surface, Uplifted Peneplain

At the top of mountain, mountain ridge, and mountainside in this area, there are hilly gentle slopes and terraced flat areas. They could be formed in the process of uplifting of peneplain.

Uplifted erosion surface and uplifted peneplain are divided into two main stages in elevations. Two staged gentle slopes exist in the basin so that it implies there were regional differences in crustal alteration. Higher Stages exist widely near the northern boundary of this basin and the boundary between the Madarsoo and the Ghyz Ghaleh. On the other hand, lower stages exist at the mountaintop and ridge of hilly area in the eastern part of Dasht village. Some parts of uplifted erosion surface and uplifted peneplain form karst that is typical landform of limestone hill.

Uplifted Erosion Surface, Higher Terrace

There are some wide gentle slopes not to belong to terrace and hilly area at parts of mountainside and ridge in Ghyz Ghaleh basin. These slopes are at higher area than uplifted erosion surface and uplifted peneplain in the eastern part of Dasht village, so that these slopes could be regarded as same as above-described uplifted erosion surface and uplifted peneplain. However, the surfaces of this landform seem to connect to higher terrace, and are gentler than the uplifted erosion surface and uplifted peneplain in the eastern part of Dasht village. Therefore these are categorized into other landform.

1.2.9 Others

Former Riverbed

This topography is the old river channel interpreted in the floodplain and alluvial fan. This area is located slightly lower so that it might alter to the main flood channel easily.

1.3 Usage of Gemorphological Land Classification Map

Geomorphological land classification map shows following contents:

- Process how classified landform was formed,
- Structure material,
- Spatial position (height from existing riverbed, elevation, mutual position of each landform),
- Degrees of slope, and
- Formed age.

On landform, the changes such as weathering, alteration and fracturing, always occur through gravity effecting, influence of air, surface and ground water, activities of vegetation and creatures. Moreover external forces such as gravity and water flow always make landform change slightly in invisible level. On the other hand, large impacts like earthquakes or floods make landform change significantly for very short times, and they triggers serious disasters to the human societies. Therefore to clarify the force to form the topography and to investigate materials of landform and topographic conditions are quite important for prevention and mitigation of natural disasters.

Geomorphological land classification map informs us important information to forecast about natural disasters. Usage of the classification map is:

- Assessment for disaster prevention in city, settlement, and each control facilities,

- Assessment for disaster mitigation plan on delineation of disaster-prone areas and pointing out of safe evacuation sites during disaster,
- Calculation of design sediment volume, and selection of suitable sites for sediment control facilities in the sediment control plan,
- Study on landslide survey and proposition of countermeasures,
- Selection of suitable sites and their disaster assessment for various development plans such as city, road, agriculture, electricity, tourism and so on, and
- Basic information for environmental protection plan.

CHAPTER 2 TOPOGRAPHIC CONDITIONS IN PRINCIPAL BASIN

2.1 Gelman Darreh-Sefid Daly-Nardin River

In the Gelman Darreh-Sefid Daly-Nardin basin, topographic condition is clarified through aerial photo interpretation for the downstream area only. The river flows from southwest to northwest approximately over the wide flat basin, and its catchment is the largest among the major tributary's basins of the Madarsoo River. It changes the flow direction toward north at 12 km upstream of Dasht village and flows through mountain gorge, and changes again toward west-northwest at 7 km upstream of Dasht village. The river joins with the left-bank tributaries, Dasht-e-Sheikh and Ghyz Ghaleh rivers, around Dasht village. At Dasht village, it changes the flow direction again toward north, and joins with the right-bank tributary, Cheshmeh Khan River at 2.5 km downstream of Dasht village center.

Photo interpretation area is downstream area of entry point to Dasht plain from gorge, where the river changes the flow direction toward west-northwest from north at 9km upstream of Dasht village.

River channel of mainstream forms valley-shaped topography. Width of valley bottom plain changes at each location;

- About 200 m wide: Upstream of entrance of Dasht plain
- About 350 m to 600 m wide: Downstream of the entrance, changing flow direction toward west-northwest
- About 1,100m wide: Vicinity of confluence with Dasht-e-Sheikh

In mountain gorge, wide riverbed with no vegetation can be interpreted, while riverbed cannot be interpreted around the entrance of the Dasht plain. This fact implies that flow rate of usual floods decreases through infiltration to subsurface flow and most transported sediment may be deposited there.

Mainstream from the entrance flows forming downcutting channel on the valley bottom plain for 4 km with meandering. From 2.5 km upstream of Dasht village, height differences between mainstream and valley bottom plains become very little. In vicinity of Dasht village, width of valley bottom plain become narrower because of alluvial fan development from left-bank tributary of Ghyz Ghaleh River.

In upper stretch of confluence with Cheshmeh Khan River, mainstream becomes gully-like valley with slight erosion, and forms nick point before the confluence.

In the 2001 Flood, the gully head widened significantly and progressed upstream-ward together with nick point. These topographic changes were caused by riverbed degradation and channel widening due to bank erosion around the confluence with Cheshmeh Khan River.

Area interpreted is categorized into the following five topographic sub-areas.

Left Bank upstream of the Entrance

This area has steep slope at lower portion below nick point, while gentle slope with undeveloped valley along ridgeline exists at higher portion above nick line. In particular valley topography cannot easily develop in some places with exposed limestone, and mountain shape is roundish with sparse vegetation.

Right Bank upstream of the Entrance

This area has steeper mountains with more significant undulation than the left bank and almost no uplifted erosion surface found. There are exposed rocks with steep cliffs at the top

of slope, and terraced collegial slope and river terraces developed along the foot of slope. According to aerial photos, small alluvial fans are formed at the mouths of those tributaries along the mainstream due to intensive sediment supply in their tributaries' basins.

Left Bank downstream of the Entrance (to the confluence with Dasht-e-Sheykh River)

The river terraces, which were alluvial fans in origin, developed with 20 to 30m higher above the valley bottom. According to geological map, these river terraces are formed by erosion of ground surface accumulated in Pleistocene, and categorized as ancient terrace. Slope of the terrace surfaces increases by approaching to southern mountains.

Many tributaries have dissected the river terraces so that unclear cliffs were formed at the mouths of the tributaries along the valley bottom plain of the mainstream (Gelman Darreh-Sefid Daly-Nardin).

Right Bank downstream of the Entrance

Hilly mountains composed of tertiary deposit with 200 to 300m of relative relief extend along the mainstream, and alluvial fans developed at the foot of the mountains. The mountains of tertiary deposits have uplifted erosion surface around the mountaintop, and edges of the uplifted erosion surface have clear nick points. Lower part of the nick points is steep hillside slope. Many gullies developed on the hillside slopes.

Many valleys dissecting hilly area form a series of composite fans along the foot of mountains. Most of composite fans have unclear cliff or steep slope at the downstream end. These formations reveal that the composite fans are in the process of terracing and that the composite fans were formed in the olden times.

Right Bank downstream of the confluence with Ghyz-Ghaleh River

Some part of this area has similar topographic characteristics to the Ghyz Ghaleh River. Tributary at east side of G01 (refer to Figure 2.1) forms comparatively large alluvial fans. Sediment may move on the fan surface in the flood time. Landslide areas exist in the uppermost of the tributaries located north of Dasht village.

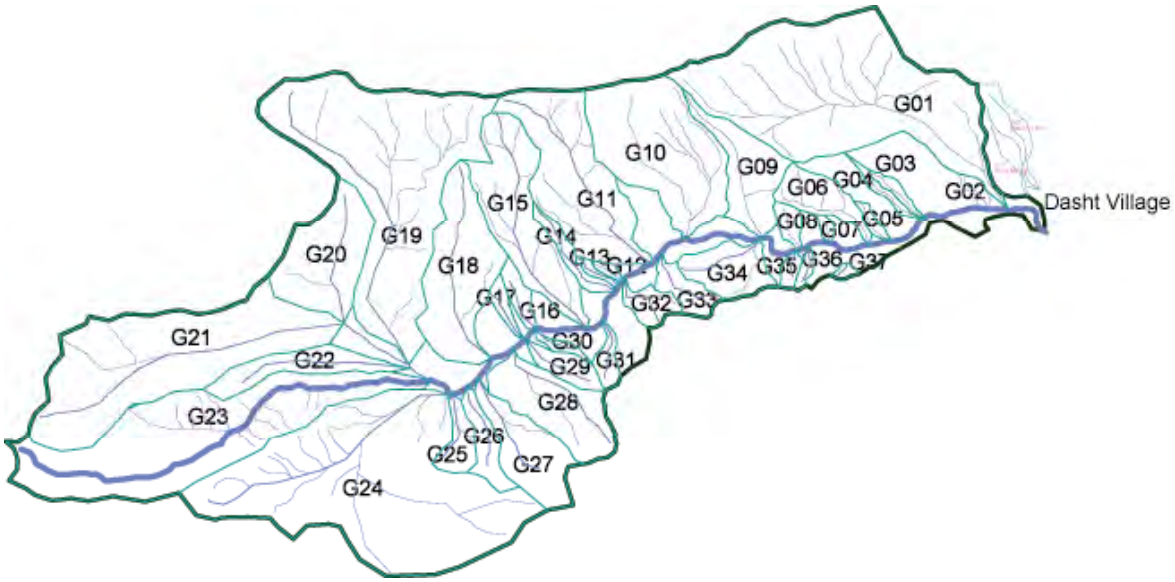

Figure 2.1 Valley Code of the Ghyz Ghaleh River Basin

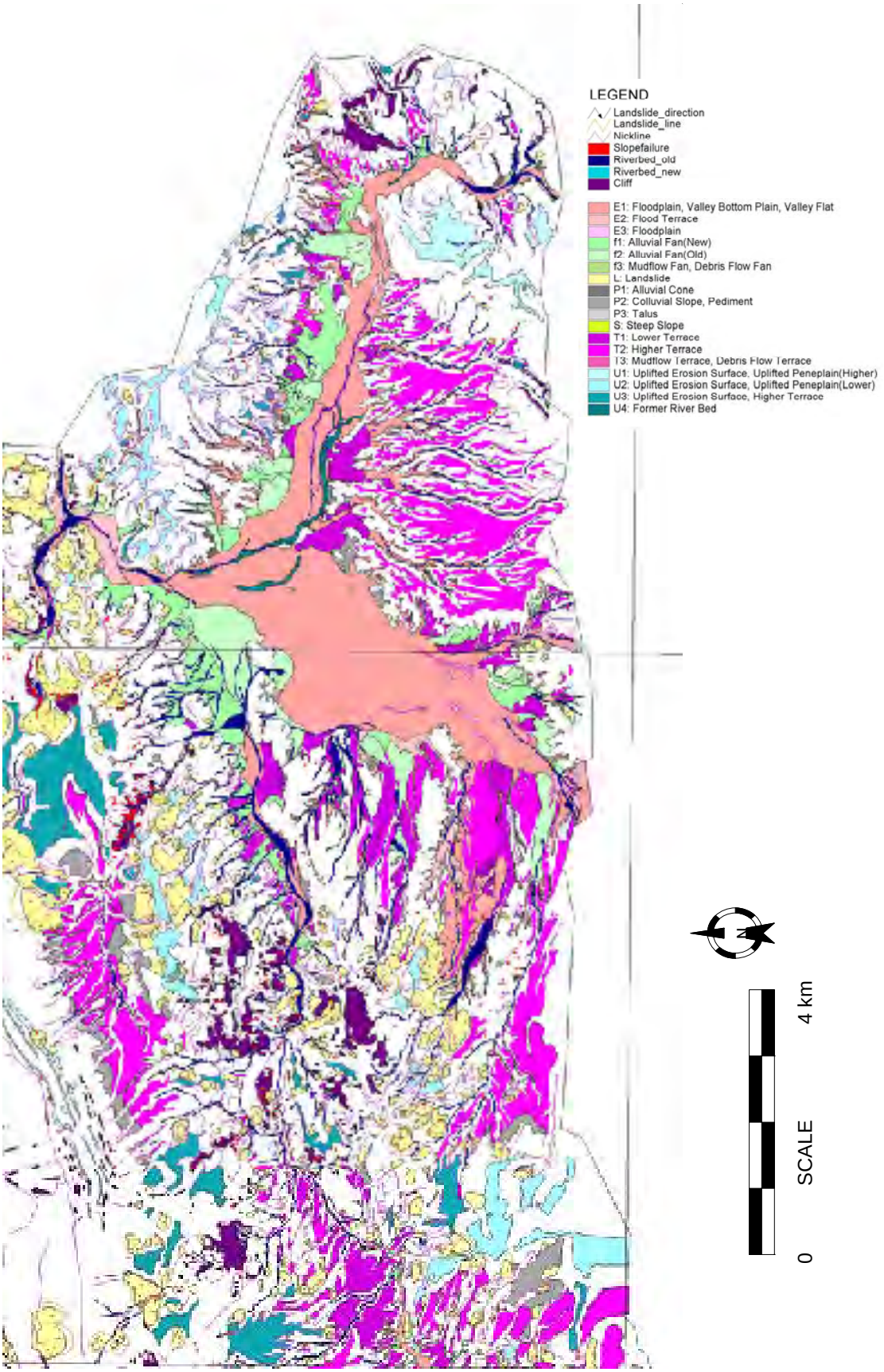

Figure 2.2 Geomorphological Land Classification in the Gelman Darreh, Dasht-e-Sheikh and Lower Reaches of Ghyz Ghaleh Basins

2.2 Dasht-e-Sheikh River

In the Dasht-e-Sheikh River basin, topographic conditions were interpreted in the downstream area and left bank of midstream area only. The basin extends to the west at Dasht-e-Shad with 1,600 m in height and to the south along the mountain ridge being bounded by the Gelman Darreh-Sefid Daly-Nardin River basin.

The topography of the basin could be characterized as wide valley bottom plain of alluvial fan origin in the downstream area. Around 5.5 km upstream of Dasht village valley width of mainstream is about 150m, while around 2 km upstream of Dasht village the valley plain changes to broad one with some undulations and 2.2 km wide.

Upstream of interpreted area have the trace of sediment movement and flooding, but the middle and downstream area with wide valley have little trace of sediment movement. In particular present channels are not prevailing at present in the lower reaches, and partly form the shallow and discontinuous gully valley. This valley is categorized as valley bottom plain in geomorphological land classification.

Numerous erosive valleys developed in the hilly areas and terraces along the left bank. In the upper and middle reaches, sediment movement could be interpreted in the existing river channel, but could not be interpreted in the downstream area. A few river channels could be identified up to the valley bottom plain of Gelman Darreh River.

The mountain ridge being bounded by the Ghyz-Ghaleh river basin could be characterized as higher peaks around hilly mountains mainly composed of tertiary deposit. These peaks composed of mesozoic sediment might be a type of monadnock formed through erosion in the peneplanation period. Around the monadnock, there are high terraces and hilly mountains with little flat face and gentle slope at mountaintop. These terraces and mountains have been clearly dissected by the numerous mountain streams and gullies. The landslide terrains could be seen in the hilly areas consisting of tertiary deposits.

Both hilly areas and terraces lower toward east in elevation. The hilly areas have 1,400 m height at west end of the basin, and 1,000 m height at east end of Dasht village. Terraces also have 20 to 30 m height from existing riverbed at the western area, and 5 to 10 m height at vicinity of valley bottom plains of Dasht-e-Sheikh River. Some part of lower terraces becomes no significant height difference to the valley bottom plains of Dasht-e-Sheikh River.

2.3 Ghyz Ghaleh River

The Ghyz Ghaleh River originates in Dasht Shad, flows to the east and finally joins to the Gelman -Darreh River at Dasht village. Northern boundary of the Ghyz Ghaleh River is steep crest with about 2,000 m high lying east to west, while southern boundary to the Dasht-e-Sheikh River is hilly mountains, terraces, and isolated peaks like monadnock.

The basin of Ghyz Ghaleh River has different topographic components in left and right bank, and upper, middle and lower reaches.

2.3.1 Upper Reaches (Upstream of G16)

This area has large well-developed river terrace. Boundaries of both sides to F101 sub-basin (refer to Figure 2.3), which is tributary of the Madarsoo River, and to the Dasht-e-Sheikh River are made up of terrace, lower uplifted erosion surface, and uplifted peneplain with gentle slopes. Dasht-e-shad village is located on the terraces in the upper most area of the boundary between F101 sub-basin and Ghyz Galeh basin. The higher terrace among the higher and lower ones extends widely with 30 to 50m high above the existing riverbed. The Ghyz Ghaleh River and tributaries down-cut the higher terraces and flow down forming box-shaped valley. The widest part of the valley including lower terrace is about 850 m, and even valleys of tributaries extend to about 200 m wide. Lower terraces can be found inside the

box-shaped valley, and some of them are covered with fan deposits because of small height differences between lower terrace and existing riverbed.

Only tributary originated from the monadnock on the right bank and uppermost area of the left bank tributaries can be interpreted as sediment yielding or moving riverbeds. As a whole, the upper reaches of the basin generally have less landslide terrains and slope failures, and produce less sediment yield and runoff.

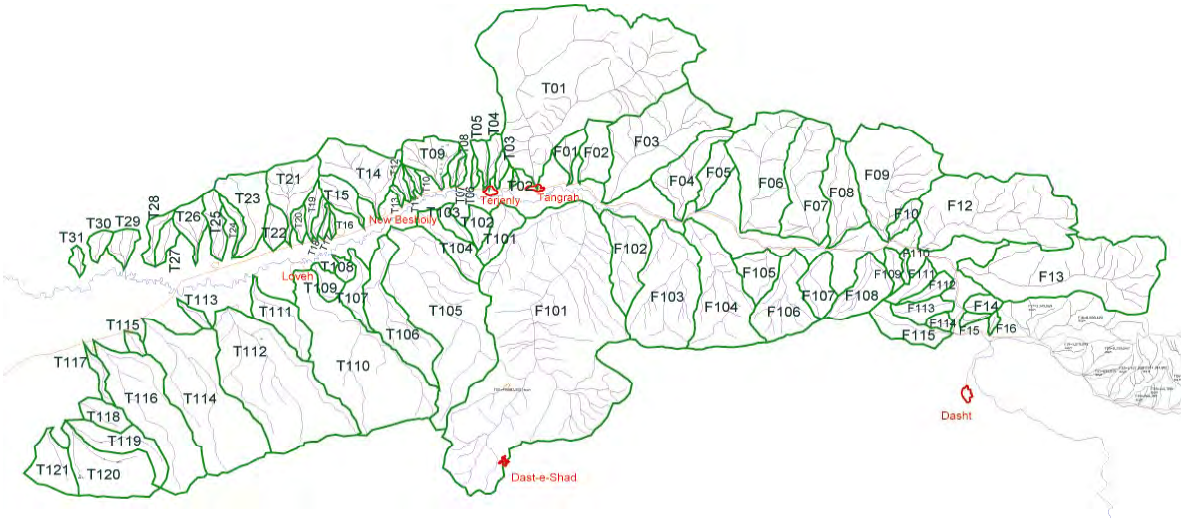

Figure 2.3 Valley Code of the Middle Madarsoo River Basin

2.3.2 Middle Reaches (G15 to G07)

In contrast to the upper reaches, wide valley bottom plain did not develop in the middle reaches. The middle reaches are narrow path of river valley, and topography of both banks is distinctly different. Elevation of the boundary is 2,000 m in the left bank, while it is 1,200 to 1,400 m in the right bank. As a result, river stream is biased toward the right bank. In addition, large-scale tributaries occur in the left bank, while no large ones occur in the right bank. Sediment movement can be interpreted in both channels of Ghyz Ghaleh and tributaries in the downstream stretch from the confluence with G15.

In the middle reaches there are many slope failures, small unsteady landslide terrains and new unsteady talus terrains so that they could have been source areas to yield sediment. Especially the mountain crests in sub-basins G07 and G09 may be intensively weathered and deteriorated because of lineament like dividing the shape of mountain and lying east to west. Active erosion and sediment yielding take place in this area because of significant topographic deformation as a result of river captures, earth movements.

2.3.3 Lower Reaches (Downstream of G06)

The river channel runs with biased shift toward the right bank similar to the middle reaches. Elevation of the basin boundary is about 1,800 m in the left bank, while it is about 1,000 m in the right bank. The reaches show extremely asymmetric features, in which the distance from the river channel to the boundary of the left bank is 4.5 km and it is 0.5 km in the right bank. Thus large-scale tributaries have developed only in the left bank as similar to the middle reaches.

Valley bottom plain of 150 to 600 m wide has developed in the river stretch downstream of the confluence with G07. Originally the river has formed alluvial fans with gentle slope that had the fan end at vicinity of Dasht village, and had joined to the Gelman Darreh River. At present the Ghyz Ghaleh River was diverted to the Dasht-e-Sheikh River due to construction of polder diking system after the 2001 Flood.

There are some points at which the floodwater flowed over the boundary of the right bank in the past. The lower terrace with a little height from existing riverbed exists in the left bank forming board valley bottom plain at 2.5 km upstream of Dasht village. This terrace is higher than the saddle portion of the boundary in the right bank so that floodwater and sediment runoff seemed to flow over it to the Dasht-e-Sheikh River basin in the past. Over this overflow area, the gullies have been formed towards the Dasht-e-Sheikh basin. Furthermore the divide in valley has been formed in the valley bottom plain, and river capturing has started in this area between the Ghyz Ghaleh and the Dasht-e-Sheikh.

Steep slope alluvial fans were formed on valley bottom plain along the tributaries in the left bank. The fans in a stretch upstream of G03 became terrace, while the fans in the downstream area expand their end onto the valley bottom plain of the Ghyz Ghaleh River resulting in narrowing the plain. Lots of sediment yielding and transporting can be interpreted in these tributaries of the left bank.

G01 is the down-most tributaries of the left bank in the Ghyz Ghaleh River, and it formed a large alluvial fan. In the upstream area of this tributary, there are gentle slopes and flat surfaces. Meanwhile, there is a V-shaped canyon in the middle stream. Many slope failures can be identified along the steep valley wall, and they are one of sediment supply sources in this sub-basin.

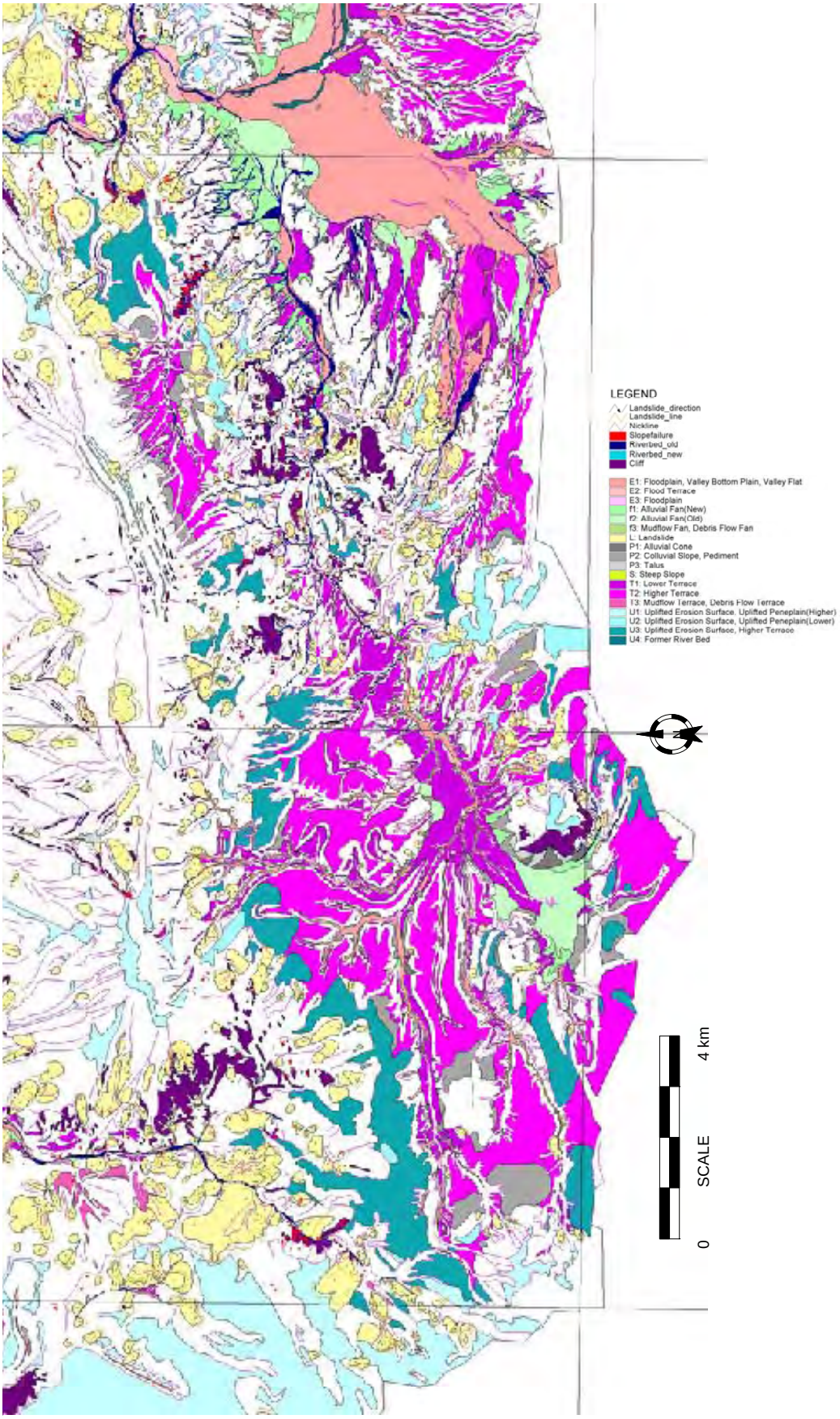

Figure 2.4 Geomorphological Land Classification in the Ghyz Ghaleh Basin

2.4 Upper Madarsoo River (Cheshmeh Khan to F101)

Headward erosion occurs 250 m upstream of the confluence with the Cheshmeh Khan River, and it forms nick point of the Madarsoo channel. Riverbed of the mainstream becomes wide from the headward erosion point towards downstream.

Basically, Middle Paleozoic Sediment in this area has the geological structures lying east and west, so that the mainstream flows westward in major part following the geological structures as a subsequent stream. Meanwhile, the mainstream sometimes flows northward crossing the geological structures as an antecedent valley.

According to geological study results, geological structures are clearly different between left and right banks. For instance, there is no fault and fold in the left bank, while there are many faults and folds in the right bank. The Madarsoo River may flow following the boundary of geological structures, mainly faults.

2.4.1 Upper Reaches (Cheshmeh Khan to F13)

This stretch is an antecedent valley that the Madarsoo runs northward. Mesozoic and Paleozoic sediment extends widely in this area, and the geological structures mainly run in the east-west direction. Landslide terrains and many slope failures well developed in sub-basins of F13, F115 and small tributaries. In addition talus slopes and alluvial fans in debris flow origin well developed in the small tributaries as well. Since most of the landslide terrains can be clearly identified, the landslide terrains may be considered new and active. Large fan formation compared with basin scale implies that large sediment yielding and supplying occurred in the past.

2.4.2 Left Bank (F13 to F101)

The geological structure of left bank is monocline that Mesozoic sediment slopes toward north, and the boundary in the east-west direction is cuesta or hogback topography. This area is composed of slope corresponding to bedding plane, back slope and tributary basins eroding the slopes, except for remnant basin along the mainstream.

In this area, there are some unclear landslide terrains, of which distribution density is lower than the right bank of Madarsoo River and their scale is not so large. This area has also slope failures that originated from exposed rock. Main tributaries form alluvial fans at the confluence with mainstream.

The Madarsoo River flows through very steep valley wall with height of 200 m to 350 m. The terrace terrains are only formed with some steps and gentle slopes between F105 and F106. They may be complex terrains being formed in combination with mainstream terraces, tributaries' alluvial fans and landslide deposits.

2.4.3 Right Bank (F03 to F12)

Geological structures of the right bank are more complex than that of left bank because of well development of faults and folds. This area has a lot of landslide terrains, since faults and folds may weaken the geological strength. Many landslide terrains are originated from rockslide and rock creep, and part of them become like talus due to progress of crushing.

This area has also much more slope failures than that in the left bank. Most of them are slope collapse of exposed rock so that sediment yielding may not be so much.

The Madarsoo River flows through less vegetation valley wall with steep slopes and about 300 m height. Upper portion of valley wall slopes have very clear continuing nick lines. Upper parts of the points are gentle slopes. These gentle slopes have many landslide terrains, but part of them may be also older flat area than higher terraces. Tributaries form waterfalls and nick points, generally so-called hanging-valley, near the confluence with the mainstream

because the mainstream down-cut deeply. Alluvial fans are formed downstream of these nick points.

Continuous terraces are formed along the F03, and terraced fan was formed at the confluence with the mainstream. Terraced gentle slopes covered with talus are found in the mountain foots upstream of F06 and F07 sub-basins. These terrains might be originated from the products of landslide in the past.

2.4.4 Main Stream

The Madarsoo River flows through canyon in both sides of steep valley wall slopes with about 300 m high from existing riverbed. Valley of mainstream is about 60 to 200 m wide. From the photographs taken before the 2001 Flood, riverbed with no vegetation was only about 20 to 50 m wide. In contrast, the riverbed extends over the valley bottom plain after the 2001 Flood. Furthermore, hard bank erosion occurs along the flood terraces and the end of alluvial fans.

2.4.5 Tributary F101

The left tributary F101 is the largest sub-basin in the Golestan Forest area. Its headwater is Dasht Shad village, and it flows toward north and joins to the Madarsoo River about 2.5 km upstream of Tangrah village. At the vicinity of Dasht Shad, lower uplifted erosion surfaces and higher terraces become the basin divide, and higher crests have already eroded resulting in being scraped away.

Valley bottom plain seldom developed along the tributaries in the left bank of the upper Madarsoo, while valley bottom plain with 100 to 200 m width developed in the middle reaches of F101. In the lower reaches, valley bottom plain expands wider up to above 500 m, and the gentle sloped alluvial fan was formed in the downstream end. In the alluvial fan, micro-topography such as former channel is found through aerial photo interpretation.

Landslide terrains developed in the upper and middle reaches, and terraced terrains can be found as well. Terraces with little height from existing riverbed are originated from floods or landslides. Parts of terraces with large height from existing riverbed seem to be originated from landslides as well.

Several large-scale slope failures can be identified at the top of small mountain streams of the left bank in the middle reaches, while exposed weathering rocks with little vegetation can be found in the right bank in the middle reaches. According to these topographic features, base rocks of this area are considered in progress of crashing.

Large-scale landslide block consisting of collapsing scar and surplus soil is found at 2.5 km north of Dasht Shad village. Downstream end of this block blocks existing riverbed, and many slope failures occur around those areas. Thus those areas can be regarded as unsteady from topographic viewpoints. They have high possibility that accumulated soil at the end of this block will be eroded and transported downstream in the flood time.

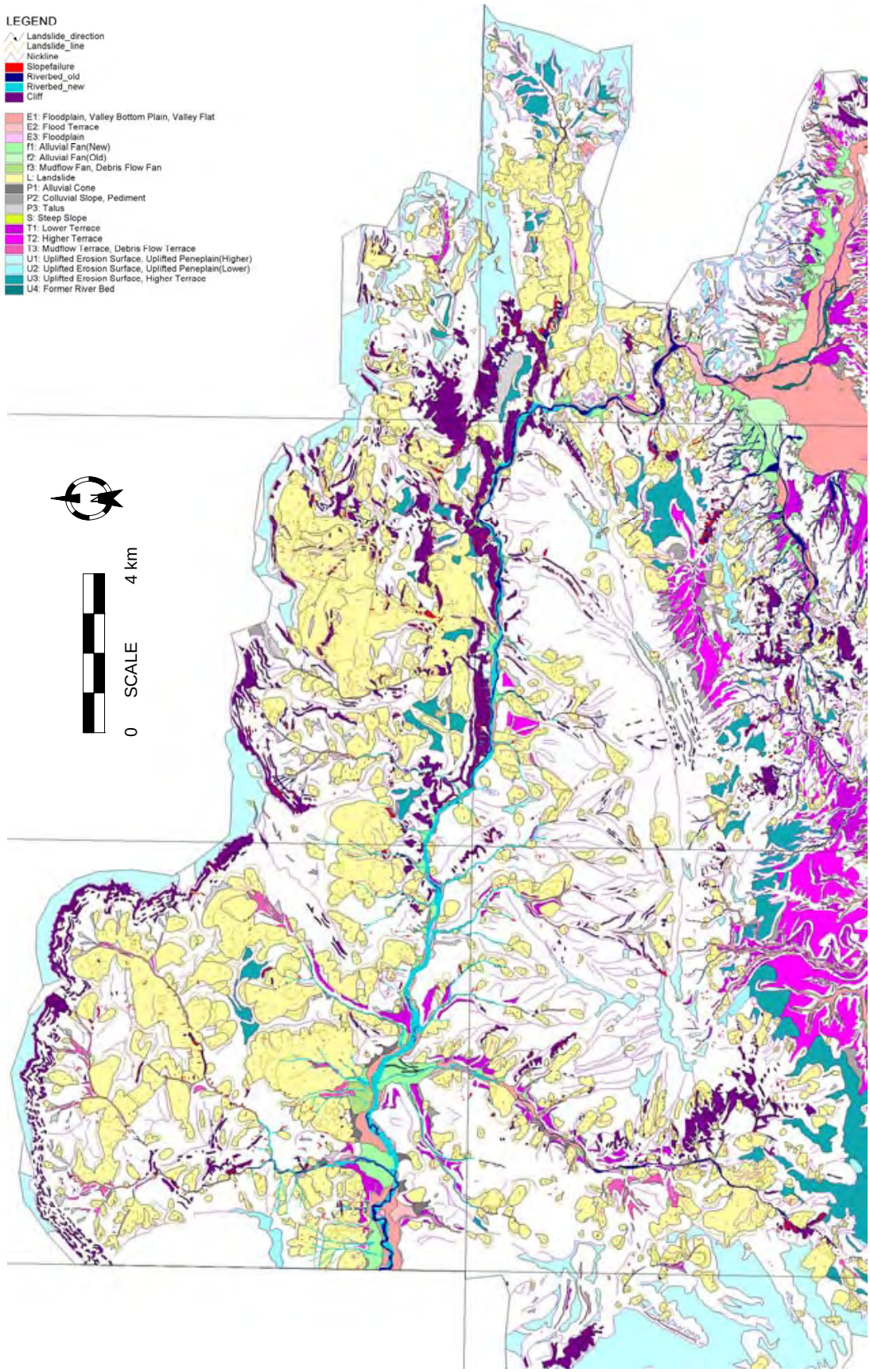

Figure 2.5 Geomorphological Land Classification in the Upper Madarsoo Basin

2.5 Vicinity of Tangrah Village

This area consists of the large tributary T01, of which valley mouth is located at Tangrah village, mainstream of the Madarsoo, and small tributaries joining to the mainstream directly.

Mainstream

The Madarsoo River forms the valley with 400 to 600 m width at the vicinity of Tangrah village downstream of the confluence with F101. Valley bottom plains as well as alluvial fans and lower terraces formed by the tributaries can be found in the valley. Valley bottom plains consist of river channel, high-water channel with thick vegetation, and general surface of valley bottom plain. Current river channel is meandering along the left bank because of development of alluvial fans formed by the right bank tributaries.

Mountain streams in the right bank form alluvial fans. The largest fan is made by F101 due to the largest catchment, but the large fans are also made by F01, T04 and T05 even though their catchments are not large. These mountain streams form compound alluvial fans, and unsteady landslide terrains may have produced much sediment in the past times. Mountain streams T04 and T05 also form large alluvial fan since unsteady landslide terrains cover over their whole basins.

T01 (tributary in the right bank)

T01 is the tributary that has the largest basin in the left bank and forms alluvial fan, on which Tangrah village is located. Continuous steep-sloped wall rocks exist in the uppermost area of this basin. There are exposed steep rocks under stepped nick lines of the wall rocks.

There are many large-scale landslide terrains in this basin. Most of the ends of landslide terrains form steep valley wall, and do not supply the soil/sediment to the riverbed at present. Slope failures with exposed rock are found mainly along the river stream. Upper reaches of the stream forms narrow gorge, and the valley becomes wider only 2 km upstream of Tangrah village. Alluvial fan extends from an apex of Tangrah village, and terraced fan can be found in its right bank.

CHAPTER 3 SEDIMENT PRODUCTION AND MOVEMENT

3.1 Upper Reaches of Dasht Basin

3.1.1 Gelman Darreh River

The condition of sediment production and movement in the Gelman Darreh River is summarized below.

Upper Part of Gelman Darreh

In a stretch of about 8 km upstream of Dasht village toward upstream, wide riverbed with no vegetation and sediment supply from upper reaches could be identified. At river bend only 1 km downstream of the above-described point, existing riverbed becomes unclear and sediment movement cannot be identified because certain flow quantity could be reduced through infiltration to groundwater or sub-surface water aquifer.

In a stretch downstream of the bend, alluvial channel runs steadily with slight meandering and little sediment runoff.

According to interview survey, the 2001 Flood flowed down over the almost entire valley bottom plain downstream of the bend, and fruit trees, which had been cultivated over the plain, were washed away. The flood brought much more serious damages of crops as well as casualties in Dasht village.

Lower Part of Gelman Darreh

A little upstream of the confluence with the Cheshmeh Khan River, shallow gully had been formed along the mainstream. However, the gully was remarkably widened and nick point at valley bottom plain receded toward the upstream. These topographic changes could be due to riverbed degradation around the confluence with the Cheshmah Khan River and channel widening by bank erosion.

(1) Right bank just upstream of the bend and (2) right bank of just downstream of the bend, and (3) left bank downstream of Dasht village can be identified as intensive sediment yielding and supplying basins in this area, based on interpretation of aerial-photo taken before the 2001 Flood. These tributaries form large alluvial fans from the mouths of gorge towards the mainstream. (1) The right bank is steep slope, which also has slope failures and landslide terrains. Additionally, there is no riverbed vegetation to the valley bottom plain so that sediment runoff actively occurs in the floods. (2) The right bank is hilly mountain formed with tertiary deposit of comparatively low concreteness. Valleys and gullies develop well so that sediment yield seems to be intensive. Riverbed with no vegetation can be found, but river channel cannot be traced to the valley bottom plain of the mainstream. (3) Tributary in the left bank forms a large alluvial fan as well. New river channel can be traced to the downstream end of fan so that it implies sediment runoff occurred recently.

3.1.2 Dasht-e-Sheikh River

Poor vegetation covers over the whole basin so that the major sediment yielding process could be gully erosion.

Sediment runoff can be traced along the riverbeds of many tributaries. Few channels, however, can be traced to the valley bottom plain of the Dasht-e-Sheikh River. Further existing riverbed of mainstream also becomes unclear 5 km upstream of Dasht village. Sediment runoff in the valley bottom plain of mainstream might contain only fine sediment in the usual flood time, but such conditions in the 2001 Flood are not confirmed.

3.1.3 Ghyz Ghaleh River

To easily understand the sediment yield and runoff situations in the Ghyz Ghaleh River, three parts, as described in 2.3, may be the best way, namely upper, middle and lower reaches.

Upper Reaches (upstream of G16)

Flat field and gentle slope extend widely, and less landslide terrain and gully developed in the upper reaches. Thus sediment yielding may not be intensive compared with those of middle and lower reaches. Alluvial scarp and talus are formed along the foot of the Monadnock mountain, and sediment yielding can be found on the steep slope rocks of the mountain. Riverbed movement can be seen in the valley eroding the Monadnock mountain, but the sediment transported does not reach to the mainstream.

Middle Reaches (G15-G07)

Numerous slope failures can be found due to weathering and deterioration of base rock caused by intensive topographic change and earth movement. In addition, numerous steep weathered wall rocks can be found, and therefore it implies intensive sediment yielding. Unconsolidated and unsteady talus terrains well developed along the foot of these slopes. Enormous sediment runoff occurs in the process of not only collapse and slope failures but also secondary erosion on the steep and unsteady talus and on the steep valley.

Riverbed with no vegetation and trace of sediment movement can be identified continuously in a stretch downstream of G15. Riverbed of each tributary can be also traced clearly to the confluence with the mainstream. Therefore this stretch is regarded as the most intensive sediment yield and runoff occurring area in the Ghyz Ghaleh River basin.

Wide and low terraces are formed in the right bank 2.5 km upstream of Dasht village, and current stream flows on slightly lower part below the terraces. This situation could imply that more intensive sediment runoff had occurred and the mainstream had flowed on the lower terraces having accumulated sediment in the certain past period. It may happen due to remarkably intensive sediment yield and runoff in the middle reaches.

Lower Reaches (downstream of G06)

According to aerial-photos taken before the 2001 Flood, the mainstream flowed over the saddle portion on the right bank 1 km upstream of Dasht village into the Dasht-e-Sheikh River basin. Alluvial fan was formed in the tributary of the Dasht-e-Sheikh River and covered slightly with sediment originated from overflow by the floodwater of the Ghyz-Ghaleh River.

The 2001 Flood flowed down into Dasht village through the alluvial fan formed by the mainstream of the Ghyz Ghaleh. Sediment deposition and bank erosion might be occurred along the mainstream, but those sediment damages in Dasht village was unclear.

Since many slope failures and landslide terrains can be interpreted in similar situations to the middle reaches, new riverbed surface can be identified along the tributaries in the left bank resulting from active sediment yield and runoff. Weathered rock and collapse can be seen in the mid-stream gorge of G01, which is large tributary in this area, and its alluvial fan had received sediment deposits before the 2001 Its sediment runoff reached to the mainstream of the Ghyz Ghaleh River.

3.2 Upper Madarsoo River (Cheshmeh Khan to F101)

Upper Reaches (Cheshmeh Khan to F13)

The Madarsoo River forms an antecedent valley running through both sides of steep slope banks toward the north. Numerous landslide terrains and slope failures can be seen in this area. The landslide terrains are clearly defined, and most of them seem to be active. The taluses with no vegetation are formed along the foot of sharp cliffs of exposed rocks. In addition, alluvial fans except for F13 are relatively large-scale compared with their

catchments. Riverbed of these tributaries was considered steady before the 2001 Flood since vegetation cover filled on the riverbed throughout the channel of the tributaries clarified by the aerial-photo interpretation. After the 2001 Flood unsteady sediment on the riverbed increased remarkably.

Regarding F13 tributary, many landslide terrains take place in the middle and downstream areas, and some of them form talus with no vegetation by active sediment yielding. Further slope collapses occur in the front faces of landslide block.

