WATER RESOURCES MANAGEMENT COMPANY
THE MINISTRY OF ENERGY
THE ISLAMIC REPUBLIC OF IRAN

THE STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIDRUD RIVER BASIN IN THE ISLAMIC REPUBLIC OF IRAN

Final Report

Volume I Main Report

November 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI Engineering International Co., Ltd.

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COMPOSITION OF FINAL REPORT

Volume I	**:**	**Main Report**
Volume II	**:**	**Summary**
Volume III	**:**	**Supporting Report**

Currency Exchange Rates used in this Report:

USD 1.00 = RIAL 9,553.59 = JPY 105.10
JPY 1.00 = RIAL 90.91
EURO 1.00 = RIAL 14,890.33

(As of 31 May 2008)

WATER RESOURCES POTENTIAL AND ITS DEVELOPMENT PLAN IN THE SEFIDRUD RIVER BASIN

1 ISSUES OF WATER RESOURCES MANAGEMENT IN THE BASIN

The Islamic Republic of Iran (hereinafter "Iran") is characterized by its extremely unequally distributed water resources: Annual mean precipitation is 250 mm while available per capita water resources is 1,900 m^3/year, which is about a quarter of the world mean value. On the other hand, the water demands have been increasing due to a rapid growth of industries, agriculture and the population.

About 55 % of water supply depends on the groundwater located deeper than 100 meters in some cases. Uncontrolled use of groundwater creates problems such as lowering of the groundwater table and drying up of groundwater storage. Regarding the surface water, each province has a plan for water resources development with dam construction, among which some development scheme is planned to withdraw water from other basin(s). Hence integrated water resources management is required to coordinate demands of provinces concerned keeping balance to the water resources potential.

The Sefidrud River, one of the largest rivers in Iran, is located in the northwestern part of the country and its basin encompasses eight (8) provinces having the total drainage area of about 59,090 km^2 and the population of about 4.72 million people. The river runs to the northwestern part of Teheran and is expected to be the water source for the Teheran Metropolitan Area due to its abundant water supply compared to the other rivers in the country. In addition, the downstream basin area includes the primary paddy fields in the country, requiring a huge amount of water for irrigation.

Each of the provinces has a plan to construct dams without an integrated water resources development and management plan, so that optimum allocation and efficient use of water resources are urgent issues requiring resolution.

2 WATER RESOURCES DEVELOPMENT POTENTIAL OF THE BASIN

The annual average precipitation from 1985 to 2005 is 346 mm, which consists of evaporation of 229 mm, groundwater recharge of 32 mm, and the surface water potential of 85 mm. Converting the surface water potential into volume in the Sefidrud basin, it is about 5 billion m^3/year. On the other hand, the water resources potential of groundwater is estimated at about 1.9 billion m^3/year, using the MIKE-SHE model. The summarized water balance is present in the following table and figure.

Table 1 Water Resources Potential in the Sefidrud Basin

Annual Precipitation	Evapotranspiration	Water Resources Potential		
		Surface Runoff	Groundwater Recharge	Total
346 mm (= 20.4 billion m^3)	229 mm (= 13.5 billion m^3)	85 mm (= 5.0 billion m^3)	32 mm (= 1.9 billion m^3)	117 mm (= 6.9 billion m^3)

Note: Data from 1985 to 2005

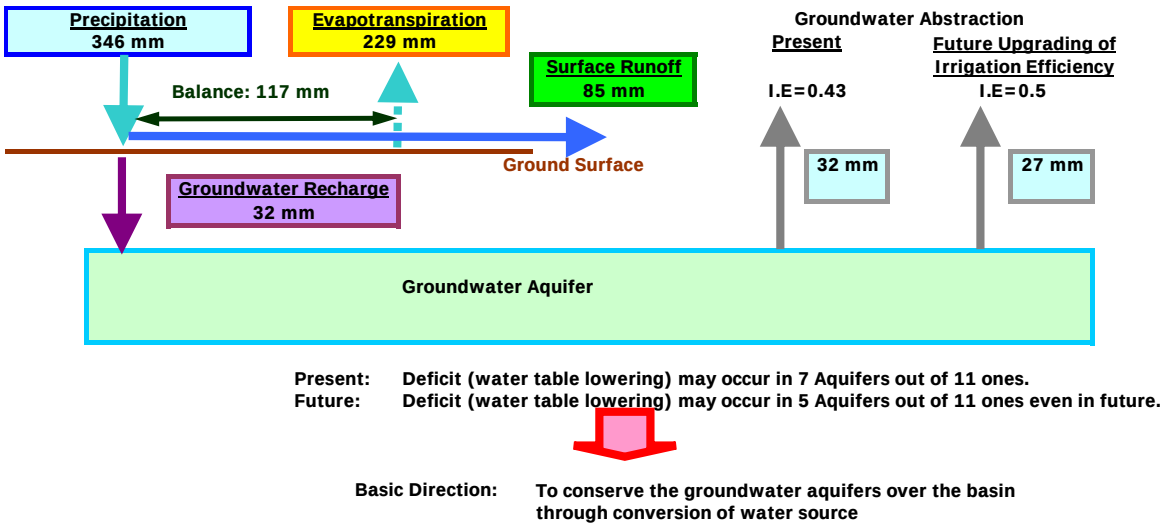

Figure 1 Water Balance and Water Resources Potential

3 WATER DEMAND PROJECTION

Future water demand is projected in 2016 and 2031 as midterm and long-term targets, respectively. It is considered that 14 dams under construction will be completed until 2016 of the midterm target year, while 21 dams and the Qazvin inter-basin transfer project will be completed until 2031 of the long-term target year. The summary of calculation results is presented in Table 2. In this projection, the future irrigation efficiency proposed by WRMC is employed for the projection of agricultural water demand.

Table 2 Summary of Water Demand Projection

Target Year	Irrigation Area (ha)	Irrigation Efficiency Proposed by WRMC (%)	Water Demand (unit: MCM)			
			Agriculture	Domestic	Industry	Total
Present (2006)	474,100	33.4	7,074	609	43	7,726
			91.6%	7.9%	0.6%	100.0%
Midterm (2016)	577,800	40.0	7,068	859	121	8,048
			90.1%	11.0%	1.5%	102.6%
Long-Term (2031)	646,700	50.0	6,714	1,268	204	8,186
			83.9%	15.8%	2.5%	102.3%

The future irrigation efficiency is set as one of the parameters in the future scenarios. The lower figures are without improvement and the upper figures are based on the targets proposed by WRMC, as shown in Table 3. Since a considerable amount of investment is necessary for improvement of irrigation efficiency, its improvement shall be considered as one of the future improvement scenarios.

Table 3 Irrigation Efficiency in the Future

Area	Present (2006)	Midterm Target Year (2016)	Long-Term Target Year (2031)
SIDN Area (Paddy field in Gilan)	42%	42-45-48%	42-51-55%
Traditional Irrigation Area (Upper basin of Manjil Dam)	33%	33-37-40%	33-44-50%

4 WATER RESOURCES DEVELOPMENT PLAN

Since the groundwater development in the Sefidrud River basin has been reaching its capacity, the surface water has become a subject for further water resources development. There are 174 dam projects in the basin, as shown in Table 4. Among them, 92 sites are under operation with a total volume of about 2.24 billion m^3. The total number of dams under construction and planning is 82, with the total storage capacity of about 3.74 billion m^3. Thirty eight (38) "Larger Dams" with a storage capacity greater than 5 million m^3 is 21.8% of all the dams, while their total storage capacity is about 5.85 billion m^3 or 98% of the entire reservoir volume in the basin. Locations of the 38 large dams are as indicated in Figure 2.

Table 4 Dam Development Projects in the Sefidrud Basin

Development Stage	Large Dam		Small Dam		Total	
	(sites)	(million m^3)	(sites)	(million m^3)	(sites)	(million m^3)
Under operation	3	2,178.1	89	65.2	92	2,243.3
Under construction	14	2,344.9	13	21.6	27	2,366.5
Under planning	21	1,323.2	34	52.6	55	1,375.8
Total	38	5,846.2	136	139.4	174	5,985.6

Source: WRMC Report (2007)

Figure 2 Location of Large Dams in the Sefidrud Basin

CONFLICT MANAGEMENT ON WATER RESOURCES MANAGEMENT

1 CONFLICT AND STUDY APPROACH

Water resources are becoming scarce due to demand increase accompanying social development. Conditions of surface water runoff and groundwater recharge differ in each basin due to meteorological (precipitation) and geological/topographical conditions. Historically, water conflicts continue between the upper and lower reaches or between the urban and rural areas, as well as between provinces and countries in the world. Such conflicts are resolved by mutual agreements or by promoting integrated water resources management.

Consensus building among the provinces is considered most important in the Sefidrud basin. Thus consensus among the eight provinces concerned was pursued in the following stages.

1) First Stage: Confirmation of Will to Formulate an IWRM

To clearly present the image of what water resources would be without an IWRM, the workshop on conflict analysis was conducted from June to July 2008.

2) Second Stage: Confirmation of Relation between Water Resources Potential and Design Water Demand in the River Basin

To present the water resources potential in the river basin as a result of scientific estimation and to present acceptable water demand estimations, Stakeholder Meetings in February and May 2009, and Workshop for technical training on the simulation model for engineers of the provinces in

May 2009 were conducted.

3) Third Stage: Confirmation of Principles of Water Allocation

Water use coordination based on simulation and setup of improvement in irrigation efficiency in the future was discussed in the local consultation and stakeholder meetings. An RBO (River Basin Organization) is considered as the place for the discussion of tentative agreements. For this purpose, Stakeholder Meetings in May 2009 and the Local Consultation in each province to obtain comments on the draft of the M/P also in May 2009 were conducted.

2 CHARACTERISTIC OF THE PROVINCES AND THEIR OPINIONS

The differences of ethnicity and socio-economic background in the related seven provinces could be summarized below.

Table 5 Grouping of Related Provinces

		Overwhelming in Agriculture and Stock Raising		Industries and Commerce Developed
Majority is Non-Persian Speaking Ethnicities	Upper Reaches	Ardebil, Kordestan, Zanjan		East-Azarbaijan
Majority is Persian Speaking Ethnicities	Lower Reaches	Gilan		—
	Others	-	Qazvin	Tehran

In general, the participants in each province expressed similar ideas on IWRM, namely; efficiency and equity of water resources are shared considering environment and ecological conservation. For the actual water allocation, provinces in the upper reaches require water allocation based on the potential of future development, while the lower reach provinces expressed that the existing use of water should be esteemed highly. The confrontation about water allocation was clear at that point.

In addition, they proposed information sharing, cooperation of related organizations among the provinces, and requirement for the establishment of an integrated organization. This reflects the participants' concern on the present situation where related authorities manage water resources without coordination among the provinces from the viewpoint of organization and functions.

The following proposals were noticeable during the workshop discussions, especially those related to the water problem in all of the provinces:

- Drafting of laws and regulations on integrated water management and the establishment of an organization to implement them;
- Drafting of rules for promoting cooperation or resolving confrontation among the provinces; and
- Examination of measures for the effective implementation of laws and regulations.

3 ANALYSIS OF CONFRONTATION AND MEASURES

It was confirmed that there exists a confrontation about the coordination of water use among the upper reach provinces and the lower reach province (Gilan). Key points of the confrontation are analyzed as follows:

Table 6 Analysis of the Confrontation and Measures

Key Points of Confrontation	Opinions of Upper Reach Provinces	Opinions of Lower Reach Province	Solvable Measures
Right of Water Use	Those who have water sources have the primary right to use the water.	Those who have been using the water for more than 40 years have the vested right for water use.	To start discussion aiming at situations better than the present for all of them as much as possible. To attain effective water use through improvement of irrigation efficiency.
Economic Efficiency (Productivity)	Land in the upper reach areas is fertile and has the potential for development. Water use in the lower reach area is inefficient.	Gilan has the best land for producing rice, which is a strategic agricultural product.	To improve water use efficiency in even cultivating the national strategic products of rice.
Equity/Social Justice	It is equitable to increase the income in the upper reaches by developing agriculture and industries because the income is lower than the national average.	The income of farmers in Gilan has already decreased due to water shortage. Further decrease in the income would lead to social unrest.	To solve the confrontation through the above coordination of water use.
Reliability of Information/Data	Information and data provided by the lower reach province are not reliable.	Information and data provided by the upper reach provinces are not reliable.	To store the reliable data by the integrated basin organization of RBO.

Furthermore, land use, cropping patterns and water demand in each province were evaluated objectively and comprehensively through analyzing the high resolution satellite imagery working together with Iranian consultants in the course of this study. Utilization of such data/information with high objectivity and their analyzed results could contribute fostering relationship of mutual trust among the provinces and resolving the water conflicts.

4 NECESSITY OF RBO

The establishment of a permanent organization to promote cooperative communication among the stakeholders, namely; an RBO (River Basin Organization) is recommendable for conflict solution. Stakeholders are expected to increase mutual understanding and seek solutions with the Win-Win Approach. It is expected to have the following functions, and the conceptual organization is presented in Figure 3:

- To formulate the implementation plan of the Sefidrud River Basin Integrated Water Resources Management Master Plan (the M/P);
- To decide on the use and updating of the simulation model constructed in the study as a decision support system tool;
- To formulate the final draft of an agreement on water allocation among the provinces concerned; and
- To formulate the final draft of arbitration on water conflict among these provinces.

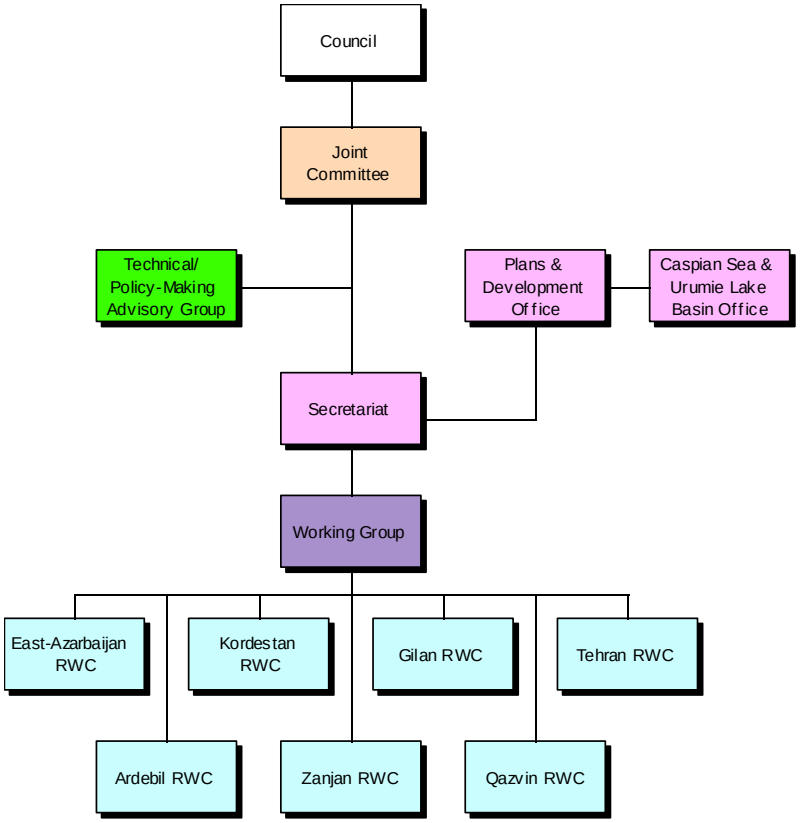

Figure 3 Organizational Structure of the RBO

In addition, the following figure illustrates conceptual integrated water resources management process as a central core of the RBO.

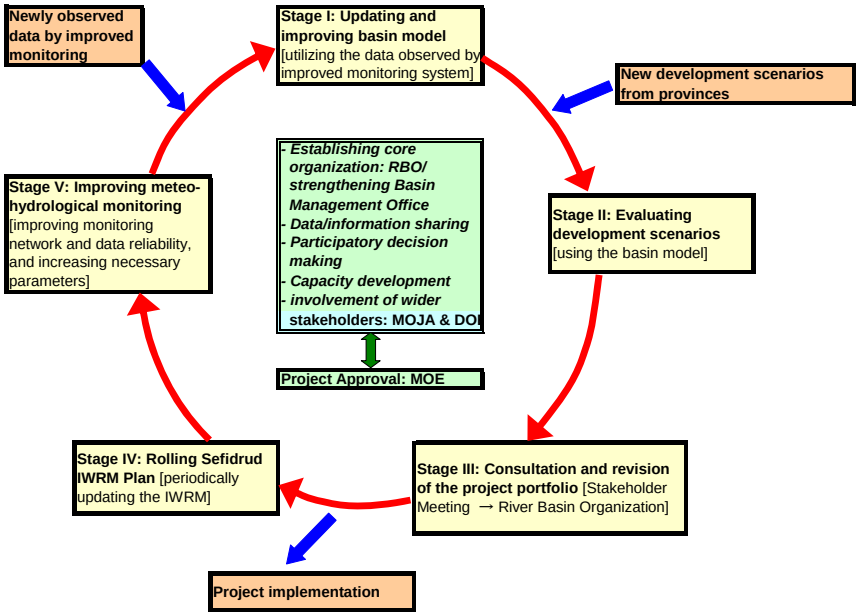

Figure 4 Conceptual Management Process in the Sefidrud IWRM

INTEGRATED WATER RESOURCES MANAGEMENT MASTER PLAN

1 PLANNING FRAMEWORK AND BASIC CONDITIONS

1) Target Year

The master plan shall be setup with target years of 2016 for the Midterm Plan and 2031 for the Long-Term Plan.

2) Basic Directions

The priority of water source should be given to surface water, so that the main sources of water to be utilized could be the water regulated by dam reservoirs. In the areas where groundwater conservation is needed, irrigation water extraction shall be shifted from the groundwater aquifer to surface water.

3) Prioritization of Water Supply and Safety Level

The 1st, 2nd and 3rd priorities shall be given to domestic, industrial and irrigation water uses, respectively. On the other hand, the safety level of water use could be given by drought recurrence period; i.e., a 5-year drought for all of the water uses.

4) Irrigation Water Management

Irrigation water makes up around 95% of all of the water usage at present. In fact irrigation water requirements widely depend on irrigation efficiencies. The irrigation system improvement including upgrading of irrigation efficiencies in the traditionally irrigated areas, which are presently estimated at 0.33 on average, shall be set as one of the future improvement scenarios in the master plan.

5) Study Approach

As the first step, all of the water resources development projects proposed by the provinces concerned shall be evaluated through basin model simulation how those projects influence the water demand of the traditional irrigation areas in the upper reaches and of the SIDN in the Gilan province. Furthermore, considering socio-economic and environmental issues, in particular, those seriously lowering groundwater table and environmental flow requirements, the midterm and long-term development scenarios shall be finally modified into the sustainable ones. The evaluation processes is illustrated in Figure 5.

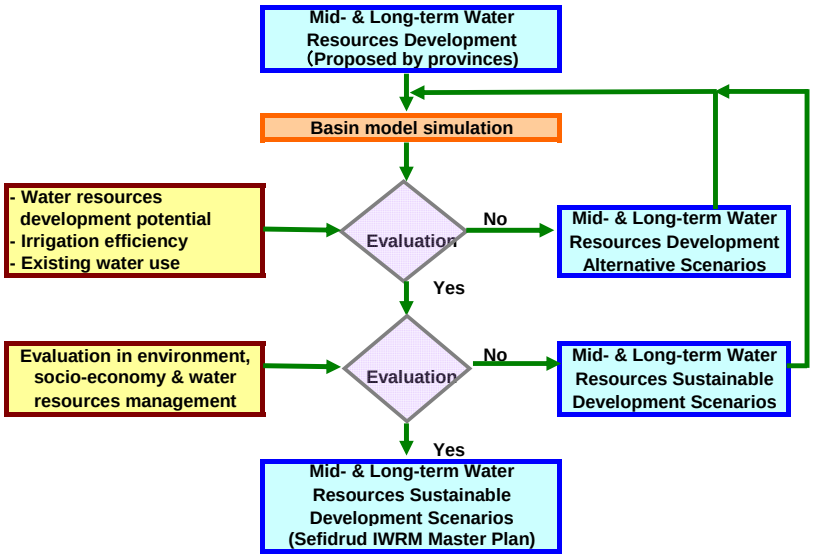

Figure 5 Planning Approach for the Formulation of a Sustainable Sefidrud IWRM

2 MASTER PLAN

Incorporating the future water resources development projects and improvement of irrigation efficiency into the basin model simulation, the following irrigation sufficiency in the upstream traditional irrigation areas and in the SIDN was clarified at 5-year drought.

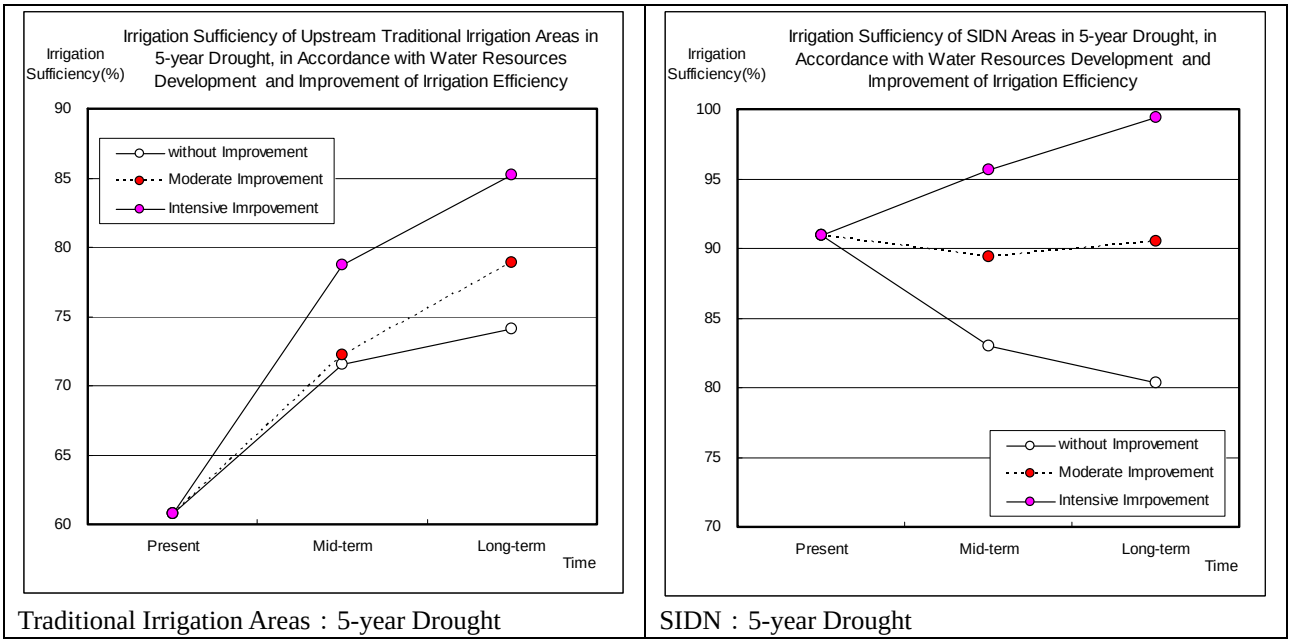

Figure 6 Agricultural Water Demand Sufficiency by Irrigation Efficiency Improvement Scenarios

Based on the simulation results, the desirable directions for water resources management could be summarized as follows:

- In the upper reaches of Manjil Dam, water resources development projects by dam construction contribute to the upgrading of water demand sufficiency due to flow regime

modification in the drought time. Furthermore the sufficiency could be upgraded much more through irrigation efficiency improvement.

