CHAPTER 3 PRESENT WATERSHED MANAGEMENT

3.1 Institutional Framework

3.1.1 Laws and Regulations

There are many laws and regulations related to the management of rangelands and forests in the country. The most relevant are the following two laws and based on these laws, MOJA and NRGO have issued numerous internal regulations.

- Law of Land Reform (1963)

This is the principal law governing land management. The law stipulates that NRGO shall mainly be responsible for the management of natural lands.

 Law on Exploitation and Protection of Forestry and Rangelands (1967, amended in 1997)

This law defines the following: rules for exploitation; protection of forests and rangelands, taxes and levies received from beneficiaries, financial and technical issues and other land use matters in forests and rangelands.

An amendment to the Law on Protection and Utilization of Forests and Rangelands stipulates that MOJA shall issue permits for any exploitation of natural dense forests and rangelands.

3.1.2 Organizations

The Ministry of Jihad-e-Agriculture (MOJA) is responsible for the management of watersheds in the present institutional setup. In the headquarters of MOJA, the Deputy for Watershed Management, Forest, Rangeland and Watershed Management Organization are in charge of watershed management. In Guilan Province, the Deputy of Watershed Management of MOJA Guilan Provincial Office is responsible for erosion control. On the other hand, the management of rangelands and forests is the responsibility of the Natural Resources General Office (NRGO) of Guilan Province. For agricultural lands, the Deputy for Cultivation and Agriculture of MOJA is the responsible organization to manage agricultural lands in the watershed. The organization charts of MOJA and NRGO are shown in Figures 3.1.1 to 3.1.4.

DOE also has responsibility of managing parts of the watershed that are designated as protected areas, while the Ministry of Energy (MOE) is in charge of the management of rivers, floodways, natural creeks, natural waterways, ponds and so on. At the provincial level, the Regional Water Authority of Guilan Province manages rivers in the province.







Figure 3.1.2 Organization Structure of NRGO Headquarter

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Figure 3.1.3 Organization Structure of MOJA Guilan

Figure 3.1.4 Organization Structure of NRGO Guilan

3.2 Current Soil Erosion Control

Erosion protection works in the watershed, such as construction of check dams, construction of stone masonry walls, biological works, introduction of protected areas, etc., are the duties of MOJA in Guilan province. In addition, MOJA Guilan is responsible for preventing outbreaks of landslides in the watershed, although the construction of forestry roads is the responsibility of NRGO Guilan.

3.2.1 Direct Measures for Soil Erosion Control

(1) Erosion Process and Countermeasures

Due to overgrazing, parts of the rangelands have been deteriorated or become very poorly vegetated. The initial stage of the erosion is known as sheet erosion. At this stage, topsoil is lost and, if allowed to progress, the sub-soil may be exposed. In the early stages of sheet erosion, the area may be recovered by stopping grazing, applying fertilizer and seeding. However, once the surface soil is loosened by rainfall, snow melt or wind, it becomes increasingly difficult to achieve natural recovery. As the erosion process progresses, the ground surface is eroded and shallow channels are formed; this is called rill erosion. Rill erosion may develop into gulley erosion with a large amount of sediment flowing downstream.

MOJA Guilan tries to control erosion by applying measures, such as, 1) gabion check dam; 2) wooden dam; 3) stone masonry wall; 4) vegetation works; 5) biological works; 6) introduction of protection area, etc. The construction of a concrete check dam is now on planning.

(2) Watershed Management Study of MOJA

MOJA Guilan has planned to carry out a Study for Watershed Management Master Plan of Guilan province, but it has not been commenced yet. MOJA Guilan has prepared eight (8) execution studies for eight sub-watersheds as shown in Figure 3.2.1. Besides, there is one execution study presently under preparation for one sub-watershed and one preliminary study completed in Masuleh sub-watershed.

Aside from the studies mentioned above, the GIS Center of MOJA Guilan is carrying out a GIS study of the province and has been producing various data concerned with watershed management such as erodibility maps and flood potential maps of western Guilan.

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Source: MOJA Guilan, Deputy of Watershed Management, GIS center

Figure 3.2.1 Existing Execution and Preliminary Studies on Watershed Management

(3) Soil Erosion Control Works

Table 3.2.1 presents the sediment and erosion control works that MOJA Guilan has conducted in the study area from 1998 to 2002. As shown in the table, the erosion control works are concentrated in the Masuleh watershed and the most common measure is the construction of check dams.

Watershed (River)	Type of Work	Quantity	Year
	Concrete Check Dam	Planning	
	Gabion Check Dam	$1,150 \text{ m}^3$	1999 - 2002
Masuleh Watershed	Wooden Check Dam	850 m ³	2000
	Stone Masonry Wall	550 m ³	1995
	Vegetation (Grassing, Planting) and Protected Area	400 ha	1996
Masal Watershed	Biological Works (Grassing, Planting)	220 ha	1998
	Gabion Check Dam	450 m^3	2000
Knorni watersned	Wood Check Dam	700 m^3	2000 - 2002
Delen even Diven	Protection Area	120 ha	1999 – 2002
(Tanian Watarshad)	Gabion Check Dam and Non-gabion	430 m^3	2000 - 2002
(Talilali watershed)	Wooden Check Dam	250 m ³	2001 -2002
Gohalu	Tree Planting	85 ha	1998 -2002
Chasher area	Wooden Check Dam	250 m ³	1999
Choobar afea	Protected Area	30 ha	2001 -2002

 Table 3.2.1
 Erosion Control Works implemented by MOJA Guilan

Source: MOJA Guilan Provincial Office

Although MOJA has put in effort to control soil erosion, most of the areas with gully and rill erosion still remain untreated. If these areas are left without any countermeasures, erosion process would progress and slope failures might cause serious problems such as debris flow and floods. In the past, floods caused severe damage to social infrastructure (roads, irrigation facilities, etc.), personal assets (houses, farmlands, animals, etc.), natural resources (forests, wetlands, rivers) and, if the worst comes to the worst, human lives in the study area. Table 3.2.2 shows the past record of outbreaks of floods in the upper watershed.

Sub-watershed	Record of Past Floods
Masulehroudkhan	8 times (1951, 1986, 1997, 1998, 2001, 2002, 2003 and 2004)
Pasikhan	4 times (1998, 1999, 2000 and 2001)
Siahroud	3 times (1951, 1952, and 1957)
Shakhraz	2 times (1991 and 1996)
Morghak	Once (2002)
Khalkai	Once (2001)
Plangvar	Once (1926)
Chafroud and Bahamber	None

Table 3.2.2	Occurrence	of Floods in	the Study Area
1 4010 0.2.2	occurrence	of 1 foods in	the Study Mica

Source: WMD, MOJA

The following pictures show erosion control works on the northwest slope of the Masuleh. The deforested slope around the gabion check dam is designated as a protected area to avoid the invasion of livestock. For such places, measures such as contour bunds, wattling and straw matting need introducing.

Figure 3.2.2 Erosion Control Works in Masuleh

3.2.2 Prevention of Landslides and Slope Collapse

According to the GIS Center of MOJA Guilan, there are 20 landslides in the Anzali Wetland Watershed. Five are distributed near Masuleh Town, and others are distributed in Morghac Watershed (2), Khalkai Watershed (3), Palangvar Watershed (3) and Shakhraz Watershed (7), and all the landslides are located in the mountainous forest areas. As described in Chapter 2, no countermeasures are taken following slope collapse or land slides in many areas due to lack of technique and budget. Landslides and slope collapse eventually block roads in the upper watershed.

3.3 Present Forest and Rangeland Management

3.3.1 Jurisdiction of NRGO

A total of 215,000 ha of forests, rangelands and some farmlands in the watershed are under the jurisdiction of NRGO Guilan as tabulated below. Figure 3.3.1 shows the areas the locations of forests, rangelands and farmlands presently managed by NRGO.

Watershed Name	Total Area Managed by	Forest Area <1		Rangeland Area		Farm Land	
watershed wante	NRGO (ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)
No. 10 (Chafroud)	16,917	10,769	64	595	4	5,553	33
No. 11 (Morghak) (including Banbahr)	40,335	30,470	76	5,810	14	4,055	10
No. 12 (Khalkai)	24,989	18,095	82	5,552	25	1,342	6
No. 13 (Palangvar)	13,595	11,736	86	73	1	1,786	13
No. 14 (Masulehroudkhan)	25,703	17,909	70	5,746	22	2,048	8
No. 15 (Ghalaroudkhan)	24,791	19,316	78	2,416	10	3,059	12
No. 16 (Siahmazgiroud)	18,981	11,349	60	6,579	35	1,053	6
No. 17 (Pasikhan)	26,222	21,562	82	352	1	4,308	16
No. 18 (Siahroud)	23,801	20,134	85	-	-	3,667	15
Total	215,334	161,340	75	27,123	13	26,871	12

 Table 3.3.1
 Areas
 Managed by NRGO

Note: <1 The forest areas managed by NRGO include rangelands that used to be forests. Source: NRGO Guilan

The areas shown in above table are managed by six (6) NRGO local offices, namely, Rezvanshahr, Shaft, Masal, Fuman, Rasht and Somehsara. The numbers of employees in each office are shown below.

Township	No. of stations	Responsible basins	No. of staff (no.)		
	(no.)		Total	Technical staff	Forest rangers
Rezvanshahr	5	8, 9, 10	81	18	18
Shaft	3	16, 17	20	6	7
Masal	4	11, 12	17	5	11
Fuman	2	14, 15	21	4	4
Rasht	3	18, Plain area forest	40	6	22
Somehsara	2	13	21	3	3
Total	19	-	200	42	69

 Table 3.3.2
 Number of Employees in Local NRGO Offices

Source: NRGO Guilan

It seems that the number of employees, especially forest rangers, is not sufficient to manage all the responsible areas. There are no plans to increase the staff numbers at present.

3.3.2 Forest Management

The forests in the watershed are in relatively good condition, although about 182 km² of forests have been degraded as shown in Table 2.3.3. The overall goal of NRGO Guilan in forest management is to "achieve scientific and best management of the forest according to its biological potential and sustainable development principles, allowing continuous production without damaging production, environment, recreation, ecology and forest values". The concrete aim of NRGO is to restore the forests to the conditions they were in during the 1960s. To this end, NRGO Guilan has carried out i) livestock resettlement; ii) reforestation; iii) conservation of protected forests and genetic flora; iv) forest management by entrusting private firms, and v) development of eco-tourism plans.