Left Bank (F13 to F101)

Landslides, slope failures and unsteady deposits such as river deposit material and talus near riverbed were rarely found before the 2001 Flood. However, intensive sediment runoff occurred in the tributaries of F102 to F107 in the 2001 Flood. River valleys cannot be interpreted from the aerial-photos taken before the 2001 Flood due to completely covering with tree crowns. In contrast, continuous riverbeds to the confluence with the mainstream can be identified from the satellite imagery taken after the 2001 Flood because riparian forests were washed away in the flood time. In particular, wide riverbed can be clearly seen in the tributaries of F102, F103 and F104, and sediment runoff were deposited on the alluvial fans at the mouths of F102 and F103. Debris flow might occur in F103 according to sediment deposits clarified through site investigation.

Occurrence points and conditions of debris flow cannot be interpreted since shooting area of satellite imagery is limited between middle and lower reaches. However, sediment runoff can be traced continuously from new slope failures to the downstream channel in the F103 basin. From this point, debris flow in this area could result from slope collapse in the floods.

Right Bank (F03 to F12)

Numerous landslide terrains exist in the right bank. Most of downstream ends of landslide terrains are composed of steep valley walls, and few of them are new active landslide areas moving recently. Most of the landslide terrains can be categorized into bedrock landslide or fracturing landslide so that no landslide terrains always produce sediment. However, many collapsed slopes can be seen along the ends of landslide in the basin of F05 and F08. There is possibility that the landslide terrains are slightly unsteady.

Most of slope failures are originated from valley bank erosion and collapse of exposed rock. In particular, collapse in wall rock does not produce much sediment.

Less unsteady deposits can be found in the valley bottoms of the tributaries as a whole. Hanging valley was formed in the down-most stretches of F06 to F12. In these stretches, little unsteady deposits exist near the waterfalls and nick points since valleys are so narrow and consist of exposed rock.

Sediment runoff can be seen in the tributaries of F03 to F07 in the 2001 Flood. According to satellite imagery taken after the flood, volume of sediment runoff from the right bank seems to be less than that of the left bank. Similar to the left bank, shooting area of the satellite imagery is limited to the middle reaches so that only F04 can be interpreted from source of sediment yielding to the confluence. Sediment runoff originated from collapse of valley-head in the basin of F04. The collapse of valley-head could be a source of debris flow in the F04.

Mainstream (Upstream of the Confluence with F06)

Valley width of mainstream ranges from 60 m to 200 m. In photos taken before the 2001 Flood, riverbed with no vegetation, of which width is several ten meters, can be interpreted to the confluence with F06, since riverbed was wider than that downstream of F06 and valley bottom plain has no or low density of large trees. In the 2001 Flood, riverbed expanded as wide as valley bottom plain, and bank erosion occurred all along the river. Riverbed shows significant degradation to the confluence with F07 during the 2001 Flood.

In this river stretch, major sediment runoff sources toward downstream might originate from bank erosion and riverbed degradation in the 2001 Flood. These sediment sources might influence downstream riverbed fluctuation during the flood. In comparison with them, sediment runoff from the tributaries might not be predominant.

Mainstream (Downstream of the Confluence with F06)

Most of riverbed before the 2001 Flood was covered with thick canopies so that it is hardly to interpret the riverbed conditions in the photos. However riverbed expanded to 150 m in maximum after the 2001 Flood through satellite imagery interpretation. Bank erosion occurred along the mainstream as well. In this stretch channel degradation and aggradation repeatedly occurred. Similar to the upstream stretch area, sediment runoff from the tributaries might not be predominant.

Tributary F101

Many landslide terrains occur in the middle and upper reaches of the F101 sub-basin, and many collapses occur around nick points in the upper reaches. From the aerial-photos taken before the 2001 Flood, riverbed with no vegetation, of which maximum width is several ten meters, can be interpreted continuously between nick points at upper reaches and middle reaches. Meanwhile, riverbed in the lower reaches cannot be interpreted since width of the riverbed becomes narrow and vegetation cover along the river course is thick.

Riverbed in the lower reaches can be identified newly through interpretation of satellite imagery taken after the 2001 Flood. Although some parts were overflowed in the valley bottom plains, floodwater mainly passed through the river channel and bank erosion slightly occurred.

3.3 Vicinity of Tangrah Village

Many landslide terrains can be found in this area. In particular, landslides with progressing fracture were predominant in the sub-basin of F01, F02, T03, T04, and T05. In addition many landslide terrains and bank erosion sites along the valley wall slopes can be also found in the sub-basin of T01. However, sediment yield from the above landforms seems not to be so large amount because most of the collapses originate from exposed rocks. On the other hand, mudflow-origin alluvial fans developed in the mouth of the sub-basin of F01 and F02. It implies the large amount of sediment was yielded in these sub-basins in the past.

According to aerial-photos taken before the 2001 Flood, riverbed with no vegetation can be seen in the lower stretch of the confluence of T01. The mainstream of the Madarsoo River with several ten meters wide flowed down meandering in the valley bottom plain before the floods. Meanwhile, the river course expands up to 100 m after the floods. Furthermore, the river stream of T01 also becomes wider after the floods. Scattering large boulders can be found, as part of discharged sediment in the floods, in valley bottom plain a few hundred meters upstream of Tangrah village.

Sediment deposits were seen in the 2001 Flood from other tributaries in the left bank, T03, T04, T05, F01, and F02. In particular, sediment deposits were scattered widely on the alluvial fan in the F02.

SUPPORTING REPORT I (MASTER PLAN)

PAPER VI

Environmental and Social Considerations

THE STUDY ON FLOOD AND DEBRIS FLOW IN THE CASPIAN COASTAL AREA FOCUSING ON THE FLOOD-HIT REGION IN GOLESTAN PROVINCE

SUPPORTING REPORT I (MASTER PLAN)

PAPER VI ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

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CHAPTER 1 GENERALITIES

The proposed disaster mitigation and management project would be implemented in the Madarsoo River basin, suiting in Golestan, Khorasan and Semnan provinces, to reduce flood/debris flow damages, prevent soil erosion/land degradation and safeguard the people lives/properties against disasters. This project is in line with laws of Socio-Economic and Cultural Development Plans of the country, as well compatible with Islam philosophy, which require the Islamic Government to protect the entire citizen against disasters and care for God-gifted natural resources.

At international level project match the sprit of Agenda 21 of Earth Summit, Rio-1992, which emphasis on care for fragile mountainous areas (watershed). Traditional works for conservation of river basins have been done for a long time in Iran with late/less response. The project aims to introduce modernized/improved structural and non-structural disaster prevention measures into the Madarsoo River basin and establish a model for being propagated in other similar basins in the country.

JICA (Japan International Cooperation Agency) study team, which has been dispatched to Iran, in response to request of Iranian Government will formulate a master plan up to the target year of 2025, select priority projects among those proposed in the master plan, and conduct feasibility study on them. Iranian side will implement the prioritized projects to accomplish the task. Ministry of Jihad-e-Agriculture (MOJA) is the project proponent, and Generate Directorate of Environment in Golestan province is competent agency collaborating with the project in environmental related matters.

CHAPTER 2 SEQUENTIAL UNDERTAKING OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

2.1 Review of Environmental Guidelines and Laws

Revised version of JICA Guidelines for Environmental and Social Considerations published in April 2004, provides the following definitions "environmental and social considerations" means considering environmental impacts on air, water, soil, ecosystem, fauna and flora as well as social impacts including involuntary resettlement and respect for human rights of indigenous people and so on. The guidelines Categorizes the projects as shown below:

Table 2.1 Project Categorization in JICA Guidelines

Category	Description
A	Projects likely to have significant adverse impacts on the environment and society. Projects in sensitive sectors with characteristics liable to cause adverse environmental impacts, as well projects located in or near sensitive areas are also fall in category A
B	Projects are classified as category B if their potential adverse impacts on the environment and society are less adverse than those of category A. Most of impacts are site-specific and reversible through normal mitigation measures
C	Projects with minimal adverse impacts on the environment and society are in category C.

For details on the JICA Environmental Guidelines (categorization, list of sensitive sectors) see Scoping for the Study attached to this Report.

Main objectives of JICA Guidelines are the followings:

(1) To encourage recipient governments to take appropriate considerations of environmental and social factors as well as to ensure that JICA's support for and examination of environmental and social consideration are conducted accordingly.

(2) To outline JICA's responsibility and procedures, and requirements for the recipient governments to facilitate achievement of the objectives.

Disclosure of information (transparency), consultation with local stakeholders, and participation of people in projects are emphasized in the guidelines. However JICA refers to international standards, treaties/declarations and good practices which Japan, international and regional organizations have, it urges the recipient government to conduct environmental assessment (evaluation) in accordance with laws, regulations and guidelines of the country.

DOE (Department of the Environment) of Iran published its revised version of Environmental Guidelines and Standards in the autumn of 2003. The guidelines provide information and guidance on conduction of environmental studies and preparation of environmental impact assessment report. According to the guidelines, 18 kinds of projects are expected to have significant adverse impacts on the environment and society, thus requiring environmental impact assessment (EIA) prior to their implementation. For long list of projects and organization chart of DOE see Scoping for the Study attached to this report.

Laws of all Five-Year Socio-economic and Cultural Development Plans of Islamic Republic of Iran address the environmental issues and emphasize wised utilization of natural resources through sustainable development.

Islamic Punishment Law (Taazirat) 2004 edition, discusses the environmental issues, and forbids the people from damaging the natural environment and destroying historical/cultural heritages, through warning and punishment.

For detail on environmental laws, regulations and standards prevailing in Iran see Scoping for the Study Annexed to this report.

2.2 Field Survey

To reveal present condition of natural, socio-economic, and cultural/historical environments of the study area, field survey was conducted with the collaboration of Jihad-e-Agriculture Organization, General Directorate of Environment, General Directorate of Cultural Heritage and Tourism Organization, and Natural Resources General Office of relevant Provinces, by using questionnaires. Draft of questionnaires was prepared by the JICA study team and finalized after consultation with counterparts in Ministry of Jihad-e-Agriculture (MOJA). To fill the questionnaires members of Rural Islamic Council, Village Chief, public servants (schoolteachers, personnel in sanitary office), farmers, and other informed sources were contacted and requested to answer the questions as precisely possible.

Since there were two questionnaires, one for Environmental and Social Considerations and another for Land use (agriculture), totally it took about four hours to complete a set of questionnaire. Some points from survey output are tabulated below and details presented in Annex of this report.

Table 2.2 Summery of Village Interview Survey on Environmental and Social Considerations

Item	Description
Total population	93,141 person
Population density	0.39 person/ha
Average household size	6.5 person
Major occupation	Agriculture, livestock breeding and laboring (mostly outside village)
Main source of income	Agriculture, livestock breeding and laboring
Major source of fuel	Gas and petrol
Major expenditure	Food/cloth, fuel/transport and education
Widely available infrastructure/institution	Piped water, electricity, telephone, school, sundry shop, mosque, cemetery, rural Islamic council and village chief
Main mass media	Radio and television
Major crop	Wheat, barley and sunflower
Major fruit	Plum, pear and olive
Major vegetable	Cucumber, tomatoes and watermelon
Main livestock	Sheep, goat and cow
Means of feeding livestock	Rangeland, farm residue and commercial materials
Major social nuisance and agricultural problem	Unemployment, lack of medical/sanitary, education, recreational and sport facilities. Threat of farmlands by flood/debris flow, water shortage for irrigation, infestation of weed/pest, lack of storage and marketing facilities. Difficulty in getting agriculture/livestock loan.

Source: JICA Study Team, Survey for Environmental and Social Considerations/Land use- October 2004～June 2005.

It should be noted that in some villages people were anxious about spread of drug, sexy video and smuggling, which threat the health and progress of society. It seems that most of people have last their confidence on authorities responsible for improvement of rural areas. Because while answering the questionnaires they mentioned that: “till now about 50 persons like you have came to village, completed their questionnaires and return to their institution, but we have not seen any action by them for removing the villager’s problems. And we do not thing that you will do any thing for us, anyhow fill up your questionnaires and go-away”.

To identify the sites with historical, cultural and religious importance, and indicate them on map of the study area, investigation was carried out with cooperation of Cultural Heritage and Tourism Organization of relevant provinces. Relevant document/materials were collected,

carefully examined, thence confirmed in the field to accomplish the task. Totally 53 of such site fall in boundary of the Madarsoo river basins, which are outlined in Scoping for the Study being provided in Annex of this report.

2.3 Preparation of Scoping for the Study

"Scoping" means deciding alternatives to be analyzed, a range of significant and likely significant impacts, and study methods.

Document of environmental Scoping for the Study was prepared based on the collected data/ information, field survey, discussing with counterparts in MOJA and consultation with relevant institutions such as DOE. Key point of the document prepared in JICA format is given below, and its text is provided in the Annex.

Conduction of Scoping revealed that the captioned project falls in category B of JICA environmental categorization, with following justification:

(1) The proposed project is of disaster mitigation and management in nature and sprit, aiming at reducing flood/debris flow damages, preventing soil erosion/land degradation, thereby enhancing the status of ecosystem. Such works are environment-friendly, widely known, easily accepted by people, and executed with small scale in a limited area. Thus inserting no significant adverse impact on the environment or society.

(2) Structural measures being established in hazardous localities are so designed to counter deterioration of physical and biological environments, and safeguard the society.

(3) However part of Golestan National Park occurs in study area, but no structural measure is recommended for this park. Instead, flood forecasting and warning systems are installed to alarm the visitors/campers about occurrence of flood on time and accelerate evacuation.

(4) Locations of historical/cultural sites existing in the area have been pinpointed, marked on the maps and provided to the study team, for being referred when selecting sites for establishment of structures. Thus no construction work is done at such sites, and no harms to those assets.

(5) According to environmental laws and regulation prevailing in Iran, only large-scale projects (corresponding to category A of JICA), require environmental impact assessment, while captioned project is of small scale and for disaster mitigation and management.

(6) The project neither plans involuntary resettlement, nor proposes any change in existing institution and customs, thus its smooth execution is expected.

(7) Disaster mitigation and management tasks have been undertaken for a long time in Iran, and are quite familiar/acceptable to inhabitants, hence no adverse social impact (conflict among communities, increase in income disparities) is expected.

(8) No peat-land, mangrove forest or coral reef occur in the project area, thus no complicated formalities or sophisticated countermeasures are required. Adverse impacts (if any) of the project can be avoided/reversed through simple and common countermeasures.

CHAPTER 3 RESULTS AND OUTPUT OF DOCUMENT REVIEW AND FIELD SURVEY

Data, information, map and materials collected through study and field survey were carefully examined, important points extracted and compiled as presented below:

3.1 Environmental Situation in Iran

3.1.1 Social, Economic and Political Situation

Administrative division and population

Covering an area of about 1.64 million km^2, Iran is located in southwestern Asia, and in heart of Middle East. Caspian sea, Turkmenistan, Azerbaijan and Armenia in north; Afghanistan and Pakistan in east; Turkey and Iraq in west surround the country. On the south Iran borders Persian Gulf and the Sea of Oman. It is divided into 30 Ostan (province), 314 Shahrestan (district), 928 Shahr (city), 842 Bakhsh (county), and 2,350 Dehestan (rural district). A governor-general, a governor and a lieutenant governor administer each province, township and district, respectively. A governor-general is appointed by, and works under guidance of the Ministry of Interior (MOI).

According to the recent estimation (2003) population of Iran is about 68.8 million, of which 45.9 million (66.8%) live in urban, and 22.8 million (33.2 %) live in rural areas. About 39% is under 15 year, and population growth rate is 1.8% (long term basis), with a decreasing trend. Life expectancy is 69 years, and population density is 42 persons/km^2. It is said that about 11 million of population live below the "absolute poverty line", and 25 % of Iranians suffer from malnutrition.

Religion and tribe

According to Article 12 of constitution of the Islamic Republic, the official religion of Iran is Islam (Shiite). Although about 99.5 % of population is Muslim, other religions such as Zoroastrian, Christian, and Judaism are also officially recognized (article 13 of constitution) and their disciples have equal political, social and economical rights as Muslims.

Though about 65% of population is Persian (Farsis), many tribes are dispersed throughout the country, such as Turkeman in Golestan and Khorasan provinces, Azaris, (Azarbayejan), Kurds (Kurdestan and Kermanshah), Baluch (Sistan and Baluchestan), Lors (Lorestan and Khuzestan), Bakhtiyari (Chaharmahal-Bakhtiyari) and Arabs in Khuzestan provinces. According to article 19 of the Constitution, all tribes have equal rights and by no means one is superior to another. Official language of Iran is Persian (Farsi) but tribes are free to use their own language beside Farsi.

According to Article 44 of Constitution, economy of Iran is composed of three sectors: State, cooperative, and private. Large industries and mines, foreign trade, large dams and water/energy supply networks are incorporated in state sector. Predominant ownership is concentrated in state and private sectors, and cooperatives own only a small portion (2.5 %) of country's economy. It should be noted that the Iran economy largely depends on oil exportation, thus fluctuation of oil price in international market seriously affects its economic performance. Gross Domestic Product (GDP) is composed of 4 major sectors: agriculture, industry and mine, services, oil and gas. Share of economic activities in GDP in the year 2000 was as follows:

Table 3.1 Share of Economic Activities in GDP, 2000

Agriculture	Mining	Manufacturing	Oil/ Gas	Water and Electricity	Construction	Trade/ Tourism	Transport/ Communication	Services
12.9%	0.6%	12.9%	22.4%	0.9%	3.5%	14.5%	6.3	26.0

Source: Statistical Yearbook of Iran- 2001.

Government of Iran is Islamic Republic, established as the result of Islamic Revolution in 1979, which ousted the king (Shah) and abolished the Monarchy system. In accordance with the Constitution of the Islamic Republic of Iran (article 62) members of the Islamic Consultative Assembly (Parliament), the President (article 114) and members of different Councils (Article 100) are directly elected by the people for a 4-year term to administer the country. The three powers in Iran are Legislative, Executive, and Judiciary that independent, but coordinated by the president and supervised by Supreme Spiritual Leader (*Valiyeh Fagih*). Supreme leader is the highest authority in the country with enormous power such as selection of commander of Armed Forces, declaration of war/peace and dismissal of president. Judiciary power is supportive of individual and social rights of people, directed by Head of Judiciary, who is selected by supreme leader for a 5-year term.

3.1.2 Natural Environment and Ecology

Iran lies in northern part of temperate zone, between latitudes 25° 03' and 39° 47' north and longitudes 44° 14' and 63° 20' east. Alborz Mountain Range in north, Zagross Mountain Range in west and some other mountain chains extending from Khorasan to Baluchestan in east, surround plateau of Iran which is mostly desert in the middle. There are many summits in Iran, of which Damavand with 5,671 m from sea level, in northeast of Tehran is the highest one. Two major deserts namely Dasht Loot and Dasht Kavir, covering an area of 360,000 km^2, occur in central part. These are among the hottest and driest places in the world. Average altitude of the country is about 1,200 m.

Topographically Iran can be roughly divided into followings:

Table 3.2 Topographic Divide in Iran

Topography Condition	Area (km^2)	% of Country Area
Land with elevation >2000 m above seas level	260,000	15.7
Land with elevation between 1000 to 2000 m	879,000	53.3
Land with elevation between 500 to 1000 m	154,000	9.3
Land with elevation between 0 to 500 m	332,000	20.1
Land below mean sea level (Caspian coastal area)	11,000	0.7
Inland lakes and water bodies	14,000	0.9
Total	1,648,000	100.0

Source: Soil Institute of Iran, 1981

Iran is in northern moderate dry region of the earth mean latitude close to the equator, and has three main climatic regions:

- Arid and semi-arid regions of interior and far south, being characterized by long, warm and dry periods, low annual precipitation (30 to 250 mm) and cover 85 % of the country.
- Mediterranean climate (Alborz, Zagros mountains), characterized by warm, dry summers and cool, damp winters, with annual precipitation between 250 to 600 mm, and covering about 5 % of the land surface.
- Humid and semi-humid regions (Caspian area), with annual precipitation of about 600 to 2000 mm, and cover 10 % of the land surface.

In Iran precipitation comes in form of rain, snow and sleet, with an annual average of 240 mm, corresponding to 392 billion cubic meters.

Iran hosts about 8,200 species of flora, of which 2,500 species are endemic. Forests in north of Iran are comprised of beech, ample, ash, walnut, and fig tree, while oak is the main tree in forests of Zagros Mountains. Desert forests are composed of small trees and shrubs, mainly of spinach family (Tagh, Shureh), being enables to grow in salty soil. Many wild medicinal plants and herbs grow all over Iran, being used domestically or exported for gaining hard currency. Among such plants, gum tragacanth, saffron, henna, indigo, borage, madder, and jasmine play significant economic role.

A vast variety of animal species have their habitat in Iran, and so far about 160 species of mammals, 164 species of reptiles, and 500 species of birds have been identified, of which some are endemic species. Most of species live in Alborz and Zagros Mountains, and on the coasts of Caspian Sea. Mammals include wild ram/goat, deer, bear, gazelles, boar and wolves. The most famous birds are partridge, pheasant, quails, vulture, golden eagle and falcon.

Rivers of Iran are of 3 categories:

- Rivers which originate in Alborz Mountains and flow into Caspian Sea,
- Rivers which originate in Zagros Mountains and flow into Persian gulf, and
- Low yielding rivers, flowing across the country and pouring into swamps and lakes.

From hydrological point of view, Iran has been divided into 6 main watersheds, receiving an annual average (for last 33 years) precipitation of 411 billion cubic meters. Characteristics of watersheds are tabulated below:

Table 3.3 Major Watersheds in Iran

Watershed	Area (1,000 km^2)	Precipitation (BCM)*
Caspian Sea	177	72.365
Persian Gulf and Oman Sea	430	166.045
Orumiyeh Lake	53	18.544
Markazi	831	143.879
Hamum	106	7.731
Sarakhs	44	10.012
Total	1,641	418.576

* Volume of precipitation (billion cubic meters) for water year 2002～2003.
Sources: Ministry of Energy, Iran Statistical Yearbook-2003.

3.1.3 Natural Rreserves

Degradation of natural environment as a consequence of human activity and overexploitation of natural resources has resulted in destruction of some of valuable flora and fauna species. To prevent further degradation of the environment some localities in the country have been declared as natural reserves by DOE. Total area of these reserves is about 11.7 million hectares, corresponding to 7.2 % of total area of the country.

Table 3.4 Type, Number and Area of Natural Reserves in Iran

Type	Number	Area (ha)	% of Reserve Area	% of Country
National Park	16	1,741,528	14.84	1.05
Wildlife Habitat	33	3,607,000	30.75	2.18
Protected Area	90	6,363,621	54.25	3.86
Natural Monument	13	16,337	0.13	0.00
Total	152	11,728,486	100.00	7.11

Source: JICA Study Team- 2005, based on documents of Department of the Environment (DOE), Iran.

There are more than 100 sizable wetlands in Iran, 21 of which are of international importance, and registered by Ramsar Convention. Moreover numerous natural attractions exist in Iran, being visited by foreign and domestic tourists and nature lovers throughout the year. Some of these attractions are listed in table below.

Table 3.5 List of Significant Natural Attractions in Iran

Name	Type	City/Area	Province
Alisadr Cave	Cave	Kabutarahang	Hamadan
Alvand Summit	Summit	Hamadan	Hamadan
Amir Kabir Dam Lake	Dam lake	Tehran	Tehran
Anzali Lagoon	Lagoon	Anzali	Gilan
Aras River	River	Maku	East Azarbayjan
Avan Lake	Lake	Qazvin	Qazvin
Caspian Sea Shore	Sea shore	Mazandaran	Mazandaran
Choqakhor Lagoon	Lagoon	Gandoman	Chaharmahal
Damavand Summit	Summit	Damavand	Tehran
Dena Mountain	Mountain	Hafshejan	Chaharmahal
Desert Attraction	Desert	Yazd	Yazd
Eil Goli Pool	Pool	Tabriz	Tabriz
Eram Garden	Garden	Shiraz	Shiraz
Gahr Lake(Gol Gahar)	Lake	Aligudarz	Lorestan
Gavkhoony Lagoons	Lagoons	Esfahan	Esfahan
Genoo Hot Spring	Hot spring	Bandar Abbas	Hormozgan
Golestan National Park	Natural park	Gorgan	Golestan
Golshan Garden	Garden	Shiraz	Shiraz
Hamoon Lake	Lake	Zabol	Sistan Baluchestan
Karkheh River	River	Shush	Khuzestan
Karoon River	River	Ahvaz	Khuzestan
Kavir National Park	Natural park	Varamin	Tehran
Kish Island	Island	Bandar Abbas	Hormozgan
Lar Protected Zone	Natural area	Damavand	Tehran
Loot Plain	Plain	Zahedan	Sistan Baluchestan
Mahan Place	Place	Kerman	Kerman
Maharloo Lake	Lake	Shiraz	Shiraz
Moorzard Zilaei Lake	Lake	Yasuj	Boyer Ahmad
Neor Lake	Lake	Ardabil	Ardabil
Orumieh Lake	Lake	Orumieh	West Azarbayjan
Oshtoran Mountain	Mountain	Aligudarz	Lorestan
Parishan Lake	Lake	Kazeron	Fars
Persian Gulf Coasts	Sea coasts	Chabahar	Sistan Baluchestan
Qeshm Island	Island	Qeshm	Sistan Baluchestan
Qoori Qaleh Cave	Cave	Paveh	Kordestan
Sabalan Mountain	Mountain	Tabriz	East Azarbayjan
Salt Lake	Lake	Qom	Qom
Sefidrud River	River	Gilan	Gilan
Tochal Run	Run	Tehran	Tehran
Valasht Lake	Lake	Chaloos	Mazandaran
Zerivar Lake	Lake	Marivan	
Zayandehrud River Banks	River Banks	Esfahan	Esfahan

Source: Iran Caravan Documents. Info*@Irancaravan.com*

3.1.4 Historical, Cultural and Religious Heritages

Plateau of Iran is among the oldest civilization centers in the history of humanity and has an important place in archeological studies. The Achaemenidae established first great Persian Empire after defeating the Medes and conquest of their capital. Achaemenian territory during

reign of Dariush I (522-485 BC) extended from plains of Sand River in east to the borders of Greece in west. Pasargadae and Persepolis are among important historical sites belonging to this period. The Sassanides, after defeating the last Parthian king in 224 AD, founded a new empire, which lasted until mid 7th century AD. Introduction of Islam in Iran began in early 7th century AD, and caused fundamental changes in social, political, religious, and governmental system of the country, which ultimately led to Islamic Revolution under leadership of Imam Khomeini in 1979 and establishment of Islamic governing system- Islamic Republic of Iran.

Table 3.6 Historiography of Iran

Era/Period	Duration	Era/Period	Duration
Achaemenian	533-330 BC	Mongol Invasion to Iran	1220 AD
Selecuidian	330-247 BC	Elkhanian	1256-1353 AD
Parthian	247 BC-224 AD	Mozaffarian	1314-1393 AD
Sassanide	224-651 AD	Teymurids	1370-1506 AD
Arab Attack	645 AD	Turkmens	1380-1468 AD
Omavian and Abbasian	749-932 AD	Safavid	1501-1732 AD
Saffarian	866-903	Afsharian	1734-1796 AD
Samanian	819-999 AD	Zandian	1750-1794 AD
Al Bouyeh	945-1055 AD	Qajar	1779-1924 AD
Qaznavian	977-1186 AD	Pahlavi	1924-1979 AD
Seljukian	1038-1194	The Islamic Revolution	1979 AD
Kharazmshahian	1077-1231 AD		

Source: Iran Caravan Documents.
Info@Irancaravan.com BC, Before Christ; AD, Anno Domini in the year of the Lord.

Cultural Heritage and Tourism Organization of Iran has registered more than 100,000 sites of historical, cultural and religious importance. Seven of these sites, are registered by UNESCO (United Nations Educational, Scientific and Cultural Organization) as "world cultural heritage" as shown below:

Table 3.7 World Cultural Heritage in Iran

Name	Type	Location	Registration Date
Chogha Zanbil	Temple	Vicinity of Such city, Khuzestan province	1979
Persepolis	Palace	Vicinity of Shiraz city, Fars province	1979
Meidan Imam	Cultural site	Inside the Esfahan city, Esfahan province	1979
Takht Soleyman	Castle	Vicinity of Takab (Chaloos) city	2003
Pasargadae	Tomb	Marvdasht	2004
Bam and its cultural landscape	Citadel, Bam old city	Bam city and its vicinity	2004

Source: UNESCO World Heritage Center, World Heritage List. http://whc.unesco.org

With expansion of Islam in Iran, tombs of the Imams (descendants of the prophet of Islam and Shiite religious leaders) were gradually changed to places of pilgrimage and shrines, some with international fame like shrine of Imam Reza in Khorasan province and shrine of Hazrat Masomeh in Qom province. Shrines of Shah Cheraq in Fars province, Hazrat Abdol Azim in Tehran province, and Mausoleum of Danial Nabi in Khuzestan province are also well known in the country and visited by millions of people throughout the years.

In addition to Muslims, there live in Iran other religious minorities such as Zoroastrian, Assyrians, Armenian, and Jews who have their own sacred religious places. Zoroastrians

usually go to Persepolis, Naghsh Rostam, Taq Bostan, and Bistoon Inscription for religious ceremonies and rituals. Old Azargoshasb fire-temple in Takht Solaiman, Kashmar Tower in Khorasan, and Orumieh Lake in Azarbayejan are also sacred sites for Zoroastrians. It should be noted that Iran is birthplace of Zoroaster, founder of Zoroastrian religion, one of the oldest religions of the world. Tatavoos and Stepanous churches in Azarbayejan province, as well as 13 churches in Jolfa area (Esfahan province) are among sacred places for Armenians. The most important place of pilgrimage for Jews is the tomb of Esteroo Mord Khay in Hamadan. Significant historical and cultural sites of Iran are listed in Table 3.8.

3.1.5 Environmental Laws, Regulations and Standards

Islamic Republic of Iran has established comprehensive environmental legislations, which are rooted in the Constitution and Islamic culture and wisdom. Article 50 of Constitution, and Articles 684 to 688, 560, 558 of the Islamic Punishment Law (*Taazirat*) provide foundation and strength to all environmental laws, regulations and standards prevailing in the country. Legislations relevant to the captioned project are tabulated below with brief content.

It should be noted that Department of the Environment (DOE) is principal organization for administrating the environmental status in Iran. DOE is attached to Office of President of the country, and president appoints its head. DOE has a General Directorate in each province, which monitors status of environment as well as implementation of environmental programs at provincial level. For details of legislations and organization chart of DOE see Scoping for the Study in Annex of this report.

Table 3.9 Environmental Laws, Regulations and Standards in Iran

Legislation	Brief Content
(1) Civil laws	
Law of nationalization of water-1968	Designation of water as a national resource
Environmental protection and enhancement law- 1974 (amended in 1992)	Protection and enhancement of ecosystem
Law on conservation and utilization of Forests and rangeland- 1975	Sustainable and wised utilization of forest and rangeland
Law of just distribution of water-1982	Definition of pollution and prohibition of water pollution
Law on prevention of water pollution-1994	Prevention of water pollution
Law of third five-year socio-economic and cultural development plan of Iran- 2000	Requirement of EIA for large production and service providing projects
Law of fourth five-year socio-economic and cultural development plan of Iran- 2004	Necessity of conducting EIA on large projects, in accordance with guidelines provided by DOE
Environmental Guidelines and Standards, published by DOE in the year 2003	Itemization of projects requiring EIA, and guidelines for conducting EIA
Regulation on limits of bed and banks of rivers, stream, wetlands, and water supply and irrigation/drainage networks- 2000	Identification and delineation of limits of river banks
Regulation concerning the requirement of environmental impact assessment (EIA) in developmental projects- 1994	Mandatory of conducting EIA for large projects
Regulation for conducting EIA-1997	Preparation of EIA in accordance with the guidelines of Department of the environment
(2) Islamic Laws	
Islamic punishment law (Taazirat)- 2005.	Punishment for causing environmental pollution, damaging public facilities (dam, canal), and destroying cultural/historical heritages.

Table 3.8 List of Significant Historical/Cultural Sites in Iran

Name	Type	Area	Province
Acropol	Castle	Shush	Khuzestan
Agabozorg	School	Kashan	Esfahan
Alamoot (Hassan Sabah)	Castle	Qazvin	Qazvin
Alavian	Dome	Hamadan	Hamadan
Ali Qapoo	Edifice	Esfahan	Esfahan
Anahita	Temple	Kangavar	Kermanshah
Attar Nayshaburi Tomb	Tomb	Nayshabour	Khorasan
Avecina Tomb	Tomb	Hamadan	Hamadan
Baba Taher Oryan	Tomb	Hamadan	Hamadan
Bam Citadel	Citadel	Bam	Kerman
Chahar Baq	School	Esfahan	Esfahan
Chak Chakoo fire	Temple	Yazd	Yazd
Chehel Sotune	Palace	Esfahan	Esfahan
Choqazanbile (Ziggurat)	Temple	Shush	Khuzestan
Citadel Gate	Gate	Semnan	Semnan
Eil Goli	Edifice	Tabriz	Tabriz
Esteroo Mord Khay	Tomb	Hamadan	Hamadan
Falacol Aflak	Castle	Khoram Abad	Lorestan
Ferdowsi tomb	Tomb	Toos	Khorasan
Ganj Ali Khan Bath	Bath	Kerman	Kerman
Ganj Nameh	Inscription	Hamadan	Hamadan
Golestan Palace	Palace	Tehran	Tehran
Gonbad Qaboos Tower	Tower	Gonbad Kavoos	Golestan
Hafez Tomp	Tomb	Shiraz	Shiraz
Hasht Behesht	Palace	Esfahan	Esfahan
Hegmataneh Hills	Hills	Hamadan	Hamadan
Kalat Nadery	Complex	Kalat	Khorasan
Karim Khani Citadel	Citadel	Shiraz	Shiraz
Khajeh Rabi Tomb	Tomb	Mashad	Khorasan
Khajoo Bridge	Bridge	Esfahan	Esfahan
Kharaqan Tower	Tower	Qazvin	Qazvin
Khayam Nayshaburi Tomb	Tomb	Nayshabor	Khorasan
Khorshid Palace	Palace	Toos	Khorasan
Koorush Shrine	Shrine	Marvdasht	Fars
Menar Jonban	Minaret	Esfahan	Esfahan
Naqsh Rajab Inscription	Inscription	Marvdasht	Fars
Narenj Castle	Castle	Maybod	Yazd
Pasargade	Edifice	Marvdasht	Fars
Perspolis	Edifice	Marvdasht	Fars
Sadi Tomb	Tomb	Shiraz	Shiraz
Shapour Palace	Palace	Shush	Khuzestan
Sialk Hills	Hills	Kashan	Esfahan
Sio Seh Pol	Bridge	Esfahan	Esfahan
Taq Bostan Inscription	Inscription	Kermanshah	Kermanshah
Tamishan Palace	Palace	Noor	Mazandaran
Teimareh Epigraph	Epigraph	Khomein	Markazi
Toqrol Tower	Tower	Ray	Tehran

Source: Iran Caravan Documents. Info@Irancaravan.com

3.2 Environmental Situation in Golestan Province

Golestan province lies between longitudes 53° 57' and 56° 22' east, and latitudes 36° 30' and 38° 08' north, in northern part of Iran. Turkmenistan in the north, Semnan province in south, Khorasan province in east, and Caspian Sea and Mazandaran province in west surround

this province. Golestan is divided into 11 Shahrestan (district), 23 Shahr (city), 21 Bakhsh (county), and 50 Dehestan (rural district) and 1,064 Rusta (village). Total area of the province is 20,438 km^2, with a population density of 81 persons/km^2. Golestan is one of important and strategic provinces having marine and overland connecting routes to Central Asia.

Golestan province has two distinguished features: mountainous and plains with slope reducing from heights to plains towards Caspian Sea. The most important mountain is Abar Kuh, with Shavar peak of 3,945 m in elevation.

According to the recent estimation (2005) by Management and Planning Organization of Golestan Province, population of Golestan is about 1.7 million, of which 0.8 million (46.8 %) live in urban, and 0.9 million (53.2 %) live in rural areas. About 30.4 % of total population is under 15 year, and 6.1 % is over 60 year. Life expectancy is 66.9 years, and average annual population growth rate (on long term basis) is 1.72 % (urban area 2.30 %, rural area 1.14 %).

Parts of project area occur in Kalaleh and Minu Dasht districts, which their population status is tabulated below:

Table 3.10 Population of Kalaleh and Minu Dasht Districts

District	Total population	Urban population	Rural Population
Kalaleh	163,579 (100 %)	40,370 (24.7 %)	123,209 (75.3 %)
Minu Dasht	157,270 (100 %)	53,193 (33.8 %)	104,077 (66.2 %)

In Golestan literacy rate of population more 15 years is 85.0 % for male and 70.8 % for female. Most of population is Farsis (Persian), but other communities such as Turkeman, Baluch, and Armenians also live in this province, preserving their traditions and rituals.

In 2003, employment and unemployment rates were 86.3 % and 13.7 %, respectively, and distribution of employed population in major economic activities was as below:

- Agriculture : 34.3 %
- Industry : 24.8 %
- Services : 40.9 %

Agriculture is an important sector in Golestan, and more than 92 kinds of field and orchard crops are produced here, of which cotton, oilseeds, wheat, rice, potato, tobacco, and barley can be mentioned. Livestock raising and fishery are also widely practiced and contribute to economy of the province.

Area of rangeland is 1,126,000 ha, and area of forest is 430,000 ha. Total area for farmland and orchard is 580,000 ha. Annual rainfall varies from 200 to 700 mm, in accordance with topography and localities.

Golestan National Park, the first Iranian national park registered by UNESCO, and some other natural reserves occur in this province, which their status is given table below:

Table 3.11 Type, Number and Area of Natural Reserves in Golestan Province

Type	Number	Area (ha)	% of Reserve Area	% of Province
National Park	1	88,576	61.1	4.3
Wildlife Habitat	3	56,318	38.9	2.7
Protected Area	0	0	0	0
Natural Monument	0	0	0	0
Total	4	144,894	100.0	7.0

Source: JICA Study Team- 2005, based on documents of Department of the Environment (DOE), Iran.

History of human settlements in territory of Gorgan dates to a millennium BC (before Christ). Evidences of the ancient city of Jorjan are near the current city of Goragn. This was one of the important cities on Iran located on Silk Road, which was destroyed by Mongols attack.

3.3 Environmental Situation in Semnan Province

The province Semnan covers an area of 95,815 km^2, to the east of which is Khorasan province, to the north are provinces of Golestan and Mazandaran, to the west stand the provinces of Tehran and Qom, and to its south are Esfahan and Yazd provinces. This province is located in southern part of Alborz Mountains and has two distinguish regions: mountainous, and plains which ends in desert of Kavir Namak in central part of Iran. Climate of mountainous region is cold/temperate, while that of plain region is warm. The province is attractive area from aspect of natural beauty, since it possess rivers, springs, forests, mountains with high peaks and large caves. To conserve natural of the province, some localities have designated as natural reserves as shown in table below:

Table 3.12 Type, Number and Area of Natural Reserves in Semnan Province

Type	Number	Area (ha)	% of Reserve Area	% of Province
National Park	2	674,017	28.5	7.03
Wildlife Habitat	2	506,111	21.4	5.28
Protected Area	3	1,183,418	50.1	12.35
Natural Monument	0	0	0	0
Total	7	2,363,546	100.0	24.67

Source: JICA Study Team- 2005, based on documents of Department of the Environment (DOE), Iran.

According to recent estimation (2003), population of Semnan province is 568,310, of which 421,486 (74 %) live in urban area and 146,824 (26 %) live in rural area. Population density in the province is 5.9 persons/km^2. The province is comprised of 4 districts, namely Semnan, Shahrud, Garmsar and Damghan. Part of the study area occurs in Shahrud district. Population of Shahrud district is 229,816 inhabitants, of which 150,346 (65.5%) live in urban area, and 79,469 (34.5%) live in rural area. Population density in Shahrud district is 4.5 persons/km^2. Northern sector of Shahrud has cold climate, while its central and southern sectors are temperate and warm respectively. Highest elevation in Shahrud district is about 1,970 m above sea level.

Literacy rate in Semnan province is very high (87.7 %), and large number female inhabitants attend higher education. In 2003, total number of students enrolled in higher education was 20,985, of which 9,633 (46 %) were male and 11,352 (54 %) were female. (Excluding figures for Azad University, which is a private educational network).

The territory of Semnan province is an ancient area dating back to the time of Avesta. During Medes and Achaemenia periods this area was one of the largest provinces of the Parthians, as well it held its importance in Sassanide period and the Islamic era. Silk Road paved its way from midst of this territory. Semnan province now is rich in historical relics such as palaces, castles, and ancient inns/Caravansaries, of which palaces of Agha Mohammad Shah and fathali Shah in Damghan district, and castles of Saroo, Kushmoghan and Pachenar in Semnan district could be mentioned. Among the religious site, Soltani mosque, Jaame mosque, and Tarikhaneh mosque are important ones.

3.4 Environmental Situation in Khorasan Province

Khorasan province with a total area of 247,618.3 km^2 is divided into 25 Shahrestan (district), 85 Shahr (city), 88 Bakhsh (county), and 318 Dehestan (rural district). Total population is 6,571,466 inhabitants, of which 3,958,328 (60 %) are in urban area and 2,613,138 (40 %) in rural area. Population density in the province is 26.5 persons/km^2. Part of the study area is in Jajarm district. Mashhad, the capital of Khorasan, is the country's second largest city, and the

third most favorite tourist spot in Iran after Isfahan and Shiraz, and is known as a center of Shiite pilgrims from all over the world, due to presence of the Shrine of Imam Reza. Imam refers to descendants of the prophet of Islam and religious leaders. Imam Reza is the 8th Imam of Shiite, and the only Imam buried in Iran.

In 2003 total number of students enrolled in primary, secondary and high schools was 1,749,946, of which 908,385 (52 %) was male and 841561 (48 %) was female. In same year total number of students enrolled in university was 67,231, of which 29,016 (43 %) were male, and 38,215 (57 %) was female, indicating high desire of female for education/social activities.