- To sustain the present level of water demand of the SIDN sufficiency continuously in drought time, at least, the intermediate level of irrigation efficiency improvement (upstream: 0.37 in midterm and 0.44 in long term, SIDN: 0.45 in midterm and 0.51 in long term) shall be conducted over the basin.

It is, therefore, concluded that it is indispensable to implement the water resources development projects as well as irrigation efficiency improvement in the intermediate level, at least, so that sufficient water could be made available to both sides, i.e., the downstream and upstream areas of Manjil Dam, without any severe conflict. As a result, entire basin could receive the benefits of water resources in better equity level and water saving structure would be created through such efforts.

The possibility of conversion to the surface water sources was examined in the aquifers of which groundwater table has been lowering. Most of them the conversion of water source could be possible as a result of the water balance study. However, it was clarified that more detailed study shall be necessary to conserve the groundwater resources in some areas due to constraint of available surface water resources.

Regarding environmental flow, WRMC proposes the tentative flow rate of 10% of AAF (Average Annual Flow) for the environmental flow. This methodology is one of the hydrological methods most popularly applied all over the world among the environmental flow settings. Since flow regime at the major monitoring points would be improved in parallel with water resources development projects, the above environmental needs could be secured in comparison between 10% of AAF and the improved flow regimes of 90% flow in an average hydrological year.

Water resources development projects principally aim at increasing the irrigation areas so as to boost the regional economy. In particular, Kordestan, Zanjan, East Azarbaijan and Ardabil provinces in the upper reaches of the basin are distinguishable. Alfalfa or fruit trees as high-cash crops have been cultivated in the upper reaches in the recent years resulting in high productivity. As water supply capacity increases, the productivity also increases. On the other hand, the sufficiency in traditional irrigation areas would be upgraded in the midterm and long-term targets due to the increase in water supply occasioned by the progress of water resources development projects and savings in water consumption due to the progress of irrigation system improvement.

RECOMMENDATIONS

1 ESTABLISHMENT OF RIVER BASIN ORGANIZATION (RBO) AND ITS FUNCTIONAL OPERATION

Establishment of River Basin Organization (RBO) is a pressing issue in the Sefidrud River Basin in order to coordinate and arbitrate in the various conflicts related to water resources. This organization shall coordinate water resources development plans prepared by related provinces from the basin-wide viewpoints through hydrological and environmental evaluation on their effects, and shall monitor surface water as well as groundwater and share such data/information among the provinces.

For the establishment of RBO, the necessary staff will be dispatched from RWCs concerned. Basically provincial RWCs have highly trained staff and administrative operational ability. In order to smooth operation of RBO, however, further capacity development assistance on proper monitoring and project coordination activities shall be necessary.

2 IMPROVEMENT OF IRRIGATION EFFICIENCY

As clarified through water utilization simulation, efforts in both sides of water supply and water consumption are indispensable for the future water resources management. The efforts in the supply side are improvement of flow regime through construction of dam reservoirs. In other words, it means effective water use of limited water resources. On the other hand, the efforts in the consumption side are improvement of irrigation efficiency. It means also effective water use near the consuming sites.

The improvement of irrigation efficiency is listed up as one of the important issues in the National Water Resources Strategy, and Ministry of Jihard-e-Agriculture has carried out the agricultural infrastructure improvement project to solve the water shortage problems. In parallel with such activities, irrigation efficiency shall be gradually improved so as to realize the effective water use even though it is time taking process due to wide target areas. From this view point, continuous technical assistance is crucial.

3 ADDRESSING LOCAL ISSUES IN THE BASIN

Twenty-one (21) large-scale dams with reservoir storage of more than 5 million m^3 will be constructed toward the long term target year of 2031. Basin-wide evaluation using the basin simulation model was conducted in this study. Some dams planned can be recognized as low storage efficiency comparing among storage capacity, drainage basin and stream inflow. For these dams more detailed study and evaluation on planning conditions shall be necessary.

Ardebil inter-basin transfer project, in which water to be stored in Ostor dam will be transferred to Ardebil plain beyond the basin boundary, and hydropower generation project of series dams to be constructed between Ostor and Manjil dams were proposed during the study period, and their hydrological effects were evaluated in the study. Although these projects have not been consolidated yet, it is clear that they have large effects to the basin-wide water resources management. Therefore more detailed assessment of their effects shall be necessary.

Regarding environmental flow, since flow regime at the major monitoring points would be improved in parallel with water resources development projects, the environmental flow could be secured in comparison between 10% of AAF as tentative criteria proposed by WRMC and the improved flow regimes of 90% flow in an average hydrological year. However, from microscopic viewpoints, there are some stretches with highly concentrated salinity, and urban wastewater effluents influencing water quality of surface water. These intractable issues remain in the water

quality field, so that more detailed and continuous assessment in water quality shall be necessary based on the strengthened comprehensive monitoring including general parameters such as BOD etc.

4 CONSERVATION OF GROUNDWATER RESOURCES

In most groundwater aquifers in the Sefidrud basin, water abstraction exceeding rechargeable capacity by precipitation has been made resulting in serious lowering of groundwater tables. The remedial measures for conservation of groundwater aquifers should be considered, based on the local features, such as hydrology, geological structures of aquifer, industrial structure and groundwater demand, and possibilities of water source conversion to surface water and necessary facilities. Thus it needs certain period to solve this issue.

Accordingly conservation of groundwater resources should be also proposed and conducted on the basis of more detailed local features and issues and clarification of present physical conditions.

LOCATION MAP OF THE STUDY AREA

ABBREVIATION

Abbreviation	:	English
C/P	:	Counterpart
DB	:	Database
DOE	:	Department of Environment
DF/R	:	Draft Final Report
DIC/R	:	Draft Inception Report
EHC	:	Environmental High Council
F/R	:	Final Report
FAO	:	Food and Agriculture Organization
GDP	:	Gross Domestic Product
GIS	:	Geographical Information System
GIS-DB	:	Geographical Information System Database
GRDP	:	Gross Regional Domestic Product
IEE	:	Initial Environmental Examination
IC/R	:	Inception Report
IRIMO	:	Islamic Republic of Iran Meteorological Organization
IT/R	:	Interim Report
IWRM	:	Integrated Water Resources Management
JICA	:	Japan International Cooperation Agency
MG	:	Mahab Ghodss Consulting Engineering Co.
MOE	:	the Ministry of Energy
MOJA	:	the Ministry of Jihad-e-Agriculture
M/M	:	Minutes of Meeting
M/P	:	Master Plan
OMC	:	Operation and Management Company
PANDAM	:	Pandam Consulting engineering
P/R	:	Progress Report
QPIP	:	Qazvin Plain Irrigation Project
RBO	:	River Basin Organization
Reach	:	Catchment Area (includes Constructed, Under Construction, Under Study Dams)
RWA	:	Regional Water Authority
RWC	:	Regional Water Company
RWWC	:	Rural Water and Wastewater Company
SDC	:	Sustainable Development Committee
SEA	:	Strategic Environmental Assessment
SIDN	:	Sefidrud Irrigation and Drainage Network
SHM	:	Stakeholder Meeting
SRMB	:	Sefidrud River Basin Management Bureau
USGS	:	United States Geological Survey
UWWC	:	Urban Water and Wastewater Company
WRC	:	Water Research Center
WRI	:	Water Research Institute (changed to WRC on 2002)
WRM	:	Water Resources Management
WRMC	:	Water Resources Management Company
WUA	:	Water User Association
WWC	:	Water and Wastewater Company

UNIT

(Time)			(Volume)		
h, hr	:	hour(s)	l, ltr	:	liter(s)
d, dy	:	day(s)	mcm	:	million cubic meter(s)
y, yr	:	year(s)	bcm	:	billion cubic meter(s)

THE STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIDRUD RIVER BASIN IN THE ISLAMIC REPUBLIC OF IRAN

FINAL REPORT

MAIN REPORT

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Islamic Republic of Iran (hereinafter "Iran") is characterized by its extremely unequally distributed water resources: Annual mean precipitation is 250 mm while available per capita water resources is 1,900 m^3/year, which is about a quarter of the world mean value. On the other hand, the water demands have been increasing due to a rapid growth of industries, agriculture and the population. About 55 % of water supplies depends on the groundwater located deeper than 100 meters in some cases. Uncontrolled use of groundwater creates problems such as lowering of the groundwater table and drying up of groundwater storage. Concerning the surface water, each province has a plan for water resources development by withdrawing water from other basin(s) and dams in order to compensate for the shortage of water. Hence integrated water resources management is required in each basin.

The Sefidrud River, one of the largest rivers in Iran, is located in the northwest part of the country and its basin runs through 8 provinces with the total area of 59,090 km^2 and a population of about 4.7 million. The River flows through the northwest edge of Teheran province and could potentially be a major water source to Teheran Metropolitan Area for its relatively large volume of water. The River is also expected to supply sufficient water to its downstream area including the paddy fields which produce most of the rice in Iran.

Although the Sefidrud River plays an important role in the country to supply water, each province has requested to construct dams. If all the dams are constructed and operated it would cause an imbalance of water distribution. Thus, an optimum allocation and efficient use of water resources is an urgent issue in the Sefidrud River Basin.

The government of Iran officially requested technical assistance from the government of Japan in 2004 to formulate an integrated water resources management plan in the Sefidrud River Basin. The integrated water resources management plan is intended to be a national plan as well as regional. In response to this request, the government of Japan dispatched a preparatory study team in February 2007, and had discussions to confirm the contents, scope and an implementation organization concerned for the Study. Both sides agreed upon the Scope of Work (S/W) and Minutes of Meeting (M/M) for the Study. The Study is conducted on the base of the S/W and M/M. JICA has dispatched a Study Team, headed by Mr.Teruo Tahara of CTI Engineering International, Co., Ltd of Japan, to Iran on August 9, 2007 to carry out the Study.

1.2 OBJECTIVES OF THE STUDY

The objectives of the Study are:

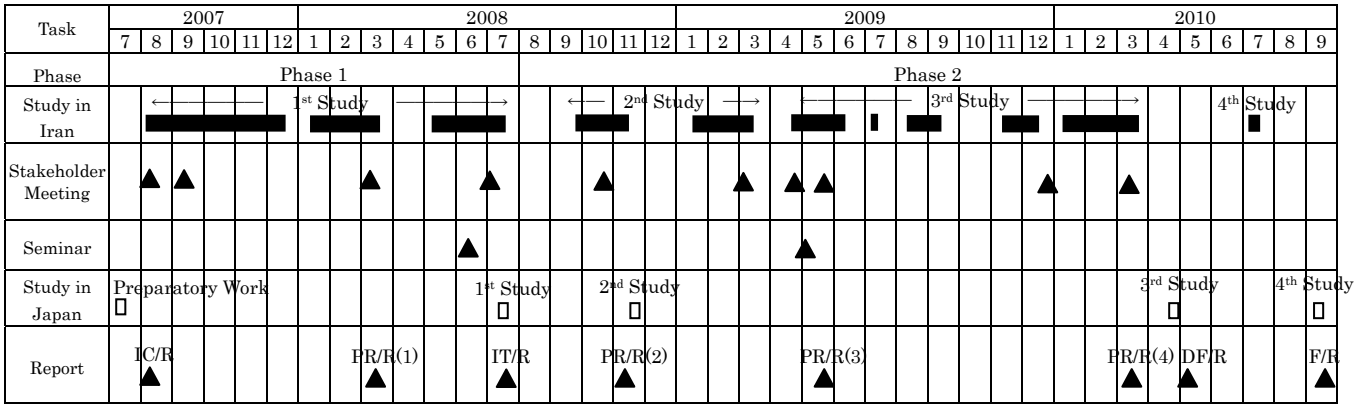
- to formulate a Master Plan (hereinafter called as "M/P") for integrated water resources management on the Sefidrud River Basin in the northwest of Iran, and
- to transfer the technology and to conduct training on integrated water resources management to the counterpart personnel through the course of the Study.

1.3 STUDY AREA

The Study Area is the Sefidrud River Basin with an area of 59,090km^2 covering 8 provinces; Zanjan, Kordestan, East Azarbaijan, Gilan, Qazvin, Ardebil, Hamadan, and Tehran as shown in “Study Area Map” at the beginning of the Report.

1.4 STUDY SCHEDULE

A time line for a work schedule is shown below in Figure R 1.4.1. The entire study duration is 21 months and each report shall be submitted as scheduled.



Legend: IC/R: Inception Report P/R: Progress Report IT/R: Interim Report
DF/R: Draft Final Report F/R: Final Report
Phase I: Basic Study
Phase II: Formulation of Integrated Water Resources Management M/P

Figure R 1.4.1 Study Schedule

1.5 IMPLEMENTATION ORGANIZATION OF THE STUDY

In order to support the Study comprehensively and to direct the implementation of it in an appropriate manner, a system to compile opinions and inputs from key organizations concerned such as the Steering Committee must be established. The Steering Committee will perform the following tasks:

- to review regularly the progress and achievements of the Study,
- to exchange views on major issues arising from or in connection with the Study, and
- to approve modification of the activities as needed.

The Steering Committee is convened by the chairperson as necessary. The Steering Committee consists a chairperson selected from the Water Resources Management Company (hereafter "WRMC") and representatives from the Regional Water Companies (hereafter "RWC") in the concerned provinces and other organizations.

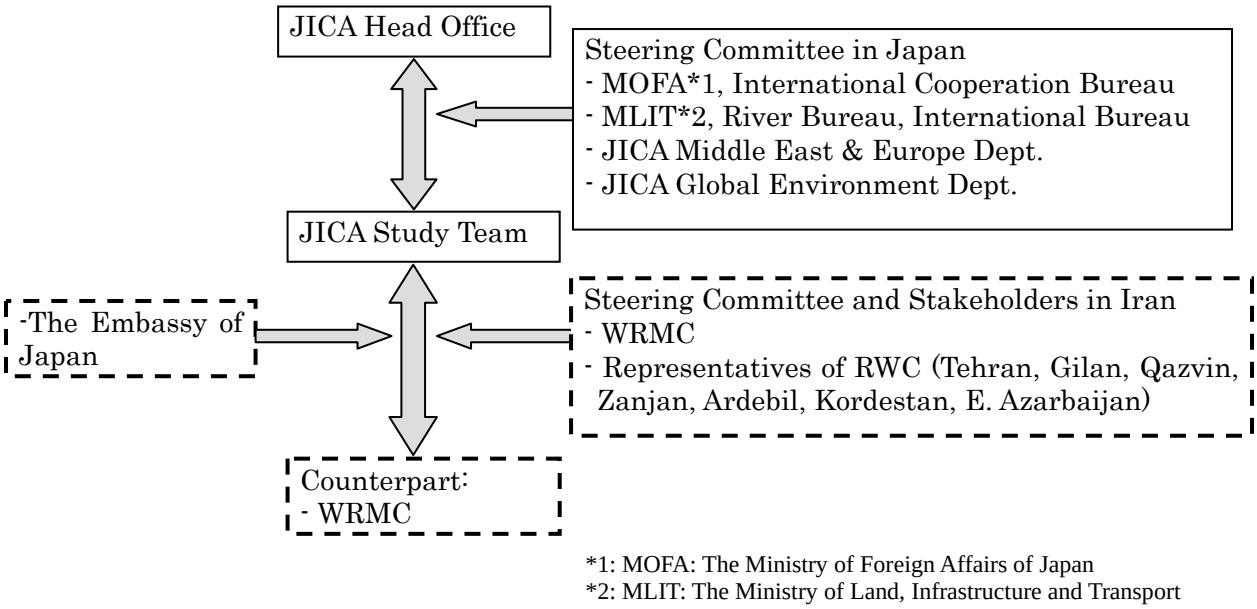


Figure R 1.5.1 Study Organization

CHAPTER 2. BACKGROUND CONDITION FOR THE STUDY

2.1 SOCIO-ECONOMY IN IRAN

System of the Iranian calendar and the Gregorian calendar is different as follows:

Table R 2.1.1 The Iranian Calendar and the Gregorian calendar

Iranian Calendar	Farvardin	Ordibehesht	Khordad	Tir	Mordad	Shahrivar	Mehr	Aban	Azar	Dey	Bahman	Esfand
	=	=	=	=	=	=	=	=	=	=	=	=
Gregorian Calendar	21-Mar - 20-Apr	21-Apr - 21-May	22-May - 21-Jun	22-Jun - 22-Jul	23-Jul - 22-Aug	23-Aug - 22-Sep	23-Sep - 22-Oct	23-Oct - 21-Nov	22-Nov - 21-Dec	22-Dec - 20-Jan	21-Jan - 19-Feb	20-Feb - 20-Mar

The Iranian year begins on March 21st of the year in A.D. and ends on March 20th of the next year. In order to convert the Iranian year into Christian year, 621 should be added to the former. For example, the year 1384 in Iranian calendar means the year 2005 of the year in A.D. In this report, the Gregorian calendar system is used, and a year starts on March 21st and ends on March 20th of the next year since the statistic datas in Iran are edited based on Iranian calendar.

2.1.1 Population

According to the Statistics, population of the nation has been increased drastically since the year 1958, the year when first census has been made, till the year 1993. However, after this year, the rate of increase has fallen down to the present as shown in the following table and figure. The population of the nation is 70.5 million as of 2006 referring to Census.

Table R 2.1.2 Historical Population Trend of Iran after First Census

Year in A.D.	Year in Iranian Calendar	Status	Population	Average Annual Growth
1956	1335	Census	18,954,704	3.10%
1966	1345	Census	25,788,722	3.61%
1976	1355	Census	33,708,744	3.07%
1986	1365	Census	49,445,010	4.67%
1991	1370	Census	55,837,163	2.59%
1996	1375	Census	60,055,488	1.51%
1997	1376	Projection	60,693,788	1.06%
1998	1377	Projection	61,768,682	1.77%
1999	1378	Projection	62,843,039	1.74%
2000	1379	Projection	63,916,859	1.71%
2001	1380	Projection	64,990,142	1.68%
2002	1381	Projection	66,062,889	1.65%
2003	1382	Projection	67,135,100	1.62%
2004	1383	Projection	68,206,775	1.60%
2005	1384	Projection	69,277,916	1.57%
2006	1385	Census	70,495,782	1.76%

Source: Iran Statistical Year Book 1385, Statistical Center of Iran, Management and Planning Organization, Iran.

Remark: Projection made by JICA Study Team during 1997 over 2005 by logarithmic mean as "y=2,147,102,390,.30Ln(x)-16,255,998,980.29" based on past trend.

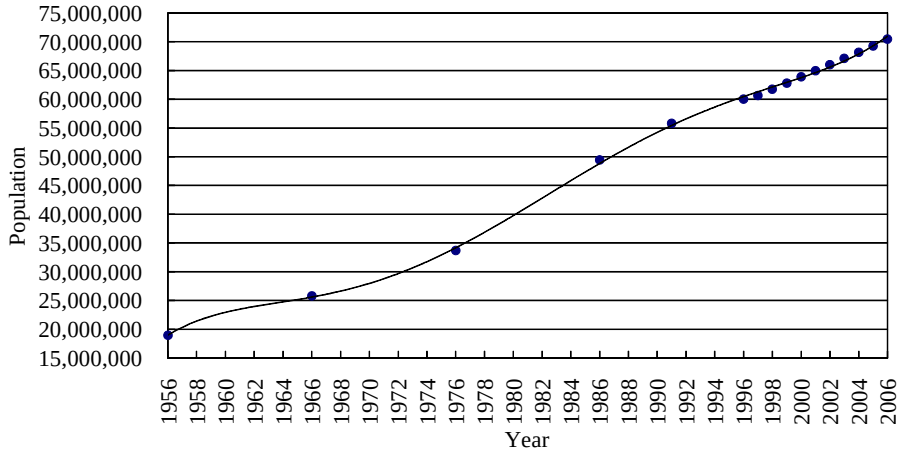


Figure R 2.1.1 Illustrated Historical Population Trend in Iran

Annual average increasing ratio of the population during 10 years period since 1996 till 2006 is 1.62 %. So far as indicated in the above table and figure, the population of Iran may be increased with the same rate.

2.1.2 Distribution of Ethnic and Religious Group

On ethnic, there are 11 well-known ethnic groups as (1) Persian (51 %), (2) Azeri (24 %), (3) Kurd (7 %), (4) Arab (3 %), (5) Lur (2 %), (6) Baloch (or Baluchi) (2 %), (7) Qashqai (unknown), (8) Turkmen (2 %), (9) Gilaki and (10) Mazandarani (8 %), and (11) Talysh and some others[1].

Figure R 2.1.2 Ethnic and Religious Groups and their Geographical Distribution

Shia Islam Twelvers is the state religion (around 90 %), but there are a little devotee groups of Sunni Islam (around 9 %) mainly living in border areas with Turkmenistan, Iraq and/or Turkey. Almost all of Baloches are the devotees of Sunni Islam. In addition to the Islamic religion, there are

[1] Percentages of ethnic groups are estimated value. There is no any formal statistics on ethnic group in Iran according to Wikipedia.

some minorities as Bahaism, Zoroastrianism (state religion in the Sasan Dynasty era), Judaism, and some Christianity as shown in the above figure.

2.1.3 Administrative Setup

Administrative setup in Iran is as shown in the following figure.

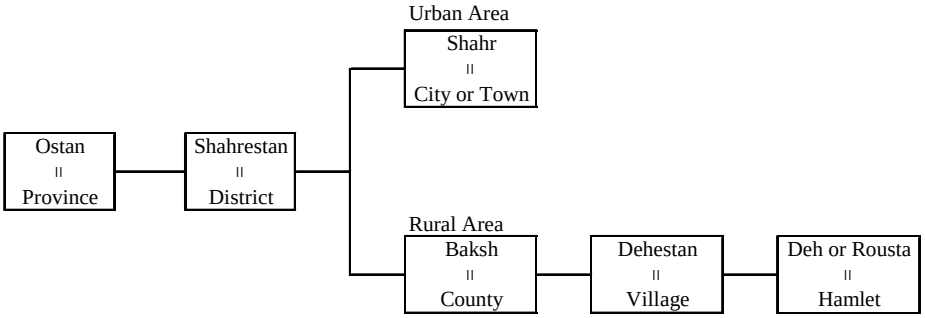


Figure R 2.1.3 Administrative Setup in Iran

In the above figure, the term of "Shahrestan" locally called is also translated as "township." However, according to administrative customs in almost of all the European countries, the township is usually set under the county after province. Accordingly, the term of "the shahrestan" has been translated into English as "District". The term of "shahr" means as "town" or "city". Village is locally called as "dehestan". However, above the dehestan, there is "baksh" which has been translated as "county", but this term is used for rural community only. The most subordinate administrative unit is locally called as "deh" or "rousta" that has been translated into English as "hamlet" in this report.

The whole territory of the nation of the Iran consists of 30 Provinces. Under the provinces, there are 336 Districts. Sub units of Districts are 1,015 Cities/Towns and 889 Counties. Following table shows its detail.