On the other hand, the Iranian Government approved in August 2003 the "Presidential Decree of the Council of Ministers of MOJA-DOE-MPO on the Management of the Northern Forest (No. 26239/16276)¹" to facilitate conservation of the Northern Forest. The decree stipulates that MOJA and DOE shall establish a committee and take necessary actions to conserve forests in the northern region, which include i) implementation of the livestock resettlement program; ii) reforestation; iii) conservation of forests; iv) promotion of sustainable forest management; and v) monitoring and evaluation of conservation activities.

In 2003, NRGO Guilan established a forest conservation committee at the provincial level along with the decree. The organization chart of the committee is presented in Figure 3.3.2.

¹ The Northern Forest is the forest on the northern slopes of the Alborz Mountains in Guilan, Mazandaran and Golestan Provinces.

Figure 3.3.2 Organization Structure of the Conservation Committee in NRGO Guilan

- (1)Livestock Resettlement Program
 - Outline of the Resettlement Program 1)

NRGO has implemented resettlement activities to reduce the number of livestock and negative impact on the forest since the 1990s. The progress and results of the activity in the past was not as satisfactory as expected, since the compensation scheme was inflexible and there were few consideration of socio-economic aspects. In line with the aforementioned presidential decree, the NRGO elaborated a livestock resettlement program with its implementation guideline. The outline of the program is described in Box. 3.3.1. According to the guideline, the resettlement program targets the following rural residents in the forest.

- a. Graziers (groups/individuals) who raise more than 30 head of livestock in the forest
- b. All families who reside in the village with less than 20 households
- c. Families who raise less than 30 head of livestock but reside in sensitive/critical areas

(Among them, graziers/families who can receive compensation are those who have resided in the area since 1985 or who have grazing licenses issued before 1985.)

Box 3.3.1: Outline of the Livestock Resettlement Program

Resettlement of Livestock

All livestock raised by the graziers listed above shall be resettled from the forest. The guideline defines the groups/graziers eligible for compensation for resettlement and the scope of the compensation.

(to be continued)

Target group: 1.

The project aims at the following groups as subjects for resettlement.

a. Graziers (Groups/individuals) who raise more than 30 head of livestock in the forestb. All families which reside in the village with less than 20 households in the forest

c. Families who raise less than 30 head of livestock and reside in sensitive/critical areas of forest

2.1 Groups eligible for compensation:

- a. Graziers whose names are listed in the Statistical list of the Initial Integrated Project (1985-86)
- b. Graziers who were approved by the Forest Management Project
- c. Graziers who have grazing license and can fulfill one of the following conditions.
 - Have raised livestock in the forest since 1985
 - Own a private livestock shed in the forest which was constructed before 1985
 - Own a private feeding (grazing) lot in the forest

2.2 Scope of compensation

The number registered/approved in Initial Integrated Project/Forest Management Project can be accepted. But, the number should be not more than 250 head. In case the registered number is more than 250, the value of excess livestock is evaluated at 1/3 of that for the approved animal. In case the number of livestock has increased from the registered/approved, the increment will be accepted up to 250 head.

2.3 Mode of compensation

The Government will compensate the eligible graziers who voluntarily cooperate with the project for their loss. Payment equivalent to annual income derived from resettled livestock will be made by the Government. In case the grazier requests his or her own lands, he or she could have the land within the limits of amount of payment.

3. Resettlement of Households

All families who live in villages with less than 20 households must be resettled under the project. Their houses and other properties will be compensated.

3.1 Groups eligible for compensation:

- a. Families who have lived in the targeted villages since 1986
- b. Families who own legally registered properties in the targeted villages
- c. Families in the villages who receive support from families categorized as (a).

3.2 Scope of compensation

Legally registered properties (such as buildings and lands) and domestic livestock (which are those raised in farmlands/backyards of households) will be compensated. In case the buildings were constructed after 1986, they will not be covered by this guideline and destructed without any payment. The number of domestic livestock to be compensated must not exceed 20 head.

4. Work processes to be taken

The following steps are to be undertaken in the project.

a. Notification of project \rightarrow b. Information gathering by filling out the form \rightarrow c. Determination of eligible households \rightarrow d. NRGO's site visit \rightarrow e. Survey and cost evaluation \rightarrow f. Agreement \rightarrow g. Handover of properties \rightarrow h. Conclusion of the contract \rightarrow i. Cancellation of grazing permit \rightarrow j. Compensation

Source: NRGO Guideline on Livestock Resettlement (2002)

There is no precise information about the number of graziers/rural residents who presently stay in the forest since no inventory survey has been carried out yet. According to NRGO Guilan, about 80~90 % of total registered graziers or about 3,930 families reside in the forest and will be compensated by the program. The remaining graizers, who reside in plain areas and use the rangeland for grazing in spring/summer, can continue livestock grazing in the rangeland. NRGO estimates the number of graziers to be compensated as about 3,930 families based on the survey records conducted in 1984.

Sub-watershed	Graziers to be relocated (families)	Graziers to quit grazing (families)	Total affected graziers (families)	Total livestock units to be resettled (units)
No. 10 (Chafroud)	344	0	344	24,398
No. 11 (Morghak)	428	182	610	59,059
No. 12 (Khalkai)	228	145	373	70,647
No. 13 (Palangvar)	43	395	438	44,322
No. 14 (Masulehroudkhan)	250	245	495	75,190
No. 15 (Ghalaroudkhan)	40	392	432	41,024
No. 16 (Siahmazgiroud)	91	226	317	22,806
No. 17 (Pasikhan)	272	409	681	70,708
No. 18 (Siahroud)	78	160	238	13,541
Total of Anzali watershed	1,774	2,154	3,928	430,930

 Table 3.3.3
 Numbers and Types of Affected Graziers

Note: *1: No. of livestock units is estimated by using the average size of livestock units. Source: NRGO Chalues

2) Present Status and Effect of the Resettlement Program

A total of 337 graziers or 52,170 units of livestock have been relocated by 2002. Consequently, 3,591 (3,928 - 337 = 3,591) families and 378,760 (430,930 - 52,168 = 378,762) units of livestock will be affected for the next six years.

	Accomp	lishment	Planned for 6 years			
Basin	Graziers	Livestock	Graziers to	Graziers to	Livestock to	
	relocated	resettled	be relocated	be affected	be resettled	
	(families)	(units)	(families)	(families)	(units)	
No. 10 (Chafroud)	104	9,235	240	0	24,398	
No. 11 (Morghak)	18	7,958	410	182	51,101	
No. 12 (Khalkai)	0	0	228	145	70,647	
No. 13 (Palangvar)	0	0	43	395	44,322	
No. 14 (Masulehroudkhan)	3	3,778	247	245	71,412	
No. 15 (Ghalaroudkhan)	0	0	40	392	41,024	
No. 16 (Siahmazgiroud)	0	0	91	226	22,806	
No. 17 (Pasikhan)	157	27,497	115	409	43,211	
No. 18 (Siahroud)	55	3,700	23	160	9,841	
Total of Anzali watershed	337	52,168	1,437	2,154	378,762	

 Table 3.3.4
 Accomplishment and Target for the Next 6-Year

Source: NRGO Chalues

As a result of the resettlement program, the numbers of graziers and livestock are expected to be 693 families (4,621-3,928=693) and 76,046 units (506,976-430,930=76,046), respectively.

3) Implementation Schedule

Accordingly, about 70% of the estimated budget for the livestock resettlement program was already programmed in the 4th 5-year national development plan (2005-2009). The implementation schedule of the program is shown below.

Year Target Basin		Total Livestock	Total Affected	Total Budget
		(units)	Families (HHs)	(Rials Billion)
2004 /2005	7, 17 , 24, 23	83,641	928	89.7
2006	3, 1, 10 , 19, 22, 26	294,366	1,368	159.4
2007	11, 12, 18 , 25, 28	247,810	1,676	148.8
2008	1, 14, 11, 27	201,887	614	103.4
2009	5, 4, 9, 15, 16	178,632	655	103.5
2010	6a & 6b, 20, 21, 24	273,178	1,545	1,76.8

 Table 3.3.5
 Implementation Schedule of the Resettlement Program

Source: NRGO Chalues

4) Limitation of the Resettlement Program

The existing guideline of the program has no description of the consultation process nor assistance with livelihood recovery for affected families, although it gives the definition of target families, scope of compensation, and agreement forms to be used. A participatory study carried out by a NGO under contract with JICA Study Team also reported that the consultation and explanation to affected families were very limited in the implementation of the resettlement program at the field level.

(2) Conservation of Protected Forests and Biosphere Reservation

A total of 3,250 ha or 29 protected areas are located in the watershed area. To conserve forests and encourage natural regeneration, NRGO restricts entrance of people and livestock in the protected areas and also implements tree planting in accordance with the Law on Protection and Exploitation of Forest and Rangeland. Some protected forests are also fenced around, but some places along the rivers are left without fencing because people and animals live there.

NRGO Guilan has also designated 25 biosphere reservation areas which have genetically important flora. The biosphere reservation areas range from several hectares to several tens of hectares in general.

A vast tract of forest called the Shaft-Siahmezgi forest (39,511 ha) was designated by DOE Guilan as a protected area. Although NRGO Guilan and DOE Guilan agreed that the jurisdiction for the area would be transferred to DOE, the final designation of the Shaft-Siahmezgi protected forest still awaits approval by the parliament. Therefore, the area is still under the management of NRGO Guilan at present. Approved as a protected area of DOE, the area would be protected according to the Environmental Protection Act (1992) and any activities that lead to negative impact on vegetation, such as cutting trees, burning wood, etc., would be prohibited.

The Shaft-Siahmezgi forest (39,511 ha) covers half of Ghalaroudkhan sub-watershed and

almost all the Siahmazgiroud sub-watershed as shown in Figure 3.3.3. There is, however, no information available of locations of other protected forests.

- (3) Forest Management under the Forestry Plan
 - 1) Sub-watersheds managed under the Forestry Plan

Out of nine (9) sub-watershed, four (4) sub-watersheds, namely, Chafroud, Morghak, Pasikhan and Siahroud, are presently used as forestry areas (production forests) under the management of local private firms. NRGO made 10-year contracts with private firms and entrusted the management of the sub-watersheds to them in accordance with forestry plans prepared by NRGO Guilan. The contract can be renewed in the last year of the contract if the performance of the firm is satisfactory. The locations of the four (4) sub-watershed are presented in Figure 3.3.3.

2) Components of Forestry Plan

NRGO prepared 29 forestry plans for four (4) sub-watersheds² in accordance with "Terms of Reference (TOR) of Forestry Plans in the North of Iran" (2000). The said TOR prescribes that the forest management plan should cover a) Topography, b) Meteorology, c) Geology, d) Soil, e) Reforestation, f) Pastures, g) Socio-economic conditions, h) Forestry, i) Construction and maintenance of forest roads, buildings, facilities, 10) Conservation and protection, j) Silvicultural practice (forest establishment) and reforestation, k) Exploitation, l) Financial balance-sheet and economical explanation for execution of plans, and m) Summary table and control formula.

