CHAPTER 4 RIVER RESTORATION PLAN IN DASHT AREA -RIVERBANK STABILIZATION WORKS-

4.1 Generalities

Based on the respective structural and non-structural measures proposed in the master plan, the following three projects have been selected as the priority projects on the viewpoints for the previous flood damages, the immediate project effect, economic viability and the suitable and essential themes on technology transfer to the MOJA personnel.

Three projects are:

(1) Construction of sediment control dam in the Ghyz Ghale River and riverbank stabilization works in the Madarsoo River nearby the Dasht village

(2) Strengthening of the disaster management with Flood forecasting, warning and evacuating system in the Golestan Forest National Park

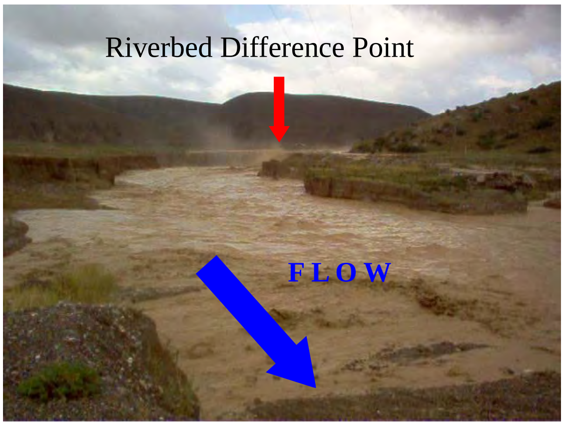
(3) Publication of probable flood and debris flow hazard map

The main aim of this chapter is to prepare an appropriate preliminary structural design for the said riverbank stabilization works based on 1) structural recommendations in the master plan and 2) results of relevant research and investigation such as the topographic survey, the geological investigation, the hydrological study review.

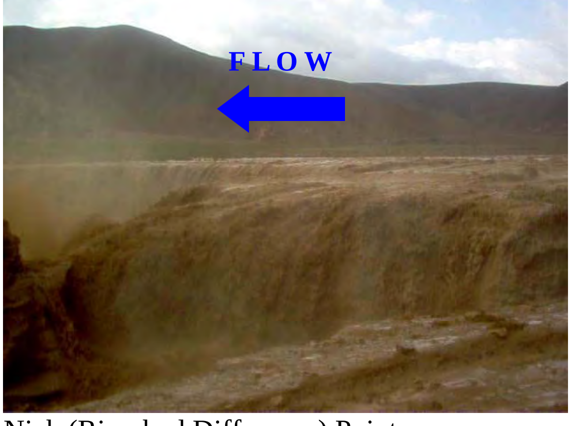
4.2 Objectives

Under the current situation during the flooding period, the existing river on the Dasht basin is prone to overflow the neighboring farmlands immediately since the river has insufficient flow capacity against the probable flood. The floodwater spreading out on the farmlands is going down to the Madarsoo River and the floodwater causes the unstable riverbank erosion at the nick point with the heavy flood flow meandering.

The following photos show the flood state at the nick point in the Madarsoo River during the 2005 Flood.



Overall the Unstable Riverbank Area
The floodwater is going down to the Madarsoo River, turbulently.



Nick (Riverbed Difference) Point
The floodwater spreading out on the farmland is falling down like a large scale waterfall.

Fig. 4.1 Valley Head Erosion Downstream of Dasht Village
Source: taken by MOJA-North Khorasan on August 9, 2005

Consequently, the unstable riverbank collapse is accelerated further and the valley head of unstable riverbank, which is in accordance with the nick point, might gradually go forward to the upstream area nearby Dasht village whenever the flood occurs.

The riverbank stabilization works of the Madarsoo River nearby Dasht village is the proposed structural countermeasure to prevent the above said damage to the Dasht village. The works has the following three objectives.

The objectives are:

- To stabilize the existing unstable riverbanks of the Madarsoo River nearby Dasht village;
- To prevent the farmland from losing further caused by flood, and
- To reduce an exceeding sediment conveyance into the downstream of the Madarsoo River.

Additionally, this proposed structure is one of the essential structures for the River Restoration Plan under the Master Plan. This structure shall be set with the most downstream of the Gelman Darreh River improvement since it is expected that its function is not to stabilize the existing riverbanks but also to maintain the river course in the upstream as same function as the groundsill.

This riverbank stabilization works can bring the further effect to prevent the flood damage from appearing in and around the Dasht village under the proposed design scale when the river improvement works of the Madarsoo River and the Gelman Darreh River nearby Dasht village will be executed in accordance with the Master Plan scheme and the improved river system will be connected to the riverbank stabilization works.

The image photos before and after construction of the proposed riverbank stabilization works are shown in the following figure.

Before Construction

The Present State of Riverbed Difference Point
Source: Taken by JICA team on January 2006

After Construction (Image Photo)

Employment of Concrete Dam
Source: Web Homepage of the Ministry of Land, Infrastructure and Transport, Japan

Fig. 4.2 Image of the Proposed Riverbed Stabilization Works

4.3 Design Conditions

Design Scale

The design scale applied to the proposed structures is in accordance with the flood discharge under 25-year return period since MOE, which conducts the planning and construction of infrastructure nationwide in Iran, adopts that the flood scale in the rural area is applied with 25-year floods, while the flood scale in the urban area is in accordance with 50- to 100-year floods on the flood control planning.

In conformity with standard of Iran and MOE planning, the following design scales have been adopted in the master plan.

- Protecting farmlands and rural village: 25-year flood
- Protecting important structures (main road and bridges) and town areas: 100-year flood

Design Discharge

The design discharge applied to the proposed structures is in accordance with the flood discharge under 25-year return period.

The hydrological study results have provided that the main river and the tributaries of the Madarsoo River Basin in and around Dasht Village have the following probable peak discharge:

Table 4.1 Design Discharge under 25-Year Return Period

Location	Design Discharge	Remarks
Madarsoo River (Upstream)	660 m^3/s	After confluence of Dasht-e-Sheikh River
Gelman Darreh River (Downstream)	430 m^3/s	
Dasht-e-Sheikh River	90 m^3/s	
Ghyz Ghale River	160 m^3/s	

Additionally, design discharge in the above table includes the effect with watershed management plan conducted by MOJA-Golestan and it is assumed that sediment volume of bed load is included in the respective design discharges since these discharge analyses are based on the large recorded floods in 2001 and 2005, of which recorded floodwater contained sediment runoff.

Design Water Level

Design water level for proposed channel sections is provided with the Manning Formula, which calculates an hydraulic state under the uniform flow condition, since the existing riverbed slope gradient of the Madarsoo River basin is steep as same as torrential stream riverbed slope gradient and supercritical flow is prone to occur under the hydraulic calculation.

The equation of the Manning Formula is shown as follows:

$$Q = V A$$
$$V = \frac{1}{n} R^{2/3} I^{1/2}$$
$$R = A/P$$
$$A = h (B + m h)$$
$$P = B + 2h\sqrt{1+m^2}$$

where:
Q : Design Discharge (m^3/s)
V : Design Flow Velocity (m/s)
n : Roughness Coefficient
I : Design Riverbed Gradient
A : Required Flow Section (m^2)
P : Wetted Perimeter (m)
h : Design Water Depth (m)
B : Design Invert Width (m)
m : Riverbank Slope Gradient (1: m)

Source: River Works in Japan complied under River Bureau in the Ministry of Land, Infrastructure and Transport, Japan River Association, 1997

On the other hand, design water level of the spillway section on the proposed dam or hydraulic drop structure is provided with the weir formula taking into account of the backwater effects.

The weir formula is shown as follows:

$$Q = \frac{2}{15} C \sqrt{2g} (3B_1 + 2B_2) h^{3/2}$$

$$B_2 = B_1 + 2 m h$$

where:
Q : Design Discharge (m^3/s)
C : Discharge Coefficient
(useable between 0.60 and 0.66)
g : Gravitational Acceleration (9.8 m/s^2)
B_1 : Design Bottom Width of Spillway (m)
B_2 : Design Water Surface Width (m)
h : Overflow Water Depth (m)
m : Spillway Bank Slope Gradient (1: m)

Source: River Works in Japan complied under River Bureau in the Ministry of Land, Infrastructure and Transport, Japan River Association, 1997

Freeboard

Required freeboard height shall be determined with the design discharge scale. The freeboard has the margin against unexpected wave height and overtopping.

Required dike crest or spillway section height is made from the sum of the design water depth and the required freeboard height.

The freeboard height in the torrential stream is required higher than the river course on an alluvium plain since, in the torrential stream, the riverbed change and/or sediment discharge are occurred frequently during the flood time and water surface is prone to become turbulent.

Consequently, determination of the required freeboard height in the torrential stream shall be considered with design discharge but also with channel bed gradient.

For instance, relation between design discharge and required freeboard height, which the Japanese Technical Guideline for river works recommends, is tabulated as follows:

Table 4.2 Relation Between Design Discharge and Required Freeboard

Design Discharge	Freeboard Height (minimum)
Less than 200 m^3/s	0.6 m
200 to 500 m^3/s	0.8 m
More than 500 m^3/s	1.0 m

Table 4.3 Relation Between Channel Bed Gradient and Required Freeboard

Bed Gradient	More than 1/10	1/10 to 1/30	1/30 to 1/50	1/50 to 1/70	1/70 to 1/100	Less than 1/100
h/H	0.50	0.40	0.30	0.25	0.20	0.10

Sources: River Works in Japan complied under River Bureau in the Ministry of Land, Infrastructure and Transport, Japan River Association, 1997

In the above table, "h " and " H" indicate the freeboard height based on the design discharge and the design water depth, respectively. Value of h/H shall be set up more than value shown above table.

Geological Condition Based on the Geological Investigation

According to the geological investigation results, the following comments for the confluence of the Madarsoo River and the Cheshmeh Khan River are described:

- N-value of Standard Penetration Test (SPT) is more than 50 for the riverbed deposit composed of sand and gravel. The allowable bearing capacity is estimated as about 29.4 tf/m^2 (294 kN/m^2) under the normal condition with bearing capacity equation utilizing the SPT results since it is assumed that a submerged unit weight of the soil is 1.0 tf/m^3 and internal friction angle of the soil is 40 degrees.
- Clay layer of riverbed deposit is distributed from 8.2 m to 13.3 m below the ground surface and it is categorized as "hard" with a N-value of 29 to 41. The allowable bearing

capacity (qa) will be estimated as the range from 29 to 41 tf/m^2 (290 to 410 kN/m^2) under the normal condition with the equation of qa = 1.0N.

- But, clay layer of lake deposit distributed from 13.3 m to 19.2 m below the ground surface is classified as "stiff or very stiff" with a N-value of 14 to 24. The allowable bearing capacity will be estimated as the range from 14 to 24 tf/m^2 (140 to 240 kN/m^2) under the normal condition with the equation of qa = 1.0N.

The summary of the borehole drilling result at the confluence of the Madarsoo River and the Cheshmeh Khan River is shown as follows:

Table 4.4 Summary of the Borehole Log at the Confluence Point

Depth (m)	Geological Name	Soil Class.	N-Value (Averaged)	Allowable Bearing Capacity
-8.2m	Riverbed Deposit	Sand and Gravel with Clay	More than 50	29.4 ft/m^2
-13.3m	Riverbed Deposit	Clay with Gravel	33	29 tf/m^2
-19.2m	Lake Deposit	Clay	18	14 tf/m^2
-25.0m	Old Talus Deposit	Sand, Gravel, Clay	More than 50	

According to the above geological investigation results, it is assumed that the proposed structural foundation is adopted with a spread foundation type.

One borehole drilling including SPT has been carried out for the preliminary design of the proposed riverbank stabilization works so that it is insufficient to implement the detailed design and construction stage. Consequently, before the implementation stage, the additional detailed geological investigation shall be executed including laboratory tests to ensure the more reliable results of the geological characteristics.

The additional geological investigation is proposed as follows:

- Unconfined Compression Test
- Field Permeability Test
- Field Density Test
- Particle Size Analysis
- Borehole Drilling at several points (with Standard Penetration Test)

4.4 Preliminary Design

4.4.1 Consideration of Proposed Channel Section

<u>Channel Stretch between Dasht Bridge and Nick Point</u>

According to the topographical survey in the F/S study, the river width between Dasht Bridge and the nick point is about 55 m in minimum and the distance between Dasht Bridge and nick point is about 640 m with a map measurement of scale 1:25,000.

The riverbed elevation nearby Dasht Bridge is obtained with EL+954.0 m under the field reconnaissance, while the riverbed elevation of EL+956.6 m nearby the nick point is provided with the topographical survey results.

Based on the above information, the existing waterway hydraulic characteristics between the bridge and the nick point are assumed as follows:

Table 4.5 Topographic Relation between Dash Bridge and Nick Point

Location	Riverbed EL.	Distance	Assuming Riverbed Gradient
Riverbed Difference Point	EL+956.5m	640 m	I = 1/260
Dasht Bridge (Existing)	EL+954.0m		

The channel section accommodating the design discharge of Q_{25} = 660 m^3/s in accordance with 25-year return period is designed with the uniform flow calculation of the Manning's Formula. The hydraulic calculation results are shown as follows:

Table 4.6 Hydraulic Calculation Results in the Downstream Reaches

Conditions	Value	Remarks
Riverbed Width	55.0 m	
Water Depth	3.3 m	
Side Slope Gradient	1:0.5	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/260	Same as existing riverbed gradient
Sectional Area (A)	186.95 m^2	
Wetted Perimeter (P)	62.38 m	
Hydraulic Radius (R)	2.997 m	
Flow Velocity (V)	3.68 m/s	
Flow Capacity (Q)	688.6 m^3/s	Design Discharge: 660 m^3/s

Required freeboard height is 1.0m high based on the design discharge and the value of h/H is 1.0m/3.3m = 0.303 with riverbed gradient I=1/260. The value satisfies the standards shown in Table 4.3. Therefore, the freeboard height of 1.0m is adopted.

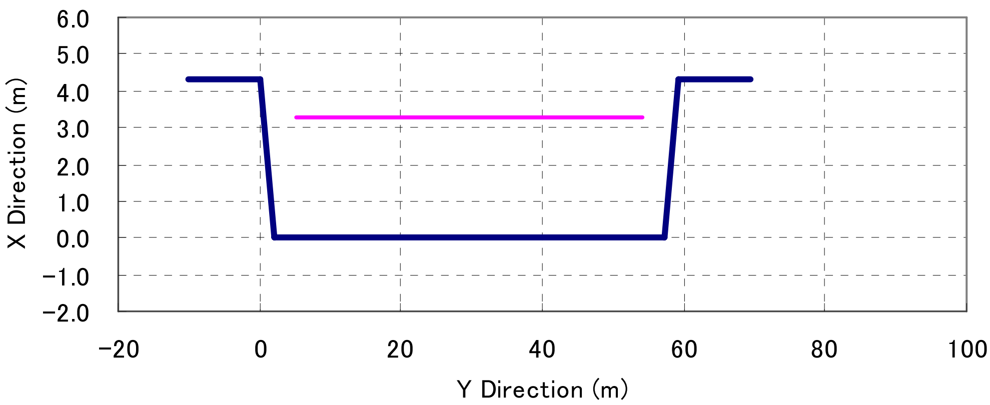


Fig. 4.3 Typical Cross Section of the Downstream Section

<u>Channel Stretch Upstream of Nick Point</u>

According to the field reconnaissance and a map measurement with scale of 1:25,000, the ground surface slope gradient of the Dasht basin is about 1/100 between the nick point to the confluence of the Madarsoo River and the Dasht-e-Sheikh River.

In terms of economic and social environmental aspects on the channel improvement, the proposed channel bed gradient is adopted as same as the existing surface gradient to reduce the excavation volume and to avoid setting the proposed design water level higher than the existing ground surface.

Proposed channel width follows the immediate downstream river width of 55.0 m as well as the downstream stretch between Dasht Bridge and the nick point.

The channel section accommodating the design discharge of 660 m^3/s in accordance with 25-year return period is designed with the uniform flow calculation of the Manning's Formula. The hydraulic calculation results are shown as follows:

Table 4.7 Hydraulic Calculation Results of the Upstream Section

Conditions	Value	Remarks
Riverbed Width	55.0 m	
Water Depth	2.5 m	
Side Slope Gradient	1:0.5	
Roughness Coefficient	0.035	Sand & Gravel
Riverbed Gradient	1/100	Same as existing ground surface gradient
Sectional Area (A)	140.63 m^2	
Wetted Perimeter (P)	60.59 m	
Hydraulic Radius (R)	2.321 m	
Flow Velocity (V)	5.01 m/s	
Flow Capacity (Q)	704.3 m^3/s	Design Discharge: 660 m^3/s

Required freeboard height is 1.0 m high based on the design discharge and the value of h/H is 1.0 m/2.5 m = 0.40 with riverbed gradient I=1/100. The value is satisfies the standards shown in Table 4.3. Therefore, the freeboard height of 1.0 m is adopted.

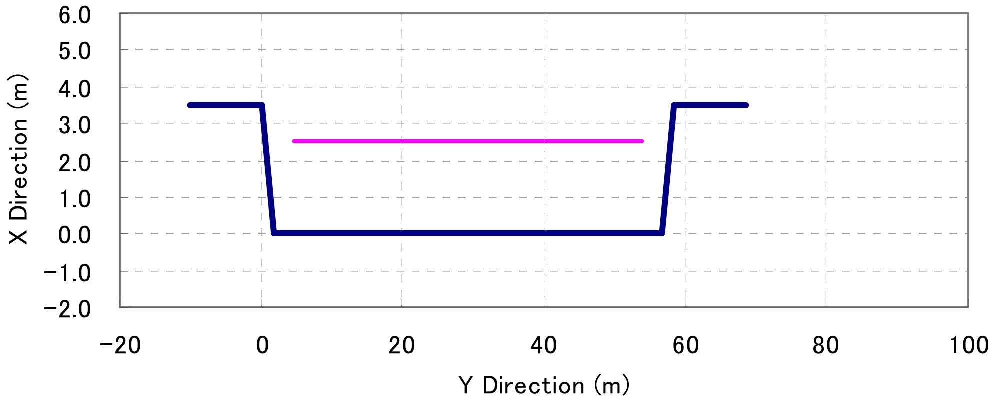


Fig. 4.4 Typical Cross Section of the Upstream Section

4.4.2 Consideration of Optimum Structural Type for the Countermeasures

Three types are elaborated for alternative schemes based on the topographical and hydraulic conditions. These alternative features are described as follows:

Alternative-A is composed of concrete main dam, sub-dam, concrete apron with stilling basin and concrete block.

Alternative-B is composed of concrete main dam, sub-dam, concrete apron with stilling basin, hydraulic drop structure and concrete blocks for the riverbed protection.

Alternative-C consists of three (3) hydraulic drop structures and concrete blocks for the riverbed protection.

The following criteria are prepared to compare the respective alternatives:

- The downstream design riverbed is in accordance with the existing riverbed.
- The upstream design channel bed is set on the proposed channel bed considered with proposed river channel improvement of the Gelman Darreh River.

- Proposed concrete apron surface is set based on the difference between the conjugate depth of the hydraulic jump and downstream water depth.
- Proposed drop height are considered with the condition that the conjugate depth of the hydraulic jump is about the same as the design water depth on the channel.
- Proposed spillway invert width of the main dam and/or hydraulic drop structure is 55.0 m wide as same as the width immediately downstream of spillway in the Madarsoo River.
- The bottom of main dam is set on the concrete apron surface below 2.0 m deep to prevent the unexpected scouring caused by the water falling down from the spillway section.
- The bottom of sub dam is set on the bottom of concrete apron below 2.0 m deep.

Salient features of the three alternatives are tabulated as follows:

Table 4.8 Salient Features of the Alternative Dimensions

	Structural Scale					
	Downstream Design Riverbed	Conc. Apron Surface	Main Dam Height	Hydraulic Drop Structure		Upstream Channel Bed
				Nos.	Drop Height	
Alternative-A	EL+956.5 m	EL+954.0 m	9.0 m	N/A	N/A	EL+963.0 m
Alternative-B		EL+954.6 m	5.8 m	1	2.0 m	
Alternative-C		N/A	N/A	3	2.0 m	

These alternatives are compared and the optimum structural type is selected from the viewpoints of structural characteristics, social environment and construction cost.

Comparison of the three structural combinations for the riverbank stabilization works is tabulated in Table 4.9 and the schematic drawings are shown in Fig. 4.5.