Table R 2.1.3 List of Provinces with Areas and Number of Administrative Units in Target Provinces

Province	Capital of Province	Area (km^2)	Number of District	Number of County	Number of Cities	Number of Village
East Azarbaijan	Tabriz	45,650	19	42	57	141
Ardebil	Ardabil	17,800	9	25	21	66
Tehran	Tehran	18,814	13	35	53	79
Zanjan	Zanjan	21,773	7	16	16	46
Qazvin	Qazvin	15,549	5	19	24	46
Kordestan	Sanandaj	29,137	9	26	23	83
Gilan	Rasht	14,042	16	43	49	109
Hamedan	Hamedan	19,368	8	23	27	72
Total of the Targeted Province		182,133	86	229	270	642
Total in Whole Iran		1,628,554	336	889	1,015	2,400

Source: Iran Statistical Year Book 1385, Statistical Center of Iran, Management and Planning Organization, Iran.

People living in Cities/Towns are classified as "urban population", and all the people living in Counties are classified as "rural population". Under the Counties, there are 2,400 villages. The lowest administrative unit is Hamlet, and unfortunately the number of Hamlets and population by hamlet are not reported in the statistics.

2.1.4 Financial Status of Government

As shown in the following table, the present financial status of the Government of Iran is 1,915 trillion Rials as of 2006 in terms of budget scale. This amount includes all the revenue sources

including central Government and local administrative, so that it literally is considered as "the national financial status".

Table R 2.1.4 Summary of Governmental Financial Status in Recent Years (Resources)

(billion Rials)

Budget Resources	2002	2003	2004	2005	2006	2007
1. Government Public Budget Resources	273,228	436,023	519,015	569,837	587,597	691,828
1.1 General Resources	240,240	395,554	459,925	537,859	548,571	639,452
1.1.1 Revenues	82,670	204,508	222,666	286,887	244,455	277,508
1.1.2 Cession of Capital Assets	102,558	126,852	150,834	137,371	154,878	175,725
1.1.3 Cession of Financial Assets	55,012	64,194	86,425	113,601	149,238	186,218
1.2 Special Resources	32,988	40,469	59,090	31,978	39,026	52,376
1.2.1 Special Revenues	32,988	40,469	59,090	31,978	39,026	52,376
2. Resources of Government Corporations, Banks and Affiliated for Profit Enterprises	435,915	554,337	688,921	1,055,969	1,372,838	1,677,065
2.1 Government Corporations	391,188	495,257	610,386	956,452	1,226,633	1,497,073
2.2 Banks	37,586	51,350	65,955	83,840	122,513	156,095
2.3 Affiliated for Profit Enterprises	7,141	7,730	12,579	15,678	23,691	23,898
Less: Duplications	15,841	22,099	23,429	35,817	45,329	52,037
Budget Resources in Total	693,302	968,261	1,184,507	1,589,990	1,915,105	2,316,857

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

Table R 2.1.5 Summary of Governmental Financial Status in Recent Years (Uses)

(billion Rials)

Budget Uses	2002	2003	2004	2005	2006	2007
1. Government Public Budget Uses	273,228	436,023	519,015	569,837	587,597	691,828
1.1 General Uses	240,240	395,554	459,925	537,859	548,571	639,452
1.1.1 Expenditures	155,635	285,750	315,711	382,829	377,935	399,400
1.1.2 Ownership of Capital Assets	54,987	85,206	99,841	112,979	156,551	184,438
1.1.3 Ownership of Financial Assets	29,618	35,554	44,373	42,051	14,084	55,614
1.2 Special Uses	32,988	40,469	59,090	31,978	39,026	52,376
1.2.1 From Government Special Revenues	32,988	40,469	59,090	31,978	39,026	52,376
2. Uses of Government Corporations, Banks and Affiliated for Profit Enterprises	435,915	554,337	688,921	1,055,969	1,372,838	1,677,065
2.1 Government Corporations	391,188	495,257	610,386	956,452	1,226,633	1,497,073
2.2 Banks	37,586	51,350	65,955	83,840	122,513	156,095
2.3 Affiliated for Profit Enterprises	7,141	7,730	12,579	15,678	23,691	23,898
Less: Duplications	15,841	22,099	23,429	35,817	45,329	52,037
Budget Uses in Total	693,302	968,262	1,184,507	1,589,990	1,915,105	2,316,857

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

In the "Budget Resources", the main resources is to be "Revenue", and the item corresponding to the Revenue is "Expenditure" in "Budget Uses" side. The detail of Revenue and Expenditure is shown in the following table. The item of so called as "the oil money" is not appeared in this table. And, the Government has continuously registered deficits in these several years. In other words, the financial status of the Government is not considered as "healthy financial status" in case that oil revenue is not included.

Table R 2.1.6 Revenue and Expenditure of the Government in Recent Years

(billion Rials)

Item of Revenue and Expenditure	2002	2003	2004	2005	2006	2007
Revenues						
Tax Revenues	62,416	74,781	88,998	130,160	177,617	197,295
Social Contributions	0	0	0	0	0	0
Grants	0	0	0	0	0	0
Revenues from Government Properties	4,562	119,581	114,861	139,111	50,345	57,212
Revenues from Sale of Goods and Services	4,738	5,372	6,892	12,159	9,413	12,504
Revenues from Penalties and Losses	1,671	1,548	2,821	2,493	2,709	3,306
Miscellaneous revenues	9,284	3,227	9,094	2,964	4,372	7,192
Revenue in Total	82,670	204,508	222,666	286,887	244,455	277,508
Expenditures						
Employees Compensation	57,132	63,639	74,362	84,747	116,659	140,266
Utilization of Goods and Services	22,492	25,419	26,367	29,550	32,263	35,872
Expenditures of Properties and Assets	2,616	399	343	432	463	799
Subsidies	38,692	36,309	39,676	44,298	60,600	62,862
Grants	6,965	8,142	8,837	11,545	43,857	13,823
Social Contributions	21,941	32,554	28,944	44,575	69,959	64,492
Other	5,797	119,289	137,182	167,683	54,134	81,286
Expenditure in Total	155,635	285,750	315,711	382,829	377,935	399,400
Operational Balance	-72,965	-81,241	-93,045	-95,942	-133,480	-121,891

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

The oil revenue is counted in "Cession of Capital Assets" in Capital Assets as shown in the following table in detail.

Table R 2.1.7 Detail of Capital Assets of the Government in Recent Years

(billion Rials)

Description	2002	2003	2004	2005	2006	2007
Section 1. Oil revenue	100,060	124,232	146,790	134,294	151,801	172,450
Section 3. Sale of public buildings and installations	276	116	312	-*	-*	-*
Section 4. Sale and cession of lands	155	274	393	-*	-*	-*
Section 5. Sale of machinery and equipment	574	430	450	-*	-*	-*
Section 9. Sale and cession of other capital assets	1,493	1,800	2,889	3,077	3,077	3,275
Total	102,558	126,852	150,834	137,371	154,878	175,725.1

*: According to Statistical Year Book, those data may not be separated by sections 3, 4 and 5.
Source: Management and Planning Organization, Iran Statistical Year Book 1385.

As shown in the above table, "Transfer of Oil Concessions" has mainly shared in the Capital Assets. From this viewpoint, it is clear that the Governmental finance is depended on oil revenue.

2.1.5 International Balance of Payment and Balance of Trade

As shown in the following table, the International Balance of Payment of Iran has been almost sound since 1996 except that in 1991.

Table R 2.1.8 International Balance of Payment in Iran in Recent Years

(million US$)

Description	(Iranian Calendar)	1370	1375	1380	1381	1382	1383	1384
	(Gregorian Calendar)	1991	1996	2001	2002	2003	2004	2005
Current account balance		-9,448	5,232	5,985	3,585	816	1,442	14,037
Trade balance		-6,529	7,402	5,775	6,201	4,430	5,653	19,043
Exports		18,661	22,391	23,904	28,237	33,991	43,852	60,012
Oil and gas		16,012	19,271	19,339	22,966	27,355	36,315	48,823
Non – oil exports		2,649	3,120	4,565	5,271	6,636	7,537	11,189
Import		25,190	14,989	18,129	22,036	29,561	38,199	40,969
Services balance		-4,919	-2,633	-495	-3,503	-4,535	-5,011	-5,894
Receipts		881	1,348	3,488	5,025	6,249	6,905	7,612
Transportation charges and insurance		0	366	731	1,316	1,704	2,051	2,288
Passengers services		61	123	231	250	233	261	337
Travel		57	19	891	1,357	1,033	1,044	992
Investment revenues		213	488	655	653	781	918	1,018
Other public services		218	51	576	632	1,099	1,128	1,263
Other private services		332	301	404	817	1,399	1,503	1,714
Payments		5,800	3,981	3,983	8,528	10,784	11,916	13,506
Transportation charge and insurance		2,737	1,668	1,539	434	756	876	1,213
Passengers services		127	16	6	240	278	309	430
Travel		734	258	708	3,750	3,842	4,093	4,380
Investment revenues		85	898	397	1,082	1,046	1,129	1,307
Other public services		1,567	872	1,135	2,065	3,306	3,706	4,040
Other private services		550	269	198	957	1,556	1,803	2,136
Transfers		2,000	463	705	887	921	800	888
Capital accounts		6,032	-5,508	1,150	2,534	4,476	7,388	-411
Long-term		1,350	-5,246	2,361	3,329	2,045	1,659	410
Short-term		4,682	-262	-1,211	-796	2,431	5,730	-821
Exchange rate changes(1)		0	1,403	-156	-210	-506	1,213	-1,000
Statistical discrepancies		1,319	1,219	-2,219	-1,242	-1,076	-1,312	948
Total balance		-2,097	2,346	4,760	4,667	3,710	8,731	13,574

1. Including decrease or increase in amounts of some foreign debts because of changes in exchange rates of some currencies.

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

However, in case that the amount of export of oil and gas is excepted, the amount of export has continuously exceeded the amount of import in international trade excerpted from the above table as the following table.

Table R 2.1.9 International Balance of Trade in Iran in Recent Years

(million US$)

Description	1991	1996	2001	2002	2003	2004	2005
Exports	18,661	22,391	23,904	28,237	33,991	43,852	60,012
Oil & gas	16,012	19,271	19,339	22,966	27,355	36,315	48,823
Non-oil	2,649	3,120	4,565	5,271	6,636	7,537	11,189
Share Rate of "Oil & Gas" to Export in Talal	85.80%	86.07%	80.90%	81.33%	80.48%	82.81%	81.36%
Imports (F.O.B)	25,190	14,989	18,129	22,036	29,561	38,199	40,969
Balance of Trade	-6,529	7,402	5,775	6,201	4,430	5,653	19,043

Source: Management and Planning Organization, Iran Statistical Year Book 1385, and the Central Bank of Islamic Republic of Iran.

As shown in the above table, the amount of oil and gas and their products has made up over 80 % every year. That is a reflection of the characteristic of this nation as second-largest oil producing country after Saudi Arabia in the world.

2.1.6 Value Added and Gross Domestic Product (GDP)

Gross Domestic Product means a balance of total producers' products in all the economic activities after deducting intermediate consumptions of them for production. Namely, the GDP is a cumulative amount of value added derived from all economic activities in the country.

Following table shows a summary of the value added in all the economic activities and the GDP in Iran during last several years since the 1991 till the 2005.

Table R 2.1.10 Value Added in All the Economic Activities and GDP in Iran

(billion Rials)

Description	1991	1996	2001	2002	2003	2004	2005	Share Rate to the Total GDP in 2005
At Current Prices								
Agriculture, Hunting, and Forestry	7,217	37,381	73,170	80,815	103,873	127,216	152,076	10.04%
Fishing	237	992	1,933	2,070	2,328	2,878	3,021	0.20%
Mining and Quarrying	3,932	38,234	113,838	115,648	169,093	212,781	316,916	20.93%
Manufacturing	10,428	41,824	98,958	117,659	142,962	179,743	234,936	15.52%
Water Supply, Electricity and Natural Gas	684	4,599	13,547	14,366	19,502	30,854	39,445	2.61%
Construction	3,816	16,578	28,258	37,337	47,095	47,464	56,386	3.72%
Wholesale & Retail Trade; Repair of Motor Vehicles and Personal and Household Goods	8,770	39,126	90,155	108,479	125,716	148,251	189,571	12.52%
								0.00%
Hotels and Restaurants	311	2,126	6,070	7,523	9,555	12,513	13,727	0.91%
Transport, Storage and Communications	3,441	13,943	44,561	54,107	67,979	82,387	100,220	6.62%
Financial Intermediation	550	3,026	13,181	16,977	26,736	36,376	48,429	3.20%
Real Estate, Renting and Business Activities	5,987	33,742	73,159	85,891	113,907	138,941	157,277	10.39%
Public Administration and Defense; Compulsory Social Security	3,379	15,822	35,932	42,599	53,244	68,113	87,651	5.79%
Education	1,546	9,007	22,433	28,647	37,084	45,270	46,549	3.07%
Health and Social Work	904	6,753	17,357	22,231	31,643	38,553	52,427	3.46%
Other Community, Social and Personal Service Activities	468	2,358	6,673	8,692	9,888	11,682	15,559	1.03%
Total	51,669	265,510	639,226	743,040	960,603	1,183,022	1,514,190	100.00%
Net Taxes on Imports	805	238	6,629	9,959	15,114	21,643	32,201	
Taxes on Imports	952	3,110	8,488	12,291	17,030	22,686	33,490	
Subsidies on Imports	-147	-2,872	-1,859	-2,332	-1,916	-1,043	-1,289	
Gross Domestic Product (at Market Prices)	52,474	261,767	733,909	952,563	1,185,192	1,547,991	1,931,304	
Gross Domestic Product excl. Oil (at Market Prices) *	46,410	226,862	528,156	633,358	800,338	983,468	0	
Net Income from Abroad	99	-1,649	1,455	-15,932	-21,772	-24,937	0	
Gross National Product = Gross National Income	52,573	260,118	735,364	936,631	1,163,420	1,523,054	0	
Less: Consumption of Fixed Capital	4,990	35,978	88,297	116,572	138,617	183,917	247,499	
National Income	47,583	224,140	647,067	820,059	1,024,803	1,339,137	0	
At 1997 Constant Prices								
Agriculture, Hunting, Forestry	33,900	41,911	44,463	50,646	51,959	49,280	55,206	11.51%
Fishing	1,449	1,297	1,242	1,276	1,488	1,707	1,823	0.38%
Mining and Quarrying	42,113	39,635	35,319	34,154	38,919	38,627	39,379	8.21%
Manufacturing	38,195	44,625	61,153	70,575	80,630	85,339	91,743	19.13%
Water Supply, Electricity and Natural Gas	2,360	5,460	5,340	5,545	5,872	6,360	7,255	1.51%
Construction	12,343	22,453	22,125	23,025	21,413	21,513	22,369	4.67%
Wholesale & Retail Trade; Repair of Motor Vehicles and Personal and Household Goods	42,740	44,777	66,013	69,870	76,069	86,754	91,543	19.09%
								0.00%
Hotels and Restaurants	2,310	2,436	3,024	2,678	2,451	2,717	2,705	0.56%
Transport, Storage and Communications	9,178	17,091	24,153	28,067	33,283	38,202	38,981	8.13%
Financial Intermediation	835	2,618	4,957	4,974	5,873	7,130	8,118	1.69%
Real Estate, Renting and Business Activities	24,952	43,916	46,792	51,951	55,082	59,784	63,013	13.14%
Public Administration and Defense; Compulsory Social Security	13,302	17,462	19,691	21,332	21,319	20,638	20,768	4.33%
Education	9,740	11,484	14,129	14,388	14,228	14,298	14,476	3.02%
Health and Social Work	5,786	8,430	10,458	11,228	11,605	11,802	12,988	2.71%
Other Community, Social and Personal Service Activities	3,309	3,148	6,149	6,238	6,233	7,854	9,083	1.89%
Total	242,511	306,743	365,009	395,947	426,423	452,003	479,452	100.00%
Net Taxes on Imports	4,215	262	1,590	2,056	2,272	3,650	522	
Taxes on Imports	4,984	3,418	7,036	9,136	10,466	13,584	14,288	
Subsidies on Imports	-770	-3,156	-5,445	-7,080	-8,194	-9,934	-13,766	
Gross Domestic Product (GDP at Market Prices)	246,726	307,004	366,599	398,003	428,695	455,653	479,974	
Gross Domestic Product excl. Oil (at Market Prices) *	201,380	272,297	314,911	335,263	365,641	393,350	0	
Terms of Trade Adjustment	-14,738	1,555	33,457	36,912	42,950	82,934	122,682	
Net Income from Abroad	-2,655	-1,675	485	-2,522	-2,780	-2,756	0	
Gross National Product =Gross National Income	229,332	306,885	400,542	432,392	468,865	535,832	0	
Less: Consumption of Fixed Capital	14,916	41,827	49,236	57,883	62,891	65,438	76,839	
National Income	214,416	265,058	351,306	374,510	405,974	470,393	0	

Source: Management and Planning Organization, Iran Statistical Year Book 1385 (and 1384 for Gross Domestic Product excl. Oil (at Market Prices).

The following table shows GDPs in terms of "Current Price" and "1997 Constant Price" excerpted from the above table together with calculated annual average increasing ratios.

Table R 2.1.11 Fluctuation of GDP in Iran and Its Annual Average Growth Ratio

(billion Rials)

Price Level	1991	1996	2001	2002	2003	2004	2005	Annual Average Growth
At Current Prices	52,474	261,767	733,909	952,563	1,185,192	1,547,991	1,931,304	25.64%
At 1997 Constant Prices	246,726	307,004	366,599	398,003	428,695	455,653	479,974	4.28%

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

As shown in the above tables, in the current price level, GDP growth has changed with quite high rate as 25.6 % of annual average growth rate. However, in case of 1997 constant price level, a real growth rate has only changed at 4.3 %. It means that the price increase has changed with quite high rate during this period.

From the viewpoint of contribution of the economic activities, "mining and quarrying" makes up 21 % to GDP as of 2005. The second and the third highest ones are "manufacturing", and "transport, storage and communications" with 15 % and 12% respectively. The economic activity of "agriculture" shares only 10 % to GDP as same as "real estate".

2.1.7 Consumer Price Index (CPI) and Inflation Rate

The inflation rate in Iran during 1980s to the former half of 1990s was quite high as more than 20 % per annum as shown in the following table.

After the year 2000, it becomes rather low comparing that in 1980s as around 15% in urban area. However, it is considered as the high rate.

For reference, the paper "Tehran Times" on October 11th, 2007 reports as "Iran's inflation rate rises to 15.8 % in the last 12 months to Sep. 22, 2007". And according to the said paper, the inflation rates have changed ranging from 12.8 % to 14.8 % until August 2007. This means that the consumer prices are still changing in high level.

Table R 2.1.12 Consumer Price Indexes in Urban Area and Inflation Rate

(1997 - 100)

Iranian Calendar	1365	1370	1375	1380	1381	1382	1383	1384	1385
Gregorian Calendar	1986	1991	1996	2001	2002	2003	2004	2005	2006
General index	8.8	22.4	85.2	177.9	206.0	238.2	274.5	307.6	349.5
Annual Average Inflation Rate Since 1986(%)	-	20.55	25.49	22.19	-	-	-	-	
Annual Average Inflation Against Previous Year(%)	-	-	-	-	15.80	15.63	15.24	12.06	13.62
Annual Average Inflation During Previous 5 Year (%)	-	20.55	30.63	15.86	(Average Since 2001)				14.46

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

As shown in the Table R 2.1.13, the inflation rate in the rural area is rather low comparing with that in the urban area.

Table R 2.1.13 Consumer Price Indexes in Rural Area and Inflation Rate

(2002 = 100)

Iranian Calendar	1382	1383	1384	1385
Gregorian Calendar	2003	2004	2005	2006
General index	114.60	130.20	145.90	163.9
Annual Average Inflation Against Previous Year(%)	12.74	13.61	12.06	12.34
Annual Average Inflation During Previous 4 Year (%)				13.15

Source: Management and Planning Organization, Iran Statistical Year Book 1385.

2.2 NATIONAL AND REGIONAL DEVELOPMENT PLANS

Iran is now in course of the Fourth Economic, Social and Cultural Development Plan (hereinafter referred to as 4th Development Plan) starting from 2005 to 2009.

In this plan, the Government has set several numerical targets in the forms of 4 categories as (1) Economic Sector, (2) Social Sector, (3) Sector on Cultural, Research and Technology and (4) Sector. The details are as indicated in the following tables.

Table R 2.2.1 Overall Numerical Targets of 4th Development Plan of Iran (Economic Sector)

Indicators		Average Growth during 1991 - 2001	Average Growth during 2005 - 2009
GDP Growth Rate	(%)	3.9	8.0
Per Capita GDP Growth Rate	(%)	2.4	6.6
Investment Growth Rate	(%)	4.3	12.2
Population Growth Rate	(%)	1.5	1.4
Labor Force Productivity Growth Rate	(%)	1.3	3.5
Unemployment Rate	(%)	4.7	4.2
Non-Oil Export Growth Rate	(%)	5.6	10.7
Liquidity Growth	(%)	27.3	20.0
Inflation Rate	(%)	23.0	9.9

Table R 2.2.2 Overall Numerical Targets of 4th Development Plan of Iran (Social Welfare Sector)

Indicators	1991	2001	2009
Expenditure Ratio of 10 % Richest to 10 % Poorest Families	33.4	19.4	14
Expenditure Ratio of 20 % Upper to 20 % Lower Families	14.2	10.0	5.5
Gini Coefficient	0.49	0.43	0.38
Social Welfare Indicators	251	423	800
Human Development Indicators	0.736	0.719	0.820
Percentage of Population under the Relative Poverty Line (50 % of the Median Income)	-	15	7
Mortality Rate for Children under 5 Years Old (per 1,000 people)	64.5	34.0	17.0
Life Expectancy at Birth (Year)	64.7	69.8	73.0

Table R 2.2.3Overall Numerical Targets of 4th Development Plan of Iran (Sector on Culture, Research and Technology)

Indicators	Existing Conditions	2009
Technology Accessibility Indicator	0.26	0.45
Educational Development Indicator Base = 100	78	84
Number of Scientists and Engineers Employed in Research and Development Sector (per 1,000,000 people)	336	2,000
Number of Registered Scientists License (per 1,000,000 people)	1	4
Percentage of Export of Hi-Technology Goods to Total Non-Oil Export	2	6
Percentage of Literate Persons 6 Years Old and Over	85.5	90.0
Number of Published Book Titles per 100,000 People	33.7	54.9

Table R 2.2.4 Overall Numerical Targets of 4th Development Plan of Iran (Sector on Government Systems)

Indicators	Numerical Target
Decrease in Number of the Government Employees	5.00%
Increase in Amount of Budget for the Government Units Administrated	50.00%
Volume of the Government Social and Cultural Undertaking Divested to Private Sector	15.00%
Decrease in Production of the Nation's Total Budget to GDP	10.00%
Decrease in Number of Managerial and Superintending Positions	20.00%
Percentage of the Government Agencies with Internet Facilities	100%
Percentage of the Clients Satisfied Manner of Service Provision	95%
Average Per-Capita Training of the Government Administrators and Employees per Year	40 hours
Share Rate of Budget for the Executive Agencies Divested to the Non-Government Sector for Development	15.00%

Source: "Law of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, 2005 – 2009", Management and Planning Organization).

In the 4th Development Plan, they have set GDP forecast in more detail as shown in the following table.