The activities planned for the four (4) sub-watersheds are summarized as follows:

Sub-	No. of	Total	Production	Annual	Exploitation	Planed Road
watershed	Series	Area	Forest	Exploitation	Rate	Construction
	(nos)	(ha)	(ha)	(m3/yr)	(m3/ha/yr)	(km)
Chafroud	7	16,917	8,085	7,200	0.89	34.1
Morghak	10	40,334	9,186	9,000	0.98	14.9
Pasikhan	9	26,222	6,557	8,000	1.22	23.0
Siahroud	3	23,802	6,018	6,000	1.00	2.6
Total	29	107,275	29,846	30,200	1.02	74.6

 Table 3.3.6
 Outlines of Forestry Activities in the Four Sub-Watersheds

Source: NRGO Guilan

 $^{^{2}}$ A sub-watershed is divided into 3 to 10 "series", which ranges from 2,000 to 3,000 ha. The forestry plan was prepared for each series. For management purposes, series are further divided into parcels of 30-80 ha.

3) Recommended Forestry Practices

The forestry plan also specifies that contractors shall adopt the following sustainable forestry practices to maintain and improve the quality of forests.

- a. Forests should be maintained as mixed-aged forests. In other words, the age composition of forests should be maintained as complex as possible.
- b. Contractors should i) protect forests from illegal activities and fires, ii) protect reforested areas by fencing and other measures, and iii) designate special protected areas for ecological protection.
- c. Selective cutting should be adopted. (Clear cutting is not allowed.)
- d. In selection of trees and exploitation, contractors should comply with the regulation of NRGO, which includes:
 - Exploitation should be adjusted based on the existing volume of wood.
 - The volume of cutting should be reduced in sensitive / critical areas.
 - No cutting should be allowed in steep valleys.
 - Rare species should be protected from cutting.
 - Adequate number of productive trees should be left for regeneration.
 - Light conditions of the understory should be taken into account in selection of trees.
- e. Forest roads should be constructed in accordance with the design of NRGO.
- f. Grazing activities should be controlled in the area.
- g. 70% of the sales income should be spent on the forest conservation activity.
- 4) Issues and Concerns

The Technical Department of NRGO Guilan points out that the following are the issues and concerns identified in the four sub-watersheds.

- a. Some of the forestry plans were prepared based on limited information by external technical consultants. The forestry plans need to be more accurate or site-oriented.
- b. Reforestation program has not progressed as planned because of the existence of graziers.
- c. Contractors sometimes do not follow the technical regulations of NRGO due to lack of knowledge.
- d. Contractors use traditional equipment in operation of forestry activities. This might damage the forest.

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(4) **Reforestation Plan**

The principle target of NRGO's reforestation plan is to restore the forest to the vegetation level around 1963. Between 1981 and 2002, a total of 31,500 ha have been reforested by NRGO Guilan as shown in Table 3.3.7.

				(Unit: ha)
Rasht	Rezvanshahr	Somehsara	Fuman & Shaft	Total
3,023	18,579	6,440	3,495	31,538
Source: NRGO Gu	ilan 2003			

Table 3.3.7	Reforested Ar	ea between	1981	and 2002
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Source: NRGO Guilan, 2003

The accomplishments by sub-watershed for the last five years are summarized in Table 3.3.8.

					(Unit: ha)
Sub- watershed	1999	2000	2001	2002	2003
No. 10 (Chafroud)	0	0	320	270	150
No. 11 (Morghak)	51	135	62	24	31
No. 12 (Khalkai)	0	0	0	105	135
No. 13 (Palangvar)	17	84	22	90	400
No. 14 (Masulehroudkhan)	25	15	0	0	115
No. 15 (Ghalaroudkhan)	0	0	0	0	0
No. 16 (Siahmazgiroud)	0	0	0	0	0
No. 17 (Pasikhan)	17	125	28	0	38
No. 18 (Siahroud)	40	84	52	0	0
Total	150	443	484	489	869

 Table 3.3.8
 Reforestation Areas by Sub-Watershed for the Last Five Years

Source: NRGO Guilan

NRGO Guilan has not extensively undertaken reforestation activities for the last 5 years. The accomplishments for the last five (5) years range from 150 to 870 ha/annum. In 2004, NRGO Guilan plans to reforest about 600 ha, mainly in Khalkai/Morghak and Masulehroudkhan sub-watersheds. There is no long-term reforestation plan prepared by NRGO at present.

The suggested tree species for reforestation include Quercus sp., Fraxinus coriarifolia, Alnus glutinosa, Acer insign, Pinus sp. and Polus sp. In principle, native species are recommended to minimize any unwanted environmental impacts.

(5)Ecotourism Development Plan

The Eco-tourism Plan aims to promote tourism through developing forest parks in the NRGO plans to develop the parks in three (3) watersheds, namely mountain areas. Masulehroudkhan (Masuleh town), Shakhraz (Ghalerudkhan Castle), and Siahroud (Salawan Park).

Sub-watershed	Area	Tree planting	Electricity *1	Camping site	Others
Masuleh	2,401 ha	615 ha	926 ha	168 ha	Ropeway:2,200m
Shakhraz	1,878 ha	-	220 ha	780 ha	-
Siahroud	1,487 ha	15 ha	1,200 ha	1,300 ha	-

 Table 3.3.9
 Eco-tourism Development Plan

Note: *1 Figures indicate the areas where electricity facility will be distributed. Source: NRGO Guilan

The locations of the proposed eco-tourism sites are shown in Figure 3.3.3.

(6) Others

In addition, NRGO Guilan has studied about livelihood development potentials in the watershed, such as, horticulture, cold water fish culture, production of medicinal plants, mushroom production, strawberry production, handicraft making, etc., as part of forest protection activities.

3.3.3 Rangeland Management

(1) Management Activities undertaken

The main organization responsible for rangeland management is the Rangeland Management Department of NRGO Guilan. The following management activities have been undertaken by the division, so far.

- Control of grazing practices (period of grazing, the number of livestock in the rangelands)
- Preparation of rangeland management plan

(2) Balancing the Number of Livestock

Balancing the number of livestock is the main goal of rangeland management. In the past, grazing licenses were issued to control the number of livestock in the mountains, but there were many illegal graziers entering the rangeland to raise livestock and licensing alone was not able to stop overgrazing. For this reason, NRGO has stopped issuing licenses. Instead, NRGO has been trying to control the number of livestock through discussions with graziers.

(3) Planning of Rangeland Management Plan

The Rangeland Management Department (RMD) of NRGO Guilan has prepared more or less 40 rangeland management plans dividing the rangeland into 156 areas. The rangeland management plan gives the existing livestock units, stocking potential of the area, recommended management practices, etc., but has no scheme to reduce the number of livestock. So far, no rangeland management plan has yet been implemented, since RMD realized that overgrazing problem could not be solved without reducing the number of

livestock and, consequently, graziers. At present, RMD has no clear program for managing rangelands and just waits for the implementation of the resettlement program expecting it to reduce the number of livestock and change the situation drastically. After the resettlement program, RMD plans to revise the management plans based on the situation. Accordingly, the management plan will include the following activities.

- a. to have discussions with remaining graziers who have limited number of livestock in order to persuade them out of grazing activities
- b. at the same time, to request graziers who will quit grazing to sell their livestock to those who have a large number of livestock
- c. After reducing the number of livestock, to train the graziers on proper rangeland management procedures, such as grazing season, rotation schedule, intensity of use, etc.
- d. to seed degraded areas in rangelands
- e. to fence around the degraded area after seeding
- f. to apply fertilizer to rangelands every year

(4) Estimation of Carrying Capacity of Rangeland

NRGO Guilan is also carrying out a detailed survey to determine the carrying capacity of the rangelands. Some 150 km^2 have been surveyed so far, and the rangelands were classified into 4 levels according to the estimated carrying capacity of the land.

Level I	4 units/ha
Level II	3 units /ha
Level III	2 units /ha
Level IV	1 units /ha

NRGO Guilan has yet to reach its final conclusion on appropriate carrying capacity in the watershed. Therefore, the office estimates average carrying capacity of the rangeland at about 3 units/ha based on the estimated stocking density. The master plan study also uses the same estimation for the time being.

Assuming the rangeland is located between EL. 1500 m and EL. 2000 m, the total area of the rangeland would be about 280 km². By applying such estimated carrying capacity (3 units/ha), the stocking capacity of the rangeland is estimated at about 840,000 units, which is equivalent to about 8.4 billion Rials³.

³ Total value of livestock is computed by applying the estimated price of livestock (100,000 Rials / Unit) presently used by NRGO.

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(5) Traditional Rangeland Management by Graziers

The participatory study conducted by the local NGO under contract with JICA Study Team revealed that graziers were aware of the importance of forests and rangelands, especially the functions of forest and rangeland in their lives. Some graziers informed that they protected forests since they understand forests are sources of fuelwood, housing materials, fodder, and shade for animals. On the other hand, the graziers who use the rangeland for livestock grazing urged that they were conscious of the necessity to manage the rangeland. Accordingly, graziers are applying the following management practices.

- Rotation of grazing area
- Protection of some parts of the rangelands
- Fixed grazing seasons
- Support for regeneration (graziers put a pack of seeds around the neck of sheep/goat when they graze livestock in rangelands.)

(6) Characteristics of Graziers and Grazing in the Rangeland

Any activities for rangeland management could not be successful without consideration of graziers who permanently use rangelands. Major characteristics of graziers to be taken into account in the rangeland management plan are:

- a. Graziers use rangelands for animal grazing from spring to autumn. They temporarily stay in rangelands during the grazing season, but they stay in either forests or plain areas in winter.
- b. Consequently, they can be classified into two (2) types, namely, graziers who live in the forest (80~90 % of graziers) and those live in the plain area (10~20 %).
- c. Grazing is deeply rooted in the traditional life of Iran, and it is not simple to change such a lifestyle.
- d. As illustrated in Chapter 2, the overgrazing problem has been incorporated in a vicious cycle; overgrazing \rightarrow erosion \rightarrow further deterioration of rangeland \rightarrow concentration of livestock in other parts of rangelands \rightarrow overgrazing.
- e. Graziers are simple, economically-disadvantaged people. They are not well educated to take up other occupations and are dependent upon livestock. This condition of poverty, lack of education and total dependence on livestock has worsened with the recent changes in lifestyle.
- f. Graziers who stay in forests have less social infrastructure support, such as electricity, water supply, transportation, education and health services.

g. There are different types of graziers in the area. Some keep his/her own livestock, while others are paid to keep livestock for somebody else. Some are completely dependent on livestock, while others may have other sources of income.