Table 4.9 Comparison of Structural Combination for Riverbank Stabilization Work

	Alternative- A (Concrete Dam Type)	**Alternative-B** (Concrete Dam + Hydraulic Drop Type)	**Alternative-C** (Hydraulic Drop Structure Type)
General View	Refer to Figure 4.5	Refer to Figure 4.5	Refer to Figure 4.5
Structural Characteristics	❑ The countermeasure is composed of concrete main dam, sub-dam, concrete apron (with stilling basin), concrete blocks and revetment as riverbank protection. ❑ Dam height of 9.0m is required to retain the existing riverbed difference by itself. ❑ The entering flow as kinetic energy created by flood flow fallen down is the strongest among other alternatives. ❑ The entering flow has high velocity flow of more than 15m/s on the concrete apron, so that there is a possibility to appear a heavy turbulent flow on the riverbed protection and to affect an immediate riverbed condition. ❑ Soil improvement works shall be required in implementation stage since subgrade reaction of the main dam exceeds an allowable bearing capacity.	❑ The countermeasure is composed of concrete main dam, sub-dam, concrete apron (with stilling basin), hydraulic drop structure, concrete blocks and revetment as riverbank protection. ❑ Dam height of 5.8m and drop structure difference of 2.0m are required to retain the existing riverbed difference. ❑ The entering flow as kinetic energy created by flood flow fallen down is smaller than Alternative-A because the installation of hydraulic drop structure can reduce the proposed dam height.	❑ The countermeasure is composed of three (3) hydraulic drop structures, concrete blocks and revetment as riverbank protection. ❑ Proposed drop structure height of 2.0m is required individually. ❑ It is required to keep the interval of 76.5m between the drop structures since hydraulic profile is set smoothly. ❑ The potential energy created by flood flow is the smallest among the three alternatives. ❑ It is expected to reduce the effect on riverbed change in the downstream section of the Madarsoo River.
Required Land Area	A1 = 84.5m X 94.0 m = 7,950 m^2	A2 = 110.6m X 92.0m = 10,180 m^2	A3 = 228.2m X 84.4 m = 19,260 m^2
Construction Cost	8.05 billion Rials (direct cost only)	7.83 billion Rials (direct cost only)	11.94 billion Rials (direct cost only)
Evaluation	Advantageous with regard to required area to be constructed, however, problem is left in possibility of turbulent flow effect and the countermeasure against the exceeding allowable bearing capacity. **(Inadequate)**	Cost performance is the best among the others. It is expected to reduce the effect of downstream stretch against a turbulent flow more than Alternative-A. **(Adequate)**	This type is more costly than other alternatives and the largest area is required by the construction. **(Inadequate)**

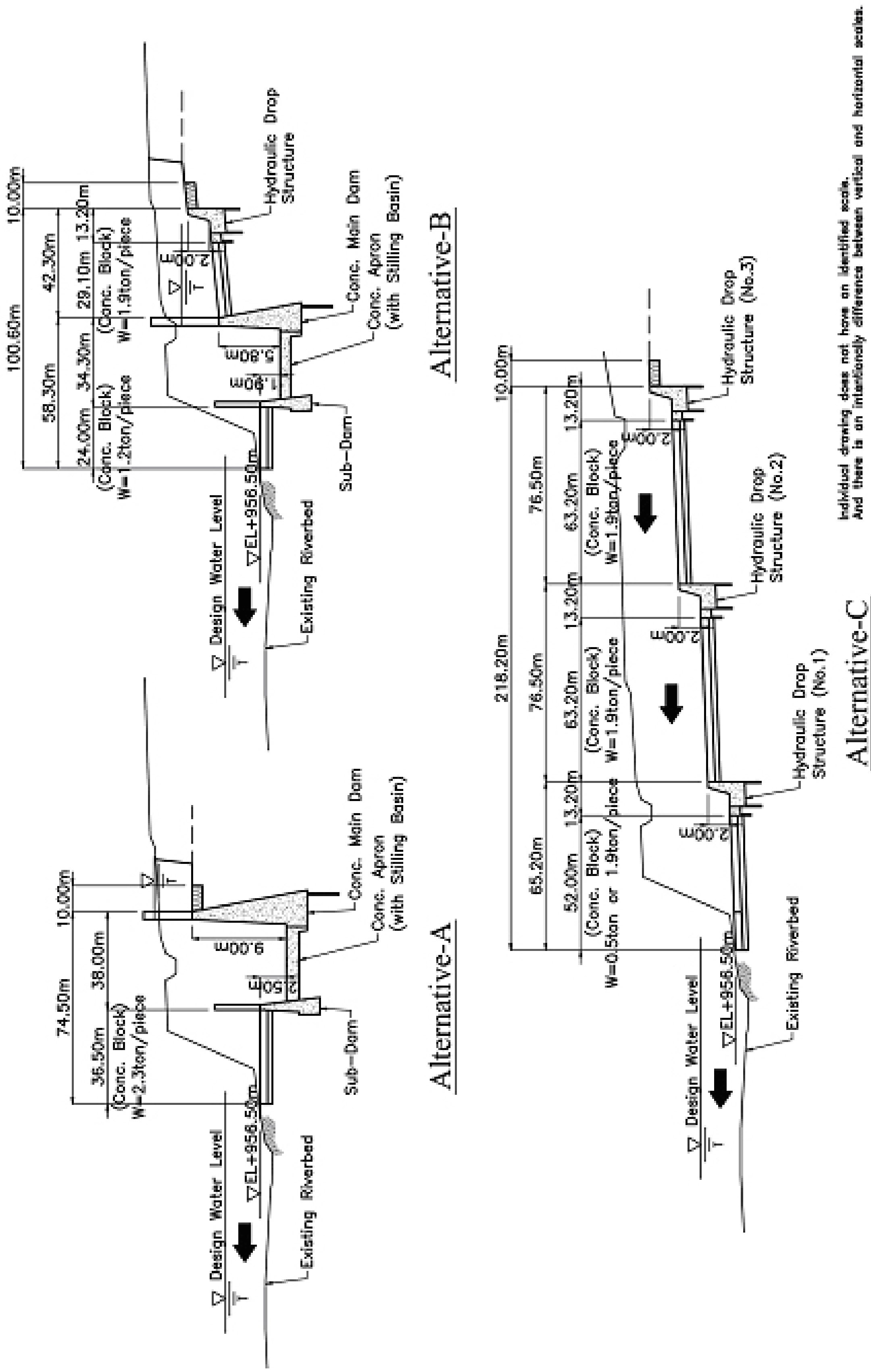


Fig. 4.5 Schematic Drawings of Structural Alternatives for Riverbank Stabilization Works

4.5 Conclusion

4.5.1 Optimum Structural Type

Based on the comparison for the structural type selection, Alternative-B (Concrete Dam + Hydraulic Drop Structure Type) is selected for the following reasons.

(1) The potential energy created by probable floodwater at the proposed dam spillway is reduced comparatively because the installation of proposed hydraulic drop structure in the upstream side of the concrete dam could reduce the concrete dam height.

(2) The reduction of the potential energy is expected to bring the effect mitigating the downstream riverbed scouring caused by the floodwater and to contribute stabilizing the existing riverbed further.

(3) Cost performance to be estimated is the best among the three alternatives and it is expected that the required area to place the proposed structures can be set on the current devastated area without the land acquisition of the farmland.

The salient structural dimensions of the concrete dam and hydraulic drop structure are tabulated as follow:

Table 4.10 Essential Dimensions for the Riverbank Protection Works

Structural Features	Value	Remarks
(**Concrete Dam**)		
Design Dam Crest Width	B = 3.0 m	Required by dam stability
Design Dam Height	H = 7.8 m	
Design Downstream Slope Gradient	1: 0.20	Required by dam stability
Design Upstream Slope Gradient	1: 0.75	Ditto
Seepage Blockage Wall for Concrete Dam	L = 3.0 m	Required by dam stability Against uplift
Design Upstream Concrete Block Weight	1.9 ton/piece	
Design Downstream Concrete Block Weight	1.2 ton/piece	
(**Hydraulic Drop Structure**)		
Design Drop Height	H = 2.0 m	
Design Drop Crest Width	B = 2.3 m	Required by drop structure stability
Design Footing Length	L = 5.0 m	
Design Footing Thickness	T = 1.5 m	Required by drop structure stability
Design Cutoff Height	H = 1.5 m	

In addition, additional foot section shall be required to secure the dam stability against tiling and the structural stability results shall be reviewed with the updating information during the detail design stage.

Drawings of plan and typical sections for the proposed riverbank stabilization works are shown in Figs. 4.6 to 4.8, respectively.

4.5.2 Preliminary Project Cost

The preliminary project cost estimate for the Alternative-2 as the optimum structural scheme is shown in the following table based on the results of preliminary design calculation and topographical survey.

The components of indirect cost mentioned below the table is referred to the estimate manner as well as the previous JICA study report on "the Integrated Management for Ecosystem Conservation of The Anzali Wetland in the Islamic Republic of Iran, March 2005".

Baseline of the unit price for project cost estimate is adopted as of August 2005. The exchange rate is shown as follows:

USD 1 = 8,996 Rials and JPY 100 = 8,025 Rials (as of August 1, 2005)

In addition, basis of unit price in the below table refers to the document of index of expenses for projects related with irrigation, drainage and engineering of water in Islamic year 1383 (European year of 2004) issued by Deputy of Technical Affairs, Technical Affairs Bureau, Management and Planning Organization (MPO), Islamic Republic of Iran.

Table 4.11 Preliminary Project Cost Estimate

Alternative-2

Work Item	Quantity	Unit	Unit Price (Rials)	Amount (1,000 Rials)
I. Construction Base Cost				**8,611,000**
1. Preparatory Works	1	l.s.		783,000
(10% of Sub-total of Item 2 to 3)				
2. Riverbank Stabilization Work for Madarsoo River at Dasht Village				7,828,000
a. Excavation				
- Sand & Gravel	72,300	m^3	7,000	506,100
b. Random Backfilling	9,560	m^3	7,000	66,920
c. Backfilling with Compaction	1,940	m^3	9,000	17,460
d. Embankment		m^3	11,000	0
e. Removal of the Surplus Soil	61,000	m^3	19,000	1,159,000
f. Gravel Bedding	3,210	m^3	9,000	28,890
g. Sodding	1,730	m^2	1,000	1,730
h. Concrete				
- Plain Concrete	8,550	m^3	270,000	2,308,500
- Reinforced Concrete (including 20kg rebar)	1,270	m^3	355,000	450,850
- Wet Stone Masonry	2,880	m^3	227,000	653,760
i. Gabion Mattress	710	m^3	149,000	105,790
j. Concrete Block				
- 1.9ton/piece	1,080	nos.	602,000	650,160
- 1.2ton/piece	1,295	nos.	443,000	573,685
k. Miscellaneous	1	l.s.		1,305,155
(20% of "a" to "j")				
II. Land Acquisition Cost				**0**
a. Dry Farming Land	0	m^2	400	0
b. Irrigated Land	0	m^2	4,200	0
c. Orchard	0	m^2	11,000	0
d. Residential Area		m^2	60,000	0
III. Administration Cost	1	l.s.		**431,000**
(5% of Item I)				
IV. Engineering Cost	1	l.s.		**862,000**
(10% of Item I)				
V. Physical Contingency	1	l.s.		**1,981,000**
(20% of Item I + II + III + IV)				
VI. Total				11,885,000
Round Total				**11,890,000**

Note:

- Unit price is as of 2004 (in accordance with the Islamic Year of 1383)
- Number of respective ratios for indirect cost is referred with the previous JICA study adopting.

4.6 Recommendations

(1) Necessity of Detailed Design Stage Execution

This study results is limited to carry out the preliminary design and it shall be conducted to further elaborate the implementation plan with the additional detail in survey, geological investigation, planning and design for the proposed structures in order to prepare the necessary documents such as detail design drawings, more precise construction quantity, tender documents including technical specifications, etc.

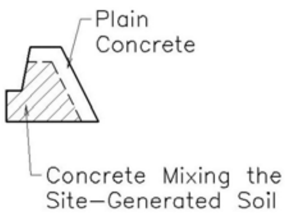
(2) Utilization of the Site-Generated Soil

According to the geological field reconnaissance, the riverbeds in the Madarsoo River and the Ghyz Ghaleh River are thick covered with coarse sand, which is relatively good quality for concrete materials caused by the ancient sediment deposit in the Cambrian Period or the Jurassic Period.

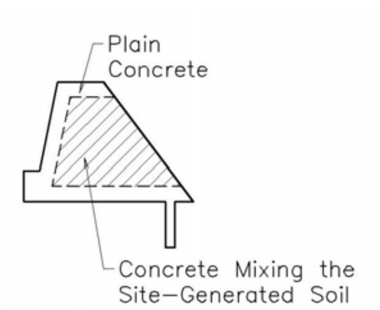
It is recommended to conduct the detail applicable study including the design of mix proportion for the site-generated soil utilization to the concrete material on the detail design stage.

If the coarse sand of the site-generated soil might be applied to the aggregate material of the appropriate concrete, the surplus soil generated by the excavation is utilized as the useful construction materials and it is expected to reduce the construction cost of the hauling and removal of surplus soil expenses.

In the proposed countermeasures, the proposed applicable section with the concrete mixing site-generation soil is shown with the following examples.



(Sub-Dam Section)



(Main Dam Section)

Note: Above drawings reference only

Fig. 4.9 Example of Proposed Applicable Sections in the Proposed Countermeasures

(3) Early Implementation of the River Restoration in the Gelman Darreh River

This works is one of the essential structural measures for river restoration plan, which is proposed in the Master Plan. In viewpoints of the Dasht village protection against the probable flood, it is insufficient to protect the Dasht village with the proposed riverbank stabilization works independently unless the channel improvement will be executed to control the flood discharge and the channel is completely connected to the proposed riverbank stabilization works.

After the riverbank stabilization works completion to be proposed, it is desirable to execute the channel improvement as soon as possible to reduce the flood damage occurrence in and around the Dasht village. Furthermore MOE-North Khorasan is planning the flood control dam located at the entrance of Dasht basin in the Gelman Darreh River. Such large-scale reservoir is one of the alternatives to the said river improvement. Thus it is also recommended that MOE-North Khorasan shall conduct careful and technical-sound investigation for the dam planning.