Aggregates of tombs or mausoleums consist of construction of buildings, which are regarded as pilgrimage sites or tombs of prominent or religious personalities and the resting abode of persons of reputes. Many of such establishments exist in Khorasan province, adding to its historical/cultural value, of which mausoleums of Imamzadeh Tabas, Sheikh Abu Nasr Iravehei, Sheikh Rashidudin Mohammad, Imamzadeh Shahzadeh Zeid, and Imamzadeh Shahzadeh Jaffar, Sheikh Bahei and Sheikh Ameli's tombs can be mentioned. Gowharshad Mosque, one of the most famous buildings from the 7th century, stands near Iman Reza shrine.

To conserve natural beauty and wildlife of Khorasan, parts of high natural importance/value have been designated as natural reserves by DOE. These sites also contribute in research and preservation of genetics resources as well play an important role in production of medicinal plant and progress of pharmaceutical industry (table below).

Table 3.13 Type, Number and Area of Natural Reserves in Khorasan Province

Type	Number	Area (ha)	% of Reserve Area	% of Province
National Park	3	50,717	11.0	0.20
Wildlife Habitat	3	150,356	32.5	0.61
Protected Area	7	261,833	56.6	1.06
Natural Monument	0	0	0	0
Total	13	462,906	100.0	1.87

Source: JICA Study Team- 2005, based on documents of Department of the Environment (DOE), Iran.

It should be noted that in 2004 Khorasan has been divided into three separate provinces: namely Northern Khorasan, Southern Khorasan and Razavi Khorasan. But map and statistics for separated provinces are not available yet, therefore data/information for entire (single) former Khorasan province have been considered and used in this report.

3.5 Environmental and Social Considerations in the Study Area

The study area covers entire watershed of the Madarsoo River, one of tributaries of Gorgan River emptying into the Caspian Sea. Part of Golestan National Park occurs in this watershed. Madarsoo river originates in mountain range (vicinity of Nardein village) in Semnan province, passes through Dasht village in Khorasan province, then enters into Golestan province via Golestan National Park, joins to Gorgan river in vicinity of Garkaz village, thereafter empties into Caspian sea. The river is 142 km in length, having an average slope of 1.4 %, and a catchments area of 236,400 ha, which has been divided into 8 sub-basins as shown in Table 3.14.

Total present population (2005) in study area is 93,141 inhabitants, with a population density of 0.39 persons/ha, and average family size of 6.5 persons, as attained by JICA study team through filed survey and data collection activities. Breakdown figures for population are shown in Table 3.15. While details on living condition and availability of infrastructures in the basin are provided in Tables 3.16 and 3.17, respectively.

Table 3.14 Sub-basin Divide of the Madarsoo River Basin

Sub-basin Code	Sub-basin Name	Sub-basin Area (ha)	Relevant Provinces
①	Gelman Darreh	78,700	Semnan-Khorasan
②	Cheshmeh Khan	45,200	Khorasan
③	Dasht-e-Sheikh	12,500	Khorasan-Semnan
④	Ghiz Ghaleh	12,600	Semnan-Khorasan
⑤	Upper Madarsoo	36,200	Golestan
⑥	Middle Madarsoo	28,100	Golestan
⑦	Agh Soo	13,600	Golestan
⑧	Lower Madarsoo	9,500	Golestan
Total		236,400	

Source: JICA Study Team- 2005.

Table 3.15 Village Population in the Madarsoo River Basin in 2005

Village/City	Population	Village/City	Population
Dasht	1,600	Ajan Shir Meli	342
Terjenly	1,220	Ajen Gareh	1,117
Kose	1,450	Amam Jafar	1,357
Dar Abad	900	Baghcheh	1,620
Gharavol	1,500	Chahar Mozy	226
Pasang Bala	2,100	Cheshmeh Nai	360
Robat Gharabil	1,000	Garkaz	1,198
Agh Ghamish	1,050	Ghaleh Barbar	888
Sadegh Abad	2,000	Gheregh Ghiz	188
Nardein	3,100	Gink Lig	1,446
Banial	1,300	Kalaleh City	31,471
Ghojmarz	1,950	Kamardar	210
Bolok Ajen	440	Kangor	1,614
Kamal Abad	1,100	Khajeh Lor	907
Kazem Khojeh	1,700	Kondoskuh	302
Turang Tappeh	550	Korang	1,320
Ajan Yeli	800	Manjelo	259
Besh Oily	600	Mirzabaylo	6
Google Bozorg	180	Sefid Dali	50
Ghanjigh	1,550	Sheikh Lar	308
Hosein Abad Ghorbani	500	Sodaghlan	1,066
Tarajigh	1,800	Tangeh Gol	4
Sad	1,200	Chaghar Besh Ghardash	1,400
Pasang Pain	220	Gheregh	530
Heydar Abad Polad	2,000	Gilanshah	400
Chaghar Shirmely	750	Yekeh Ghoz Bala	1,300
Ghangigh Shahrak	1,650	Yekeh Ghoz Payeen	600
Achar	750	Bidak	485
Espakhoo	450	Cheshmeh Khan	900
Gonily	220	Armanloo	450
Haghol Khajeh	700	Loveh	615
Korang Kaftar	1,000	Tangrah	1150
Barani	300	Dast-e-Shah	1422

Source: JICA Study Team- 2005.

Village Situation					Household No.	Household Size (person)			Population Composition					Able to Read and Write		Work Situation		Migrated for Job		Annual Income and Expenditure of an Household (Million Rials, and %)							Source of Fuel	
Code	Name	Oldness (years)	District	Province	Total	Smallest	Largest	Average	Total	Male	Female		Child<9 year	Male	Female	Main Job	Jobless Person	Person	Main Destination	Income	Income Source	Expenditure	For Food/Cloth	Fuel/Transport	Education	Others	Gas/Petrol	Wood
K01	Dasht	150	Jajarm	Nk	330	4	11	6	1,600	1,000	600	1,600	150	650	210	Ag	300	180	Jajarm	13	Ag	8	55%	25%	10%	10%	100%	0%
G02	Terjenly	100	Minu Dasht	Go	325	3	15	7	1,220	580	640	1,220	200	250	100	Ag	120	55	Tehran	12	Ag	11	55%	25%	10%	10%	70%	30%
G03	Kose	150	Kalaleh	Go	180	2	15	7	1,450	700	750	1,450	250	600	400	Ag	200	35	Tehran	17	Ag	15	50%	15%	25%	10%	100%	0%
G04	Dar Abad	250	Minu Dasht	Go	200	2	10	6	900	400	500	900	80	250	200	Ag	70	25	Gorgan	18	Ag	15	50%	20%	20%	10%	50%	50%
G05	Gharavol	100	Kalaleh	Go	150	2	10	7	1,500	700	800	1,500	210	450	200	Ag	150	30	Tehran	16	Ag	15	50%	25%	20%	5%	80%	20%
G06	Pasang Bala	250	Minu Dasht	Go	420	2	12	7	2,100	1,000	1,100	2,100	300	600	450	Ag	270	80	Tehran	17	Ag	15	50%	20%	20%	10%	60%	40%
K07	Robat Gharabil	400	Jajarm	Nk	220	3	10	7	1,000	450	550	1,000	210	300	250	La	50	15	Bojnurd	14	La	12	55%	25%	15%	5%	80%	20%
G08	Agh Ghamish	100	Kalaleh	Go	180	2	12	7	1,050	500	550	1,050	200	350	200	Ag	55	30	Tehran	15	Ag	14	50%	20%	20%	10%	90%	10%
G09	Sadegh Abad	100	Kalaleh	Go	350	2	12	6	2,000	900	1,100	2,000	400	600	350	Ag	250	75	Semnan	15	Ag	14	60%	10%	20%	10%	90%	10%
S10	Nardein	110	Shahrud	Se	800	2	13	6	3,100	1,450	1,650	3,100	600	900	700	Ag	390	135	Mayamey	24	Ag	20	50%	15%	25%	10%	100%	0%
G11	Banial	400	Kalaleh	Go	350	2	12	8	1,300	600	700	1,300	330	450	350	Ag	170	20	Semnan	18	Ag	17	60%	10%	20%	10%	90%	10%
K12	Ghojmarz	200	Kalaleh	Go	285	2	12	7	1,950	950	1,000	1,950	250	450	300	Ag	190	55	Semnan	17	Ag	15	60%	15%	15%	10%	100%	0%
G13	Bolok Ajen	60	Kalaleh	Go	90	2	12	6	440	210	230	440	70	90	50	Li	25	10	Semnan	22	Ag	20	50%	20%	20%	10%	90%	10%
G14	Kamal Abad	60	Minu Dasht	Go	210	2	14	7	1,100	500	600	1,100	210	300	250	Ag	80	35	Damghan	16	Ag	14	60%	15%	20%	5%	60%	40%
G15	Kazem Khojeh	100	Kalaleh	Go	310	2	12	7	1,700	800	900	1,700	300	350	200	Li	135	40	Semnan	22	Ag	16	50%	20%	20%	10%	50%	50%
G16	Turang Tappeh	60	Minu Dasht	Go	135	2	12	7	550	250	300	550	80	150	100	Ag	30	5	Zahedan	18	Ag	15	60%	15%	20%	5%	100%	0%
G17	Ajan Yeli	80	Kalaleh	Go	150	4	16	7	800	370	430	800	110	170	120	Li	40	15	Tehran	15	Li	14	55%	20%	20%	5%	95%	5%
G18	Besh Oily	3	Minu Dasht	Go	132	2	15	8	600	250	350	600	100	180	150	Ag	25	10	Kalaleh	15	Ag	14	60%	20%	10%	10%	100%	0%
G19	Google Bozorg	80	Minu Dasht	Go	30	2	14	7	180	85	95	180	30	50	30	Li	15	5	Tehran	10	Li	10	50%	25%	20%	5%	90%	10%
G20	Ghanjigh	100	Minu Dasht	Go	210	2	12	7	1,550	750	800	1,550	200	300	200	Ag	210	45	Tehran	17	Ag	15	50%	20%	20%	10%	100%	0%
G21	Hosein Abad Ghorbani	200	Minu Dasht	Go	60	2	10	7	500	220	280	500	120	150	100	Li	35	10	Shahrud	17	Li	16	50%	20%	20%	10%	100%	0%
G22	Tarajigh	350	Minu Dasht	Go	180	2	10	7	1,800	850	950	1,800	270	600	500	Ag	180	35	Semnan	15	Ag	14	50%	20%	20%	5%	95%	5%
G23	Sad	50	Kalaleh	Go	220	3	10	7	1,200	550	650	1,200	250	600	500	Li	80	20	Bushehr	22	Li	17	55%	15%	20%	10%	100%	0%
G24	Pasang Pain	50	Minu Dasht	Go	42	2	10	7	220	100	120	220	40	40	20	Ag	15	10	Semnan	17	Ag	16	50%	20%	20%	10%	70%	30%
G25	Heydar Abad Polad	200	Kalaleh	Go	330	2	11	7	2,000	950	1,050	2,000	380	600	400	Ag	290	35	Shahrud	17	Ag	15	50%	20%	20%	10%	100%	0%
G26	Chaghar Shirmely	200	Kalaleh	Go	157	2	15	9	750	350	400	750	120	80	20	Li	40	15	Gonbad	16	Ag	15	50%	20%	20%	10%	70%	30%
G27	Ghangigh Shahrak	80	Kalaleh	Go	300	2	12	7	1,380	800	580	1,380	250	500	400	Li	145	50	Tehran	20	Ag	17	50%	20%	20%	10%	50%	50%
G28	Achar	50	Kalaleh	Go	140	2	13	7	750	350	400	750	150	200	100	Li	40	15	Tehran	19	Li	17	50%	25%	20%	5%	100%	0%
K29	Espakhoo	250	Jajarm	Nk	100	3	9	6	450	200	250	450	110	110	80	Ag	25	10	Jajarm	20	Ag	15	50%	20%	20%	10%	20%	80%
G30	Gonily	250	Kalaleh	Go	35	2	11	7	220	100	120	220	40	50	40	Ag	20	5	Kalaleh	20	Ag	17	50%	20%	20%	10%	20%	80%
S31	Haghol Khajeh	150	Shahrud	Se	130	2	10	6	700	320	380	700	150	200	150	Ag	45	10	Mayamey	13	Ag	12	50%	25%	20%	5%	100%	0%
G32	Korang Kaftar	200	Minu Dasht	Go	190	2	10	6	1,000	450	550	1,000	200	250	150	Ag	60	10	Tehran	18	Ag	15	50%	20%	20%	10%	80%	20%
G33	Barani	50	Kalaleh	Go	70	2	10	7	300	140	160	300	50	90	50	Ag	30	5	Tehran	18	Ag	17	50%	25%	20%	5%	100%	0%
G34	Chaghar Besh Ghardash	200	Minu Dasht	Go	300	2	13	7	1,400	650	750	1,400	200	300	200	Ag	190	35	Semnan	17	Ag	15	50%	20%	20%	10%	60%	40%
G35	Gheregh	27	Minu Dasht	Go	75	2	10	6	530	240	290	530	100	150	80	Ag	40	15	Semnan	15	Ag	14	50%	20%	20%	10%	80%	20%
G36	Gilanshah	13	Minu Dasht	Go	75	2	10	6	400	180	220	400	100	100	100	Ag	30	10	Tehran	15	Ag	14	55%	25%	15%	5%	100%	0%
G37	Yekeh Ghoz Bala	100	Kalaleh	Go	250	2	11	7	1,300	600	700	1,300	250	400	250	Ag	135	30	Tehran	20	Ag	18	50%	20%	20%	10%	50%	50%
G38	Yekeh Ghoz Payeen	50	Kalaleh	Go	110	2	12	8	600	270	330	600	100	150	100	Ag	30	5	Tehran	18	Ag	16	50%	20%	25%	5%	40%	60%
K39	Bidak	100	Jajarm	Nk	110	2	16	6	485	265	220	485	97	185	66	Ag	60	15	Garmsar	3	Ag	2	50%	35%	15%	0%	50%	50%
K40	Cheshmeh Khan	50	Jajarm	Nk	165	3	15	6	900	450	450	900	150	292	157	Ag	45	15	Garmsar	12	Ag	10	55%	20%	15%	10%	90%	10%
K41	Armanloo	200	Jajarm	Nk	85	2	11	6	450	200	250	450	50	140	75	Ag	25	10	Garmsar	6	Ag	5	50%	30%	10%	10%	100%	0%
G42	Loveh	70	Minu Dasht	Go	139	3	9	4	615	350	265	615	120	195	180	Li	55	10	Tehran	3	La	2	50%	30%	15%	5%	80%	20%
G43	Tangrah	72	Minu Dasht	Go	350	3	11	5	1150	580	570	1,150	150	522	399	Ag	70	40	Tehran	8	Ag	7	60%	15%	15%	10%	90%	10%
S44	Dasht-e-Shad	60	Shahrud	Se	293	4	11	6	1422	738	684	1,422	427	682	637	Ag	290	40	Shahrud	8	Ag	7	50%	30%	15%	5%	80%	20%

Sources: JICA Study Team, Survey for Environmental and Social Consideration- October 2004 - September 2005.
Nk, North Khorasan; Go, Golestan; Se, Semnan.
Ag, Agriculture; Li, Livestock; La, Laboring.

Table 3.16 Status of Inhabitants of Villages in the Madarsoo River Basin

Village		Basic Human Needs									School/Special Class						Cultural/Religious				Health/Sanitary					Shop/Bank					Other Public Facilities					Institutions			
Code	Name	Piped Water	Electricity	Telephone	Piped Gas	Capsule Gas	Post Office	Post Box	Telephone Office	Common Bath	Pre-school	Primary	Secondary	High School	Night/Adult	Quranic/Religious	Library	Mosque	Mausoleum	Cemetery	Medical Clinic	Physician (Doctor)	Sanitary Office	Sewerage System	Waste Collection	Sundry	Cooperative	Fuel Station	Vehicle Repair	Bank/Islamic Fund	Recreational	Sporting	Gathering Hall	Public Transport	Asphalt Road	Security Forces	Voluntary Unit	Village Council	Village Chief
K01	Dasht	E	E	E	E	E	N	N	E	E	E	E	E	E	E(O)	E(O)	N	E	N	E	N	N	E	E	E	E	E	E	N	N	E	E	N	E	E	N	E	E	E
G02	Terjenly	E	E	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	E	N	E	E	N	E	E	E	E	E	E
G03	Kose	E	E	E	E	E	N	N	E	N	N	E	E	N	N	E(O)	N	E	E	E	N	E	E	N	N	E	E	N	E	N	N	E	N	E	E	N	E	E	E
G04	Dar Abad	E	E	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	N	E	N	N	N	E	N	N	E	N	E	E	E
G05	Gharavol	E	E	E	N	E	N	N	E	E	N	E	E	N	N	E(O)	N	E	N	E	N	E	E	N	N	E	N	E	N	N	N	E	N	E	E	N	E	E	E
G06	Pasang Bala	E	E	E	N	E	N	E	E	E	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	E	E	N	N	N	E	N	E	E	N	E	E	E
K07	Robat Gharabil	E	E	E	N	E	N	E	E	E	N	E	E	N	N	E(O)	N	E	N	E	N	E	E	N	N	E	NE	E	E	N	E	E	N	E	E	N	E	E	E
G08	Agh Ghamish	E	E	E	N	E	N	E	E	E	N	E	E	E(B)	E(O)	E(O)	N	E	N	E	E	E	E	N	N	E	E	E	E	N	E	E	N	E	E	N	E	E	E
G09	Sadegh Abad	E	E	E	N	E	N	E	E	N	N	E	E	E	E(O)	E(O)	N	E	E	E	N	E	E	N	N	E	E	E	E	N	E	E	N	E	E	N	E	E	E
S10	Nardein	E	E	E	N	E	E	E	E	E	N	E	E	E	E(O)	N	N	E	N	E	E	E	E	N	N	E	E	E	E	N	N	E	N	E	E	N	E	E	E
G11	Banial	E	E	E	N	E	N	E	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	E	E	N	N	N	N	N	N	N	N	E	E	E
K12	Ghojmarz	E	E	E	N	N	N	E	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G13	Bolok Ajen	E	E	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	E	E	N	N	E	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G14	Kamal Abad	E	E	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G15	Kazem Khojeh	E	E	N	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	E	N	E	E	N	N	N	E	E	N	E	E	E
G16	Turang Tappeh	E	E	N	N	E	N	E	E	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	N	N	N	N	N	E	E	E
G17	Ajan Yeli	E	E	E	N	E	N	E	E	N	N	E	N	N	N	E(O)	N	E	N	E	N	N	N	N	N	E	N	N	N	N	E	N	N	E	E	N	N	E	E
G18	Besh Oily	E	E	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	E	E	E	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G19	Google Bozorg	E	E	E	N	E	N	N	E	N	N	N	N	N	N	N	N	E	N	E	N	N	N	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G20	Ghanjigh	E	E	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	E	E
G21	Hosein Abad Ghorbani	E	E	E	N	E	N	E	E	N	N	E	N	N	N	N	N	E	N	E	N	N	N	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G22	Tarajigh	E	E	E	N	E	N	N	E	E	N	E	E	N	N	E(O)	N	E	E	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	E	N	E	E	E
G23	Sad	E	E	E	N	E	N	E	E	N	N	E	E	N	N	E(O)	N	E	N	E	N	N	E	N	N	E	E	E	N	N	N	E	N	E	E	N	E	E	E
G24	Pasang Pain	E	E	N	N	E	N	E	E	N	N	E	N	N	N	N	N	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	N	E	E	N	N	E	E
G25	Heydar Abad Polad	E	E	E	N	E	N	E	E	N	N	E	E	N	N	E(O)	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	E	N	E	E	E
G26	Chaghar Shirmely	E	E	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	N	E	E	N	E	E	E
G27	Ghangigh	E	E	E	N	E	N	N	E	N	N	E	E	E	N	E(O)	N	E	N	E	N	N	E	N	N	E	N	E	N	N	N	E	N	E	E	N	E	E	E
G28	Achar	E	E	E	N	E	N	E	E	E	N	E	E	E	N	E(O)	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	E	N	E	E	E
K29	Espakhoo	N	E	N	N	E	N	N	E	E	N	E	E	N	N	N	N	E	N	E	N	N	N	N	N	E	N	N	N	N	N	N	N	N	N	N	N	E	E
G30	Gonily	E	E	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	N	N	N	E	E	E	N	N	N	N	N	E	N	N	N	N	N	E	E
S31	Haghol Khajeh	E	E	N	N	E	N	N	E	E	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	N	N	E	E	N	N	E	E
G32	Korang Kaftar	E	E	E	N	E	N	N	N	E	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	E	N	E	E	E
G33	Barani	E	E	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	E	E	E	N	N	N	N	N	N	N	N	N	E	E	E
G34	Chaghar Besh Ghardash	E	E	E	N	E	N	N	N	N	N	E	E	N	N	E(O)	N	E	E	E	N	N	E	N	N	E	E	E	N	N	N	E	N	E	E	N	E	E	E
G35	Gheregh	E	E	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	N	N	E	E	N	E	E	E
G36	Gilanshah	E	E	N	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	E	N	N	N	N	N	N	N	N	N	N	E	E
G37	Yekeh Ghoz Bala	E	E	E	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	E	E	N	N	E	N	N	N	N	N	E	N	E	N	N	E	E	E
G38	Yekeh Ghoz Payeen	E	E	E	N	E	N	N	N	N	N	E	N	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	N	E	N	N	N	N	E	E	E
K39	Bidak	E	E	N	N	E	N	N	N	N	N	E	E	N	N	N	N	E	E	E	N	N	N	E	N	E	N	E	N	N	E	N	N	N	N	N	N	E	E
K40	Cheshmeh Khan	E	E	N	E	E	N	N	E	E	N	E	E	N	N	E(O)	N	E	N	E	N	E	E	E	N	E	N	N	E	N	E	N	N	E	E	N	E	E	E
K41	Armanloo	N	E	N	N	E	N	N	E	N	N	E	E	N	N	N	N	E	N	E	N	N	E	N	N	E	N	N	N	N	E	N	N	N	E	N	N	E	E
G42	Loveh	E	E	E	N	N	N	N	E	N	N	E	N	N	N	N	E	E	N	E	E	N	E	N	N	E	N	N	N	N	E	E	N	E	E	N	E	E	E
G43	Tangrah	E	E	E	N	E	E	E	E	N	N	E	N	E(G)	N	E(O)	N	E	N	E	E	E	E	E	N	E	N	N	E	N	E	E	N	E	E	E	E	E	E
S44	Dasht-e-Shad	E	E	E	E	E	N	N	E	N	N	E	E	N	N	N	E	E	E	E	E	E	E	E	N	E	N	E	N	N	N	E	N	E	N	N	E	E	E

Source: JICA Study Team, Survey for Environmental and Social Consideration- October 2004 - September 2005.
E, Exist; N, Not exist; O, Occasionally exist.
B, for boys only; G, for girls only.

Table 3.17 Status of Infrastructures, Public Facilities and Institutions of Villages in the Madarsoo River Basin

Director	T. Director	Officer

ANNEX -Scoping for the Study-

1. Title of the Cooperation Project and Name of the Project Proponent

Title of the Cooperation Project: The Study on Flood and Debris Flow in the Caspian Coastal Area Focusing on the Flood-Hit Region in Golestan Province in the Islamic Republic of Iran

Name of the Project Proponent: Deputy for Watershed Management, Forest, Range and Watershed Management Organization, Ministry of Jihad-e-Agriculture, Islamic Republic of Iran

2. Categorization and its Justification

Environmental Impact: ***Category B***

This project falls in Category B of JICA categorization, with following justification.

1) The proposed project is of disaster management and mitigation in nature and sprit, aiming at reducing flood/ debris flow damages, preventing soil erosion/land degradation, thus enhancing the status of ecosystem. Such works are environment-friendly, widely known, easily accepted by people, and executed with small scale in a limited area.
2) Structural measures are established in a limited area and so design to counter deterioration of physical and biological environments, without inserting any impact on social environment.
3) However part of Golestan National Park occurs in the study area, but no structural measure is proposed/constructed in the park. Instead of structural measures, flood forecasting and warning system is proposed to save visitors and campers in the Park from disastrous floods.
4) Locations of historical/cultural sites existing in the area have been pin pointed, marked on the maps and provided to the study team, for being refers when selecting sites for establishment of structures. So no construction work is done at such sites, thus no harms to those assets.
5) According to environmental laws and regulation prevailing in Iran, only large-scale projects correspond to A category of JICA categorization, thus requiring conduct of EIA. While captioned project is of small scale and for disaster prevention purpose.

6) The project neither plans involuntary resettlement, nor proposes any change in existing institution and customs.
7) Watershed management tasks have been practiced for a long time in Iran, and are quite familiar/ acceptable to inhabitants, thus no adverse social impact (conflict among communities, increase in income disparities) is expected.
8) No peat-land, mangrove forest or coral reef occur in the project area.

3. Outline of the Project Environment

3.1 Background of the Study

In general the provinces of Golestan, Mazandaran, and Gilan in Caspian coast are subjected to disasters of flood and debris flow. Madarsoo River basin is one of disaster prone basins in Golestan province, in which about 300 persons, and thousands of livestock were killed as consequences of floods/debris flow, which occurred in summer of 2001 and 2002. In addition to lives causalities, many infrastructures such as bridges and roads were destroyed, causing economic and psychological damages to people. The Madarsoo River originates in northern side (Caspian side) of Alborz Mountains, after passing the Golestan National Park it joins the Gorgan River, and thereby empties into Caspian Sea. The Madarsoo River with a length of about 100 km, has a catchment area of 2,364 km^2 in which 60,000 people inhabit. Average annual rain in this basin is about 1,000 mm, with uneven distribution (time/location) pattern.

In addition to Madarsoo River basin, there are some other basins in Caspian coastal area, having similar hazardous topography and climatic conditions. Of these Nekka River basin in Mazandaran province, and Maslee River basin in Gilan province could be mentioned.

In this circumstance the Government of Iran has taken some emergency actions for lessening the panic of the people and enhancing their safety mostly through non-structure measures such as providing emergency relief and advise on relocation. But the Government has not drawn any concrete plan for disaster prevention and basin management, therefore formulating a master plan bearing short, mid, and long terms objectives, and comprising of structural and non-structural measures is an important task to revert the confidence of inhabitants in Caspian coastal area.

In response to official request of the Government of Iran, Japan International Cooperation Agency (JICA) dispatched a Study Team to Iran in October 2004, for realizing the formulation of such master plan.

3.2 Objectives and Goals of the Study

Objectives

i) To formulate a master plan up to the target year 2025 for prevention of flood and debris flow disaster in Madarsoo River basin,
ii) To select priority projects among the measures/schemes proposed in the above-mentioned master plan and to carry out the feasibility study on them,
iii) To prepare technical manual and guidelines, containing planning and designing of

flood and debris flow countermeasures, applicable not only to Madarsoo basin but also to similar other basins in Caspian coastal area, and

iv) To pursue technology transfer to counterpart personnel in the course of the study, mainly focusing on planning and designing processes on flood and debris flow disaster mitigation and management.

Goals

1) The projects, which are proposed through the study, will be carried out, and disaster of flood and debris flow will be mitigated.
2) The provincial offices in the Caspian coastal area will conduct the proper planning and designing with necessary measures for flood and debris flow disaster mitigation and management.

3.3 Study Area

The study area is mainly the Madarsoo River basin in Golestan province with a drainage area of 2,364 km^2. Some of similar basins in Caspian coastal area are also covered; these include Nekka River basin in Mazandaran province, and the Maslee River basin in Gilan province.

3.4 Target Year

The master plan for prevention of flood and debris flow disaster in Madarsoo River basin shall be formulated setting the target year at 2025.

3.5 Project Components

To cope with disaster of flood and debris flow, and assure the safety of inhabitants of river basins the master plan shall propose structural measures such as construction of river improvement and sediment control structures, as well non-structural measures such as installation of warning system and provision of hazard maps indicating the safe location for sheltering upon warning. Following this context the master plan contains seven components as tabulated below.

Table 1 Master Plan Components: Flood and Debris Flow Mitigation and Management Master Plan

No.	Component	Major areas to be conducted
1	Watershed Management Plan	Headwaters and Middle Reaches
2	River Restoration Plan	Headwaters: Ghiz Ghaleh and Dast-e-Sheikh River Basins
3	Golestan Forest Park Disaster Management Plan	Middle Reaches: Golestan Forest
4	Debris Flow Control Plan	Middle Reaches:

No.	Component	Major areas to be conducted
5	Flood Control Plan	Middle and Lower Reaches: Tangrah to Golestan Dam Entrance
6	Floodplain Management Plan	Middle and Lower Reaches: Tangrah to Golestan Dam Entrance
7	Flood Preparedness Plan	Entire Basin

4. Overall Environmental and Social Conditions

4.1 Legal Framework of Environmental and Social Consideration

The Islamic Republic of Iran has established comprehensive environmental legislations, which are rooted in the Constitution and the Islamic culture and philosophy. These legislations are effective instruments for protection of the environment, management of natural resources, and realization of sustainable development. Article 50 of Constitution of the Islamic Republic of Iran states that: " It shall be considered a public duty in the Islamic Republic to protect the natural environment in which the present as well as future generation shall have a developing social life. Therefore, economic activities or otherwise which cause pollution or an irreparable damage to environment shall be prohibited." This Article provides foundation and strength to all environmental laws, regulations, standards and guidelines prevailing in the country.

The Department of the Environment (DOE) is the principal organization for administering the environmental status in Iran. The DOE is responsible for protection and enhancement of the environment, prevention and control of any form of pollution/degradation leading to disturbance of environmental balance, and dealing with all matters related to wildlife and aquatic biota of the territorial waters. Defining and presenting the environmental rules, regulations and standards, ensuring proper implementation of environmental legislations and monitoring the status of environment in the country are also among responsibilities of this department. DOE is attached to Office of President of the country, and the president appoints its head. DOE has a Provincial Directorate in every province, which monitors status of the environment as well as the implementation of environmental programs in the province.

4.1.1 Laws

Among environmental legislations prevailing in Iran, those related to this study are listed in Table below with brief content.

Table 2 List of Environmental Legislations Prevailing in the Islamic Republic of Iran

Legislation	Brief Content
(1) Civil laws	
Law of nationalization of water-1968	Designation of water as a national resource
Environmental protection and enhancement law-1974 (amended in 1992)	Protection and enhancement of ecosystem
Law on conservation and utilization of Forests and rangeland- 1975	Sustainable and wised utilization of Forest and rangeland
Law of just distribution of water-1982	Definition of pollution and prohibition of water pollution
Law on prevention of water pollution-1994	Prevention of water pollution
Law of third five-year socio-economic and cultural development plan of Iran- 2000	Requirement of EIA for large production and service providing projects
Law of fourth five-year socio-economic and cultural development plan of Iran- 2004	Necessity of conducting EIA on large projects, in accordance with guidelines provided by DOE
Environmental Guidelines and Standards, published by DOE in the year 2003	Itemization of projects requiring EIA, and guidelines for conducting EIA
Regulation on limits of bed and banks of rivers, stream, wetlands, and water supply and irrigation/drainage networks- 2000	Identification and delineation of limits of river banks
Regulation concerning the requirement of environmental impact assessment (EIA) in developmental projects- 1994	Mandatory of conducting EIA for large projects
Regulation for conducting EIA-1997	Preparation of EIA in accordance with the guidelines of Department of the environment
2) Islamic Laws	
Islamic punishment law (Taazirat)- 1999	Punishment for causing environmental pollution, damaging public facilities (dam, canal), and destroying cultural/historical heritages.

EIA; Environmental Impact Assessment. DOE; Department of the Environment (Iran)

4.1.2 Competent Agency

According to item 1 of Clause II of the Minutes of Meeting on Inception Report of the Study agreed upon between the Ministry of Jihad-e-Agriculture (the project proponents) and Japan International Cooperation Agency (JICA) on November 7, 2004 in Tehran, Department of the Environment (DOE) is one of the parties collaborating with this Study. So General Directorate of Environment in Golestan province will coordinate all the environmental related matters.

4.1.3 Projects Subject to Environmental Impact Assessment

(1) In accordance with Regulation for Conducting Environmental Impact Assessment (EIA)-1997, performing EIA for large projects become mandatory. Article 1 of this Regulation states that: Executors of Plan and Projects named in Article 2 of this Regulation are required to prepare EIA Report, along with Feasibility Study (F/S) Report for their plan and projects in accordance with guidelines of the Department of the Environment (DOE).

Article 2: Plan and projects requiring EIA are:

① Petrochemical plants of any scale

② Refineries of any scale

③ Power plants with production capacity of more than 100 Mega-Watt

④ Steel industries:

a) Steel mills with production capacity of more than 300,000 ton/year
b) Rolling mills with production capacity of more than 100,000 ton/year.

⑤ Dams and other water structures:

a) Dams with height of more than 15 m, or affiliated facilities of more than 40 ha, or reservoir area of more than 400 ha.
b) Man-made ponds with area of more than 400 ha.
c) Irrigation/Drainage projects of area more than 5,000 ha.

⑥ Industrial complex with area more than 100 ha

⑦ Airports with runway length of more than 2,000 meters.

(2) Environmental Guidelines and Standards published by DOE in 2003, instruct the project proponents to conduct Environmental Impact Assessment (EIA) on their project in accordance with Guidelines provided by the Department of the Environment. Projects requiring EIA are:

(a) Petrochemical plants of any scale
(b) Refineries of any scale
(c) Power plants with production capacity of more than 100 Mega-Watt
(d) Steel industries:
- Steel mills with production capacity of more than 300,000 ton/year
- Rolling mills with production capacity of more than 100,000 ton/year.

(e) Dams and other water structures:
- Dams with height of more than 15 m, or affiliated facilities of more than 40 ha, or reservoir area of more than 400 ha.
- Man-made ponds with area of more than 400 ha
- Irrigation/Drainage projects of area more than 5,000 ha

(f) Industrial complex with area more than 100 ha
(g) Airport with runway length of more than 2,000 meters.
(h) Agro-industries with an area more than 5,000 ha
(i) Large slaughtering complex
(j) Dumping ground for wastes of cities more than 200,000 population, and new cities
(k) Compost making factories

(l) Oil and gas pipeline projects
(m) Oil terminal projects
(n) Oil storing facilities
(o) Large afforestation projects
(p) High way construction
(q) Railway construction
(r) Eco-tourism projects

4.1.4 Procedures

If the project component proposed in the Master Plan or adopted as a priority project in the Feasibility Study falls under the category listed above, the project proponent has to follow DOE guidelines when implementing the project. Otherwise prepare Environmental Management Program and Environmental Monitoring Program depending on possibility and adversity of the predicted environmental impacts.

Whenever EIA is required the following procedures should be followed:

- Executors of plan and projects should prepare preliminary project summary and submit it to Department of the Environment (DOE) for consideration. DOE will provide its comments and advise to the executor within one month.
- EIA report prepared by project proponent should describe the situation for Construction Phase and Operation Phase separately, and include countermeasures and costs for minimizing the negative impacts of project on the environment.
- The prepared EIA report should be concluded in one of the three following forms and submitted to Department of the Environment for consideration.
  a) Due to its serious negative impacts on the environment, implementation of subject plan or project is not recommended.
  b) With comprehensive countermeasures for reducing its negative environmental impacts, implementation of subject plan or project is acceptable.
  c) With simple environmental consideration, the plan or project can be implemented.
- Department of the Environment shall examine the EIA Report and notify the executor about its decision within three months.
- In conducting EIA the following components must be considered:

I. Study of Impacts on Physical Environment

- Soil: Morphology and quality
- Water: Quantity and quality
- Climate and Air: Climate changes and air quality
- Secondary impact on soil, water and air

II. Study of Impacts on Biological Environment

- Impacts on fauna
- Impacts on flora
- Impacts on habitats, landscape and route of migratory birds

III. Study of Impacts on Social, Economical and Cultural Environments

- Impact on people health and living standard
- Education, employment and housing
- Religious belief, cultural values and historical heritage

IV. Impact on related Developmental Plans in the other sectors

- Agriculture, industry and service sectors
- Land consolidation
- Land use

4.1.5 Information Disclosure

Information disclosure is stipulated in Executive By-Law No. 156 approved by Environmental High Council in December 1997. Article 64 of Law of Fourth Five-Year Socio-economic and Cultural Development Plan of Iran- 2004 emphasis on disclosure of environmental related issues through radio, television, and other mass media.

In accordance with Clause 7 of Minutes of Meeting on Inception Report agreed upon between the Ministry of Jihad-e-Agriculture (the project proponent) and Japan International Cooperation Agency (JICA) on November 7, 2004 in Tehran, the public information on this project would be made through publication of News Letters.

4.1.6 Stakeholders Participation

Public participation is emphasized in documents published by Department of the Environment (Introduction of Environmental Impact Assessment- 1997), as well as in Laws of Ministry of Jihad-e-Agriculture (1992), which stipulate establishment of a Ministerial Deputy for promoting Extension and Public Participation in developmental projects and handling the relevant affairs.

4. 2 Outline of the Location

4.2.1 Population

Population density of Golestan province is higher than that of whole Iran as shown in Table below. The JICA study team is figuring the data up for Madarsoo River basin by field (village) survey.

Table 3 Statistics on Population and Household- 2004

Items	Whole Iran	Golestan Province	Madarsoo River Basin
Population (1000)	67,477	1,614	60
Population Density (persons/km^2)	41	77	25
Average household size (persons)	4.4	4.6	6.0
Women Heads of Household (%)	8.7	7.7	2.0

4.2.2 Race

In general local people can be divided into Turkmen, and non-Turkmen (Farsis, Baluch) groups; all being Muslim comprising of Shiite and Sunni fates.

4.2.3 Economy

According to the Article 44 of Constitution of the Islamic Republic, the economy of Iran is composed of three sectors: private, state, and cooperative. Presently, only 2.5% of the country's economy is owned by cooperatives; the most predominant ownership is concentrated in state and private sectors. About 60% of Gross National Product (GNP) comes from governmental firms, mostly through export of oil and gas.

Since the beginning of the First Developmental plan in fiscal year 1989, the Iranian economy has seen a constructive growth. In 1995, the Gross Domestic Product (GDP) rose 4.5% to 13,880.2 billion Rials, compared to 1994. Meanwhile, regardless of oil revenues, the GDP grew 5.4%. Figures for GNP and GDP for 1990 to 1995 are presented below:

Table 4 Recent Changes of National Economy

Unit: Billion Rials

Item	1990	1991	1992	1993	1994	1995
GNP	10,997.5	12,377.9	12,985.6	13,370.8	13,163.5	13,707.6
GDP	10,664.9	11,824.8	12,477.8	13,071.0	13,280.4	13,880.2
GDP (Oil excluded)	8,400.2	9,308.1	9,924.3	10,425.7	10,784.3	11,362.4

GDP is composed of four major sectors, agriculture, industry and mine, services and oil. Trend of GDP for the year 1990 to 1995 is shown below:

Table 5 Recent Changes of GDP and Sectoral Products

Item	1990	1991	1992	1993	1994	1995
Agriculture	2,967.5	3,120.2	3,351.6	3,535.7	3,605.5	3,739.4
Oil	2,264.7	2,516.7	2,553.5	2,645.3	2,496.1	2,517.8
Industry/mine	2,391.8	2,802.3	2,932.2	2,970.0	3,114.9	3,293.1
Services	4,499.6	4,945.9	5,343.5	5,743.7	5,885.2	5,956.2
GDP	*10,664.9*	*11,824.8*	*12,477.8*	*13,071.0*	*13,280.4*	*13,880.2*

In the year 2000, shares of economic activities in GDP are tabulated below:

Table 6 Sectoral Share of GDP (Unit: %)

Agriculture	12.9
Mining	0.6
Manufacturing	12.9
Oil	22.4
Water, electricity, gas	0.9
Construction	3.5
Trade/Tourism	14.5
Transport/Communication	6.3
Services	26.0

4.2.4 Education

Schooling situation for whole Iran and the Golestan province is summarized in Tables Below:

Table 7 Schooling Situation in Iran- 2002

Schooling Level	Number of Students		
	Male	Female	Total
Pre-School	160,822	168,240	329,062
Primary School	3,924,999	3,588,016	7,513,015
Lower Secondary School	2,698,328	2,255,566	4,953,894
Upper Secondary School	2,020,296	1,964,854	3,985,150
Pre-University	182,732	294,496	477,228
University /Higher Education	98,589	106,437	205,026

Table 8 Schooling Situation in Golestan Province- 2002

Schooling Level	Number of Students		
	Male	Female	Total
Pre-School	5,708	5,875	11,583
Primary School	99,068	91,054	190,122
Lower Secondary School	65,474	51,918	117,392
Upper Secondary School	43,728	41,667	85,395
Pre-University	3,650	5,749	9,399
University /Higher Education	1,616	1,512	3,128

Since there are no many schools and educational facilities in Madarsoo River basin, and many children do farm works to assist their parents, rate of literacy in the basin seems to be low. JICA study team will determine the exact situation of schooling in the basin by conducting socio-economy survey in December 2004.

4.2.5 Land Use

Major types of land use in Iran, Golestan province and Madarsoo River basin for the 2001 is shown in Table below:

Table 9 Land Use Unit: (100 ha)

Land use Type	Whole Iran	Golestan Province	Madarsoo River Basin
1. Agriculture			
a) Annual Crops			
- Irrigated	5,524	290	149
- Rainfed	5,496	331	313
b) Fruit Trees	2,068	18	
c) Others (fodder)	113	-	
2. Forests	124,000	3,792	675
3. Rangeland			
- Good	93,115	-	73,220
- Fair	372,905	11,432	7,139
- Poor	433,979	1,884	14,336

Note: Figures in the Madarsoo River Basin shall be clarified during the following stage.

4.2.6 The Environment

The environmental status of Madarsoo River basin is summarized below.

Social Environment

- Local people are mainly composed of Turkmen, Persian (Farsis) and Baluch, all being Muslim, consisting of Shiite and Sunni fates Population density in the area is very low (25/km^2) as compare to whole Iran and the Golestan province.
- Major economic activities are agriculture (grain/fruit production) and livestock breeding. Due to low agricultural productivity and absence of any industry in the area, most of young persons go to large cities, undertake simple jobs, collect some money and send home to support their families. People in some villages such as Lueh economically are poor, because have no suitable land to cultivate, and psychologically under stress due to regular damage by floods and debris. Women of this village go nearby villages and work as farm labor for large

landowners against a small salary of 20,000 Rials ($2.5) per day.

- In some villages such as Besh Oily, population of women is higher than that of men.
- Most of the villages possess water and electricity, telephone system, Mosque, primary school, graveyard, and Rural Islamic Council, which deal with daily life affairs of people. But there is lack of sporting facilities in the villages.
- Major problems in most of villages are:
  - ✓ Low agriculture productivity attributed to decrease in soil fertility and land productivity brought about by erosion, debris flow and flood.
  - ✓ Unemployment due to absence of any large industry in vicinity of the basin to engage some of the local people.

