FIGURE 3.1-1 LOCATION MAP OF HYDROLOGICAL AND METEOROLOGICAL STATION

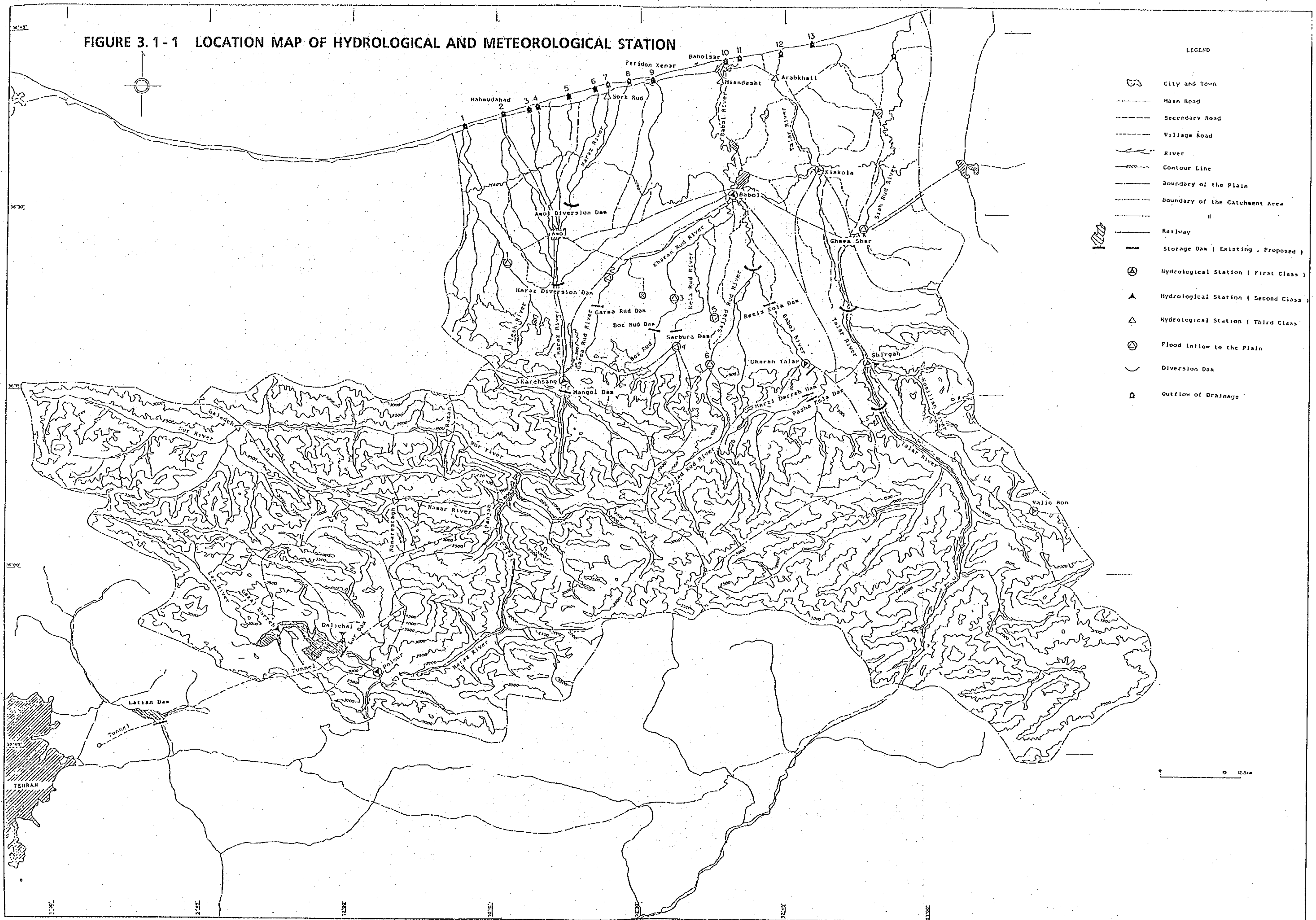
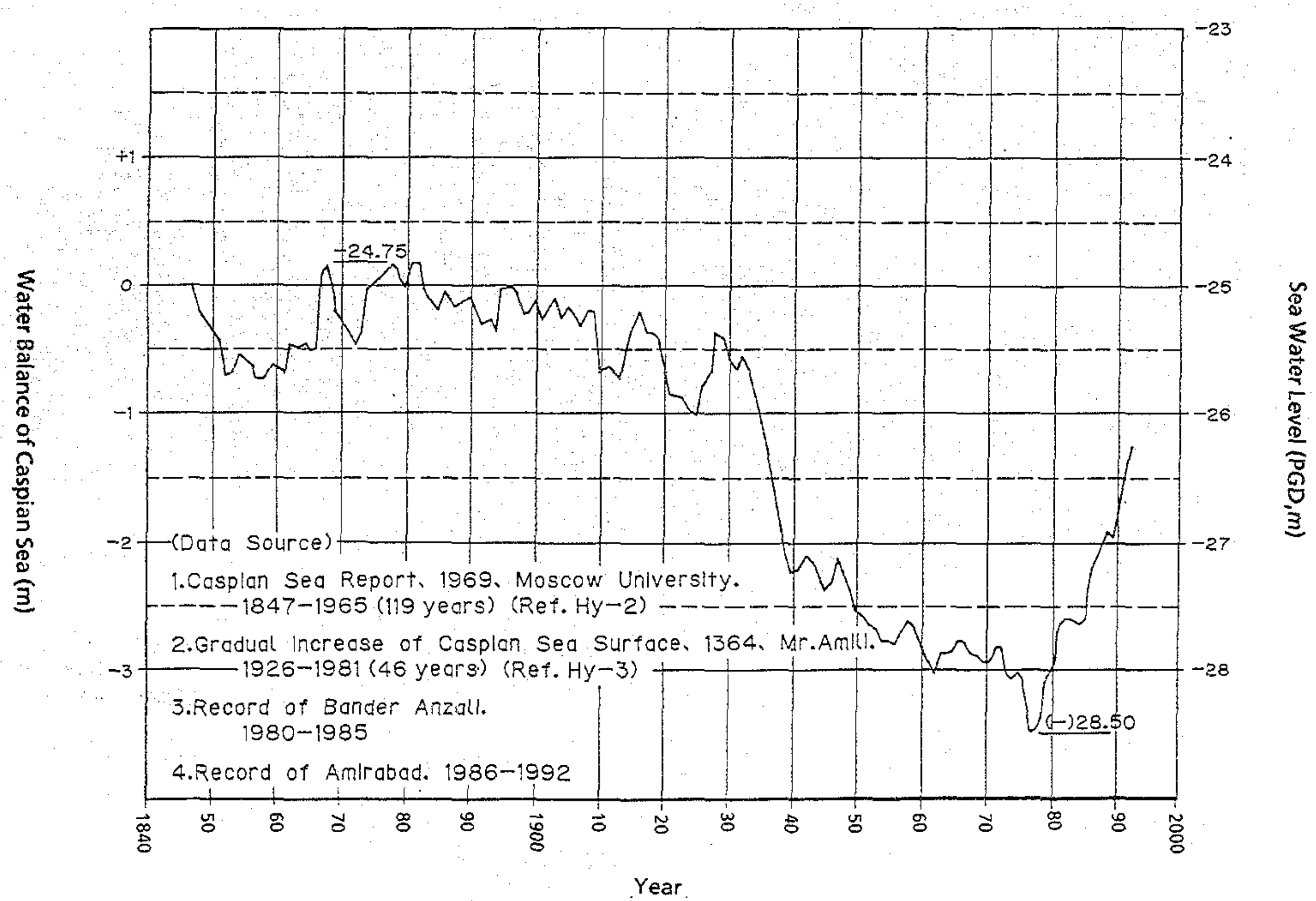


FIGURE 3. 1-2 LONG PERIOD FLACTUATION OF CASPIAN SEA



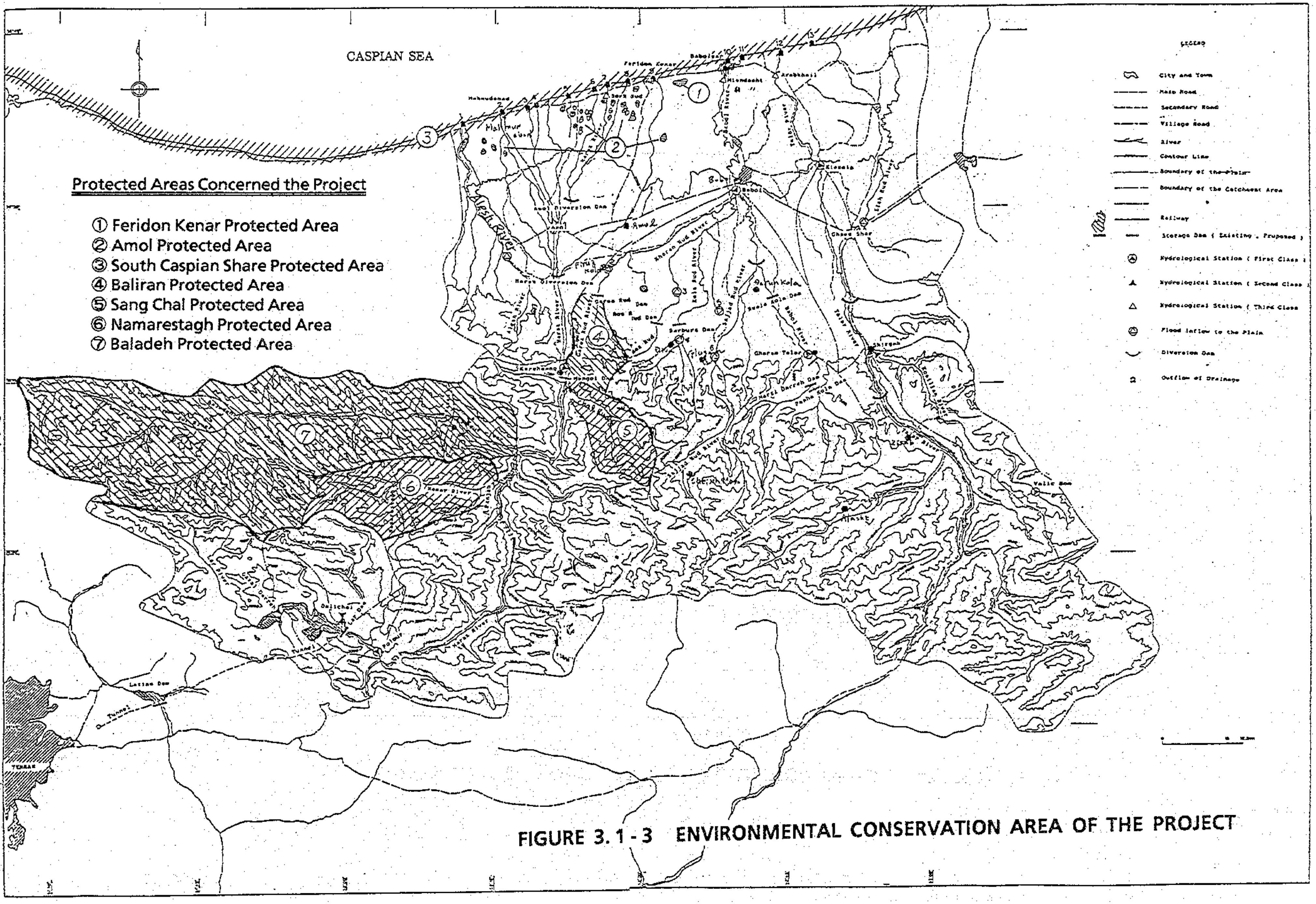


FIGURE 3.1-3 ENVIRONMENTAL CONSERVATION AREA OF THE PROJECT

3.2 Socio-economic Aspect

3.2.1 Administrative Division

The Project Area consists of 3 Shahrestans of Amol, Babol and Babolsar in Mazandaran Province in accordance with the recent revision of administrative boundary.

The latest administrative division in the Project Area is as shown below:

Shahrestan	Shahr	Bakhsh Dehstan	No. of Villages in Project Area
1. Amol	- Amol	(1) Markazi	
	- Mahmud Abad	Chalav	3
		Bala Khiaban Latikuh	18
		Poin Khiaban Latikuh	39
		Dasht Sar	54
		Dabu Junubi	90
		Harazpei Junubi	46
		Sub-total	250
		(2) Haraz	
		Ahlamrostagh	35
		Harazpei Shomali	33
		Dabu Shomali	23
		Sub-total	91
2. Babolsar	- Babolsar (partly)	(1) Markazi	
		Rud Bast	19
	- Feridon Kenar	Sub-total	
		(2) Feridon Kenar	
		Emamzadeh Abudallah	18
		Barik Rud	16
		Sub-total	34
3. Babol		(1) Markazi	
	- Babol (partly)	Laleh Abad	39
		Karipei	58
		Sub-total	97
		Total of Project Area	491

Besides, 2 villages which belong to Mianrud Dehstan of Chamastan Bakhsh in Nur Shahrestan are locating inside of the Project Area along the Alesh river, however both of them are not beneficiaries of the Haraz river.

3.2.2 Population and Man-power

(1) Population

The Census in 1986 reported that the total population in the Project Area was 425,348; 300,668 in Amol district, 63,492 in Babol district and 61,188 in Babolsar district, and those Shahrestan basis population were sharing 92.4%, 16.8% and 52.4% of the total population of each of 3 Shahrestans. Besides, the Babolsar part was included in Amol and Babol parts in that Census year.

The rate of population increase in Amol district was 3.4% in the rural area and 5.5% in the urban area, that in Babol district was 3.0% in the rural area, and 3.4% in the rural area and 4.2% in the urban area in case of Babolsar district. The mean rate of population increase in whole Project Area was about 4.0%. The mean rate of population increase in the urban area was 5.4% both by country and province, and that of the rural area was 2.4% by country and 2.7% by province. The mean rate of total population increase was 3.9% by country and that of province was 3.7%, therefore the rates of increase in the Project Area were at comparatively high levels.

The age group structure is available by the previous administrative division. In 1976, the age group of less than 20 years old shared 58.0% in ex-Amol Shahrestan and that of ex-Babol Shahrestan was 57.6%, but those figures decreased to 54.8% and 54.9% in 1986. Simultaneously, the ratio of 20 ~ 39 years old group was increased in 1986. This age group of 20 ~ 39 used to leave the rural areas to work in the urban areas, etc., but it might be assumed that many of them returned to their native place due to nationwide stagnation of economic activities.

(2) Population Distribution

The summary of population distribution in the Project Area in 1976 and 1986 were as shown in the table below:

	1976			1986		
	Household	Population	Ratio	Household	Population	Ratio
Amol District:	35,243	198,746	-	52,294	300,668	-
Urban Area	14,399	76,061	38.3	25,719	133,098	43.3
Rural Area	20,844	122,685	61.7	28,575	170,570	56.7
Babol District:	10,050	47,148	-	10,669	63,492	-
Urban area*	-	-	0.0	-	-	0.0
Rural Area	10,050	47,148	100.0	10,669	63,492	100.0
Babolsar District:	6,139	42,818	-	11,310	61,188	-
Urban Area*	2,607	13,944	32.6	4,128	20,997	34.3
Rural Area	3,532	28,874	67.4	7,182	40,191	65.7
Whole Project Area:	51,432	288,712	-	76,273	425,348	-
Urban Area	17,006	90,005	31.2	29,847	151,095	35.5
Rural Area	34,426	198,707	68.8	46,426	274,253	64.5

Note: * A part of Babol and Babolsar cities are included in the Project Area, however those portions can not be separate from the available data. Therefore the population of those 2 cities are excluded.