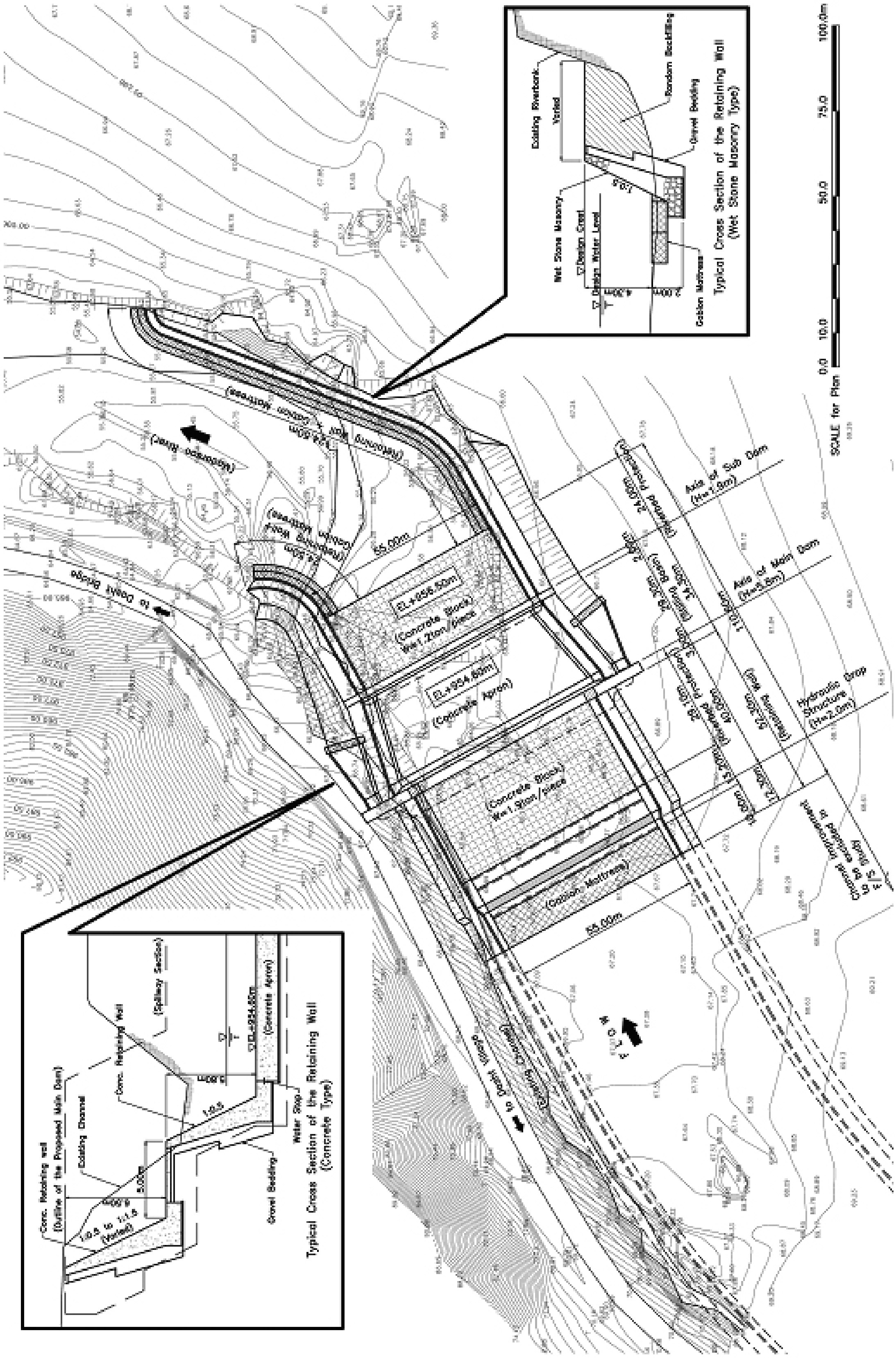


Fig. 4.6 Plan of Proposed Riverbank Stabilization Works

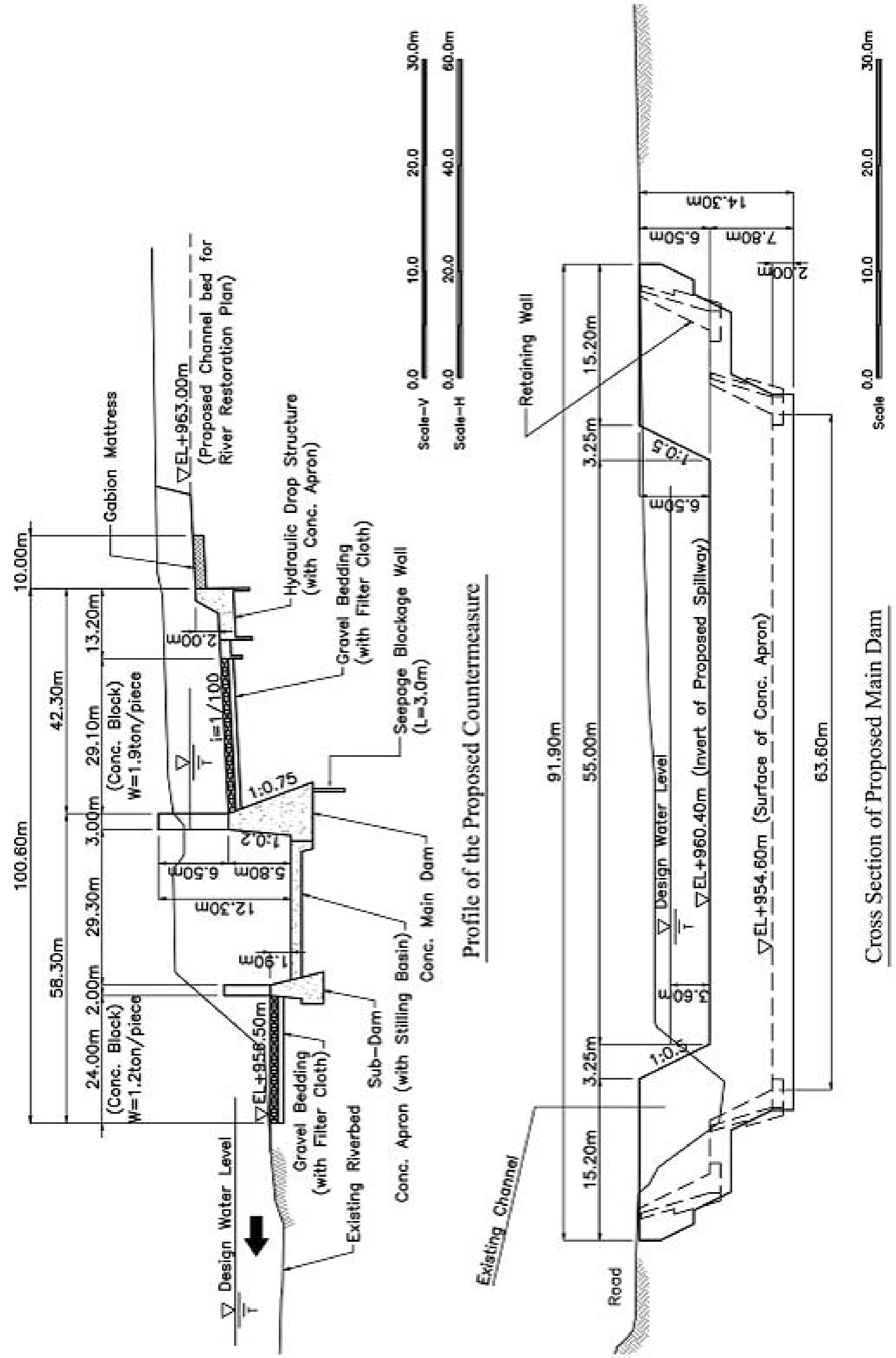


Fig. 4.7 Typical Sections of Proposed Riverbank Stabilization Works

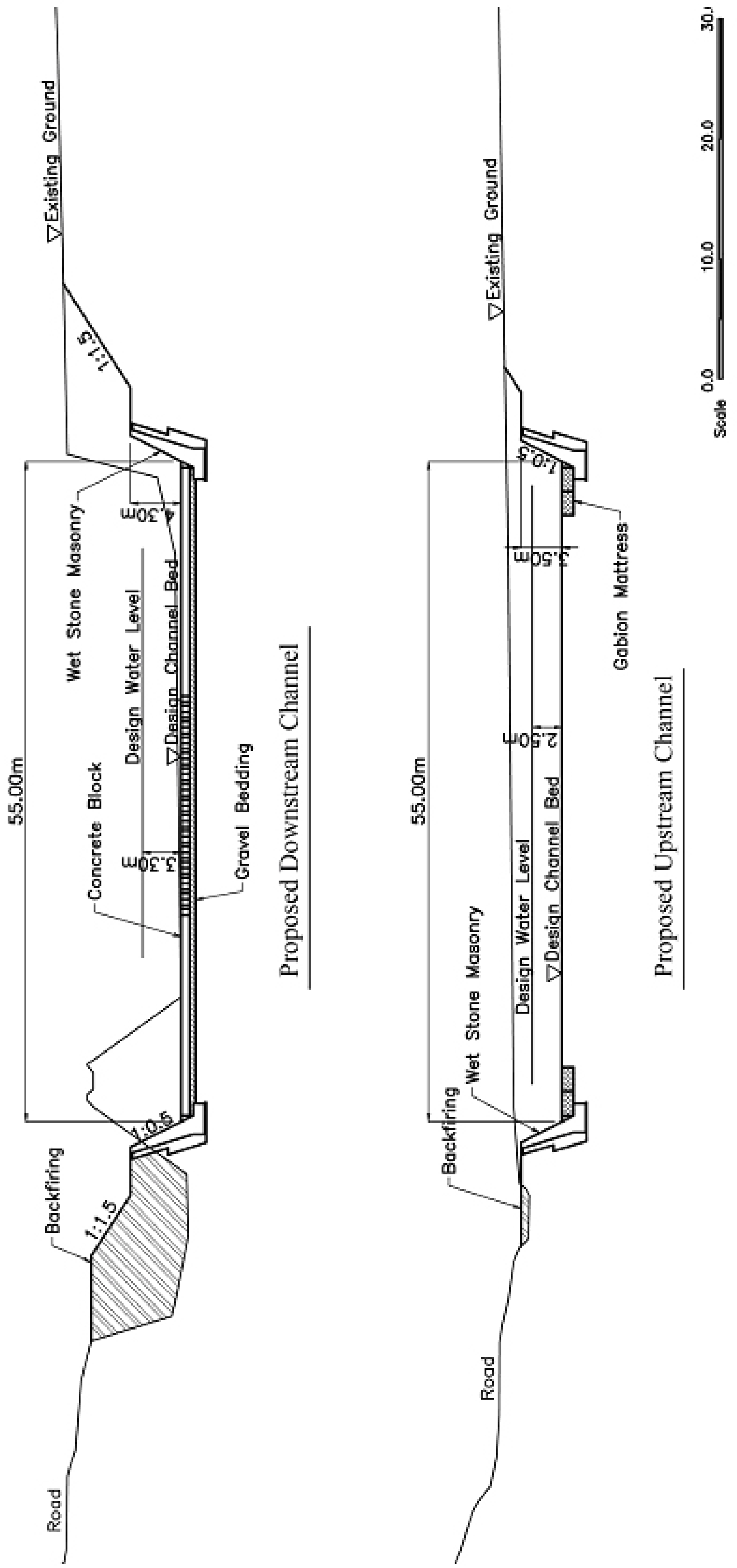


Fig. 4.8 Typical Cross Section of Proposed Channel Works

CHAPTER 5 GOLESTAN FOREST PARK DISASTER MANAGEMENT PLAN

5.1 Present Conditions

5.1.1 Organization for Flood Management in Golestan Province

Overall Organization for Flood Management

Highest decision-making organization for disaster management in the Golestan province is the Provincial Disaster Management Center under the command of the General PDMC of Golestan Province. General PDMC succeeded the existing organization of Mazandaran Province to organize Golestan Disaster Management Committee among the government agencies. 27 provincial and governmental agencies are member of the committee. The major committee members concerning flood management are shown in Table 5.1.

Table 5.1 Major Members of Disaster Management Committee

Organization in Province	Code
PDMC General (Chairmanship)	PDMC
Managing Director of the Red Crescent Society in Province	RCS
General Director of Road and Transportation in Province	MORT
General Director of MOE in Province	MOE
General Director of Meteorological Office in Province	MET
General Director of DOE, Golestan Park Office	DOE
Commander of the Disciplinary Region in Province	DRP
Commander of Traffic Police, Golestan Province	TPG
Senior Commander of the Army in Region	ARMY
General Managing Voice and Vision of the Islamic Republic of Iran. (Radio &TV)	RADIO/TV
Head of Organization of Provincial MOJA	MOJA
General Director of Management and Programming Organization in Province	MPO

Present Flood Information Flow

Fig. 5.1 shows present flood information flow. All flood information is concentrated into the Province Disaster Management Center (PDMC). PDMC will issue necessary instruction and order to related agencies as well as inhabitants in disaster area. Initial information of the flood comes from Meteorological Office, Golestan (MET) to PDMC formed by a weather bulletin and flood warning notice. At the same time, Ministry of Energy, Golestan (MOE) also sends hydrological information concerning the flood to PDMC. PDMC issues an order to take action for flood to all concerning agencies based on such collected information.

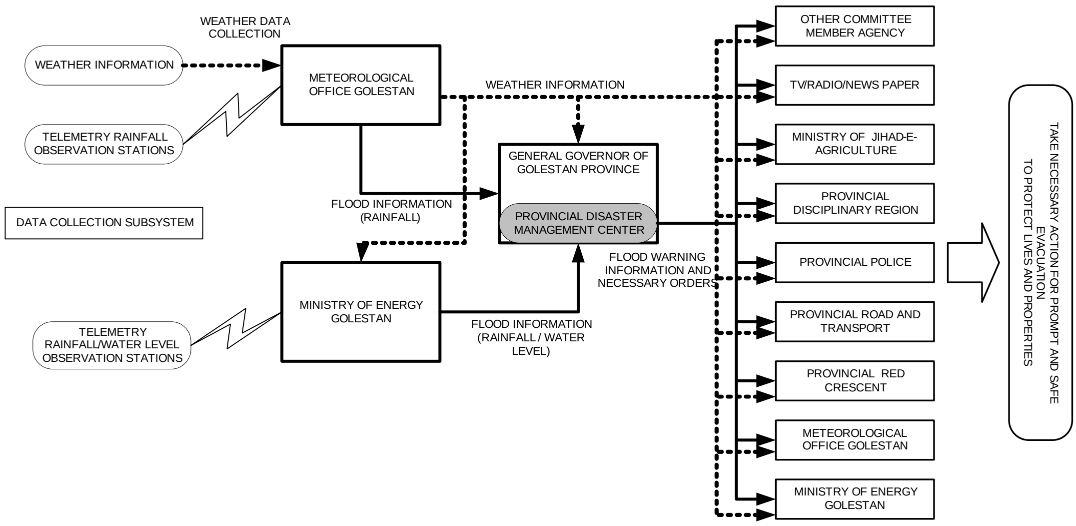


Fig. 5.1 Present Flood Information Flow

Province Disaster Management Center (PDMC)

The core organization of the disaster prevention and fighting is PDMC under the control of General Governor of the Golestan Province. The PDMC is decision-making organization for the disaster mitigation measures and necessary actions to be taken by the committee members based on their disaster prevention and fighting action program. Therefore, Committee has only four (4) staff and no flood fighting materials. Especially, PDMC takes an active part for coordination of flood warning, fighting and recovery of damages by the flood. PDMC staffs always prepare the disaster occurring. Telephone including mobile telephone and facsimile are used for communication between PDMC and MET. All staffs of PDMC prepare for the disaster in 24 hours. When PDMC instruct disaster mitigation measures to the related agencies, the agencies shall follow such instruction. At the same time flood information is conveyed to the Ministry of Interior for preparation of flood mitigation at the adjacent river basin. If flood become serious, PDMC establishes flood measure task force at Gorgan city or the disaster site and call necessary committee members for discussion of countermeasure.

Activities for related agencies

Large numbers of Disaster Committee members play important role when flood is foreseen. Activities of major agencies describes below.

(1) Ministry of Energy, Golestan (MOE)

MOE is responsible for the floods in entire Golestan Province. Some online rainfall and water level gauges have been installed after the 2001 and 2002 floods. Total six (6) of rainfall and water level gauging stations have been installed and operational. In addition, MOE plans to expand the early flood warning system all over the Golestan Province.

When MOE receives weather information from MET, they start data collection from their online system. Collected data will inform to PDMC by telephone or facsimile for flood warning purpose.

(2) Meteorological Office, Golestan (MET)

At first, MET issues two (2) kinds of weather information namely Weather Bulletin and Flood Warning Notice to PDMC as well as related government agencies and public. Flood Warning Notice is closely related with the flood forecasting and warning. However, accuracy of the information is not enough from viewpoints of flood forecasting system since it is prepared based on global weather information. Increase of accuracy for spot weather forecasting is not easy. To increase accuracy of forecasting, it will require three-hour weather forecasts and the Radar rain gauge system etc.

Weather Bulletin:

MET issues the weather bulletin and delivers it to members of PDMC when stormy weather especially heavy rainfall is foreseen. The general weather situation will be described on the bulletin at least 48 hours to one week prior to the occurrence of phenomenon.

Flood Warning Notice:

After weather bulletin issued, if the possibility of flood occurrence will increase within short period by their weather forecasting, MET shall diffuse the flood warning notice to the PDMC and the Committee members to recommend the preparation of flood warning, evacuation and fighting.

(3) Red Crescent Society (RCS)

This organization is most organized and powerful for disaster prevention operation. They have enough experience staffs and relief goods. Red Crescent Society Golestan has responsibility to act necessary prevention, evacuation and rescue before, during and after the disaster. There is RCS Road Center in Gorgan City and Major Township has branch offices that are mainly placed for traffic accident rescue. When disaster occurs, Road center has function of local disaster rescue center. At first, RCS receives weather bulletin and flood notice from MET, and then receives dispatch order to the disaster site from PDMC. Nearest RCS branch office staff including flood specialist and volunteers are dispatched to the disaster site for flood evacuation and fighting aid to coordinate with village chief. In this action, young volunteers play main role of the action. Therefore, RCS promotes [one from one family program] to increase numbers of volunteers.

(4) Traffic Police

Traffic Police shall conduct the traffic control in corporation with Ministry of Road and Transport, Golestan. When MET issues weather information, the Disciplinary Region (a kind of army) that is upper organization of the police, will order to traffic police to close the road gate to the Golestan Forest National Park. The Disciplinary Region will the receive recommendation for road closing from MORT too. After an order for road closing, no one can pass the road except the concerning officials. An order shall remain force until cease of disaster.

5.1.2 Existing Online Data Collection System

MET System

MET under I. R. Iranian Meteorological Organization installed three (3) climatologic and rain gauge stations and those stations are located in the Madarsoo River basin and adjacent river basin. Golestan Forest National Park rain data is one of the important data for flood forecasting purpose. All online station connects with MET through telephone line and GSM MODEM. Furthermore, MET plans to expand four (4) more rainfall gauging stations as tabulated below.

Table 5.2 Inventory of Online Gauging Stations of MET

Station	Class	Location (Deg. Min)		Elevation (m)	River Basin	Remarks
		Long. E	Lat. N			
Golestan Park	Climatologic	55.47	37.24	460	Madarsoo	Existing
Dasht	Climatologic	56.00	37.18	1,005	Madarsoo	Existing
Farsian Farang	Rain gauge	55.37	37.13	670	Oghan	Existing
Hossein Abad Kalposh	Climatologic	55.45	37.13	1,540	Oghan	Planning
Ghaleh Ghafeh	Rain gauge	55.29	37.03	1,200	Chehl Chay	Planning
Bidak	Rain gauge				Madarsoo	Planning
Dasht Shad	Rain gauge				Madarsoo	Planning

MOE System

Ministry of Energy, Golestan office installed online observation stations for flood monitoring and warning after the 2001 and 2002 floods. The four (4) stations out of six (6) are located in the Madarsoo River basin as listed in Table 5.3. All stations are connected to MOE-Gorgan office through the public telephone network.

Table 5.3 Inventory of Online Gauging Station of MOE

Station	Class	Location (Deg. Min)		Elevation (m)	River Basin	Remarks
		Long. E	Lat. N			
Tangrah	Water level	55.44	37.27	330	Madarsoo	
Dasht	Water level			1,005	Madarsoo	
Galikesh	Rain gauge	55.27	37.15	250	Oghan	
Dasht	Rain gauge				Madarsoo	
Narab	Rain gauge				Tillabad	
Dashy Shad	Rain gauge	55.55	37.16	1540	Madarsoo	

5.1.3 Data Processing System

The personal computer based data collection system for both MET and MOE is operational.

MET System

MET online data collection system software, made by German Mevis T. version 1.7 UMAD, has an automatic observation function. One of control function is polling instant value (ON/OFF) and can be set any time interval including online mode. This shall be used for automatic observation of online station every one-hour data collection. System has two inputs, one is GSM MODEM and other is public telephone network MODEM. In case of flood event, both lines shall connect as online bases. Therefore, real time online observation data for two stations can be received. As the output of data processing, several kind of graphics and tables can be displayed and printed out.

MOE System

MOE data collection system software, made by OTT [HIDLAS], has function for automatic data collection. This function has not been used so far. It shall be used for automatic observation of station every one-hour data collection. System has only one input by public telephone network MODEM.

5.1.4 Telecommunication Condition in the Madarsoo Basin

<u>Fixed Telephone Service</u>

Golestan Telephone Company gives telephone service in Golestan province having 378,715 lines against 1,426,288 of population, equivalent to 26 lines/100 persons. There are 1,055 villages within Golestan Telephone Company responsible area. Telephone lines already install at 977 villages out of 1,055 and remaining 78 villages is under expansion of telephone lines using WLL technology. Fixed telephone service in the Madarsoo River is well installed and nominal 56 kbs quality is guaranteed. However, actual transmission speed is more less than 23 kbs due to long telephone line between exchange and subscriber. Telecommunication Company has a basic policy to install the public telephone exchange those village living inhabitants over 100 of population. Village telephone exchange has Microwave network or fiber optical cable network to connect nearest bigger telephone exchange and distribute to village subscribers through electronics switch.

<u>Mobile Telephone Service</u>

There is only one service provider for mobile telephone, Mobile Telephone Company belonging to the Iranian Telephone Company that is one of government enterprise. 6,681,554 sets of hand terminal are operational in Iran that is equivalent to 36 sets/100 persons. About 64,670 sets hand terminal are operational within Golestan territories that is equivalent to 4.5 sets/100 persons and 116 mobile base stations were installed in the area. Semens GSM model 900 is installed. Micro cellular that has many base stations in short distance is employed for installation of mobile base station in urban area. However, mountainous areas do not have such plural base stations. It has installed on the top of mountain to keep wide propagation. It can cover huge service area. However, mobile telephone service is not covering all area due to obstruction of the mountains. Therefore, this service is not covered entire project area. Many blind service areas are found, especially in the Golestan Forest National Park.

<u>Radio Communications</u>

Radio Communication Regulatory of Iran (RCRI) is implementing agency for the management and control of the telecommunication in the I. R. Iran. Frequency allocation of radiotelephone network shall be applied to the RCRI.

5.1.5 Electrical Condition

<u>Power Distribution Condition</u>

The power distribution system in the river basin has two (2) types of power line. One is 4,400 V of middle voltage 3 phases line and the other one is 220 V of low voltage 3 phases or 5 phases line. 4,400 V is step down by the transformer that is installed depending on the demand of the customers. Voltage fluctuation is quite huge.

<u>Power Failure in the Basin</u>

The power supply in the basin is stable. Planed power down is announced to the public prior to the installation. However, power failure during the flood is another story. In accordance with previous disaster management survey, power failure occurred in very early stage of the 2001 Flood. Power failure started only 30 minutes after starting the flood in the lower and middle basin areas. Therefore, power back-up system for the flood warning equipment is essentially needed.

5.1.6 Major Issues

On-site survey was conducted to clarify the condition for existing online data collection system. Data collection systems of both MET and MOE are not prepared in order to the flood forecasting and warning purpose. In view of such point, the following issues are identified. Possible solution shall be found out and shall be reflected to the system design.

(1) To dissolve blind area of meteo-hydrological observation

There is no rainfall and water level gauging stations installed in the upper reaches of the Madarsoo River basin.

(2) To upgrade real time data collection

Both MET and MOE online data collection system is not real time data collection system.

MET collects past 1-hour, 3-hour, 6-hour and 24-hours data for weather forecasting purpose in normal condition. Once rainfall starts, MET will connect particular station on the online basis to obtain real time data. However, it is not automatic real time observation mode.

On the other hand, MOE collects past 2-hour data for hydrological data collection purpose. The flood forecasting and warning system shall require monitoring real time rainfall and water level data in every 1-hour interval at least.

(3) To exchange and share the data

There is no data exchange and sharing system between MET and MOE. In addition, MOE and MET gauging stations overlap at the same place, such as Dasht and Tangrah. Reasonable data monitoring shall be considered, and data exchange and sharing system shall be needed.

(4) To improve reliability of data transmission line

The data transmission network by the public telephone is not keep high reliability. It could be easily disconnected during heavy rain and flood.

(5) To improve gauge installation

Tangrah water level gauging station is not prepared for serious flood situations. Height of the gauge container is lower than the 2001 floodwater level. Extension of the stilling well and support material will be necessary.

Regarding Dasht Bridge water level station, the telephone pole installed near the river course is easily washed away in the flood time. In fact such telephone pole was washed away, and telephone line was physically broken in the 2005 Flood.

(6) To install power backup system

Both water level stations of MOE needs battery charger by solar panel. The battery shall be charged when it exhausts power. Solar system can charge it continuously to keep operational condition.

(7) To install flood warning posts

There is no flood warning post installed. The flood warning dissemination is made only telephone and acquired at second hand.

(8) To establish warning criteria

Warning level of threshold rainfall and water level for each gauging station is not established.

5.2 Improvement Plan on Flood Forecasting and Warning System

5.2.1 Identification of High Risk Areas

The Madarsoo basin extends from the North Khorasan Province to the Golestan dam, covering a total of 2,340km^2. There are hundreds of villages scattered over the river basin, and thousands of tourists visit in the Golestan Forest National Park in summer. There are many passengers are passing through the National Park Road toward Mashhad. On the other hand, a considerable number of villages, the roads along the Madarsoo River and the tourist spots are exposed to a rain-induced disaster such as flood, due to its topographical, geological and meteorological conditions.

The purpose of Flood Forecasting and Warning System (FFWS) is to evacuate those inhabitants and tourists in the potential disaster areas safely during such disasters. However, the problem is how to deal with those potential disaster areas scattered all over the basin within a limited investment. Therefore, prioritization is inevitable to maximize the benefits from the master plan by investing more to high-risk areas that is named priority project in the feasibility study. In this sense, such high-risk areas must be identified through a comprehensive examination in the past disasters and damage potentials comprehensively.

Disaster Characteristics

From the meteo-hydrological study on the 2001 and 2002 Floods, the past disaster experiences could be served as lessons to learn and could reflects to system design.