Natural Environment

- Topographic conditions of Madarsoo River basin is categorized into following parts:
  - ✓ Mountain and highland area of headwaters, which suffer from overgrazing, poor vegetation cover and soil erosion,
  - ✓ Steep valley of the middle reaches, consisting of Golestan National Park, and being the steepest part over the entire stretch of Madarsoo River, and
  - ✓ Alluvial plain and hills of the lower reaches, where agricultural land extends over the floodplain, and villages scatter along the river course.
- Bedrock consists of limestone, sandstone and shale, marl, conglomerate, and dolomitic limestone, chiefly belonging to pre-Cambrian and Ziorasic period.
- Soils are of gravelly loam, loamy-sand, loam, clay loam, and clay in texture with good to fair permeability, and slight, moderate and severe erosion classes.
- Terrain varies from rugged areas to level or slightly undulating terrain. Since the basin situates between Caspian sea and the arid interior, its climate varies from wet to moderately arid, with a mean annual precipitation of about 1000 mm, and temperature range of -25^{o}C to $+35^{o}$C.
- Land use is comprised of agricultural land, forest, rangeland, and residential areas.
- One natural park with following characteristic occurs in the basin (see Figure 1):
  - ✓ Official name: Golestan National Park
  - ✓ IUCN management category: II (National Park), IX (Biosphere Reserve)
  - ✓ Date of establishment: 1956. In 1977, it was recognized by UNESCO, as part of the international network of Biosphere Reserves.
  - ✓ Land Tenure: Government.
- Plant diversity of the park includes rare species which area valuable treasures of biodiversity. Various mammals such as the large Iranian deer, ram, leopard, ewe, and boar, as well birds such as partridge, falcon, quail, starling can be found in this park..

Public Pollution

- An asphalt road, which runs parallel to Madarsoo River and passes through the Golestan national park, forms a part of international corridor linked to neighboring countries,

Turkmenistan and Afghanistan, and the sacred place of Shiite Muslim, Mashhad city. Peak traffic density of the road is about 25,000 automobile units/day, which insert noise and air impacts on people, and disturb the wildlife in national park. Since the park attracts thousands of tourists every year, some camping areas with modest facilities have been established within the park to host guests. Improper handling of solid waste and sewage generated by tourists may induce some adverse on the environment.

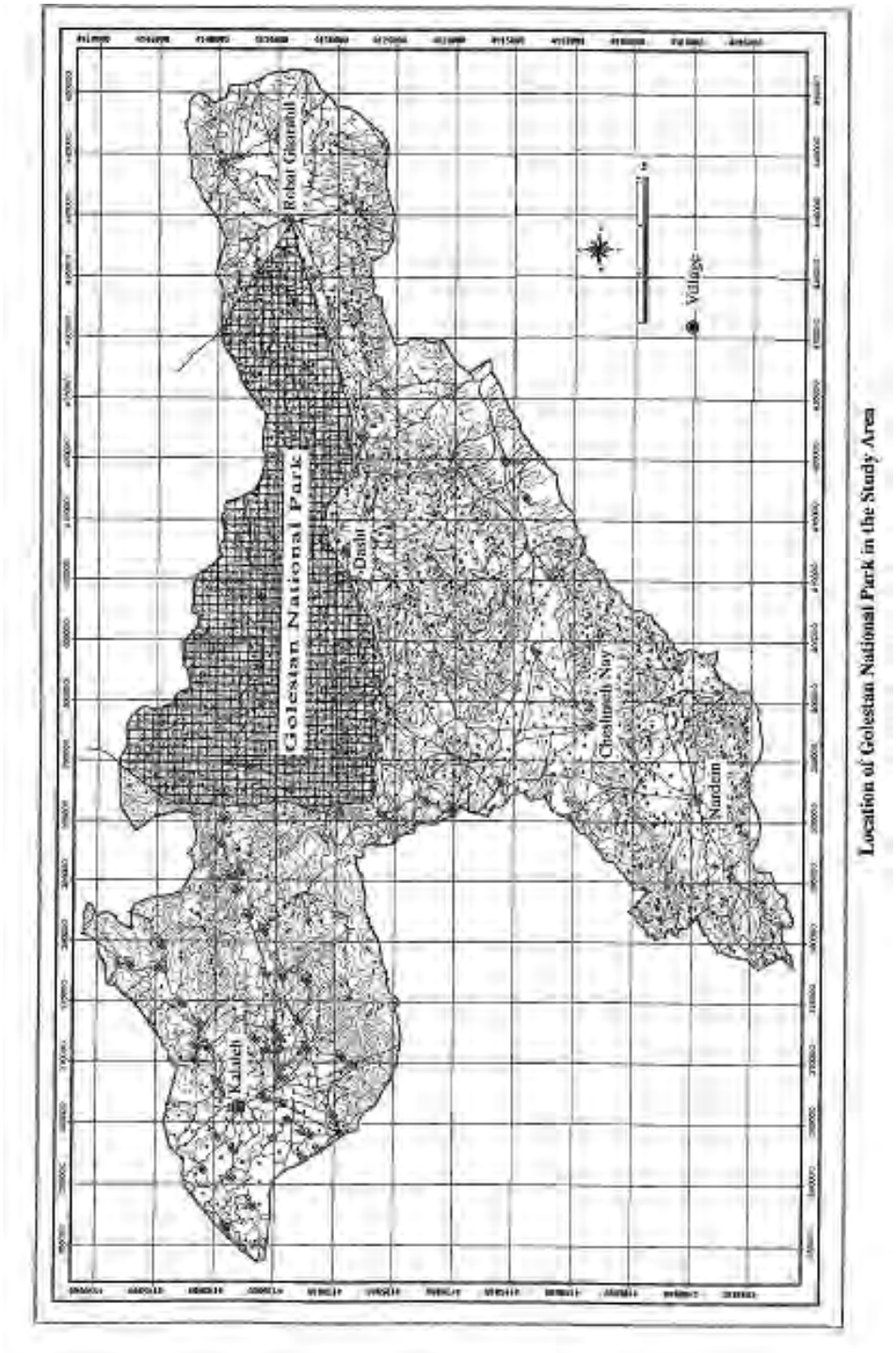


Figure 1 Location of Golestan National Park in the Madarsoo River Basin

4.2.7 Other Socioeconomic Situation

There are some mosque and other religious enclosures in the basin, to which the Project should pay attention in construction phase. Since in accordance with the Islamic doctrine and people belief, none of them should be damaged or eliminated.

5. Adverse Environmental and Social Impacts

The project intends to safeguard the people and enhance their confidence on economic activities through minimization of flood and debris flow damages, by introducing some structural measures such as river training works and establishment of few small dam/dike for flood/debris flow control, along with non-structural measures. Such limited activities would not insert serious impacts on the environment. Mover-over the project is advised to take all necessary precautions to avoid occurrence of any adverse impact during the construction, operation and maintenance activities.

Major components of the projects and relevant environmental issues summarized in Table below:

Table 10 Major Project Components and their expected Environmental Effects

Project Component		Environmental Element	Reason/Basis
Structural Measures	a) Construction of Control Dam/dike	Soil erosion	Dam construction may cause temporary erosion in construction time.
		Noise and air pollution	Construction machineries would generate noise and emission of gas.
		Change in landscape	Some structures are erected in virgin areas, affecting the landscape.
		Impact on natural beauty	Artificial structures would lessen the natural beauty.
		Impact on wildlife	Check dam would hinder transit/ movement of creatures in the area.
		Impact on historical site/cultural heritage	Many historical sites/cultural heritages exist in the area, which could be damaged during construction phase.
	b) River Training Works	River widening and riverbed dredging	Temporary soil erosion and increase in water turbidity in construction period.
	c) Other Construction Works	Establishment of access roads/detouring	Noise and air pollution caused by machineries, and temporary soil erosion during the construction period.
Non Structural Works	Flood Warning System	Establishment of warning instrument and evacuation place/route	Such works insert some minor impacts on ecosystem in installation period, and affect the landscape when erected.

Result of Scoping is given in Table below, and Matrix for project components is shown in Table 12.

Table 11 Scoping Result

Environmental Elements			Rating	Justification
Social Environment	1.	Change in population distribution	C	No relocation/resettlement is planned
	2.	Involuntary resettlement	C	No resettlement is proposed
	3.	Change of life style/livelihood	D	Not expected. Development is of small scale
	4.	Dispute among local residents	C	If project benefits are not properly distributed
	5.	Impacts on indigenous people, ethnic minority, nomadic tribe	B	Landless people are less benefited than landholders
	6.	Impact on agriculture and forestry	C	Some changes in land use may be proposed
	7.	Impacts on fishery	D	No large fishery activities in the basin
	8.	Impacts on secondary industry (including mining)	D	No large mining in the area
	9.	Impacts on tertiary industry (including tourism)	C	Construction works may insert some temporary impacts (noise) on tourists visiting the area
	10.	Income amplification differences	B	Holders of agricultural land/livestock are more benefited than others
	11.	Local community disruption	C	If no proper distribution of project resources
	12.	Impacts on land transportation	D	Not expected.
	13.	Impacts on inland navigation	D	No inland navigation in the basin
	14.	Impacts on rights of water use, fishery and common	D	Not expected
	15.	Spread of water-related diseases	C	Relation of flood water harvesting and water borne diseases should be considered
	16.	Increase of use of agrochemicals, its residue in soil	C	Project will safeguard farmlands against disasters. This may encourage input of agrochemicals
	17.	Generation of waste, dredged/ excavated soil	B	River training works may generate spoil soil
	18.	Degradation of sanitary condition during construction period	C	Construction works may bring-about increment in water turbidity, and cause air pollution
	19.	Ruin of/damage to natural, historical and cultural heritage	C	Project activities may insert some impacts on natural environment and on historical/cultural heritages
	20.	Degradation of valuable landscape	B	dams and flood warning instruments erected in the area may impose adverse impacts on landscape
Natural Environment	21.	Inducement of earthquake	D	Not expected. Project is of small scale
	22.	Generation of landslide	D	Not expected. The activities are counter to landslide
	23.	Sedimentation in backwater area	D	Not expected
	24.	Impacts on downstream reaches	C	No significant impact is expected
	25.	Soil erosion	B	Project activities, particularly at construction phase, will cause soil erosion
	26.	Salinization of soil	D	Not expected
	27.	Soil contamination	B	Discarded oil by machineries, particularly at construction phase may cause soil contamination
	28.	Watershed diversion	D	Not expected.
	29.	Impacts on groundwater	D	Not expected
	30.	Change of river flow regime	B	River training works and establishment of structural measures may affect river flow regime
	31.	Cold water hazard	D	Not expected
	32.	Eutrophication	D	Not expected
	33.	Turbid water flow	C	During the construction phase, turbidity of water would increase

	34.	Change of river bed material composition	B	With construction of structures for flood/debris flow control, the composition may change
	35.	Impacts on terrestrial flora and fauna	C	Most of flora and fauna are in Golestan national park, in which no construction work is done
	36.	Impacts on aquatic organisms	B	River training works may induce some impacts on aquatic organisms
	37.	Impacts on protected species/ endemic species	C	Such species are mainly in Golestan national park, in which no construction work is done.
	38.	Air pollution	C	Some air pollution by machineries, particularly at construction phase
	39.	Emission gas/odor	C	Some gas emission by machineries, particularly at construction phase
	40.	Noise pollution /vibration	C	Some noise pollution by machineries, particularly at construction phase.

Ratings:

A – Potential for significant adverse impact

B – Potential for some adverse impact

C – Not clear. Impact should be identified in the course of the Study

D – Unlikely to have adverse impact

EIA; Environmental Impact Assessment.

Table 12 Scoping Matrix for Project Components (River Training, Construction of Structures for Debris Flow/Flood Control)

Name of Cooperation Project			The Study on Flood and Debris Flow in the Caspian Coastal Area Focusing on the Flood-Hit Region in Golestan Province, Iran										
Environmental Item/Issue		Likely Impacts	Overall Rating	Planning Phase		Construction Phase				Operation Phase			
				Land Acquisition	Change of Land use plan, Control of Rights on Fishing and Water Use for construction	Extension of River width	Construction of check dam/dike, Banking, New Channel, and Related Facilities	Operation of Construction Equipment and Vehicles	Restriction of the economic and other activities around river	Drainage	Water Sharing	Appearance/Occupancy of building structures such as embankment, water control facilities, floodgate	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment	1	Involuntary Resettlement	*C*	*C*	*C*	*C*	-	-	-	-	-	-	-
	2	Local economy such as employment and livelihood, etc.	*B*	-	*C*	-	-	-	-	-	-	-	*B*
	3	Land use and utilization of local resources	-	-	-	-	-	-	-	-	-	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	*C*	-	-	-	-		-	-	-	-	*C*
	5	Existing social infrastructures and services	*C*	-	-	-	-	-	*B*	-	-	-	*C*
	6	The poor, indigenous and ethnic people	*B*	-	*B*	-	-	-	-	-	-	-	*B*
	7	Misdistribution of benefit and damage	*B*	-	*B*	-	*B*	-	-	-	*C*	-	*B*
	8	Cultural heritage	*C*	*C*	*C*	*C*	*C*	*C*	-	-	-	-	*C*
	9	Local conflict of interests	*C*	*C*	*C*	-	*C*	-	*C*	-	*C*	-	*B*
	10	Water Usage or Water Rights and Rights of Common	*C*	*C*	*C*	-	*C*	-	-	-	-	-	*C*
	11	Sanitation	*C*	-	-	*C*	*C*	*C*	-	-	-	-	*B*
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	*C*	-	-	-	-	-	-	-	-	-	*C*
Natural Environment	13	Topography and Geographical features	-	-	-	-	-	-	-	-	-	-	-
	14	Groundwater	*C*	-	-	-	*C*	-	-	*C*	-	-	-
	15	Soil Erosion	*B*	-	-	*B*	*B*	*B*	-	-	-	-	-
	16	Hydrological Situation	*C*	-	-	*C*	*C*	-	-	-	-	-	-
	17	Coastal Zone	*C*	-	-	-	*C*	-	-	-	-	-	-
	18	Flora, Fauna and Biodiversity	*C*	*C*	*C*	*C*	*C*	*C*	-	*C*	-	*C*	*C*
	19	Meteorology	-	-	-	-	-	-	-	-	-	-	-
	20	Landscape	*B*	*C*	*C*	*C*	*B*	*B*	-	-	-	*B*	-
	21	Global Warming	-	-	-	-	-	-	-	-	-	-	-
Pollution	22	Air Pollution	*B*	-	-	*B*	*B*	*B*	-	-	-	-	-
	23	Water Pollution	*B*	-	-	*B*	*B*	*B*	-	-	-	-	*C*
	24	Soil Contamination	*B*	-	-	*B*	*B*	*B*	-	-	-	-	-
	25	Waste	*C*	-	-	*C*	*B*	*C*	-	-	-	-	*B*
	26	Noise and Vibration	*B*	-	-	*B*	*B*	*A*	-	-	-	-	*C*
	27	Ground Subsidence	*C*	-	-	-	-	-	-	*C*	-	-	-
	28	Offensive Odor	-	-	-	-	-	-	-	-	-	-	-
	29	Bottom sediment	*C*	-	-	*C*	*C*	-	-	-	-	-	-
	30	Accidents	*B*	-	-	*B*	*B*	*B*	-	-	-	*B*	*B*

Rating: *A* Serious impact is expected, *B* Some impact is expected *C* Extent of impact is unknown (Examination is

needed. Impacts may become clear as study progresses) — No impact is expected.

6. Alternative

Without Project (No Action or no development) Alternative

Without project the local people and tourists visiting the area are subjected to economic and psychological damages of flood and debris flow. No action alternative is contrary to Iranian law, and Islamic doctrine, which require the Islamic Government to protect the entire citizen against disasters, and emphasis on wise utilization of God-gifted natural resources. Care for fragile mountainous areas (watersheds) is the sprit of Agenda 21 of Earth summit- Rio 1992.
Without project the income of farmers would further decrease, forcing them to leave the agricultural occupation and seek simple job in large cities, bring-about “imposed migration” and causing social disturbance.
Since all the National Development Plans of Iran, emphasis on implementation of efficient rural and agricultural development projects, no action alternative, cannot be justified. Therefore “with Project” alternative should be carefully examined in light of technical, economic, environmental and social viewpoints, and a Master Plan is formulated by adopting the most effective disaster prevention measures. After conducting Feasibility Study on selected priority project(s), they can be executed, starting from the most urgent one.

Table 13 (below) summarizes the master plan components, major countermeasures and alternatives except for without-project alternative, and their environmental effects anticipated.

Table 13 Master Plan Components and their Alternatives

Master plan components	Area to be mainly conducted	Major countermeasures/ Alternatives (A)	Environmental effects
Watershed Management	Headwaters and middle reaches	Afforestation, land treatment, on-site rainfall detention, etc.	Positive effects in natural and social environment
		(A) No effective alternatives	-
River Restoration Plan	Headwaters	Reconstruction of reservoirs in the Dast-e-Sheikh and construction of flood control channels in Dasht area (flood and sediment control)	Some negative effects during construction. Positive effects in natural and social environment as a whole
		(A) No realistic alternatives	
Golestan Forest Park Disaster Management Plan	Middle reaches	Establishment of flood forecasting and warning system and emergency activities	negative environmental effects during construction, but minimul
		(A) Restriction of camping activities	Negative effects in social environment
Debris Flow Control Plan	Middle reaches (Tangrah to Beshoily)	Construction of debris flow control dams and canals in parallel with watershed management	Some negative environmental effects during construction
		(A) Resettlement of debris-flow-prone villages	Negative effects in social environment
Flood Control Plan	Middle and lower reaches	Construction of necessary flood control structures to protect farmlands against 25-year flood and villages against 100-year flood	Some negative environmental effects during construction
		(A) Full-scale flood control structures against 100-year flood	Much larger negative environmental effects during construction
Floodplain management Plan	Middle and lower reaches	Publication of flood-hazard area and landuse control in the flood-hazard area	No significant environmental effects
		(A) Full-scale flood control structures against 100-year flood	Much larger negative environmental effects during construction
Flood Preparedness Plan	Entire basin	Improvement of early warning system and training activities for emergency	No significant environmental effects
		(A) Full-scale flood control structures against 100-year flood	Much larger negative environmental effects during construction

7. Terms of Reference

7.1 Objectives

The main objectives of the environmental and social considerations study are to:

(1) Minimize/mitigate the environmental and social impacts to be caused by the proposed project/action,

(2) Disclose information on proposed project and possible environmental impacts to be caused by implementing it at an early stage,

(3) Conduct accountability on implementing the project and incorporate stakeholder opinions into decision-making processes regarding environmental and social considerations, and

7.2 EIA Requirements

According to Iranian laws, and environmental guidelines introduced in 2003, only large projects require EIA, while other small development activities should simply be evaluated to ensure their environmental soundness and public acceptability. Therefore concern authorities are advised to assess the project from social, economic, and environmental viewpoint to assure the public on its socio-economic benefits and environmental soundness through information disclosure and timely contact with local people.

7.3 Study Area

The study area for environmental evaluation is priority project area that will be selected in the course of master plan formulation, as mentioned in the Inception Report agreed upon between JICA and Iranian Government on November 7 in Tehran.

7.4 Study Period

The study period for the environmental and social consideration extends in the feasibility study stage, as mentioned in the Inception Report agreed upon between JICA and Iranian Government on November 7 in Tehran.

7.5 Scope of Work

The scope of work for the environmental and social consideration study is the following:

<u>Phase I Formulation of Master Plan: Environmental Scoping and IEE</u>

(1) Scoping for environmental and social considerations

(2) Environmental examination for flood and sediment control structures

(3) Collection of data / information for clarification of existing environment

(4) Initial Environmental Examination for the Master Plan

A checklist useful for the IEE study is put in Attachment G. Some modification or adjustment

to the target basin shall be necessary in adoption.

In accordance with the DOE Guidelines, the following 'pre-EIA' document composition could be referred to for document preparation.

1) Name of company, client and project,
2) Name and address of the project implementation agency,
3) Goals and objectives of plan,
4) Salient features of the project,
5) Project phasing and its implementation schedule,
6) Construction materials and their procurement details,
7) Location of the project,
8) Basic needs and potentials for the project,
9) Necessary manpower and supply potential,
10) General conditions of the region and the project area,
11) Positive and negative effects of the project,
12) Extent and significance of the environmental effects by the project, and
13) Countermeasures required controlling and remedying the negative environmental effects by the project.

Phase II Feasibility Study

(1) Careful examination of components of projects proposed for undergoing feasibility study, and verifying their environmental and social soundness
(2) Introduction of countermeasures for nullifying/minimizing the adverse impacts (if any) of the component/activity, including suggestion for alteration of associated approach
(3) Preparation of environmental report/document in accordance with JICA format and Iranian (DOE) formal style

Some of items to be covered by environmental examination are as follows:

1) Study on physical environment- topography, geology, hydrology, climatology, and soil
2) Study on biological environment- flora, fauna and habitats
3) Study on social, economic and cultural environment- population, economy, landuse, environmental laws and regulations, as well as historical/cultural heritages
5) Examination of project impacts on physical, biological, socio-economic and cultural, environments
6) Recommendation for conservation/enhancement of environment status in the project area

In the course of the Study, the Public Consultation Meeting (PCM) is to be held three times:

the 1st PCM is held on the Draft Scoping for environmental and social considerations study, the 2nd PCM is held on the result of environmental and social considerations study for the Master Plan, and the 3rd PCM is held on that for the feasibility study.

Attachment A Data and Information Related to Golestan National Park

Golestan National Park (GNP) is one of the UNESCO designated Reserves and the first Iranian National Park. With an area of about 92,000 ha, the park is suited among three provinces of Golestan, Khorasan, and Semnan. The complex of various geomorphologic, geologic, hydrologic and climatic conditions provide a wide range of biotypes leading to a rich species and biodiversity. A total number of 1340 vascular plant species belonging to 110 families and 561 genera have been known from the park. This is astonishing because surface area of the park covers only 0.06% of Iran, but 19% of species, 45% of genera and 69% of families of Iranian vascular plants occur in the park. A large number of species are local endemic to this park. Some of flora species such as *Populus caspica* (poplar) and *Taxus baccata* (yew) are listed as endangered species in Red Data Book of Iran- 1999.

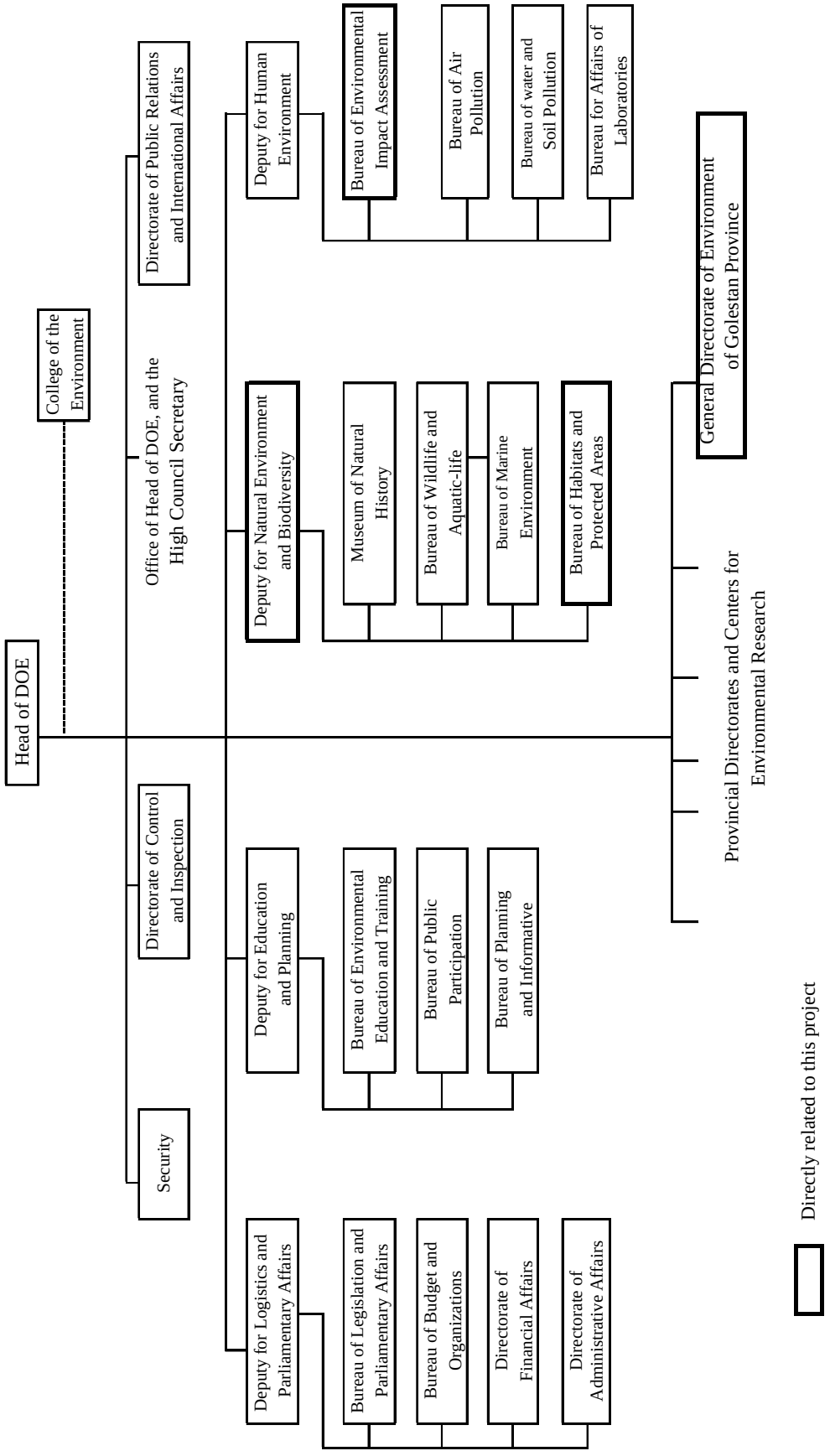
The park provide habitat for many wild animals such as Sus scrofa (wild pig) Cervus elaphus (red deer), Felis chaus (wild cat), Ursus arctos (brown bear), and Ovis ammon (wild sheep). Birds of the park include owls, pheasant, passerines, woodcock, and sparrow hawk.

However, for long the park has been used for conducting scientific research, and generating artistic photograph of natural scenery, DOE intends to establish research stations, and visitor centers in the park to enhance its scientific and recreational values. In 1997, Iranian Government launched a national project titled: Golestan National Park Improvement Project, to boost the status of the park in all aspects. It is believed that the park meets the required criteria for being designated as a World Heritage (natural site) in Iran.

Attachment B

Organization Chart of Department of the Environment (DOE)

Islamic Republic of Iran



Attachment C List of Sites of Historical, Cultural, and Religious Importance in the Study Area

Name	Type	Location
Arab Boran She Tappeh	Ancient hills	Vicinity of Arab Boran village
Tappeh Ghareh Shur Yek, Dou	Ancient hills	Vicinity of Ghareh Shur village
Seh Tappeh	Ancient hills	Obeh Gavemishi area
Tappeh Bastani	Ancient hill	Vicinity of village of Chay Ghochan Bozorg
Seh Tappeh Bastani	Ancient hills	Vicinity of Kangar village
Tappeh Bastani	Ancient hill	Vicinity of Aman Ghajeh village
Tappeh Morsal	Ancient hill	Between Aman Ghajeh and Kangor villages
Ghaleh Barbar	Ancient castle	Vicinity of Ghaleh Barbar village
Tappeh Hossein Abad	Ancient hill	Vicinity of Hossein Abad Ghorbani
Tappeh Hydar Abad	Ancient hill	Vicinity of Hydar Abad village
Narges Tappeh	Ancient hill	Vicinity of Tagek village
Imam Zadeh Abdolah	Religious enclosure	Vicinity of Tagek village
Baniyal Tappeh	Ancient hills	Vicinity of Baniyal village
Gilan Tappeh Yek, Dou	Ancient hills	Vicinity of Achar village
Tappeh Bastani	Ancient hill	Vicinity of Adarvish village
Mengoli Tappeh	Ancient hills	Ghojeh Maz village
Ajen Gharehkha	Historical site	Vicinity of Ajen Gharehkha village
Gharavol Tappeh	Ancient hills	Vicinity of Gharavol village
Taluneh Ajan	Historical site	Vicinity of Taluneh Ajan
Kateb	Historical site	Vicinity of Kateb village
Ajan Salekh	Historical site	Ajan Salekh area
Seh Tappeh	Ancient hills	Vicinity of Ajen Sangerly village
Yekeh Ghozeh Bala	Historical site	Yekeh Ghozeh Bala area
Yekeh Ghozeh Paien	Historical site	Yekeh Ghozeh Paien
Haji Hassan	Historical site	Vicinity of Haji Hassan village
Tappeh Shekh	Ancient hill	Vicinity of Shekha village
Tappeh Kazem Khajeh	Ancient hill	Vicinity of Kazem Khajeh village
Ginely	Historical site	Vicinity of Gineli village
Ghanjigh	Historical site	Ghanjigh area
Tappeh Sariseyed	Ancient hill	Vicinity of Terjenly village
Ghareh Tappeh	Ancient hill	Vicinity of Terjenly village
Shoghal Tappeh	Ancient hill	Vicinity of Sadegh Abad village
Ghoosh Tappeh Yek, Dou	Ancient hills	Vicinity of Sadegh Abad village
Tappeh Agh Ghamish Yek, Dou	Ancient hills	Vicinity of Agh Ghamish village
Tappeh Korang Kaftar	Ancient hill	Vicinity of Korang Kaftar village
Tappeh Emamzadeh Jafar	Ancient hill	Area of Ghanjigh Shahrak
Tappeh Ghanjigh Shahrak	Ancient hill	Area of Ghanjigh Shahrak
Ajan Shahrak	Historical site	Ajan Shahrak area
Charghar Shirmely	Historical site	Charghar Shirmely area
Dar Abad	Historical site	Dar Abad area
Charghar Besh Ghardash	Historical site	Charghar Besh Ghardash area
Tappeh Pasang	Ancient hill	Vicinity of Pasang Bala village
Emamzadeh Takiyeh Baba	Religious enclosure	Vicinity of Pasang Bala village
Tappeh Pasang Yek, Dou	Ancient hills	Vicinity of Pasang Paein village
Tappeh Kamal Abad	Ancient hill	Vicinity of Kamal Abad village
Tappeh Talustan Yek, Dou	Ancient hills	Talustan area
Tappeh Ali	Ancient hill	Tarajigh area
Turang Tappeh	Ancient hill	Vicinity of Turang Tappeh village

Since the hills could contain historical objects, even soil disturbance is not permitted.

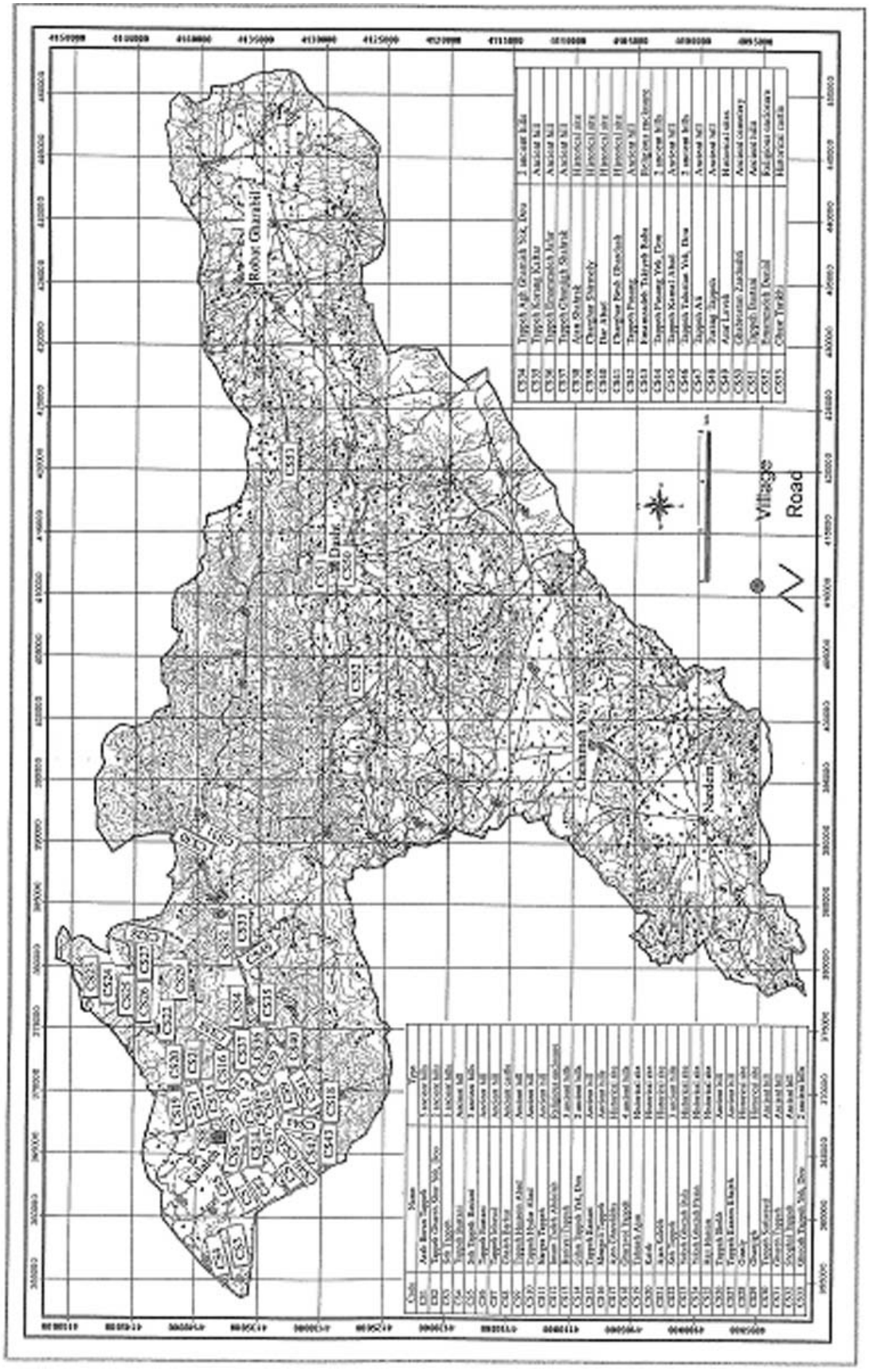


Figure 2 Historical, Cultural and Religious Sites in the Study Area

Attachment D JICA List of Sensitive Sectors, Characteristics, and Areas

According to Guidelines for Environmental and Social Considerations published by Japan International Cooperation Agency (JICA) in 2004, projects that are in *sensitive sectors*, have *sensitive characteristics*, and/or are in *sensitive areas*, would have significant adverse impact on the environment and society. Therefore are categorized as "Category A", and require full-scale environmental impact assessment prior to implementation.

1. Sensitive Sectors

(1) Mining development
(2) Industrial development
(3) Thermal power, including geothermal power
(4) Hydropower, dams and reservoir
(5) River/erosion control
(6) Power transmission and distribution lines
(7) Roads, railways and bridges
(8) Airport
(9) Ports and harbors
(10) Water supply, sewage and wastewater treatment
(11) Waste management and disposal
(12) Agriculture involving large-scale land-clearing or irrigation
(13) Forestry
(14) Fisheries
(15) Tourism

2. Sensitive Characteristics

(1) Large scale involuntary resettlement
(2) Large scale groundwater pumping
(3) Large scale land reclamation, land development and land-clearing
(4) Large scale logging

3. Sensitive Areas

(1) National parks, nationally-designated protected area, and areas for ethnic minorities or indigenous peoples and cultural heritage
(2) Areas that national or local governments believe to require careful considerations.

Natural Environment

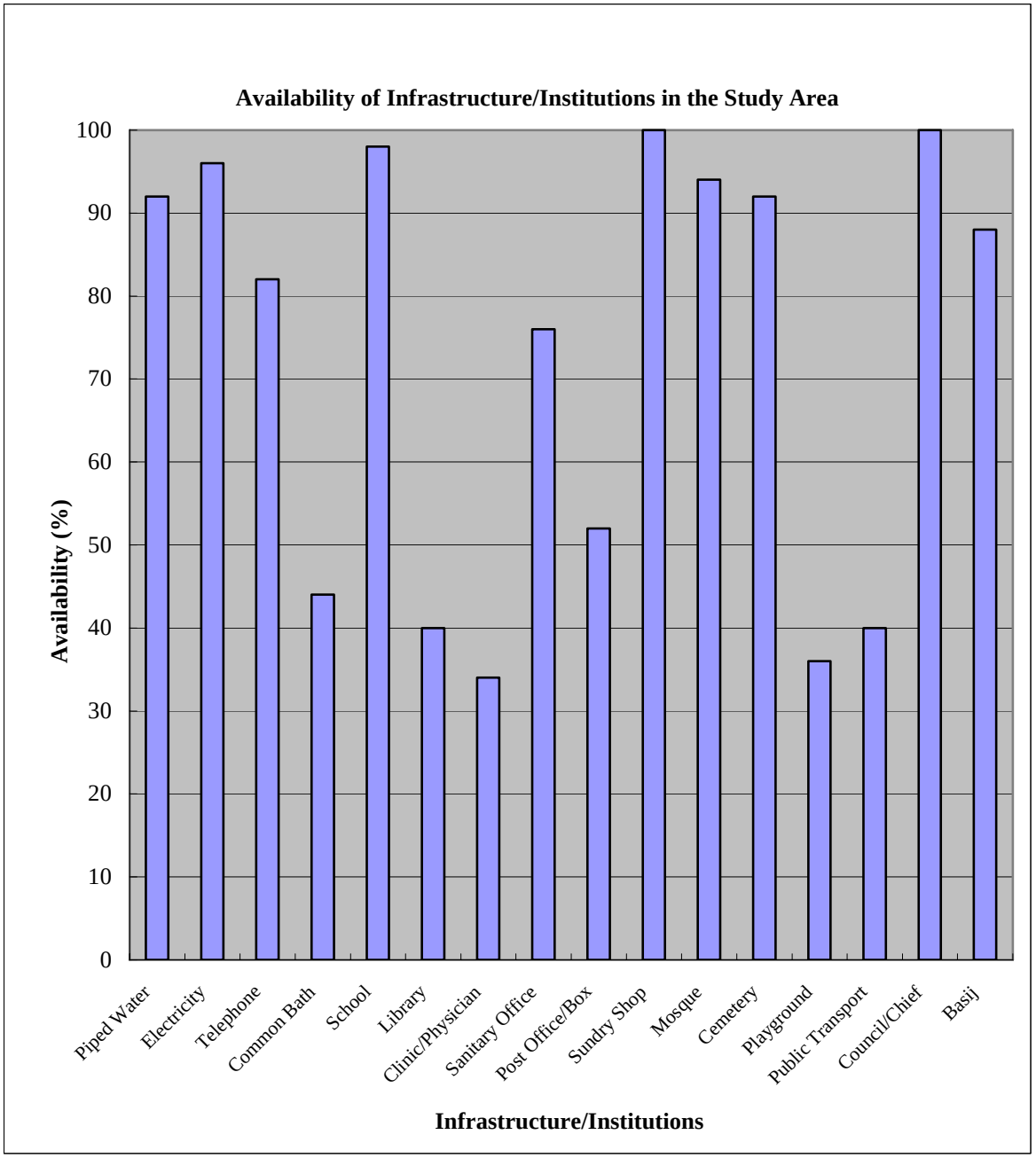
- Primary forests or natural forests in tropical areas

- Habitats with important ecological value, such as coral reefs, mangrove wetland and tidal flats
- Habitats of rare species requiring protection under domestic legislation, international treaties
- Areas in danger of large-scale salt accumulation or soil erosion
- Areas with a remarkable tendency towards desertification

Social Environment

- Areas with unique archeological, historical or cultural value
- Area inhabited by ethnic minorities, indigenous or nomadic peoples with traditional ways of life, and other areas with special social value.

Attachment E



Notes

1) In some village water is of poor quality and turbid
2) Primary and Secondary school widely exist, but high school is limited
3) In some villages library exist, while in others books (religious) are kept in the Mosque
4) In few large villages resident physician exist, while for small villages a physician come to village once a week and provide medical services
5) Most of villages are beside Tehran-Mashhad main road, and depend on passing vehicles for transport
6) Council/Chief = Rural Islamic Council/Village Chief
7) Basij = Voluntary units, which undertake social and relief works
8) In general fuel (kerosene/capsule gas) is supplied to villages through dealers by tanker/pickup cars.

Attachment F Damages Caused by Floods occurred in the Study Area

Type of Damage	*Casualty in 2001*	*Casualty in 2002*
Road demolished	194 km	182 km
Farms and orchards demolished	15000 ha	400 ha
People wounded	200 persons	5 persons
People killed and missing	254 persons	54 persons
Livestock lost	6000 heads	1000 heads
Forest demolished	5500 ha	-
Rangeland demolished	10000 ha	10000 ha
Vehicles destroyed	130 units	9 units
Residential/business building demolished	3000 units	1810 units
Telephone office demolished	7 units	5 units
Estimated Economic Damages	580 billion Rials	213 billion Rials

It should be noted that the above Table indicate only physical/economic loses, but not deal with psychological damages imposed on people by the floods.

Results of intensive surveys conducted on environmental and social conditions of villages by JICA Study Team (October 2004～February 2005) indicate that many people are suffering from psychological/emotional stress, which is a consequence of floods.