3.4 Plain Area Management

The management of the plain area in the study area is under the responsibility of MOJA Guilan. As mentioned in section 2.5.4, due to the favorable combination of flat topography and the presence of paddy fields that dominate the study area, the amount of sediment run-off from the plain is about 74,000 ton/year, which is considered to be low compared to that from the mountains (about 326,000 ton/year). No management activities related to sediment control are implemented in the plain area.

3.5 Major Management Issues and Possible Prospects under the Present Systems

Since the livelihood resettlement program is a critical issue considering its positive as well as negative effects, the program is highlighted separately from the issues of forest and rangeland management.

3.5.1 Soil Erosion Control and Prevention of Land Slides

- (1) Issues/Limitations
 - 1) Lack of Active Management to Prevent Progression of Erosion

Erosion has to be controlled when it is relatively minor. Otherwise, it will rapidly progress, and become difficult to control. However, the efforts to control erosion seem limited, and many sites are left unattended. In order to implement effective erosion control measures with limited budget, the area needs active management programs with emphasis on preventive measures, such as fencing of sensitive areas, control of early stages of erosion, and education of graziers in erosion control measures.

2) Poor Construction Methods of Roads in Mountains

Some areas of the watershed are geologically susceptible to landslides and slope collapses. However, many roads have been constructed in such areas without any countermeasures. Thus, the design and methods of road construction in the mountain areas should be improved. This problem is also related to the capability of

NRGO Guilan and its local offices to monitor and supervise the construction works of contractors.

(2) Prospective Situation of Soil Erosion and Landslides

As stated above, the lack of active management and improper construction work are the major issues in the management of soil erosion and landslides. The watershed and wetland environment would deteriorate if the situation is left as it is. Hence, the physical countermeasures to minimize the possible adverse effect on the wetland should be introduced as soon as possible.

Figure 3.5.1 Prospective Situation of Soil Erosion and Landslides

- 3.5.2 Forest and Rangeland Management
- (1) Issues/Limitations
 - 1) Lack of long-term vision for sustainable forest management

The livestock resettlement program would be effective in protecting the forests and rangelands from further destruction in the short term. However, driving graziers from forests is not always effective. Therefore, its long term effect is uncertain since overexploitation is closely related to socio-economic conditions (limited livelihoods) of graziers/forest dwellers. There is a high possibility that

relocated/affected families would return to grazing/exploitation activities unless they can establish an alternative livelihood after the program. Considering the present number of staff in the local offices, it would be difficult for NRGO to control the inflow of new migrants into all the sub-watersheds without employing more technical staff and increasing the annual operation budgets.

2) Lack of participation of local people in forest and rangeland management

Present management style of NRGO is still "government-centered" or "regulatory-based", and therefore, the incentive of local people to manage resources as well as a sense of responsibility for resources have not been created in local people's mind. Presently, local people (forest dwellers/graziers) are considered as the main cause of forest and rangeland degradation and, what is worse, incapable of managing their natural resources. The more local people/forest dwellers are involved in resource management, the more they are responsible for their resources. In fact, many community forest projects in other countries have proved that local people are capable enough of managing their own resources provided their recource use rights are secured and continuous technical support is provided by the Therefore, a "participatory management" approach should be government. introduced, in which local people will be allowed to manage natural resources in a sustainable manner so as to develop their sense of responsibility to become real managers.

3) Lack of consideration of socio-economic aspects in forest management

This is closely related to the aforementioned items (a. and b.). Socio-economic data of graziers/forest dwellers are not properly considered in forest and rangeland management. For example, NRGO Guilan collected socio-economic data on local people in planning, but the data are basically used for estimation of the number of affected families and required cost of resettlement. Livelihood improvement of the local people is the key to sustainable management and protection of natural resources in the upper watershed. However, there is no substantial scheme for that purpose at present.

4) Lack of Coordination in Forest Management

There is little coordination between NRGO, DOE and WMD regarding forest and rangeland management and also conservation. For example, both NRGO and DOE designate protected forests, but the areas are overlapping and they are not consistent with one another.

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(2) Prospective Situation of Forests and Rangelands

NRGO Guilan aims to restore the vegetation of forests and rangelands to the level of 1963. However, there is no clear management plan formulated for the entire watershed except for the four (4) sub-watersheds that are being managed under the forestry plans. The forestry plans seem appropriate from a technical point of view in general, but the plans also lack attention to socio-economic aspects of graziers/forest dwellers. Likewise, NRGO Guilan does not have a clear plan for rangeland management in the watershed. Under the circumstances, the long term effect of present management is uncertain as illustrated below.

Figure 3.5.2 Prospective Situation of Forests and Rangelands

3.5.3 Livestock Resettlement Program

(1) Issues/Limitations

1) Lack of precise information about the families and livestock in the area

The resettlement plan was prepared based on the data gathered in 1984. There is no precise data/information about the number of families/livestock staying in the forest at present. In fact, there is no clear data showing the interrelation between them, although many reports and staffs point out that overgrazing is the main cause of forest and rangeland degradation.

In addition, NRGO has no information on how many of them are pros and how many are cons for the program. Naturally, it would be very difficult for them to formulate an "adequate" plan, which sufficiently takes account of the social condition of target people and puts necessary measures in the plan in order to avoid any social conflicts.

An option not to relocate them but have them conserve natural resources by forest dwellers should be considered in case many of them object to the program.

2) Lack of consideration of unregistered families/graziers

According to the NRGO guideline, the government will provide monetary or land (or both) compensation to families/graziers who are recognized as registered families/graziers. In other word, families/graziers who are not recognized as the registered will not be able to have compensation for their houses and livestock since NRGO regards them as illegal graziers/forest dwellers. In case the project forces many unregistered families to move from the forest without compensation, it would create another social problem in urban areas.

3) Insufficient consultation in the resettlement process

NRGO is basically responsible for implementing the resettlement program but not assisting affected families in livelihood recovery after the program. Adequate consultations and discussions, especially on livelihood recovery, should be conducted in the course of the program since many of them have less knowledge of livelihood options that they can engage in outside the forest. However, this kind of support is very limited at present and the implementation guideline for the program pays less attention to that matter as pointed out in section 3.3.2.

Therefore, NRGO together with the relevant organizations should have a series of discussions with affected families to make them understand the resettlement plan, what they will have to do after the program to maintain their lives, what kind of livelihood options they can engage in, and what kind of services they can tap for livelihood development.

4) Lack of coordination among related organizations

Integrated support is indispensable for livelihood recovery of resettlers. At present, several organizations (NRGO, MOJA, Housing and Urban Development Organization, Rural Water and Wastewater Company, Agricultural bank, etc.) are involved in the resettlement program. However, the coordination between/among the organizations is not adequate and poor coordination often causes the ineffective assistance. For instance, infrastructure support, such as water supply, electrical supply, etc., is supposedly provided to resettled families when they receive lands and houses as part of the compensation. However, the provision of infrastructure support was sometimes not on schedule, and it created graziers' dissatisfaction with the program and eventually they lost confidence in NRGO.

5) Inactive/insufficient support after resettlement

The stance of NRGO on livelihood assistance seems to be "inactive" or "insufficient", since it has no responsibility for livelihood support after relocation. What the NRGO staff has often stated is "the government can provide several types of assistance to resettled families when they ask the government for its support". Since many graziers/local people have no idea of what kind of governmental support they can access, NRGO in collaboration with the other relevant organizations should be positively involved in the process of livelihood recovery.

5) Lack of monitoring

There is no monitoring activity undertaken on resettled families after relocation. NRGO should periodically monitor the situation of resettled families together with relevant organizations and provide assistance if necessary. Periodical monitoring will also give useful lessons learned for making the program more effective.

(2) Prospective Situation of the Livestock Resettlement Program

NRGO plans to relocate livestock and graziers who live in the forest for the next 6 years. If the livestock resettlement program is pursued in accordance with its implementation schedule, thousands of graziers will have to abandon their livestock by 2010. This will surely benefit the forest and rangeland in the short run. However, driving all the graziers and livestock out from the forest and protecting the forest from any traditional uses may not necessarily be effective in the long run or not always be sustainable. It is also speculated that it could create negative issues if the project is pushed through with the limitations as enumerated above. Possible situation after the program are illustrated as follows:

Figure 3.5.3 Prospective Situation of the Resettlement Program

CHAPTER 4 PROPOSED WATERSHED MANAGEMENT PLAN

4.1 General

As described in Chapter 3, much effort has already been put into watershed management by the various governmental organizations, such as MOJA, NRGO, DOE, etc., to protect and conserve watershed environment. However, there are several management issues/limitations enumerated in section 3.5, and therefore there is possibility that the wetland as well as watershed environment would be degraded if the situation is left as it is.

Figure 4.1.1 Situation of Watershed and Management Issues

The proposed watershed management plan aims to improve the above-mentioned situation and furthermore enhance the functions of the watershed for wetland environment improving the socio-economic conditions of local people (stakeholders) in the watershed.

4.1.1 Objectives

The principle objective of the watershed management plan is to improve the wetland environment through:

- reduction of sediment inflow from the watershed into the wetland; and
- restoration and protection of the fabric of the watershed to enhance the biodiversity of the area.

To this end, the watershed management plan aims to:

- 1) Minimize further progresses of soil erosion and landslides;
- Restore/rehabilitate degraded lands securing a balance between restoration of resources and socio-economic development of local people (graziers/forest dwellers);
- Attain the sustainable management of forests and rangelands in the upper watershed through developing mechanisms/schemes of: i) securing alternative livelihoods for local people and ii) involving them in managing forests and rangelands; and
- 4) Enhance capabilities of the executing organizations related to watershed management.

4.1.2 Strategies

A common theme underlying all the components is "sustainable watershed management". Therefore, the proposed watershed plan becomes a holistic program not only for solving the physical problems (soil erosion, landslides, land degradation, etc.) but also for improving social problems (livelihood, conflict with graziers, etc.) in the watershed. The basic concepts employed in planning the watershed management plan are outlined below.

(1) Control of Further Progression of Soil Erosion and Landslides

Control of erosion is crucial both to minimize the inflow of sediment into the wetland and to protect the watershed itself from further degradation. Hence, the emphasis is on taking necessary measures to prevent soil erosion and landslides as soon as possible. In particular, areas that have already been degraded to a level beyond natural recovery should be urgently stabilized by applying physical control measures (e.g., erosion control and landslide control works) in addition to vegetative control measures (e.g., tree planting, seeding and fencing).