(1) Flood Occurrence

Based on 1975 to 2002 rainfall records of Tangrah, November to May can be defined as wet months while June to October can be defined as dry months. The highest amount of monthly rainfall appears in March. However, small rainfall fell continuously throughout the month of March so that the flood did not occur in March. The flood mainly occurs in summer time, especially in August, due to localized torrential downpour by monsoon rain.

(2) Flood Victims

The 2001 Flood killed some 254 people, and the 2002 Flood killed 54 people. About 76 % in the 2001 Flood and 81 % of victims in the 2002 Flood are concentrated in the Golestan National Park. The elevation of the road of the Golestan Forest National Park running along the river course is very low in several stretches. Total 25 km of the road is vulnerable to inundation. Besides, many tourists gather at the lower places as camping sites along the river that is easy to access from the road but vulnerable to floods. It can be said that the Golestan Forest park has naturally very high potential in flood disaster.

(3) Maximum Rainfall at Tangrah

During the 2001, 2002 and 2005 Floods, maximum rainfall has been recorded at Tangrah among the gauging stations located in the Madarsoo River basin.

(4) Flood Occurrence Time

Based on the recent experiences in early 2000s, all of the three floods occurred during nighttime. Mainly rainfall starts in the evening and continues to the midnight.

Selection of High Risk Areas

Based on the above discussion, high risk areas that will be targeted for the priority project are tentatively selected and summarized below.

Table 5.4 Selected High Risk Areas

River Basin	High Priority Area	
	Area	Sub-system
Madarsoo	Golestan Forest National Park	Flood warning
	Whole Madarsoo River basin	Flood forecasting

5.2.2 Improvement Plan

Proposed Flood Information Flow

To reinforce the existing flood information dissemination organization, the following flood information organization is proposed. Main points of reinforcement are:

(1) Reinforcement of data collection network,

(2) Establishment of Flood Forecasting and Warning Center (FFWC),

(3) Improvement of the data processing process,

(4) Establishment of the flood information monitoring network, and

(5) Installation of the flood warning posts.

To consider the abovementioned indispensable points, flood information flow is proposed as shown in Fig. 5.2. Existing organization and action shows blue column.

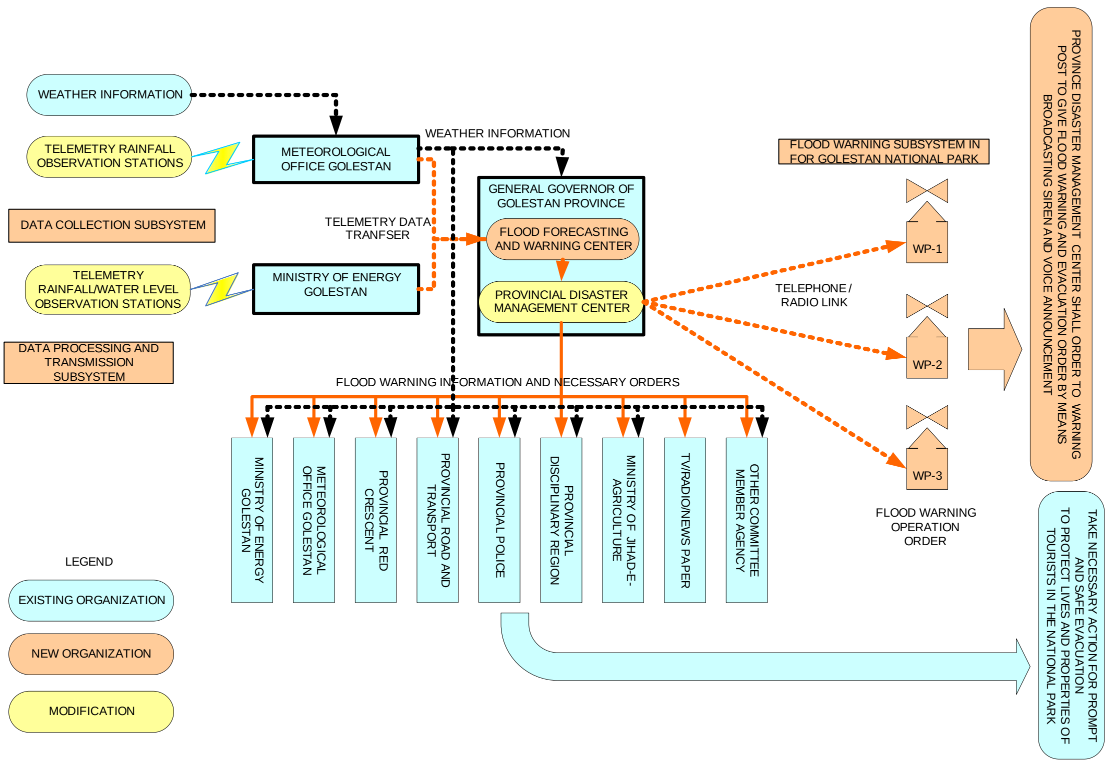


Fig. 5.2 Proposed Flood Information Flow

Establishment of Flood Forecasting and Warning Center (FFWC)

There are two online operational systems for different purposes. In view of the FFWS establishment, integration of collected data is urgently needed. In this connection, establishment of FFWC is proposed at PDMC. Main purpose of FFWC is to disseminate reliable flood warning information to the public and related agencies as earlier as possible. FFWC shall receive telemetry rain gauge data from MET and MOE and shall conduct data processing, editing, and storing the processed data into the Web server for disseminating flood information for concerning agencies. Once FFWC is established, stability and reliability of the system is necessary to avoid lacking of information during the flood.

PDMC dose not have any kind of flood information system and engineers at present. In order to establishment of unified flood management, PDMC shall employ the hydrologist and electronics engineers together with disaster prevention staff after reinforcement of organization.

Improvement of Telemetry Gauging Station Network

There are generally two directions towards improvement of the present online data collection system. The first one is extension of the covering area, which will be attained by adding rainfall and water level gauging stations. The second one is modernization of equipment including telemetry system.

(1) Installation of New Gauging Stations

Installation of new gauging stations is essential to minimize the blind areas. It brings more flood information and leads to enhancement of reliability of the system. However, the more stations will be installed, the more cost will increase. The new stations should be limited in minimum number, considering hydrological requirements and locations of the selected high-risk areas. In this sense, the following criteria are proposed to establish deployment plan of rainfall stations.

- There was no rain gauge station in the Upper Madarsoo River and its tributaries. At least 4 new gauging stations is necessary to ensure more accurate FFWS operation.
- To avoid robbery of equipment and to ease maintenance works, rainfall stations must be located in Climatic observation station of MET.

On the other hand, water level station shall be installed following the criteria.

- At least tow water level station must be installed upstream of every high risk area for floods.
- A new water level station must be installed at least 10 km upstream from the corresponding high priority area to ensure minimum lead time of one hour that allows consecutive actions from observation and data collection to evacuation.
- To avoid robbery of equipment and to ease maintenance works, water level stations must be installed accommodating instrument in well-protected housing in principle.

Based on the above criteria, deployment plan comprised of seven rainfall gauging and four water level gauging stations are tentatively proposed as shown in Table 5.5 and Fig. 5.3.

Table 5.5 Deployment Plan of Rainfall and Water level Gauging Stations

Agency	Number of Rainfall Station			Number of Water Level Station		
	Existing	New	Total	Existing	New	Total
MOE	2	0	2	2	2	4
MET	2	4	6	0	0	0
Total	4	4	8	2	2	4

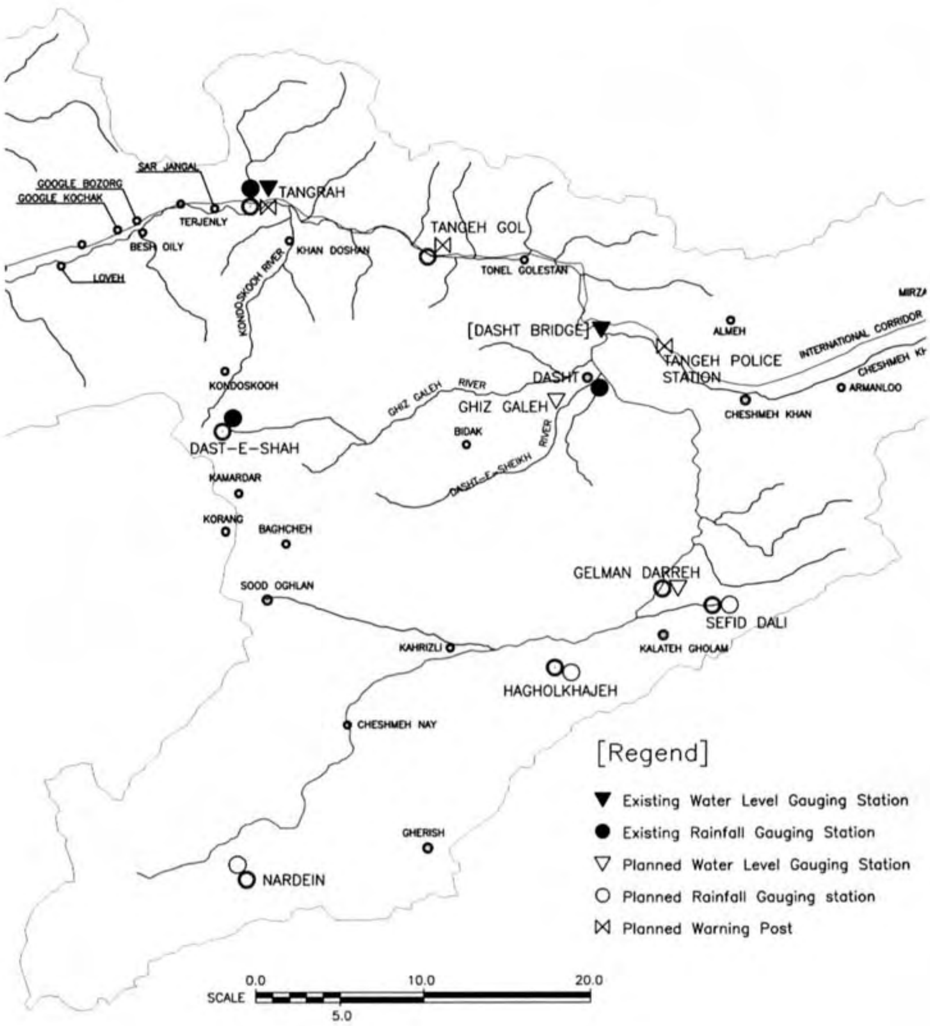


Fig. 5.3 Location Map of Proposed Gauging Station and Flood Warning Post

(2) Modernization of Equipment

Existing online data collection system is one of the telemetry data collection system. However, a big gap still exists between the present manual online system and the fully automatic system in terms of technology and cost. The present system has commenced in the Madarsoo River basin just a few years ago, and it seems to be very early to introduce a fully automatic system. In this context, three options upgrading from the existing manual system to fully automatic system are conceived and compared for determining the development level of the hydrological observation, data collection and flood warning subsystem in this section.

Information Exchange between Related Organizations

MOE and MET have their own meteo-hydrological observation networks, telecommunication measures and/or technology and equipment for data analysis. These organizations could provide to FFWC useful information on weather, rainfall, river condition and disaster so that it helps FFWC forecast floods very much. In the course of JICA study, inter-organizational collaboration with these organizations is discussed to maximize utilization of information available among them, taking into account institutional arrangement. It is also noted that these collaborations must be made in a reciprocal manner.

Table 5.6 Information from Related Organization

Organization	Possible Information
MET	Weather Forecast, Alert Message, Rainfall Data
MOE	Rainfall and Water Level Data, Flood Notice

(1) Collaboration with MET

MET is only one organization that is responsible for weather forecasting in the country. The information from this organization is very precious for FFWS. In this context, collaboration with MET should be strengthened to collect more information including satellite pictures. In return, FFWC can provide their real-time hydrological data that must be valuable to MET as well.

(2) Information Exchange with Related Organizations

Traffic Police, Red Crescent Society, DOE National Park Office and Ministry of Road and Transport can possibly play a role of telemetry gauging function. They equip with a VHF radiotelephone. These organizations shall exchange the river and road conditions including flood information with FFWC each other in the flood time.

FFWC shall prepare the flood information and distribute it to the abovementioned organizations via Internet or suitable media.

<u>Data Analysis and Forecasting</u>

According to the MOE guideline, MOE Golestan is to make hydraulic and hydrological analysis to interpret rainfall and water level data, and then to distribute flood information/ notices to PDMC. The present early flood warning system could not reach the satisfactory level, and no scientific analysis other than conversion from water level to discharge has been done. Thus, upgrading of this subsystem is of first priority.

(1) Data Analysis

Data analysis includes the following functions:

- Data processing,
- Data storage, and
- Visualization of processed data.

Rainfall data are automatically processed into accumulated rainfalls, rainfall intensities and basin mean rainfalls, and water level data are also automatically converted to discharges based on the Manning's Formula.

Table 5.7 Data to be Collected from Telemetry Gauging Station

Data	No. of Data	Interval of Collection	Information
Rainfall	8	Usually, the data collection interval is every an hour. The interval can be changed to every 10 or 30 minutes.	(1) Time of observation: year, month, day, hour, minute. (2) Total rainfall from the previous observation.
Water Level	4	Usually, the data collection interval is every hour. The interval can be changed to every 10 or 30 minutes.	(1) Time of observation: year, month, day, hour, minute. (2) Peak discharge from the previous observation.

The processed data are automatically stored in a database together with the observed time. The database is renewed every time when new data are collected from the stations.

The processed data are automatically visualized in a variety of maps, graphs and tables as summarized below.

Table 5.8 Presentation of Processed Data

No	Item	Information Included
1	Flood Status Map	Rainfall intensities and water levels classified into a few status according to their magnitude
2	Flood Status Diagram	Current rainfall intensities and discharges on the schematic diagram of the Madarsoo River
3	Rainfall Graph (All Stations)	Rainfall at all the rainfall stations for last 24 hours
4	Rainfall Graph (Each Station)	Rainfall at each rainfall station for last 24 hours
5	Discharge Graph (All Stations)	Discharges at all the water level stations for last 24 hours
6	Discharge Graph (Each Station)	Discharge, water level and basin mean rainfall at each water level station
7	Rainfall Table	Rainfall intensity and accumulated rainfall in last 24 hours
8	Water Level and Discharge Table	Water Level and discharge in last 24 hours

In these maps and graphs, the processed rainfalls and discharges are compared with two alert levels categorized by seriousness of the flood in terms of magnitude of rainfall. The two levels are Pre-alert and Alert rainfalls that are used for judgment of announcement of the flood notices.

(2) Flood Forecasting

It is stressed that flood forecasting for the Madarsoo River basin is very hard. Rainfall is so intensive in space and time, and a phenomenon is changeable so fast. Available data is also very scarce. Under these circumstances, a forecasting model can be elaborated for the flood. However, there might be possible risk to rely on the forecasting models so that the actual observed data (not forecasted results) should be used for decision-making such as announcement of flood notices.

<u>Setting of Warning Level and Relevant Activities</u>

(1) Setting of Warning Level

The setting of warning level is a basic issue of the FFWS. Warning water level and rainfall can be detected through the telemetry data and give alarm on the display and sound. Gelman Darreh, Dasht Bridge and Tangrah water level gauging station where located along with Madarsoo River have relative water level. However, flood-traveling time from Gelman Darrh to Dasht Bridge (2.5 hours) and to Tangrah (around 4 hours) is short. It is not enough time for evacuation operation. Therefore, warning rainfall level shall be employed for flood forecasting. The figure of pre-alarm and alarm rainfall level are temporarily set based on the mean level of rainfall at sub-basin reported by hydrological study of JICA team. However, the value shall be calibrated actual warning rainfall level after the every flood. The temporary warning rainfall level is shown in Table 5.9.

Table 5.9 Temporary Warning Rainfall Level Setting

Sub-basin	Station	Pre-Alert Level	Alert level
Sub-basin 1	Narden	5 mm	15 mm
Sub-basin 1	Haghalkhajeh	5 mm	15 mm
Sub-basin 1	Sefid Dally	5 mm	15 mm
Sub-basin 1	Gelman Darre	5 mm	15 mm
Sub-basin 3	Dasht	7 mm	20 mm
Sub-basin 4	Dasht-e-Shad	10 mm	30 mm
Sub-basin 5	Tangrah (National Park)	10 mm	30 mm

(2) Flood Notice

In addition to the processed flood information, MOE is supposed to distribute flood notices following the MOE Guideline for flood management. Definition of the flood notices is proposed in due consideration of the characteristics of disasters in the basin, since it has not been clearly described in the guideline.

Regarding definition of flood notices, three kinds of them could be proposed in accordance with flood progress. They are Pre-flood Notice, Flood Notice, and Cancellation of Flood Notice, as defined below.

Table 5.10 Flood Notices

Type of Disaster	Flood Notice	Definition
River Flood	Pre-flood Notice	To notify relevant organizations that rainfall and/or discharge has exceeded the Pre-Alert Level and situation is expected to further worsen.
	Flood Notice	To notify relevant organization that rainfall and/or discharge has exceeded the Alert Level and situation is expected to further worsen.
	Cancellation of Flood Notice	To notify relevant organizations that rainfall and/or discharge has decreased below the Alert Level and situation is expected to settle.

The Pre-flood Notice aims to notify relevant organizations that a symptom of disaster has been perceived, while the Flood Notice aims to notify them that a serious situation including losses of human lives is expected. Cancellation of these notices aims to notify them that the situation is improving.

These flood notices are value-added flood information that is extremely close to flood warnings that the PDMC of province issues. The final judgment for the issuance of warnings is to be made by the PDMC mainly based on these flood notices.

To assist MOE personnel to announce the flood notices objectively and promptly, two alert levels of rainfall and discharge are defined at every gauging station. Concrete values of these levels will be determined upon due consideration of results of the hydrological and hydraulic studies.

Table 5.11 Pre-alert and Alert Rainfall

Alert Level	Consideration for Determination of Values
Pre-alert rainfall/discharge	The minimum level that needs preparedness for evacuation.
Alert rainfall/discharge	The minimum level that needs immediate evacuation.

(3) Distribution of Flood Information/Notice

Processed flood information and flood notice is basically distributed to related organizations in accordance with the authorized routes as shown in Table 5.12.

Table 5.12 Flood Information/Notices Distribution

Information/Notice	Content	Recipient
Flood Notice	Pre-flood Notice, Flood Notice, and Cancellation of Notices	PDMC, MOE, MET, Red Crescent Society, Traffic Police, MORT, DOE, MOJA, etc.
Flood Information	Visualized Information (refer to Table 5.7)	

Processed flood information is very helpful to understand the flood notices for the related organizations. Sharing of the same information among these executive organizations contributes to more effective interventions against flood disaster. The reason why the flood information is given directly to PDMC members is that utilization of a computer network is considered as a communication measure to ensure prompt and accurate transmission of enormous graphic data. The chief of PDMC is to issue flood warnings mainly based on the flood notices.

Flood Warning Issuance

PDMC is responsible for security of inhabitants and tourists in his jurisdiction. PDMC finally presses the button of flood warning for evacuation, based on collected information including the flood notices. Guidelines are proposed in this Chapter in order to assist PDMC to judge the issuance of warnings promptly.

(1) Definition of Flood Warnings

Three kinds of warnings, Flood Caution, Direction of Evacuation, and Cancellation of Evacuation are defined below.

Table 5.13 Definition of Flood Warning

Flood Warning	Definition
Flood Caution	To warn inhabitants and tourists that a flood is expected.
Direction of Evacuation	To direct inhabitants and tourists to evacuate to designated places immediately.
Cancellation of Evacuation	To notice inhabitants and tourists that the Direction of Evacuation has been cancelled.

(2) Issuance of Flood Warnings

To judge the issuance of the warnings, technical information is indispensable. In addition, the judgment must be made appropriately and promptly. In this context, the flood notices announced by FFWC should be referred and connected to the flood warnings as illustrated in the following figure.