Attachment G

Checklist for Proving Environmental Impact (1/2)

1) Applicable development activities: for example, Rural development
2) Applicable development type: for example, New project
3) Applicable environmentally sensitive area: for example, Tropical rain forest

I. Social Environment

Category of Environmental Impact	Evaluation of SEI				Evaluation Base
	A	B	C	D	
1. Socio-economic Issues					
(1) Social Issues					
1. Planned residential settlement					
2. Involuntary resettlement					
3. Substantial changes in way of life					
4. Conflicts on among communities and peoples					
5. Impacts on native peoples					
(2) Demographic Issues					
1. Population increase					
2. Drastic change in population composition					
(3) Economic activities					
1. Change in bases of economic activities					
2. Occupational change and loss of job opportunity					
3. Increase in income disparities					
(4) Institutional and Custom Related Issues					
1. Adjustment and regulation of water or fishing rights					
2. Changes in social and institutional structure					
3. Changes in existing institution and customs					
2. Health and Sanitary Issues					
1. Increased use of agrochemicals					
2. Outbreak of endemic diseases					
3. Spreading of endemic diseases					
4. Residual toxicity of agrochemicals					
5. Increase in domestic and other human wastes					
3. Cultural Asset Issues					
1. Impairment of historic remains and cultural assets					
2. Damage to aesthetic sites					

Note: Applicable columns with the following impact degree are marked with "X"
SEI: Significant Environmental Impact
A: The subject SEI is unquestionably induced by the Project
B: The subject SEI is likely to be induced by the Project
C: There is no possibility of the subject SEI being induced by the Project
D: The SEI is not fully known

Checklist for Proving Environmental Impact (2/2)

II. Natural Environment

Category of Environmental Impact	Evaluation of SEI				Evaluation Base
	A	B	C	D	
4. Biological and Ecological Issues					
1. Changes in vegetation					
2. Negative impacts on important or indigenous fauna and flora					
3. Degradation of ecosystems with biological diversity					
4. Proliferation of exotic and/or hazardous species					
5. Destruction of wetlands and peatlands					
6. Encroachment into tropical rain forests and wildlands					
7. Destruction or degradation of mangrove forests					
8. Degradation of coral reefs					
5. Soil and Land Resources					
(1) Soil Resources					
1. Soil erosion					
2. Soil salinization					
3. Degradation of soil fertility					
4. Soil contamination by agrochemicals and others					
(2) Land Resources					
1. Devastation or desertification of land					
2. Devastation of hinterland					
3. Ground subsidence					
6. Hydrology and Air and Water Quality					
(1) Hydrology					
1. Changes in surface water hydrology					
2. Changes in groundwater hydrology					
3. Inundation and flooding					
4. Sedimentation					
5. Riverbed degradation					
6. Impediment of inland navigation					
(2) Water Quality and Temperature					
1. Water contamination and deterioration of water quality					
2. Water eutrophication					
3. Salt water intrusion					
4. Change in temperature of water					
(3) Atmosphere					
1. Air pollution					
7. Landscape and Mining Resources					
1. Damage to landscape					
2. Impediment of mining resources exploitation					

SUPPORTING REPORT I (MASTER PLAN)

PAPER VII

Initial Environmental Examination

THE STUDY ON FLOOD AND DEBRIS FLOW IN THE CASPIAN COASTAL AREA FOCUSING ON THE FLOOD-HIT REGION IN GOLESTAN PROVINCE

SUPPORTING REPORT I (MASTER PLAN)

PAPER VII INITIAL ENVIRONMENTAL EXAMINATION

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CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Caspian Sea region in northern part of the Islamic Republic of Iran includes provinces of Gillan, Mazandaran and Golestan, is subjected to frequent disasters of flood and debris flow. Madarsoo River basin is one of the disaster-prone basins in this region, which suffered huge damages as consequences of two big floods occurred in the years of 2001 and 2002. Some of these damages are tabulated below to reflect the severity of flood damages. It should be noted that the figures in this table indicate only physical/economic loses, but not deal with psychological and emotional stresses imposed on people by the floods.

Table 1.1 Damage in 2001 and 2002 Floods

Type of Damage	Damage in 2001	Damage in 2002
Road demolished	194 km	182 km
Farms and orchards demolished	15,000 ha	400 ha
People wounded	200 persons	5 persons
People killed and missing	400 persons	50 persons
Livestock lost	6,000 heads	1,000 heads
Forest demolished	5,500 ha	-
Rangeland demolished	10,000 ha	10,000 ha
Vehicles destroyed	130 units	9 units
Residential/business building demolished	3,000 units	1,810 units
Telephone office demolished	7 units	5 units
Estimated Economic Damages	580 billion Rials	213 billion Rials

The Madarsoo River (total length: 142 km, average slope: 1.4 %) originates in the northern side (Caspian side) of the Alborz Mountains, joins the Gorgan River after crossing the Golestan National Park, and thereby empties into the Caspian Sea. A road running in parallel with the river course is a part of the important international corridor linked to neighboring countries, Turkmenistan and Afghanistan, and the sacred place of Shiite Muslim, Mashhad city in Khorasan province. Peak traffic density of the road is about 25,000 units/day.

In addition to the Madarsoo River basin, there are some river basins being composed of similar situations in hazardous topography and climate in the region. For instance about 50 people were killed by disasters of flood and debris flow in the Nekka River basin in the Mazandaran Province. Maslee River basin in Gillan Province is also under similar situation to these basins.

In this circumstance the Government of Iran has taken some emergency steps to ease the situation mostly through temporary and non-structural means and measures, such as providing emergency relief and giving safety advice (such as relocation) to inhabitants. But the government has not drawn any concrete plan for disaster prevention and basin management in the region. Therefore formulating a master plan bearing short-, mid- and long-term objectives, and comprising of structural and non-structural measures is an important task to revert the confidence of inhabitants, and conserve/improve the natural resources in an efficient way.

In response to the official request of the Government of Iran, the Japan International Cooperation Agency (JICA) dispatched a preparatory study team, headed by Mr. Yoshifumi HARA to Iran at the end of August 2003. After continuous discussion between the team and project proponent (Forest, Range and Watershed Management Organization, Ministry of Jihad-e-Agriculture), both parties finally agreed upon the Scope of Work and the relevant Minutes of Meetings on September 3, 2003. Based on the minutes, JICA decided to

commence a Development Study in the Madarsoo River basin, in line with its technical cooperation scheme. Formulating an efficient and realistic Master Plan to mitigate the disasters of flood and debris flow, as well as carry out Feasibility Study on priority projects proposed in the master plan are main pillars of this study. Conducting environmental and social considerations in the basin and evaluating the environmental impacts of the project components are also among the undertakings of JICA. As a vital component of the JICA development study, this Initial Environmental Examination (IEE) has been made. It should be red in couple with other report (master plan) and other materials prepared by the JICA study team.

1.2 Objectives of the Study

(1) To formulate a master plan up to the target year 2025 for prevention of flood and debris flow disaster in the Madarsoo River basin,

(2) To select priority projects among the measures/schemes proposed in the above-mentioned master plan and to carry out the feasibility study on them,

(3) To prepare technical manual and guidelines, containing planning and designing of flood and debris flow countermeasures, applicable not only to the Madarsoo basin but also to similar other basins in the Caspian coastal area, and

(4) To pursue technology transfer to counterpart personnel in the course of the study, mainly focusing on planning and designing processes on flood and debris flow disaster mitigation and management.

1.3 Goals of the Study

(1) The projects, which are proposed through the study, will be carried out and disaster of flood and debris flow will be mitigated, and

(2) The Provincial Offices in the Caspian coastal area will conduct the proper planning and designing with necessary measures for flood and debris flow disaster mitigation and management.

1.4 The Study Area

The Study area covers entire basin of the Madarsoo River, which occurs in three provinces of Golestan, Khorasan and Semnan. This basin aggregates to a total area of 2,364 km^2. Fact and figures on present natural, social, economic and cultural conditions of the study area, as well as contents of the plans formulated by JICA study team for enhancing the overall environmental status of the basin are provided in following chapters.

CHAPTER 2 PHYSICAL ENVIRONMENT

2.1 Topography and Geology

2.1.1 Topography

The Madarsoo River basin with an area of 2,364 km^2 has elevations ranging for minimum 58 m to maximum 2,836 m. Its average elevation is about 1,200 m and its average slope is 23.9 %. In general mountains, hills, and floodplains feature the topography of Madarsoo River basin. Floodplains in the west and southwest are mainly allocated for agriculture. Mountains are situated in the north and eastern parts of the basin.

The percent changes in slopes in the basin are shown in Table 2-1. As shown in the table the gentle slopes comprise 32 %, level and nearly level terrains comprise 24 % of the area. Also moderately sloping lands to rolling cover 17 % and moderately to steep sloping lands cover 12 % of the area and are scattered throughout the basin. Mountains with steep and very steel slopes cover 15 % of the area and are observed in the northern parts of the basin.

Table 2.1 Slope Classification in the Madarsoo River Basin

Slope	Degree	Area (km^2)	Ratio (%)
Level to nearly level	0-3	560	24
Gently slopping to undulating	3-10	766	32
Moderately sloping to rolling	10-15	405	17
Steep sloping to moderately sloping	15-20	286	12
Steep mountains	20-30	271	12
Very steep mountains	Over 30	76	3
Total		2,364	100

Source: JICA Study Team, Progress Report, 2005.

2.1.2 Geology

Based on the geological studies carried out in the region, the area lies within the intersection of two important geological zones in the north east of the country, namely eastern Alborz (Binalood) and Kopeh Dagh. The border dividing these two zones extends along the Gorgan–Bojnoord road. From stratigraphic viewpoints, rocks and sediments of different geological ages, including Paleozoic up to present age, are spread over the area. The metamorphism has not happened in the area and igneous rocks are seldom observed. Different sedimentary rocks such as limestone, sandstone, shale, dolomite, marl, conglomerate, loess sediments and alluvium covers most parts of the area.

Geo-morphologically, mountains, hills, plains and rivers can be identified in the basin. In mountain and hill units, due to presence of regular and irregular foothills and diverse vegetative cover of foothills and different forms of erosions, there are wide variations in facets. Due to large thickness of loess in the mountain areas and improper uses of lands, landslides have occurred and there is potential for reoccurrence of it.

From erosion sensitivity point of view, rocks can be classified into five classes. The rocky units with thick layers are highly resistive to erosion. Dissected sediments over the riverbeds, loess and alluviums are highly prone to erosion. Therefore, in general it can be concluded that physical weathering is the main cause to deterioration in the mountain region and in lower altitude, with moderate climate, which allows better growth of forest vegetation, biological weathering is developed. On the other hand, dissolution action has resulted in development of crust in the area. Also in loess lands, chemical and biological weathering is considered to be the main erosion factors.

Sediments and rocks of prone and highly prone to erosion, which are widely seen in the area, indicate degree of erodibility of the area. Origin of rocks and sedimentary deposits contribute to morphologic formation of land. Tolerant limestone rocks and sandstone form the rock masses. Also, erosion prone formations like marl and clay contribute to formation of hills and gentle undulations.

(1) Permeability of Rock Masses

The permeability of rocks is controlled by different factors such as type of rock, texture, porosity, stratification, slope, vegetative cover and cracks. In assessing permeability of rocks, primary and secondary permeability are important. The primary permeability of the concentrated rocks might be low, but due to earth pressure and creation of deep cracks, their permeability significantly increases. Permeability classification of rocky and sedimentary units is as under:

Highly permeable rocks

These rocks and deposits include dissected deposits of riverbeds and flood ways, young alluvial fans and alluvial terraces. Considering the changes in texture of sediments in the southern and northern rivers, the amount of permeability changes. Deposits in the Madarsoo River are of coarse textured deposits.

Rocks with high permeability (Permeable)

These rocks include semi alluvial deposits with very weak cement including old alluvial fans, alluvial terraces, alluvial plains, karstic limestone rocks, and conglomerates of weak cements. These rocks are seen in different areas specially Robat Gharebil, Dasht and Golestan national park.

Rocks with moderate permeability

These are rocks with weak cement; deep tectonic cracks and fine textured loess deposits. Broken sandstone, marl limestone and dolomite rocks, broken shale and loess deposits and small stones are considered as rocks of moderate permeability.

Low permeable rocks

Low permeable rocks are those with small cracks and fine textured. There are also constituted of fine textured clay. Marl deposits of Neogene, silty clay deposits and Andesite rocks are considered as low permeable rocks.

(2) Possibility of mass movement occurrence and slope instability

Gravitational force in mass movement such as landslide is the main factor for movements of surface material like soil and rock. Disturbing natural stability of slope may result in slides. The main factors contributing to such phenomena include geological condition, soil type, land slope, vegetative cover, water and human interventions.

When weight of soil strata and rocks in foothills is more than their natural capacity, there are chances of landslide occurrence. Excavation and creation of trenches, construction of roads and mining, clearing deep root vegetative cover, increasing soil moisture through rainfall or effluents and irrigation are main factors accelerating landslide. Usually landslides occur in land with slops of over 25 % and low vegetative cover and high rainfall. Due to specific geological condition of the area under the study, there are high potential for landslide occurrence.

Due to geological activities at the Glacial age and creation of large alluvium loess, large area of the Kalaleh and Madarsoo regions were covered with loess deposits of varying thickness. These deposits are constituted of silt and clay with relatively good permeability, but highly prone to erosion and low sheering strengths. Any activity contributing to increased weight

and weakening stability of loess grains may result in extensive mass movement. Therefore, in general the important regions prone to potential landslide are those covered with loess deposits.

The potential for occurrence of such phenomenon is more in areas like scattered loess deposits in Kalaleh as compared to other areas. Shemshak formations constituted of argil shale with coal and erosion prone marls around banks of mainstream have significant potential for landslide. Construction of mountain roads in the areas prone to landslide creates environment for occurrence of landslide along the road margins.

2.2 Climate and Weather

For assessing climate of the area, data from five climatological stations, namely Kalpoosh, Tangrah, Kalaleh, Soodaghlene and Nardin were used. The stations located at Kalpoosh and Tangrah are considered as online stations, but at present they do not function properly and one cannot get easy access to the data observed in the stations.

In addition, there are two rain gage stations (Robat Gharabil and Tang Gol) owned by Meteorological Organization and five others (Robat Gharabill, Cheshmeh Khan, Tangrah, Kalpoosh and Dasht-e-shad) affiliated to Ministry of Energy. Rain gage stations at Kalpoosh and Dasht-e-Shad are considered as online stations. Data generated at online stations can be sent to authorize agencies through public telephone line.

2.2.1 Rainfall

The average annual rainfall data from the above mentioned stations were analyzed for the period of 1975-2002. Data on annual rainfall obtained from reliable stations indicate that the annual rainfall ranges from 695 mm to 139mm (see Table 2.2).

Table 2.2 Annual Rainfall in the Madarsoo River Basin

Station	Average Annual Rainfall (mm)
Tangrah	695
Dasht Shad	357
Robat Gharebill	198
Dasht Kalpoosh	139
Kalaleh	516
Soodaghlene	406
Cheshmeh Khan	231
Nardin	148

Source: JICA Study Team, Progress report, 2005

Based on the data available from the existing stations, isohyets curves were produced for the Madarsoo basin (see Figure 2.1). As shown in the figure, amount of rainfall in the eastern and southern parts of the basin is low, and high in western part. Highest rainfall is observed at Tangrah.

Distribution of monthly rainfall reveals that highest rainfall occurs in March. The average rainfall in March is recorded at 99 mm at Tangrah, 45 mm at Dasht-e-Shad and 30 mm at Robat Gharebil. In general, the months from November to May are considered to be the wet months, while the months from June to October are the dry months. Figure 2.2 indicates the monthly rainfall observed at the major stations.

In general, the amount of rainfall is high in the central parts of the basin, especially at Dasht-e-Shad, Tangrah, Dasht Kalpoosh and Soodaghlene. Amount of rainfall in August 2001 ranges from 80 mm to 176 mm, which occurred in 50 % of the basin, especially in the central parts. Also in August 2002, which was coincide with a flood, the amount of rainfall was

recorded at 40 to 180 mm, which was occurred in 35 % of the area of basin. The amount of rainfall recorded at Tangrah, two days before the 2002 flood, was 24 mm.

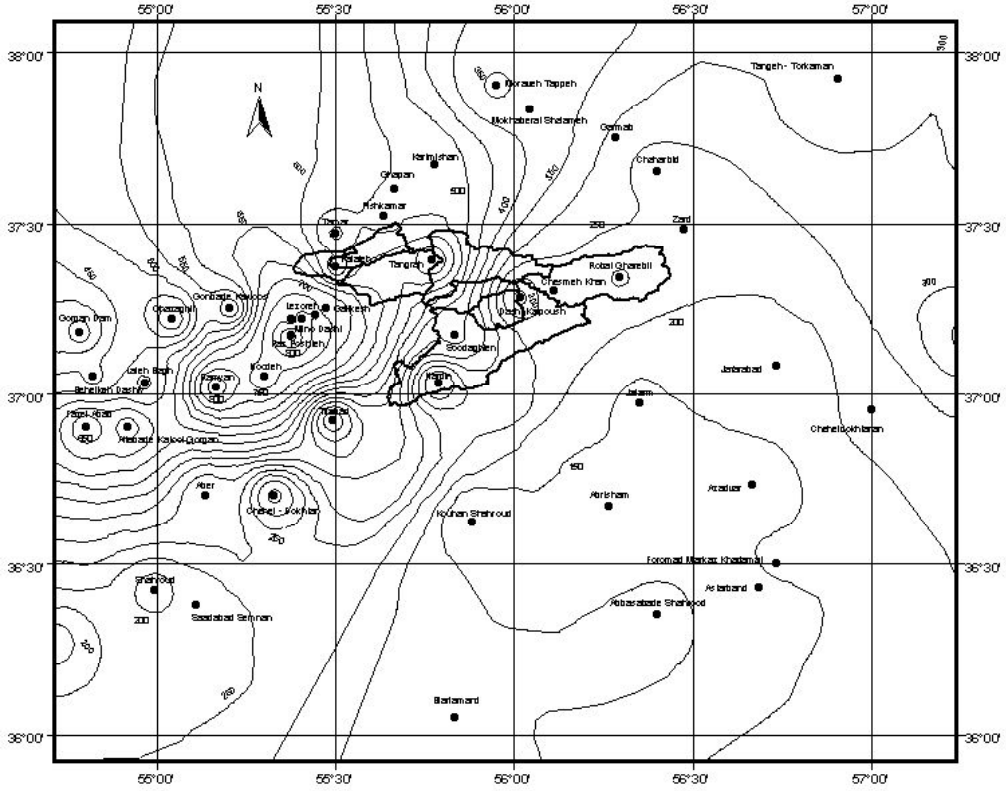


Figure 2.1 Annual Rainfall Isohyets for Madarsoo River Basin (1975-2002)

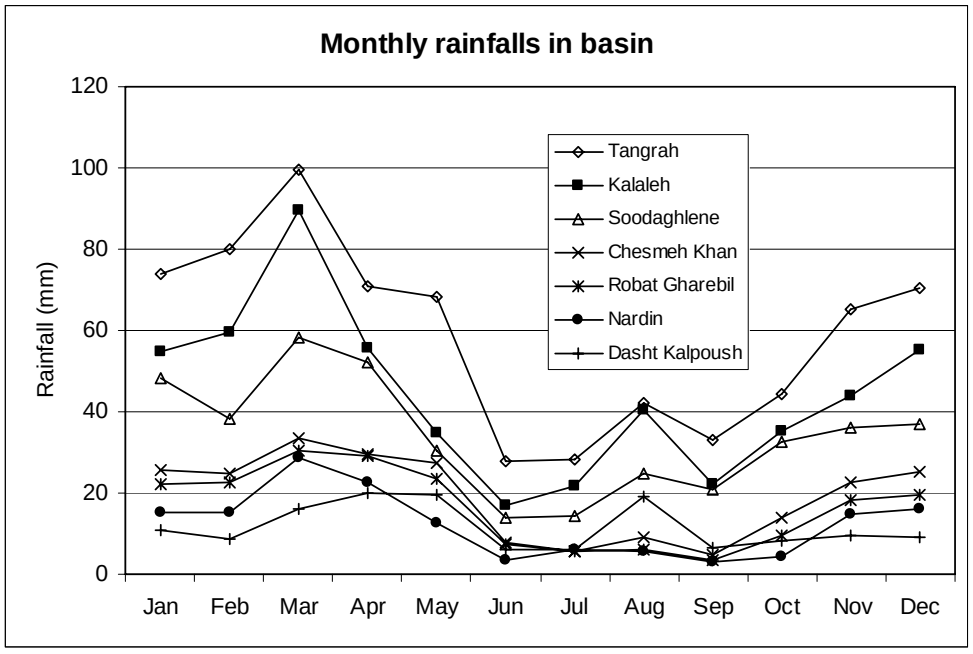


Figure 2.2 Monthly Rainfall Variation of Stations in Madarsoo River Basin (1975-2002)

Table 2.3 shows the amount of rainfall during the 2001 and 2002 floods.

Table 2.3 Daily Rainfall (during floods) in Madarsoo River Basin

Station	11 August, 2001 flood	13 August 2002 flood
Dasht Shad	176	108
Tangrah	150	30
Soodaghlene	117	33
Sasht Kalpoosh	100	60
Cheshmeh Khan	84	16
Nardin	-	25
Others	20-80	10-40

Source: JICA Study Team, Progress Report, 2005

2.2.2 Other Parameters

Other climate parameters were assessed for the 2001 and 2002 flood periods, and the results are illustrated in Table 2.4. The relative humidity in 2001 in Kalaleh and Sodaghlan stations were 52% and 94% respectively. During the same period, temperature varied from 19.5 to 23º C and wind-speed variation was from 0.5 to 2.7 meters/second. Also for the 2002 flood the changes in relative humidity were 69 % in Dasht Kalpoush to 94 % in Sodaghlan station and variation of temperature and wind speed were 19.5 ℃and 2.2 meters/second respectively. The studies indicated that average daily temperature two days before flood start decreasing.

Table 2.4 Some Other Climate Parameters During 2001 and 2002 Floods

Parameters	2001			2002				
	Sodaghlan	Nardein	Kalaleh	Kalposh	Sodaghlan	Nardein	Kalaleh	Kalposh
Relative humidity (%)	81	23	94	96	69	31	94	84
Temperature (ºC)	52	-	20.5	19.5	82	3.1	20	19.5
Wind speed (m/sec.)	22	-	2.7	0.5	21		2.2	

Source: JICA Study Team, Progress report, 2005

2.3 Soils and Landforms

Total land of a basin or region with a view to all environmental factors is called land resource. Based on existing standards adopted by Soil and Water Research Institute, land resources from morphological and physiographical point of view can be classified into nine major land types, and based on geomorphological divisions, each major land type is further divided into land units. For this purpose, map of soil evaluation and land capability study of Golestan, Khorasan and Semnan provinces (1993) are used.

Based on the current study, five major land types are identified in the Madarsoo River basin considering the conventional methodology adopted in the country (see Fig 2.3).

- Mountains
- Hills
- Plateau and upper terraces
- Piedmont plains
- River alluvial plains

Figure 2.3 Soil and Landform in the Madarsoo Basin

Based on the field investigations, out of five major land types, most areas are covered by mountain and after mountains hills occupy wide areas. Based on the topographic and geomorphologic characteristics, above mentioned types can be classified into separate land units in the study area, which are explained below:

(1) Mountains

In the Madarsoo River basin there are three land units belonging to mountain type (with steep slope, mostly more than 40 %) as follow:

- Land unit 1.1: including very high to high mountains with sharp summits, formed with hard and dolomitic limestone, sandstone and some igneous rocks.
- Land unit 1.2: including relatively high mountains with spherical and some flat summits, formed with limestone, metamorphic rocks, conglomerate, sandstone and shale.
- Land unit 1.5: including relatively high mountains with spherical and some flat summits, formed with limestone, shale, metamorphic and igneous rocks.

(2) Hills

In the Madarsoo River basin, there is one land unit belonging to hill type (mostly with more than 20 % gradient) as follow:

- Land unit 2.2: including low altitude to high hills with spherical and some flat summits, formed from limestone, conglomerate, sandstone, metamorphic rocks and shale.

(3) Plateau and Upper Terraces

In the Madarsoo River basin there is one land unit belonging to plateau and upper terraces type (relatively flat with 2-8 % gradient) as follow:

- Land unit 3.2: including plateau and upper terraces with fault-block and low to moderate erosion rate located on loess and gravel parent material.

(4) Piedmont Plains

In the Madarsoo River basin there is one land unit belonging to piedmont plain type (dominantly flat with 0.5 to 2 % gradient) as follow:

- Land unit 4.2: including piedmont plains with moderate slope and without fault-block and water erosion.

(5) River Alluvial Plains

In the Madarsoo River basin there is one land unit belonging to river alluvium plain (flat with negligible gradient) as follow:

- Land unit 2.8: including fan shape settlements with upper gravels with moderate fault-block and moderate to high water erosion.

2.4 Land Use (Land Cover)

The land use map (land cover) of the area is prepared on the basis of "Integrated Studies for Development of Agriculture and Natural Resources, Gorgan Plain Studies and Gorgan Flood Studies (Gorgan Regional Water Authority- 2004)". Using 1/250,000 topographic maps of Geographical Organization of Armed Forces, the land use map was updated, where required. These data were corrected through field investigation and using 1/50,000 topographic maps of Geographical Organization of Armed Forces.

The land use map (land cover) of the area indicates that major parts of lands in the southern parts of the Madarsoo basin have changed to rainfed farming, parts of which is located in slope lands, exposed to soil erosion and environmental deterioration.

Generally different land uses including range and forest, irrigated and rainfed agriculture and also rainfed farming in slopes are identified in the area. Rangeland with an area of 101,630 ha has the highest area and forest and dry farming with 76,940 ha stands after rangeland. Also, there are 17,000 ha of irrigated lands. The rainfed lands, which are highly exposed to erosion, cover an area of about 6,650 ha (see Figure 2.4 and Table 2.5).

Table 2.5 Area of Different Land Use (Land Cover) in Madarsoo River Basin

Land use (land cover)	Area (ha)
Forest	76,940
Rangeland	101,630
Irrigated farming	17,000
Rainfed farming	34,190
Rainfed farming in slopes	5,560
Total	236,400

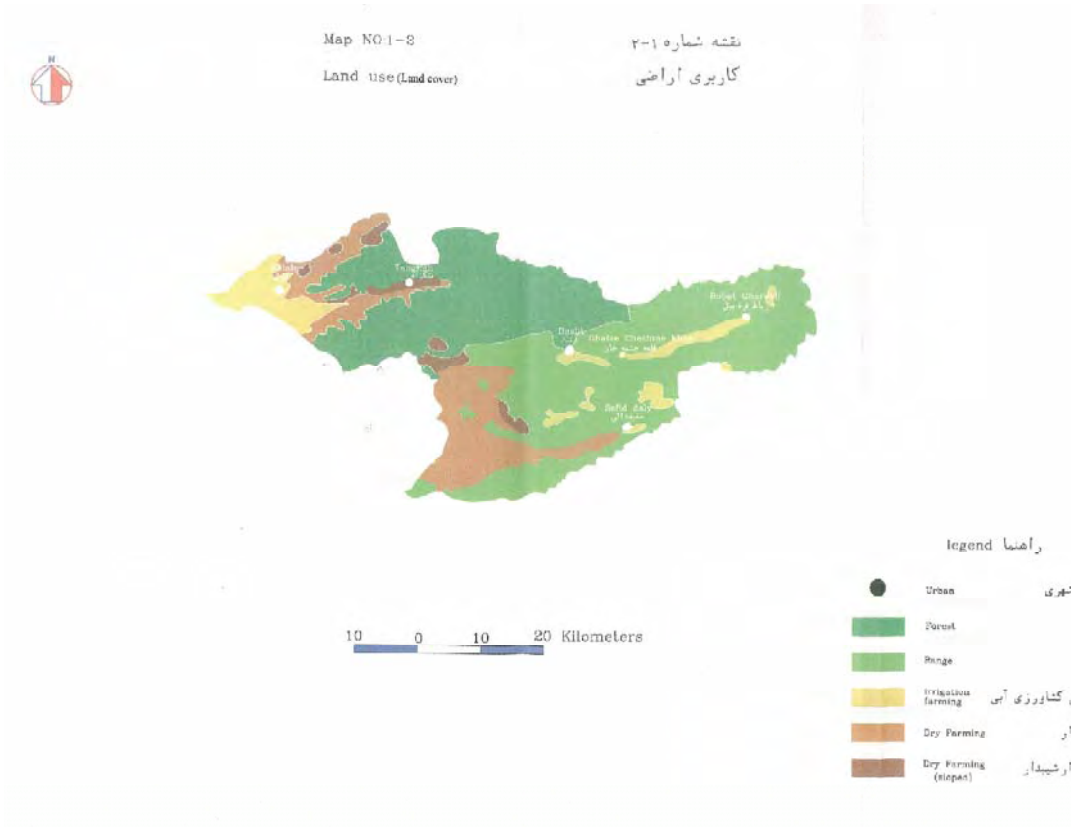


Figure 2.4 Land Use (Land Cover)

2.5 Water Resources

2.5.1 Surface Water Resources

Rainfall and Runoff

The Madarsoo River, which is a major branch of the Gorgan River, originates in eastern mountains of basin (eastern end of Alborz mountain) and is contributed by Lal, Ashkhaneh, Loveh and Karankaftar springs flowing near Kalaleh town. After joining the Gorgan River, the stream flow is conveyed to Golestan 1 dam. There are two hydrometric stations, namely Dasht and Tangrah in the basin. Following two destructive floods in 2001 and 2002, Dasht hydrometric station was established. Tangrah station was destroyed by the 2001 Flood and rebuilt in 2002. These are online hydrometric stations and their information are recorded and reported instantaneously through public telephone cable. Surface water study is mainly based on information gained at Tangrah station.

The Gorgan plain studies in 2004 are most reliable studies so far conducted in the area. Data from the Gorgan plain studies are used in water resource study, but updated.

The Tangrah hydrometric station was established in 1966. It is located at º55 ´42 "18 east longitude and º37 ´23 "20 north latitude. It is situated at 330 m above sea level. The annual average discharge from the Madarsoo River during 1966-2000 is shown in Table 2.6. Annual average discharges vary from 0.48 to 3.25 m^3/s. The average discharge during the same period was estimated at 1.57 m^3/s.

Table 2.6 Average Annual Discharge at Tangrah Station in the Madarsoo River

Year	Average Annual Discharge (m^3/sec)	Year	Average Annual Discharge (m^3/sec)
1967	0.64	1985	1.05
1968	1.35	1986	1.09
1969	2.90	1987	1.74
1970	2.39	1988	2.44
1971	0.68	1999	1.69
1972	2.38	1990	0.88
1973	2.22	1991	1.56
1974	2.27	1992	2.82
1975	1.77	1993	2.38
1976	1.18	1994	1.90
1977	0.61	1995	1.38
1978	1.07	1996	1.21
1979	0.53	1977	0.71
1980	0.74	1998	1.11
1981	3.52	1999	0.48
1982	2.01	2000	0.56
1983	1.18	2001	2.97
1984	1.48	Average	1.60

Source: Water resource studies, Gorgan Plain Studies, Boomabad Consulting Engineers- 2004

Annual average discharge of 35 years is estimated to be 50 MCM, using the above table. Daily and instantaneous maximum discharge of the Madarsoo River is shown in Table 2.7.

Maximum instantaneous discharge at Tangrah station during different periods varied from 4.4 to 1650.0 m^3/s. Also daily maximum discharge of the river during 35 years varied from 3.3 to 777.0 m^3/s.

Table 2.7 Instantaneous and Daily Discharge at Tangrah Station in the Madarsoo River

Year	Instantaneous (m^3/sec)	Maximum Daily (m^3/day)	Year	Instantaneous (m^3/sec)	Maximum Daily (m^3/day)
1966-67	11.3	9.6	1984-85	6.8	6.7
1967-68	24.0	20.0	1985-86	7.0	6.5
1968-69	56.4	35.0	1986-87	16.8	16.3
1969-70	-	-	1987-88	42.7	20.1
1970-71	10.9	8.3	1988-89	42.8	17.2
1971-72	93.2	74.8	1989-90	15.1	6.8
1972-73	38.0	21.9	1999-91	23.4	16.0
1973-74	16.7	13.9	1991-92	182.3	68.1
1974-75	25.3	17.1	1992-93	19.0	17.7
1975-76	16.4	11.6	1993-94	30.5	17.9
1976-77	4.4	3.3	1994-95	19.4	15.7
1977-78	10.4	7.2	1995-96	15.2	9.1
1978-79	5.3	4.2	1996-97	13.5	3.4
1979-80	9.4	5.0	1997-98	34.5	13.6
1980-81	22.1	19.6	1998-99	18.0	13.4
1981-82	129.0	65.0	1990-2000	14.5	4.2
1982-83	7.3	5.7	2000-01	1650.0	777.0
1983-84	11.1	9.0	2001-02	644.0	158.0
			Average	91.6	42.6

Source: Water Resource Studies, Gorgan Plain Studies, Boomabad Consulting Engineers- 2004

The maximum daily rainfall in the Madarsoo basin during 1974-2002 is shown in Table 2.8. As shown in the table, daily rainfalls on 14 May 1992, 11 August 2001 and 13 August 2002 were high enough to create some floods.

Table 2.8 Maximum Daily Rainfall in the Madarsoo Basin

Year	Date	Rainfall (mm)	Year	Date	Rainfall (mm)
1974	28 November	21	1989	6 January	23
1975	29 November	20	1990	15 May	23
1976	25 April	16	1991	4 May	28
1977	21 April	19	1992	14 May	44
1978	2 May	24	1993	16 February	14
1979	13 September	18	1994	6 January	26
1980	29 December	12	1995	23 January	32
1981	6 October	16	1996	26 January	31
1982	24 June	13	1997	6 November	16
1983	13 December	13	1998	19 March	13
1984	6 October	20	1999	12 July	18
1985	11 October	21	2000	8 August	17
1986	4 August	31	2001	11 August	104
1987	21 March	26	2002	13 August	53
1988	1 April	28			

Source: JICA Study Team, progress Report, 2005

Sediment Load

Based on Gorgan and Gonbad plain studies (Boomabad consulting Engineers. 2004), the annual average suspended sediment load in the Madarsoo at Tangrah station (drainage area of 1,560 km^2) was about 37.08 thousand tons. Maximum suspended load recorded in May was 14.52 thousand tons, while minimum ones recorded in November and December were 0.106 and 0.129 thousand tons respectively. Annual suspended load in the Madarsoo at Tangrah station was estimated at 37.60 thousand tons (see Table 2.9).

Table 2.9 Average Monthly and Annual Suspended Loads in the Madarsoo Basin in 2001

Oct.	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
0.066	0.398	0.106	0.129	0.209	1.567	8.074	14.52	0.874	0.282	10.86	0.519	37.60

Source: Water resource Studies, Gorgan and Gonbad Plain Studies, Boomabad Consulting Engineers, 2004
unit: 1000 tons

Water Quality

The water quality parameters are shown in Table 2.10. Since urban and residential areas and industries are not developed in the upstream area of the river, quality of water is good. The average electrical conductivity recorded at Tangrah station was 909 micro-mohos/cm and average total hardness was 292.5 mg/l. There is no limitation for different uses.

Table 2.10 Water Quality of Madarsoo River at Tangrah Station

Parameter	Unit	Maximum	Average	Minimum
Ca	meq/l	4.7	2.92	1.9
Mg	meq/l	4.3	2.93	1.4
Na	meq/l	9.14	4.76	0.92
K	meq/l	0.14	0.06	0.01
TDS	mg/l	1083	631	298
TH	mg/l	450	292.5	165
Cl	meq/l	7.8	4.2	0.9
So^4	meq/l	5.35	2.41	0.45
HCo3	meq/l	5.6	4	2.75
EC	mmoh/cm	1658	909	472
PH	-	8.2	7.8	7.2

Source: Water Resource Studies, Gorgan Plain Studies, Boomabad Consulting Engineers, 2004

2.5.2 Groundwater Resources

Alluvium Specifications

The alluvium of the Madarsoo is a part of large alluvium in southern and eastern areas of the Caspian Sea. Madarsoo basin's aquifer is located at the end of eastern aquifer.

In the large eastern plateau, there are sediments of old and new Caspian, with a thick layer of about 1000 m. These sediments are comprised of marl sediments, limestone, sandstone, silt and clay. River alluviums covered with heterogeneous textures are also deposited in the area. It is to be mentioned that thickness of fresh water aquifer is more at alluvial fans and the Madarsoo River has maximum as compared to other locations in the area under the study.

Existence of layers of fine textured sands and silts in between aquifers, results in collapse of well and restricting ground water utilization.

Water Level Fluctuation and its Changes

Water level on alluvia fans in the Madarsoo basin varies from 20 to 50 m and at the plains varies from 3 to 10 m. Based on the water resource studies, seasonal change in water level is estimated at 1 to 1.5 m. This range of variation occurs between the wet and dry seasons. Though some fluctuation is observed in specific years, in long run, they are not significant.

Ground Water Balance

In order to assess the possibilities of exploitation of groundwater resources and water table fluctuation, it is necessary to know recharge and discharge parameters. Recharges of aquifer in the Madarsoo basin include water-bearing formations of higher elevations, rainfall infiltration, and surface water and irrigation infiltration. Discharges from aquifers include withdrawals from wells, spring, Qanats, and the Madarsoo river drainage and groundwater evaporation in areas where ground water table is shallow.

The amount of discharge from the Madarsoo basin is estimated at 51,716 m^3 (through 12 springs with discharge of 9,643 m^3; 22 Qanats with discharge of 8,381 m^3, and 3,429 wells with discharge of 33,692 m^3). Assessment of above figures, hydrographs of eastern aquifers and inflow to aquifers indicates that ground water in the Madarsoo basin is well balanced.

Groundwater Quality

Sampling of different sources of groundwater in Gorgan plain has started in 1961 and continuing till now. Electrical conductivity (EC) in this area varies from 391 to 4,511 mmhos/cm, and total dissolved solid (TDS) varies from 254 to 2,982 mg/l. Also variation of pH is recorded at 4.4 to 8.8. Calcium ions, which are directly related to variation of bicarbonate ion or dissolution of limestone in water, vary from 1 to 5.7 meq/l, and sodium ions vary from 0.38 to 60 meq/l.

Due to lack of inorganic material, dominant formation in the geo-chemical structure of water bearing layers are bicarbonates. Based on water quality classification for agricultural purposes, waters are dominantly with moderate salinity, low sodium absorption ratio. Water quality is classified as C3-S1 and C3-S2.

CHAPTER 3 BIOLOGICAL ENVIRONMENT

3.1 Vegetation Cover (Flora)

Based on the type of the vegetation, totally the Madarsoo River basin can be divided into 3 habitats: forest, rangelands and farmlands. Result of field surveys determines that forestlands of this basin are expanded in the central and northern and west North Slope. Based on the classification of vegetative areas of Iran, these areas are included in Hyrkani forest that can be almost considered as the extreme forest areas of the Alborz Mountains. Humidity rate of these forests is less than western parts of the Hyrkani and existence of several species of Quercus and Zelkova in this part approves this matter. Ranges of this basin extend in highlands of the forest and also in the east and south slope, while farmlands extend in the west and south plains of the basin as a narrow strip in eastern highlands (see Figure 3.1).

3.1.1 Situation of Vegetative Types

After studying maps and available references (Gorgan plain improvement studies, Agricultural and natural resources master plan studies of Golestan province, Golestan province flood studies) and as a result of field surveys and applying necessary corrections on the maps, 10 vegetative types have been recognized in the study area. Rangelands cover more areas than forestlands. Table 3.1 indicates index and specifications of vegetation areas and identifying significant species of the abovementioned types. After putting together the information extracted from other studies and results of field surveys, in this area four forest types and six range types have been recognized.

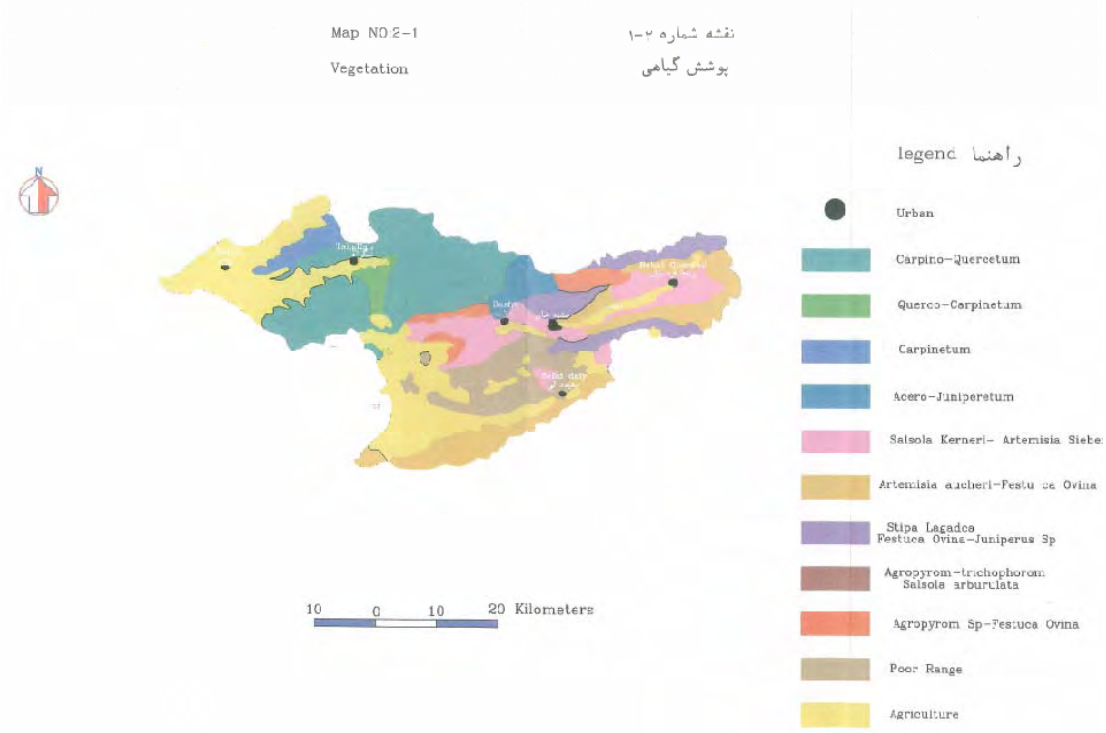


Figure 3.1 Vegetation Cover

Forest

Table 3.2 indicates the index and important specifications of forest types of the studying area, including percent of canopy, number of trees per ha and re-productivity situation of each type.

It can be observed that *Carpino-Quercetum* and *Carpinetum* types have high density per ha and *Acero-Juniperetum* type has the least density/ha. *Querco-Carpinetum* has the highest percent of canopy in comparison to the other types. This type from the view of reproduction has better situation than the others. It is well worth to mention that Golestan National Park is located in this area, which will be explained in the next sections of the report.

Rangeland

Due to lack of infiltration of north humid fronts (sea) into extreme eastern parts of Golestan province (basin is a part of this area), expansion of broad leaf forests (Hyrkani) are limited in these areas such that expanded Ranges can be seen in most areas and in east and south slopes.