Table R 2.2.5 GDP Forecast Based on Numerical Target of 4th Development Plan of Iran

(billion Rials - 2002 Constant Price)

Industry of Origin	2004	Projection Based on Numerical Target					Annual Average Growth Rate
		2005	2006	2007	2008	2009	
Agriculture Sector	119,405	126,522	133,950	142,313	152,007	163,594	6.50%
Oil Sector	225,950	231,882	238,161	245,008	252,875	261,938	3.00%
Industrial and Mining Sector	200,872	221,888	245,803	272,925	304,326	342,073	11.23%
Industry	140,610	155,321	172,062	191,047	213,029	239,473	11.24%
Mining	5,424	5,991	6,637	7,369	8,217	9,237	11.24%
Construction	45,799	50,812	56,780	63,319	71,060	80,364	11.90%
Water, Electricity and Gas	9,039	9,763	10,324	11,190	12,021	13,000	7.54%
Service Sector	504,791	545,349	591,025	642,959	703,499	776,653	9.00%
Gross Domestic Products (GDP)	1,051,018	1,125,640	1,208,938	1,303,205	1,412,707	1,544,258	8.00%

Source: "Law of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, 2005 – 2009", Management and Planning Organization).

According to the above table, it is expected that the growth rate of agricultural production rises by 6.5 % in annual average by 2009. On the other hand, according to WRMC, the irrigation water supply volume will not be increased from the current volume. It means that irrigation system should be modernized as pressurization so that irrigation efficiency is improved.

They have also set "the Government General Budget Framework" as shown in the following table.

Table R 2.2.6 Framework of the Government General Budget in the 4th Development Plan

Item	2003	2004	2005	2006	2007	2008	2009	Annual Average Growth
Resources	367,261	459,925	457,492	521,184	593,111	670,808	758,648	10.53%
Revenues	182,723	222,666	270,406	322,747	376,859	437,948	511,170	18.08%
Tax	65,099	88,998	117,830	150,398	182,522	218,559	262,631	24.16%
Transparency of Price of Energy Carriers	103,886	104,000	123,417	136,776	150,937	166,441	185,797	12.31%
Others	13,738	29,668	29,159	35,574	43,400	52,948	62,742	16.16%
Disposable Capital Asset	129,031	150,834	134,765	148,055	166,118	186,117	204,311	6.26%
Oil Royalty	126,654	145,290	128,494	140,735	157,518	175,955	192,242	5.76%
Sales of Oil Products	1,500	1,500	0	0	0	0	0	0
Other Disposable Capital Assts	877	4,044	6,271	7,320	8,601	10,163	12,069	24.44%
Disposable Financial Asset	55,508	86,426	52,321	50,382	50,134	46,743	43,167	-12.96%
Outlays	367,261	459,925	457,492	521,184	593,111	669,808	758,645	10.53%
Expenses for Credit	178,252	200,836	222,234	244,458	268,903	295,794	325,373	10.13%
Energy Carrier Subsidy	103,886	104,000	93,790	96,498	94,508	83,675	62,331	-9.73%
Reimbursement of Credits for Targeting Energy Subsidy	0	0	10,627	20,278	36,429	56,766	75,900	-
Cost of Gasoline Import	0	10,855	0	0	0	0	0	-
Acquisition of Capital Assts for Development	60,987	99,861	102,821	134,746	171,070	214,374	275,841	22.53%
Acquisition of Financial Assets	24,137	44,373	28,020	25,204	22,200	19,200	19,200	-15.43%
Operational Balance	-99,415	-82,171	-75,245	-58,486	-42,982	-24,287	0	-103.60%
Balance of Capital Assets	68,044	50,972	31,944	13,309	-4,952	-28,256	-71,530	-207.00%
Balance of Financial Assets	31,371	42,053	24,301	25,178	27,934	27,543	23,967	-10.64%
Balance of Energy Subsidy	0	-10,855	19,000	20,000	20,000	25,000	47,563	-
Balance of Overall Budget	0	1	0	0	0	1,000	3	-

Source: "Law of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, 2005 – 2009", Management and Planning Organization).

2.3 LAWS AND REGULATIONS RELATED TO WATER RESOURCES

2.3.1 Laws and Regulations Related to Water Resources

Regarding overall water resources, the Government has following 4 related laws and regulations:

(i) the Law of Promotion of Investment in Water Projects in Iran and Enforcing Bylaw,

(ii) Water Allocation Law,

(iii) Iran Water Law and the Manner of Water Nationalization and

(iv) Fair Water Distribution Act.

Regarding potable water supply and wastewater, and industrial water supply, the Government also has following related regulations as:

(v) Rules, Approvals & By-laws of Water and Waste Water,

and furthermore, regarding water tariff in agricultural water supply sector, they have the following as:

(vi) Stabilization Law of Agricultural Water Charge.

Documents other than laws and regulations, they have a guideline as:

(vii) Stabilization Law of Agricultural Water Charges.

Furthermore, there is a survey report made by UNDP entitled as:

(viii) TDA Thematic Report on Legal and Institutional Framework for Water Sector in Armenia, Azarbaijan, Iran and Georgia

However, this report is for a international river named as "Kura-Aras River", so that it is not directly related to this Project. Hence it is used as a reference for "Laws and Institution" and/or "Conflict Management" of the our Project.

The said documents are those for related laws and regulations. In addition to the above, in course of reading and checking the documents (v) and (vi) above, the existence of:

(ix) Fair Water Distribution Act

has been cleared. It has become clear that the Article 33 in this document is the basic law for establishing the water tariff in course of checking the above document No.4 and No.5.

2.3.2 Development Strategy of Water Resources

As the documents reported in previous sub-clause, the document of "Long-Term Development Strategies for Iran's Water Resources" says that the Government raises a rate of utilization of surface water for Agriculture, 46% as of 2002, to 55% within the coming 20 years. It also says that the Government controls share rate of water demand for agriculture from 92% as of 2002 to 87% within the same term. and make shift to cash crops in agriculture sector to activate the regional economy.

Table R 2.3.1 Summary of Long-Term Development Strategies for Iran's Water Resources

No.	Title	Content
1	Macro management	National water management must be based on supply and demand management, water cycle, sustainable development, land use planning and joint basin, and to realize water resources integrated management, economic, social, infrastructural and service sectors must be coordinated with the water sector.
2	Water Resources Management	The utilization of Iran's water resources in each basin must be planned in such a way that the volume of the utilized underground water does not exceed the present utilized volume. Utilized share of surface water shall be increased from 46% to 55% within the coming 20 years.
3	Consumption Management	The irrigation efficiency must be improved up to two times so that agriculture water demand shall be reduced from 92% to 87% within the coming 20years. Efficient consumption of water shall be required and economical valuable crops shall be allocated. Priority will be drinking and hygiene, industry and service, and gardening and agriculture respectively.
4	Economic Value	Water management must determine and express the economic value of water, including its natural and climatic conditions having access to water, the value of investment in supplying, transferring, distributing and recycling water to be consumed in various sectors.
5	Quality Control	All water consumers shall control water pollution and water quality. Water consumers have to observe the national standards of water resources quality conservation and sewage disposal system.
6	Water Supply Costs	The price of water for various consumptions must be fixed to meet people's essential needs for drinking and hygiene.
7	Water Exchange	Exchanging water with neighboring countries shall be considered, considering the role of water in national development and its economic value in the region's market.
8	Land use Planning	Development projects and land use planning must take into consideration cost and inherent value of water.
9	Inter-basin Water Transfer	The projects of transferring water from the view point of sustainable development while observing interested parties' right and their technical, economic, social feasibilities and explanation and national interests.
10	Management and Structure	Structure of water management of decentralization shall be considered increasing people's and local organizations' participation.
11	Watershed/Basin Consumption	In provincial development plans, basins must be considered as effective territories in the economic and social development of the province.
12	Risk Management	Plans for drought and flood management must be prepared and executed with the cooperation of all related and organizations.
13	Urban Water Distribution	Various methods preventing water losses in water transfer lines and urban and rural water distribution networks must be adopted as the first priority.
14	Public Training	Public awareness programs for conserving water quantity and quality as well as optimized consumption of water must be compiled and executed.
15	Shared Waters	All the waters flowing out and joint waters must be harnessed and consumed. And frontier river rivers must be systematized observing economic and environmental standards.
16	Informal Management	Equipping and completing water quality and quantity gauging networks and information and communication systems must be considered.
17	Preservation of Historic Structure	The sustainable preservation, revival and operation of the historic hydraulic structures must be considered in providing and compiling water planning of the country.
18	Interdepartmental Management	High Water Council will coordinate the policies in water supply, distribution and consumption.

Source: Long-Term Development Strategies for Iran's Water Resources

CHAPTER 3. PRESENT CONDITIONS IN THE BASIN

3.1 SOCIOECONOMIC CONDITIONS

3.1.1 Population

1) Population in the Related Provinces

The last population census has been made in 2006. Following table shows its summary.

Table R 3.1.1 Population in Each Targeted Province

Target Area (Province)	Area (km^2)	Population					Population Density as of 2005 (persons/ km^2)
		1976	1986	1991	1996	2006	
		1355	1365	1370	1375	1385	
East Azarbaijan	45,650	2,368,252	3,077,882	n.a.	3,325,540	3,603,456	79
Ardebil	17,800	n.a.	1,036,202	1,141,625	1,168,011	1,228,155	69
Tehran	18,814	n.a.	n.a.	n.a.	10,343,965	13,422,366	713
Zanjan	21,773	584,823	787,369	857,727	901,724	964,601	44
Qazvin	15,549	536,587	798,898	n.a.	968,252	1,143,200	74
Kordestan	29,137	782,440	1,078,398	1,230,919	1,346,383	1,440,156	49
Gilan	14,042	1,581,872	2,081,037	2,204,047	2,241,896	2,404,861	171
Hamedan	19,368	1,088,124	1,505,826	1,651,320	1,688,958	1,703,267	88

Sources: Iran Statistical Year Book 1385, Statistical Center of Iran and Statistics in each Provinces.

As indicated in the above table, the population in Tehran Province including the Capital Tehran is overwhelming the other provinces.

3.1.2 Water Tariff (Irrigation Water, Potable Water and Industrial Water)

Water tariff system is stated in the Article 8 and 33 of the Law of Equitable Water Distribution as follows.

1) Water Tariff Systems for Agricultural Water Use

Water tariff utilizing surface water is to be fixed rate. It should be established by means of the following manners as: 3% of the unit yield in monetary terms for the modernized irrigation system, 2% of the unit yield in monetary terms for the semi-modernized irrigation system (mixed type irrigation systems), and 1% of the unit yield in monetary terms for the traditional irrigation system. According to this systems, RWC in each province should make a water tariff plan, should make an agreement with farmers (customers). In this case, the first party (RWC side) should obey and guarantee the agreed price of crops which is utilized for establishing the water tariff as a basis. In other words, the said first party (RWC side) should purchase the crops based on the guaranteed prices of them.

2) Water Tariff Systems for Potable Water

Basically, the tariff for potable water should be set by RWC. In this case, all the costs including the costs for making plan and research, initial investment for construction of facilities related to water supply, and operation and maintenance. However, final decision maker is to be the Council of Economy. The water charges based on this water tariff should collect by UWWC in urban area, and RWWC in rural areas. And after that, the collected water charges should be transfer to RWC from the UWWC or RWWC, provided that RWWC may be exempted to transfer the water charges to RWC. Namely, there is no water charge in rural area for potable water for ordinal households. UWWC and RWWC should consider all the cost for purification, supplying, operation and maintenance for facilities of all the water supply networks before making and sending bills to the customers.

According to the site survey made by the JICA Study Team, RWC sell water to UWWC and RWWC based on agreement (or contract) between them.

3) Water Tariff Systems for Industrial Water

There are 2 types of tariff systems in this category as (1) fixed tariff system and (2) variable system based on unit charge. The final decision maker is to be the Council of Economy.

4) Subscription Water Tariff

In case of newly construction by using the General Budget of the Government, the water user (contractor) can apply the water usage as single payment a year (one time payment per year) based on fixed tariff (from this viewpoint, it may be said as the same manner with the fixed tariff system as mentioned above). In this case, the amount of charge should be fixed taking investment cost, cost for operation and maintenance, water volume to be supplied (water volume to be utilized), area of land, purpose of water use, type of subscriber.

5) Supervising Tariff for Groundwater Resources

There are 2 types of tariff systems in this category as (1) fixed tariff system and (2) variable system based on unit charge. Also, the final decision maker is to be the Council of Economy for amount of both the systems. It does not need any payment by water users who use the groundwater for the purpose of agriculture and animal husbandry.

6) Compensation Tariff

In case of making some projects for recharging the groundwater for keeping groundwater level and/or water balance, such projects are usually financed by the General Budget of the Government. Consequently, the projects need to use water. In this case, the water volume to be utilized should be applied previously, and the tariff should be decided taking water to be needed, actual supplied water volume, total water volume needed per year into account.

7) Tariff of Technical Services

The Ministry of Energy may decide a tariff for any technical services given by RWC, and/or giving such services by other governmental companies. Customers and/or beneficiaries of such technical services should pay such charges to RWC or other governmental companies based on decided tariff of technical services.

8) Actual Water Rate in 2006

The table hereunder shows a status of actual water rate in connection with the Government Budget in 2006.

Table R 3.1.2 Number of Subscribers and Actual Water Rate as of 2006

WC in Each Province	Service population	Number of Subscribers				Unit Rate of Water as of 2006 (Rials/m^3)		
		Irrigation Water	Potable Water	Industrial Water	Total	Irrigation Water	Potable Water	Industrial Water
East Azarbaijan	3,603,456	1,201	2	1,002	2,205	8.6	452.5	1,452.6
Ardebil	1,228,155	5,611	4	105	5,720	38.3	83.6	77.0
Kordestan	1,440,165	3,200	2	264	3,466	13.1	58.1	0.0
Zanjan	964,601	-	2	-	2	16.8	100.0	0.0
Hamadan	1,703,267	-	2	-	2	18.0	121.0	0.0
Tehran	13,422,366	12,202	2	1,960	14,164	57.2	186.9	154.0
Qazvin	1,143,200	-	2	437	439	38.4	0.0	0.0
Gilan	2,404,861	5,094	2	416	5,512	21.0	120.4	0.0

Source: WRMC

Table R 3.1.3 Revenue and Production Cost of Water and Recovery Rate of Water Charge to OM Cost

RWC in Each Province	Revenue Due to Charge Collection (million Rials)				Actual Amount of Cost for Operation and Maintenance (million Rials)			Recovery Rate of Water Charge to OM Cost (%)		
	Irrigat-ion Water	Potable Water	Indust-rial Water	Total	Irrigat-ion Water	Potable/ Industrial Water	Total	Irrigat-ion Water	Potable/ Industrial Water	Total
East Azarbaijan	5,244	48,631	37,261	91,136	99,349	22,634	121,983	5.28%	379.48%	74.71%
Ardebil	34,607	1,825	304	36,736	80,500	822	81,322	42.99%	259.00%	45.17%
Kordestan	2,683	2,133	0	4,816	16,985	729	17,714	15.80%	292.59%	27.19%
Zanjan	384	1,200	0	1,584	12,720	0	12,720	3.02%	-	12.45%
Hamadan	860	1,997	0	2,857	10,535	1,379	11,914	8.16%	144.82%	23.98%
Tehran	22,880	131,208	77	154,165	104,120	60,561	164,681	21.97%	216.78%	93.61%
Qazvin	8,277	0	0	8,277	17,284	0	17,284	47.89%	-	47.89%
Gilan	46,848	8,437	0	55,285	56,548	20,559	77,107	82.85%	41.04%	71.70%

Source: WRMC

3.1.3 Other Findings

1) Share Rate of Water by Type of Facilities for Abstraction

Table R 3.1.4 Share Rate of Water by Type of Facilities for Abstraction as of 2006

Facilities	Purpose of Water Use	Share Rate	Type of Tariff System Applied
Well	Agricultural Use (for Irrigation)	46%	Supervising Tariff
	Non-Agricultural Use	4%	Supervising Tariff
Other Ground Water as Spring etc.		6%	-
Surface Water –Commercialized ones	Agricultural Use (for Irrigation)	23%	Water Tariff and Admission Charge
	Non-Agricultural Use	1%	Water Tariff and Admission Charge
Other Surface Water		20%	-
Total		100%	

(Note) Total abstracted volume of water is estimated at 90 BMC as of 2006.
Source: WRMC

2) Admission Charge in Case of Use for Agricultural Purpose

Admission charge for irrigation water is decided based on certain coefficients taking value added of land, initial investment cost for construction of canals, socio-economic background into account. The amount is decided between (1) 700,000 Rials/ha as minimum and (2) 18,700,000 Rials/ha as maximum.

3) Admission Charge in Case of Use for Industrial Purpose and Water Rate

Both of admission charge and water rate are decided based on the type of water use at site for industrial purpose.

4) Compensation Tariff

The compensation tariff is decided based on initial investment cost for the project for keeping water resources (groundwater in most of the case). The amount is to be decided between (1) 177 Rials/m^3 as minimum and (2) 1,000,000 Rials/m^3 as maximum (based on 2003 price).

5) General Criteria for Decision of Water Tariff Systems

According to the Article 33 of the Law of Equitable Water Distribution, the following criteria are set up.

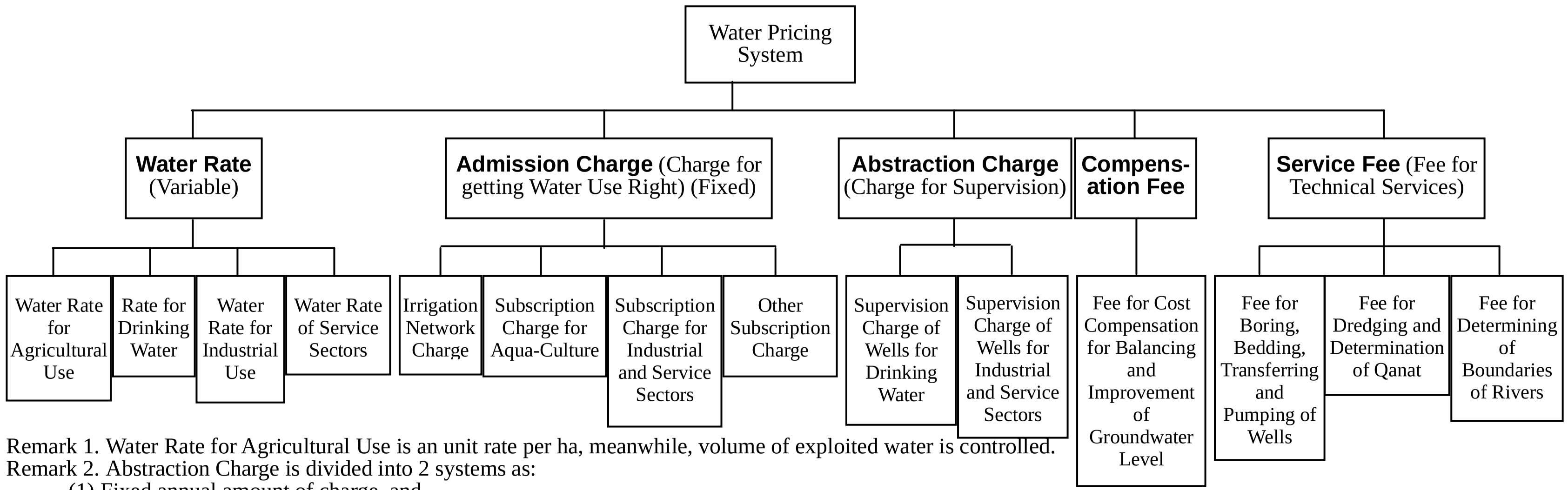
(i) The water tariff for both the agricultural use and non-agricultural use should be decided by the Council of Economy based on the type of use.

(ii) At site for execution of projects, the water tariff should be decided taking project cost, cost of operation and maintenance, repair cost, and depreciation cost into consideration.

(iii) At site other than the site of projects, the admission charge should be decided based on the costs of given services from the Government.

(iv) It should be taken differences of regional economic activities into account.

Overall Staructure of Water Tariff System



Remark 1. Water Rate for Agricultural Use is an unit rate per ha, meanwhile, volume of exploited water is controlled.
Remark 2. Abstraction Charge is divided into 2 systems as:
(1) Fixed annual amount of charge, and
(2) Unit charge for water consumed that is to be multiplied by consumed water volume.

Flow on Water Charge Collection

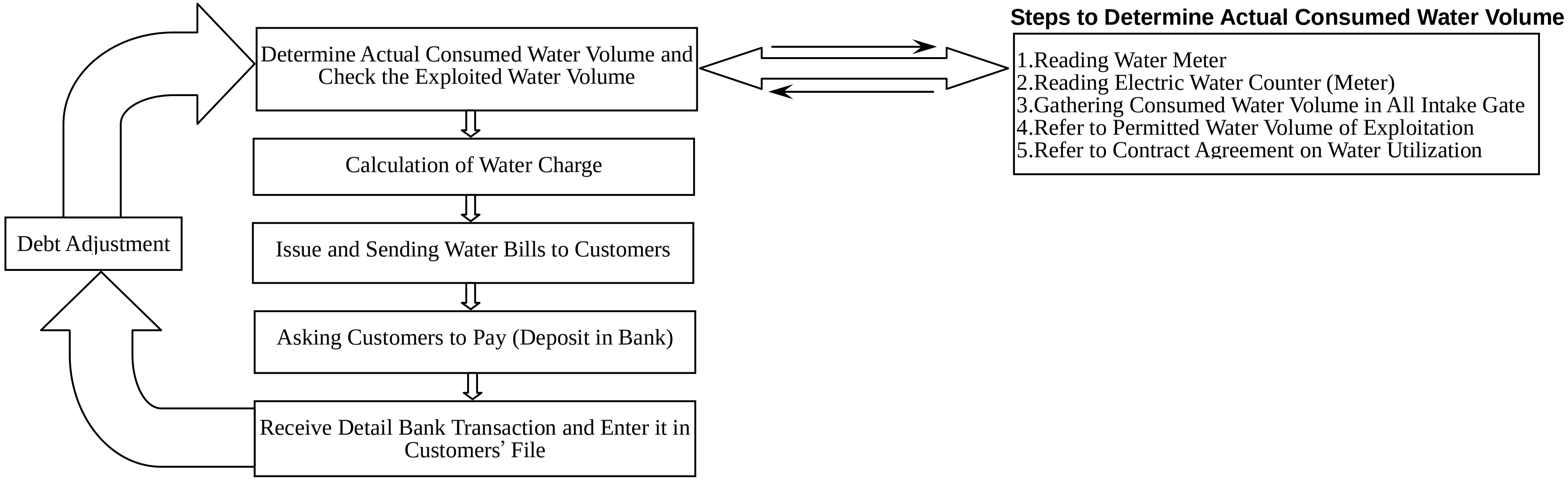


Figure R 3.1.1 Overall Structure of Water Tariff System and Flow of Water Charge Collection

As an actual application, the water tariff is decided based on 3 % of the unit yield in terms of value in previous year in case of modern irrigation system, 2 % of the unit yield in terms of value in previous year in case of semi-modern (mixed) irrigation system, and 1 % of the unit yield in terms of value in previous year in case of traditional irrigation system. Accordingly, the tariff system is revised every year because of actual unit yield in previous year.

Water tariff should be set up by "purpose of use" defined by the said laws, so that the water tariff should be different by each crops.

On the other hand, also from the viewpoint of laws, water tariff should be set up taking all the cost for initial investment, operation and maintenance. However, a practical way for setting up the tariff system is not based on cost basis, but based on yield basis (in other words, based on a basis of water productivity). It can be considered as "productivity basis" which is following as an extension of the concept of "the water tariff should be set up by the purpose of water use". However, it is not based on the concept of "to recover the cost", so that it is impossible to recover all the cost related. The cost, especially the initial investment cost, is financed by the General Budget of the Government. In the fact, recovering rates of revenue of water charge collection to the cost in total are not uniform and ranging from 3 % in Zanjan Province to 80 % in Gilan Province.