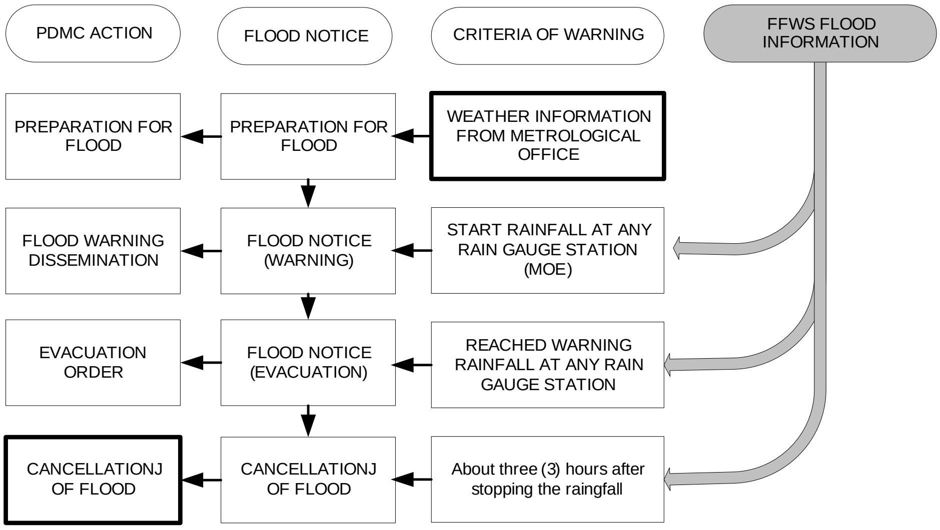


Fig. 5.4 Issuance of Flood Warning

With the above relation, PDMC will be able to judge the issuance of the warnings promptly based on the flood notices. For example, upon receiving flood notice, PDMC can issue Direction of Evacuation to the relevant high-risk areas immediately. Nevertheless, the flood notices are not directions from FFWC to PDMC. It is of course that the final decision whether to issue flood warnings or not is made by PDMC. The notices are a kind of advice from FFWC, and PDMC is still responsible for the warning issuance.

Flood Warning Dissemination

Flood warning shall be promptly and precisely disseminated to inhabitants and tourists in the areas at risk. At the same time, the warning shall be distributed to relevant organizations that might be involved in relief activities.

(1) Recipients of Flood Warning

In addition to inhabitants and tourists in the areas at risk, the following organizations are the necessary recipients of flood warning.

Table 5.14 Recipients of Flood Warning

Classification	Recipients
Individuals	Inhabitants and Tourists/Passengers
Local Authorities	Villages chief
Other Related Government Organization	Traffic Police, Red Crescent Society, Ministry of Road and Transport, DOE and other organizations involved in Disaster Management Committee
Broadcast/Mass Media	TV and Radio

Mass media such as TV and radio is very effective to disseminate information to numerous individuals at once. FFWC should release necessary flood information to the Medias to be involved in the warning dissemination.

(2) Dissemination Measures

Ordinary telecommunication measures such as telephone and fax and mobile telephone can be applied for the related governmental organizations and mass media that are far from the disaster areas. For the lower local authorities, the relevant villages and tourists, the patrol car from the police, Red Crescent Society and DOE Park office may give them flood information using their VHF radiotelephone network.

As repeatedly pointed out, the issue to be addressed is the lacking of telecommunication measures to the most important recipients, namely inhabitants and tourists whom a disaster is threatening. An appropriate communication measure including a voice amplifier with a loudspeaker (Warning Post) to disseminate warning to inhabitants and tourists shall be introduced to the selected high-risk area. Three options of the warning dissemination system are comparatively examined in the following section.

5.2.3 Comparative Study

As described in the previous sub-sections, conceivable equipment options for each of the hydrological observation and data collection sub-system, the data analysis, forecasting, transmission sub-system, and the flood warning sub-system are discussed in this sub-section.

Three different development levels are basically considered: namely Option-A is a manual system, Option-B is a semi-automatic system and Option-C is a fully automatic system. For each of the three sub-systems of the proposed FFWS, three options of different development level are comparatively studied.

Three Options for Hydrological Observation and Data Collection

(1) Option-A

This option is a kind of spatial expansion of the existing online system. The blind areas of hydrological observation network can be reduced with new stations. GSM mobile network shall be used as much as possible. However, some blind area of GSM mobile network service area still exists. The telephone network will be applicable for such gauging station. The hydrological sensors such as a tipping bucket type of rainfall gauge and a float type of water level gauge are installed at the new stations to expand the coverage areas. Existing on-line manual data collection will remain as it is. The conceptual network of option A is shown in Fig. 5.5.

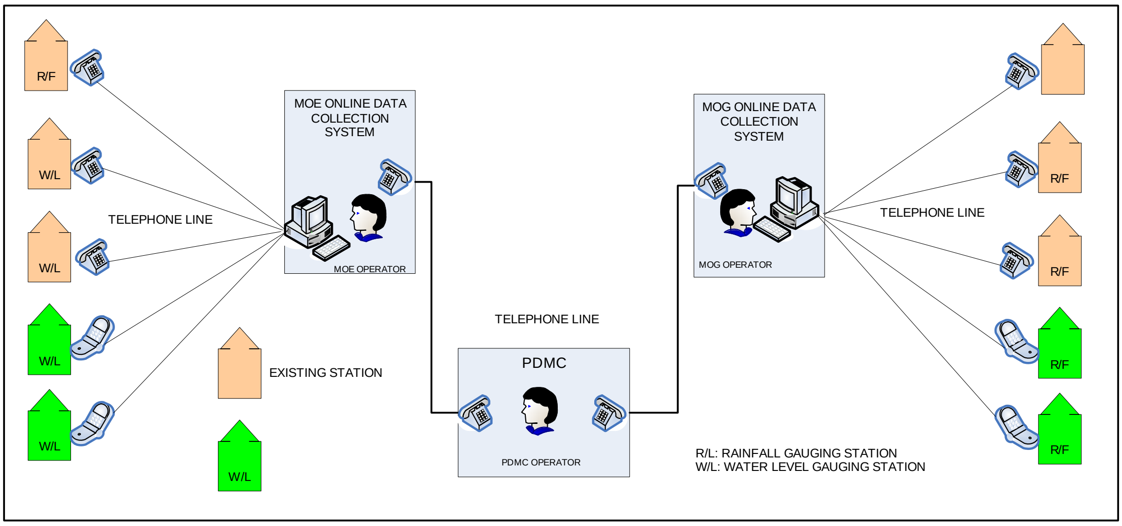


Fig. 5.5 Conceptual Network for Option-A

(2) Option-B

This option is same as option-A except for telemetry data collection system. Existing on-line manual data collection system shall be reinforced as automatic data collection system. Automatic fixed time interval polling system for data collection shall be adapted into the existing system. One-hour rainfall and water level observation shall be made during normal period. Once flood is foreseen, ten minutes observation can be started automatically for flood analysis purpose. Necessary modification on the data collection software shall be adopted on the existing software. The conceptual network of option-B is shown in Fig. 5.6.

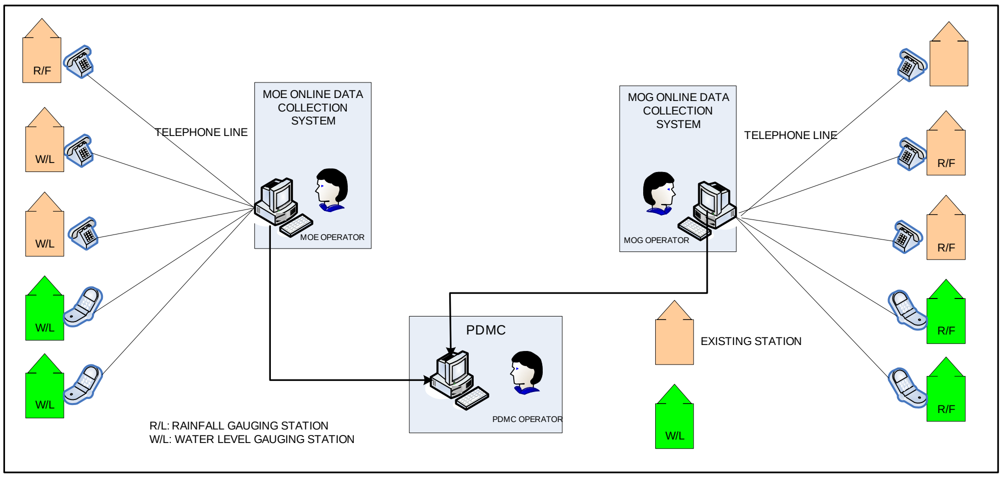


Fig. 5.6 Conceptual Network for Option-B

(3) Option-C

Option-C is a fully automatic system from observation to data collection. A fully automatic hydrological observation system based on a telemetry system is newly introduced in this option. Data transmission methods, VHF radio network shall be employed for stable data collection from all gauging stations instead of telephone line and/or GSM mobile network. In this case, about 3 to 4 repeater stations will be necessary to connect telemetry gauging stations and MET/MOE Gorgan. The service range of VHF/FM radio is as short as about 40 km under the line-of-sight condition. Therefore, the longer the communication distance is, the more relay stations are required, resulting in an increase of the initial cost. Nevertheless, VHF/FM radio communication is generally recognized to be the most suitable for low speed data communication such as hydrological telemetry system. Small running cost is also attractive. The conceptual network of option-C is shown in Fig. 5.7.

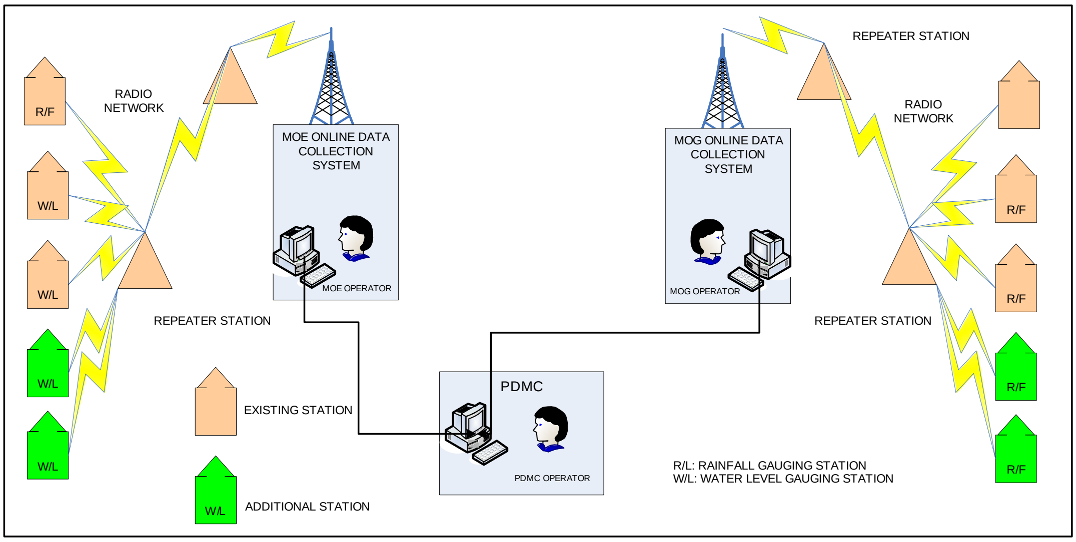


Fig. 5.7 Conceptual Network for Option-C

Three Options for Data Analysis, Forecasting and Data Distribution

(1) Option-A (Existing system)

This option follows the existing manual data processing. Collected hydrological data through a telephone from the online stations are compiled and recorded in a PC memory. Water level-discharge conversion is also made manually based on previously prepared conversion tables. Data visualization and forecasting is also made manually. Distribution of flood data/information is made through a telephone or a fax as currently made.

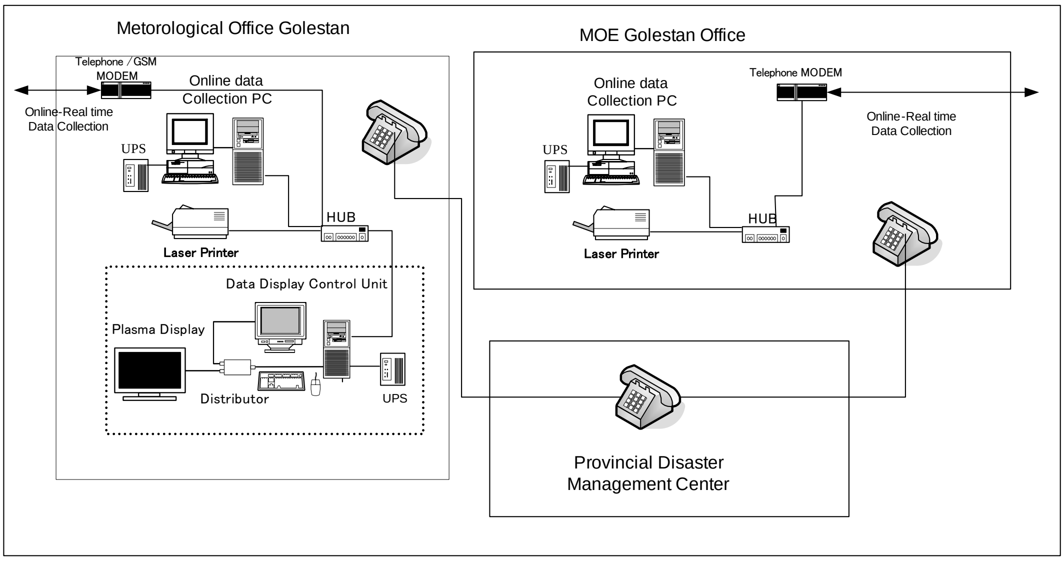


Fig. 5.8 Schematic Diagram for Option-A

(2) Option-B (Automatic Processing)

A computerized system is introduced in this option to speed up the procedure and to avoid human errors. Regarding equipment for data analysis and forecasting, the following criteria are assumed for designing of the configuration of equipment:

- Data storage capacity for two year hydrological data,
- Operation System of Windows 2000 and XP Professional,
- Installation of application software for hydrological data processing and visualization and forecasting,
- Dual mode operation of PC servers for the backup purpose,
- Display and print distribution in Web style,
- Ethernet LAN network, and
- Easiness of future expansion.

A LAN is established in FFWC for data exchange among the computers. This total computer network consists of one set of PC for telemetry gauging station data collection, data analysis and processing as telemetry control, second PC for the data display and Plasma display panel and peripheral equipment. An UPS is provided to every server and PC against sudden interruption of the commercial power supply.

Regarding data distribution, visualized flood information is distributed to PDMC to share the information among FFWC and the members. A personal computer as data monitoring equipment is connected to data processing server of FFWC via telephone line through dial-up router installed at PDMC. The lines between FFWC and PMDC are usually off, but they can be on by dialing FFWC from the monitoring stations, when necessary.

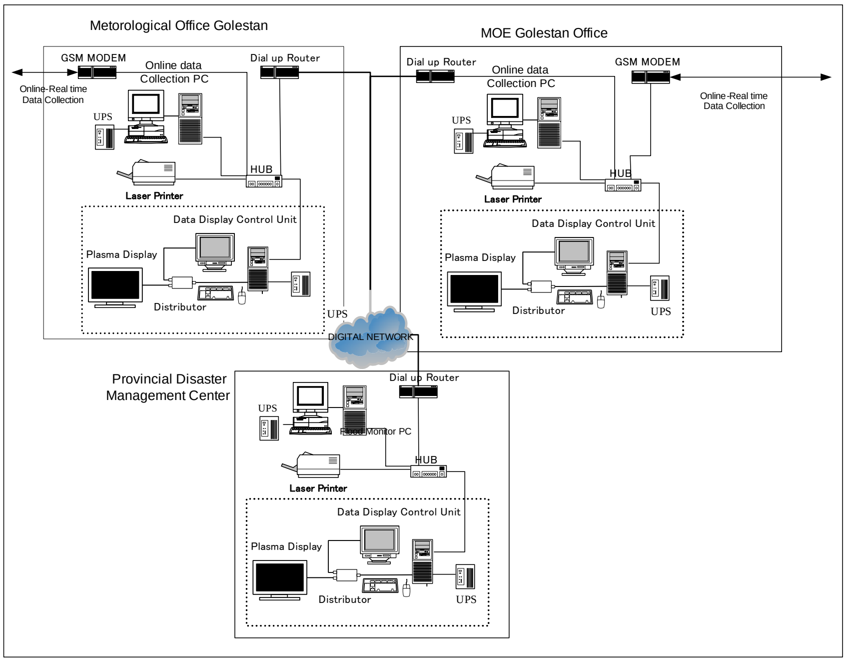


Fig. 5.9 Schematic Diagram for Option-B

(3) Option-C (Internet Option)

Internet is added to Option-B to deal with many monitoring stations. A homepage of FFWC is open through a reliable provider. Reliability of Internet providers is still doubtful at present, but it can be optimistically anticipated that the remarkably developing Information Technology can overcome this problem very soon. The monitoring stations can access the FFWC homepage through the Internet when necessary. Fig. 5.10 shows the hardware configuration of the proposed network.

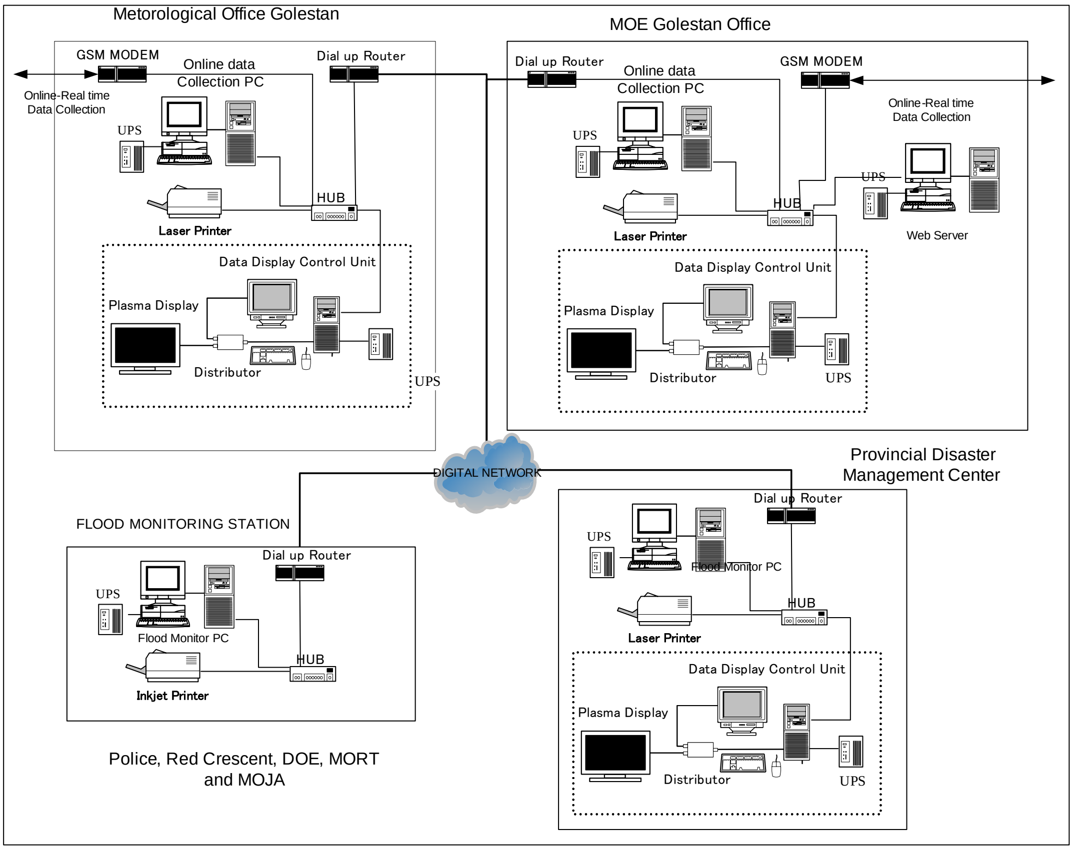


Fig. 5.10 Schematic Diagram for Option-C

Three Options for Warnings Dissemination

(1) Option-A (Manual Operation)

This option is a manual operation warning post equipment including a voice amplifier with a loudspeaker for broadcasting warnings that is installed at three (3) locations as shown in Fig. 5.3. Receiving a flood warning from PDMC through the existing telephone and radiotelephone network to the police and DOE, relevant offices are to broadcast the warning message to inhabitants and/or tourists. Fig. 5.11 shows conceptual network for flood warning system option-A.

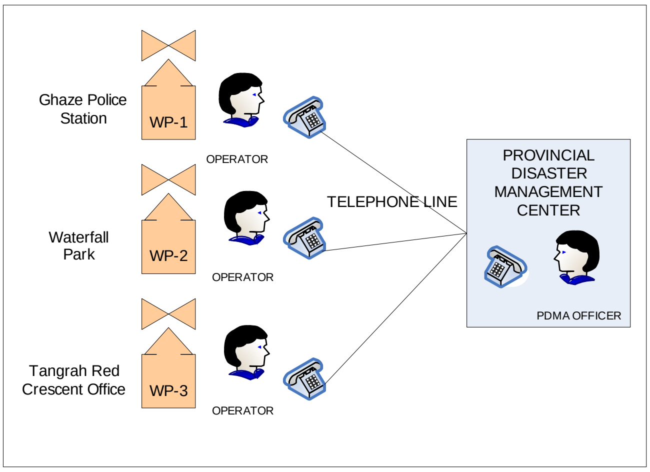


Fig. 5.11 Conceptual Network for Option-A

(2) Option-B (Remote Operation from FWC))

In this option, warning control equipment that enables remote control of warning posts is additionally installed at Flood Warning Center (FWC) offices. Warning dissemination between the PDMC and the FWC office will be made by the telephone or VHF radiotelephone. The warning broadcasting is made remotely from the FWC offices through new independent VHF radio networks. These radio networks require non-noise circuit of which the Signal to Noise Ratio is less than –40dB, and three relay stations are to be newly installed for the VHF networks. Fig. 5.12 shows conceptual network for flood warning system option-B.