There was not any notable change in the population distribution, except some increase of urban population in total. A decrease of population did not appear at Dehstan level, but the population of some villages was decreased. The mean ratio of urban:rural inhabitants was 54.3 : 45.7 in the whole country and that of the province was 38.5:61.5, however the ratio in the Project Area was 35.5 : 64.5, therefore the level of urbanization in the Project Area was still rather low.

(3) Man-Power

The ratios of Economically Active Population (EAP) and In-active Population (IAP) which shared in the age groups over 10 years old were 35.3 : 64.7 in ex-Amol and 44.5 : 55.5 in ex-Babol Shahrestans in 1976, but those figures changed to 38.8 : 61.2 and 38.9 : 61.1 respectively in 1986. Although the ratio of EAP in ex-Amol increased slightly and it decreased a few in ex-Babol, there is not any notable difference. But a distinct change appeared in the ratio of employed population in the EAP, viz., they were 62.8% in ex-Amol and 36.8% in ex-Babol in 1976, but they were counted at 90.5% and 89.6%, respectively, in 1986.

On the other hand, the employment by sectors in ex-Amol and Babol Shahrestans for 1st (agriculture, mining, etc.), 2nd (manufacturing, construction, etc.) and 3rd (different kind of services) industries were 26.1 : 31.2 : 42.7 and 13.9 : 31.4 : 54.6 in 1976, but they were changed to 43.4 : 17.3 : 39.2 and 47.8 : 13.2 : 39.0.

The most notable change in the employment situation was a sudden increase in farming population, but this change is considered to be due to a change in the counting method of farmers families, viz., most of a farmer's family were counted as IAP in 1976, but they were counted as employed in the agriculture sector in 1986.

Other changes in the employment were the doubling of employed in social service sector in both Shahrestans and a notable increase of employed in manufacturing in ex-Amol Shahrestan.

3. 2. 3 Industries and Regional Economy

It is obvious that the prosperity of economy of the Project Area is still continuing under the present high price of rice. However, more than 40% of employed are engaged in rice-culture oriented agriculture and, furthermore, the ratio of employment in rice-milling, storage-keeping, whole sale of rice and other rice related sectors are sharing large portions. In other words, the regional economy of the Project Area is greatly dependent on the paddy rice-culture. Other than those rice related industries, there are some small scale factories of furniture, agri-machinery, etc., construction, transportation, etc., but their portion of the regional gross product is not comparable to that of rice related industries taking their operational scale into account.

Taking the availability of land resources into consideration, further expansion of agricultural land is hardly possible. On the other hand, the population increase rate was rather high in the recent decades. This means that rice-culture oriented economy of the Project Area will encounter serious problems of employment, except otherwise introducing new industries.

The introduction of new industries request proper supply of material and/or production/marketing advantage to other regions. Unfortunately, the Project Area has not such advantage to be emphasized.

Considering the above, the rice culture-livestock combined farming will be most recommendable as future direction of regional development of the Project Area. Some agri-product processing industries will also be encouraged if surplus livestock production becomes available. Although some effort has been undertaken from such point of view introducing berseem as a second crop, however the effort has not reached an acceptable level as explained in para 3. 5. 5 below.

Moreover, the prevailing price of rice is not considered to be a stable price compared to the international market price of rice, and the price of rice will fall down if the government changes the policy importing more foreign rice to control the price of domestic rice from the viewpoint of protection of the consumer. In such case, many farmers will lose their willingness to cultivate paddy.

The outlines of industries in the Project Area are explained as below:

(1) Processing of Agro-products

The largest and almost sole agri-product processing industry in the Project Area is rice milling. The Agricultural Census in 1988 reported that 172 villages in the Project Area have rice mills, and many of those villages have 2 - 3 mills in a village. According to the MOA survey in 1985, the number of rice mills in the Project Area was about 280, and many rice mills have been established since then. Most of those recently opened rice mills have larger space in building and yard than the old ones, but the milling equipment is almostly the same as before, viz., bottom heating paddy dryers, vibrating pre-cleaning machines, dehusking machines which are mainly imported from Japan and Engelburg type whitening machines are the main equipment. Pre-cleaning, dehusking and whitening processes are often combined by a simple bucket elevator, and many rice mills are equipped with rice grading machines.

There is also some other agro-product processing other than the rice mill. Pickles, lime juice and jam are produced in home size workshops, and some villages at the east end of the Project Area are producing crude sugar from sugar cane.

(2) Agri-machinery Manufacturing & Repairing

There are many workshops of manufacturing tiller engine driven threshing machine, trailer and other agri-tools and repairshops of tractor, tiller, etc. in and around the urban areas. Most of them have less than 10 workers, but some workshops employ 20 - 50 workers. It is assumed that such category of workers share considerable ratio in the employed population in the 2nd industries.

A limited number of workshops are manufacturing equipment for rice mills such as bucket elevator, rice whitening machine, rice grading machine, etc. They were very busy until some years ago, but the orders decreased recently due to an end of the boom of renovation of the rice mills.

(3) Rural Industries

It may not be called rural industry exactly, but there are some cloth making factories in the Project Area, and they employ women rural inhabitants. Most owners of such factories are establishing their plants in the rural areas due to the high price of land nearby urban areas, however such kinds of manufacturing systems shall be examined in detail to formulate future industrialization in the Project Area.

3. 2. 4 Social Infrastructure

1. Communication

In the last 5 years, the asphalt paved road within the Project Area was increased considerably, especially in Dabu Junubi Dehstan, but the construction works reached stagnation recently.

Difference of density of road by Dehstan is observed. The main reason is due to difference of contribution of inhabitant to the construction cost.

According to the 1986 Census, about 20% of villages in the Project Area were connected to trunk roads by asphalt paved roads, 43% of villages have gravel paved road and remainder do not have paved roads.

Recently, MOCJ is studying a comprehensive road network plan in rural area, but the priority is set for more remote areas.

Availability of telephone in rural area is still very low, and only 21 villages were connected to the country-wide telephone networks in 1986: 2 in Ahlamrostagh, 1 in Harazpei Shomali, 4 in Dabu Shomali, 5 in Barikrud, 2 in Emamzadeh Abudallah and Rudbast, 2 in Karipei and 3 in Lalehabad.

Postal services are also under-developed in the Project Area and the rate of diffusion is only 6%, but this is mainly due to the low demand for such facilities.

2. Water Supply

The availability of tap water systems in the rural area is still low and only 25% of the villages had piped water supply system in 1986.

Most of villagers are using a shallow well nearby their houses, but the quality of water is not very good in many villages.

The responsibility of water supply in the rural area was shared by MOCJ and the Environmental Sanitary Office of Ministry of Health, up to 150 village households by the former and over 150 village household by the latter, but it has totally been transferred to the MOCJ recently.

3. Electricity

Almost all villages are, more than 95%, receiving electricity nowadays.

Most of rural inhabitants are enjoying lives with electricity.

4. Medical Services

Diffusion of medical services in the rural area is still very low, and only 1.6 physicians are available per 10,000 rural inhabitants.

30 villages have a clinic and 67 villages have a health office, which do not have a resident physician.

5. Education

Availability of education facilities are also rather low, however 75% of villages have primary school (1-5th classes) and 43% of villages have adult school for campaign against illiteracy, but only 19% of villages have secondary school of 6-8th classes.

6. Sanitation

77% of villages have common bath, but many of them are not hygienously acceptable.

Sewage facilities are not available in the rural area. Taking account of the high aquifer in the lower land of the Project Area, lack of sewage facilities will bring epidemic disease at any time.

Rural inhabitants are often using the irrigation/drainage canals which are flowing through the villages as a washing place of clothes and kitchen wares. This could also cause the spread of epidemic disease.

7. Recreation

In villages, very few recreation facilities such as small playgrounds for football and/or volley ball, are available.

Very few children and/or youth enjoy outdoor group sports in rural area.

No public organization is taking charge of recreation programs in the rural area at present.

FIGURE 3.2-1 ADMINISTRATION BOUNDARY AND POPULATION IN THE PROJECT AREA

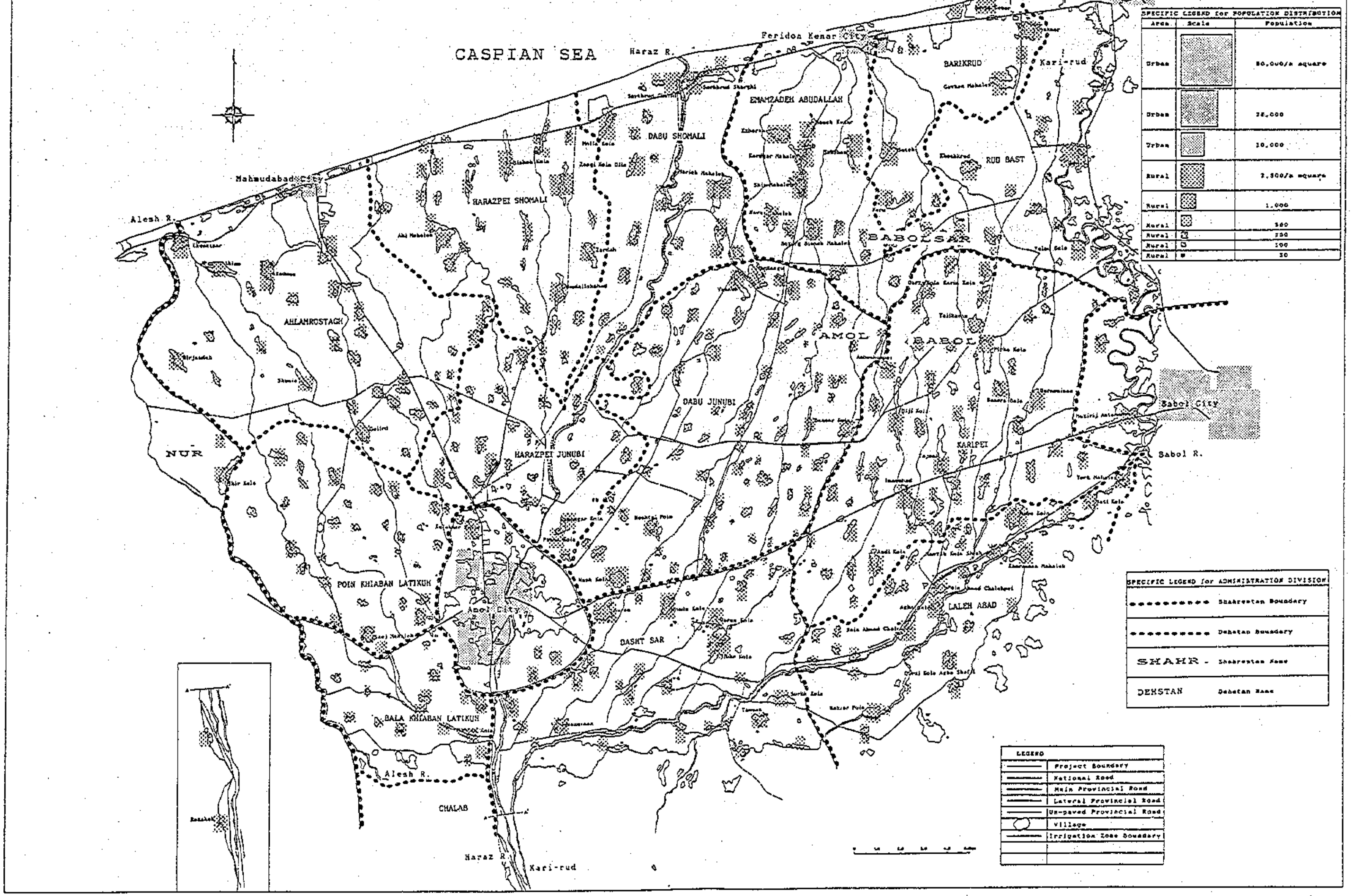
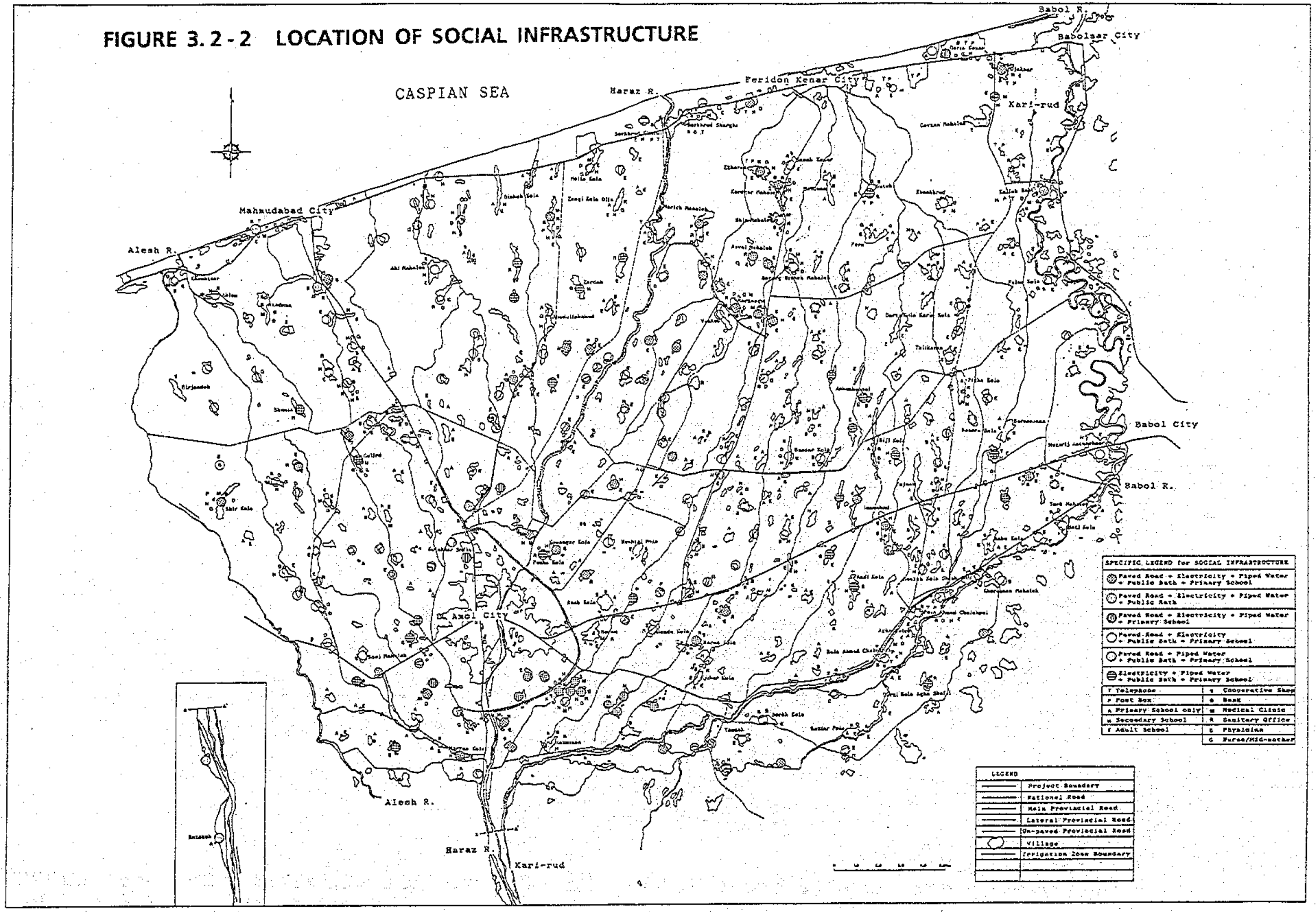


FIGURE 3.2-2 LOCATION OF SOCIAL INFRASTRUCTURE



3.3 Land Resources

3.3.1 Present Land Use

The map of present land use is provided to identify boundaries between the different land areas such as forest, upland fields, ponds and paddy fields, based on the topographical maps with a scale 1 : 20,000 compiled in 1966, by referring to aerial photographs provided in 1985, as well as by conducting a reconnaissance survey. The irrigation zoning on this map is based on the beneficiaries of the projected main and secondary canals, from which the areas are given in the following table and in Figure 3. 3 - 1.