(2) Promotion of Participatory Resource Management

In order to restore the watershed to its near natural condition, over-exploitation of rangelands and forests has to be controlled. So far, regulatory measures, such as licensing and resettlement of graziers, have been taken to control over-exploitation. However, regulating measure alone would not be able to resolve such problem since it is deeply rooted in complex social issues, especially livelihood of graziers in the upper watershed. Since graziers heavily rely on natural resources (forests and rangelands) for their lives, it is important to balance natural resource protection with livelihood stabilization to solve such problem. Therefore, a participatory resource management concept, which allows local people (stakeholders) to use resources in a sustainable manner but has them protect resources by themselves, should be introduced in the management of the upper watershed. In fact, many developing countries have shifted their attitude/policies on resource management from "government-centered or regulatory-based" to "participatory management", because many of the regulatory-based initiatives had ended in failure in the past. Box 4.1.1 describes how the management style has changed in other developing countries.

Box 4.1.1 Paradigm Sifting in Resource Management in Other Developing Countries

1. Problems/issues in Government-centered forest management

In many countries, forests had been managed by the government agencies (forest departments) and forest dwellers had been regarded as illegal exploiters who cause forest degradation. In short, the government offices functioned as the police to control people's activities in the forest and local people had very limited traditional rights to manage and utilize the forest. The government prohibited forest dwellers from doing economic activities and/or forced them to move out from the forest. Nevertheless, the pace of forest degradation could not be reduced because many of them had returned to the forest to open their farmlands.

2. Introduction of "Social Forestry"

Many developing countries and international organizations realized forest management without consideration of socio-economic aspects of forest dwellers was not sustainable any longer and, if anything, would further worsen the environment of mountains and accelerate poverty. They introduced a concept of "social forestry" in forest management in the 1970s. The concept of social forestry is to incorporate local people/forest dwellers in forest management putting their preferences and ideas in the management plan. However, many social forestry projects ended in disappointing results since they treated local people/forest dwellers as merely information sources rather than giving responsibilities of land management. Based on lessons learned from many social forestry projects, the concept of participatory forest management/community forestry has emerged.

3. Emergence of "Participatory Forest Management"/"Community Forestry"

Based on the failures of social forestry projects, they have understood that it would be very difficult to secure the project sustainability without giving forest dwellers the responsibility for managing their traditional forests. The concepts of participatory forest management, therefore, are to devolve land and resource use rights on forest dwellers and involve them in planning to make them realize that the plan is their own plan. Many projects have proved that forest dwellers/local people could properly manage forest and natural resources in their assigned area with the technical guidance of the forestry departments. Joint Forest Management (JFM) in India, Community-based forest management in Philippines, Community forestry in Nepal are well known successful cases.

Ideally, the responsibility of managing natural resources should be devolved to local people so as to make them real managers. In fact, once they realize that resources in their assigned area are part of their properties, they would be good managers of the area. As described above, it is the key to making participatory resource management initiatives more sustainable.

(3) Livelihood Development for graziers

Limited livelihood opportunity in the upper watershed is one of the basic causes of overgrazing as well as deforestation. Improvement of livelihood situation of graziers and forest dwellers is essential for sustainable resource management. It is also true in the livestock resettlement program that the livelihood support to affected families needs to be strengthened since it is insufficient at present and the long-term effect of the resettlement program is questioned for that reason. Therefore, there is a need for a scheme to assist local residents in the forest in securing their livelihoods so as to reduce their dependence on natural resources.

(4) Improvement of the Livelihood Resettlement Program

As determined in section 3.5, there are several limitations in the livestock resettlement program and it is speculated that the project would cause the deterioration of the wetland and social insecurity in urban areas. In particular, its consultation process and continuous livelihood support to affected families should be improved to minimize the adverse effect induced by the resettlement program.

1) Introduction of proper consultation process

A series of consultations is necessary in the resettlement program to avoid a social conflict after relocation. A full process of consultations should be taken from the beginning of the program so that affected families could realize their situation after resettlement. During the consultation process, the following should be discussed with affected families.

- What is the project?
- Why will they have to be relocated?
- What will happen to them after relocation?
- What will they have to do to sustain their lives?
- What kind of livelihood options can they engage in?
- What kind of support will they can use for livelihood development?

Simultaneously, several types of support should be undertaken so that affected families can operate new livelihood activities soon after relocation. The following capacity enhancement activities are considered important.

- Job/skill training
- Income generating activity
- Financial management
- Health and sanitation
- 2) Continuous support after relocation

NRGO Guilan has undertaken no monitoring activity on the resettlement program so far. At present, there is little information on whether affected graziers are satisfied with the present situation or are faced with economic difficulties. It is expected that it will take some time for affected families to settle down to their new life. Hence, NRGO should monitor the conditions of graziers periodically after relocation and provide necessary support to graziers when necessary. (5) Establishment of an Effective Institutional Set-up

The institutional strengthening is essential to smooth operation of proposed activities of the watershed management plan. The following should be considered in the watershed management plan.

1) Development of inter-organizational coordination

While various organizations are striving to do existing duties to manage the watershed, many watershed management issues involve more than one organization, and without co-operative efforts, it is difficult to implement effective management of the watershed. Among the examples of such issues are regional environmental protection, erosion control, land use management and resettlement program. The consider effective intermaster plan will thus mechanisms for and intra-organizational co-ordination.

2) Development of necessary regulations/guidelines

The concept of participatory resource management is still new to the country and only few pilot projects have been carried out so far. Legislative support is indispensable for applying the new concept extensively under such circumstances. In particular, regulations related to the resource management and guidelines for project implementation need preparing since the concept of participatory resource management requires changing the attitude of the government offices and devolving their authorities over resources on local people.

(6) Capacity Development of Provincial and Local Offices

Capacity development of local offices is essential for achieving the sustainable use of the watershed. In particular, the capabilities of proper designing of erosion control works and preventive measures for landslides, participatory resource management, livelihood support, and sustainable management of watershed based on monitoring and evaluation activity are still weak in the government offices concerned. Therefore, capacity development of provincial and local offices should be emphasized in the watershed management plan.

4.1.3 Precondition/External Condition

The following factors were considered as preconditions and/or external conditions in the preparation of the watershed management plan.

a. The livestock resettlement program is regarded as an existing program since the program is on-going and was already programmed into the 4th 5-year plan (2005-2009). Therefore, the program is not incorporated into the proposed

activities of the master plan.

b. The forest and rangeland management activities to be proposed in the watershed management plan need to be adjusted to the schedule of the resettlement program. Those activities would be ineffective or moreover might create additional conflicts with graziers if they were implemented prior to the resettlement program.

4.1.4 Components of the Watershed Management Plan

Since MOJA (WMD) and NRGO have different responsibilities for watershed management, namely, the soil erosion control under MOJA and natural resource management under NRGO, the proposed activities of the watershed management plan are also packaged based on the duties of the respective organizations. Consequently, the watershed management plan is composed of the following components:

Component	Responsible Organizations
a. Soil Erosion Control and Prevention of Landslides	MOJA, (NRGO)
b. Forest and Rangeland Management	NRGO
c. Plain Area Management	MOJA
d. Livelihood Development	NRGO
e. Institutional Arrangement	MOJA, NRGO
f. Monitoring Plan	MOJA, NRGO,
	Agriculture and Natural Research Center (MOJA)

 Table 4.1.1
 Components of the Proposed Plan and Their Responsible Organizations

4.2 Soil Erosion Control

4.2.1 Erosion Control

Although MOJA Guilan has made effort to control soil erosion to minimize sediment load from the upper watershed, there are still many areas left untreated due to budgetary constraints. Among others, areas that have been degraded to a level beyond control should be stabilized as soon as possible. Therefore, the proposed watershed management plan emphasizes preventing further land degradation in the degraded rangelands of about 77 km².

(1) Selection of Erosion Control Measures

There are various techniques to control soil erosion. The most appropriate measures/techniques are to be selected based on the site conditions, such as the stage of erosion, geology, rainfall, etc., as illustrated in Figure 4.2.1.

Figure 4.2.1 Erosion Stages and Appropriate Countermeasures

(2) Standard Designs of Erosion Control Works

The design of erosion control works requires a detailed field investigation. However, the watershed of the Anzali wetland is very extensive and there is no detailed erosion control plan formulated by the Watershed Management Department of MOJA. In order to select the erosion control measures applicable to the study area, a pilot activity was carried out. The upstream of Masuleh Town was selected as a model area (175 ha) for the following reasons: (i) erosion conditions are typical of the study area, (ii) the area has good access for field studies, (iii) the knowledge of local experts about the site is sufficient to have detailed discussions, and (iv) it has high priority for erosion control measures. A view of the model area is shown in Figure 4.2.2.

Figure 4.2.2 View of the Model Area (Upper Reach of Masuleh)

Based on a site investigation, the following standard measures were designed and applied in the model site.

- Seeding and fertilizing: for recovery of degraded vegetation cover
- Contour bund: for surface erosion and rill erosion control, interval 20 meters.
- Wooden dam: for rill erosion control, interval 20 meters.
- Gabion check dam: for gully erosion control, h=4 m, interval 20 to 25 meters (gradient of river bed)
- Concrete check dam: for sediment check and debris flow, h=10 m elevation interval 100 meters.

The model plan is shown in Figure 4.2.3, and the proposed numbers of countermeasures per unit area are shown in Table 4.2.1.

Figure 4.2.3 Proposed Erosion Control Works in the Upper Masulehroudkhan Sub-watershed

Туре	Item	Unit	Numbers	Numbers/Unit Area
Structural	Concrete Check Dam (h=10 m)	nos.	3	1.7/100 ha
Measures	100 m elevation Interval)			
	Gabion Check Dam (h=4 m 20	nos.	65	37/100 ha
	~30m Elevation Interval)			
	Wooden Dam	nos.	21	12/100 ha
	Contour Bund (20m Elevation	m	4,400	2,500/100 ha
	Interval)			
Biological	Seeding	ha	175	All areas
Measures	Fertilizing	ha	175	All areas

 Table 4.2.1
 Details of Proposed Countermeasures per Unit Area

Source: JICA Study Team

The Supporting Report Part 10 "Capacity Development" gives more detailed information on the pilot activity undertaken in the model site.