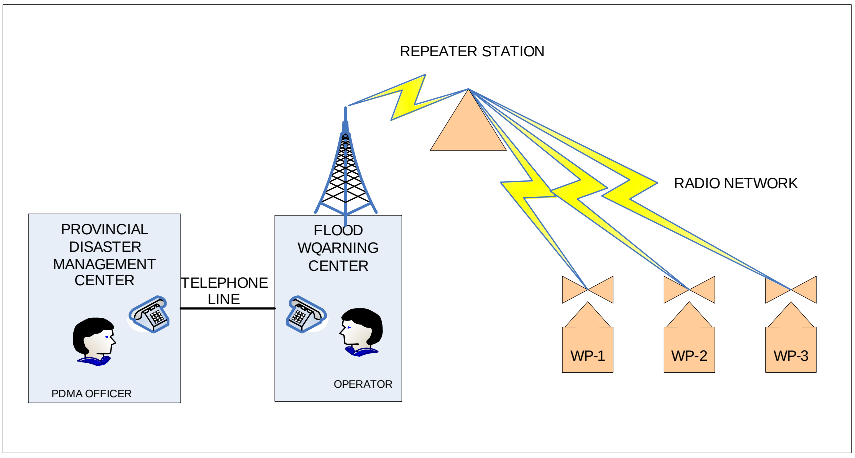


Fig. 5.12 Conceptual Network for Option-B

(3) Option-C (Direct Remote Control Operation)

This option is an on-line direct dissemination system from the PDMC to the warning posts not via FWC offices to reduce transmission time and to avoid man-made errors. Warning supervisory and control equipment is installed at the provincial office. Once the PDMC decide to issue a flood warning, recorded or live voice-messages can be sent through new independent VHF radio networks directly to the warning posts without any human interface. This system requires radio propagation of such a high quality as the Option-B. Five new relay stations are necessary for this system.. Fig. 5.13 shows a schematic diagram of the VHF/FM radio network for flood warning system Option-C.

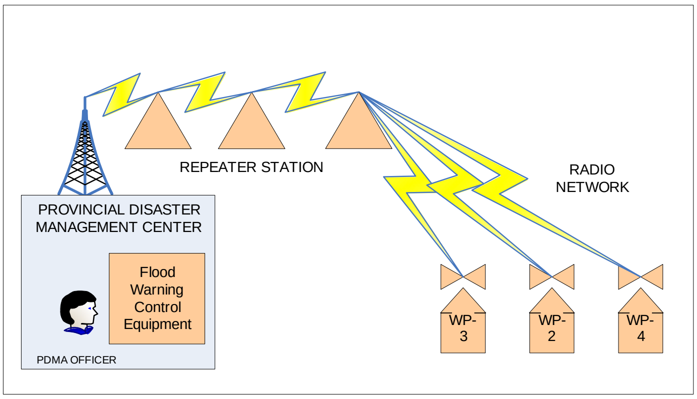


Fig. 5.13 Conceptual Network for Option C

5.2.4 Selection of Optimum System

Alternative Set-up

Several alternatives of combinations of the three options conceived for each of the three sub-systems are considered for the Priority Project. To facilitate selection of the optimum one, four typical alternatives are set up and presented in summary below.

Table 5.15 Comparison of Four Alternatives

Subsystem / Alternative	Data Collection Sub-system Option			Data Processing Sub-system Option			Flood Warning Sub-system Option			Cost (million Rials)	Warning Accuracy
	A	B	C	A	B	C	A	B	C		
Alternative-1	◎			◎			◎			1,450	Low
Alternative-2		◎			◎			◎		5,000	Medium high
Alternative-3			◎			◎			◎	5,912	High
Alternative-4		◎				◎	◎			2,360	Medium

Selection of Optimum System

It is preferable to select the optimum plan from various aspects as well as the economic aspect. Based on the following reasons, alternative-4 of semi-automatic system is selected as an optimum plan for the priority project.

(1) Alternative-1 based on manual operation is not preferable since the necessary time for system operation from observation to evacuation is limited. However, warning system has a big gap in cost between manual operation and remote control systems.

(2) It may be first time to introduce the flood warning post for the basin. The number of warning post is only three (3). Therefore, manual operation system is most suitable from the economic and technical viewpoints.

(3) As for the alternative-4, there is much gap in the cost in comparison with alternative-2, while there will not be much differences in accuracy and necessary time for system operation. Especially, the necessary time for operation can be remarkably shorten, so that effectiveness of flood forecasting and warning system can be enhanced by both alternatives.

(4) Alternative-4 is regarded as the most economic improvement way through utilization of existing facilities at the maximum.

5.3 Equipment Plan

5.3.1 System Summary

Based on the selection of optimum system, proposed system for the priority project is summarized in Table 5.16 including functions of stations and the responsible agencies for the improving Flood Forecasting and Warning System Project. The locations of the telemetry gauging stations are already shown in Fig. 5.3 and a schematic diagram of the total system is shown in Fig. 5.14. The hardware configuration of the system for the data process, analysis and data distribution is already shown in Fig. 5.10.

Table 5.16 System Summary

Station	Function	Organization in charge
1. MET data collection Station		
1.1 Telemetry real time data collection equipment	- Real time data collection - Data processing - Transmit collected data to MOE system - Access the MOE Web server to receive flood information	MET
1.2 Flood monitoring equipment		
2. MET data gauging station		
2.1 Golestan Forest National Park	Automatic rainfall data observation	MET
2.2 Nardin		
2.3 Soodaghlan		
2.4 Haghaikhajeh		
2.5 Sefid Dally		
3. MOE data collection station		
3.1 Telemetry real time data collection equipment	Real time data collection	MOE
3.2 Data display equipment	Display flood information on plasma display	
4. MOE hydro data gauging station		
4.1 Tangrah water level	Automatic real time gauging station including 2 new water level gauging stations	MOE
4.2 Dasht water level		
4.3 Dasht rainfall		
4.4 Dasht-e-Shad rainfall		
4.5 Gelman Darreh water level		
4.6 Ghyz Galeh water level		
5. PDMC-FFWC Equipment		
5.1 Flood forecasting & warning center equipment	Receive telemetry data from MOE and MET data processing	PDMC (FFWC)
5.2 Web server equipment	Dissemination of flood information to related agencies through Internet	
5.2 Data display equipment	Display flood information on the Plasma Display	
6. Flood monitoring Station		
6.1 PC and peripherals	Access to MOE Web server to receive flood information	Related five agencies.
7. Flood warning post		
7.1 WP-1: Ghazel Police	Flood warning equipment by loudspeaker	Police
7.2 WP-2: Waterfall Park		DOE
7.3 WP-3: Tangrah		Police

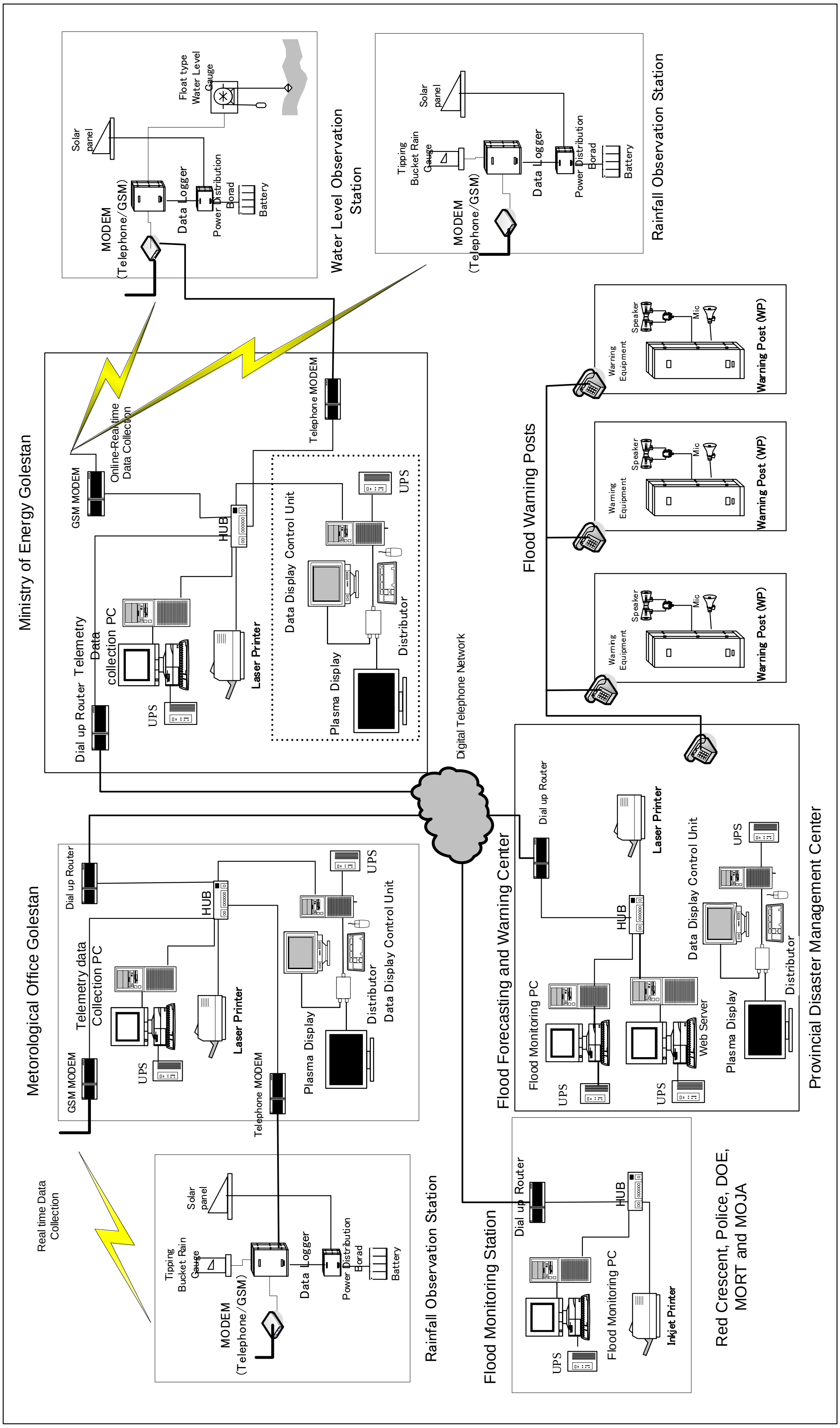


Fig. 5.14 Overall Schematic Diagram for Priority Project

5.3.2 Telemetry Data Collection Sub-system

The data collection sub-system consists of two (2) groups, MET and MOE systems as described system summary. In total seven (7) rainfall gauging stations and four (4) water level gauging stations will be operational. Data collection PC at MET and MOE will collect data automatically from each rainfall and water level gauging station. The data collection PC at MET and MOE provides automatic observation of meteo-hydrological data in the intervals of 10 min, 30 min and/or one hour. The gauging equipment is not only capable of transmitting observed data in response to the observation command, but also has an event-actuated function to automatically send a start request signal to the data collection PC at the start of rainfall or at the water level reaching to the caution or warning levels. When MET and MOE receive the start request signal, the start command is sent to all the gauging stations, which start observations. The data collection PC calculates the hourly and 3-hour rainfall data and checks the correlations between rainfall and water level data. If the data reaches to a warning value, the PC issues a warning. The warning display will be installed in MET, MOE and PDMC in order to display the same information on the PC display.

Real time Data Collection PC

The main component and functions of the observation data collection system to be installed in MET and MOE are tabulated in Table 5.17.

Table 5.17 Functions of Data Collection PC Equipment

Equipment	Function	Quantity
PC type operation console	PC type operation console provide for data collection. Gauging station-calling time is every 10, 30 and 60 minutes. Processed data are displayed on graphics and table and are transferred to the Web server automatically.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Telemetry data collection software	To improve the existing data collection software, modification on the existing software	1
Printer	To print data table, graphics of hydrological data by color	1
DC power supply unit	DC power supply unit provides the DC power to supervisory and control equipment and radio equipment. The unit can be operational about 10 minutes during power failure.	1

Rainfall Gauging Station

The component equipment and functions of the rainfall gauging station are tabulated in Tables 5.18 and 5.19.

Table 5.18 Functions of Rainfall Observation Equipment

Equipment	Function	Quantity
Remote terminal unit (data logger)	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. In addition, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Tipping bucket rainfall gauge	Tipping bucket rainfall gauge measures and it sends out the rainfall of 0.5 mm of 1 tip to the observation equipment by the pulse signal.	1
Solar panel and distribution board	Solar panel makes charging to the battery.	1
Battery	Battery secures operation without 7 days of sunshine as the power of the above equipment.	1

Table 5.19 Functions of Rainfall and Snow Gauging Equipment

Equipment	Function	Quantity
Remote terminal unit (Data Logger)	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. In addition, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Tipping bucket rainfall and snow gauge	Tipping bucket rainfall gauge measures and it sends out the rainfall of 0.5 mm of 1 tip to the observation equipment by the pulse signal. Electric heater melts snow and measures water of melted snow.	1
DC power supply	Input 220V output DC48V	1
Battery	Battery secures operation without 3 days of supply power as the power of the above equipment.	1

Water Level Gauging Station

The component equipment and functions of the water level gauging station are tabulated in Table 5.20.

Table 5.20 Functions of Water Level Gauging Equipment

Equipment	Function	Quantity
Remote terminal unit (data logger)	Data logger stores water level data every 10 minutes and sends out collected data according to the observation command from the data collection station. In addition, it detects the signal when reaching danger level and it informs a data collection station.	1
Telephone/GSM MODEM	To connect public telephone line or GSM mobile base station for online operation	1
Float type water level gauge	Float type water level gauge measures and sends out the water level of the 1 cm unit to the observation equipment as the BCD signal.	1
Solar panel and distribution board	Solar panel makes charging to the battery.	1
Battery	Battery secures operation without 7 days of sunshine as the power of the above equipment.	1

5.3.3 Data Processing and Monitoring Sub-system

The data processing/transmission sub-system consists of data processing equipment to be installed at FFWC, the flood information monitoring equipment to be installed at PDMC and five related agencies being connected to the above equipment through digital telephone network.

Data Processing Equipment

The functions of the data processing equipment to be installed with the telemetry supervisory and control equipment at FFWC are tabulated in Table 5.21 and the hardware configuration of the data processing equipment is already shown in Fig. 5.10. The equipment is used to create the database based on the hydrological observation data and to process the data.

Table 5.21 Functions of Data Processing Equipment

Equipment	Function	Quantity
Flood Monitoring PC	To receive telemetry data from MOG and MOE, and to process and analyze data for flood forecasting	1
Web server	To Store and distribute the processed data from data collection PC to monitoring station as Web information	1
Network devices	LAN network composed by Hub	1
Data display PC	PC for flood information displays and drives the Plasma display unit.	1
Plasma display unit	Large screen Plasma display unit displays the flood information by the output of data processing PC.	1
Laser printer	To print out processed flood information by color laser printer	1
Dial-up router	To connect digital telephone network to the monitoring station	1
UPS	To sustain power supply for a short period to server, web server and data display PC during power interruption.	2

Flood Information Monitoring Equipment

The flood information monitoring equipment will be installed at PDMC, MET and five related agencies. The flood information is stored in the WEB server at MOE, and each monitoring station can access to the information, if it is necessary. Each monitoring station is connected individually to the WEB server through the public digital network. Once it is connected, the monitoring station can monitor the real-time flood information that is updated in 10-minute intervals. The equipment composition for the

Table 5.22 Functions of Flood Monitoring Equipment

Equipment	Function	Quantity
Dial up router	To access the Web server at MOE to obtain details on flood information in graphs and table	1
Switching HUB	To Connect PC to router	1
Client PC	To display the contents of Web server	1
Jet ink Printer	To print out necessary data	1
UPS	Uninterrupted power supply for client PC and server will be provided for power interruption.	1

5.3.4 Flood Warning Sub-system

Warning method

The warning post will be installed with voice amplifier and loudspeaker to generate artificial siren sound.

Equipment Configuration

Warning post will equip the voice amplifier, loudspeakers and tape recorder. Recorded tape contains artificial siren sound, announcement for flood warning and evacuation instruction. In addition, necessary information for flood will be broadcasted through microphone.

Power failure on commercial power line may occur during floods. Therefore, voice amplifier shall be backed up with DC power supply unit. It can be operated around two (2) days without power supply. Sound reach distance of the loudspeaker is more or less 300 m radius.

Warning Operation

When receiving flood information from PDMC, send out the flood or evacuation warning in accordance with its flood operation rule through the public telephone line. Based on this warning order, each warning post starts operation in any of the following patterns that are so simple for people to easily understand the meanings of the sounds:

- For flood warning: five repetitions of a sounding for 10 sec. and a pause for 5 sec.
- For evacuation warning: five repetitions of a sounding for 50 sec. and a pause for 10 sec.
- For warning release: The siren does not sound, but it will be broadcasted when a flood danger has gone.

Flood Warning Post

The main equipment and functions of the warning station is described in Table 5.23.

Table 5.23 Functions of Flood Warning Equipment

Equipment	Function	Quantity
Voice amplifier	Voice amplifier broadcast tape message and voice message for flood warning. The equipment operates by manual operation by the operator.	1
Tape recorder	Three (3) kinds of siren pattern and message will record and broadcast for each occasion.	1
Loudspeaker	Loudspeaker will make blowing artificial siren sound broadcast warning announcement.	1
DC power supply Unit with battery	The unit converts AC power to DC power to supply all equipment. It can give the power to equipment around 3 days during commercial power failure.	1

5.4 Cost Estimate

The direct cost estimate for the improvement of the flood forecasting and warning system for Golestan Forest National Park Disaster Management Plan is made in the following manner. (1) Basically, equipment will procure from Iranian market as much as possible. (2) Equipment made in foreign countries will be purchase from authorized dealer in Iran. (3) Land acquisition for gauging station housing is not required. (4) All gauging station will be installed at existing area or within government properties. (5) Two new water level gauging wells and steel cabinets will be constructed. (6) All taxes are not included. (7) Such cost will be quoted separately.

Table 5.24 presents cost estimate for Golestan Forest National Park Disaster Management Plan.

Table 5.24 Cost Estimate for Priority Project

Work Item		Quan -tity	Unit	Unit Price (Rials)	Amount (1,000 Rials)
Construction Base Cost					
1. Preparatory Work		1	L.S		215,000
2. Equipment					
a	Additional Rain Gauge Equipment	4	set	63,595,000	254,380
b	Additional Water Level Gauge Equipment	2	set	83,720,000	167,440
c	Improvement work for Existing Rain Gauge Equipment	3	set	78,890,000	236,670
d	Improvement work for Existing Water Level Gauge Equipment	2	set	83,720,000	167,440
e	Improvement of Data Collection Equipment at MOE	1	set		304,290
f	Improvement of Data Collection Equipment at MET	1	set		203,665
g	PDMC Flood Monitoring Equipment	1	set		82,110
h	Flood Monitoring Equipment for five Agencies	5	set	22,057,000	110,285
i	Flood Warning Posts	3	set	96,600,000	289,800
j	Miscellaneous (Installation materials, Spares)	1	L.S		545,720
Total for Equipment					2,361,000
3. Equipment Installation Work		1	L.S		363,000
4. Water Level gauging Well and Cabinet		2	ST	80,100,000	160,200
GRAND TOTAL					3,103,000

5.5 Implementation Plan

Priority project will be implemented for 26 months tentatively. Engineering work including detailed design and preparation of tender documents will be conducted first. It will take about 8 months. Tender process, contract, purchase, and manufacturing of equipment will be taken about 9 months. Construction and installation work for water level gauge and all equipment will be taken around 8 months. Finally, on-the-job training for system operation will take one month prior to system operation.

Table 5.25 Implementation Plan for Priority Project

Work Item	1st Year	2nd Year	3rd Year
Total period	....	....	....
1.Detailed design and preparation of tender documents	8 months		
2.Tender and equipment purchase	9 months	9 months	
3.Ancillary work and equipment installation		8 months	8 months
4. On-the-job training			1 month
5.Commencement of operation			▼

5.6 Operation and Maintenance

This section describes necessity and budget for the Operation and Maintenance works.