(1) Cultivated Area

Land Use Acreage in the Project Area

(Unit : ha)

District	Number of Zones	Gross Area	Total Cultivated Area	Paddy	Upland	Orchard
A. Projected Area						
A.1 Haraz West	8	15,026	11,775	11,239	123	413
A.2 Haraz East	20	30,252	25,505	25,262	24	219
A.3 Amol West	12	24,830	18,818	18,378	67	373
A.4 Amol East	20	32,537	25,373	25,090	24	259
Projected Area	60	102,645	81,471	79,969	238	1,264
B. Urban Area						
B.1 Amol	1	3,849	1,954	1,831	26	115
B.2 Babol	1	1,515	1,073	1,052	1	20
Urban Area	2	5,364	3,027	2,865	27	135
Total	62	108,009	84,498	82,834	265	1,399
Ratio to Gross Area		100.0	78.2	76.7	0.2	1.3

The total gross area of the project covers 108,009 ha, of which cultivated area shares 84,498 ha, 78% of the total. The share of paddy field represents 82,834 ha, or 77% of the total or 98% of the cultivated land.

Water for paddy irrigation is currently diverted from the Haraz river through a number of canals and distributed by way of gravity irrigation system.

Tracts of paddy field extend from higher altitude areas of valley and piedmont or mountain foot to dune hinterland on the Caspian coast, on which paddy covers the entire field in summer. As to second crops, winter crops are grown in same parts of areas with higher elevation in beneficiaries on both west and east districts of Haraz Diversion Dam, where better drainage conditions prevail to cope with rainy winter climate.

Upland field accounts for only 0.2% of the total area, while orchards covering 1.3% of it are mainly in well-drained areas on alluvial fans and into the vicinity of living quarters, on which mainly citrus trees are grown.

(2) Non-cultivated Area

District	Total Non-Cultivated Area	Pasture	Forest	Ponds	Village/ Town	River/ Canal	Ponds	Dunes
A. Projected Area								
A.1 Haraz West	3,251	105	1,708	28	683	484	243	0
A.2 Haraz East	4,747	62	41	449	2,498	1,208	489	0
A.3 Amol West	6,012	99	1,530	1,106	1,529	699	372	677
A.4 Amol East	7,164	19	266	1,703	2,581	1,258	465	872
Projected Area	21,174	285	3,545	3,286	7,291	3,651	1,569	1,549
B. Urban Area								
B.1 Amol	1,895	40	2	5	1,461	297	90	0
B.2 Babol	442	0	0	211	179	45	7	0
Urban Area	2,337	40	2	216	1,640	342	97	0
Total	23,511	325	3,547	3,502	8,931	3,991	1,666	1,549
Ratio to Gross Area	21.8	0.3	3.3	3.2	8.3	3.4	1.5	1.3

Non-cultivated area shares 23,511 ha, or 22% of the total. Forest land covers the areas near the western boundary of the Project Area, the share of which accounts for 3.3% of the total area, where state-owned natural broad-leaved forest extends over it.

Most of the ponds are scattered in the west and east districts of Amol diversion dam, representing 3.2% of the total area, utilized as water source for paddy cropping around them.

Recreational summer resort villages are developed and widely utilized in sand dune areas, where scattered patches of orchards are also found.

3.3.2 Soils

(1) Classification of Soils

Soils in the Project Area are classified into seven sub groups.

1. Udolls: Distributed in gently sloping land, developed on upper alluvial fans and piedmont plain, with their texture of silty-clayloam up to their deep substrata.

2. Xerolls: Spreading over gentle slope in piedmont plains, fluvial basins and interfluvial land, with deep, poorly-drained clayloam profiles without perfect stratum differentiation.

3. Aquolls: Developing mostly over gentle slope in which fluvial deposits have been accumulated. Their texture ranges from loam to clay, with deeply developed, poorly drained strata.

4. Aquents: These soils cover slightly sloping land formed on diluvial deposits and alluvial basins, with poorly drained soil layers up to deep substrata.

5. Fluvents: These form gentle slope with fluvial deposits over diluvial plains with deep silty layers which show well drained permeability.

6. Psamments: Distributed in lacustrine coastal banks sand dunes. Their texture loamy sand to sand with moderately well drained.

7. Aqualfs: Mineral soils saturated with water for periods long enough to limit their use for most crops. They have Aquic, udic or Xeric Moisture regime, and Thermic temperature regime. Their base saturation percentage and water holding capacity is high.

Soil groups as described above are cross-checked based upon the soil maps (1 : 50,000) provided by Soil and Water Research Institute of MOA, and the following surface area distribution are obtained. In this connection, soil series distribution is given in Figure 3. 3 - 2.

Among breakdown figures of the distribution, the share of Aquents (typically Mollic Fluvaquents) is largest, with 79,131 ha followed by Aquolls (typically Fluventic Haplaquolls) which represents 13,660 ha. These two soil groups represent 86 percent of the total Project Area.

Aquents (Mollic Fluvaquents) have loamy to clayey textures, distributed on the plains with exceedingly gentle slope, with poor drained ability giving gley-strong gley nature. These soils are liable to cause respiratory inhibition of rice plant roots, and to lead to leaf scalding. The representative soil series are Da and Ba.

Aquolls (Fouventic Haplaquolls) are found as the inclined strata in flat plains with gentle slope. Their texture ranges from loam to clay, with poorly drained character in spite of somewhat coarser particle distribution than the association described above. They are derived from basic parent materials under forest covering, having high humus content and high base saturation throughout the whole soil, which make them more fertile than those mentioned above . Representative soil series include Su, Af etc..

<u>Acreages by Soil Groups & Series</u>

Soil Sub Group	Soil Series	Area	Ratio	Remarks
Udolls	Mt	3,438 ha	3.2%	
Xerolls	Bn-Gl	1,860	1.7	
Aquolls	Af	790		
	Ga	840		
	Af-Da	9,520		Aquents included
Sub-Total	Ba-Ga-Af	2,510		
		13,660	12.6	
Aquents	Da	7,840		
	Ba	8,700		
	Fo	890		
	Da-Su	44,890		Aquolls included
	Da-Nu-Su	16,811		
		79,131	73.3	
Fluvents	Bo	2,510		
	Ke-Su	2,620		Aquolls included
Sub-Total		5,130	4.8	
Psamments	Kz	3,970		
Aqualfs	Marsh	820		
Sub-Total		4,790	4.4	
Total		108,009 ha	100.0%	

(2) Characteristics of Soil Series

The soils distributed in the Project Area are classified into 15 soil series. Their characteristics are given as follows (for the details, refer to appendix A. 4-6).

Miantalar (Mt.): This series extends over the alluvial fan in the piedmont plain, The texture ranges from silty loam to clay-loam with soil pH in the range of 6.7 ~ 7.9. It has a medium soil fertility, but poorly drained, and high phosphate absorption coefficient, hence liable to become a phosphate deficient soils. It can be suitable to secondary crops in rice fields, and orchard trees by improving drainage condition.

Bani Kola Gavlangar (Bn-Gl): The soil is formed from the materials of both piedmont plain and fluvial deposits, with the texture of clay loam, the pH of which ranges 6.7~ 7.9. The soil is poorly drained and its phosphate absorption coefficient is low, with medium fertility. Secondary crops after rice can be introduced by improving drainage condition.

Afratakht (Af): It is formed from fluvial deposits, the texture of which ranges clay loam ~ sandy loam with the pH at 7.9, poor in drainage, the phosphate absorption coefficient is normal and the soil fertility is medium. The soil suits rice cropping, and also secondary crops if drainage is improved.

Ganjafrur (Ga): It is derived from the same fluvial deposits, having silty loam to clay loam texture, with the pH 7.8 ~ 8.2. Though poor in drainage condition, the soil has higher porosity, and phosphate absorption coefficient and fertility are at a medium level, suitable for winter cropping. Secondary crops after rice, such as vegetables can be introduced with drainage improvement.

Afralakht-Darzi Kola (Af-Da): The soil originates from fluvial deposits with the texture of clay loam, pH ranging 7.8 ~ 8.2. Poorly drained, and its phosphate absorption coefficient is normal or somewhat low, fertility as well is low. It is in the optimum condition for rice crop, and secondary crops are also cultivatable by proper drainage measures.

Babol-Ganjafrur-Afratakht (Ba-Ga-Af): It also stems from fluvial deposits, texture of which is clay loam, with the pH ranging 7.5 ~ 8.2. Though poorly drained, it has medium phosphate absorption coefficient and soil fertility, relatively high soil porosity ratio that make rice crops suitable. Secondary crops can be introduced with relevant drainage improvement.

Darjikola (Da): It is derived from alternate parent materials diluvial and alluvial origin, with the soil texture clay loam up to deep layers, with the pH ranging 7.8 ~ 8.2. Though poorly drained, phosphate absorption coefficient is low, hence, optimal for rice crop. Secondary crops like winter vegetables may be suitable through relevant drainage improvement.

Babol (Ba): The soil has alternate parent materials of diluvial and alluvial layers, with the texture clay or clay loam up to deep horizon, with the pH ranging 7.8 ~ 8.2. Also poorly drained, with low phosphate absorption coefficient, but medium fertility. Suitable to rice crop, and also to secondary crop after rice, such as winter vegetables by proper drainage improvement.

Form (Fo): Also derived from alternate diluvial and alluvial having deep horizons of clay loam or silty loam, with the pH 7.5~8.0. Poorly drained, and the fertility is medium. It suits rice crop, also suitable to secondary crop such as vegetables by drainage improvement.

Darzikola-Sufimahaleh (Da-Su): It is formed from alternate diluvial and alluvial having clay loam texture up to deep horizon, with the pH ranging 7.0 ~ 8.2. Drainage condition is poor and its phosphate absorption coefficient varies from high to low depending on the location. Soil fertility is somewhat low, but the condition is optimal for rice crop. When properly drained, it can be improved for secondary crops after rice such as vegetables.

Darzikola-
Nur-Sufimahaleh
(Da-Nu-Su): It is formed from both parent material of diluvial and alluvial with the texture of clay loam up to deep horizon with the pH ranging 7.0~ 8.2. Poorly drained and the phosphate absorption coefficient fluctuates high to low according to the location. Soil porosity shows to be somewhat low. By the drainage improvement, berseem can be introduced as secondary crops.

Kelayban-
Sufimahaleh
(Ke-Su): Also derived from diluvial and alluvial, having texture of silty clay loam up to deep horizon. The pH of which ranges 7.0 ~ 8.0. It has slightly favorable drainage condition, but the phosphate absorption coefficient lies at a high level, and soil fertility is low. It is therefore necessary to effect some extent of drainage as well as soil improvement, and this will enable the introduction of berseem as secondary crop.

Barj
(Bo): Also formed from alternate diluvial and alluvial materials, with the soil texture clay or clay loam with the pH at 8.0. It has well drained profile, with medium soil fertility, suitable to the introduction of secondary crops after rice.

Khazar
(Kz): These are the coastal lands of Caspian sea having deep soil, with sandy to loamy sand texture, single grain and loose structure. Some of these lands are used as pasture.

Marshy: Other soil classification in mapping unit with circumferential area of Marshy land.

(3) Soil Bearing Capacity

Within the Project Area, it was identified that the soil of rice fields in the off-season of irrigation has weak bearing capacity in four sites (identified by the survey during the period from Nov. to Feb. on 58 sites refer to the Master Plan Report). Among these four sites (No. 6, No. 17, No. 33 and No. 36), two sites (No. 33 and No. 36) have the problem of poor trafficability for agricultural machinery operation just after the harvest of paddy, and tracts were found on these sites when soil bearing capacity was not suitable to machinery operation, particularly after showers. (refer to the Appendix A4 - 4).

3. 3. 3 Land Classification

The lands are classified in terms of limiting or inhibiting factors, of the different categories such as soil properties, topography, drainage conditions etc, for rice plant and upland crops. These factors are classified into a few categories as presented in the following table, according to the extent of allowance in these limiting factors. Besides, a map of distribution by class is shown in Figure 3. 3 - 3 and refer to appendix A 4-5.

Land Classification Acreage in the Project Area

Land Classification	Area (ha)	Ratio (%)
1R/1U	23,940	22.2
1R/2Ud	38,360	35.2
2Rd/2Ud	170	0.2
2Rd/3Ud	30,950	28.7
3Rd/3Ud	4,740	4.4
2Rs/1U	2,510	2.3
2Rt/2Ut	2,560	2.4
3Rs/1U	930	0.8
6St/3Us	3,020	2.8
6St/6Sd	820	0.7
Total	108,000	100.0

Out of the land area within the Project Area, or 108,009 ha, 78% accounts for farmland of which rice fields represents 98%. Accordingly, the areas classified by the limiting factors of rice plant and upland crops from the pedological point of view are presented above. The following shows the summary:

(1) Land Free From any Limiting Factor in Cropping Rice and Upland Crops

Class 1 land, comprising the land free from any limiting factor in cultivating rice and upland crops classified as 1R/1U, as well as 1R/2U that has not any limiting factor to rice but slightly inferior to upland crops in terms of drainage. The sum of 1R/1U and 1R/2U accounts for 58% of the total farmland area.

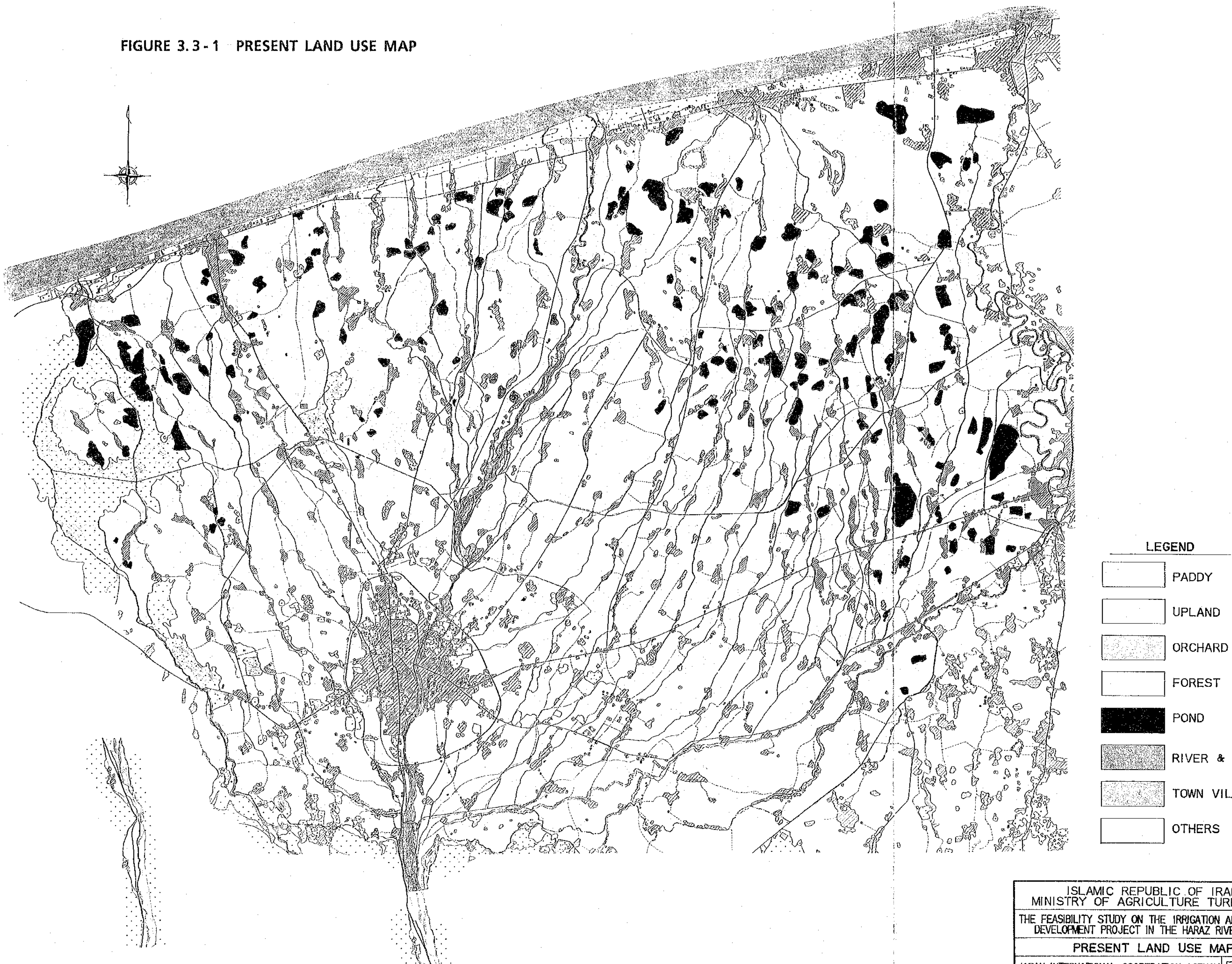
(2) Land Requiring Drainage Management for Rice Cropping and Radical Drainage Improvement for Introduction of Upland Crops After Rice.