(3) Erosion Control Plan in the Upper Watershed

Similar soil erosion control works could be applied to all the degraded areas (77 km²) in the upper watershed. Based on the pilot activity, the total quantities of erosion control measures

that would be required for the entire upper watershed are estimated as shown in Table 4.2.2

Structural Measures Concrete Check Dam Gabion Check Dam 1.7 3.24 6 nos. Chafroud Gabion Check Dam 37 3.24 120 nos. Contour Bund 2.5 3.24 39 nos. Contour Bund 2.5 3.24 8 km Biological Measures Straw matting 0.1 3.24 3.24 km ² Straw matting 0.1 3.24 3.24 km ² 3.24 km ² Bahambar Straw matting 0.1 0.0 0 nos. Gabion Check Dam 1.7 0.0 0 nos. Controte Unam 2.5 0.0 0 km Biological Measures Straw matting 0.1 0.0 0 km ² Straw matting 0.1 0.0 0 km ² Khalkai Straw matting 0.1 20.17 244 nos. Controte Check Dam 37 20.17 244 nos. Khalkai Biological Measures Straw matting 0.1 20.17 20.17 km ² Morghak Biological Measures Straw matting 0.1 20.17	Name of watershed	Counter- measures	Measures	Unit nos.(/km ²)	Area (km ²)	Total numbers
Stractural Measures Gabion Check Dam Wooden Dam 37 3.24 120 nos. Chafroud Seading 12 3.24 3.9 nos. Contour Bund 2.5 3.24 8 km Biological Measures Straw matting 0.1 3.24 0.32 km ² Seeding All areas 3.24 3.24 km ² Seeding All areas 3.24 3.24 km ² Gabion Check Dam 1.7 0.0 0 nos. Gabion Check Dam 3.7 0.0 0 nos. Wooden Dam 1.2 0.0 0 nos. Wooden Dam 1.2 0.0 0 km ² Straw matting 0.1 0.0 0 km ² Measures Straw matting 0.1 20.17 746 nos. Wooden Dam 1.2 20.17 20 km 20 km Straw matting 0.1 20.17 20 km 20 km Measures Straw matting 0.1 20.17 20 km Measures Concrete Check Dam			Concrete Check Dam	1.7	3.24	6 nos.
Measures Wooden Dam 12 3.24 39 nos. Contour Bund 2.5 3.24 8 km Biological Measures Seeding All areas 3.24 0.32 km ² Bahambar Structural Measures Serverte Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Structural Measures Structural Measures 0.1 0.2 0.0 0 km ² Khal kai Biological Measures Structural Measures Structural Measures Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 20.17 746 nos. Morghak Biological Measures Structural Measures Structural Measures Structural Seeding All areas 20.17 20.2 km ² Morghak Structural Measures Structural Measures Structural Measures Structural Measures Structural Measures Structural Seeding All areas 20.17 20.2 km ² Morghak Biological Measures Structural Measures Structural Measures Structural Mea		Structural	Gabion Check Dam	37	3.24	120 nos.
Chaffoud Contour Bund 2.5 3.24 8 km Biological Measures Straw matting 0.1 3.24 0.32 km ² Bahambar Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Bahambar Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Contour Bund 2.5 0.0 0 km ² Structural Measures Structural Measures All areas 0.0 0 km ² Structural Measures Structural Measures Structural Measures Nooden Dam 1.7 20.17 34 nos. Structural Measures Structural Measures Structural Measures Nooden Dam 1.2 20.17 20.17 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 15.66 158 nos. Morghak Structural Measures Structural Measures Concrete Check Dam 37 0.0 0 nos. Morghak Biological Measures Structural Measures		Measures	Wooden Dam	12	3.24	39 nos.
Biological Measures Straw matting Seeding 0.1 3.24 0.32 km ² 3.24 km ² Bahambar Structural Measures Concrete Check Dam Gabion Check Dam 1.7 0.0 0 nos. Bahambar Concrete Check Dam Measures 1.7 0.0 0 nos. Biological Measures Contour Bund Contour Bund 2.5 0.0 0 km ² Structural Measures Structural Measures Straw matting Concrete Check Dam 0.1 0.0 0 km ² Structural Measures Structural Measures Concrete Check Dam Fertilizing 0.1 0.0 0 km ² Structural Measures Structural Measures Concrete Check Dam Structural Measures 1.7 20.17 242 nos. Morghak Structural Measures Structural Measures Concrete Check Dam 37 12 20.17 20.17 km ² Morghak Structural Measures Structural Measures All areas 20.17 20.17 km ² Morghak Structural Measures Structural Measures Concrete Check Dam 37 15.66 15.66 km ² Planoyar Structural Measures Concr	Chafroud		Contour Bund	2.5	3.24	8 km
Biological Measures Seeding Fertilizing All areas 3.24 3.24 km² Bahambar Structural Measures Structural Gabion Check Dam 1.7 0.0 0 nos. Bahambar Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Structural Measures 0.1 0.0 0 km² Structural Measures Structural Measures Concrete Check Dam 1.7 20.17 34 nos. Structural Measures Contour Bund 2.5 20.17 242 nos. Contour Bund 2.5 20.17 20.17m² 20.17m² Biological Measures Structural Measures Structural Pertilizing All areas 20.17 20.17m² Morghak Structural Measures Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 1.566 1.57 km² Plangvar Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Morghak <		D' 1 ' 1	Straw matting	0.1	3.24	0.32 km^2
Measures Fertilizing All areas 3.24 3.24 km² Bahambar Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Bahambar Structural Measures Concrete Check Dam 3.7 0.0 0 nos. Biological Measures Structural Measures Seeding All areas 0.0 0 km² Structural Measures Structural Measures Gabion Check Dam 1.7 20.17 34 nos. Gabion Check Dam 1.7 20.17 34 nos. Concrete Check Dam 1.2 20.17 242 nos. Contour Bund 2.5 20.17 20.17 242 nos. Contour Bund 2.5 20.17 20.17 km² Morghak Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Structural Measures Structural Measures Concrete Check Dam 1.7 15.66 15.66 km² Partilizing All areas 20.17 20.17 km² 20.17 km² Gabion Check Dam 1.7 15.66 15.66 km² 27 nos.		Biological	Seeding	All areas	3.24	3.24 km^2
Bahambar Structural Measures Concrete Check Dam Gabion Check Dam Wooden Dam 1.7 0.0 0 nos. Biological Measures Biological Measures Structural Measures Structural Measures 0.1 0.0 0 km² Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam Gabion Check Dam 1.7 20.17 34 nos. Structural Measures Concrete Check Dam Gabion Check Dam 1.2 20.17 242 nos. Khalkai Concrete Check Dam Measures 0.1 20.17 242 nos. Structural Measures Structural Measures Structural Measures Concrete Check Dam All areas 20.17 20.17 km² Structural Measures Structural Measures Concrete Check Dam All areas 1.5 66 15 s66 17 nos. Biological Measures Structural Measures Concrete Check Dam All areas 1.5 66 1.5 66 km² 15 s66 Biological Measures Structural Measures Concrete Check Dam All areas 1.5 66 1.5 66 km² Biological Measures Structural Measures Concrete Check Dam All areas		Measures	Fertilizing	All areas	3.24	3.24 km^2
Bahambar Structural Measures Gabion Check Dam 37 0.0 0 nos. Bahambar Contour Bund 2.5 0.0 0 km Biological Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 20.17 34 nos. Concrete Check Dam 1.7 20.17 746 nos. 360 of the check Dam 37 20.17 746 nos. Modeln Dam 1.2 20.17 746 nos. 360 of the check Dam 37 20.17 746 nos. Modeln Dam 1.2 20.17 20.17 1746 nos. 360 of the check Dam 37 20.17 20.17 17		<u> </u>	Concrete Check Dam	1.7	0.0	0 nos.
Measures Wooden Dam 12 0.0 0 nos. Bahambar Contour Bund 2.5 0.0 0 km² Biological Measures Straw matting 0.1 0.0 0 km² Structural Measures Structural Measures Structural Gabion Check Dam 1.7 20.17 344 nos. Khalkai Concrete Check Dam 1.7 20.17 746 nos. Wooden Dam 12 20.17 242 nos. Contour Bund 2.5 20.17 20.21 m² Biological Measures Straw matting 0.1 20.17 20.21 km² Structural Measures Structural Gabion Check Dam 1.7 15.66 27 nos. Morghak Concrete Check Dam 1.7 15.66 157 nos. Morghak Structural Measures Structural Gabion Check Dam 37 15.66 15.66 km² Biological Measures Structural Gabion Check Dam 1.7 0.0 0 nos. Structural Measures Structural Gabion Check Dam 37 0.0 0 km²		Structural	Gabion Check Dam	37	0.0	0 nos.
Bahambar Contour Bund 2.5 0.0 0 km Biological Measures Straw matting 0.1 0.0 0 km ² Seeding All areas 0.0 0 km ² Fertilizing All areas 0.0 0 km ² Kasures Concrete Check Dam 1.7 20.17 34 nos. Measures Gabion Check Dam 37 20.17 746 nos. Wooden Dam 12 20.17 242 nos. Concrete Check Dam 1.7 2.02 km ² Straw matting 0.1 20.17 2.02 km ² Straw Straw 20.17 2.02 km ² Moseneree Straw matting 0.1 20.17 20.17 km ² 20.17 km ² Straw matting 0.1 20.17 20.17 km ² 20.17 km ² Morghak Structural Measures Concrete Check Dam 1.7 15.66 15.8 km Morghak Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 1.7 0.0 <td< td=""><td></td><td>Measures</td><td>Wooden Dam</td><td>12</td><td>0.0</td><td>0 nos.</td></td<>		Measures	Wooden Dam	12	0.0	0 nos.
	Bahambar		Contour Bund	2.5	0.0	0 km
Biological Measures Seeding Fertilizing All areas 0.0 0 km^2 Khalkai Structural Measures Structural Measures Concrete Check Dam 1.7 20.17 34 nos. Khalkai Concrete Check Dam 37 20.17 242 nos. Biological Measures Structural Measures Straw matting 0.1 20.17 20.17 km² Structural Measures Struw matting 0.1 20.17 20.17 km² Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 15.66 79 nos. Morghak Structural Measures Concrete Check Dam 1.7 15.66 15.66 km² Fertilizing All areas 11.7 5.66 15.66 km² Fertilizing All areas 15.66 15.66 km² Fertilizing All areas 15.66 15.66 km² Fertilizing All areas 15.66 15.66 km² Fertilizing All areas 0.0 0 nos. Gabion Check Dam 1.7 0.0 <td></td> <td></td> <td>Straw matting</td> <td>0.1</td> <td>0.0</td> <td>0 km^2</td>			Straw matting	0.1	0.0	0 km^2
Measures Fertilizing All areas 0.0 0 km² Khalkai Structural Measures Concrete Check Dam 1.7 20.17 34 nos. Khalkai Gabion Check Dam 37 20.17 746 nos. Biological Measures Structural Measures Straw matting 0.1 20.17 20.20 km² Structural Measures Structural Measures Straw matting 0.1 20.17 20.17 km² Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Gabion Check Dam 37 15.66 27 nos. Gabion Check Dam 37 15.66 188 nos. Morghak Biological Measures Structural Measures Straw matting 0.1 15.66 1.57 km² Biological Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Plangvar Structural Measures Straw matting 0.1 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. 0 0<		Biological	Seeding	All areas	0.0	0 km^2
Khalkai Structural Measures Concrete Check Dam Gabion Check Dam 1.7 20.17 34 nos. Khalkai Gabion Check Dam Measures 37 20.17 746 nos. Biological Measures Structural Measures Structural Measures 37 20.17 242 nos. Structural Measures Structural Measures Structural Measures Structural Measures All areas 20.17 20.17 km ² Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Structural Measures Structural Measures Concrete Check Dam 37 15.66 188 nos. Biological Measures Structural Measures Straw matting 0.1 15.66 15.66 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Wooden Dam 12 0.0 0 nos. Structural Measures Struc		Measures	Fertilizing	All areas	0.0	0 km^2
Structural Measures Gabion Check Dam Wooden Dam 37 20.17 746 nos. Khalkai Cabion Check Dam 12 20.17 242 nos. Biological Measures Straw matting 0.1 20.17 20.0 km² Structural Measures Straw matting 0.1 20.17 20.0 km² Structural Measures Seeding All areas 20.17 20.17 km² Morghak Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Biological Measures Structural Measures Concrete Check Dam 1.7 15.66 188 nos. Contour Bund 2.5 15.66 188 nos. 1.5.66 1.57 km² Structural Measures Straw matting 0.1 15.66 1.56 km² Vooden Dam 12 0.0 0 nos. 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. 0.0 0 km² Structural Measures Straw matting 0.1 0.0 0 km² Structural Measures Straw matting </td <td></td> <td></td> <td>Concrete Check Dam</td> <td>1.7</td> <td>20.17</td> <td>34 nos.</td>			Concrete Check Dam	1.7	20.17	34 nos.
Measures Wooden Dam 12 20.17 242 nos. Khalkai Contour Bund 2.5 20.17 50 km Biological Measures Straw matting 0.1 20.17 2.02 km ³ Fertilizing All areas 20.17 20.17 km ² Fertilizing All areas 20.17 20.17 km ² Morghak Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Gabion Check Dam 37 15.66 188 nos. Concrete Check Dam 2.5 15.66 189.15 km Morghak Biological Measures Straw matting 0.1 15.66 15.66 km ² Structural Measures Straw matting 0.1 15.66 15.66 km ² Vooden Dam 1.7 0.0 0 nos. Gabion Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Straw matting 0.1 0.0 0 km ² Structura		Structural	Gabion Check Dam	37	20.17	746 nos.
Khalkai Contour Bund 2.5 20.17 50 km Biological Measures Straw matting 0.1 20.17 2.02 km ² Seeding All areas 20.17 20.17 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Gabion Check Dam 37 15.66 579 nos. Wooden Dam 12 15.66 1.88 nos. Contour Bund 2.5 15.66 1.57 km ² Seeding All areas 15.66 1.57 km ² Biological Measures Struw matting 0.1 15.66 1.5.66 km ² Structural Measures Struw matting 0.1 15.66 15.66 km ² Plangvar Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 13.28 23 nos. Gabion Check Dam 37 13.28 <td></td> <td>Measures</td> <td>Wooden Dam</td> <td>12</td> <td>20.17</td> <td>242 nos</td>		Measures	Wooden Dam	12	20.17	242 nos
	Khalkai		Contour Bund	2.5	20.17	50 km