Table 3.1 Dominant Vegetation Types in the Madarsoo River Basin

No.	Type	Growth Areas	Species Identified
1	Carpino-Quercetum	Humid to Semi-humid slopes of south and north Tangrah, elevation about 500-1000 m	Carpinus betulus, Quercus castaneifolia, Zelkova crenata, Alnus subcordata
2	Querco-Carpinetum	Humid to Semi-humid slopes of Loveh, elevation 500-1000 m	Quercus castaneifolia, Carpinus betulus, Zelkova crenata, Alnus glotinosa
3	Carpinetum	Semi-humid, east north and east slopes of Kalaleh, elevation about 300-800 m	Carpinus betalus, Quercus castaneifolia, Acer cappadocieum, Acer velutinum
4	Acero-Juniperetum	Highlands of Carpino-Quercetom forests, semi-humid to semi-arid	Acer Campester, Acer hyrcanum, Acer platanoides, Juniperus sp. Carpinus orientalis
5	Salsola kerneri–Artemisia sieberi	Eastern slopes and some highlands of this unit with semi-arid climate	Artemisia sieberi, Salsola kerneri, Stipa barbata, Medicago polymorpha
6	Artemisia aucheri -Festuca ovina	Southern and eastern slopes of the basin	Artemisia aucheri, Festuca ovina, Astragalus sp., Rhamnus pallasii
7	Stipa lagadca-Festuca ovina-Juniperus sp.	Highland over the forest of the basin, elevation about 1500-2000 m with semi-humid to semi-arid climate	Stipa lagadca, Festuca ovina, Jumiperus sp., Onobrychis sativa, Bromus tomentellus
8	Agropyron trichoforum-Salsola arbusulata	East south slopes of the basin	Agropyrom trichoforum, Salsola arbuscula, Festuca ovina, Stipa barbata
9	Agropyron sp. Festuca ovina	East slopes and highlands over the beech and oak forests and eastern slopes of Acer and Juniperus forests, elevation over 1500 m	Agropyrom sp., Festuca ovina, Dactylis glomerata
10	Poor ranges	South part of the basin	Artemisia species

Table 3.2 Major Forest Types in Madarsoo River Basin

No.	Forest Type	Number of Tree/ha	Percent of Canopy	Reproduction
1	Carpino-Quercetum	130-210	55-75	Moderate
2	Querco-Carpinetum	120-180	70-80	Optimum
3	Carpinetum	140-200	60-75	Moderate
4	Acero-Juniperetum	60-120	40-55	Weak

Based on previous studies and results of field surveys, six dominant Ranges types, which can be determined in the basin are as follow:

- Salsola kerneri - Artemisia sieberi

- Artemisia aucheri - Festuca ovina
- Stipa lagudca - Festuca ovina-Juniperus sp.
- Agropyrom trichophorom - Salsola arbusulata
- Aqropyrom - Festuca ovina
- Poor Ranges

Poor ranges have been observed in wide expanded areas of the south plain and also in the north and west north of Sefid Dali area. Based on previous studies such as "Agricultural and natural resources master plan studies of the provinces" and "Agricultural Economy digital layers of master plans (Institute of Planning Researches and Agricultural Economy Ministry of Jahad-e-Agriculture-2004)", due to low density and scattered vegetative species, range types cannot be recognized in these lands. Field surveys also approve this matter. As a result of field surveys, different species of *Artemisia*, *Stipa* and *Juniperus* are also scattered in this sections. Therefore, considering the density situation and dispersion of species, these Ranges are called Poor Ranges. Totally, the vegetative types include a few kinds of dominant vegetative species. These species in non-forest areas are *Artemisia* species, some species of *Graminae* family like *Agropyrom cristatum, Festuca ovina* and *Stipa barbata* and some types of trees and shrub like *Juniperus Sp.* and *Astragalus* species. Among these, expansion of *Artemisia species* is significant.

Quality and quantity of the ranges of this area are not in good condition because of overgrazing (more than capacity of the ranges and long time grazing). In most areas suitable and rich forage especially permanent *Graminae* not exist and in exceptional cases they are very negligible and scattered under the shadow of other species like *Onobrychis* and different kinds of *Astragalus* species.

Expansion of rich ranges species of *Graminae* family such as *Festuca ovina, Agropyrom, A.intermedium, Bromus tomentosus, Cristatum* in the Protected Areas of the Department of Environment (DOE) can be strong reason for possibility of growth and expansion of these species in similar areas. Specification of range types is summarized in Table 3.3.

Most of the rangelands of this area have negative condition and tendency. *Agropyrom Sp.- Festuca ovina* is the unique type that has good condition and stable tendency and its potential yield is about 490 kg/ha, which is higher than yield of the other observed species of the basin.

Table 3.3 Specification of Range Types in the Madarsoo River Basin

No.	Range Type	Range Condition	Potential Yield (kg/ha)
1	Salsola kerneri, Artemisia sieberi	Weak and negative tendency	300
2	Artmisia aucheri, Festuca ovina	Weak and negative tendency	324
3	Stipa lagadca, Festuca ovina, Juniperus sp.	Weak and negative tendency	264
4	Agropyrom trichophorum, Salsola arbusulata	Good and negative tendency	450
5	Agropyrom sp., Festuca ovina	Good and stable tendency	490

Source: Gorgan and Gonbad Plain Studies, Boomabad Consulting Engineers, 2004

3.1.2 List of Important Vegetative Species

Recognizing and introducing of dominant vegetative species in the Madarsoo River basin have been done, based on maps and others available materials such as "Gorgan plain management studies", "Agricultural and natural resources master plan studies of Golestan, Semnan and Khorasan provinces", "Master plan studies of flood Control of Golestan province", as well as controlling results of field surveys. About 36 tree species and 41 shrub species belonging to 31 families have been recognized in the study area.

Aceraceae family among tree species and *Rosaceae* family among shrub species have the highest diversity. Based on the abovementioned references and as the result of field surveys, 32 range species belonging to 9 families have been recognized throughout the rangeland areas, among which *Graminae* family (with 14 species) has the highest diversity. Dominant trees, shrubs and grass species are listed in Annexes of this Report.

3.1.3 Protection Specifications of Vegetative Species

From the viewpoint of the red list of International Union for Conservation of Nature and Natural Resources (IUCN), through studying forest species of the area, 13 forest tree species can be put in this list. Two species including *Populus caspica* and *Taxus baccata* are in the list and can be considered as Endangered Species (EN). *Cotoneaster sp.* is included in vulnerable species (VU). Ten species are Low Risk (LR), of which the most important ones are the followings:

- Juniperus foetidissinia
- Fraxinus excelsior
- Zelcova carpinifolia

Five forest species are Endemic and all of them are included in the red list of IUCN. From the view point of protect specifications, 4 rangeland species including, *Achillea millefolium, Bromus tomentosus, Salvia sp.* and *Thymus kotschyanus* are in Low Risk (LR) group and two of them are Endemic.

3.2 Wild Life (Fauna)

The Madarsoo River basin due to its wide expansion includes different kinds of habitats such as Caspian forests, highland (Mountain) and steppe. In addition, farmlands and their surrounding areas are considered as a significant manmade environment. Thus diversity of animals is very considerable in this area.

Totally forestlands are located in the centre, north and west north of the basin. Ranges and barren lands are located in the east and south. Rainfed farming lands as a small part in the east, and dry farming lands are located in the south and west part of the basin. Most of animals of this basin can be seen in the natural areas, but some belong to human environments (agricultural and urban areas).

Considering previous studies (reports of the Department of Environment, and consulting engineers reports), wild lives of Madarsoo river basin (except environmentally protected areas which will be discussed in the next section) are studied in 5 classes, namely mammals, birds, reptiles, fish and amphibians.

3.2.1 Mammals

About 48 mammal species belonging to 17 families have been recognized in the Madarsoo River basin (except for protected areas). Mammals such as *Cervus elaphus, Capreolus capreolus, Panthera pardus saxoicolor, Felis chaus, Ursus arctos, Myoxus glis* and *Dryomys nitedula* can be seen in the north and west-north forest of the basin. Around farmlands and ranges there are *Vulpes vulpes, Lepus capensis* and different kinds of mouse and Hedgehog. Protection condition of mammals is studied at two levels, national and international:

At national level and based on rules of the DOE, protected species are: *Ursus arctos, Felis chaus, Panthera pardus, Cervus elaphus, Capreolus capreolus, Ovis orientalis arkal.*

At international level and based on the red list of IUCN, *Rhinolophus hipposideros, Myotis emarginatus, Capra aegagrus aegagrus* and *Ovis orientalis arkali* are classified as vulnerable species and *Panthera pardus saxoicolor* as endangered species (see Table 3.4).

3.2.2 Birds

About 101 species belonging to 32 families have been recognized in the Madarsoo River basin. Next to water deposits, egrets and ducks can be seen. In plains and over low-density forests, there are eagles and falcons. Other bird species of the basin can be found in the forests, around the forests and/or in farmlands and human living environments. From a viewpoint of protection at national level, 21 bird species of the area are protected birds which mostly belong to Accipitridae, Falconidae, Stringidaen, Ardea cinerea, Gyps fulvus, Phasianus colchicus, Apus apus and Luscinia megarhynchus species. Three species including Aquila heliaca, Aquila chrysaetos and Falco peregrinus are endangered.

From an international viewpoint, just Aquila heliaca species is in red list of ICUN and classified as vulnerable. Table 3.5 shows a list of bird species of the Madarsoo River basin (except for protected areas) and their protection specifications.

3.2.3 Reptiles

Existence 33 reptile species belonging to 13 families in the Madarsoo River basin (except under protection areas) have been approved. 15 species of existing reptiles belong to snakes order, which most of them are from *Colubridae* family. In addition, two turtle species have been recognized in the area. The other reptile species of the area belong to lizard order, which most of them are from *Lacertidae* family. From a protection viewpoint, based on the rules of DOE *Varanus griseus caspius* is in protected class and *Testudo horsfieldii* is in vulnerable class of red list of IUCN. Table 3.6 indicates a list of reptile species in the Madarsoo River basin (except for protected areas) and their protection specifications.

3.2.4 Fish

So far 8 fish species belonging to 4 families have been recognized in the Madarsoo River, among them one species naming Oncorhynchus mykiss is imported to the river.

Barbus mursa, Barbus capito, Leuciscus cephalus are in the lower parts, Alburnoides bipunctatus, Oncorhynchus mykiss are in the upper parts and Capoeta capoeta, Nemachilus malapterurus are in the middle parts of the river.

From a protection viewpoint, based on the rules of the DOE 3 species are in protected class (Barbus mursa, Barbus capito and Oncorhynchus mykiss) and there is no species in red list of IUCN. Table 3.7 shows a list of fish species in the Madarsoo River and their protection specifications.

3.2.5 Amphibians

So far 3 species belonging to 2 families from amphibians order have been recognized in the Madarsoo River basin, which can be seen in pools, wetlands and water deposits. Among them just Rana macrocnimis pseudodalmatina, based on rules of DOE is in Protected class and there is not any species in red list of IUCN. Table 3.8 presents a list of amphibian species in the Madarsoo River and their protection specifications.

Table 3.4. List and Status of Mammal in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
1	Erinaceus Concolor	Erinaceidae		
2	Hemiechinus Auritus	Erinaceidae		
3	Hemiechinus hypomelas	Erinaceidae		
4	Neomys anomalus	Soricidae		
5	Crocidura leucodon	Soricidae		
6	Crocidura russula	Soricidae		
7	Crocidura suaveolens	Soricidae		
8	Sorex minutus	Soricidae		
9	Rhinolophus ferrumequinum	Rhinolophidae		
10	Rhinolophus hipposideros	Rhinolophidae	VU	
11	Eptesicus serotinus	Vespertilionidae		
12	Miniopterus schreibersii	Vespertilionidae		
13	Myotis blythii	Vespertilionidae		
14	Myotis emarginatus	Vespertilionidae	VU	
15	Myotis mystacinus	Vespertilionidae		
16	Dryomys nitedula	Myoxidae		
17	Myoxus glis	Myoxidae		
18	Cricetulus migratorius	Muridae		
19	Arvicola terrestris	Muridae		
20	Microtus arvalis	Muridae		
21	Ellobius fuscocapillus	Muridae		
22	Meriones persicus	Muridae		
23	Rhombomys opimus	Muridae		
24	Apodemus fulvipectus	Muridae		
25	Apodemus wardi	Muridae		
26	Mus musculus	Muridae		
27	Allactaga elater	Dipodidae		
28	Pygeretmus pumilio	Dipodidae		
29	Hystrix indica	Hystricidae		
30	Lepus capensis	Leporidae		
31	Ochotona rufescens	Ochotonidae		
32	Canis lupus	Canidae		
33	Canis aureus	Canidae		
34	Vulpes vulpes	Canidae		
35	Ursus arctos	Ursidae		Protected
36	Mustela nivalis	Mustelidae		
37	Vormela peregusna	Mustelidae		
38	Martes foina	Mustelidae		
39	Meles meles	Mustelidae		
40	Lutra lutra	Mustelidae		
41	Felis silvestris	Felidae		
42	Felis chaus	Felidae		Protected
43	Panthera pardus saxoicolor	Felidae	EN	Protected
44	Sus scrofa	Suidae		
45	Cervus elaphus	Cervidae		Protected
46	Capreolus capreolus	Cervidae		Protected
47	Capra aegagrus aegagrus	Bovidae	VU	
48	Ovis orientalis	Bovidae	VU	Protected

VU, vulnerable; En, endangered, and Protected species.

Table 3.5 (1/2) List and Status of Birds in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
1	Egretta alba	Ardeidae		
2	Ardea cinerea	Ardeidae		Protected
3	Anas platyrhynchos	Anatidae		
4	Anas acuta	Anatidae		
5	Pernis apivorus	Accipitridae		Protected
6	Accipiter nisus	Accipitridae		Protected
7	Buteo lagopus	Accipitridae		Protected
8	Buteo rufinus	Accipitridae		Protected
9	Buteo buteo	Accipitridae		Protected
10	Hieraeetus pennatus	Accipitridae		Protected
11	Hieraeetus fasciatus	Accipitridae		Protected
12	Aquila pomarina	Accipitridae		Protected
13	Aquila heliaca	Accipitridae	VU	Protected
14	Aquila chrysaetos	Accipitridae		Protected
15	Gyps fulvus	Accipitridae		Protected
16	Falco peregrinus	Falconidae		Protected
17	Falco subbuteo	Falconidae		Protected
18	Falco tinnunculus	Faconidae		Protected
19	Ammoperdix griseogularis	Phasianidae		
20	Alectoris chukar	Phasianidae		
21	Coturnix coturnix	Phasianidae		
22	Phasianus colchicus	Phasianidae	-	Protected
23	Rallus aquaticus	Rallidae		
24	Columba palumbus	Columbidae		
25	Columba livia	Columbidae		
26	Streptopelia turtur	Columbidae		
27	Cuculus canorus	Cuculidae		
28	Bubo bubo	Strigidae		Protected
29	Otus scops	Strigidae		Protected
30	Athene noctua	Strigidae		Protected
31	Strix aluco	Strigidae		Protected
32	Caprimulgus europacus	Caprimulgidae		
33	Apus apus	Apoidae		Protected
34	Coracias garrulus	Coraciidae		
35	Merops apiaster	Meropidae		
36	Upupa epops	Upupidae		
37	Picus viridis	Picidae		
38	Dryocopos martius	Picidae		
39	Dendrocopos major	Picidae		
40	Dicoides medius	Picidae		
41	Dendrocopos minor	Picidae		
42	Hirundo rustica	Hirundinidae		
43	Ptyonoprogne rupestris	Hirundinidae		
44	Melanocorypha calandra	Alaudidae		
45	Galerida cristata	Alaudidae		
46	Alauda arvensis	Alaudidae		
47	Eremophila alpestris	Alaudidae		
48	Motacilla alba	Motacillidae		
49	Motacilla cinerea	Motacillidae		
50	Anthus campestris	Motacillidae		
51	Lanius isabellinus	Laniidae		
52	Lanius excubitor	Laniidae		
53	Troglodytes troglodytes	Troglodytidae		
54	Cinclus Cinclus	Troglodytidae		

Table 3.5 (2/2) List and Status of Birds in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
55	Eritacus rubecula	Turdidae		
56	Irania gutturalis	Turdidae		
57	Luscinia megarhynchus	Turdidae		Protected
58	Phoenicurus phoenicurus	Turdidae		
59	Saxicola torquata	Turdidae		
60	Oenanthe pleschanka	Turdidae		
61	Oenanthe monacha	Turdidae		
62	Oenanthe finschii	Turdidae		
63	Oenanthe picata	Turdidae		
64	Monticola saxatitlis	Turdidae		
65	Monticola solitarius	Turdidae		
66	Turdus merula	Turdidae		
67	Turdus philomelos	Turdidae		
68	Turdus vicivorus	Turdidae		
69	Cettia cetti	Sylviidae		
70	Acrocephalus melanopogon	Sylviidae		
71	Phylloscopus collybita	Sylviidae		
72	Sylvia communis	Sylviidae		
73	Sylvia hortensis	Sylviidae		
74	Ficedula parva	Muscicapidae		
75	Aegithalos caudatus	Aegithalidae		
76	Parus lugubris	Paridae		
77	Parus ater	Paridae		
78	Parus major	Paridae		
79	Parus caeruleus	Paridae		
80	Sitta europea	Sittidae		
81	Sitta tephronata	Sittidae		
82	Certhia familiaris	Certhiidae		
83	Miliaria calandra	Emberizidae		
84	Emberiza cia	Emberizidae		
85	Emberiza buchanani	Emberizidae		
86	Fringilla coelebs	Fringillidae		
87	Serinus pusilla	Fringillidae		
88	Carduelis chloris	Fringillidae		
89	Carduelis carduelis	Fringillidae		
90	Carduelis cannabina	Fringillidae		
91	Rhodospiza obsoleta	Fringillidae		
92	Passer domesticus	Ploceidae		
93	Passer montanus	Ploceidae		
94	Passer petronia	Ploceidae		
95	Sturnus vulgaris	Sturnidae		
96	Sturnus roseus	Sturnidae		Protected
97	Pica pica	Corvidae		
98	Pyrrhocorax pyrrhocorax	Corvidae		
99	Corvus corone cornix	Corvidae		
100	Corvus corax	Corvidae		
101	Corvus frugilegus	Corvidae		

VU, vulnerable; En, endangered, and Protected species.

Table 3.6 List and Status of Reptiles in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
1	Mauremys caspicacaspica	Testudinidae		
2	Testudo horsfieldii	Testudinidae	VU	
3	Trapelus agilis	Agamidae		
4	Laudakia caucasia	Agamidae		
5	Ophisaurus apodus	Anguidae		
6	Anguis fragilis colchicus	Anguidae		
7	Eublepharis macularius	Eublepharidae		
8	Agamura persica	Gekkonidae		
9	Cyrtopodion caspium	Gekkonidae		
10	Eremias intermedia	Lacertidae		
11	Eremias lineolata	Lacertidae		
12	Eremias velox velox	Lacertida		
13	Lacerta chlorogaster	Lacertida		
14	Lacerta defilippii	Lacertidae		
15	Lacerta strigata	Lacertidae		
16	Eumeces schreiderii	Scincidae		
17	Eumeces taeniolatus parthianicus	Scincidae		
18	Varanus griseus caspius	Varanidae		Protected
19	Typhlops vermicularis	Tiphlopidae		
20	Eryx miliaris	Boidae		
21	Coluber karelini	Colubridae		
22	Coluber najadum najadum	Colubridae		
23	Coluber ravergieri	Colubridae		
24	Coluber rhodorachis	Colubridae		
25	Malpolon monspessulana insignita	Colubridae		
26	Spalerosophis diadema	Colubridae		
27	Oligodon taeniolatus	Colubridae		
28	Psammophis lineolatus	Colubridae		
29	Natrix natrix natrix	Colubridae		
30	Naja oxiana	Elapidae		
31	Agkistrodon intermedius caucasica	Viperidae		
32	Echis carinatus	Viperidae		
33	Macrovipera lebetina obtuse	Viperidae		

VU, vulnerable; En, endangered, and Protected species.

Table 3.7 List and Status of Fish Species in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
1	Nemachilus malapterurus	Balitoridae		
2	Alburnoides bipunctatus	Cyprinidae		
3	Capoeta capoeta	Cyprinidae		
4	Barbus mursa	Cyprinidae		Protected
5	Barbus capito	Cyprinidae		Protected
6	Leuciscus cephalus	Cyprinidae		
7	Neogobius fluviatilis	Gobiidae		
8	Oncorhynchus mykiss	Salmonidae		Protected

Protected species.

Table 3.8 List and Status of Amphibian in the Madarsoo River Basin

No.	Scientific Name	Family	Status	Remark
1	Bufo viridis viridis	Bufonidae		
2	Rana ridibunda ridibunda	Ranidae		
3	Rana macrocnimis pseudodalmatina	Ranidae		Protected

Protected species.

3.3 Under Protection Areas

Three protected areas and one national park in Madarsoo river basin are under authority of Department of Environment (DOE), which are briefly described herein. Map no. 2.2 shows their locations in the basin.

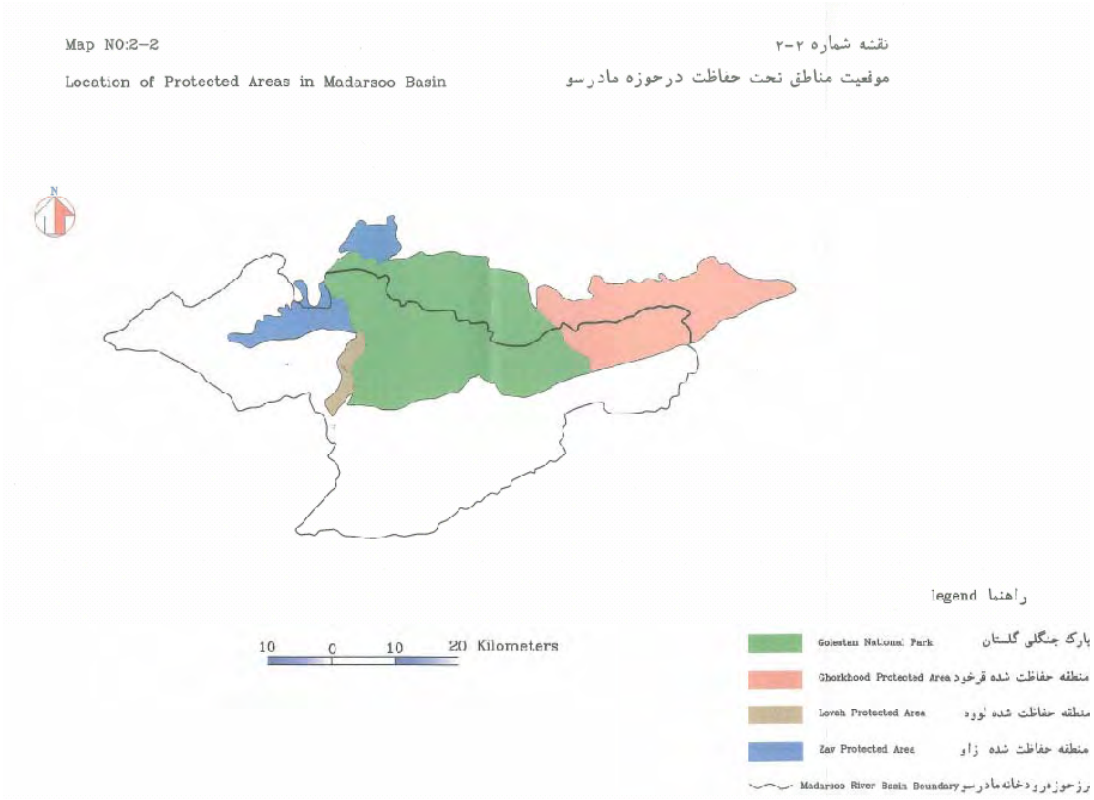


Figure 3.2 Location of Protected Areas

3.3.1 Ghorkhood Protected Area

This area covers 45,000 ha and is located in the eastern part of the Madarsoo River basin (east of Golestan National Park). 11,130 ha of it are inside the Madarsoo River basin. Ghorkhood area is hilly, mountainous and rocky with steep slope that is under protection from 1971. Wild life of this area mostly consists of mammal species such as *Ovis orientalis arkali, Capra aegagrus, Panthera pardus saxoicolor, Canis lupus, Vulpes vulpes, Sus scrofa, Ochotona rufescens, Meles meles ;* different types of rodents; birds such as different types of eagles, and reptiles such as Varanus and snakes.

3.3.2 Loveh Protected Area

This area covers 4,000 ha and is located inside the Madarsoo Rriver basin (west of Golestan National Park and south of Loveh village). The area has several waterfalls and springs. It is located next to the Golestan National Park, and this is cause a special importance to the area.

Mammal species of the area includes: *Capreolus capreolus, Cervus elaphus, Ovis orientalis arkali, Capra aegagrus, Gazella subguttorosa, Panthera pardus saxoicolor, Ursus arctos, Martes foina,* and birds: *Phasianus colchicus*, partridge, eagles and falcons.

3.3.3 Zav Protected Area

The Zav protected area covers 8,000 ha and includes two parts: northern and southern parts. The southern part is next to the Golestan National Park and inside the Madarsoo River basin.

Wild life of this area includes mammals such as *Capreolus capreolus, Cervus elaphus, Ovis orientalis arkali, Capra aegagrus, Gazella subguttorosa, Panthera pardus saxoicolor, Ursus arctos, Canis lupus, Vulpes vulpes, Felis chaus, Sus scrofa, Martes foina*; birds such as *Phasianus colchicus, Alectoris chukar*, eagles and falcons.

3.3.4 Golestan National Park

Background

Golestan National Park covers 91,895 ha, and is the first area in Iran, which is designated as a national park. Registration of this area as a national park has been done in February 1978. As well, it was under different types of protection since 1957. The Golestan National Park has been selected as Biosphere reserve and presented to the No.8 project of "Managing our Biosphere (MaB)" program of UNESCO. The Golestan National Park is significant not only for wild life habitats protection but also for protecting biodiversity in Iran. Because of its long life it can be a symbolic park for other national parks and can be considered as the most significant park in the country. The park has also a specific position in the world, because it is one of the significant vegetation areas and represents temperate rainforests in the world network of biosphere reserves.

Wildlife of Golestan National Park

Due to large area coverage of Golestan National Park and its climate diversity, a vast variety of habitats and therefore wildlife can be found there. There are mountainous habitats (including deciduous Caspian forest highland ranges), hilly lands and semi-arid plains. Based on the report published by DOE in 1993, about 69 mammal species belonging to 21 families and 6 orders have been recognized in the Golestan National Park. The most important ones are: Lepus capensis, Ochotona rufescens, Myoxus glis, Allactaga elater, Hystrix indica, Canis lupus, Vulpes vulpes, Vulpes corsac, Ursus arctos, Mustela nivalis, Martes foina, Felis chaus, Panthera pardus saxoicolor, Acinonyx jubatus, Sus scrofa, Cervus elaphus, Capreolus capreolus, Gazella subgutturosa, Capre aegagros, Ovis orientalis.

So far 149 bird species belonging to 42 families and 14 orders have been recognized in the Golestan National Park including: Egretta alba, Anas platyrhynchos, buzzards, eagles, Accipiter gentilis, Accipiter nisus, Gyps fulvus, Gybaetus barbatus, Hrriers, Falco peregrinus, Falco cherrug, Alectoris chukar, Coturnix coturnix, Phasianus colchicus, Vanellus vanellus, Scolopax rasticola, Pterocles orientalis, Columba palumbus, Strix aluco, Piciformes, and many Passeriformes.

Recognized reptiles include 51 species belonging to 14 families and 3 orders which mostly consist of Serpentes, Skinks, Lizards, Geckos respectively, two Testudines species and one Varanus species.

Amphibians include 3 species belonging to 2 families which all of them are from Aruna order including Rana macrocnemis, pseudodalmatina, Rana ridibunda, and Bufo viridis.

The Golestan National Park's fish are the same as the ones in Madarsoo River that were explained in the previous section. They include 8 species belonging to 4 families and 3 orders. Three major fish species are: Barbus capit, Capoeta capoet, Oncorhynchus mykiss. See Tables 3.9 and 3.10 for details on wildlife status in the Golestan National Park.

Among these, 5 mammal, 3 bird and 1 reptile species are included in Vulnerable (VU) category. One mammal species (Acinonyx jubatus) is included in Critically Endangered category (CR), which about its existence there is no any report since 1978, but considering the suitable habitat for this species its existence is probable in the area.

Table 3.9 Class, Order, Species and Families of Wildlife in Golestan National Park

Class	Order	Number of Species	Number of Families
Mammals	Insectivora	9	2
	Chiroptera	18	3
	Lagomorpha	2	2
	Rodentia	18	7
	Artiodactyla	6	3
	Carnivora	16	4
Birds	Ciconiiformes	1	1
	Anseriformes	1	1
	Falconiformes	26	2
	Galliformes	4	1
	Gruiformes	3	2
	Charadriiformes	3	3
	Columbiformes	6	2
	Cuculiformes	1	1
	Strigiformes	3	1
	Caprimulgiformes	1	1
	Apodiformes	1	1
	Coraciiformes	3	3
	Piciformes	3	1
	Passeriformes	93	22
Reptiles	Testudines	2	2
	Sauria	25	6
	Serpentes	24	6
Amphibian	Anura	3	2
Fish	Cypriniformes	6	2
	Perciformes	1	1
	Salmoniformes	1	1

Source: Golestan National Park Report, Department of Environment, 1993

Table 3.10 Threatened Wild Life Species in Golestan National Park

Class	Species	Category
Mammals	Acinonyx jubatus	Critically Endangered (CR)
	Rhinolophus hipposideros Myotis emarginatus, Myomimus personatus Ovis orientalis arkal, Capra aegagrus aegagrus	Vulnerable (VU)
Birds	Aqila heliaca, falco naumanni, Crex crex	Vulnerable (VU)
Reptiles	Testudo horsfieldii	Vulnerable (VU)

Source: Golestan National Park Report, Department of Environment, 1993

Vegetation Cover of Golestan National Park

According to report of DOE (1993), So far 592 plant species have been recognized in the Golestan National Park. The vegetation cover of the park is mainly of Hyrkanian, Irano-Turanian type, with Ecotone boundary.

In Golestan national park, vegetation areas mostly consist of thickets and deciduous forests, highlands, vegetation, intermediate thickets and forests, coniferous and steppe vegetation. Annual precipitation in the western portion of the park is between 500-600 mm with humid and moderate, temperate weather condition. Hyrkanian forests of highland and semi-highland regions are formed in this area. The extreme Eastern portions of the park is a steppe, dry region with an annual precipitation of 400 mm or less, and vegetation cover of them is Irano-Turanian type. Boundary between above mention portions (east and west) is covered with an intermediate vegetation cover of Hyrkanian and Irano-Turanian vegetation. Thus sometimes

elements of Mediterranean type can also be seen, which mostly includes shrubs, conifers and highland ranges.

Vegetation areas and their major species are classified in Table 3.11. Some of plant species in the park have specific protective importance, including 58 species belonging to 15 families. Twelve species belonging to 2 families (Papilionaceae, Liliaceaea) have maximum number of protective species and significance species from protection view as shown in Table 3.12.

Table 3.11 Growth Areas and Major Species in Golestan National Park

No.	Vegetation Area	Major Species
1	Hyrcanus deciduous lowlands	Quercus castaneifolia, Alnus subcordata, Acer velutinum, Populus caspica, Pterocarya fraxinifolia, Parrotia persica, Carpinus betulus, Zelkova carpinifolia
2	Hyrcanus deciduous highlands	Acer platanoides, Fraxinus excelsior, Tilia caucasica, Ulmus carpinifolia, Carpinus betulus, Quercus castanefolia
3	Hyrkanus deciduous thickets in lowlands and highlands	Carnus sanguinus, Crataegus spp., Quercus castaneifolia, Pyrus boissieriana, Phamnus spp., Acer capaduicum, Carpinus betulus, Rosa spp, Celtis caucasica
4	Grasslands and shrublands	Crataegus spp., Lonicera floribunda, Pyrus boissieriana
5	Mixed deciduous forests of highland along with Hyrkanus deciduous thickets	Sorbus orientalis, Tilia caucasica, Ulmus carpinifolia, Celtis caucasica, Pyrus boissieriana, Crataegus spp. Lonicera floribunda, Carpinus betulus, Quercus castaneifolia, Acer cappadocicum, Fraxinus excelsior
6	Mixed deciduous and coniferous areas	Cotoneaster nummularioides, Cornus sanguineus, Lonicera floribunda, Quercus castaneifolia, Rhamnus spp., Juniperus communis, Juniperus excelsa, Acer monspessulanum, Celtis caucasica
7	Juniperus thicket	Juniperus communis
8	Juniperus forests	Juniperus excelsa
9	Highlands	Poa bulbosa, Acantalimon spp., Astragalus spp., Festuca spp., Euphorbia spp.
10	Steppe and Xerophile growth areas	Acantholimon spp., Acanthophyllum spp, Salsola spp, Artemisia spp.

Table 3.12 Number of Sensitive Species in Golestan National Park

No.	Family	Number of species	No.	Family	Number of species
1	Plumbaginacea	1	9	Solanaceae	1
2	Aceraceae	2	10	Asteraceae	3
3	Malvaceae	1	11	Rosaceae	2
4	Liliaceae	18	12	Iridaceae	1
5	Orchidaceae	2	13	Boraginaceae	1
6	Papilionaceae	12	14	Scrophulariaceae	4
7	Apiaceae	8	15	Salicaceae	
8	Athyriaceae	1			

Golestan National Park Management

One environment chief guard station and 11 guard units located inside and around the park protect the Golestan National Park, and 57 officers are responsible for protecting the park. Number of annual visitors is 7,000 people on an average. Management plan of Golestan National Park has been prepared, but has not been implemented yet. The plan includes long-term and short-term projects, which aim at support, training, exploration of animal and plant species, as well as protection of environment.

3.4 Forests and Ranges Exploitation and Degradation

Forest exploitation inside the Madarsoo River basin through forestry plans and in the areas out of the plan is done through limited local utilities. Due to protective utility there isn't any type of exploitation in the park. Forestry plans through using scientific methods provide the best way for forest exploitation. Presently 5 forestry plans are active or formulated for the basin:

Karankafter Forestry Plan

This plan covers 1,980 ha in the western part of the study area.

Loveh Forestry Plan

This plan has been started since 1983 over 8,323 ha of the Madarsoo River basin. The Loveh Forestry Plan is significant for covering *Quercus castaneifolia* mountainous forests.

Terjenly Forestry Plan

This plan covers 2,574 ha of the western part of the Golestan forests. The plan has been activated after the flood of 2001.

Khandooshan Plan

Due to adjacency to the Golestan National Park, protection and management of this plan has been committed to DOE.

Aghsoo Forestry Plan

This plan with 4,701 ha coverage in Kalaleh District is in preparation stage. Proposed areas for this plan are located in the northwestern part of the basin.

Nowadays range keeping plans are in the first priorities in order to put the range in right management direction. Experiences of range keeping plans show the success of this method, which leads to attraction of private sector investments (range keeping) based on participation ratios. Dominant exploitation system of range keeping plans is in the form of cooperatives.

3.4.1 Analysis of Forest Degradation Factors

Totally the forest degradation factors can be divided into two groups: natural and artificial (man made/human affecting) factors. It is well worth to mention that human affecting factors have major role in occurring and strengthening of natural factors. The rate of deforestation is less because of existence of protected forests.

Major and minor fault chains and lack of infiltration in lower layers are of the factors causing mass slide and erosion in the forest of the basin. Construction of rural roads accelerates this phenomenon as well. In vast area of the Madarsoo River, mostly in the mountainous portion scattered collapsed layers can be observed. This status is frequently observed in the top branches of the east, center and south regions of the basin. Drought, heavy rainfall, coldness, early snow and etc. also affect the seed germination and life recycling of forest. But due to lack of meteorological stations in the forest areas, precise analysis of the effects of these phenomena on deforestation is not possible. Pests and diseases are included in natural factors of deforestation.

Deforestation and land use changes to farmlands, residential and industrial land are human affecting factors causing forest degradation.

Due to supporting laws, forests of the Golestan National Park have been saved highly, but western forests of the region are exposed to land use change and degradation continuously, for instance, southern slopes of Karangkaftar and Pasang villages. Grazing is the other factor, which leads to forest degradation by preventing forest recycling and changing forests to rangelands. Constructional activities such as road construction, mines exploitation (such as limestone) are others important human affecting factors of forest degradation.

In the study area, the most important natural factor of degradation is flood. Considering the number of floods in Golestan province shows that in 20 years period from 1971 till 1991 significant flood did not occurred, but during 1991 till 2005 more than 10 significant and highly significant floods occurred, among them the floods in 2001 and 2002 were very significant. The Madarsoo River basin has been damaged and destroyed heavily by these floods.

Destructive effects of flood were highly expanded and could be investigated from different views. As a result of the 2001 Flood, in the area and around regions more than 215 people were killed and 259 disappeared. Electricity, water and gas of 108 villages were cut, 100 km of roads destroyed (between 20 to 100 %), 20,000 ha farmlands damaged, 7,000 domesticated animals died and over than 100 ha of forests and rangelands were destroyed.

Due to leaching of waterways and lack of barriers in floodways, another flood occurred in 2002, causing destruction of over than 210 rural buildings, killing dozen of people, damaging residential houses and over than 900 ha of farmlands.

On 31 July and 9 August 2005, two floods occurred in the Madarsoo River basin and adjacent areas causing destruction of more than 14 villages and creating problems in infrastructural buildings of 120 villages. Based on the statistics, more than 63 people were killed, as well 100 ha farmlands were damaged and thousands of agricultural and industrial equipment were destroyed. Estimated financial loss of the 2005 Flood is about 600 billion Rials. As well road damage and closing communication in forest axes (Azad-shahr toward Bojnourd) are the considerable effects of floods.

Totally significant damages on vegetation cover of forests in the Madarsoo River basin in floods include destruction of waterways located on intensive slopes with increase in their width and depth, causing mass erosion in areas with shallow depth soils and destroying many trees.

3.4.2 Analysis of Range Degradation Factors

Uncontrolled increase of population and therefore increasing food requirement are always the main factors causing destruction of natural ecosystem. Under the framework of development of farmlands, especially land use change from rangelands to farmlands and development of villages, the abovementioned factor has caused the main changes in the study area.

The main range destruction factors in the study area are as follows:

- Development of farm and agriculture lands in rangelands due to fertile soils of the region,
- Tree cutting and removing range shrubs for providing fuel and other rural consumption,
- Imbalance between the number of domesticated animals and production capacity of ranges, and
- Improper farming and tillage along the slopes.

3.4.3 Role of Vegetation Cover on Flood Control

Vegetation cover (specially high density forest coverage) can reduce time of run-off concentration, simultaneously increase infiltration rate, and therefore reduce the amount of run-off.

Many destructive floods have occurred in the Madarsoo River basin since 1991 till 2005, causing a lot of damages to forest vegetation cover. Based on the available information, on the parts of the Golestan National Park with proper vegetation cover flood control has been done effectively, about 80 to 100 %.

Important casual factors of flood are as follow: forest degradation, change in land use from forest/range to farmlands, shrub removing, overexploitation from forests, uncontrolled grazing and poor vegetation cover in the upper and middle reaches of the basin.

3.4.4 People and Natural Resources Degradation

Regardless of increasing facilities in villages, but people still depends on natural resources, which sometimes leads to destruction of natural resources. The natural resources exploitation by people which leads to destruction of forests and ranges includes tree cutting, shrub removing in ranges for providing fuel, tree cutting for land use changing (developing range and farm lands) and also for domesticated animals grazing.

Among abovementioned factors, ranchers cause most destruction. They cause damages to forest coverage through cutting top branches of trees for animal feeding and cutting trees for facilitating grass growth. In addition, animals cause trouble in forest revival through feeding young trees. Land use changes are mostly occurred in marginal areas of north western and western forests. These forests are destroyed completely and have been changed to dry farming lands. As well, overgrazing is obvious in southeastern and eastern parts of the region.

References

- A Guide to Fauna of Iran (Eskandar Firooz 2000), and field surveys of experts of Iranian consultants and the JICA study.
- Environmental laws and Regulation, DOE, 2003.
- Red List of International Union for Conservation of Nature and Natural Resources.

CHAPTER 4 SOCIAL ENVIRONMENT

4.1 Social and Economic Conditions

To reveal the exact social status of the Madarsoo River basin, village surveys were conducted in the area, by using detailed questionnaires and contacting the most informed persons such as the village chief, members of Islamic Rural Council, and civil servants (teachers, healthcare personnel), farmers and other inhabitants, particularly elderly persons for knowing the history and date of establishment of village. Results and outcome of questionnaire survey are presented in the supporting report "paper VI Environmental and Social Considerations". Since many villages are closed to each other with more or less similar characteristics, to avoid duplication of similar matter and use the survey period efficiently, questionnaire were filled in villages showing typical characteristics and diverse nature. Survey was so organized to cover entire basin in a rationale and efficient manner, without accumulating similar and repeated (duplicate) information, which could delay the processing/analysis of information and data. Result of village survey are presented herein under the following headings:

4.1.1 Village Name and Age

In general villages in Madarsoo river basin bear either Farsi (Persian), Turkmen or other local names, which are nature affiliated and carry meaning such as habitable, plain, green land, and so on. The age (period of existence) of villages ranges from 13 to 200 years, with an average age of 134 years for a village (excluding age of new Besh Oily village, relocated after flood of 2001). However large portion of population is Fars (Persian) and of Shiite fate, other tribes (Turkmen, Baluch) mostly of Sunni fate, also inhabit in the basin. This indicates that different tribes of different fates, who live together in peace and harmony, inhabit the well-established villages, and aware of environmental changes occurred during past decades. This knowledge and harmony of local people can play an important role in planning measures for countering environmental degradation, and achieving objective/goals of the projects.

4.1.2 Household and Family Size

The number of households in villages of the basin ranges from 30 to 800, with an average of 204 households per village. Family size ranges between 2 to 16 persons, with an average of 7 persons in a family (in most cases comprised of grand parents and grand children).