Class 2 land, consisting of that with slightly inferior drainage condition for both rice and upland crops 2Rd/2Ud, and Class 3 land , including 2Rd/3Ud and 3Rd/3Ud, with poor drainage as limiting fan particular to upland crops. The sum of these three represent 33% of the total.

(3) Land Suitable for Upland Crops, but some Inferiority in Soil Water or Nutrient Retention Capacity for Rice Cultivation

Fluvial area along the right bank of the Babol river is classified as 2Rs/1U, alluvial fan developed in both banks of upstream of the Haraz river is classified as 2Rt/2Ut and the sand dune surrounding area in the eastern side of Feridon Kenars is classified as 3Rs/1U. The sum of these three areas is 5.5%.

FIGURE 3.3-1 PRESENT LAND USE MAP



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MINISTRY OF AGRICULTURE TURE(MOR)

THE FEASIBILITY STUDY ON THE IRRIGATION AND DRANAGE DEVELOPMENT PROJECT IN THE HARAZ RIVER BASIN

PRESENT LAND USE MAP

JAPAN INTERNATIONAL COOPERATION AGENCY | EXHIBIT No.

FIGURE 3.3-2 SOIL SERIES MAP

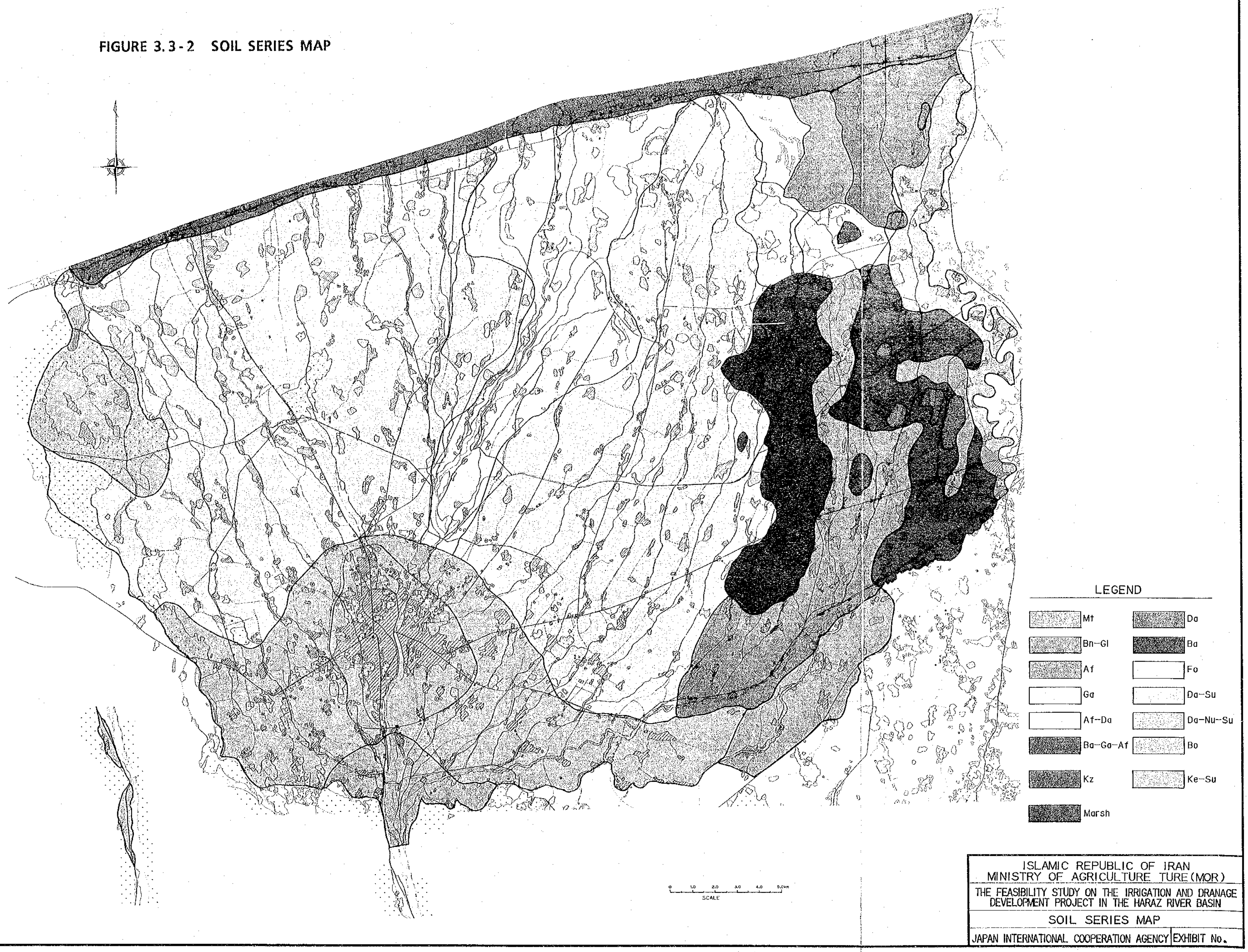
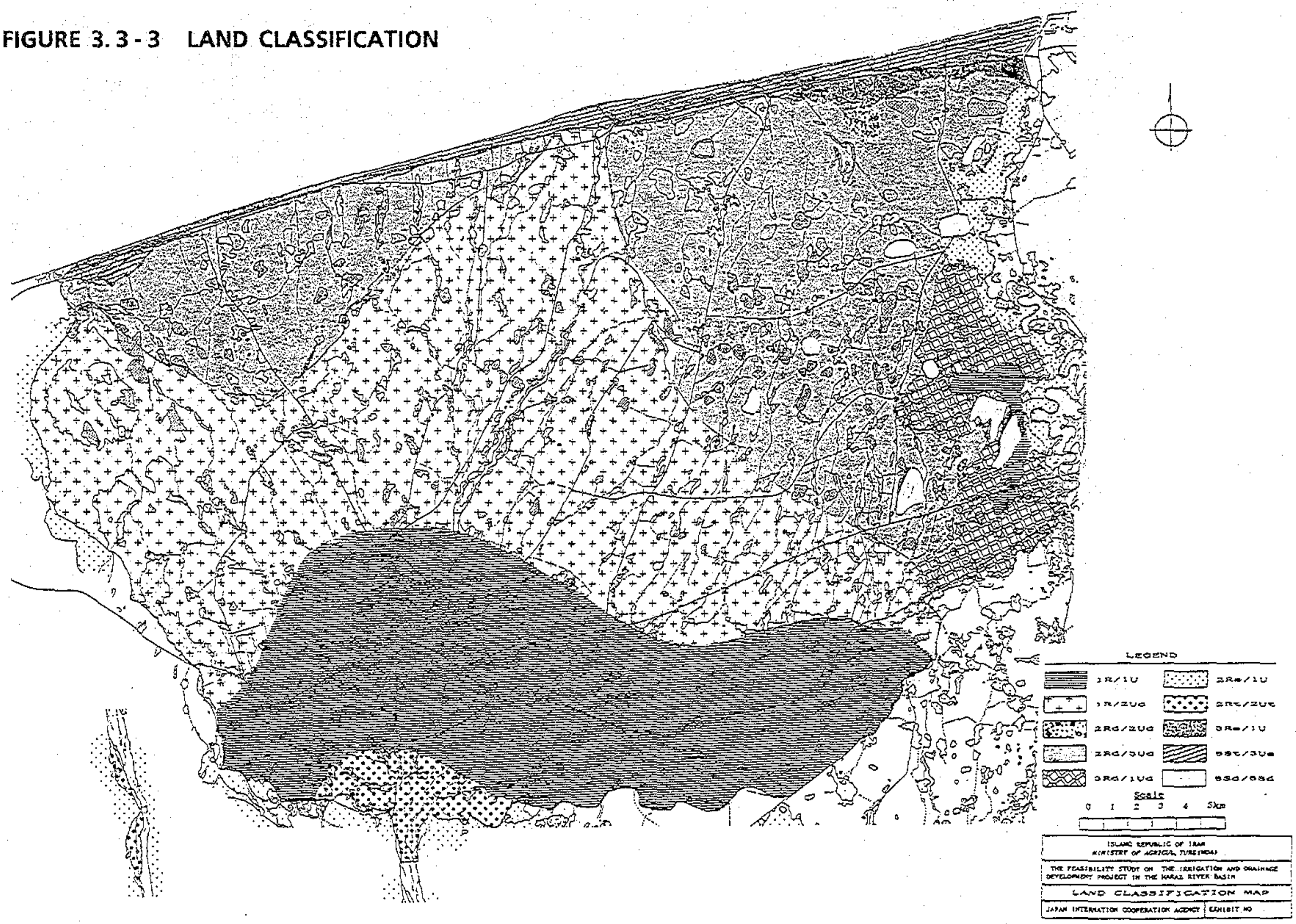


FIGURE 3.3-3 LAND CLASSIFICATION



3.4 Water Resources

3.4.1 General Climate

General climate of the Project Area is summarized as below;

General Climatic Factors in the Project Area

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Monthly Mean Temperature (°C) : averaged by Babolsar and Amol												
7.4	7.2	9.6	14.0	19.2	23.4	25.1	25.7	22.9	18.3	13.2	9.3	16.3
Monthly mean Relative Humidity (%) : ditto												
84	84	85	82	81	78	80	82	83	83	84	85	83
Monthly Mean Wind Speed (knot) : Babolsar												
2.1	2.6	3.0	2.9	3.0	2.9	2.8	2.7	2.5	2.3	2.1	2.0	2.6
Sunshine Hours (hr/day) : Babolsar												
4.29	4.35	4.19	5.21	7.30	8.30	7.87	6.76	5.59	5.45	4.90	4.34	5.72
Monthly mean Evapotranspiration (mm) : estimated by the Modified Penman (Reference Met-1)												
31	40	62	93	136	165	164	146	105	74	42	28	1,086

3.4.2 Precipitation

(1) Monthly and Annual Precipitation

Mean annual precipitation is 788 mm. Seasonal distribution varies from a minimum of around 140 mm (18% of annual) in a quarter from May to August, a maximum of about 400 mm (50%) in autumn and winter beginning from September to December. Monthly precipitation pattern is shown below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Monthly Mean Precipitation (mm)	78.4	65.5	66.6	40.0	27.5	28.2	32.4	751.6	0.3	122.6	100.0	104.8	787.9
Share by Month (%)	10.0	8.3	8.5	5.1	3.5	3.6	4.1	6.5	8.9	15.6	12.7	13.3	100
Precipitation by Season	(250.5 mm, 31.8%)				(139.7 mm, 17.7%)				(397.7 mm, 50.5%)				100

Note: The figures are calculated as "weighted by area" with the ratios 0.438 for Babolsar, and 0.562 for Amol

Non-exceedence probability of annual rainfall and that of irrigation period are shown as table below. From the rainfall of 170 mm in 10-years return period during irrigation period, 1990 is chosen as the representative drought year since the rainfall recorded was 167.8 mm.

Non-exceedance Probable Precipitation

(Unit: mm)

Period	Return Period			Precipitation of the Representative Year (1990)
	2-Year	5-Year	10-Year	
Annual Rainfall	779	685	641	726.0
Irrigation Period (April - August)	244	194	170	167.8

Note: Above figures are estimated from the observation data in Babolsar and Amol

(2) Rainy Days

It is deemed to be considerably high number of rainy days in the Project Area as 105 days in a year which is equivalent to one every 3.5 days. However, in the case of rainy days having more than or equal to 10 mm/day, there are only 28 days which is 1/4 of the annual number of rainy days. Monthly maximum number of rainy days is 12 days in March.

Monthly Precipitation in the Project Area

(Unit: days)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
≧ 0.1 mm/day												
10.8	9.8	12.1	8.9	7.0	5.5	5.2	7.1	8.9	9.3	9.8	10.3	104.7
≧ 1.0 mm/day												
8.9	8.0	8.9	5.1	3.6	3.3	3.4	5.1	6.8	7.7	8.3	8.7	77.8
≧ 5.0 mm/day												
5.2	4.9	4.5	2.0	1.2	1.2	1.7	2.5	4.0	5.4	5.3	6.2	44.1
≧ 10.0 mm/day												
3.3	2.6	2.7	1.0	0.7	0.7	1.0	1.2	2.8	3.8	3.9	4.4	28.1

Note: Data at Babolsar

(3) Daily Rainfall

In the Project Area, the maximum experienced daily rainfall was 219 mm at Babolsar in October 1971. Following table shows the probable rainfalls of one day and the consecutive rainfalls to 5-days.

Probable Daily Rainfalls in the Project Area

(Unit : mm)

	Annual				Non-Irrigation Period (Sep. -- Mar.)				Irrigation Period (Apr. - Aug.)				Harvesting Period (Aug. - Sep.)				Seeding Period of Berseem (Sep.-Oct.)			
Day	1/2	1/5	1/10	1/25	1/2	1/5	1/10	1/25	1/2	1/5	1/10	1/25	1/2	1/5	1/10	1/25	1/2	1/5	1/10	1/25
1-day	71	102	128	166	71	102	128	166	36	49	56	65	43	66	82	104	61	91	114	145
2-day	99	138	166	204			148	178			73	80			107	128	85	123	148	178
Consecutive 5-day																				
October							189													
November							212													

(Note) 1-day rainfall is analyzed by Babolsar data.
Rainfall over 2-days is analyzed by the data at Miandasht, Sorkh Rud and Mahmudabad.

3. 4. 3 River Runoff and Storage Water

(1) General Features of Rivers

The major rivers concerned to the Project Area are, as shown in Figure 3.1-1, the Haraz river flowing across the Project Area, the Babol river flowing along the eastern boundary, and the Alesh river flowing along the western boundary. All these rivers pour into the Caspian sea.

Other than the above rivers, the Kari Rud canal flows eastward along the piedmont, which functions as a main irrigation canal. The Kari Rud canal was artificially improved from a natural diversion river of the Haraz river in ancient days. The Garma Rud river flows into the Kari Rud canal from the piedmont hills. The Kharan Rud river flows in the south of the Kari Rud canal. The Kharan Rud river flows into the Babol river after joining with the Kela Rud river.

Most water resources of the Project Area depend on the Haraz river, and groundwater and storage water of abbandans are utilized supplementarily.

(2) River Runoff

1) River Basin and Hydrological Observation Network

The Haraz river originates in the Alborz mountains lying in the south of the Project Area. The Haraz river is found with the tributaries such as the Nur river and the Lar river. Catchment area of the Haraz river extends over 4,061 km^2 at Karehsang gauging station. The Lar dam was completed in the Lar river for diverting water to Tehran Water Works in 1980. The Lar dam is, however, not fully operational yet.