Namely, the concept of "the water tariff should be set up by purpose of water use" and that of "it should taking all the related cost as initial investment cost and the cost for operation and maintenance etc. for setting up the water tariff" cannot coexist in the same law Either one of the two concepts should be applied in this case. In this case, the productivity was accepted.

3.2 ORGANIZATION, INSTITUTION AND LEGAL SYSTEM

Iran water law and water nationalization law was issued in 1968, in which it is mentioned clearly that all the water resources belong to the Islamic Government. This law was amended as Fair Water Distribution Act and Water allocation Law. All the powers and responsibility concerning on water resources management belong to MOE.

3.2.1 Related Organization and Law

1) Organization

Major organization for water resources management and utilization are as below

Water policy organization

(i) Parliament, Supreme water Council (chairman is President of Iran)

Related organization of MOE

(i) WRMC (Water Resources Management Company)

(ii) RWC (Regional Water Company)

(iii) WWC (Water and Wastewater Company)

- UWWC (Urban Water and Wastewater Company)
- RWWC (Rural water and Wastewater Company)

Other ministry organization

(i) MOJA (Ministry of Jihad Agriculture)

(ii) MOI (Ministry of Industry and Mine)

(iii) DOE (Depertment of Environment)

2) Related Laws and Regulations

Major Law concerning on water resources management are shown below.

Table R 3.2.1 Major Law Concerning on Water Resources Management

No.	Law	Issued year
1	Fair Water Distribution Act	1983
2	Water Allocation Law	1983
3	Act of the Establishment of Water and Wastewater Companies	1983
4	Maintenance and Fixing of Boundary River Beds	1983
5	The law of Promotion of investment in water Projects in Iran and Enforcing Bylaw	2002
6	Preservation and Maintenance of Ground Water Resource	1966
7	Iran Water Law and the Manner of Water Nationalization	1968
8	Environmental Protection and Enhancement Act	1974
9	Prevention of Water Pollution Regulation	1994
10	Qanat and well Excavation Regulation	1984
11	Long-term Development Strategies of Water Resources	2003
12	The Articles of Association of Iran Water Resources Management Specialized Mother Company	2003
13	Farming Water Fee Law	1980

In above laws, Fair water Distribution Act ,Water Allocation Law, The Articles of Association of Iran Water Resources Management Specialized Mother Company and Long-term Development Strategies of Water Resources are especially quite significant law to manage water resources fairly.

Fair Water Distribution Act

Water and its Nationalization Law was issued in 1968. After Islamic revolution, the law was amended in 1983. The law consists of 52 Articles and 27 Notes. This law is the most basic law for water resources management with nullifying the regulations which disagree with this law.

Water Allocation Law

This Water Allocation Law was issued based on Articles 21 and 29 of the Fair Water Distribution Act and article 1 of Energy Ministry establishment law in line with the implementation of the Fourth National Development Plan in 1983. The law consists of 21 Articles and 5 Notes.

The Articles of Association of Iran Water Resources Management Specialized Mother Company

The objective of establishing the company is to arrange the activities under the charge of the Water Affairs of the Ministry of Energy, including the organization, direction and technical, engineering, legal, financial and administrative supports of the subsidiary companies to recognize, study, develop, conserve and operate water resources and installations efficiently, and exploit hydropower energy and operate the related systems. The law was issued in 2003 and consist of 21 Articles and 5 Notes.

Farming Water Fee Law

This is water fee law for agriculture and was issued in 1980. Water fee is different depending on condition of irrigation system. The law consists of 3 articles and 2 Notes.

The law of Promotion of investment in water Projects in Iran and Enforcing Bylaw

This law was issued in 2003, in order to promote cooperative and private sectors (real and legal entities) to invest in the projects for water supply and construction of drainage and irrigation networks and water and soil. Privatization is the policy of the Government and people can participate widely and implement water projects. The law consists of Single Article, 29 Articles and 12 Notes.

Long-Term Development Strategies for Iran's Water Resources

Long-Term development Strategies for Iran's Water Resources is the basic policy for the water resources management. WRMC prepared the strategies and it was approved by the Cabinet on October 19, 2003.

3.2.2 MOE

Main work of MOE is water resource management, power supply, other energy supply and training of human resources. Eight of organizations were established as legal independent entities. WRMC and WWC are one of those organizations.

RWC is established as regional organization of the WRMC in every province. RWC conducts water resources management for each province respectively.

UWWC and RWWC are regional organization of the WWC located in every province. UWWC controls urban area as town and cities, and WWC controls rural area. It was separated after "Water and Wastewater Companies Establishment Law" were issued in 1981. Then "Rural Water and Wastewater Companies Establishment law" were issued in 1995. Water supply and wastewater for rural area was transferred from MOJA to RWWC.

1) Water Section

(i) Reservation and supply of water and conveyance for domestic usage as drinking water, agricultural and public usage for commercial and industry water.

(ii) Protection, control and utilization of surface and ground water resources (rivers, river banks, springs, currents, water canals, qanats, wells and etc.)

(iii) Formulation of draft of laws on water resources and propose the bills to the government and parliament.

(iv) Participation to commission and conference related to water to improve their technology and know-how.

(v) Policy making and planning of the suitable approaches for implementation of water projects in the frame work of laws and plans of the government.

(vi) Planning and research of water resource project and employment of specialist.

(vii) Coordination, supervision and evaluation of the activities of sub-companies or public corporation for water resources.

(viii) Promotion of national and foreign investments and fostering the suitable environment for private sector to participate in water projects in the country..

2) Water and Wastewater Section

(i) Policy making, planning and implementation of water supply and treatment of urban & rural water.

(ii) Policy making, planning, implementation and development of rural water collection and conveyance.

(iii) Preparation & formulation of draft of laws on water tariffs and propose the bills to the parliament and government annually.

(iv) Researches for the activities of the water and wastewater companies, and coordination of the staff's training.

(v) Attendance in domestic and international conferences to exchange learning for water & wastewater projects and develop new project.

(vi) Preparation of standards and executive procedures in order to improve water & wastewater services, optimize the facilities and qualitative control of domestic sewage.

(vii) Coordination, supervision and evaluation of the activities of sub-companies or public corporation for water & wastewater.

3) Power Section

(i) Policy making, planning, implementation and development of power generation, transfer and distribution throughout the country.

(ii) Study and preparation of policy, code, law and program for power consumption price and power subscription, which will be presented to the government and parliament.

(iii) Research and coordination to improve the scientific level of the power industry staff.

(iv) Promotion of national and foreign investment, and fostering the suitable environment for private sector to participate in electricity projects.

(v) Attendance in domestic and international conferences to exchange their learning and to improve the power industry.

(vi) World trend research of power consumption and subsidies to improve those in Iran.

(vii) Coordination, supervision and evaluation of the activities of sub-companies or public corporation for electricity.

4) Renewable Energy Section

(i) Determination of the major energy policies.

(ii) Planning and implementation of renewable energy considering the characteristics of each region.

(iii) Study and research of potentiality and feasibility of renewable energy.

(iv) Study and research to optimize renewable energy.

5) Technology and General Control Section

(i) Study and research to improve national potential in manufacturing the equipment of water and power projects in Iran.

(ii) Management of production and manufacturing of spare parts of water and power projects.

(iii) Engineering for water projects in foreign country.

6) Planning and Human Resource Section

(i) Policy making and management of human resource to optimize the control and improve the quality of work.

(ii) Study and research to apply technology to water and power industry.

(iii) Training of engineers and planning of training for electricity and water.

(iv) Formulation of long-term water and power strategy based on short-term and middle-term strategy, and submitting the budget bill to MOE.

(v) Explanation of laws and bills of MOE to Islamic Council Majlis (Islamic Parliament).

7) Planning & Human Force Section

(i) Policy making and conducting the human resources in order to enhance the studies and programming in order to present a suitable management pattern.

(ii) To study & research in order to apply the information technology in water and power industry.

(iii) Policy making and programming to researches and studies and fostering grounds for education , training and absorption of specialized human force in water & power industry.

(iv) To formulate long-term strategic plan and to combine the short-term & middle-term of different sections of water & power sections and presenting the budget bill of the MOE.

(v) Suitable and continuous relation with Islamic Council Majlis (Islamic Parliament) to explain (justify) and make approve the required laws and bills of the MOE.

a) Organization Chart

MOE's organization is under the renewal process which has been started since 2007. Organization chart shown as below is just before renewal..

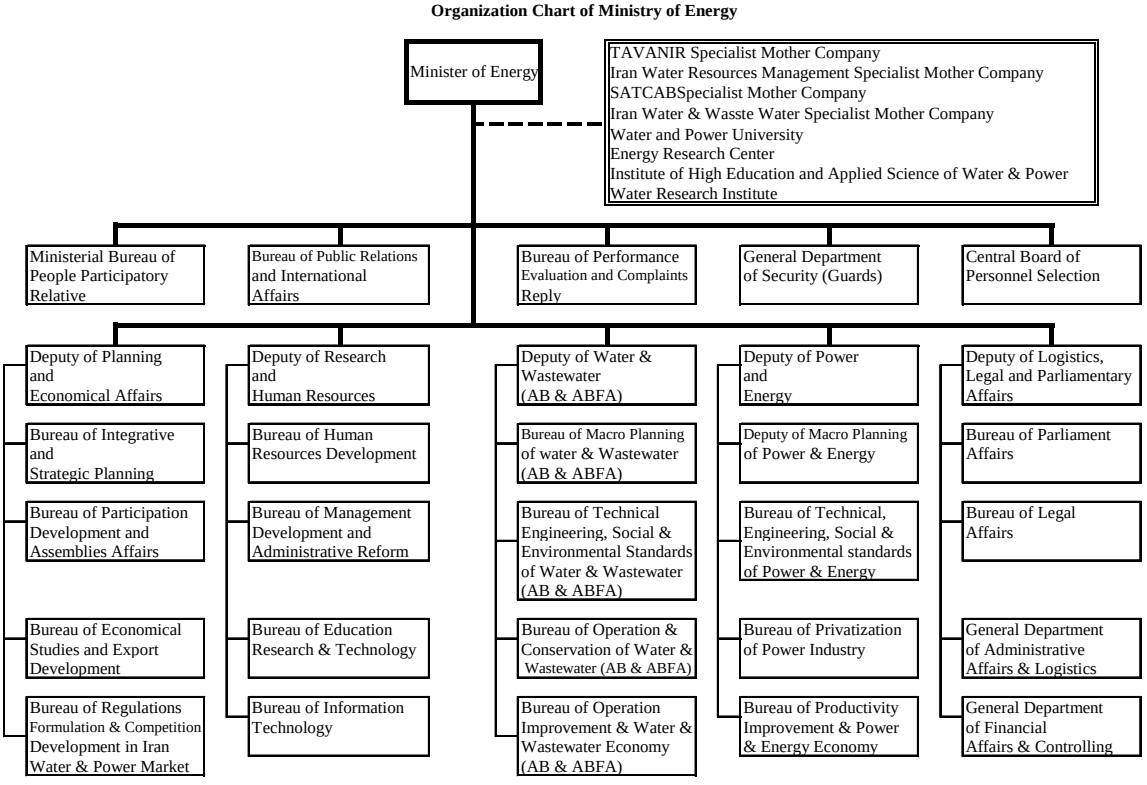


Figure R 3.2.1 Organization Chart of MOE

b) Flow for Application of Proposal and Permission

There are several water-related projects like drinking water, irrigation and industrial water, which are categorized from nation wide to provincial level. Flow for application of proposal from water users to MOE and permission is shown as below. The flow is categorized into four levels from view point of project scale, budget scale and importance.

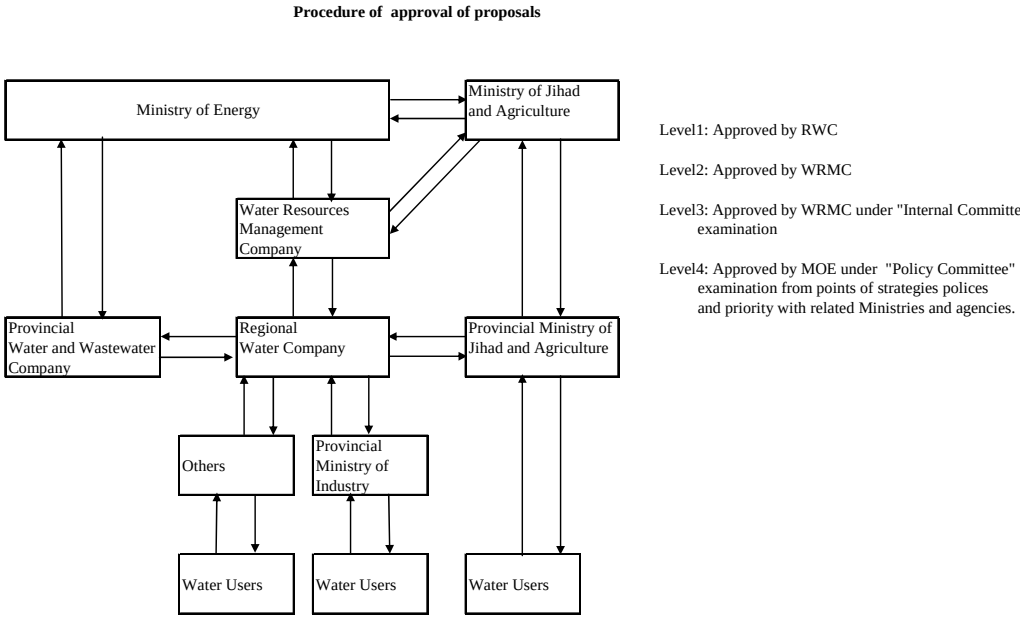


Figure R 3.2.2 Flow for Application of Proposal and Permission

3.2.3 WRMC

WRMC was established as a legal and independent entity in 2003 according to The Articles of Association of Iran Water Resources Management Specialized Mother Company.

Major work is, as an agency of the Ministry of Energy, to enforce the law of Fair Water Distribution and other rules and regulations related to water, including the planning and development, management and control of water resources, basic researches of water resources and hydropower energy.

The company's capital amounts to ten million Rials (IRR 10,000,000) divided into 100 name stocks and each stock amounts to 100,000 Rials. All the stocks belong to the government. Company's structure is same as corporation, but management is not for profit and the company acts as an agency of MOE. Operation and Duties of the company is mentioned in Chapter2 of the Articles of association of Iran Water Resources Management Specialized Mother Company as below.

(iv) To enforce the Law of Fair Distribution of Water and other regulations related to water as an agency of Ministry of Energy.

(v) Management and control of water resource, quality and quantity.

(vi) To examine strategy of long and medium term policies, which are to be submitted to Ministry of Energy.

(vii) To enforce the plans approved by Ministry of Energy.

(viii) Measurement of flow rate and water quality and related basic study.

(ix) Planning, implementation and control of following projects; water supply, irrigation and drainage networks, operation of dam, river and embankment, flood control, hydropower generation.

Note: Hydropower generation is undertaken by the subsidiaries observing operation instructions and supervised by National Dispatching Protection Center of National Power Grid.

(x) Planning of ordinance for appropriate use of water and submit to Ministry of Energy.

(xi) Control and optimization of water consumption and punishment against wasting water as a representative of Ministry of Energy.

(xii) To provide technical instructions, codes, criteria and standards required for the construction, maintenance and operation of water installations and structures and to submit them to Ministry of Energy for approval.

(xiii) Transfer of information on water and hydropower, technology transfer, development of research and financial support.

(xiv) Improvement of human resource and control of hydropower facilities.

(xv) Support of education for water sector and training of water engineer.

(xvi) Participation to domestic and international associations within the framework of the related laws and regulations.

(xvii) Cooperation with domestic and foreign organizations and exchange the scientific information.

(xviii) To suggest water tariffs to the subsidiaries of the Ministry of Energy and coordination to determine the water tariffs.

(xix) To conclude the contracts for wholesale transactions of water and hydropower via subsidiaries.

(xx) Management of financial resources, investment to supplying and transferring water and hydropower energy, efficient consumption of these resources through facilities and financial resources circulation among the company and subsidiary.

(xxi) Establishment of financial and executive management strategies for implementation of the projects.

(xxii) To arrange and collect loans and mortgages from domestic and foreign resources, issue bond and assure the revenue for budget

(xxiii) Planning and implementation to assure revenue by involvement of citizen and private sector to water-related project, financial support and management of related facilities.

(xxiv) Assistance for private sector participation in the researches, construction, operation and maintenance of water and hydropower projects.

(xxv) Coordination of technical, financial and administrative relations among participant companies.

(xxvi) Appraisal of annual operation of participant companies regarding technical, financial and administrative management and human resources.

(xxvii) Establishment of new relevant companies and partnership based on the related regulations.

(xxviii) Performance of operation related to the company's objectives and any operation related to the company's objectives.

1) Organization Chart

WRMC organization is under the renewal process in accordance with MOE. Organization chart shown as below is before renewal.

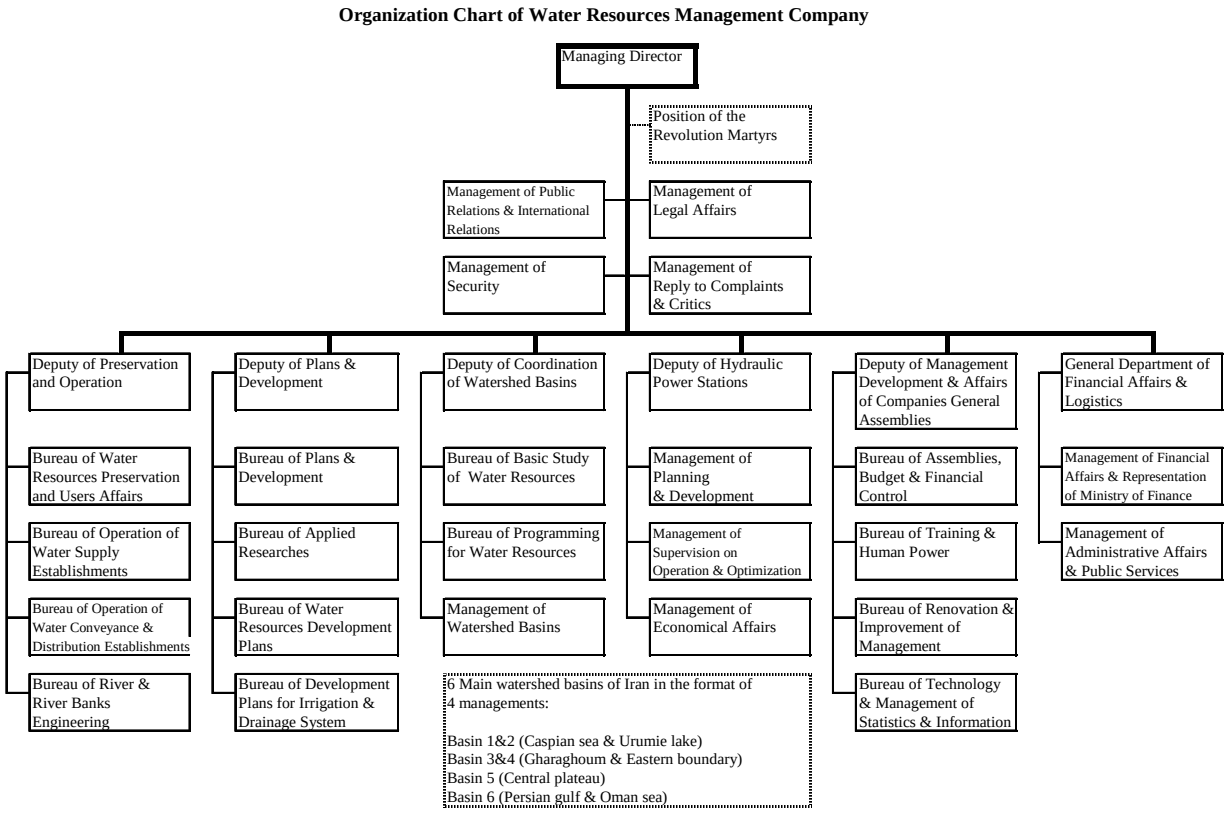


Figure R 3.2.3 Organization Chart of WRMC

2) Budget and Personnel

Number of normal personnel is 300 and the one of temporary personnel is 50. Revenue and expenditure of current five years of WRMC are shown as below.

Table R 3.2.2 Revenue and expenditure of current five years of WRMC

Year	Revenue (Million Rials)	Expenditure (Million Rials)
2003	41,651	44,519
2004	55,826	58,694
2005	66,916	69,640
2006	74,459	77,183
2007	89,845	92,845

Source：WRMC

3) Deputy of Coordination of Watershed Basins Management of Watershed Basins

Watershed basin through the country is managed by Deputy of Coordination of Watershed Basins Management of Watershed Basins. There are six main watershed basins in Iran and classified into four management divisions. Basin name and divisions are shown as below.

- Basin 1&2: Caspian Sea, Urumie Lake
- Basin 3&4: Gharaghoum & Eastern boundary
- Basin 5: Central plateau
- Basin 6: Persian gulf & Oman Sea

There are about 30 large and small rivers in the six watershed basins and Sefidrud River basin is one of them. Sefidrud River basin belongs to Basin 1&2: Caspian Sea, Urumie lake. Management of Caspian Sea and Urumie lake compose two Groups, Programming Group and Coordination, Evaluation and Supervision Group. Total personnel are 7.

TOR for Management of Watershed Basin composes of 19 articles. All of them are useful and effective. Some of them are very useful for solving conflicts and are shown below.

- To determine duties and methods of common surface and ground water resources management between RWC in River Basin
- To reform and improve water management methods in River Basin by the results of technical and social study particularly through nonstructural techniques
- To combine and integrate the results of province units' activities in River Basin
- To provide programs for research development and performance of research plans in integrated management and comprehensive water resources in River Basin in order to coordinate and perform total supervision
- To formulate consistent rules for water use rights throughout the basin as integrated water resources management in order to promote regional development
- To provide total aspect of water supply and demand in River Basin by conduct reports and regarding potential of regional water and specify critical regions and priority of some regions
- To recommend and persist in ratify laws and new guidelines and reform law and current criterion in the framework of integrated water resources management
- To settle confrontations between local managers about water allocation in River Basin
- To formulate integrated management concepts in River Basin

3.2.4 RWC

RWC is established as regional organization of the WRMC in every provincial capital. RWA (Regional Water Authority) was changed as water management organization for each province in 2006. Some of the RWA had managed plural province before then.

Table R 3.2.3 RWA and managed province before renewal

Name	Managed Province	Metropolis
East Azarbaijan/ Ardebil RWA	East Azarbaijan, Ardebil	Tabriz
Zanjan RWA	Zanjan	Zanjan
Gilan RWA	Gilan	Rasht
Tehran RWA	Tehran, Qom, Qazvin, Semnan, Markazi	Tehran
Gharb RWA	Kermanshar, Lorestan, Illam, Hamedan, Kordestan	Kermanshah

Source：JICA Expert Report February 2006

Each RWC was established newly as below. Gilan RWC is the earliest established and Kordestan is the latest established.

Table R 3.2.4 Established year of RWC

RWC	Gilan	East Azarbaijan	Qazvin	Ardebil	Zanjan	Kordestan	Tehran
Established year	1984	2003	2006	2006	1993	2007	2006

RWC is also under renewal and organization is not fixed yet. Each provincial structure is similar except some part. Number of personnel and budget are different from each province.