4.1.3 Population and Literacy Rate

Population in villages of the basin ranges from 180 to 3100 inhabitants, with an average of 1066 inhabitants per village. Average male and female population for villages is 507 and 551, respectively. And male/female ratio is 0.92, indicating higher female population in the basin. Average population for child less than 9 years old is 185 persons in a village. Literacy rate for male and female is 62% and 38%, respectively, with an overall rate of 50% for the basin. These findings indicate that the project should pay careful attention to status of women and children, who can play important roles in current and future developmental activities, thereby keeping projects viable and productive over the years to come. In general population of the basin is openhearted, openhanded and open-minded, with high hospitality, strong believe in Good, proper respect for Islamic values/moral, true obedience to civil laws and in compliance with social order and norms. People of the basin are very cooperative, frank in expressing their views and have desire for development. These characteristics are judged based on their close relation/communication, participation in mass prayers, cooperation (even serving meals) to survey teams, and prevailing security in villages.

4.1.4 Main Job and Unemployment Situation

Results of village survey indicate that majority of households (about 75%) are engaged in farming/agriculture related activities, rather than livestock raring/livestock industry (23%) and laboring/service sector (2%). Number of unemployed (absolute jobless) in villages ranges from15 to 390 persons, with and average of 108 persons in a village, creating an overall unemployment rate of 21% in the basin. It should be noted that the female population mainly contribute in seasonal agriculture/livestock related works (beside house keeping), and usually undertake no regular/designated job. However in some seldom situation, some women get engaged in education/sanitary related activities of their own village. Unemployment is the major concerns of basin inhabitants, since beside adverse economic impacts it threats the health, security and prospect of villages.

4.1.5 Migration for Job and Major Destination

Since there is no any industrial complex/large service sector in the basin to absorb/utilize the existing manpower, most of young people migrate to big cities to seek job, whose number in villages range from 5 to 180, with an average of 31 persons per village. Major destinations of job seekers are Tehran (39%), Semnan (21%), Shahrud (7%) and other cities, including port cities of Persian Gulf attract the remaining portion (33%). However these people collect some money and send back home to own families, and consequently contribute to financial status of basin, it results in family separation and impose psychological stress on children.

4.1.6 Annual Income and Its Source

Annual income of a household in villages ranges from 3 to 22 million Rials, with an average of 16 million Rials per household in a year. This depends on availability of good agricultural land, irrigation facilities and suitable rangeland to feed livestock for generating income. Main sources of income are agriculture, livestock raisings and laboring/services. About 80% of households are engaged in agriculture, 15% in livestock raisings, and 5% in laboring/service and other sectors. This indicates that the Madarsoo river basin is an agricultural area and its inhabitants largely depend on natural resources for livelihood.

4.1.7 Annual Expenditure

Annual expenditure of a household in villages ranges from 2 to 20 million Rials, with an average of 14 million Rials per household in a year. This depends not only on level of income, but also to availability of infrastructures (educational/sanitary) in the village. Where there is no secondary/high school, people send their children to other villages/cities for schooling, which bring-about increase in overall expenditure. Typically breakdown for expenditure of a household is as follows: food/cloth 52%; fuel/transport 21%; education 19%, and others 8%.

It should be noted that major sources of household fuel are gas/kerosene and wood. And rate of utilization of each source depends on availability of piped (capsule) gas, distribution efficiency of kerosene dealers, and access to woody materials. Usually villages beside the roads (Tehran-Mashhad) receive and utilize more gas/kerosene, while those in mountain areas have more access to woody material to use as fuel source. In an overall basis, a household in villages of the basin uses 80% gas/kerosene and 20% wood to fulfill its total fuel demand.

4.2 Infrastructure and Institution

4.2.1 Basic human needs

Piped water

About 95% of villages in the basins, receive piped water either from spring, well, Kanat, river or combination of these. In general there is not shortage of drinking water, but the supplied water has no good quality and turbid in rainy season. Villages (5%) with no piped water supply receive drinking water either by lorry tanker or draw water directly from the source and carrying it to their houses in various utensils.

Electricity

Almost all the villages are supplied by electricity branched from network running along the roads, however power failure, particularly in rainy/windy season is common.

Telecommunication

About 82% of villages possess telephone communication facilities, either house networking, existence of telecommunication office (cable) or via mobile phones available in spots called telephone rooms.

Gas

Nominally all the villages are covered by gas distribution system, of which 9% is via house piped network, and 91% through distribution of capsule gas by dealers. But in winter/rainy season dealers have difficulty to provide service to some villages with improper access road. Under such circumstance, inhabitants turn to wood/livestock dung that has been piled for emergency cases.

Postal service

Only 40% of villages are covered by postal service, comprising of post office in big villages and post box in some other villages. Postmen do the box collection and mail distribution usually by motorbikes.

Public bath

Only 27% of villages have common bath running in some hours of day for men and women in rotation. It should be noted that in recent days, with increase in establishment of bathroom in houses, popularity of common bath has decreased. Sanitary officials usually inspect public baths and give sanitary tips to their operators.

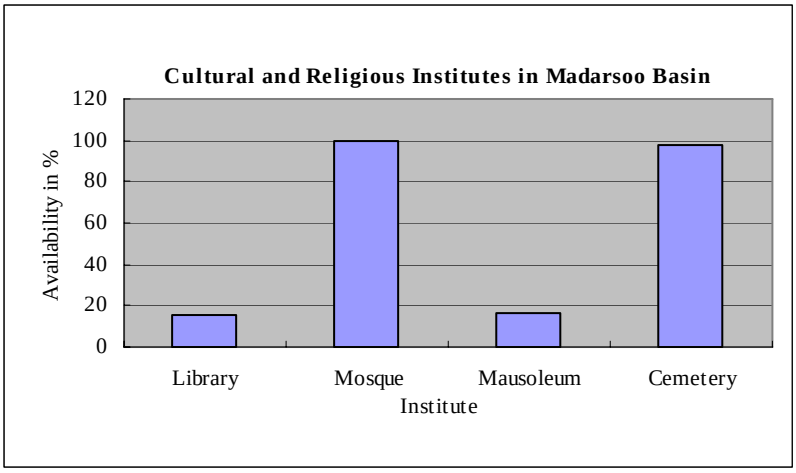
4.2.2 School and special class

Availability of schools/special classes is tabulated below. It should be noted that after Islamic revolution of 1979, the new Islamic government launched a campaign for educating people of all ages (adult) by offering special night classes, particularly in rural areas. Campaign is popular as *Literacy Movement* and uses public school/formal teachers in achieving its goals. Furthermore religious leaders encourage people to hold session for leaning holy Quran and acquiring sufficient knowledge on religious issues. Persons well acquitted to Islamic matters (Hajjis/elderly) usually chair such sessions. Some villages in Madarsoo river basin are benefited from these knowledge-disseminating instruments, though occasional.

School/Class	Pre-school	Primary	Secondary	High school	Night/adult	Quranic/ Religious
Availability in percentage	2	98	61	16	9	34

4.2.3 Cultural and religious site

These include library, mosque, mausoleum of religious leader/key persons, and cemetery in which deceased people are buried. People mass at these sites in different occasion, thereby strengthening their relation and exchanging their views on various issues. It should be noted that in some villages no independent library exist, but books (mostly religious related) are kept in a corner of mosque. In very rare cases nearby villages share the cemetery space. Availability of cultural and religious institutes is illustrated in graph below.



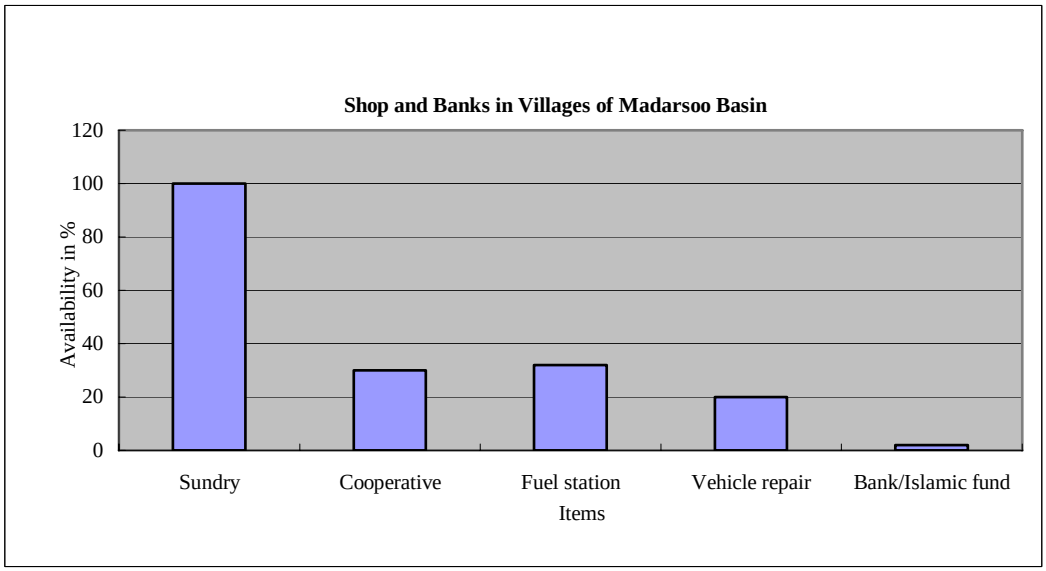
4.2.4 Health and sanitary

In general primary care resources and health services are not adequate in the basin. As shown in Table below, high percentage of villages possess no proper sanitary facilities, and basin is not sufficiently served by healthcare system. It should be noted that drugstore, medical insurance and medical-care systems are not common, and villages have no sufficient access to medicine.

Facility	Medical clinic	Physician	Sanitary office	Sewerage system	Waste collection
Availability in percentage	14	25	82	14	7

4.2.5 Shop and bank/Islamic fund

In general villages lack shopping facilities and banking services, and people usually approach big cities for meeting their requirements. In case of Islamic fund, cash is pooled and provided to needy persons with no or very low interest rate, for enabling them to overcome money related problems. However sundry shops exist in all villages, but they contain no many goods.



4.2.6 Recreational and other facilities

In general no designated recreational facility exist in villages of the basin, but some villages (about 25%) in vicinity of Golestan National Park/near Madarsoo River use these sites at leisure time. Sole space for sport is an earth playground on which youths usually play football, which is very popular in the area, and all-over Iran. Only 59% of villages have playgrounds. No hall for gathering/holding meeting exist in villages of the basin, but some inhabitants use spaces in the mosque or school for this purpose. About 76% of villages have asphalt road and access to public transportation facilities.

4.2.7 Institution

The most widespread institute is Islamic rural council, which deals with daily affairs of village. Basically the council is comprised of three members who are elected by direct vote of inhabitants, under monitoring of Interior Ministry officials. Council members are elected for a four-year term. A village chief is selected by members of Islamic rural council, and proposed to district officials for consideration. If approved, the chief will work for a four-year term. Basij (mass mobilization) is a popular unit, which undertakes all kind of voluntary work in emergency/non-emergency cases. Quick response and efficient rescue efforts of Basij units in days after occurrence of Golestan flood (2001) and Bam earthquake (2003) is remarkable work of Basij in hard days of Iran. Principal institutes in Madarsoo river basin and their availability rates are tabulated below.

Institute	Disciplinary force	Basij unit	Village council	Village chief
Availability in percentage	5	82	100	100

CHAPTER 5 MASTER PLAN FORMULATED FOR THE STUDY AREA

5.1 Goal and Objectives of the Master Plan

In two consecutive years of 2001 and 2002, as well in current year (2005) intensive downpour occurred in the Madarsoo River basin. Triggered by torrential downpour in August 2001, visitors of the Golestan National Park, and residents of basin suffered severe damages from flood and debris flow not previously experienced. The master plan for food and debris flow mitigation and management shall cover the entire fields and shall integrate the efforts made by the relevant organizations for execution of structural and non-structural measures.

In due consideration of above situation, the goals and objectives are set up followings:

Goals

To have the river basin well managed against flood and debris flow disasters, through which enhance the people's living standard. It implies that only minimal and tolerable damages cloud be admitted in the basin during the design flood.

Objectives

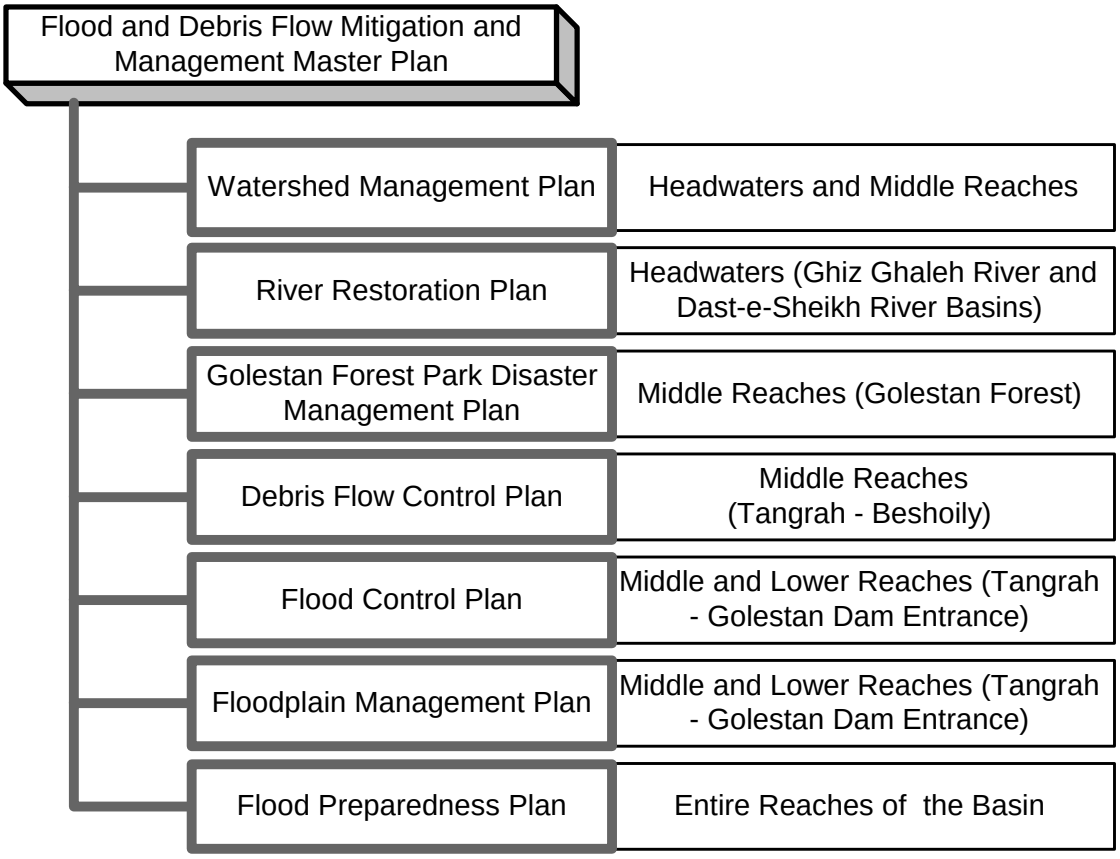
(1) To save people's lives, and

(2) To secure social, environmental and economic functions of natural and social assets.

To achieve its goals and objectives, the master plan shall cover the wide fields in space and time and integrate protective, remedial and improving measures against flood and debris flow.

5.2 Target Year and Major Components of the Master Plan

As agreed between JICA (Japan International Cooperation Agency) and MOJA (Ministry of Jihad-e-Agriculture) the target year of Master Plan is 2025 (Iranian Year 1404), being divided into two or three periods for phased implementation. For instance, the initial period and the first phase is set for urgent implementation of priority projects, and the remaining phases are allocated for remaining works of the master plan. In realizing the master plan hydrological design scale of 25 and 100 years flood are adopted. Major components of the master plan with brief explanation are presented below.



(1) Watershed Management Plan

From flood control aspects, this plan contributes attenuation of runoff peak and volume and retardation of lag-time by combination of increase in infiltration rate and onsite retention of rainwater. This would reduce potential of debris flow through reduction in sediment yield as its source material.

(2) River Restoration Plan

This plan is purposed to consolidate the stored sediment in river channel, to control floodwater, to discharge floodwater safely through newly proposed channel system, and to increase the groundwater and sub-surface water recharge into the aquifer.

(3) Golestan National Park Disaster Management Plan

Golestan national park is the most disastrous area in Madarsoo River basin, in which about 200 visitors and campers died during the 2001 flood. In order to make the park as safer area for people, the master plan proposes the followings measures:

Therefore it could be considered that the most tributaries have also potential to produce disastrous debris flow.

- Early warning and evacuation plan for visitors and campers, and
- Traffic safety plan during floods.

(4) Debris Flow Control Plan

In vicinity of Tangrah village (entrance of Golestan national park in Golestan province) there are several mountain streams with potential of debris flow, in five of which disaster occurred during the 2001 flood, and resulted in death of 3 in habitants of the village. So debris flow control measures are planned for these streams.

(5) Flood Control Plan

Flood control, in particular bank protection in and around the housing area of villages and in immediately up and downstream stretches of bridges, shall be planned from Tangrah down to the entrance of the Golestan Reservoir. For structural designing of bank protection and relevant structures, the design scale is being set at 100-year flood.

(6) Floodplain Management Plan

Meteo-hydrological attributes of Madarsoo river floods are characterized as big differences between flood discharges in normal years and ones in excessive severe floods. Another topographic attribute is terracing by free meandering of the Madarsoo river course. In floodplains, extending into Gorgan river and Madarsoo river basins, villages are on upper terrace, while farmlands are on lower terrace. Habitat selection could be traditionally made due to low population pressure. In due consideration to these characteristics, the optimum way for flood control could be formulated with utilization of;

- River channel for average flood conveyance, and
- Lower terrace as high-water channel for excessive flood conveyance.

In order to realize the above flood control scheme, the floodplain management plan is indispensable. This plan includes-

(i) To delineate flood hazard area, which means high-water channel area in 100-year flood

(ii) To control land use in the flood hazard area, and

(iii) To closely link to flood preparedness plan, in particular early warning system.

(7) Flood Preparedness Plan

Flood preparedness plan including early warning system is indispensable to mitigate damages against flood and debris flow, from the viewpoints of saving people's lives. The plan will contain the following sub-schemes;

- Meteo-hydrological monitoring network improvement
- Early flood warning system
- Warning dissemination system, and
- Training for emergency.

This plan has to keep close relationship with related plans in accordance with area characteristics, such as Floodplain Management Plan for the floodplain area.

5.3 Flow of Socio-Economic Frame Forecast

Socio-economic frame in the target year of 2025 is forecasted for the basis of the Master Plan of the Study. Socio-economic frame is comprised of (1) population, (2) income or GRDP, (3) industrial structure, (4) land use and (5) infrastructure development. Therefore, in order to make a forecast of socio-economic frame, it is necessary to make forecasts of all (1) to (3) factors. The national development plan and the regional development plan are the basis for such forecasts.

Population Projection

Total present population (2005) of the study area is 93,141. Since the target year of the master plan is 2025, population for target year is estimated with 5-year interval, to provide ground

for design and establishment of infrastructures/institutions to meet future demand of the area. In estimating future population, following relation has been applied: $Fp = Pp \times (1+Pgr)^n$

Where Fp is future population; Pp present population; 1 is constant number; Pgr is average annual population growth rate, and n is years in 5-year interval.

Here population is estimated for the next 20 years with 5-year interval, so n = 5, 10, 15, 20, and average annual growth rate is set at 1.80%, assuming all factors on population growth remain constant.

Bases/reference for applying the figure 1.80% growth rate in this formula:

- Average of long-term of annual population growth rate in Golestan province is 1.72% (2.30% in urban area and 1.14% in rural area). Since the study area is comprised of urban and rural areas and largely occurs in Golestan, figure 1.72% can be used for estimating its future population.
- Result of statistical analysis performed by Iranian consultants working for Ministry of Jihad-e-Agriculture in the Madarsoo River basin, indicates that growth rate of 1.80% is reasonable in predicting population of this area. They have applied the same figure in their calculations.
- Average annual growth rate of population for the country (on long-term basis) is 1.80%, with decreasing trend.

It should be noted that with introduction/encouragement of family planning schemes by the Iranian government, and prevalence of old motto- "*less child, better life"*, population growth rate would keep its constant trend, or even show decreasing tendency in future. Therefore data on population growth presented in Table below can be reliably used in development plans.

	Present	Future			
Year	2005	2010	2015	2020	2025
Madarsoo Basin	93,141	101,831	111,332	121,719	133,075
Population Density (inhabitant/ha)	0.39	0.43	0.47	0.51	0.56

Drainage area of the Madarsoo River is 236,400 ha, and kept constant.
Sources: JICA Study Team, Survey for Environmental and Social Considerations- October 2004 –June 2005, and Statistical Yearbook of Golestan Province, Management and Planning Organization of Golestan- 2003.

Land Use

(1) Present Land use

Draft of present land use map (2005) was prepared by using the latest (2002) available satellite imagery of the area, checked through field surveys and then revised based on experiences and knowledge of MOJA experts, with collaboration of JICA study team. Final outputs of this work are presented in Table 4.2, and Figure 4.1.

Careful examination of present land use and comparing it to that of 1990s reveal that:

- Area of bare land has decreased by about 51%, and mainly converted to dry farms.
- Area of dry farming has increased by about 22%, and the increment is more significant in those parts of the basin occurring in the Semnan and Khorasan provinces.
- Forest area has decreased by about 4%, particularly in less elevated areas nearby villages.
- Area of irrigated farming has increased by 51%, and the increment is more pronounced in those parts of the basin occurring in the Khorasan and Semnan provinces.

- Area of rangeland has reduced by 21%, and mostly converted to dry farms.

Table 5.1 Present (2005) Land use in Madarsoo River Basin

Land Use	Area (ha)	% of Total
Afforestation	1,830	0.77
Bare Lands	2,693	1.14
Desert	1,078	0.46
Dry Farming	39,276	16.61
Forest	64,781	27.40
Irrigated Farming	30,703	12.99
Lake	126	0.05
Rangeland	94,709	40.06
Mixed Dry Farming and Rangeland	938	0.41
Residential (Urban)	266	0.11
Others (limits of sites for structures, roads, observatory stations, etc)	-	-
Total	236,400	100.00

Sources: Golestan Provincial Jihad-e-Agriculture Organization, GIS Division, with collaboration of JICA study team- September 2005.

(2) Future Land use

In formulating the future land use plan by paying attention to following points:

(a) Noting chronic changes in land use during the past decades by examining relevant documents and materials

(b) Predicting the future population till target year of 2025

(c) Realizing the biological capability and environmental condition of the area

(d) Paying attention to concept of sustainable development and wise/efficient utilization of natural resources

(e) Avoiding any harm to national natural reserves or historical/cultural heritages

(f) The plan is a back to future approach, means attempt is made to bring the status of natural resources more or less near to that of 1960s, which reflects the biological capability of the area on that period. And in planning biological capability should be highly considered

(g) Emphasizing on crop yield increment in existing irrigated fields by enhancing water use efficiency and improvement in farm practices, rather area expansion.

Jihad-e-Agriculture Organizations of relevant provinces will use the figures given in Table 4.3 (below) in designing and preparing schedule for implementing the proposed watershed management plan.

Table 5.2 Future (2025) Land use in Madarsoo River Basin

Land Use	Area (ha)	% of Total
Afforestation	1,840	0.79
Bare Lands	1,616	0.68
Desert	647	0.27
Dry Farming	34,095	14.42
Forest	67,371	28.50
Irrigated Farming	30,703	12.99
Lake	126	0.05
Rangeland	98,970	41.87
Mixed Dry Farming and Rangeland	141	0.06
Residential (Urban)	741	0.31
Others (limits of sites for structures, roads, observatory stations, etc)	150	0.06
Total	236,400	100.00

Source: Golestan Provincial Jihad-e-Agriculture Organization, GIS Section, with collaboration of JICA Study Team- September 2005.

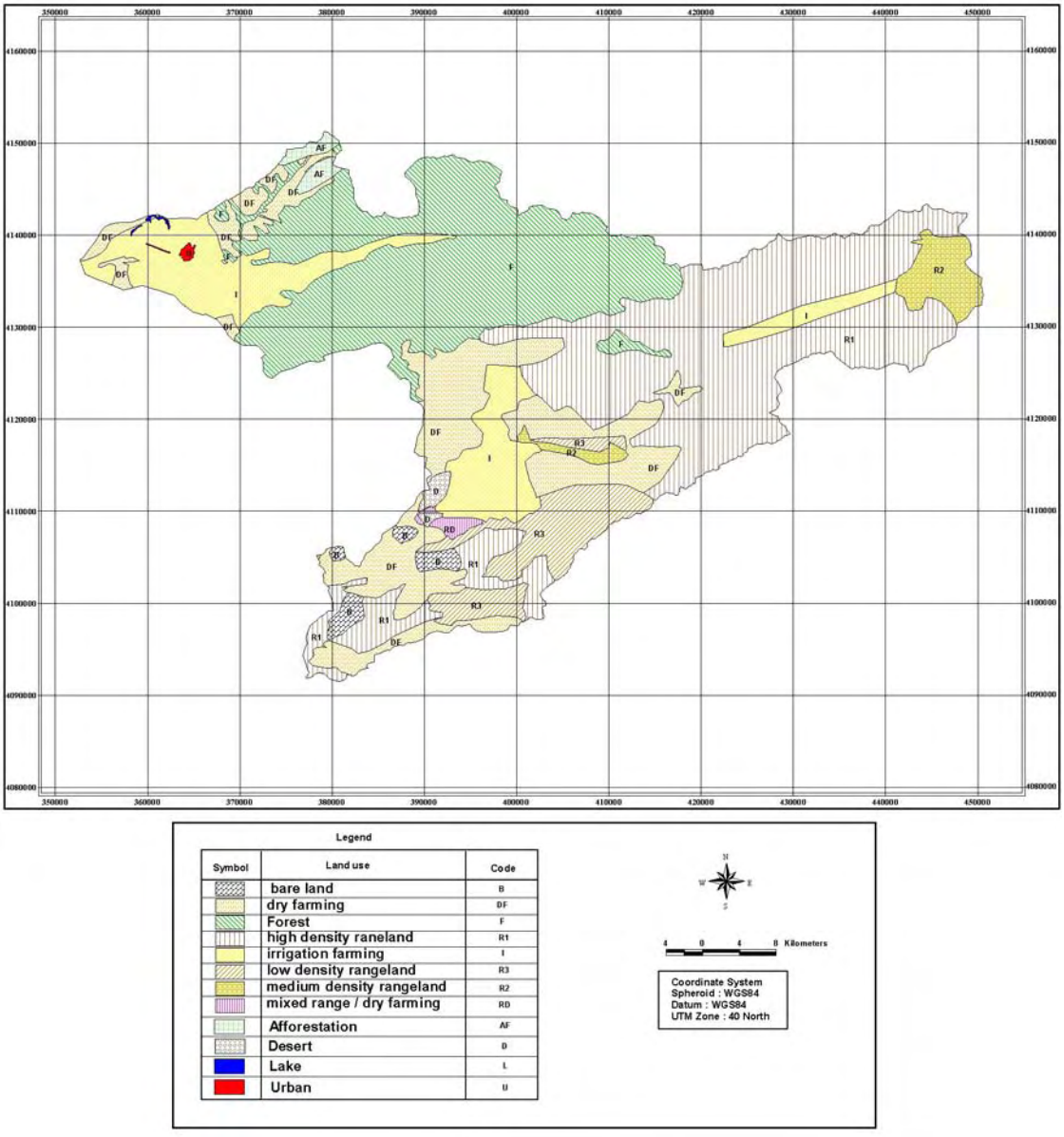


Figure 5.1 Present (2005) Land use in Madarsoo River Basin

5.4 Watershed Management Plan

The purpose of the formulation of the watershed management plan is to review and evaluate the Implementation Plan prepared by Ministry of Jihad-e-Agriculture (hereinafter referred to as MOJA), Golestan province in 2003. And it is to propose the improvement point to the Implementation Plan on the basis of the evaluation result.

Background of Implementation Plan

Disaster of flood and debris flow was occurred in 2001 and 2002 in Gorgan River basin and many villagers and visitors fell victim to the flood and debris flow. After the disaster of flood and debris flow, Flood Control Committee was organized to coordinate the rehabilitation and prevention activities among the organization concerned.

MOJA dispatched the experts to Gorgan River basin to investigate the disaster condition and arranged the issue of the rehabilitation and prevention of the Gorgan River basin. In response to the result of investigation, MOJA formulated watershed management plan to the Madarsoo River basin, which was seriously damaged in the 2001 Flood among the Gorgan River basin, under flood control committee.

In the Madarsoo River basin, MOJA selected the 5 sub-basins at the viewpoint of runoff, soil erosion, severity of damage and so on, and MOJA formulated an implementation plan in these sub-basins. The position of the watershed management plan is one of the components of the master plan for flood and debris flow mitigation and management.

Purpose and Strategy

Implementation plan for different sub-basins and relevant purpose and strategies are tabulated below:

Purpose of Planning	Strategy of Planning
☐ Increasing infiltration rate & decreasing runoff ☐ Increasing the vegetation cover in range land and forest areas ☐ Decreasing peak discharge of floods ☐ Soil conservation ☐ Improvement of life condition of people and increasing their income	☐ Flood control and decreasing flood damage ☐ Sediment and soil erosion control

For realizing its goals and objectives the plan makes the following approaches:

- Mechanical engineering
- Bio-mechanical engineering
- Biological engineering
- Protective works

Functions of watershed management activities are summarized in Table 4.4, and estimated costs for watershed management works are presented in Table 4.5. For more details on implementation of watershed management plan, refer to Master Plan Report and other materials prepared by JICA Study Team.

Table 5.3 Summaries of Watershed Management Activities

Countermeasure	Purpose
1. Mechanical Engineering Gabion dam, masonry dam, earth dam and river engineering works	To prevent harmful sediment production in the headwaters of torrential streams. To control sediment discharge in river course To protect the stream channel from bank erosion and/ or streambed scouring To confine the existing sediment deposit in the stream To avoid heavy bank erosion and streambed scouring in the downstream To decrease the flow impact To control or mitigate debris flow
2. Bio-Mechanical Engineering Terracing	Increasing infiltration rate and decreasing run off Soil erosion control Creation of suitable land for wood and fruit production
Banquette	Precipitation storage and runoff control Soil erosion control Increasing vegetation cover Increasing agriculture production Production of forage for livestock
Furrow	- Precipitation storage and runoff control - Soil erosion control - Increasing vegetation cover - Production of forage for livestock
3. Biological Engineering Changing dry farming and Strip cropping	- Increasing infiltration rate and decreasing run off - Soil erosion control - Increasing agriculture production - Production of forage for livestock
Fertilizing in rangeland	- Increasing vegetation cover - Soil erosion control
Seeding in range land	- Increasing vegetation cover and decreasing runoff - Soil erosion control
Mass seeding	- Increasing vegetation cover - Decreasing runoff - Soil erosion control
Planting	- Precipitation storage and runoff control - Soil erosion control - Increasing vegetation cover - Production of forage for livestock
Tending forest and Planting tree in forest area	- Protection forest areas - Increasing the number of appropriate forest species in the area that the forest were destroyed - Creation of suitable place for promotion of eco-tourism, and conservation bio-diversity
4. Protective Works Enforcement of closures and Proper maintenance	- Protection rangeland - Protection forest areas - Control grazing and vegetation improvement - Forest and rangeland rehabilitation
Existing livestock from forest	- Rangeland management (vegetation improvement) - Forest and rangeland rehabilitation - Sustainable land utilization
Training and extension	- Introduction of watershed management activities - Demonstration of the management system to villagers - Establishment of the good relationship with villagers

Table 4.4 Estimated Costs (2005) for Watershed Management Works

Type of Work	Unit	Unit Cost (Rial)
-Gabion dam	m^3	246,653
-Masonry dam	m^3	288,066
-Terracing	ha	28,107,299
-Banquette	ha	750,000
-Furrow	ha	250,000
		20,171,428
-Changing dry farming	ha	5,000,000
- Provision of drinking water for livestock	N	
-Fertilizing in rangeland	ha	90,250
-Seeding in rangeland	ha	156,000
-Mass seeding	ha	300,000
-Planting	ha	1,290,416
-Training and extension	lump-sum	600,000,000
-Enforcement of closures and maintenance	lump-sum	300,000,000
-Tending forest	ha	1,000,000
-Planting (forest)	ha	5,000,000

5.5 River Restoration Plan

The proposed river restoration plan aims to protect the human life and private properties, and public infrastructures in the basin from flood/sediment flow damages, under the design scale of a 25-year return period. This plan contains countermeasures to enlarge flow capacity, strengthen channel bed, protection of rivers banks against a probable flood occurrence, through following approaches:

(1) Creation of Diversion Channel

In 2001, Dasht village suffered flood damages including the victims caused by flood surging from the southern and western parts of the village through both rivers of the Gelman Darreh and the Ghiz Galeh. The proposed diversion channel aims to prevent flood damages from spreading directly toward the Dasht village with the existing watercourse diversion. It recommends that the watercourse of the Ghiz Galeh River be diverted to the southwest Dasht farmlands and the channel is connected to Dasht-e-Sheikh river in order to ensure the appropriate drainage channel system. Design discharge for proposed channel is 150 m^3/s.

(2) Construction of Flood Control Dam

A flood control dam is planned to reduce the peak probable flood discharge with its water reservoir function, as well to provide irrigation water in and around the Dasht village as an ancillary functions.

The dam location is proposed by taking into account the comparatively narrow river section and rock foundation existence in the riverbank base on the site survey. Design scale of its spillway is provided with a 100-year return period of Ghz Ghaleh river and proposed outlet is in accordance with a 25-year return period and the proposed channel improvement.

(3) Proposed Sediment Control Dam

The proposed sediment control dam is planned to rehabilitate a function of existing earth dam, which has been breached by the 2001 flood and to retain the sediment deposits of the existing earth dam at the original position in order to protect the Dasht village and its farmlands from the eroded sediment deposits.

The design scale of its spillway is provided with a 100-year return period and design invert elevation of its spillway (same as proposed dam height) is considered with the surface elevation of existing sediment deposits in the upstream.

Layout of the above mentioned structures/facilities is show in Figure 4.2.

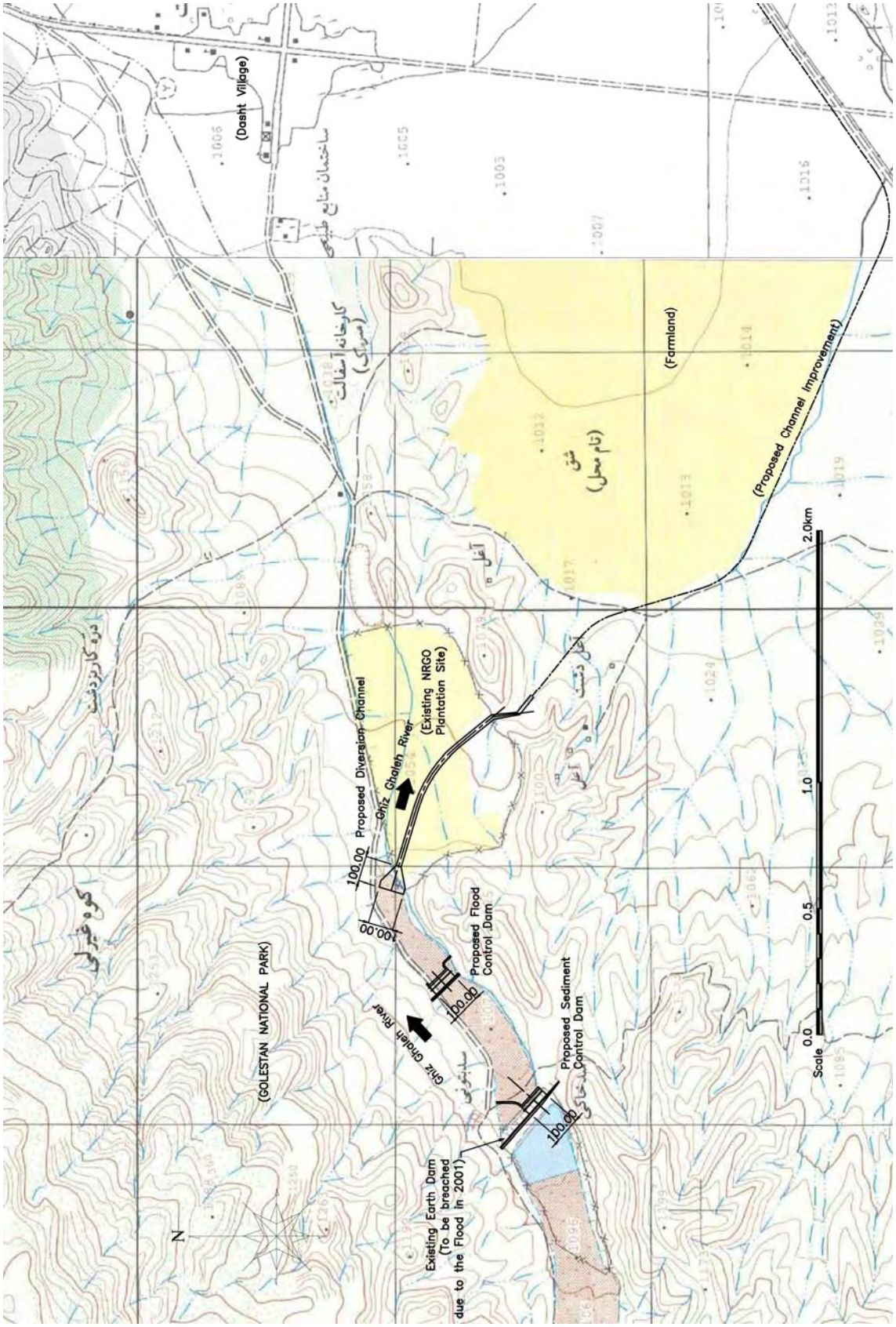


Figure 5.2 Layout of Structures/Facilities Proposed in River Restoration Plan

5.6 Golestan Forest Park Disaster Management Plan

In the 2001 Flood, around 200 visitors and campers died in the park. Most of the camping sites are situated on the previous debris flow deposits due to flat topography, and usually campers and visitors enjoy its natural environment extending over 15 km along the riverbank. In the 2001 flood, debris flow occurred in the six mountain streams in the park. Debris flow in five streams out of six attacked the camping sites. Furthermore extremely large floodflow coming from the upper stretch simultaneously swept away visitors and campers as well as natural forest alongside of the Madarsoo River course in the park. Thus the Golestan Forest Park area is the most disastrous part in the Madarsoo River basin during the 2001 Flood.

Recently the large-scale flood attacked the Golestan Forest Park again on 10 August 2005. Beforehand Meteorological Office-Golestan announced flood warning as their weather forecast on 8 August, and Traffic Police shut off the connection road and drove visitors out of the Park in the afternoon on 9 August. As a result these activities achieved no casualties being affected by the 2005 Flood in the Golestan Forest Park.

Issues on the total flood forecasting and warning system could be broadly categorized into three items through carefully reviewing the activities during the 2005 Flood and the existing hydro-meteorological monitoring system.

(1) Improvement on Meteo-Hydrological Data Collection System

Existing meteo-hydrological data monitoring and collection system has various issues, if those systems are utilized for flood forecasting and warning system in the Madarsoo River basin. These are:

- Meteorological Organization-Golestan (MOG) collects past 1-, 3-, 6- and 24-hour data for weather forecasting purpose in the normal time. Once rain starts, MOG will connect only ~~one~~two stations through their online network to obtain real time data at the same time. It is not automatic real time observation system.
- Ministry of Energy (MOE) collects past 2-hour data for meteo-hydrological data collection purpose. The flood forecasting and warning system requires to monitor real time rainfall and water level data at least 1 hour interval. This system is also not automatic real time observation system.
- The data transmission network using public telephone line has not high reliability. It is easily disconnected during heavy storms and floods.
- There are two water level monitoring sites in the basin; Tangrah and Dasht Bridge. Those stations are located at the entrance of Golestan Forest Park and upstream end of the Park along the Madarsoo River. Monitoring data at those two stations cannot be utilized for flood forecasting and warning to protect visitors and campers in the Park since there is no lead-time gaining for warning and evacuation activities. Thus another stations shall be installed in the upper part so as to gain the lead-time for the emergency activities.

(2) Establishment of Responsible Organization for Flood Forecasting and Warning

There is no data exchange between MOG and MOE. Furthermore there is no responsible organization to integrate meteo-hydrological data, to analyze those data, to determine an announcement of flood warning, and to strongly support the decision making by the Provincial Disaster Management Center (PDMC). Such responsible organization is necessary as a Center of Flood Forecasting and Warning System.

(3) Improvement of Smooth and Efficient Emergency Activities for Evacuation

So far weather bulletin issued by MOG is only a basis for initial action of emergency activities against flood disaster. The weather bulletin gives global weather information and no precise rainfall data. As a result, hitting ratio of the forecast is

rather low. If the ratio is too low, people concerning will not believe the official information, and preparation activities for floods may be considered loss of budget.

In the 2005 Flood, it was proven that emergency activities to evacuate people from the Golestan Forest Park area were very effective and mounted. It might be great learning effects from the disastrous 2001 Flood. Therefore improving hitting ration of the forecast shall be a succeeding target to create the safer region against the flood disaster.

5.7 Disaster Management Plan

All flood information is concentrated into the Provincial Disaster Management Center (PDMC) will disseminate necessary instruction and order disaster preparedness to the related offices as well as residents in the disaster-prone area. Initial information of the flood comes from Meteorological Organization Golestan (MOG) to PDMC as a weather bulletin and flood warning notice. PDMC announces an order to take action against floods to all concerning agencies.

Regarding the existing flood information system, MOG shall continue to issue weather bulletin and flood notice. In addition, the Flood Forecasting and Warning System (FFWS) shall be established utilizing existing equipment and facilities as much as possible. MOG will observe rainfall through existing and additional rain gauge station, and the data shall transfer to the FFWS center by digital telephone network. MOE will also observe own gauges through existing and additional rain gauges and water level stations.

Temporarily the FFWS center shall be established at MOE water resources. The FFWS center will perform integrating data processing and data editing in a form of flood forecasting and warning information. This flood information shall transfer to the PDMC immediately by the digital telephone network through the data transmission system. Simultaneously the related agencies can be accessed to MOE Web server to obtain the latest flood information on graphic and table basis.

The PDMC is responsible for announcing warning and evacuation order to concerning agencies as well as municipality within the Madarsoo River basin through the telephone or Facsimile. Each municipality officers where flood-warning posts will be equipped are responsible to operate flood-warning equipment by manual operation. Warning for visitors and campers in the Golestan Forest National Park shall be made in the same manner of present flood-warning method that the police shall close the entrance of both side of road and the patrol car shall call attention to the visitors and campers for evacuation to outside of the park. The concept of the total system is illustrated in Figure 3.21.