The Babol river also originates in the Alborz mountains. Altitude of the catchment area of the Babol river is rather low compared to the Haraz river. The catchment area is 1,643 km^2 at Babol gauging station which is around one-third of the Haraz river.

Among major rivers, hydrological observation stations have been installed in the Haraz river and the Babol river as shown in Figure 3.1-1. Other than major rivers, observation stations have been installed only for the Kela Rud river and the Sajjad Rud river since 1975.

2) River Runoff

Water resources of the Haraz river depend mainly on snowmelt. The runoff, as shown in Figure 3.4-1, increases from the latter half of March, and reaches a peak discharge of about 80 cms in June. Runoff decreases gradually after this peak approaching August. The discharge is considerably constant at around 20 cms more or less from September to March. This runoff pattern is not only stable but fits irrigation demand pattern. The snow on the Alborz mountains can be considered to be a natural water reservoir. Moreover, since runoff sources are snowmelt during high water stage and groundwater at low flow stage, water flow of the Haraz river is rather stable and able to be utilized easily and efficiently for irrigation.

On the other hand, water flow of the Babol river fluctuates unstably, because this river is fed mainly by rainfall. As shown in Figure 3.4-1, peak discharge appears twice in March to April and in September to October. Since the latter peak discharge corresponds to the peak of rainfall, it is considered to be rainfall runoff. The former peak discharge is considered to be snowmelt runoff. Because water flow of the Babol river decreases from May to August and fluctuates unstably, it is, therefore, rather difficult to utilize water of the Babol river from the view point of water utilization. The Alesh river and the Garma Rud river also flow at the same flow pattern as the Babol river.

Mean monthly and annual runoff of rivers are as shown below:

Mean Monthly Runoff of River

River/Station	C.A (km^2)	Meh (Oct)	Aba (Nov)	Aza (Dec)	Deh (Jan)	Bah (Feb)	Esf (Mar)	Far (Apr)	Ord (May)	Kho (Jun)	Tir (Jul)	Mor (Aug)	Sha (Sep)	Total (MCM)
Haraz River														
Polour	780	5.20	4.63	4.08	5.00	4.25	3.88	13.81	41.58	39.62	18.35	9.39	6.38	416
Residual Basin	3,281	15.05	16.20	14.38	11.75	12.14	14.97	20.37	37.16	41.26	28.36	23.05	18.51	670
Karehsang	4,061	20.25	20.83	18.46	16.75	16.39	18.85	34.18	7874	80.88	46.71	32.44	24.89	1,086
Babol River														
Babol	1,643	20.73	21.45	14.96	15.87	17.79	21.42	22.99	11.66	8.56	6.15	8.25	14.37	484
Sajjad Rud River														
Bandpei Galugah	261	Average 2.53												80
Kela Rud River														
Diva	136	1.37	1.77	1.95	1.95	2.01	2.68	2.70	1.85	1.78	1.92	1.75	1.48	61

The discharge of the Haraz river, which is a major water resource of the Project Area, in terms of non-exceedence probability is estimated in the following Table. Taking into consideration the runoff of 227 MCM in an irrigation period for a 10-year return period, the hydrological year 1969-70 (1348 - 49) was selected as a representative drought year for the Haraz river.

Non-Exceedance Runoff the Haraz River

Station	Runoff (MCM) Annual			Runoff (MCM) Irrigation Period			Representative Year (1969 - 70*)	
	1/2-Yr	1/5-Yr	1/10-Yr	1/2-Yr	1/5-Yr	1/10-Yr	Annual	Irr. Period
Polour	416	310	274	328	232	199	285	176
Residual Basin	670	551	510	402	271	227	523	225
Karehsang	1,086	863	784	730	530	454	808	401

(Note) Irrigation Period: April - August (Far - Mor)

(3) Water Storage

Water storage for the Project Area is estimated at 276 MCM.

Lar Dam	240 MCM	(Release from Lar Dam)
Abbandans	36 MCM	(Average depth 1.03 m, area 3,501 ha)
Total	276 MCM	

3.4.4 Floods

Floods in the Project Area and their routes are shown in Fig. 3.4-2. River flood is summarized as below.

Floods of Related Rivers

River Station	C. A.	Flood	Experienced Maximum	Probable Floods (cms)					
	km²	Type	Record	1/2	1/5	1/10	1/20	1/25	1/50
Haraz River		*	(cms) (date)						
Karehsang	4,086	instant	-	188	270	320	380	-	450
		d.mean	311 (May 1969)	-	-	-	-	-	-
Kosilian R.		instant	188 (1963)	60	100	140	175	190	230
Shirgah	343	d.mean	121 (1963)	37	60	78	100	105	120
Babol River		instant	465 (Jun 1963)	115	204	275	351	376	461
Gharantalar	393	d.mean	238 (1963)	67	109	141	175	186	224
Babol	1,643	instant	620 (Oct 1963)	277	397	471	539	560	624
		d.mean	456 (1963)	178	268	327	383	401	456
Kari Rud		instant	-	-	-	96	-	130	-
(No. 18+400)									
Kari Floodway	152	d.mean	-	-	-	56	-	73	-
Alesh River		instant	-	-	-	271	-	362	-
No.10	525	d.mean	-	-	-	172	-	221	-

Note :
1. referred to the report HWDP-1, A2 for probable flood of the Haraz and the Kosilian Rivers.
2. Probable flood of the Babol River was estimated by cross-checking the reliability of recorded data at Gharantalar and Babol.
3. for that of Garma Rud and Alesh River, they were estimated using the result of Gharantalar

* instant: instantaneous flood,
d.mean: daily mean
C.A. : catchment area

As seen in the Table shown above, the peak flood discharge of the Babol river is evidently larger, despite the fact that its basin is relatively smaller than that of the Haraz river. The occurrence of flood in the Haraz river is concentrated in May to June, coinciding with the peak of snow thaw in the Alboz mountains. Since peak discharge coincides with peak irrigation, about 200 m^3/s had been diverted into the Project Area before the construction of Lar

Dam. Therefore, the difference between peak flood discharge and the maximum permissible discharge was small. After the construction of Lar Dam, which functions to mitigate floods, no serious flooding problems have yet arisen in the Haraz basin.

On the other hand, floods of the Babol river have occurred during the months from August to November, the experienced maximum occurring in October. This implies that these floods are caused mainly by rainfall. In the Garma Rud and the Alesh river where the basins are located at elevations lower than that of the Babol, river floods will occur around the same flooding period.

It is concluded that flood control measures for the protection of the Project Area are necessary in the Babol, the Alesh and the Garma Rud rivers.

(1) Floods in the Babol River

Floodmark tracing survey has revealed that overflow flooding occurred at the cross-section surveying point (No.8), located about 6 km upstream of Babolsar city. The maximum permissible capacity at this point is estimated at 500 m^3/sec from the cross-section. The permissible capacity drops to the lowest point at the section between No.7 and No.8. For the rest of the channel it is above 700 m^3/sec.

(2) Floods in the Garma Rud and Kari Rud

Flood water in this river is confluent with the Kari Rud, and because of low capacity in the Kari Rud, overflow was traced downstream of location No.20. Part of the flood water flows down the Kari Rud, but the rest into the Project Area through the intakes, or overflowing from the both sides of the dikes.

(3) Alesh River

The cross-section in the downstream of the Alesh river is too narrow to allow passage of floods. At present flood water is dispersed into the forest along the banks. The dispersed floods flow into the forests and finally drain into the

Caspian Sea through the Alesh river and the Waz Rud, which drains westward on the Nur side.

(4) Roughness Coefficients of Rivers

Roughness coefficients "n" are estimated from a discharge rating curve observed at a gauge station in Babol and the hydraulic gradient (1/2,700) assumed by the observed floodmarks at locations up and downstream of the same station. The station is located at No.40 + 500, and the river bed is covered with smooth sediments of pebbles, sand and silt. Lower parts on both banks of the stream are covered with weeds and shrubs. Tall trees are found at the higher banks, and the boughs extend over the stream. The width of the river is measured at about 60 m. The estimated roughness coefficients range from 0.032 to 0.040. The higher value will be used for higher water level since it is observed that when flood level is high, water flow is disturbed by these boughs. In this context, 0.035 is estimated for channel with weeds and shrubs. If the river is well-maintained, "n" is expected to approach 0.032.

3.4.5 Sediment Yield

According to HWDP-I it is understood that sediment yield in the Haraz river is larger than those in other rivers. The data of the said report is duplicated here.

Sediment Yield by River

River	Gauge Station	Area of Basin	Sediment Yield
Talar River Basin			
Kosilian river	Shirgah	343 km^2	568.7 t/km^2
Talar river	Shirgah	1,773	750.5
Babol River Basin			
Babol river	Garantalar	393	717
Haraz river basin			
Lar river	Polur	780	922.2
Haraz river	Karehsang	4,061	1,074

Source: HWDP-I (A-2)

3.4.6 Groundwater and Spring

The Project Area bears highly productive yield attributed to the extensive watershed, which covers over 4,000 km^2 of the Alborz mountains, and to the thick aquifer involving alluvial fan deposits. Accordingly, the groundwater draft had been done from olden times. Further, with the highly productive yield as well as sufficient resources, the utilization of groundwater has suddenly increased in the recent 10 years for the purpose of securing irrigation water in line with the expansion of paddy field. Hereby, the groundwater resources are going to undergo a depletion in the future which may cause the drying up of wells and bring about difficulties for pumping up at the shallow level. Hydrogeological features in connection to these complications of groundwater resources in this area can be summarized below.

(1) Aquifer and Groundwater Occurrence

The classification of aquifers in this basin has not been still clear. Although exploratory drilling or electric prospecting had been carried out for detecting the hydrogeological structure, the data is limited for revealing the whole structure and it covers indefinite places in comparison with the extent of objective area. The previous study, however, had resulted in three discernible hydrogeological units which consisted of,

Shallow Aquifer: Shallow water table aquifers which have been utilized by numerous shallow wells for agricultural and drinking purposes. The aquifer is composed of the alluvial sequence of cemented homogeneous materials, where is located as the alluvial fan of alternate permeable and impermeable layers.

Deep Aquifer: Artesian aquifers, which give heavy discharge in places. It is composed of several aquifers which are first semi-artesian aquifer beneath shallow wells for aquifer and deeper aquifers separated from each other by aquicludes.

A rather permeable layer: It is located between water tables and artesian aquifers. The existence of this part can be distinguished from the deep well facies observed in this area.

The detail localities and respective potential of aquifer has not been recognized yet, to this end, a consideration for respective aquifers can not be made in this stage. The groundwater utilization, however, is mostly from Shallow Aquifer, it reaches more than 80% of all, consequently, the target for analysis in this study has to be applied exclusively to the Shallow Aquifer or unconfined shallow zone.

(2) Level and Direction of Flow in Groundwater

The fluctuation of groundwater level and its flow direction can be traced out by the observation data obtained from the well network in this area. The arrangement of well data has been conducted for 44 wells for a long period over 20 years. On the basis of these results, the hydrogeologic condition in the Haraz basin can be comprehended to a certain extent.

The groundwater level in the Project Area has been plotted on the grid points by the interpolated method during the last 10 years from 1360 (AD 1981) on the Iranian calendar in order to check groundwater flow. Whenever it had been calculated, the pattern for groundwater table was always that the area with a pronounced higher table was distributed along the Haraz river while that with a lower table was in the zone adjacent to the Babol river as shown in Figure 3.4-3. Especially in the highland portion along the Babol river, the groundwater level is constantly lower than its surroundings.

Furthermore, the direction of groundwater flow tends to be bound for the Babol river from the Haraz alluvial fan area whereas the lowland flow is in the ordinary orientation to the Caspian sea which is the shortest distance away.

(3) Time Series Changes of Groundwater Level

As shown in Figure 3.4-3, the groundwater fluctuation during the observed 20 years seems to be recognized as two types which are up and down in conflicting tendency at different portions. This is to say, the former type is discernible only in the highland except for along the Babol river while the latter is in the lowland especially beside the sea coast.

(4) Aquifer Coefficient

The results of aquifer tests can be summarized in the pattern map (Appendix A.3, Figure A.3.7) which is noted by a transmissibility of 50 m^2/day to 2,000 m^2/day. The highest zone, over 1,500 m^2/day, fringes the apex of the alluvial fan, and down stream the value decreases gradually till about 100 m^2/day. Further down the coastal strip, the transmissibility is observed to be a constant value of 500 to 1,000 m^2/day.

(5) Groundwater Use at Present

The present utilization of groundwater resources in this area had been estimated by both the methods of field investigation and cumulative study of well inventories.

The field investigation mainly consists of an interview for well management with farmers, however, due to the difficulty to meet the well keeper, these investigations have to be restricted to the low land areas where well observations have been previously done.

The arrangement of well inventory, aimed at estimation of the total present utilization in Project Area, is based on the following materials.

- Well inventory covering Sari to Mahmudabad published 1985, vol. 1-2, investigation dated 1982 to 1984.
- Well inventory covering Mahmudabad to Alesh Rud published 1987, vol. 1, the investigation data dated 1985 to 1986.

The estimation of the final amount of groundwater draft obtained as a provisional accumulation indicates more than 200 MCM annually contained in the 6,000 wells in the whole Project Area as shown in Table 3. 4-1. The regional differences of groundwater draft arranged from the above results are drawn in Figure 3. 4-4.

(6) An Estimation of Groundwater Storage Change

On the basis of the groundwater level fluctuation, remade as grid data from the well observation results by interpolation, the groundwater storage has been calculated for the last 10 years as shown in Figure 3. 4-5. The estimation has been executed with the use of a fixed standard of Caspian sea level of (-)27 m PGD, seeing that the storage quantity is indicated at an apparent volume excluding the sea level changes during calculation period. The general tendency appears that the storage volume is in a condition which is gradually rising till the present time.

(7) Caspian Sea Level and Its Influence to Groundwater Level

The Caspian Sea fluctuation has been collected and the data has been treated by the Fast Fourier Transformation Analysis (FFT), hereafter, the data had been rebuilt to the fluctuation curve again for taking the meaningful average of its fluctuation, eliminating the trivial changes.

From the results of analysis, it can be imagined that the Caspian Sea level affects not only the groundwater level but the apparent storage of groundwater near the coastal strip. Depending on the information of observation data which the Caspian Sea level has risen up during last 10 years from 1360, the difference between the observation groundwater level and specific level when the sea level is stable can be presumed to some extent.

The degree of influence by sea transgression and apparent increment storage volume, corresponding to practical movement, is also appraised in this analysis.

(8) Revised Groundwater Storage Fluctuation

The estimated Caspian Sea fluctuation during 1360 to 1370, which is correlated to the analytical period for groundwater storage capacity, is made by interpolation as stated above. The increment storage volume relating to this curve has been also calculated. Hereafter, the devised groundwater storage, meaning that the influence of Caspian transgression is reduced from the original storage, have been led as shown in Figure 3.4-5.

(9) Groundwater Runoff

For obtaining the basic data for the groundwater runoff, the well observation has been carried out with the following items.

- Observation period ranging 1st of June to 24th of June, 1991 (1370).
- Observation line including 9 lines with 62 points.
- Observation items comprising casing elevation, depth of well, s.w.1/d.w.1., EC and Temperature.

At most of the observation points, the dynamic water level near the sea coast has been positioned beneath the present sea level. This condition indicates from the above proving that the groundwater had hardly gone out into the sea, at least at this stage of 1991 (1370).

3.4.7 Return Flow

(1) Utilization

The secondary canal for irrigation has been constructed to be 10 km to 20 km wide, generally, and occasionally 30 km. Total canal length of the secondary and tertiary canals is estimated at 1,790 km in the Project Area, and the canal density is counted at around 22.0 m/ha.