Major work is to conduct planning and development of water resources(surface water and underground water), conservation, utilization, operation and maintenance for water facilities, planning of water distribution, permission for water use, permission for construction of well, river protection and maintenance.

RWC permits the proposal of small scale projects which is possible within RWC'S budget. In case of important projects and insufficient budget, the proposal is counseled at WRMC. In case of much more important projects and insufficient budget of WRMC, the proposal is counseled at MOE. The entire proposal is counseled from view point of technical, economic, social, environment and political points. Procedure for permission of water use is made by RWCand final permission is given by MOE.

Proper water allocation is discussed among MOJA, UWWC, RWWC and RWC and conducted. Basic demarcation for management is provincial border. Sefidrud river basin is expanded over eight provinces and each province maintains their water resources to secure and use respectively.

Management of whole river basin is quite difficult under present system and it causes conflict among related provinces. Although WRMC coordinate stakeholder to balance the benefit throughout the country as a representative of MOE, management is difficult in fact.

Water resources management committee is established in RWC. Committee members consist of managing director, deputy of each bureau and expert. The committee is held regularly. Other committees were established such as Council for dam and technique, project development committee, planning committee, organization improvement committee, ISO steering committee, IT work group and so on. Number of committee and kind is different from each province.

1) Organization Chart

Its organizational structure is under reorganizing in each RWC. As the interview result, structure of each RWC is quite similar. Gilan RWC structure is shown as a typical organization. Chart.

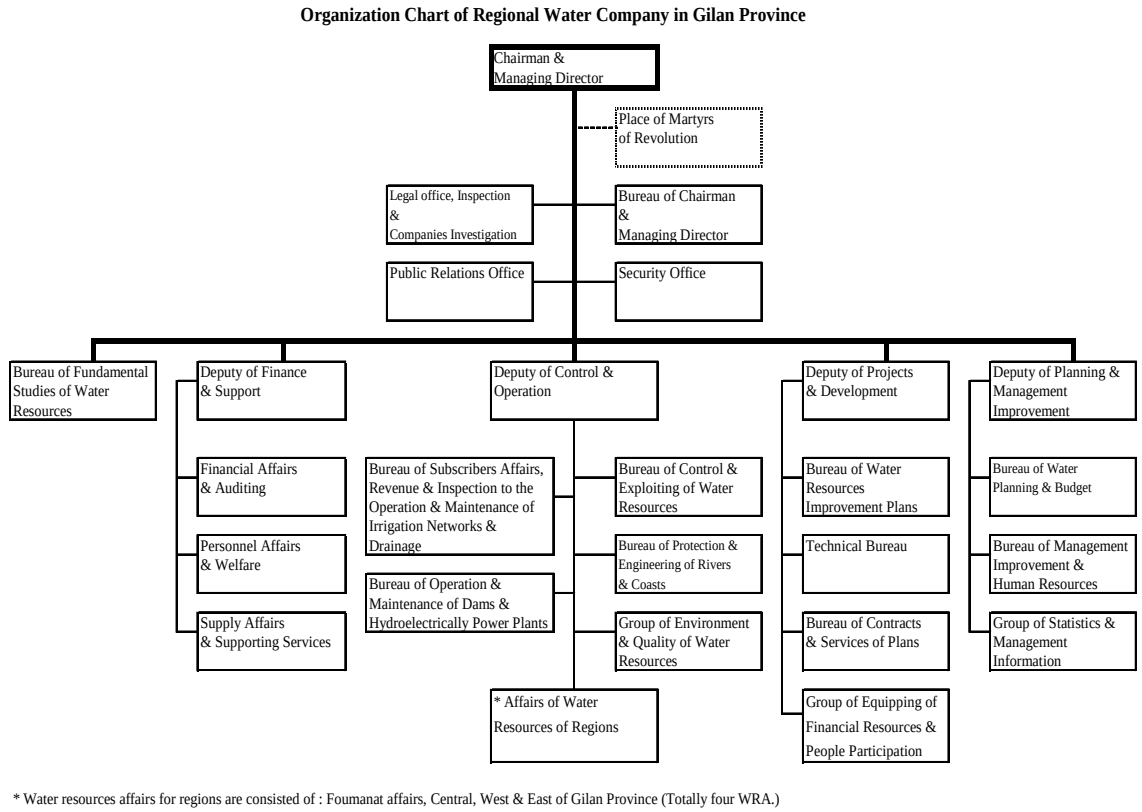


Figure R 3.2.4 Organization Chart of RWC

2) Budget and Personnel

Their expenditure exceed the revenue in most of RWCs. The shortage of budget was made up by the Central Government. Tehran RWC is the largest expenditure with 356 billion Rials and Zanjan RWC is the smallest expenditure with 22 billion Rials.

Numbers of staff vary from 100 to 600 including temporary workers, average about 300. Revenue and expenditure in 2007 and numbers of staffs are shown as below.

Table R 3.2.5 Revenue and expenditure in 2007 and personnel

RWC	Revenue (Million Rials)	Expenditure (Million Rials)	Staff (Numbers)
Gilan	164,408*	174,538*	397
East Azarbaijan	162,911	265,995	592
Qazvin	12,425	45,362	100-150
Ardebil	57,616	83,960	160
Zanjan	8,213	21,821	210
Kordestan	10,445	32,484	300
Tehran	356,599	356,599	400

Source: RWC and WRMC
Note:* Gilan RWC shows budget of 2006

3) Role of Work

Overall water resources management in Province including:

- Planning of water allocation for irrigation, drinking water and industry water

- Study for water resource development plan for province
- Planning and implementation of water facilities
- Operation and maintenance for major water facilities
- Maintenance and preservation of river
- Preparation of application document for water users
- Coordination of trouble regarding water use
- Observation for hydro-meteorology
- Preparation of database on data, statistics and information

3.2.5 UWWC and RWWC

UWWC and RWWC were established through the country and counting 64 in total. Each Province has one UWWC and one RWWC except Esfahan, Khoseztan, Khorsan and Fars province. These provinces are so wide that they have three in one Province. UWWC manages water distribution for urban areas and RWWC for rural areas.

National Water and Wastewater Engineering Company (Head Quarter of UWWC and RWWC) was established in 1988, and UWWC and RWWC were established later in each province.

Water consumption plan is made by UWWC and RWWC every year and the water is requested to RWC in each province. Water amount requested in the plan tends to increase every year. UWWC and RWWC buy water from RWC. Water fee is collected in accordance with tariff. The tariff is decided by the Council of Economy. Water fee is different in each province and between urban and rural areas. Water fee in rural areas is usually set lower than that of urban area by 70%.

3.2.6 OMC (Operation and Management Company)

OMCs are established in some provinces. Organizational structure varies by Province. For example, some OMC's stocks are held with 49% by WRMC and 51% by private companies (Qazvin, Gilan). Another OMC's stocks are held with 100% by private companies (East Azarbaijan). OMC conducts operation and maintenance work for irrigation under the contract with RWC.

OMC in Gilan province and East Azarbaijan are explained as examples hereinafter.

1) Gilan Province

WRMC holds 49% of the company's stocks and the remaining are held by private companies. Its main task is operation of water distribution for irrigation water and maintenance for irrigation facilities under the contract with RWC. Number of staff is 15. Among them 11 is approved by MOE and 4 is approved by Managing Director in central organization. There are five regional offices under Vice Director of Operation. Besides, there is a Sub-region Office under each Regional Office.

a) Organization Chart

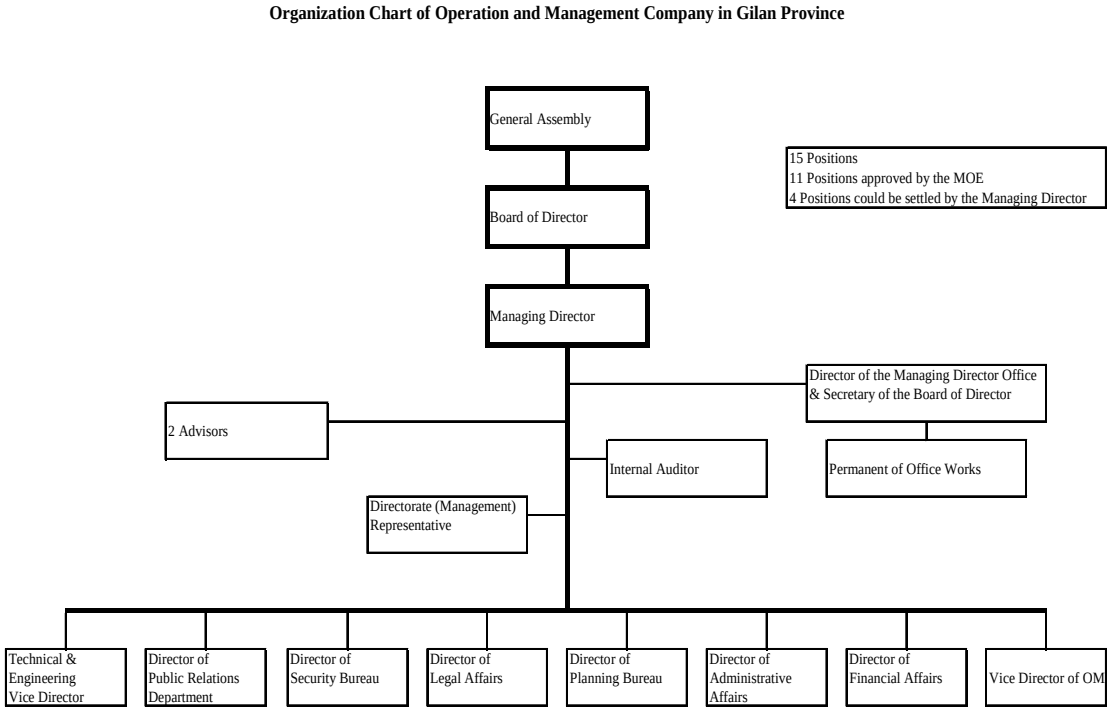


Figure R 3.2.5 Organization Chart of Gilan Province OMC

b) Personnel

Number of regular personnel is 191, temporary personnel 40 and seasonal personnel 260 (Four months from May to August).

c) Role of work

- Operation for irrigation water distribution
- Maintenance for irrigation facilities

2) East Azarbaijan Province

Previously, WRMC had held 49% of the stocks and the remaining had been held by private companies. WRMC sold all its stocks to private companies in 2007, and now OMC is completely a private company.

By its privatization, OMC can join ranking system determined by Government.

a) Personnel

Number of regular personnel is 300.

b) Role of work

- Operation for irrigation water distribution
- Maintenance for dam and irrigation facilities

3.2.7 Water User Association (WUA) in the Study Area

WUA (Water Users Association) is established under instruction of MOJA and MOC. After establishment of WUA, RWC instructs to WUA members operation and management. Traditional WUAs have existed from long time before, but only a few modern WUAs are established so far.

Traditional WUAs were established a long time ago, but a few modern WUAs are established so far. Just a few Provinces have WUAs. Qazvin and East Azarbaijan Province only have WUAs in the Sefidrud River basin.

Its main task is water distribution and farming supports. Since each province has multi ethnicity, religion, language, tradition, culture, climates, custom and so on inside, it takes time to establish a modern WUA.

1) Summary of WUA

Characteristics of WUA of the Qazvin and East Azarbaijan are summarized below.

Table R 3.2.6 Summary of WUA of Qazvin and East Azarbaijan

Item	Qazvin	East Azarbaijan
Number of WUAs	158	108
Number of Beneficiaries	30,000	21,000
Number of personnel of one unit	30-4000	200-700
Major works	- Water distribution to Tertiary canal - Maintenance work of canal such as desilting, clearing and minor repairs - Exchange information of cropping - Collection water fee	- Water distribution to Tertiary canal - Maintenance work of canal such as desilting, clearing and minor repairs - Exchange information of cropping - Collection water fee - Coordination of jobs for youth

2) Water Fee

Water fee varies by Province every year. Water fee is decided by MOE and new water fee is informed to each WUA by RWC at the beginning of year for irrigation. Water fee also varies with the conditions of irrigation facilities as follows.

- Modern irrigation facilities: 3% of previous crop,
- Semi modern irrigation facilities: 2% of previous crop,
- Traditional irrigation facilities: 1% of previous crop.

If WUA exists, water fee is collected and paid to RWC bank account by WUA. If WUA does not exist, water fee is collected and paid RWC bank account by private company or farmer themselves.

3) WUA in Qazvin Province

WUA in Qazvin Province is a quite successful organization. It is explained as one of case study below.

WUAs were established from 2002 to 2005. The number of WUAs is 158 and beneficiary is 30,000. These were the first case in Iran. The number of staff of one WUA ranges 30-40 at least and 3000-4000 at most. Duty of the WUA is water distribution to tertiary canal, rotation control of water, dredge work, clearing and minor repair of canals. And information for cropping is exchanged.

a) Organization Chart

Management center is established at main canal and eight offices are established at secondary canals. One General Manager, one district Manager, one Finance Manager, one Public Manager and two Site Managers are placed in the center. One Sales Administrative Officer and one or two Water Masters are placed in the secondary canal office.

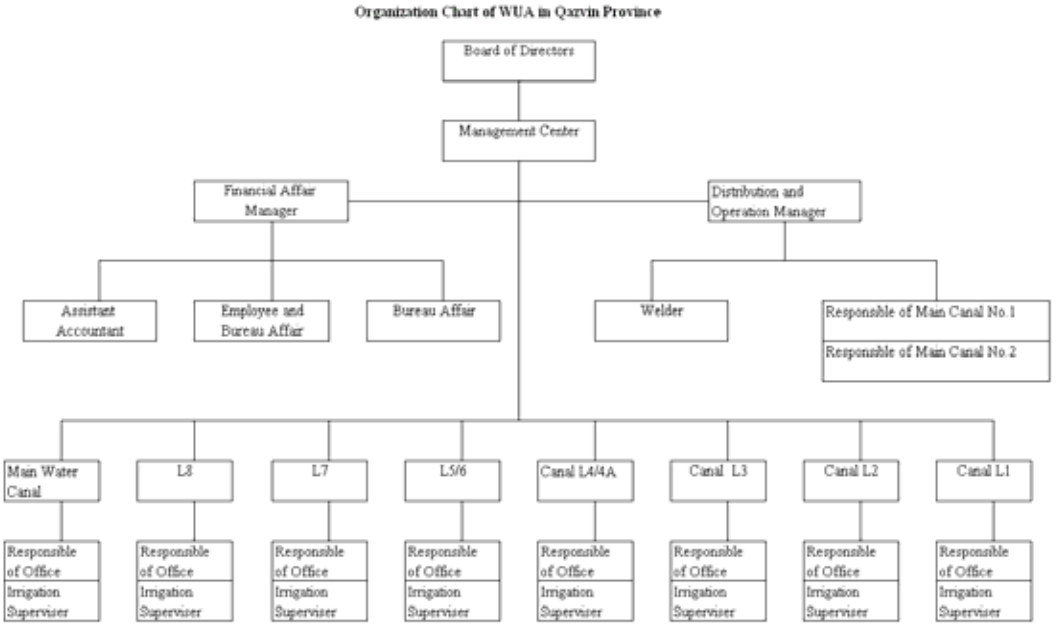


Figure R 3.2.6 Organization Chart of Qazvin WUA

b) Water Fee

Water fee is collected before water distribution. Collection ratio is 100%. Representative of the each WUA informs WUA members of the water fee. Collected water fee were paid to RWC bank account, and registered to computer system. Situations of water selling are confirmed at 11 A.M. every day.

Water fee for 2007-2008 is 67 Rials/m3. This is 3% of production in 1 ha in the previous year. Production data is informed by MOJA. 7% of water fee is paid from RWC bank account to the Management center as operation fee of WUA.

3.2.8 Operation & Maintenance System for Irrigation

Irrigation facilities consist of dams, main canals, secondary, tertiary and quaternary canals and related structures. Basic and major facilities such as dams, main canals, water transfer systems for drinking and industry water, water purification plants are constructed by RWC. Secondary and tertiary canals are constructed by RWC or MOJA. Quaternary canals are constructed by MOJA. Wells are constructed by owner after permission by RWC. Newly constructed qanat is not found at present.

Operation and Maintenance for dams, main canals, water transfer systems for drinking and industry water, water purification plants are conducted by RWC. Some time small dams are maintained by MOJA. Secondary canals are normally maintained by RWC, sometimes by MOJA. Tertiary and quaternary canals are maintained by MOJA. Water distribution networks are maintained

by UWWC and RWWC and sometime purification plants are included. Qanat is maintained by MOJA, and wells by owners.

Contractors are selected through bidding and consultants supervise construction work. Operation and maintenance is conducted by responsible organization directory or through OMC.

Table R 3.2.7 Responsible Organizations for Construction and Operation & Maintenance

Facilities	Responsible organization	
	Construction	Operation & Maintenance
Dam	RWC/ MOJA（Small）	RWC, MOJA（Small）
Main canal Secondary canal Tertiary canal Quaternary canal	RWC RWC, MOJA MOJA, RWC MOJA	RWC RWC, MOJA MOJA MOJA
Urban water & wastewater facility Rural water & wastewater facility	RWC (Water transfer, Purification) UWWC (Water distribution network) RWC (Water transfer, Purification) RWWC (Water distribution network)	RWC (Water transfer, Purification) UWWC (Water distribution network) RWC (Water transfer, Purification) RWWC (Water distribution network)
Industry water facility	RWC (Water transfer, Purification)	RWC (Water transfer, Purification)
Qanat	New construction is not Found/MOJA/Owner	MOJA
Well	Owner with a permission of RWC	Owner

3.2.9 Management System of Hydro-Meteorological Observation

RWC controls hydro-meteorological observations. Observed data are kept and exchanged with WRMC and other provinces. Observation is conducted by manual, automatic log and telemeters. Telemeter system is installed in water transfer project from Zarrineroud River to Tabriz. The telemeters are connected from intake point of water transfer to RWC office in East Azarbaijan. 24 hours observation is possible by this system. Adoption for telemeter system is proposed in many places. Discharge observation is conducted twice a month and flooding time. Water quality is checked at the same time.

Laboratory is provided and experts are placed. Every data is submitted to WRMC. When abnormality is found, information is to be reported to Ministry of Environment. Number of staff for observation varies by provincial conditions. Number of staff ranges from a few to more than 20. Budget for observation rages 1500 million to 2500 million Rials.

3.2.10 Water Rights in the Study Area

Water right is classified into customary water right and licensed water right.

Customary water right;

A water right for consumption of water before enactment of “Iran water Law and the Manner of Water Nationalization (1968).” Customary water right is mostly irrigation water and permitted by MOE according to Article 21 of “Fair water distribution Act (1983).”

Licensed water right;

A water right acquired with permission by MOE according to Article 21 of “Fair Water Distribution Act (1983)”.

Water right is applied to RWC and permitted by MOE finally.

The order of priority of water right is drinking, industry and agriculture as stated in "Long-Term Development Strategies for Iran's Water Resources (2003)." Priority of water right in Gilan province is drinking, agriculture and industry.

Although there is no law that allows people in upstream to take water from the river by priority, but the water is taken from upstream traditionally. If water right is permitted, taking water from river is possible within allowable range. Rotation distribution management is applied in the area where modern facilities are provided.

Water fee for drinking, industry and agriculture is varied every year and contract with RWC is renewed.

3.2.11 Environmental Laws and Institution Frameworks

Iran has established a comprehensive legislative foundation for environmental policy. The Article 50 of the constitution of Iran declares that protection of the environment is a public obligation and therefore "economic and any other activity, which results in pollution or irremediable destruction of the environment is prohibited". The legal framework for environmental protection and management of Iran comprises the constitution of Iran, domestic laws, regulations and by-laws, and as well as international environmental conventions, treaties and agreements.

The competent body for Environmental Assessment as defined in Decree 138 of 12/04/1994 is the Department of Environment. In addition to Environmental Assessment, there a wide range of regulations regarding environmental protection including the Environmental Protection Act 1974 and its executive by-law dated 1975, the Clean Water Act 1982 that was amended in 1994, the executive by-law on the Prevention of Water Pollution 1994, the Air Pollution abatement the Game and Fish law 1957 amended 1975 and 1996.

A number of governmental organizations have responsibilities for managing and monitoring environmental impacts.

1) Environmental High Council (EHC)

Headed by the President of Iran, EHC decides environmental policies and strategies and approves environmental standards.

The Environmental High Council is composed of the Minister of Jihad-e-Agriculture, the Minister of Health, the Director of the Plan and Budget Organization, the Director of Department of Environment and four other qualified persons recommended by the Chairman of the EHC and appointed for a term of three years by the chairman. The Chairman of the Environmental High Council is the President of Iran. The followings are the members of the council.

- Ministry of Jihad-e-Agriculture
- Ministry of Industry
- Ministry of Interior
- Ministry of Housing and Urban Development
- Ministry of Health and medial Education
- The Director of Planning and Budget Organization
- The Director of the DOE and
- Four qualified persons recommended by the Chairman of the EHC appointed for a term of Three (3) years.
- EHC has a specific committee called the Sustainable Development Committee (SDC).

The SDC prepares the reports for discussion on issues regarding environmental protection and management.

2) Department of Environment（DOE）

The Environmental Protection and Enhancement Act (1974) established the Department of Environment (DOE) under the EHC as an authority for controlling activities harmful to the environment of Iran. DOE is a corporate body with financial independence functioning under the supervision of EHC and the Vice-President of Iran is the Chairman of the DOE.

Along with its provincial environmental offices, the DOE is the principal environmental protection agency with mandate to monitor implementation of environmental policies and enforce relevant laws and regulations.

The DOE is responsible for the protection and enhancement of the environment, prevention and control of pollution and degradation, overseeing protected areas, and setting and monitoring standards.

The DOE is the competent authority for approving EIA reports as defined in Note 2 of Decree 138 under the authority of Environmental High Council (EHC). The DOE processes the EIA reports and gives its recommendations to the government directorate responsible for a project. In case a project execution is found to be inconsistent with the recommendations of the DOE, it shall notify a relevant ministry and any controversy shall be resolved by the decision of the President of Iran.

The responsibilities of the DOE with respect to water issues include:

- Conducting economic and scientific research and studies concerning environmental protection and enhancement.
- Preparing plans for the elimination or reduction of pollution in any area or province.
- Monitoring and enforcing the regulations.
- Controlling pollution and preventing any disturbance in the environmental balance

3) Ministry of Energy

The ministry oversees a major part of the country's development and resource exploitation activities and is responsible for generation and distribution of energy for light and heavy industries consumption, supply and improvement of energy consumption, supply and distribution of water to all sectors of society, urban sewage system control, quantitative and qualitative protection of water resources, and implementing river and coastal development plans.

4) Ministry of Agriculture Jihad

The Ministry of Jihad and the Ministry of Agriculture were merged together in 2001 to focus on protecting the environment and sustainable development. The ministry attempted to reduce the consumption of chemical fertilizer and pesticides and proposed plans to replace the old methods of pest control with new techniques. For example,

- No hazardous high-risk pesticide can be imported,
- The subsidy for buying agricultural chemicals is to be gradually eliminated,
- Further use of agricultural chemicals will be gradually adjusted to the need of the land and the specific product efficiency
- According to the general laws of the country, responsibilities concerning protection and proper utilization of water and aquatic resources, forest and pasture are as follows
- Conducting comprehensive research studies on the water resources of the country and presenting plans for proper exploitation of the land.