Proper position of the FFWS Center will be in the PDMC. Nevertheless, there is no hydrologist to analyze meteo-hydrological data and to set the threshold level of rainfall and water level. Therefore, the FFWS Center will be transferred to the PDMC, if reinforcement of human power is successfully made.

The flood forecasting system will give early flood warning information. The related agencies take necessary actions based on such information. After that, information dissemination system (warning post) to inform flood warning and evacuation order should be necessary for inhabitants who live and work within the Madarsoo river basin. The warning posts will be installed in each village where the flooding water affects along the Madarsoo River. The warning post will also use for public information broadcasting during normal period.

The following table lists up entire villages in the basin not only for the purpose of Golestan Forest Park Disaster Management but also for Flood Preparedness in the entire basin as described in Section 3.8. The following 26 warning posts are planed to disseminate warning information to particular area. Planned warning post will be installed from Ghazal Police station where is entrance of the Golestan Forest National Park from the east side, to the

rivermouth at the Golestan Dam. Necessity numbers of warning post will be discussed with concerning agencies and village residents. The warning post will be installed at the village office or house of the village master.

5.8 Debris Flow Control Plan

Debris flow in five mountain streams occurred in the 2001 Floods in the area downstream of Tangrah. These streams are: (1) one stream in Tangrah, (2) two streams in Terjenly (3) one stream between Terjenly and Google Bozorg, (4) one stream in new Beshoily. During the 2001 Flood, three residents died due to miss-evacuation from debris flow in Tergenly village. Major features of these tributaries are summarized below.

Table 5.5 Major Features of Tributaries occurring Debris Flow in 2001 Flood

Stream	Drainage Area (km^2)	Channel Length (km)	Channel Slope near Outfall	Relation to Village
Tangrah	53.5	11.3	0-5 degree	Directly hitting at village
Terjenly-1	1.1	2.7	5-15 degree	Directly hitting at village
Terjenly-2	1.5	2.0	5-15 degree	Directly hitting at village
between Terjenly and Google Bozorg	4.1	2.9	5-15 degree	No village
New Beshoily	7.6	4.4	0-5 degree	No village

Note: Streams are arranged from Tangrah towards lower reaches.

These debris-prone streams are covered by the Tangrah sub-basin in the middle-term watershed management plan as described in Section 3.2 Watershed Management Plan. So far MOJA-Golestan has been conducting the construction of masonry dams and gabion dams for debris and sediment control as mechanical measures in parallel with bio-mechanical and biological measures such as terracing, banquette, furrow, planting and so on. The plan's details are described in Section 3.2 Watershed Management Plan.

In parallel with the master study, MOJA-Golestan staff and team members have discussed on planning and designing for debris flow control structures at the sites. Although designing and construction works are still on going, the improvement directions are summarized below. Furthermore in the course of feasibility study, the team and MOJA-Golestan staff will continue to collaborate together in the improvement works.

Regarding emergency evacuation for residents, debris flow hazard map shall be prepared as illustrated below. In both Tangrah and Tergenly villages, residential areas are located in the fan area, where is formed from debris and sediment deposits. Thus residents shall evacuate to nearby terrace.

5.9 Flood Control Plan

After demolition of structures of road and riverbank during the disastrous 2001 flood, MOE and MORT conducted urgent rehabilitation works to the damaged structures. In particular, MOE has a responsibility to hydrological and hydraulic analysis for river structures. MOE is preparing two-phased plan: namely urgent measures and master plan.

(1) Urgent Measures

The major task of urgent measures is rehabilitation of structures damaged by the 2001 Flood. The river improvement stretch is about 65 km from Kalaleh Bridge through the Golestan Forest National Park up to Dasht Bridge. The design discharge in the urgent plan ranges between 250 m^3/s of the upper stretch near the Golestan Forest Park and 400 m^3/s of the lower stretch near the Kalaleh Bridge, on the basis of 50-year design flood.

MOE selected nine locations for the urgent river improvement works; namely 1) Golestan National Park, 2) Tangrah Check Point, 3) Terjenly, 4) Sadegh Abad Diversion Dam, 5) Loveh Bridge, 6) Korang Kaftar Bridge, 7) 14 Metry Bridge, 8) Ajen Ghareh Khojeh and 9) Kalaleh Bridge, from upstream.

Most of the locations were completed before the recent flood attacked in the Madarsoo River basin on 10 August 2005.

(2) Master Plan in the Golestan Dam Basin

MOE simultaneously has been formulating the master plan covering the Golestan dam basin including the Madarsoo River basin. A 100-year return period was adopted as a design scale. However, the master plan has not been finalized yet.

Under the above situation, the 2005 Flood made an attack to the Madarsoo River basin. The damage situations at major sites are summarized in Table 3.29. As described in the table, the recently rehabilitated structures and newly installed flood control structures were seriously damaged in one or two years after completion of construction works.

After the flood disaster, MOE has to prepare or modify their rehabilitation plan based on the damages experienced. Furthermore the master plan being prepared by MOE should be also adjusted to the statistic background of rainfall affected by recent successive floods in 2001, 2002 and 2005. Therefore, the JICA team will propose some recommendations from engineering and disaster management viewpoints to MOE so that the master plan and rehabilitation plan will be elaborated, and the structures to be constructed by MOE and MORT will be much more strengthened to the previous one. Furthermore some confusion and discrepancies originated from both parties' master plan could be avoided in this manner.

The recommendation points are:

(1) Hydrological Planning,

(2) Structural Considerations,

(3) Critical Constrictions of the Madarsoo River Course, and

(4) Road Improvement for Smooth Emergency Activities.

5.10 Summary of Master Plan Component

As discussed in Section 3.2 to 3.8, the master plan components become more concrete, their necessary costs are estimated and implementation schedules are proposed. The following table summarizes the proposed master plan components.

Table 5.6 Summaries of the Proposed Master Plan Component and Sub-Scheme

Master Plan Component		Sub-Scheme	Component/Scheme Digest	Project Cost (million Rials)
1	Watershed Management Plan	5 sub-basins	Conducting improvement measures combining mechanical, bio-mechanical and biological engineering measures	79,374
2	River Restoration Plan	Sediment and flood control dams	Rehabilitating the damaged earth dam to consolidate stored sediment, and newly constructing flood control and riverbed consolidation dam in Ghiz Galeh	58,090
		River improvement	Constructing channel system in three rivers of Gelman Darreh, Dasht-e-Sheikh and Ghiz Galeh	195,200
3	Golestan Forest Disaster Management Plan	Flood forecasting and warning system	Improving existing meteo-hydrologic monitoring system, data transmission and processing system to utilize real time data for flood forecasting, and installing warning posts	3,300
4	Debris Flow Control Plan	Assistance for MOJA activities	Constructing sediment control structures and channeling works in debris flow affected villages	-
5	Flood Control Plan	Recommendation to MOE and MORT plans	Rehabilitating damaged structures in both of the 2001 and 2005 floods and establishing the master plan for the Golestan dam basin	-
6	Floodplain Management Plan	Publication of flood hazard map	Publishing the flood and debris flow hazard map and utilizing it for evacuation activities and land use management	-
7	Flood Preparedness Plan	Extension of flood warning system	Installing warning posts at villages located in the middle and lower reaches to announce the flood warning to the villagers	3,300
		Educational assistance	Conducting education and awareness of flood hazard and training exercise for evacuation in the villages	-

As summarized above, the master plan integrates newly proposed plans and on-going projects since they are closely related each other. Watershed management plan, including debris flow control plan, will be commenced soon by MOJA, and flood control plan will be also conducted soon as a rehabilitation part by MOE and MOJA. Regarding flood control plan by MOE and MORT, hydrological information could be provided by the JICA team, if necessary, so as to elaborate the hydro-hydraulic designing and to strengthen the structures to be rehabilitated.

5.11 Implementation Plan

Regarding the newly proposed projects, their implementation programs were already proposed in parallel with presentation of each component in the previous sections. As for on-going projects such as MOE and MORT rehabilitation projects, these projects shall be continuously conducted to restore the damaged structures as early as possible. In addition to the urgent implementation, hydrological review and re-planning are also necessary as proposed in this report.

Based on the above considerations, implementation plan is summarized in the following table.

Table 5.7 Implementation Plan of Master Plan Component

M.P. Component		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1.	Watershed Management Plan											
2	River Restoration Plan											
	Sediment and Flood Control Dams											
	River Improvement											
3.	Golestan Forest D.M. Plan											
4.	Debris Flow Control Plan											
5.	Flood Control Plan					→	→	→	→	→	→	→
6.	Floodplain Management Plan		→	→	→	→	→	→	→	→	→	→
7.	Flood Preparedness Plan		→	→	→	→	→				→	→
	Extension of Flood Warning											
	Educational Assistance		→	→	→	→	→	→	→	→	→	→

→: Continuous conducting the scheme

5.12 Project Evaluation

The Project consists of 7 components as (1) Watershed Management Plan, (2) River Restoration Plan, (3) Golestan Forest Park Disaster Management Plan, (4) Debris Flow Control Plan, (5) Flood Control Plan, (6) Floodplain Management Plan, and (7) Flood Preparedness Plan. Results of the economic evaluation are given by each component hereunder.

This works is planned by the MOJA, and under studying its detail. The purposes are (1) to mitigate damages caused by flood/debris flow, (2) to control run-off to the rivers, (3) to lengthen time-rug of run-off to the river after rainfall so that peak discharge could be attenuated.

For the above purposes, the MOJA has several counter-measure as (1) terracing in farmland, (2) banquette in farmland and in rangeland, (3) furrow in rangeland, (4) changing dry farming and/or strip cropping, (5) fertilizing the rangeland, (6) seeding in the rangeland, (7) mass seeding, (8) planting and/or reforestation, (9) tending forest and/or reforestation. There are several land conditions ranging from moderate slope to steep slope in the whole catchment area. Therefore, these counter-measures should be applied according to such land conditions.

The MOJA has plans to use land after making the above mentioned counter measures as to plant such fruit trees as olive, walnut, corylus, peach, apple, atriplex, quercus (oak), etc. Among them, atriplex is the provender for livestock, and oak has big and strong root, in other words it may have capability to keep water massively and to protect soil erosion.

From the above-mentioned contents of planning, following economic benefit items may be derived due to the execution of the plan as:

(1) From the terrace field and banquette field including furrow, it is expected that such agricultural products as Olive and so on may be generated. These products will contribute to the farmers' income. It means that the plan contributes to the rural economy.

(2) From the fertilizing and/or planting atriplex as provender, it is expected that breeding of such livestock as sheep, goat and cow will be promoted more than the present situation. From sheep and goat, meat supply to markets could be expected. In other words, this work also contributes to the rural economy.

(3) Cow breeding is usually made for milk, cheese and butter production. Therefore, the dairy industry will also be promoted.

(4) To keep water by roots of such trees and grasses contributes to lengthen time-lag of runoff to the river after rainfall so that peak discharge could be controlled as mentioned above. It means that people may have a lead-time to evacuate from floods after receiving a warning given by the natural phenomenon like heavy rainfall or by an artificial warning system for natural disasters as the JICA Study Team proposed named as "Flood Preparedness Plan". The Flood Preparedness Plan will be discussed later. Therefore, it is expected that damages caused by floods will be decreased or mitigated.

(5) To control of soil erosion contributes to decrease sedimentation of the river so that the river condition and/or discharge capacity of the river will be kept in original situation. This may also contribute to lengthen the lifetime of the Golestan Dam in the downstream of the Madarsoo River.

A part of this Watershed Management Plan is included in the next "River Restoration Plan" discussed hereunder.

The project site of the river restoration plan is located in the Dasht area upstream of the Madarsoo River. Three major river systems join together in the Dasht plain. These are Gelman Darreh, Dasht-e-Sheykh and Ghiz Galeh rivers. Among them, the watershed management is also planned in the Dasht-e-Sheykh and Ghiz Galeh basins. Therefore the watershed management plan should be premised as an antecedent project.

The river restoration plan consists of two schemes as (1) the flood control works and (2) the river improvement works. In addition, the project benefit shall be considered including the benefit produced by the watershed management plan. Following benefits are estimated from the above-mentioned plans.

Designed scale of the facilities is for flood/debris flow in 25 years in return period. Damages are to be converted into annual average amount by using probability analysis. The above table shows its result. In this case, the target year is set at 2025 so that the benefit (= the amount of damages expected to be decreased with the project) is estimated under both present and 2025-year conditions.

Summary of financial and economic costs and their annual disbursement is showing in the following Table.

Table 5.8 Summary of Project Cost and Its Annual Disbursement

(Million Rials)

Item	Total Cost	Disbursement									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Watershed Management Only											
Financial Cost	55,471	18,484	8,227	10,490	6,849	8,344	2,717	180	180	0	0
Economic Cost	50,074	16,686	7,427	9,469	6,183	7,532	2,453	163	163	0	0
Watershed Management + Flood Control											
Financial Cost	124,652	25,717	15,073	29,038	24,669	26,462	3,260	216	216	0	0
Economic Cost	95,648	20,222	11,490	22,127	18,841	20,190	2,453	163	163	0	0
Watershed Management + Flood Control + River Improvement											
Financial Cost	319,848	25,717	15,073	29,038	24,669	38,093	24,247	40,861	40,861	40,645	40,645
Economic Cost	246,175	20,222	11,490	22,127	18,841	31,820	16,189	31,453	31,453	31,290	31,290

The annual operation and maintenance cost is applied at 3 % of the cost for the watershed management plan, and 5 % is applied for equipment portion (60 % of the direct construction cost) of the other two plans.

Using a cash flow of the said cost and benefit, the economic evaluation is made. For evaluation, the Net Present Value (NPV, i.e. B-C in terms of the present value), the Economic Internal Rate of Return (EIRR) and the Benefit-Cost Ratio (B/C Ratio) are adopted as evaluation indicators. The discount rate is applied at 10 % taking similar projects in developing countries into account. The results are summarized as shown in following table.

Table 5.9 Summaries of Economic Evaluation Results

Evaluation Indicator	Under the Present Condition			Under the 2025-Year Condition		
	WM Only	WM + FC	WM + FC + RI	WM Only	WM + FC	WM + FC + RI
NPV	111,127	84,581	28,374	111,306	85,005	30,903
EIRR	23.83%	17.13%	10.18%	23.86%	17.17%	10.36%
B/C Ratio	4.46	2.43	1.24	4.47	2.44	1.26

(Note) NPV is expressed by "million Rials".

As shown in the above table, the watershed management plan (WM) indicates a quite high viability to execute the project by showing the 23.83 % of EIRR under the present socio-economic condition (hereinafter referred to as “at present condition”) and 23.86 % under the socio-economic condition of the year 2025 (as “at 2025-Year condition”).

On the other hand, in the cases of combination of WM + FC (the flood control plan) and of WM + FC + RI (the river improvement plan), EIRRs are gradually come smaller than that in the WM only as 17.13 % and 10.18 % at present condition, and 17.17 % and 10.36 % at 2025-Year conditio0n. It implies that, comparing with the result of the WM only, costs for the other 2 cases are greater than the amount of benefits.

Nevertheless, EIRRs are still higher than 10 % of the applied discount rate as mentioned above in both at the present condition as 10.18 % and at the 2025-Year condition as 10.36 % in the full combination (WM + FC + RI, the whole works of this component). It means that the project of river restoration plan has enough viability to execute.

Golestan Forest Park Disaster Management Plan

The Golestan Forest National Park (hereinafter referred to as “the Golestan Forest”) has only one route passing through it. Before the 2001 flood, this route was also using as a trunk road

connecting to Mashad, in addition to recreation purpose. But after the said flood, the Government has provided another detour route to Mashad. Therefore, for estimation of economic benefit of this component, it may be enough to be taken damages to people for the recreation purpose as campers or visitors to the Golestan Forest into account.

There are a lot of attractive places and/or historical heritage in the Golestan Province including the Golestan Forest. Following table shows a numbers of tourists together with the museum of the Golestan Forest.

Table 5.10 Number of Tourists in Golestan Province and Visitors of Museum of Golestan Forest

Year	Number of Tourists in the Golestan Province (People/annum)			Number of Visitors to DOE Museum of Golestan Forest National Park (People/annum)	
	Domestic People	Foreigners	Total	Number of Visitors	Remarks
2000	42,518	648	43,166	n.a.	Before the 2001-Flood/Debris Flow, the number of visitors were around 30 % higher than the number of 2001 and it has been increased by 5 – 10 % every year. And, the visitors do not always enjoy in the Golestan Forest National Park.
2001	21,957	420	22,377	10,912	
2002	32,368	482	32,850	8,526	
2003	112,735	1,074	113,809	5,159	
2004	114,802	1,657	116,459	7,850	

Sourse: The Cultural Heritage and Tourism Organization(CHTO), Gorgan.

Among the data above, the number of visitors to the museum of the Golestan Forest is somewhat relating to the people for recreation purpose passing through the Golestan Forest, but all of them may not entirely enter into the Golestan Forest for recreation purpose.

There is another information as follow:

Table 5.11 Information on Visitors to Restaurants near Both Entrances of the Golestan Forest

Average Number of Visitors to Take Lunch in the Restaurants Located Near the Entrances of the Golestan Forest at the Up-stream Side and Down-stream Side of the Madarsoo River	500,000 People/ annum

Remarks:
There are restaurants near the entorances in up-stram side and in down-stream side, and some campers and/or visitors take their lunch at these restaurants. However, 2 times or 3 times of this number of campers and/or visitors carry their own cokking sets, and they cook by themselves for their lunch and/or dinner. Therefore, this number does not reflect the actual number of campers and/visitors to the Golestan Forest National Park. But, it may be sure that this number of people must be visited to the Park for their recreation.

Sourse: The Cultural Heritage and Tourism Organization(CHTO), Gorgan.

If one tenth (1/10) of the above number of people is usually visiting to the Golestan Forest, following estimation can be made:

Table 5.12 An Estimation Parameters of Flood Damages in the Golestan Forest

(1)	Annual Average Visiters to the Golestan Forest National	50,000	Assumed at 1/10 of the above number of visitors.
	For Reference:	208	/day as an average number of peoples per day:
(2)	Population in Urban Area by Sensus 1375:	36,817,789	
(3)	Number of Households in Urban Area by Sensus 1375:	7,948,925	
(4)	Average Family Size as of 1996/97:	4.63	persons/HH
(5)	Annual Number of Families visited to the Golestan Forest National Park:	10,795	HHs/annum
(6)	Daily Number of Families visited to the Golestan Forest National Park:	45	Families/day assumed that the people may visit to the Park during 8 months from April to November.
(7)	Average Income Level of People Living in Urban Area:	55,521,629	Rials/annum estimated based on Iran Statistic Year Book 1382.
(8)	Frequensy of Flood/Debris Flow in the Golestan Folest National Park:	20%	It means that the Flood/Debris Flow may occur once 5 years according to a discharge analysis.
(9)	Average Expected Working Period Assumed after Casualtie:	20	years.
(10)	Average Annual Damages Caused by Flood/Debris Flow in the Golestan Forest National Park:	9,989,222	1,000 Rials/annum.

In the Golestan Forest, the route passes through at the center of narrow valley. Therefore, when once floods occur, the people staying there have no any place to evacuate. According to the information, 194 persons have lost their life with no any survivals. From a viewpoint of the number of casualties, the assumption of the above item (1) is reasonable because the average number of visited people is estimated at 207 persons per day with not so much difference with the said actual number of casualties.

The items from (2) to (4) and (7) are excerpts from the Iranian Statistic Year Book 1382. In this case, it could be assumed that most of the campers and/or visitors who are enjoying in the Golestan Forest are the urban residents.

If floods occur, the people who are just enjoying in the Golestan Forest must surely lose their life. It means that they lose their expected all the income to be gotten in future after their ends.

As a result, the amount of around 9,9990 million Rials may be lost as a damages in total in case of the same scale of the 2001 Flood as shown in the above estimation. If the damages in 5-year flood in scale are to be 1/10 of the said amount, the annual average damages to casualties caused by floods can be estimated by using a following formula:

The amount of annual average damages to expected income in total is estimated at a sum of 760 million Rials per annum as shown in the following table:

Table 5.13 Estimation of Annual Average Damages to Expected Income

Without Project — 2005-price Level (1,000 Rials)

Return Period (Year)	Exceedance	Difference of Exceedance	Damages (Million Rials)		Damages (Million	Cummulative Damages (Million Rials)
			Amount	Mean	Segment	
1	1.0000	-	0	0	0	0
5	0.2000	0.8000	999,000	499,500	399,600	399,600
10	0.1000	0.1000	1,350,000	1,174,500	117,450	517,050
25	0.0400	0.0600	2,580,000	1,965,000	117,900	634,950
50	**0.0200**	**0.0200**	**9,990,000**	**6,285,000**	**125,700**	**760,650**

At present, several places destroyed caused by the floods in the past are under rehabilitated. But, these works are only for rehabilitation to the former state. Therefore, if no any drastic measures are made, the same damages will suffer again in the future. Most important

measures are to inform to the people who are coming to enjoy in the Golestan Forest when the flood likely occur.

A systematic flood warning system is one of such measures. This component is a plan to establish a suitable Flood Forecasting and Warning System. Annual cost disbursement is planned as follows:

Table 5.14 Annual Cost Disbursement for Golestan Forest Park Disaster Management Plan

(Million Rials)

Item	Cost in Total	Annual Disbursement				
		2007	2008	2009	2010	2011
Financial Cost	3,215	995	688	526	526	480
Economic Cost	2,902	898	621	475	475	433

Using a cash flow of the said cost and benefit, the economic evaluation is made in the same manner of the above "River Restoration Plan". Also for evaluation, the Net Present Value (NPV, i.e. B-C in terms of the present value), the Economic Internal Rate of Return (EIRR) and the Benefit-Cost Ratio (B/C Ratio) are used as evaluation indicators in this component too. The discount rate is applied at 10 % taking similar projects in developing countries into account. The results are summarized as shown in the following table.

Table 5.15 Summary of Economic Evaluation Result

Evaluation Indicator	Under the Present Economic Condition	Under the 2025-Year Economic Condition
NPV	2,799	5,128
EIRR	17.71%	23.40%
B/C Ratio	2.49	3.72

(Note)
NPV is expressed by million Rials.

As shown in the above table, both EIRRs at present condition and at 2025-Year condition are higher than 10 % of the applied discount rate as 17.71 % and 23.40 %, respectively. Thus the Golestan Forest Park Disaster Management Plan has enough viability to execute.

Debris Flow Control Plan

This component consists of construction of sabo dam and channel improvement works in the debris flow prone villages in the area downstream of Tangrah village. It is under planned by MOJA, and will be executed by them.

For instance, Terjenly Village has no any rangeland, but they are breeding lots of livestock such as sheep, goat and cow in the residential area. Therefore, if once floods occur, damages are not only to houses and household movables but also to livestock in their residential area. Therefore the amount of land value of the residential area is rather high comparing with Dasht village.

Following table shows a land value per unit area of damaged area caused by the 2001 Flood. If the village could be protected from floods, these damages will be mitigated depending upon flood scale.

Flood Control Plan

This component consists of river improvement works for the mainstream of the Madarsoo River. Basically the flood control plan shall be conducted by MOE in cooperation with

MORT for the road improvement part. Rehabilitation works have been progressed to the damaged portions by the 2001 Flood. However, the recent 2005 Flood destroyed again rehabilitated structures. Now MOE is going to restart their rehabilitation works.

After the recent 2005 Flood, the JICA team gained new and reliable meteo-hydrological information and simulated results. The team made some recommendations for the flood control plan. These are (1) necessary hydrological designing, (2) necessary foundations of the flood control structures, (3) considerations to improve the river constriction parts, (4) considerations to improve the road between 14 Metry Bridge and Tangrah for ensuring the emergency activities during floods.

The constrictions bring about flood damage for the huge areas, maybe several hundred ha upstream of the locations. As discussed above, even in rural areas, following amount of damages per ha might be brought about from the floods. If it is taken into consideration that the targeted areas are the urban areas, they should have several times greater value of land to be damaged when the areas will be left as it is without any counter measures. Moreover, the area to be damaged would also expand till hundred hectares in its extents.

Table 5.16 Summary of Land Value to be Damaged in Rural Area

Million Rials/ha

Village	Residential Area	Irrigated Agricultur-al Area
Dasht Village	680	6
Terjenli Village	1,182	11

Floodplain Management Plan

In the lower reaches of the Madarsoo River from the Kalelah Bridge, the river-terrace structure has been developed with several meters (5 or 6 m, or sometimes 10 m) height differences between upper and lower terraces. The upper terrace is the Gorgan plain where people live on. Villages and public facilities like roads are constructed on the plain. People who live along the river-terrace (lower terrace) use it as the agricultural area. Therefore, there will be no any human damages, while there will be agricultural damages during floods.

However, because of lack of information concerning the flood occurrence and/or lack of suitable information network system on flood forecasting and warning, people, especially farmers, come into such river-terrace for operation and maintenance of their agricultural land located on it, and they lose their life. As already discussed in the Golestan Forest Park Disaster Management Plan, damages to expected lifetime of the people after their ends will become a huge amount.

If the people can receive the following warning and/or information and they obey such warning and/or information, they should not lose their life:

- Public announcement on specified area to be inundated by floods,
- Warning to forbid anybody to enter such specified area to be inundated,

For realizing this system practically, there should be good reliability between people and the Government. Thus an effort to establish the reliability of the Government is to be needed to the residents too. For this purpose, a suitable and reliable flood forecasting and warning system should be developed.

From this viewpoint, this component may be closely connected with the next component of flood preparedness plan.

Flood Preparedness Plan

This component comprises:

(1) To establish a flood forecasting and warning system,

(2) To establish a System for avoidance and/or mitigation from or of flood damages for making smooth activities of evacuation from floods based on the flood forecasting and warning system above,

(3) To develop flood hazard maps, and

(4) To take activities as training and/or education for developing the public awareness for making people rouse their self-consciousness so that they can take smooth activities avoiding from dangers of floods.

If these systems could be practically realized and successfully functioned, social effects (or socio-economic effects) derived from such systems and such functions will be great with a little fund of the Government because that the said systems could be operated by the Government's daily works.

Considerable social effects and/or socio-economic effects may be as follows:

- To save the people's life (this will mitigate the damages to all the income to be gotten in the future after their ends as already discussed above),
- To stabilize the mind of the people,
- To generate a reliability of the people against the Government, and
- To ensure the good relationship between the people and the Government,

Of course, there will be a lot of hurdles to realize the said systems as (1) to revise the Law and the Regulation, (2) to re-structure the existing official organization of the Government, (3) to improve the relationship among the existing official organization of the Government, (4) to recruit suitable experts for the systems, (5) to improve the working system in Iran because the flood forecasting and warning system should be continuously functioned without any pause. Natural disasters do not wait for people's actions.

But, the most important thing is to start from a part that could be easy to start. One success leads the next success. Strengthening staffs' capacity of the Government will be gradually established and ensured through this process, and strengthening staffs' capacity of the Government lead further success after that. Then, the people will become to rely on the Government's staffs to do their best for operating the systems.

This component is proposed to give such opportunity to start. From the socio-economical viewpoint, this component is quite valuable one.

5.13 Environmental Evaluation

Generalities

The proposed master plan would be implemented in the Madarsoo River basin, suiting in Golestan, North Khorasan and Semnan provinces, to reduce flood/debris flow damages, to mitigate soil erosion/land degradation and to safeguard lives and properties of the people against disasters. Part of the Golestan National Park being under authority of Department of the Environment (DOE) occurs in the project area. The captioned project is inline with laws of Socio-Economic and Cultural Development Plans of the country, as well as compatible with Islam philosophy, which require the Islamic Government to protect the entire citizen against disasters and take care of God-gifted natural resources.

At international level the project is in harmony with Agenda 21 of Earth Summit-Rio 1992, which emphasis on care for fragile mountainous areas (watershed). Restoration of degraded environment and conserving/improving current status of environment is among principles of Japanese ODA (**O**fficial **D**evelopment **A**ssistance). JICA (**J**apan **I**nternational **C**ooperation **A**gency) also put much emphasis on environmental issues while rendering its Cooperation Schemes.

Traditional works for conservation of river basins have been done for a long time in Iran, with late/less response. The project aims to introduce modernized/improved structural and non-structural disaster mitigation/management measures into the Madarsoo River basin and to establish a model for being propagated in other similar basins in the country. The JICA Study Team, which has been dispatched to Iran, in response to request of Iranian Government will formulate a Master Plan up to the target year of 2025, select priority projects among those proposed in the master plan, and conduct Feasibility Study on them. Iranian side will implement the prioritized projects to accomplish the task. Ministry of Jihad-e-Agriculture (MOJA) is the project proponent, and Generate Directorate of Environment in Golestan province is competent agency collaborating with the project in environmental related matters.

Revised version of JICA Guidelines for Environmental and Social Considerations published in April 2004, categorizes the projects as shown below:

Table 5.17 Categorization on Environmental and Social Considerations in the JICA Guidelines

Category	Description
A	Projects likely to have significant adverse impacts on the environment and society. Projects in sensitive sectors with characteristics liable to cause adverse environmental impacts, as well projects located in or near sensitive areas are also fall in category A.
B	Projects are classified as category B if their potential adverse impacts on the environment and society are less adverse than those of category A. Most of impacts are site-specific and reversible through normal mitigation measures.
C	Projects with minimal adverse impacts on the environment and society are in category C.

For details on JICA Environmental Guidelines, see Scoping for the Study attached to the Mater Plan Report.

Based on review of background and examination of formal documents prepared for this master plan, from environmental viewpoint it falls in Category B of JICA categorization, with following justification.

(1) The proposed master plan is of disaster management in nature and sprit, aiming at reducing flood/ debris flow damages, preventing soil erosion/land degradation, thus enhancing the status of ecosystem. Such works are environment-friendly, widely known, easily accepted by people, and executed with relatively small-scale in a limited area.

(2) Structural measures are established in a limited area and are designed to counter deterioration of physical and biological environments, without inserting any impact on social environment.

(3) However part of the Golestan National Park occurs in the study area, but no structural measures are proposed/constructed in the park. Instead of structural measures, flood forecasting and warning system is proposed to save visitors and campers in the Park from disastrous floods.

(4) Locations of historical/cultural sites existing in the area have been pinpointed, marked on the maps and provided to the study team, for being refers when selecting sites for establishment of structures. So no construction work is done at such sites, thus no harms to those assets.

(5) According to environmental laws and regulation prevailing in Iran, only large-scale projects correspond to A category of JICA categorization, thus requiring conduct of

EIA. On the other hand, the captioned plan is of small-scale and for disaster prevention purpose.

(6) The project neither plans involuntary resettlement, nor proposes any change in existing institution and customs.

(7) No peat-land, mangrove forest or coral reef occur in the project area.

DOE (Department of the Environment) of Iran published its revised version of Environmental Guidelines and Standards in the autumn of 2003. According to the guidelines, 18 kinds of projects are expected to have significant adverse impacts on the environment and society, hence require environmental impact assessment prior to their implementation. The captioned project is not of these kinds. For list of projects (18 kinds) and organization chart of DOE see Scoping for the Study attached to this report.

Project Components and their Environmental Evaluation

To cope with disasters of flood and debris flow, and assure safety of inhabitants of the river basin, master plan of the project proposes structural measures such as construction of river improvement and sediment control structures, and non-structural measures such as installation of warning system and provision of hazard maps indicating the safe location for sheltering upon warning. In this context the master plan contains seven components as tabulated below.

Table 5.18 Master Plan Component and their Salient Features

Item No.	Component	Main Area to be Conducted	Major Works to be Done
1	Watershed Management Plan	Headwaters and middle reaches	Afforestation, land treatment, and on-site rainfall detention
2	River Restoration Plan	Headwaters	Reconstruction of dam in Ghiz Galeh, construction of flood control dam and channels in Dasht area
3	Golestan Forest Park Disaster Management Plan	Middle reaches	Establishment of flood forecasting and warning system and emergency activities
4	Debris Flow Control Plan	Middle reaches (Tangrah to Beshoily)	Construction of debris flow control dams and canals along with watershed management
5	Flood Control Plan	Middle and lower reaches	Construction of flood control structures to protect farmlands and villages
6	Floodplain management Plan	Middle and lower reaches	Publication of flood-hazard map and land use control in the flood-hazard area
7	Flood Preparedness Plan	Entire basin	Improvement of early warning system and training activities for emergency

To justify the overall environmental effect of the proposed project, its components together with relevant alternatives are individually discussed here. The discussion is based on collected data/information, consultation with Iranian experts, results of field surveys, exchange of view with local people and conduction of Scoping for the Study, documents of which are presented in Annex of this report. To accelerate the works and accomplish tasks on time, part of investigation was entrusted to local consult companies/capable individuals, but supervised by JICA study team. Reports of study conducted by Iranian institutions (MOJA Golestan, Mazandaran-Golestan Regional Water Board) in parts of the basin, were also reviewed.

(1) Watershed Management Plan

This includes afforestation, land treatment, and on-site rainfall detention works, and aims at disaster prevention and enhancement of environmental status of the area. These approaches are environmental-friendly and Iranian experts have sufficient knowledge/skill to execute and maintain them without causing any harm to the environment. These activities are cost-effective, compatible with Islamic teachings and in harmony with people believe, as three elements of rain, land and plants are honored in the holy Quran (Surah Abas, Ayeh 24 to 32). Thus local people would cooperate in execution/maintenance works, ensuring success of the project.

Moreover watershed management tasks have been practiced for a long time in Iran, and local people are quite aware of their equable and equitable benefits, thus no adverse social impacts (conflict among communities/increase in income disparities) is expected. Furthermore this plan will leads to efficient/sustainable utilization of natural resources, creation of job and reduction in migration rate, thereby contributing to enhancement of living status (economically/spiritually) of inhabitants. Vegetation/forest established and rainwater detained through these works, are not only important for environmental enhancement and reduction of flood damages, but also important for keeping the livestock sector alive, because most of livestock depends on natural vegetation/water sources occurring in the areas. Forests will provide cleaner air and healthier society.

Considering the points mentioned above and realizing the fact that presently no better alternative is known, this watershed management plan from environmental point of view is justified as acceptable, thus it can be implemented. But project is advised to pay careful attention to the following points and take proper precautions accordingly.

(a) In afforestation works, trees should be so selected to avoid introduction of any plant diseases in the area, since some exotic plants may serve as hosts for plant pathogens and encourage their spreading to endemic plants.

(b) In land treatment activities, which require disturbance of soil, some air pollution may occur. To nullify/minimize this impact, works must not be conducted in windy hours.

(c) Rainwater detained must be properly managed to avoid occurrence of impacts such water logging, salinity, and spread of water related diseases in the area.

(d) Regular consultation with a well experienced/knowledgeable environmental expert in all stage of the project.

(2) River Restoration Plan

This item involves construction of some structures, which are beneficial for protecting people and farmlands against flood and sedimentation hazard. Some jobs are created and overall social status in associated villages is enhanced. Construction of reservoir and channels has been practiced in Iranian territory dating back to millenniums BC (before Christ) as evidenced in Choqazanbil area in southern Iran. Thus Iranians are very familiar to such tasks and have sufficient background/ knowledge and experience to accomplish them. Since local people know benefit of this plan they would cooperate in works for its realization. But the plan has some defects such as:

- In construction phase there might be some noise and air pollutions by machinery and as result of soil disturbance.
- Construction activities might bring-about temporary soil erosion.
- Natural vegetation and wildlife in the area are disturbed.

- Machinery and employees engaged in construction works would generate some wastes.

With due attention to points mentioned earlier in section of Generalities, and since a present there is no better alternative to this plant, from environmental viewpoint it is conditionally acceptable, and some of conditions are set herein.

- Heavy construction works should be done in day hours to minimize disturbance of people and wildlife.
- Works requiring disturbance of soil should be haltered in windy hours to minimize the air pollution.
- Wastes generated by machinery (discarded oil) as well by employees should be properly collected and disposed in designated place.
- Reservoir site should be properly guarded (fenced) to prevent accidental collapse of people and animal into it.
- Since there are many known and unknown historical/cultural objects in the area, the project should highly consider this matter and take proper precautions. In construction phase whenever employees face any ruin/strange object should immediately report it to the nearest office/representative of Cultural Heritage and Tourism Organization.

Moreover the project is advised to have regular contact and consultation with authorities in Cultural Heritage and Tourism Organization, and Department of the Environment.

(3) Golestan Forest Park Disaster Management Plan

This item proposes establishment of flood warning system and means of evacuating the visitors and campers in case of emergency. Such activities have their deep roots in Iranian history and culture, and are outlined in holy Quran (Surah Abniya, Ayeh 75 to 77; Surah Noah Ayeh 28). In ancient time, when a heavy flood (Noah flood) occurred, Noah warned his tribe to evacuate, and guided them to a safe place through his *paperless hazard map*. So such activities are very suited to Iranian society and acceptable by the people. They involve only simple construction work, not require large space, and capable of saving lives of people through timely operation. Therefore from environmental viewpoint this plan is acceptable and can be implemented. But project should take some precautionary measures such as:

(a) The established instruments should be properly maintained and occasionally tested in normal case to ensure their efficient operation in emergency cases.

(b) Test operation should be done in day hours and people are informed about the test well in advance, to avoid any public panic and social disturbance.

(c) Since the instruments are established in the national park, their coloring and decoration is important in matching them with natural environment of the park.

(4) Debris Flow Control Plan

Under this plan some small dams are erected in waterways to minimize the flow of debris toward villages, particularly in Tangrah to Beshoily axis. Implementation of this plan will contribute to social stability and health of inhabitants, by safeguarding them against disasters. Under present condition people find the villages unsafe and may migrate to other areas, which has its own social impacts, or remain in villages and suffer psychological stress, which cause decline in health (mental) of people, and impose additional spend for medical care on the society. Therefore from humanitarian (social environment) point of view the plan is welcome, but it is un-pleasure to

natural environment, since the proposed dams will insert some negative impacts on flora and fauna at all stage of the project. Upon completion, the erected dams are nuisance to creatures transiting in relevant waterways, and would lessen the natural beauty of landscape. Significant alternative to this plan is the relocation of villages subjected to debris flow, which requires long time study and careful consideration from economic and social aspects. Relocation is a time consuming and expensive approach involving complicated formalities and sophisticated arrangement. In affairs dealing with people's life, "no action" is not a reasonable alternative. Therefore from environmental viewpoint this plan is acceptable with caution. In this context the project should consider the following points:

(a) Construct minimum number of dams in highly dangerous location with proper design, using natural materials such as boulder and stone,

(b) To increase safety coefficient of the area, in addition to structural measures, under take some non-structural measures such as installation of instruments for monitoring and conveying the status of debris flow to certain station and thereby to people,

(c) Take some measures for conserving/enhancing the natural vegetation, which could contribute in reduction of damages of debris flow,

(d) The reveal the actual impact of dams on the environment, periodical survey on flora and fauna in dam site should be conducted, and

(e) Regular consultation with authorities in General Directorate of Environment and Natural Resources General Office of Golestan province is highly recommended.

(5) Flood Control Plan

This plan aims at protecting the farmlands and villages against flood with defined return period. Since livestock largely depend on farm residue, this approach will contribute to sustainability of livestock sector and diet of people. With protection people will get more hope on life and confidence on agriculture/livestock activities, which could enhance the economy and social stability of the area. The advantage and disadvantages of this plan are more or less similar to that of plan given under item (4). Therefore all issues discussed for item (4) should be noted for this plan too.

(6) Floodplain Management Plan

This plan is of advisory and precautionary types, involving not structural measures, hence inducing no any adverse impact on the environment. In contrary it will play an important role in safety of people, with a low cost and less complicity. Therefore from environmental point of view it can regarded as highly acceptable, and executed at any time.

(7) Preparedness Plan

Under this plan the existing disaster warning system is improved and people are trained to safeguard themselves against disaster and efficiently evacuate in case of emergency. This plan is inline with the strategy of Iranian government for enhancing the capability and readiness of nation in facing disasters. It also matches the effort of State Corps of Unexpected Events, which prepare and disseminate materials to promote the knowledge and understanding of public on disaster and prepare them for dealing with crises of unexpected events.

Conclusion

By considering the points explained and discussed above, it can be concluded that all the plans (table above) proposed by the JICA Study Team are environmentally sound and can be implemented with proper arrangement and efficient management. But the project should consider the following points:

- Involve experienced and knowledgeable environmental experts in all stages of the projects (design, construction, operation and maintenance).
- Report any abnormality to relevant institutions immediately (department of the environment, natural resources general office, and cultural heritage and tourism organization) and seek their advice for solving the problem.

CHAPTER 6 PHOTOGRAPHS SHOWING THE SITUATION OF MADARSOO RIVER BASIN

Site Photo	Necessary Improvement Works
	Tangrah Construction of debris flow deposition basin immediately upstream of village Channeling works from basin to outfall
	Terjenly (two streams) Channeling works, in particular downstream of road crossing Installation of drainage culvert under the road
	Between Terjenly and Google Bozorg Construction of debris flow deposition basin immediately upstream of the road Channeling works from basin to outfall including drainage culvert under the road
	Beshoily Construction of a series of sabo dams Closure of another stream at the bifurcation

Site Photo	Necessary Improvement Works
	14 Metry Bridge One of serious constrictions in the lower reaches. Floodwater flowed down over the road. (Photo taken on August 10,2005)
	Loveh Bridge The right bank approach of submerged bridge part was away. Bolder spur dike to protect Loveh village was also washed away. (Photo taken on August 10,2005)
	Beshoily Bridge Serious constriction in the middle reaches. Floodwater inundated over the valley-bottom plain. (Photo taken on August 10,2005)
	River Bend in Terjenly village River floodwall fell down due to insufficient foundation depth. (Photo taken on August 12,2005)
	River Bend in Tangrah village River floodwall fell down due to insufficient foundation depth. (Photo taken on August 10,2005)
	Golestan Forest Approach road of temporary bridge was washed away. (Photo taken on August 10,2005)

Site Photo	Necessary Improvement Works
	Golestan Forest River floodwall downstream of the Dasht Bridge fell down due to insufficient foundation depth. (Photo taken on August 12,2005)
	Dasht Bridge Floodflow near flood peak was passing over and through the Dasht Bridge. (Photo taken by MOJA-North Khorasan on August 10, 2005)
	Dasht Bridge Immediately downstream of the Dasht Bridge was seriously scoured. (Photo taken in middle of August, 2005)