On the other hands, these irrigation canals are functioning also as drainage canals in the rainy season (winter), and these canals are connected to abbandans in some cases down stream in order to keep/regulate return flow water. Typical reuse of the return flow in the Project Area is as follows;

- The terminal drainage canals of upper irrigation block is connected with the secondary or tertiary canals at downstream irrigation block. Abbandans are generally utilized repeatedly twice or more in an irrigation period.
- The excess waters of the upper blocks flow into the next lower blocks through above mentioned canals. Also, excess water is reused in downstream area.

(2) Estimation of Volumes of Return Flow

The functions, or procedures of the return flow can be understood through field investigation. However, it is required to have the systematic discharge measurement in the canals for the evaluation of return flow.

In connection with this, observation was carried out for a water balance study in typical three terminal irrigation units, at Ejibar Kola, Eslamabad and Suteh. Each irrigation unit has an irrigation area of about 100 ha. However, utilization system of return flow is composed of a rather larger scale of irrigation system. It was, therefore, hardly able to obtain successful results by means of observation of the terminal irrigation unit. For clarifying the utilization system of return flow quantitatively, it is required to conduct a rather extensive observation covering an area over a secondary irrigation canal system. Another observation was carried out in this respect, however it was discontinued due to the following reasons;

- It needed a wholesale observation of discharges at the extensive sites because discharges of secondary irrigation are unsteady not only in places but periodically due to various inflow and outflow caused by the operation of irrigation and the movements of return flow and groundwater.
- It needed numerous measuring sites to segregate groundwater and return flow, and it was a very laborious work.

Accordingly, the estimation of return flow has been carried out based on some extent of assumption:

- 50% of the conveyance losses will flow out as a return flow.
- 50% of the field application losses will flow out as a return flow.

As a result of computation, dependency on above return flow will be expected to be about 8% of intake water at the diversion dam. (Refer to Appendix B. 1.)

3.4.8 Water Quality

Water quality was monitored for a year from May 1991 to April 1992 from sample water from river, irrigation canals and ground water. The results were evaluated based on water quality evaluation criteria for irrigation water by FAO (refer to literature Hy-4). No particular hazardous contamination was found as detailed in Table 3.4-2. Monitoring sites are shown in Figure 3.4-6.

(1) Quality of Flowing Water in the River

Water quality was monitored at the site SW1 in the Haraz river. Water temperature during irrigation period falls to a minimum of 13.5°C in April, and rises to the minimum requirement for paddy growth after flowing into the irrigation canals. After flowing into the fields, it sharply rises, and cause no cold water damage problem. No other particular concern on water quality was identified.

(2) Quality of Water in the Irrigation Canals

The sampling points for canal water, SW2 and SW3 are located in the upperstream and lowermost boundary in the same canal (Said Rud). The water quality at the respective sampling points was compared.

As water flows down to the Project Area, values for water temperature, electric conductivity, sodium adsorption ratio (SAR) and total dissolved solubles (TDS) become higher. However, these values are not high enough to affect paddy growth.

(3) Quality of Groundwater

As for of groundwater quality, no anomalous data has been identified. Water temperature remains constant throughout the year. Also that of the artesian wells is fairly high at 23°C.

3.4.9 Current Status of Water Resources Development

(1) Water Resources Development in the Haraz River Basin

1) Lar Dam

(a) Plan and Dimensions

Lar Dam, an earthfill dam with a total storage capacity of 960 MCM, was constructed in 1980 in the Lar river, a tributary of the Haraz river to supply municipal water to Tehran and irrigation release to the Haraz Plain (refer to Figure 3.1-1). The Dam was planned and designed by Sir Alexander Gibb & Partners. The design was completed in 1972, and the construction work was started in 1975, taking 7 years to complete.

Water storage started soon after completion, but it failed to reach the planned full storage. Leakage was the main concern since the initial storage, and it was found mainly in the right bank, leaking at a rate of 10 m^3/sec. Two leakage points were found and the leaked water returns to the Haraz river. The Government has applied additional grouting to stop the leakage. Simultaneously, it has also followed an operation rule setting a limit for the storage level of the dam not exceeding 2,507 m. The effective storage under this operation is estimated to be 300 MCM.

Major dimensions of the dam are as follows.

Dam Type	Earthfill Dam
Dam Height	105 m
Dam Length	1,500 m
Dam Crest Elevation	EL.2,538 m
Full Water Level	EL.2,531 m (tentatively EL.2,507 m)
Earth Volume	21 MCM
Catchment Area	679 km^2
Reservoir Area	29 km^2
Total Storage Capacity	960 MCM
Effective Storage Capacity	860 MCM (tentatively 300 MCM)
Water Allocation 416 MCM/year	Tehran Water Works : 170MCM/year Haraz Irrigation 240MCM/year
Spillway	1,100 cms (1/1,000 year)
Right Bank	120 cms
Left Bank (overflow depth 4.7 m)	980 cms

(b) Operation Rule

Lar dam is planned to allocate annually 410 MCM, 170 MCM to Tehran municipal water and 240 MCM to irrigation release to the Haraz Plain. In this context, 240 MCM has been fixed as the maximum release during an irrigation period, and no discharge above 240 MCM has so far been released.

Though the Lar dam has never been fully operational, the release into the Haraz river has been partially sustained since 1981. It is considered that 240 MCM or close to that amount is being released, taking into account leakage, as can be seen in the performance of dam release from 1984 to 1985.

Irrigation Release Achieved by Lar Dam

(Unit:MCM)

Mouth		(1981) 1360	(1981) 1361	(1983) 1362	(1984) 1363	(1985) 1364	Average
April	(Far)	not reported on month			22	10	16
May	(Ord)				67	72	70
June	(Kho)				61	69	65
July	(Tir)				38	38	38
Augut	(Mor)				29	29	29
Total		222	185	141	217	218	197

Note: Amount of irrigation release includes leakage.
Source: MRWB

2) Mangol Dam

Mangol dam is planned as a storage dam to develop water resource of the residual basin below Lar dam. the dam site was proposed at the location just upstream of Karehsang gauging station, as shown in Figure 3.1-1.

Some geological problems are yet to be studied by the technical possibility of its construction. When they are solved, it is expected to exploit almost all of the water resources available in the Haraz basin, because the site covers nearly all of the Haraz river basin.

Some extent of hydrological and geological conditions of the dam site is explained in the Table below;

Hydrological and Geological Features of the Mangol Dam

Catchment Area	
The Whole Area	4,043 km^2
Residual Area of Lar dam	3,368 km^2
Mean Annual Discharge	
The Whole Area	1,085 MCM
Residual Area of Lar dam	670 MCM
Specific Sediment Yield	1,074 t/km^2/year
Elevation of River Bed	EL. 387 m PGD
Geology	limestone

According to HWDP-1 study (Ref. B9), the dimensions of Mangol dam have been proposed as follows.

Dimensions of Mangol Dam

Water Supply Conditions		Dimensions of Dam		Irrigation Area (ha)	Environmental Release from Mangol Dam (cms)
Haraz Release from Lar Dam	Abbandans	Storage Total	Capacity Effective		
230 MCM	with	285 MCM	99 MCM	90,285	0.3 (Jan - Sep)
0 MCM	Without	755 MCM	569 MCM	90,300	0.6 (Oct - Dec)

(2) Water Resources Development Project in the Babol River

No dam has so far been constructed in the Babol river. As shown in Fig. 3.1-1, three storage dam sites are presently proposed and are under study by MRWB. Details of these proposals are described in Para. 3.1.4. Of the proposed dams, the Pasha Kola dam is in the planning stage. Coordination between MOE and MOA is on-going to find the possibility of supplying 100 MCM for irrigation supply to the Project Area.

(3) Water Resources Development Project in the Kela Rud River

HWDP-1 study has proposed a storage dam, Sarbora dam, in the Kela Rud river, a tributary in the left bank of the Babol river.

Sarbora Dam

Catchment Area	136 km^2
Annual Runoff	60 MCM

TABLE 3.4-1 DRAFT VOLUME OF GROUNDWATER

	GRID	6D	7D	8D	9D	10D	4E	5E	6E	7E	8E	9E
NOS. OF WELL	SHALLOW	3	14	20	30	6	111	330	73	3	101	200
	DEEP	0	0	0	0	*	0	2	3	0	0	0
	ATESIAN	0	0	0	0	*	0	0	0	0	0	0
	AGRICULTURE	0	*	*	*	*	*	*	*	*	*	*
	INDUSTRY	0	0	0	0	0	0	*	0	*	0	0
	DRINKING	*	*	*	*	0	*	*	*	*	*	*
	TOTAL	3	14	20	30	6	111	332	76	3	101	200
	UNCONFIRMED	3	14	14	30	0	0	0	0	0	0	0
WELL DRAFT (M3/YEAR)	AGRICULTURE	0	*	46,857	0	143,540	5,288,989	8,838,353	4,244,341	38,880	6,694,427	5,148,707
	INDUSTRY	0	0	0	0	0	0	0	0	0	0	0
	DRINKING	0	0	0	0	0	2,642	24,606	524,966	1,855	0	0
	DRINKING(CITY)				500,000	2,000,000						
	UNCONFIRMED	425,736	1,986,768	1,986,768	4,257,360	0	0	0	0	0	0	0
	TOTAL	425,736	1,986,768	2,033,625	4,757,360	2,143,540	5,291,631	8,862,959	4,769,307	40,735	6,694,427	5,148,707
SPRING POUROUT(M3/YEAR)		0	0	0	0	0	0	0	0	0	0	0
GROUND TOTAL(M3/YEAR)		425,736	1,986,768	2,033,625	4,757,360	2,143,540	5,291,631	8,862,959	4,769,307	40,735	6,694,427	5,148,707
YIELD	AVERAGE	0.00	0.00	4.50	*	5.00	5.50	10.00	10.00	10.00	7.00	6.50

	GRID	10E	2F	3F	4F	5F	6F	7F	8F	9F	10F	2G
NOS. OF WELL	SHALLOW	46	127	52	233	155	118	43	349	635	129	33
	DEEP	0	0	0	1	2	2	2	0	0	6	1
	ATESIAN	0	0	0	0	0	3	3	0	0	0	2
	AGRICULTURE	*	*	*	*	*	*	*	*	*	*	*
	INDUSTRY	0	0	0	0	0	0	0	0	0	0	0
	DRINKING	*	*	0	*	*	*	0	0	0	0	*
	TOTAL	46	127	52	234	157	123	48	349	635	135	36
	UNCONFIRMED	0	0	0	0	0	0	0	0	0	0	0
WELL DRAFT (M3/YEAR)	AGRICULTURE	928,720	1,924,248	637,767	4,462,044	3,018,167	2,268,779	1,215,509	5,793,004	12,242,326	4,946,124	2,123,118
	INDUSTRY	0	0	0	0	0	0	0	0	0	0	0
	DRINKING	2,678	52,192	0	10,512	51,840	68,040	20,401	0	0	0	1,010,340
	DRINKING(CITY)			1,500,000					2,000,000		1,000,000	
	UNCONFIRMED	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	931,398	1,976,440	2,137,767	4,472,556	3,070,007	2,336,819	1,235,910	7,793,004	12,242,326	5,946,124	3,133,458
SPRING POUROUT(M3/YEAR)		0	0	0	0	0	0	0	0	0	0	0
GROUND TOTAL(M3/YEAR)		931,398	1,976,440	2,137,767	4,472,556	3,070,007	2,336,819	1,235,910	7,793,004	12,242,326	5,946,124	3,133,458
YIELD	AVERAGE	5.50	5.50	5.00	5.25	5.00	6.00	5.00	6.50	7.50	7.20	7.50

	GRID	3G	4G	5G	6G	7G	8G	9G	10G	2H	3H	4H	5H	6H
NOS. OF WELL	SHALLOW	416	218	51	85	280	131	480	307	2	86	0	8	77
	DEEP	9	5	1	2	5	2	3	3	3	4	2	0	0
	ATESIAN	2	1	0	1	10	0	0	0	0	7	0	0	0
	AGRICULTURE	*	*	*	*	*	*	*	*	*	*	*	*	*
	INDUSTRY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DRINKING	*	0	0	*	0	*	*	0	*	*	*	*	0
	TOTAL	427	224	52	88	295	133	483	310	5	97	2	8	77
	UNCONFIRMED	0	2	0	0	277	0	0	0	0	0	2	0	0
WELL DRAFT (M3/YEAR)	AGRICULTURE	2,668,532	3,340,066	1,455,782	2,463,631	541,381	3,349,599	8,473,812	12,350,817	100,639	1,629,850	0	146,610	3,274,628
	INDUSTRY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DRINKING	1,009,152	0	0	224,177	0	36,450	157,680	0	27,278	1,051,436	0	7,480	0
	DRINKING(CITY)								7,500,000	0	0	0	0	0
	UNCONFIRMED	0	90,720	0	0	13,556,722	0	0	0	0	0	315,360	0	0
	TOTAL	3,677,684	3,430,786	1,455,782	2,687,808	14,098,103	3,386,049	8,631,492	19,850,817	127,917	2,681,286	315,360	154,090	3,274,628
SPRING POUROUT(M3/YEAR)		0	0	0	0	0	0	0	0	0	2,018,304	9,445,032	671,454	523,498
GROUND TOTAL(M3/YEAR)		3,677,684	3,430,786	1,455,782	2,687,808	14,098,103	3,386,049	8,631,492	19,850,817	127,917	4,699,590	9,760,392	825,544	3,798,126
YIELD	AVERAGE	5.00	5.00	5.00	5.70	5.30	5.50	7.40	10.00	11.00	10.00	*	7.00	5.50

	GRID	7H	8H	9H	10H	2I	3I	4I	5I	6I	7I	8I	9I
NOS. OF WELL	SHALLOW	8	11	108	147	0	58	0	2	28	0	36	253
	DEEP	0	1	1	2	2	2	4	4	2	0	0	2
	ATESIAN	1	3	2	1	0	3	0	0	0	1	4	3
	AGRICULTURE	*	*		*	0	*	*	*	*	*	*	*
	INDUSTRY	0	0	0	0	0	0	0	0	*	0	0	0
	DRINKING	0	*	0	*	0	*	*	*	*	*	*	*
	TOTAL	9	15	111	150	2	63	4	6	30	1	40	258
	UNCONFIRMED	0	0	0	0	0	0	4	4	0	0	0	0
WELL DRAFT (M3/YEAR)	AGRICULTURE	286,657	582,560	4,370,350	5,067,244	468,504	2,114,412	0	36,000	184,558	113,760	879,138	6,859,419
	INDUSTRY	0	0	0	0	0	0	0	0	91,121	0	0	0
	DRINKING	0	189,216	0	66,839	0	313,332	0	0	22,649	0	346,901	580,277
	DRINKING(CITY)	0	0	0	0	0	0	0	5,000,000	0	0	0	0
	UNCONFIRMED	0	0	0	0	0	0	630,720	487,296	0	0	0	0
	TOTAL	286,657	771,776	4,370,350	5,134,084	468,504	2,427,744	630,720	5,523,296	298,328	113,760	1,226,039	7,439,696
SPRING POUROUT(M3/YEAR)		13,140	0	0	0	0	1,955,232	3,153,600	0	78,731	63,072	0	0
GROUND TOTAL(M3/YEAR)		299,797	771,776	4,370,350	5,134,084	468,504	4,382,976	3,784,320	5,523,296	377,059	176,832	1,226,039	7,439,696
YIELD	AVERAGE	5.30	5.00	5.00	6.60	23	10	*	6.00	6.30	3.50	5.50	10.00