5.6.1 Necessity of Operation and Maintenance

Establishment of the maintenance organization is indispensable for continuous operation of FFWS. The telemetry equipment has much long durable period by the technical innovation in recent years. However, the durable period will changes by the operation environment. Generally, system lifetime will be around 10 years in Japan. Nevertheless, if the user gives efficient preventive maintenance, the system lifetime can be extended to about 15 years. It is necessary to establish efficient organization having enough maintenance budgets to keep system at least 10 years long operational condition.

5.6.2 Maintenance for the System

Maintenance of the system shall be conducted by each agency responsible for system operation. Table 5.26 shows contents of maintenance and period.

Table 5.26 Summary of System Maintenance

Service	Station	Contents	Period
Daily maintenance	FFWC	Clean and outside view test	Flood period
Periodical maintenance (3-month interval)	Telemetry gauging station, Warning post	Clean and outside view test	Non-flood period
Overhaul maintenance (1 year interval)	Telemetry gauging station, Warning post, Monitoring station	Clean and outside view test and detailed test by professionals	Non-flood period
Trouble maintenance	Telemetry gauging station, Warning post, Monitoring station	Repair and detailed test by professionals	When necessary

The maintenance work can be divided into two categories, namely in-house maintenance and professional maintenance. The in-house maintenance conducts by the operation and maintenance staff of each agency, while the professional maintenance means to invite the system specialists from the supplier or maintenance companies.

The staff at the FFWC and MET will conducts daily maintenance in the flood season and periodical maintenance every three months in non-flood season. Once a year, the specialists who require high technical skill will conduct overhaul and troubleshooting maintenance. It is not realistic to employ such full-time engineer/technician at FFWC and MET. Therefore, professional engineer on separate contract shall execute overhaul and troubleshooting maintenance in outsourcing method.

5.6.3 Operation and Maintenance Man Power

Flood forecasting and warning operation shall utilize three (3) months from July to September in a year. At least two engineers require staying at FFWC for 24-hours stand-by, especially monitoring for flood by localized torrential downpour during flood season.

Proposed manpower for operation and maintenance at FFWC, MOE, MET and related agencies is shown in Table 5.27.

Table 5.27 Required Staff for Operation and Maintenance

Organization	Office in charge and assistant	Hydrological engineer	Electronics engineer	Subject Equipment
MOE	1 person	1 person	1 person	Telemetry data collection, Data process and transmission
MET	2 persons	-	1 person	Telemetry data collection
PDMC	2 persons	1 person	1 person	Flood monitoring Flood warning
MOJA, MORT, DOE, Traffic Police and Red Crescent	1 person each	-	-	Flood monitoring

5.6.4 Cost for Operation and Maintenance

Maintenance cost will not be constant figure in view of long-term operation. It depends on the period of the equipment lifetime. In addition, initial maintenance cost within one year after the installation mainly free of charge by means of free guarantee contract by the supplier. This warrantee contract is very important. The initial defectives of the system will occur by miss design, miss installation and miss operation within one year after the installation together. The supplier has responsible to solve such troubles within warrantee period free of charge. Therefore, first year maintenance cost after system establishment can be estimated only with the personnel expenses and the electric bill. On the other hand, the mechanical parts such as the hard disk drive, the CD drive, the display in the computer equipment and materials becomes necessary to change in three (3) to five (5) years. The rough maintenance cost is estimated to be 2.9 % for ten (10) years average; first's three (3) years are estimated to be 0.56 % and from four (4) to ten (10) years are estimated to be 3.9 % of the equipment cost. Therefore, maintenance cost will be prepared into two categories, "initial maintenance cost" and "maintenance cost after 3 years operation". On the other hand, operation cost will consists of electric fee, telephone subscription fee and consumable spare such as ink cartridge, toner and copy paper. O/M cost is estimated under the following conditions.

(1) including spare parts and unit,

(2) including operation cost such as electric fee, telephone subscription fee and consumable spare such as ink cartridge, toner and copy paper,

(3) including outsourcing charge for equipment supplier, and

(4) excluding salary and allowance. (This cost will be quoted in the administrative cost separately.)

These are summarized in Table 5.28.

Table 5.28 Operation and Maintenance Cost Estimate

Organization	Necessary staff for one year operation	Initial O/M cost for 1st to 3rd year (1,000 Rials)	O/M cost for 4th to 10th year (1,000 Rials)
MOE	9 men/months	20,000	50,200
MET	9 men/months	20,000	50,200
PDMC	12 men/months	19,500	33,300
MOJA	3 men/months	5,100	6,000
MORT	3 men/months	5,100	6,000
DOE	3 men/months	5,100	6,000
Traffic Police	3 men/months	5,100	6,000
Red Crescent	3 men/months	5,100	6,000
TOTAL	42 men/months	85,000	163,700

CHAPTER 6 FLOOD PREPAREDNESS PLAN

6.1 General Concept of Flood Preparedness Plan

6.1.1 Principle of Community-based Disaster Management

In order to mitigate flood and debris flow disaster, structural measures as engineering intervention has been generally planned. However, there may be always limitation of such mitigating measures for overwhelming level of hazards. To mitigate only by structural measures is unrealistic in respect to cost and duration of construction.

To prepare for such overwhelming disasters that mitigation measures cannot completely prevent, it is necessary to establish risk management system under which villagers and passengers can access to appropriate information about floods and debris flows and immediately evacuate in coordination with the concerned public authorities.

The mitigation measures of structures and such community resilience are the two major components of the holistic disaster risk management, and they are complimentary to each other for establishing safer community. For this reason, establishment of village-based risk management system, which is autonomously conducted by villagers are essential.

Actors at each level, such as public officials, village community, and individuals are all responsible for disaster risk management. Actions by public sector, community, individuals are called public help, mutual help, and self-help. Public sectors give support the activities of village community and individuals. Village community and individuals cooperate with public officials. Through these activities, capacity of disaster management can be enhanced.

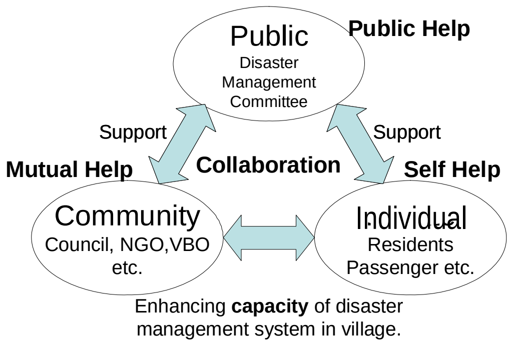


Fig. 6.1 Collaboration among Public, Community, and Private

6.1.2 Goal and Target Group

The goal of the disaster risk management is to stop human loss and to reduce property damages. Target groups are villagers of hazardous areas in the Madarsoo River basin. In the basin, population ratio of less than 15 years old is approximately one third and majority of victims in the past disasters are children. For this reason, school children are focal target along with villagers.

6.1.3 Strategy

Encourage Self-help

To establish village-based risk management system, it is important for villagers and tourists to understand the basic concept that each individual has to have self-help attitude that their lives should be protected by themselves. It is also important that everyone has to have proper knowledge about disaster risk management, identify the risk judging from information of mass media such as TV and radio, and decide evacuation actions accordingly. Such information and evacuation system need to be established. There is an indigenous way of communication within the village, and therefore such system needs to be enhanced for development.

Enhance mutual Help and Cooperation Network

To establish such system, it is important to develop the system not only by self-help endeavor but also by mutual help, in cooperation with local communities, such as village council, non-governmental organizations, village-based organizations, and local public authorities. The role of the public authorities is to give necessary support to the village community. Major role of the public authorities is to establish systems of proper information distribution and evacuation order within public authorities and to village council. Disaster risk management is not enough just at village level so that it is necessary to have joint efforts, among villagers, local communities, and public authorities. It is also effective to go through participatory planning process.

Step-by-Step Approach

It is time taking process to establish this system in the communities. Thus things that can easily be accomplished may conduct first as step-by-step approach. Following the approach, pilot activities in the course of JICA study are shown in 6.3, and framework of village disaster risk management is proposed in 6.4 in this Chapter.

6.2 Hazard Map Preparation

6.2.1 Processes of Hazard Map Generation

Hazard Map

People, who live in or travel to the Madarsoo River basin, should know what kind of and how serious natural disasters happened in the basin in the past. Usually, people forget or keep little their memory on the past disasters. Especially to the children, they do not know on the disasters. Therefore, JICA team prepared the hazard map for keeping or recalling the past disasters in people's mind. In the long run, people could learn how to protect against the future disaster utilizing the hazard map.

Simulation of Past Flood

In the Madarsoo River the large-scale disastrous flood occurred successively in 2001, 2002 and 2005. To utilize meteo-hydrological data observed in these floods, JICA team conducted model construction and parameter identification. Based on the results, flooding simulation was made using 100-year flood. The result of the flooding simulation shows in Fig. 6.2 as flood extent over the riparian areas.

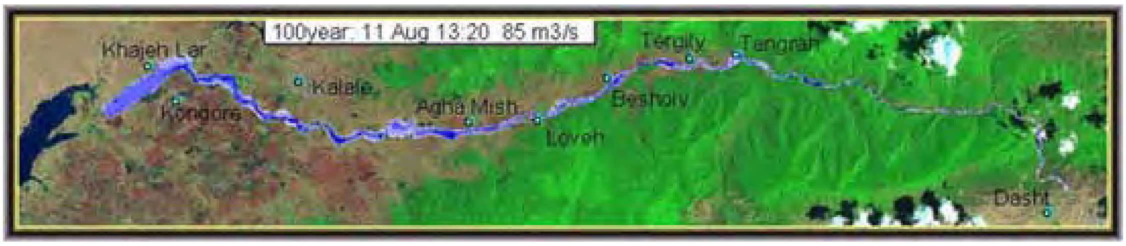


Fig. 6.2 Simulation Result of 100-Year Flood in the Madarsoo River

Engineering Field Adjustment

With the simulation result, JICA team implemented the field survey to check the accuracy of flood extent and to make engineering adjustment of the extent along the river course. This work was done village by village. Finally, the extent of flood zone was adjusted.

Fig. 6.3 Engineering Field Adjustment in Gharavol Haji Tajy village

<u>Hazard Map Generation</u>

To overlay the flood extent, topographic data and satellite images in GIS software, JICA team generated the hazard map as shown in the followings.

6.2.2 Hazard Map Description

The Madarsoo River could be categorized into four parts from geomorphologic features.

- Gorgan Plain: Downstream of Kalaleh Bridge,
- Valley-bottom Plain: From Kalaleh Bridge to Tangrah village,
- Mountain Gorge: From Tangrah village to Dasht Bridge, and
- Dasht basin: Upstream of Dasht Bridge

Topographic conditions are already described in Chapter 2 for each area. From the viewpoints of hazard map preparation, the characteristics of each part are briefly described below.

<u>Gorgan Plain</u>

Through the hazard map, the villages can be found to be located in the Gorgan Plain, which is flood-free area from the Madarsoo floodwater, since the Madarsoo runs forming lower terraces with about 10 m lower than the plain. People who live in the area during flood time should only keep one thing in mind; “do not come nearby the river course for a curiosity looking”, because the flood sometimes rushes the riverbank and make it collapse. To keep away from river is an important rule for flood preparedness against flood disaster.

Fig. 6.4 Hazard Map in 100-Year Flood between Golestan Dam and Kalaleh Bridge

Valley-bottom Plain

The valley-bottom plain extends from Kalaleh Bridge to Tangrah village. Usually, the river did not form clear natural levee, and the floodwater easily overflows along the river course. People are living near to the water, and it is the hazardous area to be flooded. Besides the debris flow occurred in some mountain streams in the 2001 Flood.

To refer to the hazard map, the villages of Gharavol Haji Tajy and Ghoghor Shirmelly are all inside of the flooding area. However it was verified that the floodwater velocity was not so fast and the water level increased slowly in the 2001 Flood, through interview survey. Therefore people should not be in panic in the flood time. “Keep calm and stay at home until floodwater subsiding, or evacuate to the higher place” is the key for this area. In the flood time people should also keep away from the river course.

Ejen Ghareh Khoojeh village has two parts. The northern part of the village is on the top of hills, and it is the safer area. On the other hand the southern part is located in the flooding zone and is near to the river, so that people living in this area should escape to northern part immediately when flooding occur.

Ghanjagh Shahrak village is located in wide flooding zone. But the floodwater velocity and the water level increment are slow. In this area, people should move fast if they evacuate to Darabad village by truck, or they should stay at home until floodwater subsides.

From Agh Ghamish to Tangrah village, the floodwater velocity is fast so that people should keep far away from the river. People should use much more caution to the debris flow from the mountain streams.

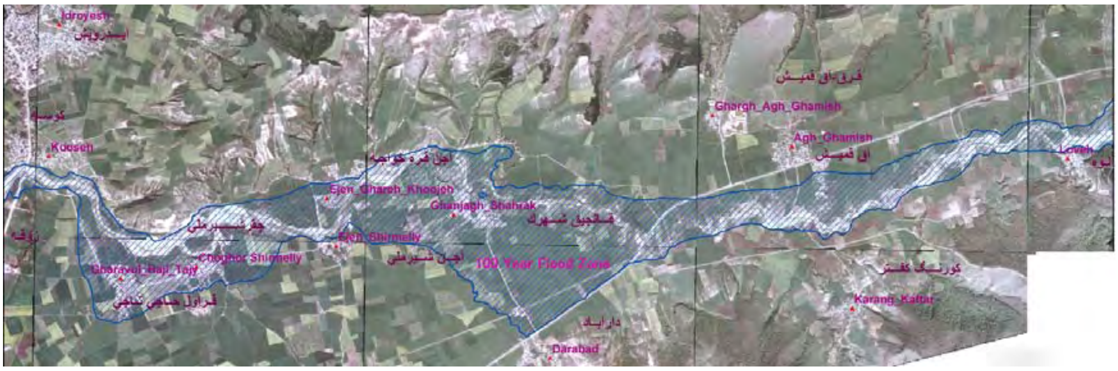


Fig. 6.5 Hazard Map in 100-Year Flood between Kalaleh Bridge and Loveh Village

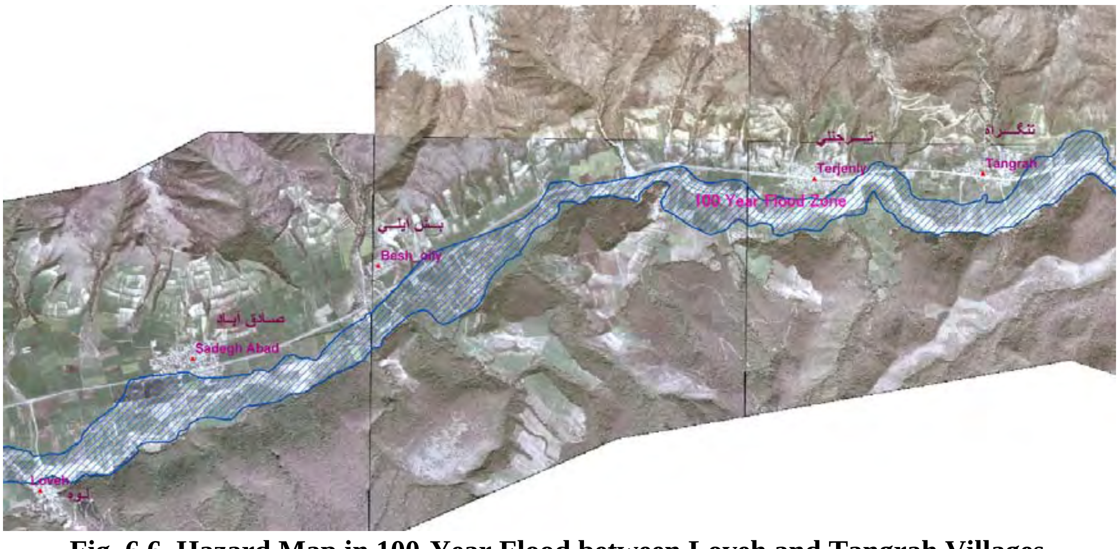


Fig. 6.6 Hazard Map in 100-Year Flood between Loveh and Tangrah Villages

<u>Mountain Gorge</u>

From Tangrah village to Dasht Bridge, the Madarsoo runs through mountain gorge of the Golestan Forest National Park. There are no resident inside the park, but there are many campers and visitors in summer season.

The floodwater rushes down very fast in the flood time due to the narrow gorge and steep riverbed slope. It is only way to force the people into going out of the park before flood comes. Thus establishment of early flood forecasting and warning system is indispensable to save the visitors in the park from the floods.

<u>Dasht Basin</u>

Agricultural land widely extends in the Dasht basin, and Dasht village is located in the downstream end of the basin. The three river systems join together near Dasht village, namely Gelman Darreh, Dasht-e-Sheikh and Ghyz Ghaleh rivers. Thus the village is situated in the center of flood-prone area.

6.2.3 Evacuation Route

Based on above considerations, the residents in Terjenly, Tangrah and Dasht villages should take refuge from both flood and debris flow when an evacuation order is announced. JICA team prepared the evacuation route maps for these three areas by using GIS tools.

<u>Terjenly Village</u>

Terjenly village is developed on the alluvial fan, which is flood- and debris-prone area from its origin. Two mountain streams divide the village into three parts. In torrential downpour, the residents shall take evacuation route of the green arrow toward the yellow zones in accordance with divided three locations as indicated in Fig. 6.7. Yellow areas are higher terraces so that the areas can be regarded as flood-free zones.

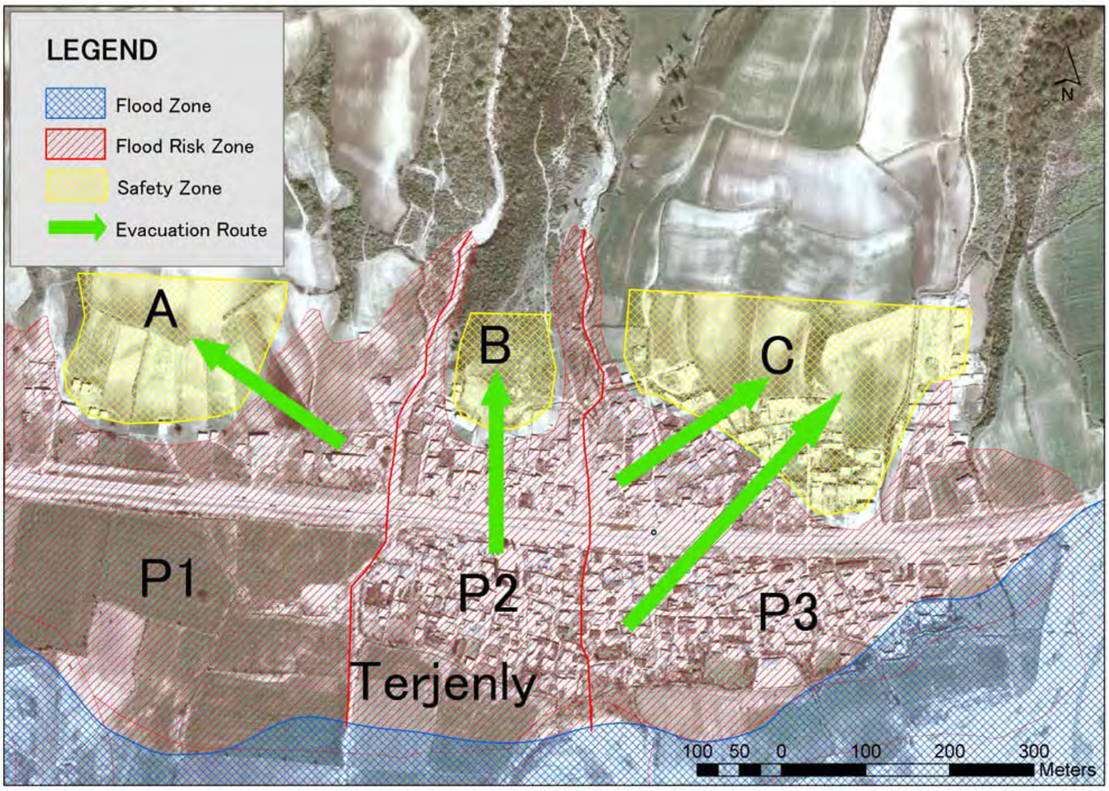


Fig. 6.7 Evacuation Route of Terjenly Village

Tangrah Village

Tangrah village is also developed on the alluvial fan. Tangrah River divides the village into two parts. In torrential downpour, the residents shall take evacuation route of the green arrow toward the yellow zones in accordance with divided two locations as indicated in Fig. 6.8. Yellow areas are higher terraces so that the areas can be regarded as flood-free zones.