- Developing policies and taking the required measures to preserve, renovate, develop, expand, and put into proper use all the water and aquatic resources.
- Policy-making, planning, constructing, developing, and maintaining the systems of potable water (provision, treatment, transmission, and distribution) in villages as well as the proper disposal of the wastewater.

5) Ministry of Health and Medical Education

The articles and the comments of the Regulations concerning environmental health ratified by the Cabinets in 1992 define the responsibility of the ministry for supervision of the quality of potable water.

According to article 4 of executive by-law, a committee for the protection of potable water resources has been formed in each province and is headed by the province governor general and the membership of provincial managers and director generals of the Ministry of health & Medical Education, Department of Environment, Regional Water Organization of the province, Organization of Agriculture-e-Jihad, Management & Planning Organization and Water & Sewage Company.

The committee is to examine possible causes of water pollution and ways for treatment and protection of water resources.

6) Institute of Standard and Industrial Research

Affiliated with the Ministry of Industries and Mines, this institute is responsible for setting and publishing national standards.

7) Cultural Heritage Organization

This organization has the following responsibilities.

- Prepare and regulate the ancient relics research programs in the country.
- Study and recognize precincts, hills, buildings and historical collections and prepare a list of maps
- Purse legal claims against violators related to cultural heritage
- Take necessary action to recognize and reclaim Iranian cultural properties.
- Prepare and perform necessary plans to secure and safeguard, repair and revive masterpieces.
- Encourage people to participate in all activities related to promoting, saving, and restore cultural heritage.

3.2.12 Environmental Impact Assessment System

The competent body for Environmental Assessment or EA as defined in Decree 138 of 12/04/1994 is the Department of Environment, under the authority of the Environmental High Council: EHC. EA in Iran was enabled by Note 82 of the Law for the Second State Economical, Social and Cultural Development Plan of 1994, amended by Note 105 of the Third Development Plan.

The standard procedures for implementation of Environmental Impact Assessment (EIA) was approved by the EHC through a collaborative project (July, 1997) with United Nations Development Programme (UNDP).

According to the EHC (1997), guidelines proponents of the following national projects and programmes are obliged to prepare and submit environmental evaluation and feasibility studies as well as an EIA.

- Petrochemical Plants
- Industrial Estates (more than 100 hectares)
- Forestry Plans
- Highways
- Railways
- Thermal Power Plants (more than 100MW)
- Airport project
- Dams and other water construction projects (e.g. manmade lakes, water and irrigation projects)
- Industrial Slaughterhouses
- Steel Mills
- Refineries
- Irrigation and Drainage projects
- Agro-Industry units
- Urban solid waster landfills
- Solid Waste Incineration Plants

In accordance with the Third Five Year Economic, Social and Cultural Development Plan, about twenty-one types of development projects are obliged to prepare the EIA as well as Feasibility Studies.

The EIA procedure from the implementation manual of the DOE is shown in the following chart (Figure R 3.2.7).

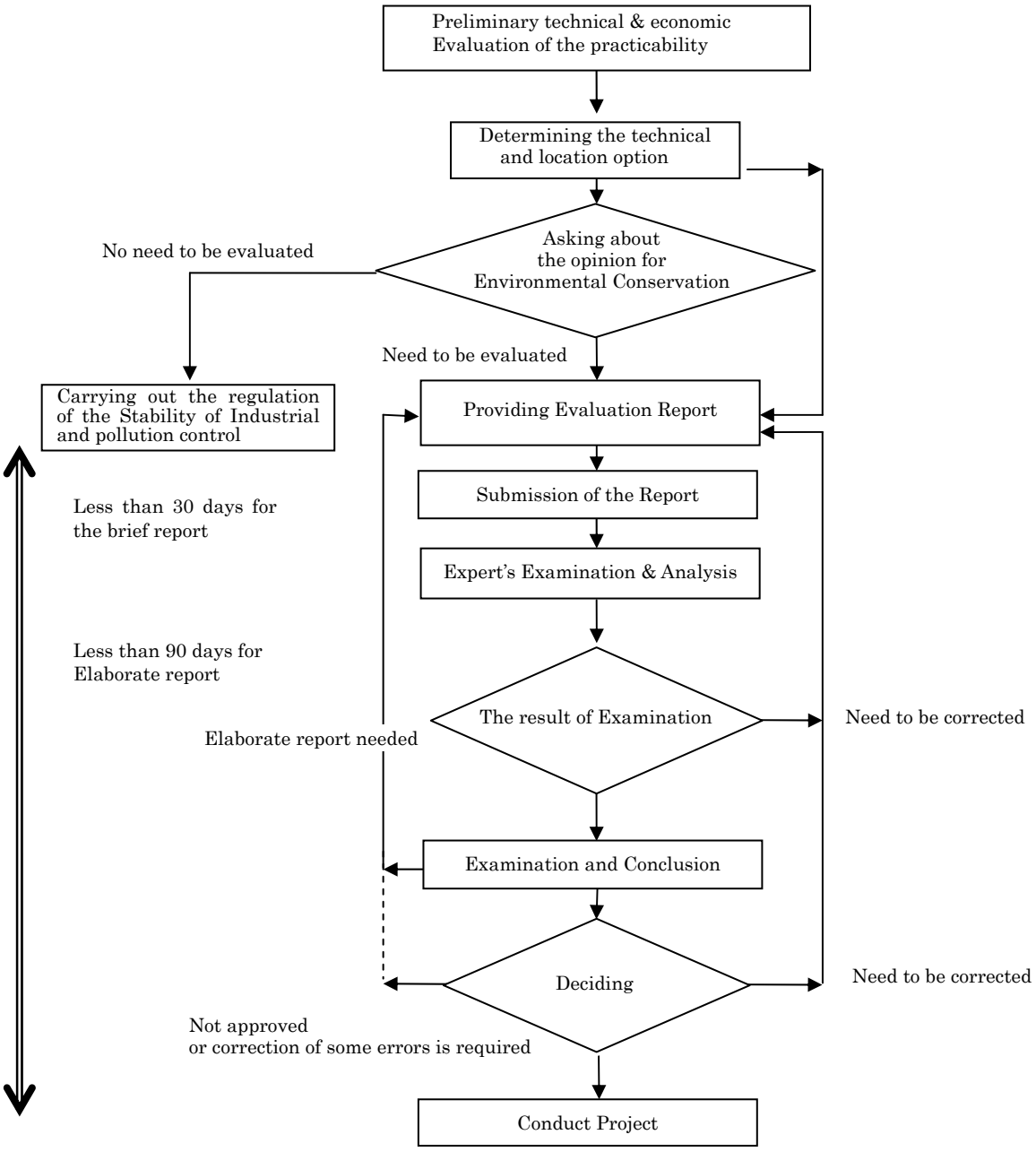


Figure R 3.2.7 Flowchart of EIA in Iran

3.3 TOPOLOGY AND GEOLOGY

3.3.1 Topography

The Albultz and Zaglos Mountains are located along the Caspian Sea from east to west and along the Persian Gulf from southeast to northwest respectively. The two mountain ranges meet at the northwestern part of Iran or in East Azarbaijan Province. Damavand Mountain of the Albultz Mountains possesses the highest peak with an elevation of 5,780 meters, and peaks of 3,000 to 4,000 meters continue to the Zaglos Mountains.

The country is divided into six major river basins: Urmia Lake Basin, Caspian Sea Basin, Markazi Basin, Gara Gom Basin, Hamoon Basin, and the Persian Gulf Basin. The Study Area is located in the northwestern part of Iran. The Sefidrud River Basin is classified as a sub-basin of the Caspian Sea Basin.

Table R 3.3.1 Major Basins in Iran

Basin	Area (%)	Average Precipitation (mm/year)	Precipitation (%)	Surface Resource (%)	Discharge Resource (%)
Urmia Lake	3.2	370	5.0	7.0	3.3
The Caspian Sea	10.7	430	20.5	20.4	10.6
Markazi	50.9	165	31.8	12.7	44.9
Gara Gom	2.7	142	2.8	1.3	3.4
Hamoon	6.5		3.2	0.8	1.6
Persian Gulf	26.0	366	36.7	57.8	36.0
Total	100	252	100	100	99.8
Total in Iran	1,648,195km^2	-	415km^3/year	-	-

The Study Area extends to 59,090 km^2 and most of it is located between the Albultz Mountains and the Zaglos Mountains. Only Gilan Province is located north of the Albultz Mountains, facing the Caspian Sea. Topographic classifications are shown in Figure R 3.3.1. Mountains and hills (hills, plateaus, upper terraces) are dominant in the Study Area. Alluvial layers of Alluvial plains, River Alluvial plains, that may be the most suitable aquifer, distributes only in the river mouth of Sefidrud River. Secondary good aquifer will be terrace deposits that are composed of sand and gravel with clay.

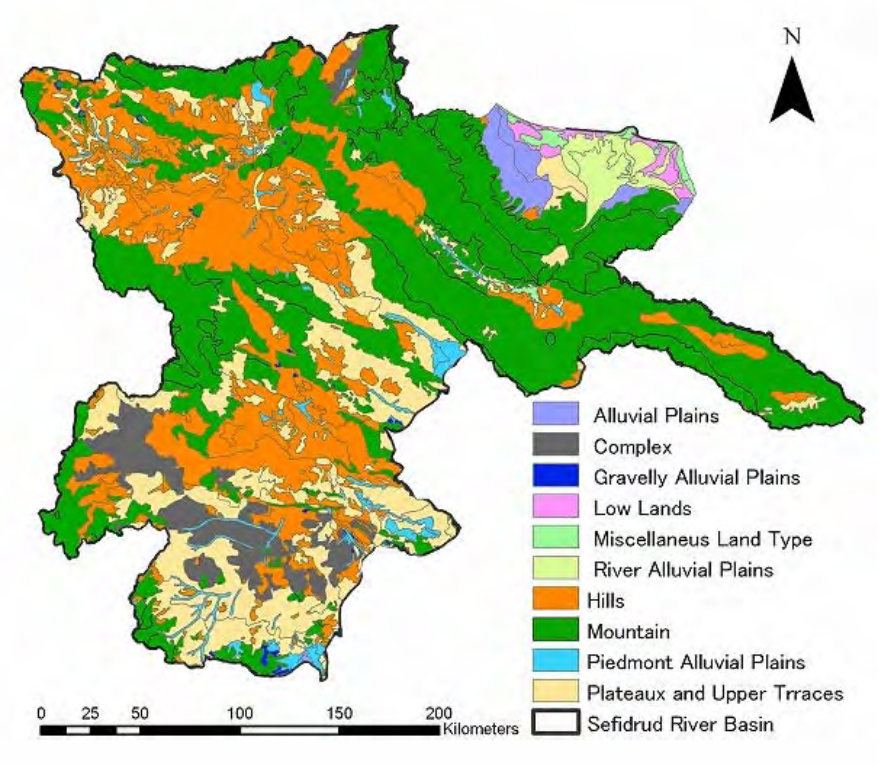


Figure R 3.3.1 Topographic Map

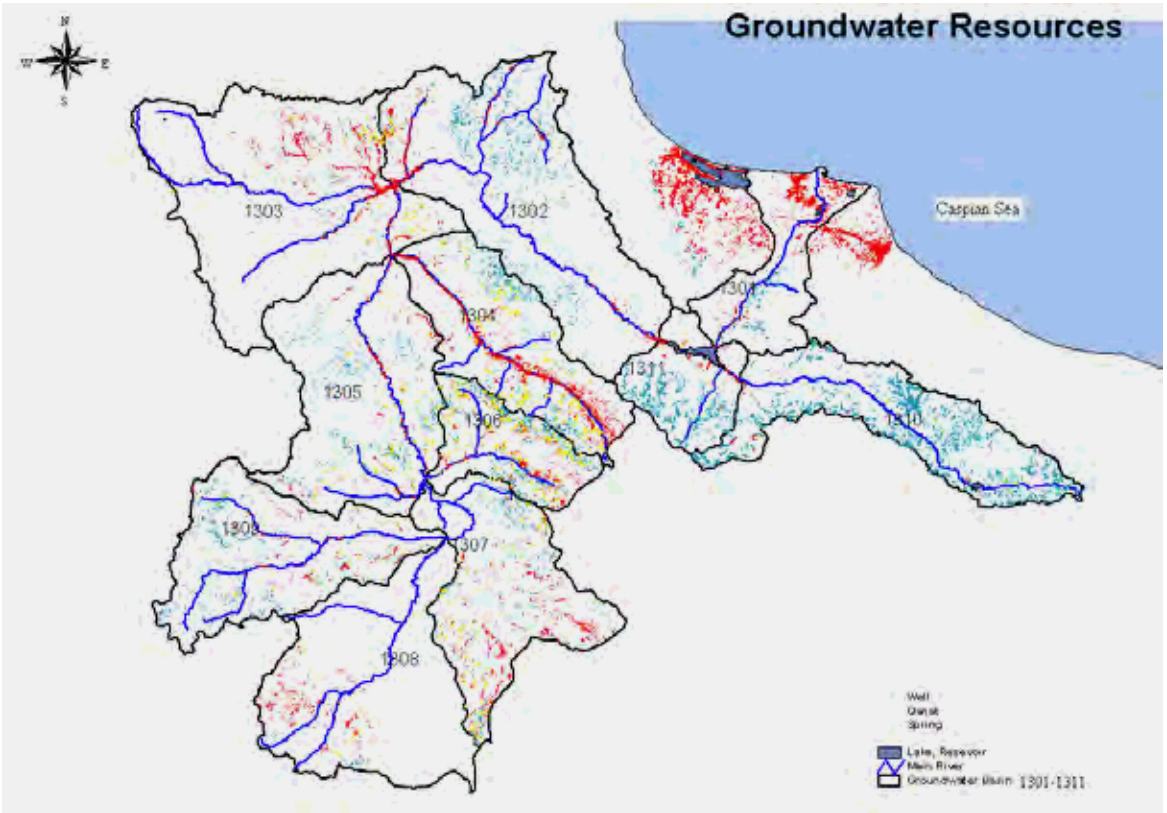


Figure R 3.3.2 Classification Map of Groundwater Basin

The Sefidrud River Basin is divided into eleven groundwater basins as shown in Figure R.3.3.2. The characteristics of topography in the groundwater basins are summarized in the following table in each basin.

Table R 3.3.2 Outline of Topography in the Groundwater Basin

No.	Groundwater Basin		Province	Area (km^2)			Topographic Characteristics
	Name	Code		Total	Plain, Hilly	Mount-ainous	
1	Astaneh-Kuchesfahan	1301	Gilan	1,923	991	932	Highest peak: 2705m & lowest point: -25m. It is facing the Caspian Sea. 39% of the basin is covered by alluvial plains and 52% including fan and hill. Other is mountain topography covering 48% located in the upper part of the basin.
2	Tarum-Khakhal	1302	Ardebil	8,604	1,085	7,519	Mountainous topography. Alluvial topography is limited along the rivers.
3	Miyane	1303	East Azarbaijan	9,226	1,607	7,619	Gentle mountain topography is predominant and mountain is distributed in southwest and northeast in the basin.
4	Zanjan	1304	Zanjan	4,672	2,368	2,304	It is composed of plain and hilly region with an elevation of about 1500 to 2000m and mountain area with 2500 to 3000m.
5	Mahneshan-Anguran	1305	Zanjan	7,172	2,598	4,574	
6	Sujas	1306	Zanjan	2,497	1,715	782	
7	Goltapeh-Zarinabad	1307	Kordestan	5,131	2,093	3,038	It is composed of hilly region and gentle mountain regions.
8	Ghorveh-Dehgulan	1308	Kordestan	7,284	2,807	4,477	It is composed of plain and hilly region with an elevation of about 1500 to 2000m and mountain area with 2500 to 3000m.
9	Divandareh-Bijar	1309	Kordestan	5,385	2,225	3,160	
10	Taleghan-Alamut	1310	Qazvin	4,864	358	4,506	Mountainous region in Qezel Ozen River with Talegan Dam. Alluvial topography is narrow. Alluvial plain; 7.4%
11	Manjil	1311	Gilan	2,261	192	2,069	Mountainous region with Manjil Dam. Alluvial plain; 8.5%
Others: including of a part of provincial border of Kermansher, West Azarbaijan and Mazandaran				71	0	71	-
Total Area of the Sefidrud River Watershed				59,090	18,039	41,051	

Source: MG Study Report Vol. 2, with modification by the JICA Study Team

3.3.2 Geology

Iran is located on the Eurasian Plate and the border of the Arabian Plate. Zagros Mountains are the Thrust Mountains formed on its border, and this condition may be the cause of earthquake activities in Iran.

The Study Area consists of the plain facing the Caspian Sea and the plateau between the Alborz Mountains and the Zagros Mountains. Pre-Cambrian to present Quaternary deposits are distributed in the Sefidrud River Basin without the geology of Ordovician period and Silurian period of Palaeozoic era and Paleocene epoch of Cenozoic. General geology in the Sefidrud River Basin is summarized in the following table.

Table R 3.3.3 Outline of General Geology in the Sefidrud River Basin

Era	Period/Epoch	Formation/Group	Symbol	Lithology
Cenozoic	**Quaternary**			
	Alluvium	Recent alluvial	Qal	Coastal/Deltaic/levee/Flood plain deposit clay, sand with clay, gravel
0.01*		Terrace & Fan	Qt	sand and gravel with clay
		Loess	Ql	loess
	Pleistocene	High terrace,		sand and gravel with clay
2				
	Tertiary	Plio-Pleistcene	Pl	sandstone, conglomerate, marl, tuff
	Pliocene			
	Miocene	Upper red	M	conglomerate, red claystone, tuff, mudstone with gypsum
		(thickness <100m)	-	marl, conglomerate, coral
	Oligocene	Qom	OMq	Marl, shale, limestone
		Lower red	O	Conglomerate, sandstone, shale, tuff, volcanics
	Eocene	Karaj	Ek	Andesitic lava, tuff, shale
		Limestone	En,	*Nummulitic* limestone
		Ziarat	Ez	Limestone with sandstone & conglomerate
		Fajan	Ef	Conglomerate, sandstone,
65*	Palaeocene	-	-	-
Mesozoic	**Cretaceous**	- (partly Tiz)	K	Sandstone, shale, marly limestone, volcanics
	Jurassic	Lar limestone	J_l	Limestone, partly Dalichai layer
		Shemshak,	Js	Conglomerate, sandstone, shale, quartzite
247*	**Triassic**	Elikah	Trc	Dolomitic limestone, dolomite, sandstone, shale, conglomerate
Palaeozoic	**Permian**	Dorud, Ruteh	Pdr	Sandstone, shale, limestone, dolomite, quartzite
	Carboniferous	Mobarak	Cm	Limestone, sandstone, shale, Phyllite (Rasht area)
	Devonian	-	D	Shale, quartzite, conglomerate, diabase, basic volcanics, limestone
	Silurian	-	-	-
	Ordovician	-	-	-
	Cambrian	Mila	εm	Shale, limestone, dolomite
575*		Lavan	εl	Sandstone, partly quartzite
Pre-Cambrian		Zaigun,Barut	Pεz	Red sandstone, red slate
		Saltanieh	Pεs	dolomite
		Kahar	Pεk	Green &grey sandstone and shale
		Others		Phyllite, quartzite, biotite schist
Igneous rocks	**Unknown**	Lava	-	rhyorite (r)、andesite (a), basalt (b)
	Tertiary	-	g	Granite, granodiorite
		-	qd	quartzdiorite
		-	p	Intrusive rocks: porphyrite, diorite porphyrite
		-	d	Gabbro, diorite
	Pre-cambrian	-	gd	Doran granite

Source: Geological Quadrangle Map of Iran, 1/250,000. Geological Survey of IRAN
* Geological age (x106)

The outline of geology in the Study Area is divided into four in the table below, together with the topographic characteristics.

Table R 3.3.4 Outline of Geology in the Study Area

Area	*Main Distribution Provinces*	*Topography*	*Geology*
Lower Reach (Caspian Sea side)	*Gilan*	*1. Mountain* *2. Along river: Fan, Alluvial plain*	*1. Mountain side: Sandstone, Conglomerate and Limestone in Mesozoic Era* *2. Along river: Clay, sand, gravel in Quaternary*
Middle Reach 1 (Alborz Mountains)	*Ardebil, East Azarbaijan, border between Gilan and Zanjan*	*Mountainous area. Alluvial topography is distributed only along rivers. Highest point is 2,750m.*	*Sandstone, Conglomerate, and Limestone in Mesozoic Era are mainly distributed in the Alborz Mountains.*
Middle Reach 2, (between Alborz Mountains and Zagros Mountains)	*Zanjan, Kordestan*	*This area is composed of the plateau with elevations of 1,500 to 2,000m, and the mountain region with elevations of 2,500 to 3,000m.*	*Plateau region: Fan, terrace, and alluvial deposits are mainly distributed.* *Mountainous region: Pyroclastic rocks of Karj Formation in Tertiary are distributed in Zanjan Province with a part of intrusive rocks of granites and porphyrite; Tertiary rocks are distributed in mountains in Kordestan.*
Upper Reach (Zagros Mountains)	*Southwestern part of Kordestan*	*Mountainous region with elevations of 3,000 to 4,000m.*	*Various limestones in Mesozoic Era are widely distributed.*

Lower Reach

Geology is classified into two: in mountain areas and along the Sefidrud River side in the lower reach. The geology is composed of unconsolidated clay, sand and gravel of alluvium in the river side of the Sefidrud River. Conglomerate and limestone of Mesozoic Era are distributed in the mountain side.

Middle Stream Reach 1

In Middle Stream Reach 1, distributed are the sedimentary rock of sandstone, conglomerate and limestone of Mesozoic.

Middle Reach 2

In Middle Reach 2 located southeast of Middle Reach 1, are Pyroclastic rocks (tuff, lava) of Tertiary Eocene Karaji Formation, and granite and porphyrite formed the mountains. Fan and terrace deposits are widely distributed around the mountains from Zanjan Province to Kordestan Province. The Qom Formation composed of marls, shale and limestone is distributed on the gentle slope in Middle Reach 2. Old rocks of shale, limestone and dolomite of Precambrian and Paleozoic are also partly distributed in this area.

Upper Reach

Limestones of Mesozoic, Triassic and Cretaceous are distributed in the Upper Reach of the Study Area.

The distribution area of limestone and lava has high permeability and precipitation is easy to infiltrate into the ground compared with the other rocks. The same phenomenon exists in the distribution area of recent river deposits, terrace deposits and the fan deposit composed of sand and gravel with clay. These are reflected in the GIS database utilized for the analysis of water balance.

Geology of each groundwater basin is summarized in Table R 3.3.5.