	GRID	3J	4J	5J	6J	7J	8J	9J	total
NOS. OF WELL	SHALLOW	1	0	0	0	97	90	46	5,837
	DEEP	1	3	2	8	2	3	1	98
	ATESIAN	1	0	0	0	0	0	0	48
	AGRICULTURE	*	*	*		*	*	*	*
	INDUSTRY	0	0	0	*	0	0	0	*
	DRINKING	*	*	*	*	0	*	*	*
	TOTAL	3	3	2	8	99	93	47	5,983
	UNCONFIRMED	0	0	1	0	0	0	0	351
WELL DRAFT (M3/YEAR)	AGRICULTURE	117,872	429,159	0	0	536,019	2,430,947	1,013,677	135,289,523
	INDUSTRY	0	0	0	146,000	0	0	0	237,121
	DRINKING	9,504	10,950	101,702	299,304	0	277,375	54,038	6,555,813
	DRINKING(CITY)	0	0	0	0	0	0	0	19,500,000
	UNCONFIRMED	0	0	157,680	0	0	0	0	23,895,130
	TOTAL	127,376	440,109	259,382	445,304	536,019	2,708,322	1,067,715	185,477,586
SPRING POUROUT(M3/YEAR)		0	0	0	0	0	0	5,256	17,927,319
GROUND TOTAL(M3/YEAR)		127,376	440,109	259,382	445,304	536,019	2,708,322	1,072,971	203,404,905
YIELD	AVERAGE	10.50	15.00	7.00	12.75	6.40	5.00	5.00	6.57

Note : Cumulation excludes a well which is located out of the range of Project area at the border area.
: Unit is shown in m^3/year

TABLE 3.4-2 EVALUATION OF WATER QUALITY

Items	Haraz River	Irrigation Canal		Groundwater				Water Quality Standard by FAO
	SW1	SW2	SW3	Shallow Wells GW 2, 5, 7	Deep Wells GW1, 6, 8	Spring GW4	Artesian Well GW3	
Temperature (°C) (*1)								
Maximum	21.5	23.5	29.8					Water temperature for paddy (*2)
Mean	18.1	19.5	25.0	18.0	19.0	17.0	23.0	Minimum for growth 13~14°C
Minimum	13.5	15.4	17.1					Temp. affecting yield ≦23°C
								Optimum for growth 30 ~32 °C
Electric Conductivity (EC micromhos/cm, 25°C)								
Maximum	757	1,054	1,401					Free from stress on paddy
Mean	628	818	1,071	913	927	844	744	<2,000 micromhos/cm
Minimum	424	506	736					(equivalent 1,400 ppm)
PH								
Mean	7.8	7.8	7.7	7.5	7.5	7.2	7.8	Normal range 6.5 ~ 8.4
Sodium Adsorption Ratio (SAR)								
Maximum	0.5	0.9	3.3	0.5	3.0			SAR in case of range 0 ~ 3
Mean	0.4	0.6	1.5	0.5	1.4	0.3	1.5	EC>700 Non stress
Minimum	0.3	0.4	0.8	0.5	0.4			EC 700~200 Same
								EC<200 Serious
Nitrate Nitrogen (N-No$_3$, mg/ℓ)								
Maximum	1.00	2.20	2.80					N-NO^3<5 mg/ℓ Non stress
Mean	0.56	1.34	0.62	0.2	-	2.0	2.0	
Minimum	0.16	0.60	0.00					
Total Dissolved Solubles (TDS, mg/ℓ)	340	424	806	589	566	531	473	TDS<450 mg/ℓ Non stress
Mean								TDS 400 ~ 2,000 Same

Note: (*1) Temperature during an irrigation period (April - August).
(*2) Agricultural Engineering Handbook, Japan (Edition 5), (Reference Hy-5)
Water quality was monitored from May 1991 to April 1992.

FIGURE 3.4-1 AVERAGE MONTHLY PRECIPITATION AND RUNOFF

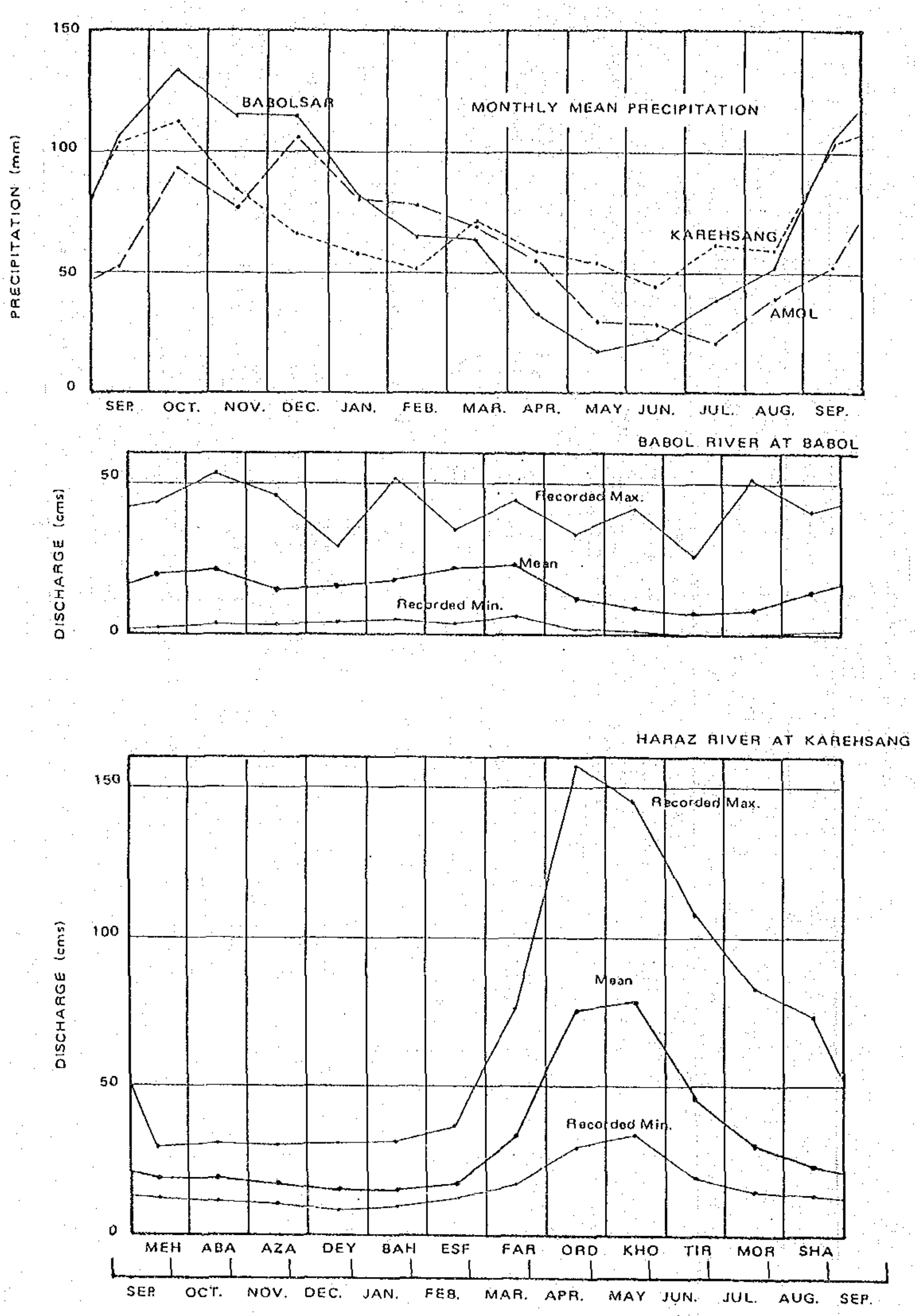
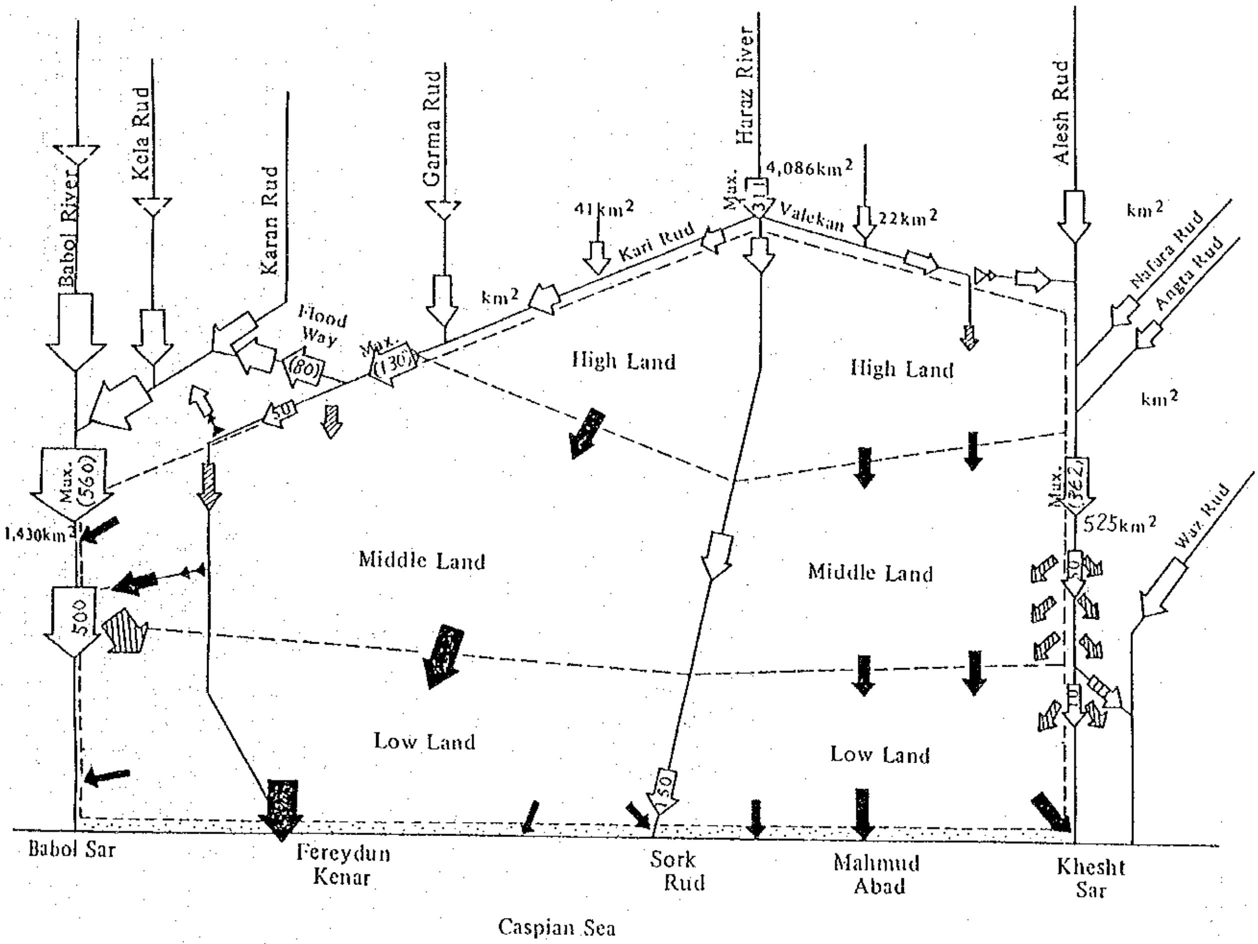


FIGURE 3.4-2 FLOODING OF THE PROJECT AREA



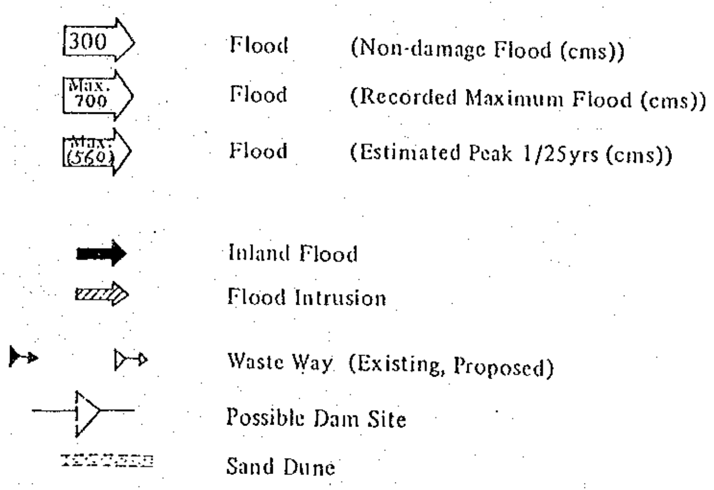
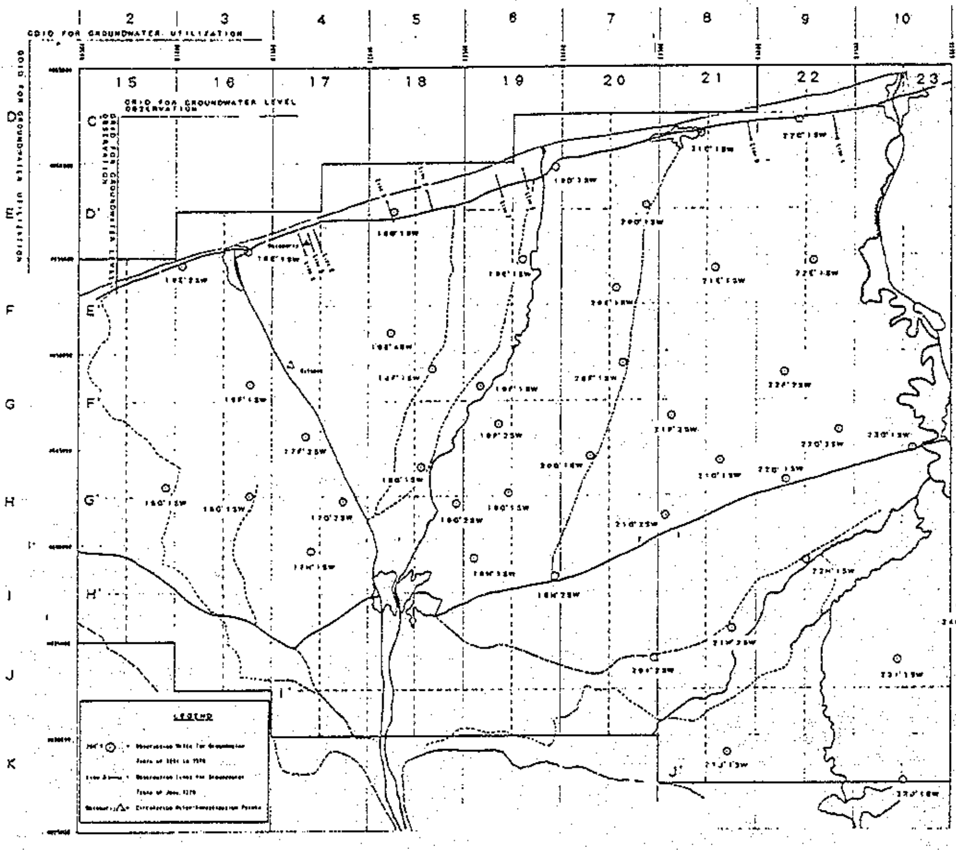
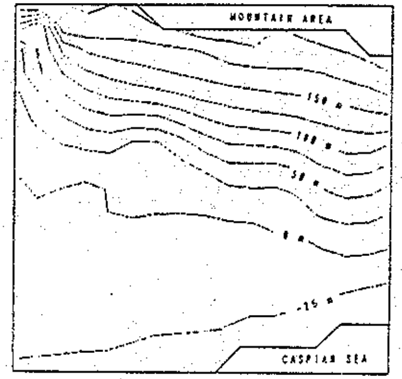
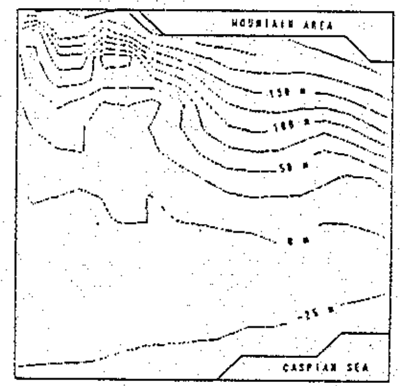