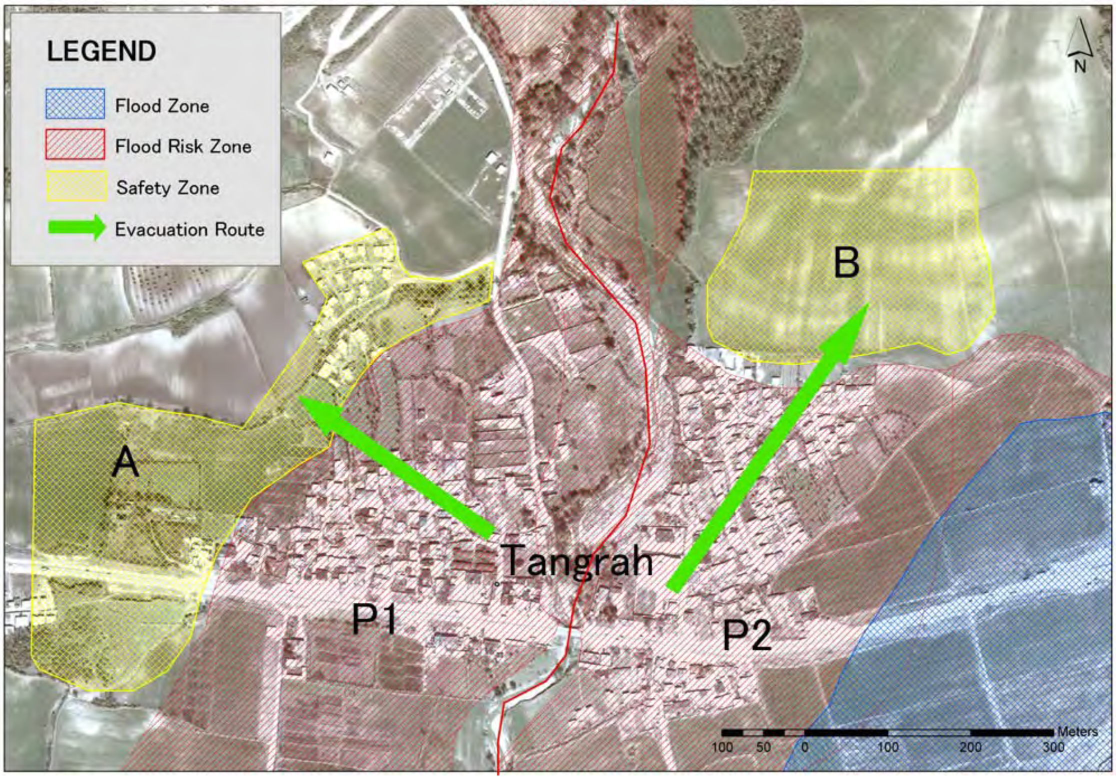


Fig. 6.8 Evacuation Route of Tangrah Village

Dasht Village

Dasht village is located in the downstream part of the Dasht basin. There are three floodwater and sediment runoff sources around the village as mentioned before. After the 2001 Flood, the polder diking system was constructed and protected the village from the floods of the said three river systems as illustrated in Fig. 6.9.

There is a hill southwest of the village, and the polder diking system anchors to the hill. It could be used as evacuation place. The evacuation rule for Dasht village may be enumerated below.

(1) In the flood time, people should evacuate to the mosque that is located in village center, or stay in their own houses. At the same time some young and strong villagers shall be dispatched to two flood-watch sites on the top of polder dike to keep watching floodwater of three streams.

(2) If floodwater of the Gelman Darreh increases and village starts to be inundated with floodwater, people should follow the green direction to evacuate to the safety zone. The direction of evacuation route is toward higher and farther place from the Gelman Darreh River course, and the route on the dike is protected by the hill against the Ghyz Ghaleh flood.

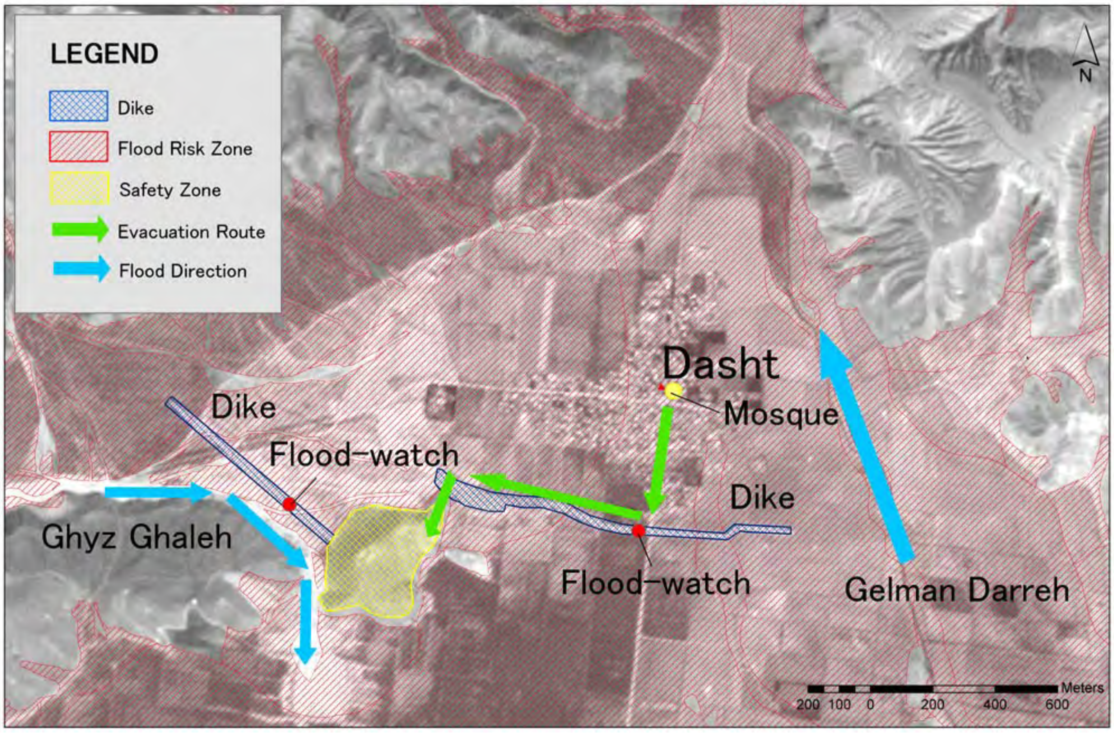


Fig. 6.9 Evacuation Route of Dasht Village

6.3 Pilot Activities

6.3.1 Aim

Pilot activities are conducted to examine the plan of village disaster risk management activities on site and get feedback and revise the original plan. This plan aimed to be served as a template for other vulnerable villages. The following figure shows the risk management steps and village activities are planned according to the steps. Planned activities are categorized in table below.

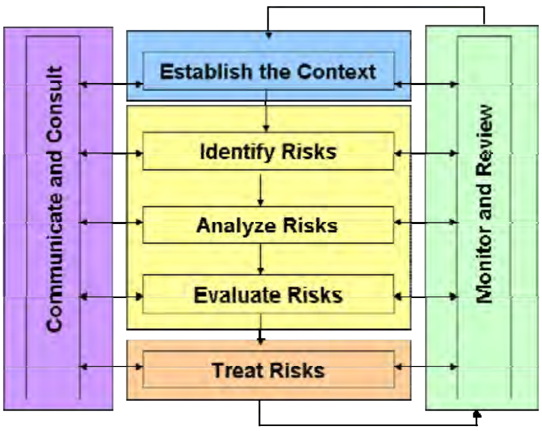


Fig. 6.10 Disaster Risk Management Steps

Table 6.1 Stage-wise Activity

Stage	Activity
Establish the Context	Discussion with public officials, Strategic Meeting w/ Village Council
Identify, Analyze, Evaluate Risk	Social Survey, Risk and Resource Mapping
Treat Risk	Village Based Disaster Risk Management Planning
Communicate & Consult	Advisory Committee, Forum, Educational Materials
Monitoring & Review	Drill, Map Maneuver

6.3.2 Formation

Dasht and Terjenly villages were selected as pilot activity sites. Pilot villages serve as demonstration sites of activities which are observed by other vulnerable village councils. Advisory committee was held among related public organizations and Red Crescent Society to share the experiences in the pilot villages, lessons learned, to review master plan and action plans of village disaster risk management. The JICA team has assisted to such activities.

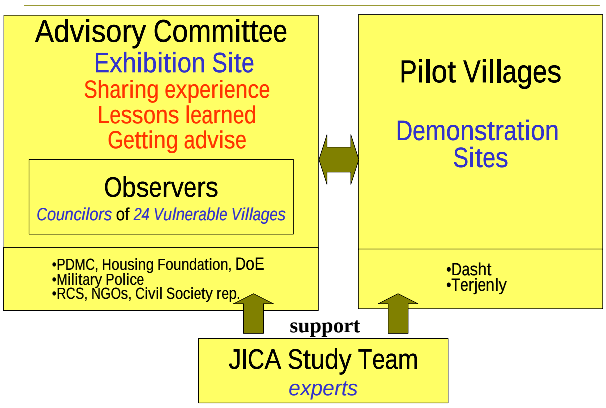


Fig. 6.11 Formation of Implementing Pilot Activities

6.3.3 Sequence of Activities

Model activities are summarized in Fig. 6.12.

6.3.4 Schedule

Vulnerability and capacity assessment was conducted from January 2005 to May 2005 in 33 vulnerable villages along the Madarsoo River basin. In August to September 2005, based on the assessment results, two pilot villages were selected and preliminary activities of Village Watching and Mapping has been conducted. In February to March 2006, workshops were conducted every week at each village. The schedule is shown in the following table.

Table 6.2 Schedule of Village Activities

Activity	Jan 29–Feb 3	Feb 4–10	Feb 11–17	Feb 18–24	Feb 25–Mar 5
Consensus building with Public officials	▬				
Strategic Meeting with Council		▲▲			
Mapping			▲▲		
Village Plan				▲▲	
Educational Materials for villagers and Passengers	▬	▬	▬		
Writing Scenario for Drill				▲▲	
Drill and Critic					▲▲
Documentation of village DM activities	- - -	- - -	- - -	- - - ▬	▬
Advisory Committee for review					▲

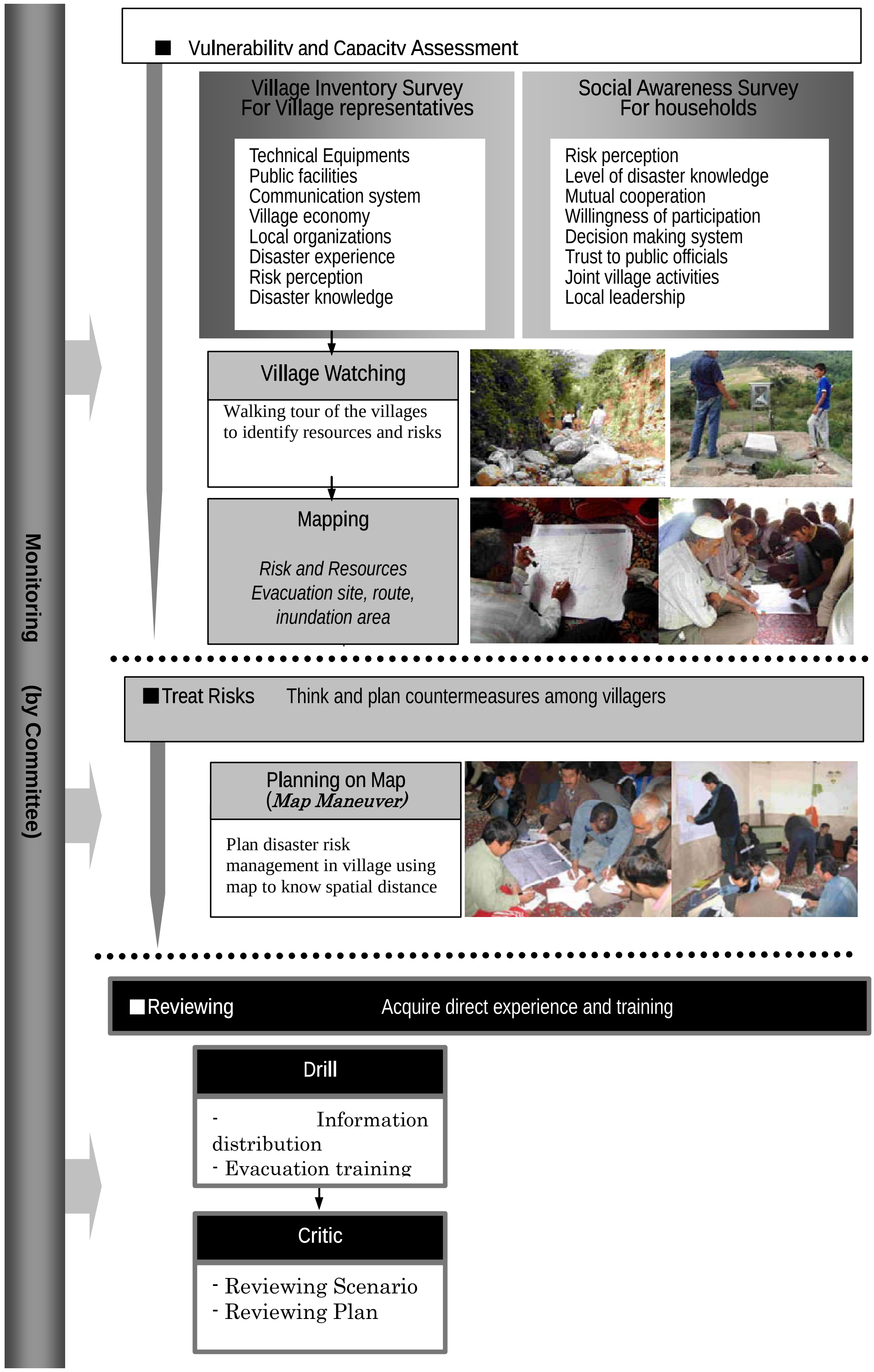


Fig. 6.12 Pilot Activities

6.4 Framework of Village Disaster Risk Management

Framework of village disaster risk management has been delineated in the following table.

Table 6.3(1) Recommended Task Target Matrix

Number	Task	Item	Description	Target: Public Sector	Target: Villagers	Target: Schools	Target: Tourist
1	**Risk Communication**	**Disseminate accurate weather information**	Accurate timely weather information from Meteorological office to mass media. TV telop need to run to give timely warning of heavy rain.	◎			
		Understand distributed hazard map	Hazard map prepared by JICA team need to be authorized by the Golestan provincial government and Red Crescent Society trainers explain about the hazard map during village workshops. It can be used for mapping exercise.	◎			
		Village Watching and Risk and resource mapping	Villagers conduct Village Watching, which is a walking tour of village, to understand the location and size of the risk and resources in villages. The surveyed information will be included in the village risk and resource map. Since the prepared hazard map covers wide area, villagers will prepare village focused big scale map during workshops. Same exercise can be done at school. Red Crescent Society trainers will be facilitator. Recommended Scale: at least 1/2,000,1/5,000	○	◎	◎	
2	**Public Awareness Raising**	**Public Information Dissemination**	Utilizing mass media; TV, radio, and newspapers for disseminating disaster mitigation information, introducing activities of public authorities. Producing leaflets, pamphlets, booklets for disseminating disaster knowledge for villagers, passengers, and tourists in the National Park, promoting preparedness among villagers.		◎	◎	◎
		School Education	Draw up School Curriculum in proportion to different levels of class and authorize it for the national standard. Schools located in vulnerable villages need to conduct tentative programs urgently.	○		◎	
		Signboard and Notice board of Flood Risk for Tourists and Passengers	Signboards to inform flood risk in the Golestan National Park will be constructed. Small place to inform flood risk in museum of the Park will be provided by DOE. Past disaster situation, disaster experience, and damage photos are displayed.	○			◎
		Holding Seminars, Workshops	Seminars, workshops will be held for raising awareness of the general public.	○	◎	◎	◎

Table 6.3(2) Recommended Task Target Matrix

Number	Task	Item	Description	Target: Public Sector	Target: Villagers	Target: Schools	Target: Tourists
3	**Human Resource Development**	**Administrator Training**	Training administrators to gain knowledge for daily services. Expert of Red Crescent Society will be trained for village council members and village leaders to train as trainers.	◎			
		Training of Local Leaders	Training village council members and voluntary leaders in the villages with specific and practical knowledge to lead the village based disaster risk management activities such as planning, information dissemination, issuing evacuation order, rescue, first-aid, and relief in the emergency situation. Red Crescent Society will train village leaders.		◎		
		Conducting Village Workshops by Village Leaders	Trained village council members and voluntary members will hold village workshops to plan village disaster risk management, educate disaster knowledge, train emergency responses, and conduct drills by support of Red Crescent Society.	○	◎		
		Conducting Annual Drill	Yearly drill including school will be conducted by the initiative of village disaster risk management committee. Joint drill in wide area, including relevant authorities such as township and provincial disaster management center, police and Red Crescent Society can be held.	○	◎		
4	**Organizational Capacity Development**	**Formulation of Disaster Management Committee**	Disaster management committee will be formed at each village to promote understanding and responsibilities before, during and after disasters. Such responsibilities as information distribution, monitoring, evacuation, transportation, stockpile, rescue and first-aid will be designated and trained. The head of the committee plays an incident commander and make contacts with outside organizations. Red Crescent Society will give support to conduct workshops.	○	◎		
		Emergency Response	Upgrading organizational skills and capacity for emergency response including monitoring, information distribution, evacuation, rescue, first-aid etc. Red Crescent Society will give training for villagers.	○	◎		
		Strengthening Coordination	Information database of each vulnerable village will be kept at relevant organizations, which is effective during emergency situations. In ordinary time, at yearly drills, relevant organizations will co-organize the activities. Emphasis will be given to establish linkage and coordination among these organizations.	◎	◎		

Number	Task	Item	Description	Target			
				Public sector	Villagers	School	tourists
5	**Preparation of Equipment and Construction**	**Preparation of Equipments**	Village will prepare necessary tools and equipments for emergency by subsidies of local government. Those items are recommended to be used ordinary time and maintained by village council.	◎	◎		
		Construction of Shelter cum Village Cultural Center	Village cultural Center which can be used as shelter will be constructed. In vulnerable villages, no cultural facilities exist. Labor for construction is provided by villagers. Housing Foundation will discuss the construction plan with villagers.	◎	◎		
		Construction of mitigating measures	To enhance mitigation capacity of flood and debris flow, planned engineering works will be discussed with villagers. In the construction program, including villager's labor contribution is feasible.	◎	◎		

To implement village activities, Red Crescent Society is the focal organizations to train villagers. Following figure shows steps of village training and workshops.

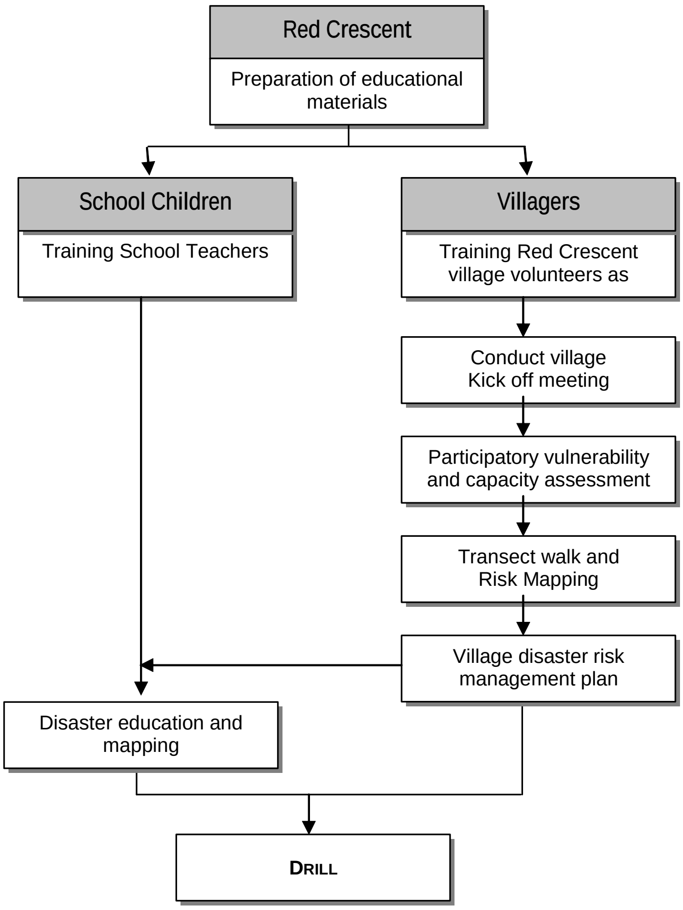


Fig. 6.13 Steps of Village Training and Activities