Biological Measures Seeding Fertilizing All areas 20.17 20.17 km ² Morghak Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Morghak Concrete Check Dam 1.7 15.66 27 nos. Biological Measures Contour Bund 2.5 15.66 188 nos. Structural Measures Structural Measures Straw matting 0.1 15.66 15.66 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. 0 nos. Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. Contour Bund 2.5 0.0 0 km ² Structural Measures Structural Measures Structural Gabion Check Dam 37 13.28 23 nos. Masulheroudkhan Structural Measures Structural Measures <td< td=""><td></td><td></td><td>Straw matting</td><td>0.1</td><td>20.17</td><td>2.02 km^2</td></td<>			Straw matting	0.1	20.17	2.02 km^2
Measures Measures Fertilizing All areas 20.17 20.17 km ² Morghak Structural Measures Concrete Check Dam 1.7 15.66 27 nos. Gabion Check Dam 37 15.66 579 nos. Wooden Dam 12 15.66 188 nos. Contour Bund 2.5 15.66 19.15 km Biological Measures Straw matting 0.1 15.66 15.76 km ² Seeding All areas 15.66 15.66 km ² 5.66 km ² Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. 6abion Check Dam 37 0.0 0 nos. Biological Measures Concrete Check Dam 37 0.0 0 nos. 6abion Check Dam 37 0.0 0 nos. Structural Measures Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 13.28 491 nos. Wooden Dam 12		Biological	Seeding	All areas	20.17	20.17 km^2
Morghak Structural Measures Concrete Check Dam Gabion Check Dam Wooden Dam 1.7 15.66 27 nos. Biological Measures Biological Measures Concrete Check Dam Wooden Dam 37 15.66 188 nos. Biological Measures Biological Measures Straw matting 0.1 15.66 1.57 km ² Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam Fertilizing 1.7 0.0 0 nos. Biological Measures Structural Measures Concrete Check Dam Wooden Dam 1.7 0.0 0 nos. Structural Measures Concrete Check Dam Wooden Dam 1.7 0.0 0 nos. Structural Measures Concrete Check Dam Struw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Concrete Check Dam Struw matting 1.7 13.28 23 nos. Gabion Check Dam Measures Concrete Check Dam Struw matting 0.1 13.28 13.28 km ² Structural Measures Struw matting 0.1 13.28 13.28 km ² Shakhraz		Measures	Fertilizing	All areas	20.17	20.17 km^2
Structural Measures Structural Measures Structural Gabion Check Dam 37 15.66 579 nos. Morghak Biological Measures Straw matting 0.1 15.66 188 nos. Biological Measures Straw matting 0.1 15.66 1.57 km ² Seeding All areas 15.66 15.66 km ² Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. Gabion Check Dam 0.0 0 nos. Structural Measures Structural Measures Straw matting 0.1 0.0 0 nos. Biological Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Structural Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Straw matting 0.1 13.28 13.28 km ² Straw matting 0.1 1.2 13.28 13.28 km ²			Concrete Check Dam	1 7	15.66	27 nos
Morghak Measures Mooden Dam 12 15.06 188 nos. Morghak Biological Measures Straw matting 0.1 15.66 188 nos. Biological Measures Straw matting 0.1 15.66 15.66 15.77 km ² Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Biological Measures Concrete Check Dam 37 0.0 0 nos. 0 nos. Biological Measures Concrete Check Dam 1.7 0.0 0 nos. 0 nos. Structural Measures Structural Measures Concrete Check Dam 37 0.0 0 km ² Structural Measures Structural Measures Structural Measures Structural Measures Concrete Check Dam 1.7 13.28 23 nos. Shakhraz Structural Measures Straw matting 0.1 13.28 13.28 km ² Shakhraz Structural Measures Straw matting 0.1 13.28 13.28 km ² Shakhraz Straw matting <td< td=""><td></td><td>Structural</td><td>Gabion Check Dam</td><td>37</td><td>15.66</td><td>579 nos</td></td<>		Structural	Gabion Check Dam	37	15.66	579 nos
Morghak Instant <		Measures	Wooden Dam	12	15.66	188 nos
	Morghak		Contour Bund	2 5	15.66	39.15 km
Biological Measures Biological Seeding Outwinner All areas 15.66 15.66 km ² Plangvar Structural Measures Structural Measures Concrete Check Dam 1.7 0.0 0 nos. Biological Measures Structural Measures Concrete Check Dam 37 0.0 0 nos. Biological Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Straw matting 0.1 0.0 0 km ² Structural Measures Structural Measures Straw matting 0.1 1.7 13.28 23 nos. Shakhraz Structural Measures Straw matting 0.1 13.28 1332km ² Shakhraz Structural Measures Straw matting 0.1 1.3.28 13.28 km ² Shakhraz Structural Measures Straw matting 0.1 1.3.28 13.28 km ² Shakhraz Structural Measures Gabion Check Dam </td <td>Morghan</td> <td></td> <td>Straw matting</td> <td>0.1</td> <td>15.66</td> <td>1.57 km^2</td>	Morghan		Straw matting	0.1	15.66	1.57 km^2
Measures Secting All areas 15.00 15.00 Image: Instance Fertilizing All areas 15.66 15.66 km ² Fertilizing All areas 15.66 15.66 km ² Measures Concrete Check Dam 1.7 0.0 0 nos. Gabion Check Dam 37 0.0 0 nos. Wooden Dam 12 0.0 0 nos. Concrete Check Dam 37 0.0 0 km Biological Measures Straw matting 0.1 0.0 0 km ² Seeding All areas 0.0 0 km ² Seeding All areas 0.0 0 km ² Structural Measures Structural Gabion Check Dam 1.7 13.28 23 nos. Gabion Check Dam 37 13.28 491 nos. 0.0 Wooden Dam 12 13.28 13.9 km ² Masulheroudkhan Straw matting 0.1 13.28 13.28 km ² Biological Measures Straw matting 0.1 13.28 13.28 km ²		Biological	Seeding	Δll areas	15.66	1.57 km^2
		Measures	Fertilizing	All areas	15.66	15.60 km^2
PlangvarStructural MeasuresConcrete Check Dam 1.7 0.0 0.05 Plangvar $Gabion Check Dam$ 37 0.0 0 nos.Biological Measures $Gabion Check Dam$ 12 0.0 0 nos.Biological Measures $Straw matting$ 0.1 0.0 0 km²Structural MeasuresStructural Measures $Straw matting$ 0.1 0.0 0 km²Structural MeasuresStructural MeasuresConcrete Check Dam 1.7 13.28 23 nos.Structural MeasuresConcrete Check Dam 37 13.28 491 nos.Structural MeasuresStraw matting 0.1 13.28 159 nos.ShakhrazStructural MeasuresStraw matting 0.1 13.28 13.28 km²ShakhrazStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos.Gabion Check Dam 1.7 1.96 3 nos.ShakhrazStructural MeasuresConcrete Check Dam 37 1.96 73 nos.ShakhrazStructural MeasuresGabion Check Dam 37 1.96 24 nos.Contour Bund 2.5 1.96 4.9 kmStructural MeasuresStructural Wooden Dam 0.1 1.06 $0.201 m²²$			Concrete Check Dam	1 7	0.0	0 nos
PlangvarMeasuresOnlot of flock Dam 37 0.00 0 hos.Plangvar 12 0.0 0 nos.Biological MeasuresStraw matting 0.1 0.0 0 km²Structural MeasuresStructural MeasuresStructural Gabion Check Dam 0.1 0.0 0 km²MasulheroudkhanStructural MeasuresConcrete Check Dam 1.7 13.28 23 nos.MasulheroudkhanStructural MeasuresConcrete Check Dam 37 13.28 491 nos.MasulheroudkhanStructural MeasuresStraw matting Structural Measures 0.1 13.28 132 masShakhrazStructural MeasuresStraw matting Fertilizing 0.1 13.28 13.28 km²ShakhrazStructural MeasuresConcrete Check Dam Structural Measures 1.7 1.96 3 nos.ShakhrazStructural MeasuresConcrete Check Dam Structural Measures 1.7 1.96 3 nos.ShakhrazStructural MeasuresConcrete Check Dam Structural Measures 1.7 1.96 73 nos.ShakhrazStructural MeasuresConcrete Check Dam Structural Measures 1.96 4.9 kmBiological MeasuresStructural Measures 0.1 1.96 4.9 km		Structural	Gabion Check Dam	37	0.0	0 nos
PlangvarHoden Dam12 0.6 0 hos. Biological MeasuresStraw matting 0.1 0.0 0 km^2 SeedingAll areas 0.0 0 km^2 FertilizingAll areas 0.0 0 km^2 Structural MeasuresConcrete Check Dam 1.7 13.28 23 nos. Gabion Check Dam 1.7 13.28 491 nos. Wooden Dam 12 13.28 491 nos. Biological MeasuresStraw matting 0.1 13.28 13.28 km^2 ShakhrazStructural MeasuresStraw matting 0.1 13.28 13.28 km^2 ShakhrazStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. Biological MeasuresStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. ShakhrazStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. Biological MeasuresStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. ShakhrazStructural MeasuresConcrete Check Dam 37 1.96 73 nos. Biological MeasuresStraw matting 0.1 1.96 4.9 km		Measures	Wooden Dam	12	0.0	0 nos
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Planovar		Contour Bund	25	0.0	0 1103. 0 km
Biological MeasuresBiological SeedingStraw matting 0.1 0.0 0.1 MasulheroudkhanStructural MeasuresStructural MeasuresConcrete Check Dam 1.7 13.28 23 nos. MasulheroudkhanStructural MeasuresConcrete Check Dam 37 13.28 491 nos. MasulheroudkhanStructural MeasuresStructural Structural MeasuresStraw matting 0.1 13.28 13.28 MasulheroudkhanStraw matting 0.1 13.28 13.28 13.28 13.28 Biological MeasuresStraw matting 0.1 13.28 13.28 13.28 13.28 ShakhrazStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. ShakhrazStructural MeasuresConcrete Check Dam 37 1.96 73 nos. ShakhrazStructural MeasuresStraw matting Gabion Check Dam 37 1.96 73 nos. ShakhrazStructural MeasuresStraw matting Gabion Check Dam 37 1.96 73 nos. ShakhrazStraw matting Resources 0.1 1.96 24 nos.	i lungvui		Straw matting	0.1	0.0	0 km^2
MeasuresSectingAll areas 0.0 0 km^2 FertilizingAll areas 0.0 0 km^2 Structural MeasuresConcrete Check Dam 1.7 13.28 23 nos. Gabion Check Dam 37 13.28 491 nos. Wooden Dam 12 13.28 491 nos. Biological MeasuresStraw matting 0.1 13.28 13.28 km^2 ShakhrazStructural MeasuresStraw matting 0.1 13.28 13.28 km^2 ShakhrazStructural MeasuresConcrete Check Dam 1.7 1.96 3 nos. Gabion Check Dam 1.7 1.96 3 nos. 3.28 km^2 ShakhrazStructural MeasuresConcrete Check Dam 3.7 1.96 73 nos. Gabion Check Dam 3.7 1.96 24 nos. $Contour Bund$ 2.5 1.96 4.9 km Biological MeasuresStraw matting 0.1 1.26 0.201 m^2		Biological	Seeding	Δll areas	0.0	0 km^2
MasulheroudkhanStructural MeasuresConcrete Check Dam1.713.2823 nos.MasulheroudkhanConcrete Check Dam3713.28491 nos.MasulheroudkhanContour Bund2.513.28159 nos.Biological MeasuresStraw matting0.113.281.33km²ShakhrazStructural MeasuresStraw mattingAll areas13.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.Gabion Check Dam1.71.963 nos.Gabion Check Dam371.9673 nos.ShakhrazStructural MeasuresConcrete Check Dam371.9673 nos.1.9624 nos.Biological MeasuresContour Bund2.51.964.9 km2.0 km²2.0 km²		Measures	Fertilizing	All areas	0.0	0 km^2
Structural MeasuresStructural Gabion Check Dam1.713.282.5105.MasulheroudkhanGabion Check Dam3713.28491 nos.Wooden Dam1213.28159 nos.Contour Bund2.513.2833.2 kmBiological MeasuresStraw matting0.113.281.33km²ShakhrazStructural MeasuresStructural MeasuresStructural Gabion Check Dam1.71.963 nos.ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.3 nos.ShakhrazStructural MeasuresConcrete Check Dam371.9673 nos.Biological MeasuresContour Bund2.51.964.9 kmBiological MeasuresStraw matting0.11.060.20km²			Concrete Check Dam	1 7	13.28	23 nos
MeasuresMeasuresGabin Check Dam3713.28491 Hos.MasulheroudkhanWooden Dam1213.28159 nos.Biological MeasuresStraw matting0.113.2833.2 kmShakhrazStructural MeasuresStructural MeasuresStructural Gabion Check Dam0.113.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.ShakhrazStructural MeasuresConcrete Check Dam371.9673 nos.Biological MeasuresContour Bund2.51.964.9 kmBiological MeasuresStraw matting Gabion Check Dam0.11.060.201m²		Structural	Gabion Check Dam	37	13.28	<u>401 nos</u>
Masulheroudkhan1213.28139 lbs.MasulheroudkhanContour Bund2.513.2833.2 kmBiological MeasuresStraw matting0.113.281.33km²ShakhrazStructural MeasuresStructural MeasuresAll areas13.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.Gabion Check Dam371.9673 nos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 kmBiological MeasuresStraw matting0.11.060.20km²		Measures	Wooden Dam	57 1 2	13.20	491 llos.
Biological MeasuresStraw matting0.113.2835.2 km²ShakhrazStructural MeasuresStructural MeasuresStructural Gabion Check DamAll areas13.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.ShakhrazStructural MeasuresConcrete Check Dam371.9673 nos.Biological MeasuresContour Bund2.51.964.9 kmBiological MeasuresStraw matting0.11.060.201m²	Masulheroudkhan		Contour Bund	2.5	13.28	33.2 km
Biological MeasuresStraw matting0.113.2813.98mShakhrazStructural MeasuresSeedingAll areas13.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.Gabion Check Dam371.9673 nos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 km	Wasumeroudkham	Biological Measures	Straw matting	0.1	13.28	1.33km^2
MeasuresSecurityAll areas13.2813.28 km²ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.Gabion Check Dam371.9673 nos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 km			Seeding	V.1 All areas	13.28	13.28 km^2
ShakhrazStructural MeasuresConcrete Check Dam1.71.963 nos.Gabion Check Dam371.9673 nos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 km			Fertilizing		13.20	13.20 km^2
Structural MeasuresStructural Gabion Check Dam1.71.205 Hos.Wooden Dam371.9673 nos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 km	Shakhraz		Concrete Check Dam	1 7	1 06	3 nos
MeasuresGastion Check Dam571.5073 hos.Wooden Dam121.9624 nos.Contour Bund2.51.964.9 kmBiologicalStraw matting0.11.060.20 km²	SHAKIILAZ	Structural	Gabion Check Dam	1./ 27	1.70	73 nos
Wooden Dam121.5024 flos.Contour Bund2.51.964.9 kmBiologicalStraw matting0.11.060.201 m²		Measures	Wooden Dom	12	1.90	7.5 HOS. 24 nos
$\begin{array}{c cccc} \hline $			Contour Dund	12	1.90	<u> </u>
		Biological		2.3	1.90	$\frac{4.7 \text{ Km}}{0.20 \text{ km}^2}$