FIGURE 3.4-3 HYDROGRAPH AND CONTOUR OF GROUNDWATER

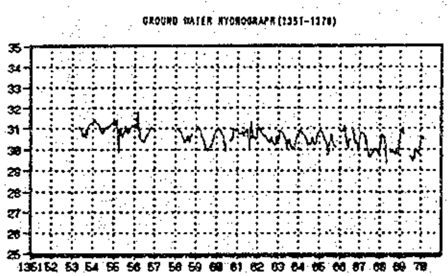




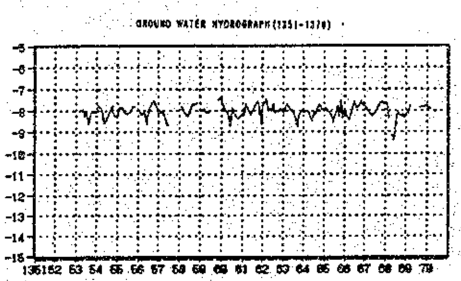
CALCULATED CONTOUR MAP OF GROUND WATER TABLE 1365.12 (CONTOUR INTERVAL IS 25 m)



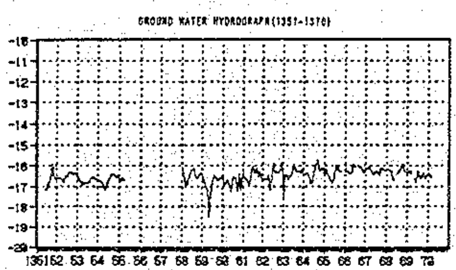
CALCULATED CONTOUR MAP OF GROUND WATER TABLE 1366.5 (CONTOUR INTERVAL IS 25 m)



201'2SW

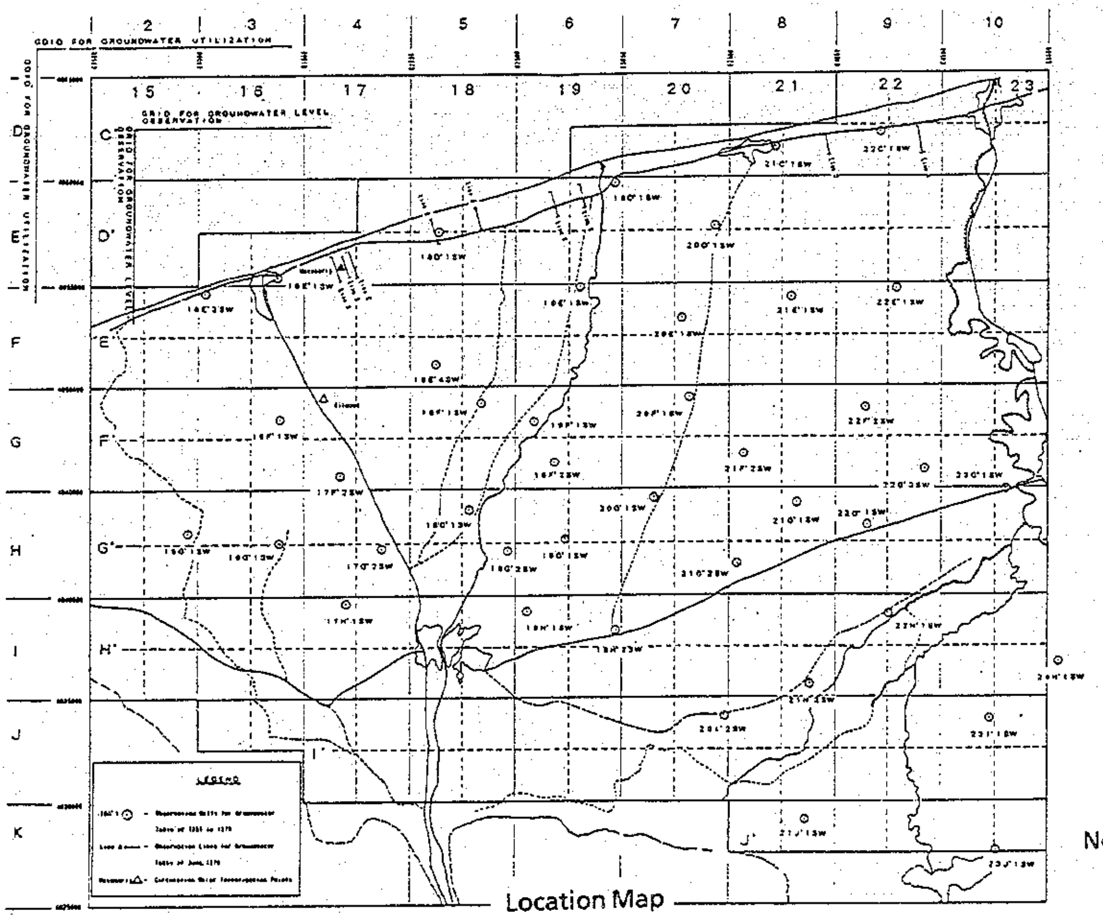


18E'4SW



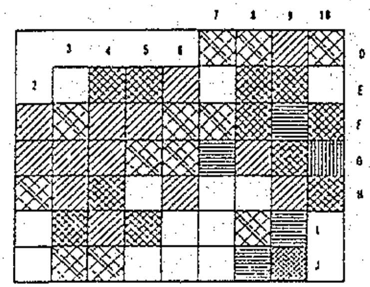
16E'2SW

FIGURE 3.4-4 REGIONAL DIFFERENCE OF GROUNDWATER DRAFT



Location Map

GROUNDWATER UTILIZATION QUANTITY IN MARAZ BASIN
- TOTAL QUANTITY OF GROUNDWATER DRAFT -

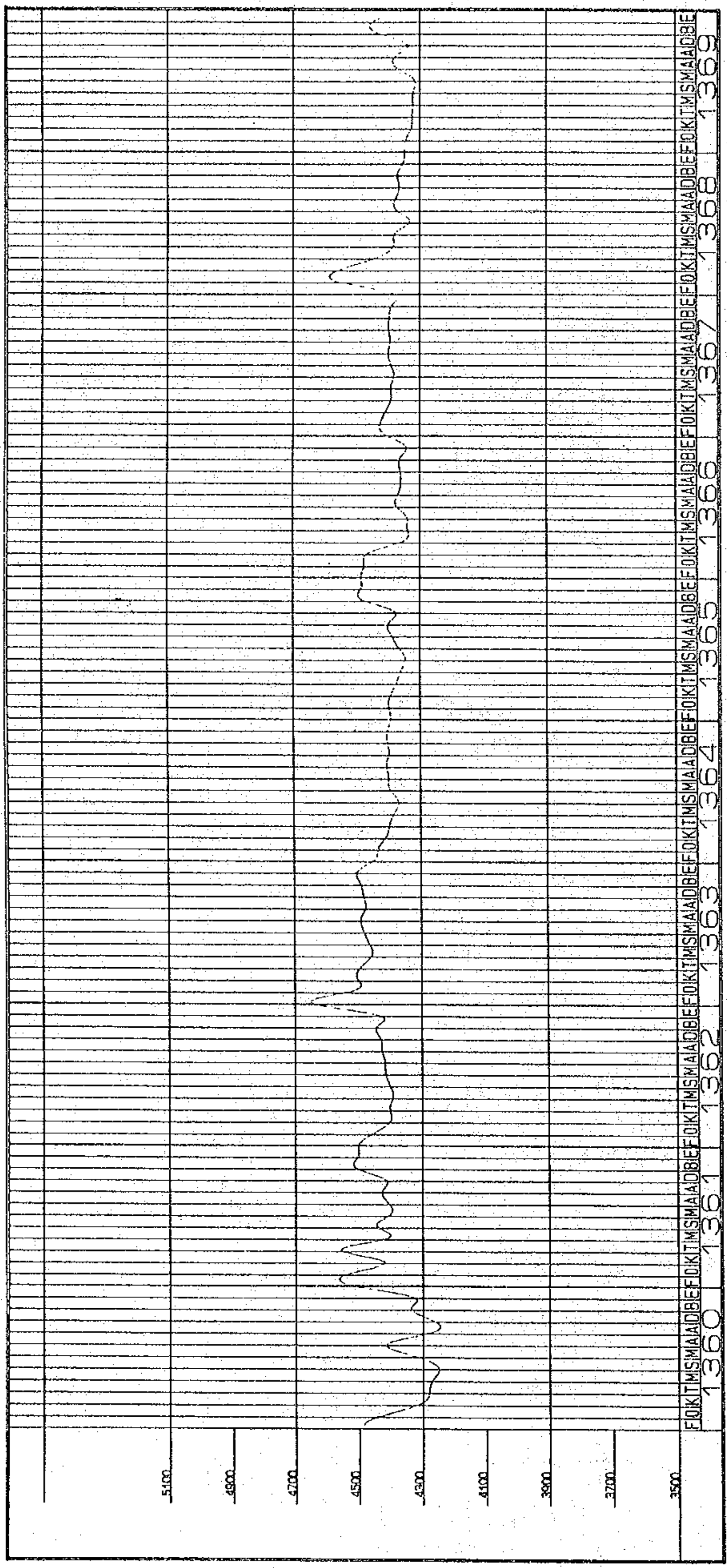


	2	3	4	5	6	7	8	9	10
D						1987	2034	4257	2144
E		0	5292	8863	4269	41	6694	5149	931
F	3600	2138	4473	3070	2332	1236	7793	12242	5966
G	3133	3678	3431	1456	2688	14058	3386	8631	19851
H	2968	4700	9750	825	3790	300	222	4370	2941
I	659	5549	3284	5523	377	172	1225	3260	
J		1146	1120	259	445	536	11670	21814	

Note: Cumulation includes all wells within the drawing grid even those which are located out of the range of Project Area at the border area. Unit is shown in 1,000 m per year.

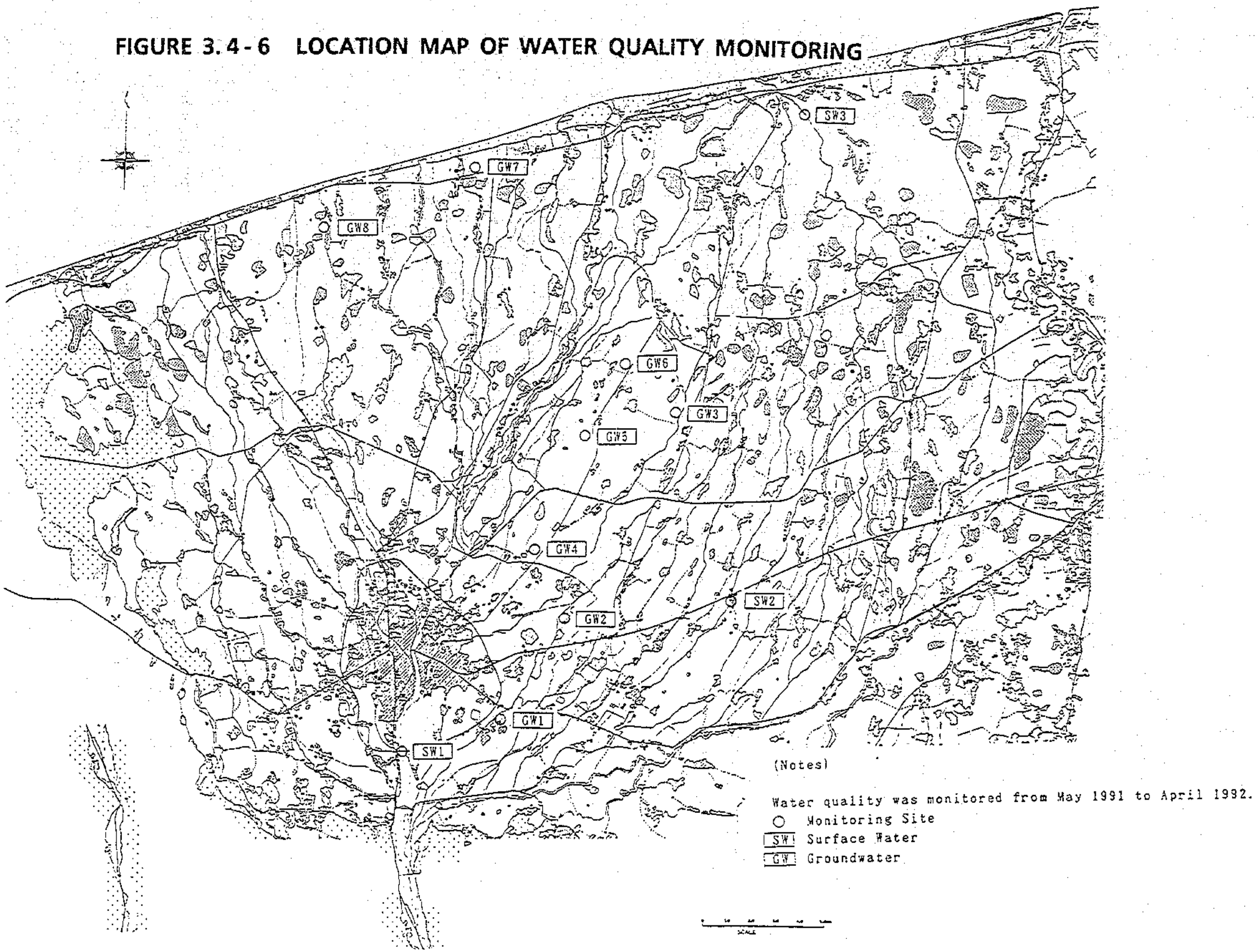
Total Quantity of Groundwater Draft

FIGURE 3. 4 - 5 FLUCTUATION OF GROUNDWATER STORAGE



Apparent Volume above Caspian Sea level
(MCM)

FIGURE 3.4-6 LOCATION MAP OF WATER QUALITY MONITORING



3.5 Regional Agriculture and Livestock

3.5.1 Land Ownership

Due to the execution of land reform in 1960s, most farmers in the Project Area are land owner/farmers. The village survey by MOA in 1985 reported that the ratios of land owner/farmers in Amol, Babol and Babolsar districts were about 85%, 65% and 60%, respectively. Among the land owner/farmers, about 65% in Amol district, 71% in Babol district and 75% in Babolsar district had less than 2 ha of land contrarily the ratio of land owner/farmers of more than 3 ha in Amol, Babol and Babolsar districts were about 15.1%, 11.1% and 11.4%, respectively. In particular, about 13% of land owner/farmers, 16% of those in Babol and 16% in Babolsar districts were small land holder of less than 0.5% (For details of Land Ownership refer to Appendix C. 1-1).

The land reform as mentioned above limited the land holding by setting the ceiling of landholding per farm household at 30 ha as far as the Project Area is concerned. It has been encouraged to grant the farming right to a successor to avoid fragmental holding, but in fact it is assumed a large number of farmers have divided their land at the occasion of their inheritance. However, it is often observed that many villagers failed to have their land registered through cadastral maps because they follow traditional Mosha system in executing land reform. This results in failure of explicit registration for the transfer of land, even if such occurred later on, and this has led to difficulty in identifying the current pattern of land-holding.

Note: Mosha system; a traditional way of land use found mainly in rural areas in Iranian Plateau, by which a certain area of land is jointly held, for which cropping land for a particular farmer is changed every season. This system has been formed with a view to equitably using water source jointly appropriated, so it is considered a system to distribute equal opportunity for all the tenants under a land-owner under tenancy.

A considerable difference in land holding patterns is observed among Dehstan, for instance in the case of Bala Khiaban Latikuh Dehstan 32.5% of the total farm households are landless and small land-holders with less than 2 ha account for 73% of the rest, leading to an average land holding of 1.25 ha per household. In contrast, in Harazpei Junubi Dehstan only 18.1% of the total are