Table 4.2.2	Total Numbers of Measures in the Whole Watershed	

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Name of watershed	Counter- measures	Measures	Unit nos.(/km ²)	Area (km ²)	Total numbers
	Measures	Seeding	All areas	1.96	1.96 km ²
		Fertilizing	All areas	1.96	1.96 km ²
	Ctures to real	Concrete Check Dam	1.7	22.35	38 nos.
	Structural	Gabion Check Dam	37	22.35	827 nos.
	Measures	Wooden Dam	12	22.35	268 nos.
Paskihan		Contour Bund	2.5	22.35	55.9 km
	Dialogical	Straw matting	0.1	22.35	2.24 km^2
	Maggirag	Seeding	All areas	22.35	22.35 km ²
	Measures	Fertilizing	All areas	22.35	22.35 km ²
	Structural Measures	Concrete Check Dam	1.7	0.0	0 nos.
		Gabion Check Dam	37	0.0	0 nos.
		Wooden Dam	12	0.0	0 nos.
Siahroud		Contour Bund	2.5	0.0	0 km
	Biological Measures	Straw matting	0.1	0.0	0 km^2
		Seeding	All areas	0.0	0 km^2
		Fertilizing	All areas	0.0	0 km^2
	Structurel	Concrete Check Dam	1.7	76.7	130 nos.
Total area	Measures	Gabion Check Dam	37	76.7	2838 nos.
		Wooden Dam	12	76.7	920 nos.
		Contour Bund	2.5	76.7	192 km
		Straw matting	0.1	76.7	7.67 km^2
	Biological	Seeding	All areas	76.7	76.7 km^2
	Measures	Fertilizing	All areas	76.7	76.7 km^2
		Fertilizing	All areas	76.7	76.7 km^2

Source: JICA Study Team

Figures 4.2.4 to 4.2.9 show the proposed sites of erosion control works in the watershed.

Although the total quantities of erosion control works for the entire watershed are clarified, it is necessary for WMD of MOJA to prepare a basic plan on soil erosion control and detailed execution studies for the respective degraded areas prior to the application of control measures.

(4) Unit Costs of the Works

Based on the results of the pilot activity, the unit costs of the works are estimated as follows:

Works	Unit	Unit Cost
WOIKS	Unit	(1000 Rials)
Concrete check dam	no	360,000
Gabion check dam	no	17,500
Wooden check dam	no	3,000
Contour band	ha	5,000
Straw Matting	ha	50,000
Seeding	ha	356
Fertilizing	ha	93

 Table 4.2.3
 Unit Costs of Erosion Control Works

Source: JICA Study Team