Table R 3.3.5 Outline of Geology in the Groundwater Basin

Groundwater basin		Zone*	Province	Area (Km^2)	Geology
Location	Code				
Astaneh-Kochesfahan	1301	E-1 E-2	Gilan (Downstream of Manjil dam)	1,923	Permian sediments to Alluvium deposits are distributed in the basin. Quaternary deposit of Alluvial deposits and fan deposits are distributed in the plain facing Caspian Sea and along the Sefidrud River. Sandstone and shale with coal of Permian to Cretaceous and volcanic rocks are partly distributed in the upper part of the basin. Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Lar limestone may have the possibility.
Tarom-Khalkhal	1302	C-1 C-2 C-3	Ardebil	8,604	Tertiary volcanic rocks are widely distributed in the basin and Tertiary intrusive rocks and sandstone, marl, conglomerate, tuff are distributed. Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Cretaceous limestone may have the possibility.
Miaheh	1303	B-5 B-6 B-7	East-Azerbaijan	9,226	Sandstone, conglomerate, and tuff etc of Tertiary sedimentary rock and andesitic volcanic rocks are distributed. Period unknown acidic (granite, rhyorite) to intermediate (andesite) intrusive rocks are distributed here and there. Layer to be aquifer Granular aquifer: Quaternary deposit.
Zanjan	1304	B-3	Zanjan	4,672	Following formations are distributed: - Quaternary sediments on the plain and hills. - Tertiary volcanic rocs of Karaj Formation; lava, tuff, shale in the northeastern mountains - Volcanic rocs and Palaeozoic sedimentary rocks with intrusive rocks Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Lar limestone may have the possibility.
Mahneshan-Anguran	1305	B-1 B-4	Zanjan	7,172	From Pre-Cambrian to Quaternary formation are distributed in this basin. Tertiary volcanic rocks are widely distributed in the western part of this basin with Tertiary sedimentary rocks and Quaternary sediments and old rocks. Layer to be aquifer Granular aquifer: Quaternary deposit.
Sojas	1306	B-2	Zanjan	2,497	Quaternary sediments are distributed on the plain to hill. Tertiary volcanics of Karaj Formation (lava, tuff, shale) are distributed in the mountain area and Palaeozoic sedimentary rocks are distributed with intrusive rocks in the part of central mountain. Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Lar limestone may have the possibility.
Goltapeh-Zarinabad	1307	A-3	Kordestan	5,131	Tertiary sedimentary rocks and Quaternary sediments are widely distributed in the basin and sedimentary rocks (sandstone, shale, limestone) of Cretaceous to Jurassic period are distributed in the central part of the basin. Salt domes are distributed partly. Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Lar limestone may have the possibility.
Ghorveh-Dehgulan	1308	A-1	Kordestan	7,284	Tertiary sedimentary rocks and Quaternary sediments are widely distributed on the plain and hill. Tertiary volcanic rocks are dotted like monadonock with NW-SE direction Mesozoic to Paplaeozoic volcanic are distributed in the southeastern part of mountain. Layer to be aquifer Granular aquifer: Quaternary deposit.
Divandareh-Bijar	1309	A-2	Kordestan	5,385	Tertiary sedimentary rocks and Quaternary sediments are widely distributed on the plain and hill. Mesozoic volcanic rocks are widely distributed in the western part of mountains.

					Layer to be aquifer Unknown
Taleghan-Alamut	1310	D-1 D-2	Qazvin	4,864	Palaeozoic Permian, Mesozoic Triassic-Jurassic-Cretaceous formations are distributed. Intrusive rocks are distributed here and there. Layer to be aquifer Granular aquifer: Quaternary deposit. Karst aquifer: Ruteh limestone may have the possibility.
Manjil	1311	C-4	Gilan	2,261	Tertiary volcanic rocks and intrusive rocks are predominant in the basin and Tertiary sedimentary rocks and Quaternary sediments are distributed in the downstream reach of this basin. Layer to be aquifer Granular aquifer: Quaternary deposit.
others	Including the provincial border of a part of Kermansher, West Azerbayjan, and Mazandaran			71	
Total				59,090	

*: Zone: refer to Chapter 5

3.4 RIVER SYSTEM

3.4.1 River System

The Sefidrud River basin is in the northwest part of the country with the total area of 59,090km^2. The Sefidrud River flows about 100 km from the Sefidrud dam to the river mouth and two main tributaries, Gezelozen River and Shahrud River flow into the Manjil dam. Based on the topographical map and GIS database which is established in this Study, the river system is lined out as shown Figure R 3.4.1.

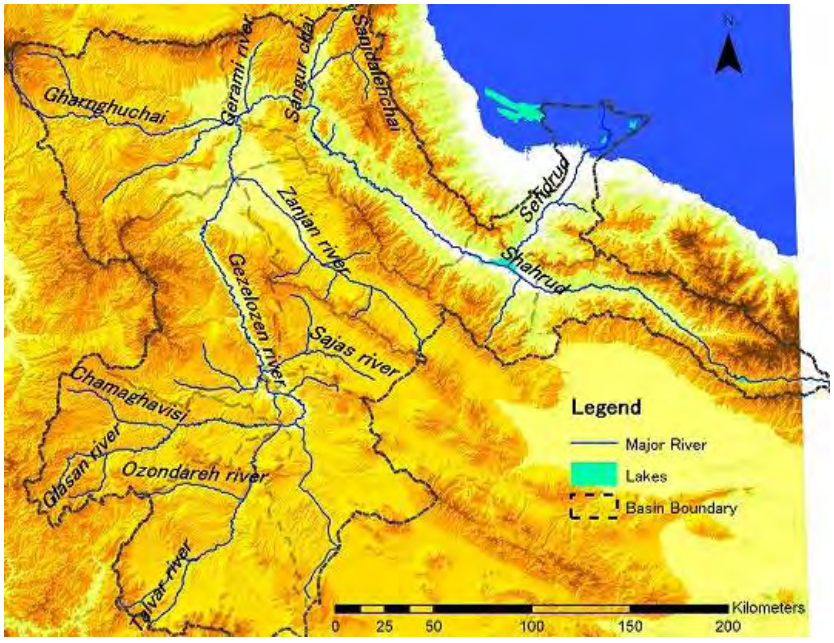


Figure R 3.4.1 River System

3.4.2 Feature of Rivers

The length of main river is estimated at 750 km from the Sefidrud River and Gezelozen River with the slope of 1/340. The feature of Sefidrud River and major tributaries are summarized in Table R 3.4.1 and the river profile is presented as shown in Figure R 3.4.2.

Table R 3.4.1 Feature of Rivers

No	River	Catchment Area (km^2)	River length (km)	Average Slop (1/I)
1	Shahrud River	4,850	210	1/110
2	Gezelozen River	48,600	670	1/340
3	Zanjan River	4,690	150	1/140
4	Talvar River	5,920	160	1/290
5	Main River	59,090	750	1/360

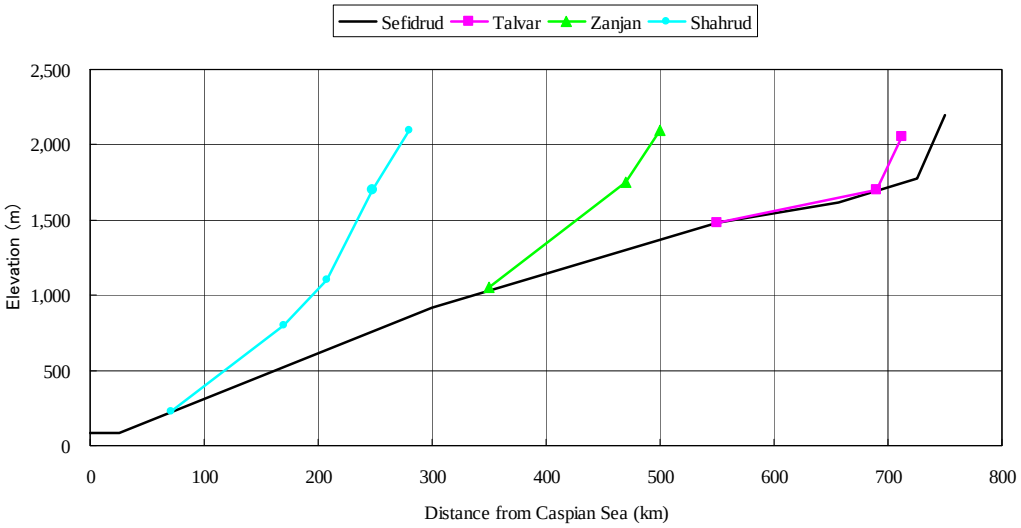


Figure R 3.4.2 River Profile

3.4.3 Flow Regime

The flow regime at major rivers is summarized in Table R 3.4.2.

Table R 3.4.2 Feature of Rivers

(m^3/s)

No.	River	Code of Observatory	Average Annual Maximum	High-Water flow	Normal-Water Flow	Low-Water Flow	Draught Water Flow	Annual Average Flow	Period (year)
1	Shahrud River	17-041	224.5	42.4	16.8	10.0	7.0	32.9	34
2	Qezel Ozan at the end	17-033	814.9	109.9	60.3	19.1	6.6	105.7	39
4	Qezel Ozan at the middle	17-011	377.6	36.0	18.2	4.7	1.3	34.4	28
5	Zanjan	17-019	70.5	3.9	1.3	0.0	0.0	4.6	31
7	Sajas	17-013	52.0	5.5	3.5	0.5	0.1	4.5	31
8	Garnghuchai	17-026	189.6	17.3	9.4	2.8	0.5	18.1	28
9	Gerami	17-430	40.8	2.1	0.7	0.0	0.0	2.2	10
10	Sangur chai	17-031	50.4	4.9	3.2	1.4	0.2	4.9	9
11	Chamaghavis	17-001	173.7	18.1	8.3	2.4	0.9	17.4	26
12	Talvar	17-007	105.4	9.7	5.9	1.3	0.5	8.5	38

3.5 METEOROLOGY AND HYDROLOGY

Based on the collected data for the Study, the meteorological conditions in the Study Area are summarized in this chapter.

3.5.1 Precipitation

The annual average precipitation in the areas between the Caspian Sea and Albultz range (the north part of the Sefidrud River Basin) is estimated to be more than 1,000 mm while it is from 200 mm to 400 mm in its south. More than 90 % of the averaged annual precipitation in the southern part occurs during the seven months between November and May (Figure R 3.5.1). On the other hand, at the northern Albultz, the seven month between September and March is considered being pluvial period although the clear variation of a precipitation pattern does not appear.

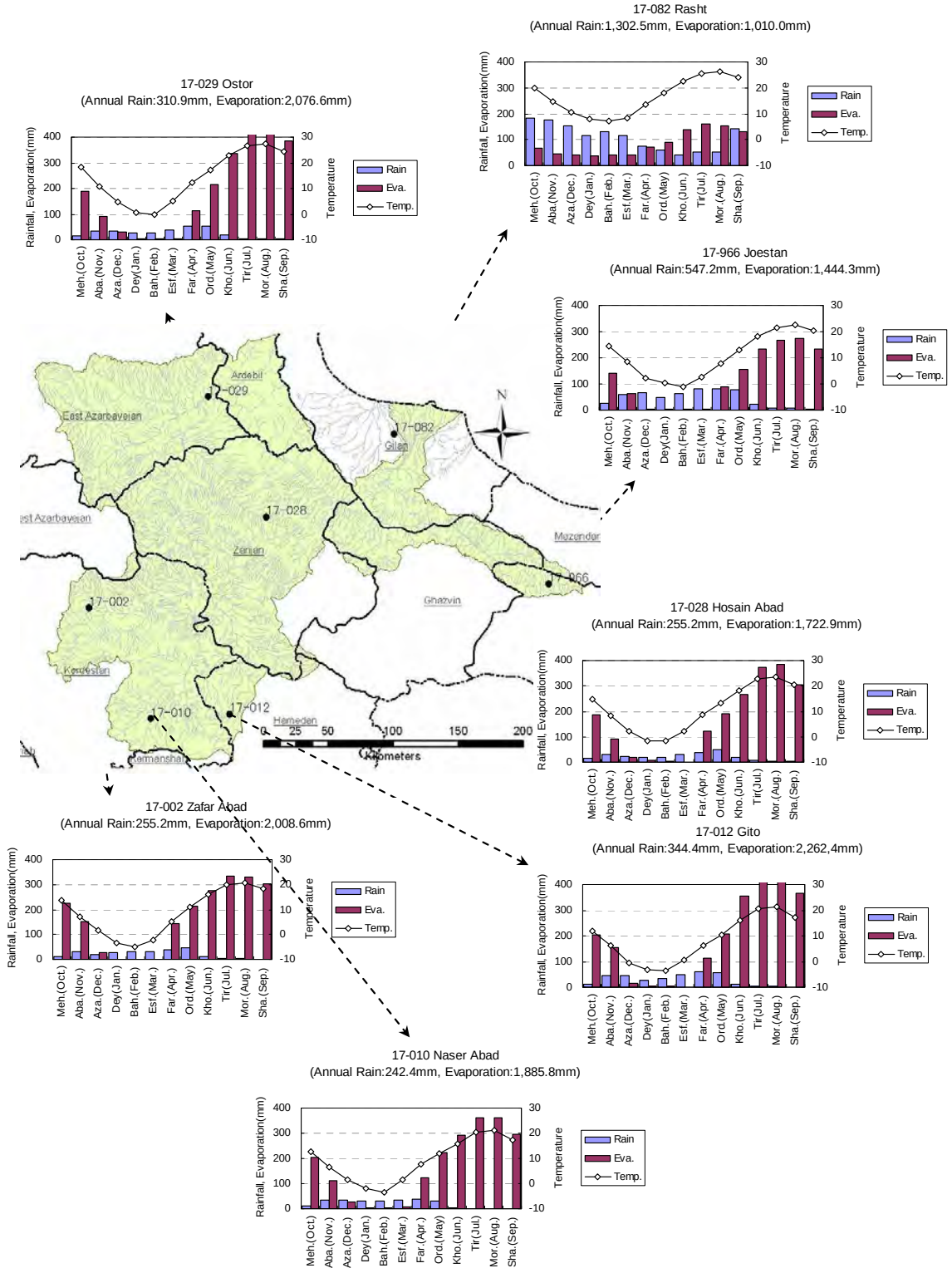


Figure R 3.5.1 General Meteorological Condition

3.5.2 Evaporation

The annual evaporation in the south of the Albultz range is approximately 2,000 mm, which is about quadruple the annual precipitation. However, the annual evaporation in the northern area is estimated less than 1,500 mm. However, according to "Hydrology" issued by McGRAW hill, the value of evaporation measured by a pan with the influence of wind and humidity is maximum 70% larger than that under natural conditions in the semi-arid area. The pattern of evaporation is inversely proportional to the precipitation (Figure R 3.5.1).

3.5.3 Temperature

The annual average temperature in the Study Area is between -5 and 25 Celsius, which tends to be warmer in the south than the north. The difference in annual averaged daily temperature between Rasht observatory located in the north of Albultz range and Naser Abad observatory at the south end of the Study Area is about 5 degrees centigrade (Figure R 3.5.1). The lowest and highest temperatures tend to occur in February and August respectively.

3.5.4 Discharge

The Qezel Ozan and the Shahrud Rivers are the major tributaries which flow into Manjil Dam. A hydrograph (Figure R 3.5.2) was constructed by using data collected at Gilvan and Loshan observatories located on the rivers. The UPSF is the gross total inflow volume to the dam which is calculated by adding the discharges recorded at Gilvan and Loshan observatories. The river discharge starts to increase in February and reaches its peak in April as shown Figure R 3.5.2.

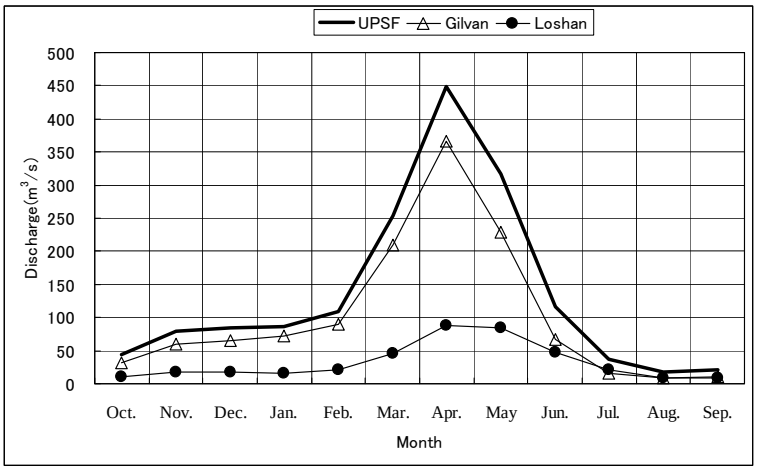


Figure R 3.5.2 Variation of Annual Average of Daily Discharge (to Sefidrud Dam)

3.5.5 Runoff-Ratio

Annual averaged runoff-ratio for the past 30 years is estimated at 0.22 as shown in Table R 3.5.1, while the ratio at the dry year between 1999 and 2001 is less than half of the annual averaged runoff ratio. The annual rainfall of whole basin upstream of Manjil dam, annual runoff volume and annual runoff ration is summarized in Table R 3.5.1. In addition, as a result of analysis, it can be considered that the runoff ratio drop to a low value compared with the annual average when the annual rainfall is below 300 mm.

Table R 3.5.1 Runoff Ratio (Upstream of Manjil Dam)

Period	Annual Average rainfall (mm)	Annual Average Runoff (MCM)	Average Runoff
1969～2005	375	4,158	0.22
Dry Year（From 1999 to 2001）	289	1,240	0.09

3.5.6 Monitoring Stations

The location map of Rainfall station, Climate station and Discharge Station are shown in Figure R 3.5.3, Figure R 3.5.4 and Figure R 3.5.5 respectively.

Figure R 3.5.3 Location map of Rainfall Station

Figure R 3.5.4 Location map of Climate Station

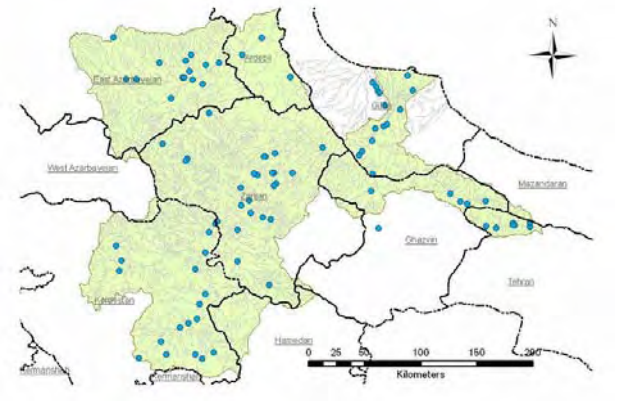


Figure R 3.5.5 Location map of Discharge Station

3.5.7 Probability of Rainfalls

1) Probable Minimum Rainfall

Annual probable minimum rainfall and the amount of rainfall in the rainy season are estimated at some of the rainfall observation stations in the Sefidrud River Basin. Stations with a long history of observation are selected in such way that there would be a uniform distribution of observation points throughout the Basin. The results are stated below and shown in Figure R 3.5.6.

- The annual precipitation ranges from 230 mm to 530 mm in a 2-year return period, except for Gilan and Tehran provinces.
- The probable amount of precipitation in the rainy season was calculated to be larger than the annual rainfall for the Station 17-012 in Gito. This error was caused by using different calculation methods. If the same methods were used they could be almost an equal.
- At Station "17-002 Zafar Abad", the decrease in rainfall in accordance with the return periods is relatively large in comparison to the other stations. This means that the amount of rainfall widely varies depending on the year.
- Rasht, Gilan province predicted more than 1,000 mm of annual rainfall even in a 30- year return period. This means that the rainfall is relatively constant in this area.

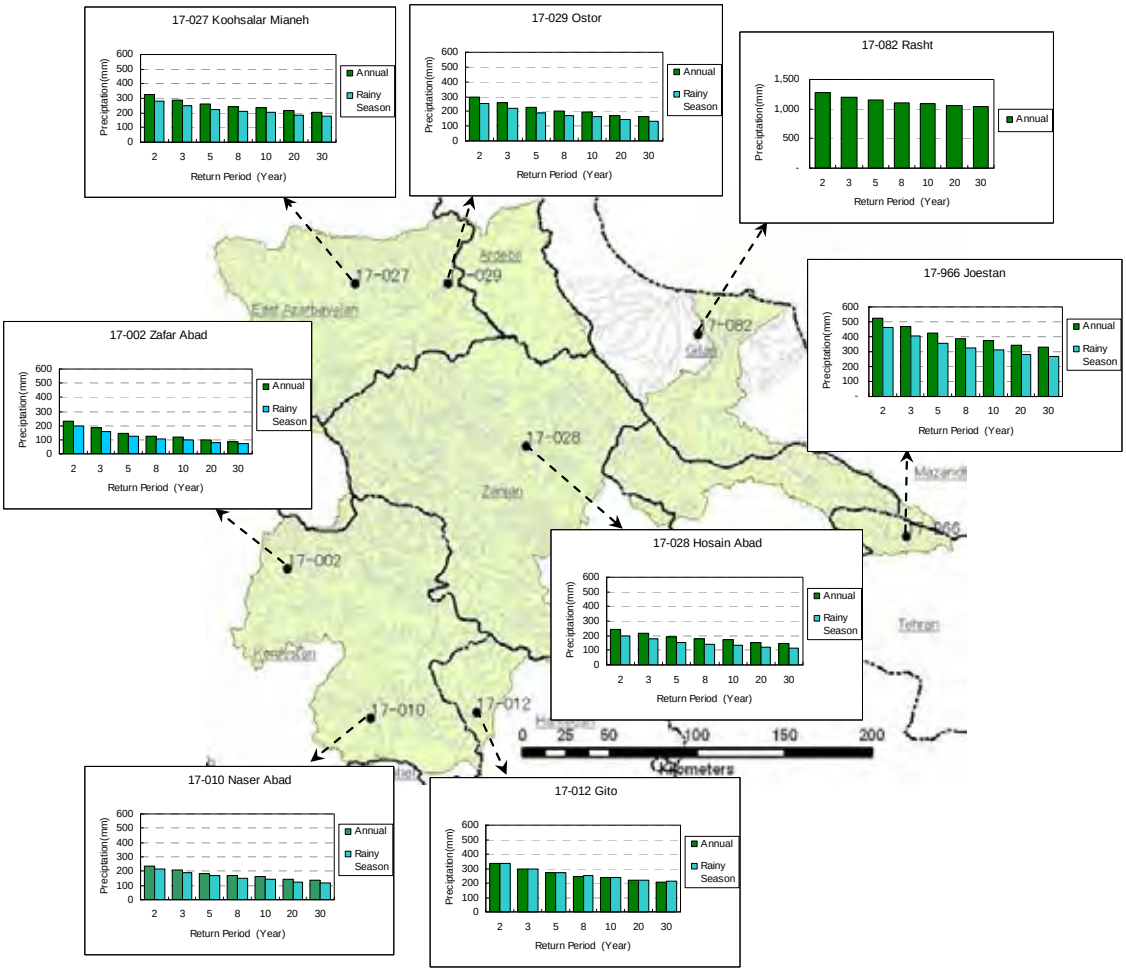


Figure R 3.5.6 Probable Minimum Rainfall

2) Probable Maximum Rainfall

Probable Maximum 5-days Rainfall is estimated by assembling the collected daily rainfall data and making the probabilistic calculation. The result of the calculation is summarized in the Table R 3.5.2.

Table R 3.5.2 Results of Probable Maximum Rainfall

Return Period	17-002 Zafar Abad	17-010 Naser Abad	17-012 Gito	17-027 Koohsalar Mianeh	17-028 Hosain Abad	17-029 Ostor	17-082 Rasht	17-966 Joestan
2	64.7	39.5	56.9	49.6	38.4	42.9	154.2	64.7
5	83.6	52.6	75.1	66.0	52.3	57.1	186.4	83.6
10	96.2	58.9	87.4	75.1	60.0	67.3	205.0	96.2
20	108.2	63.6	99.4	82.9	66.4	77.7	221.4	108.2
30	115.2	65.8	106.5	87.0	69.7	84.0	230.3	115.2
50	123.8	68.1	115.3	91.7	73.5	92.1	241.0	123.8
100	135.5	70.7	127.4	97.7	78.2	103.7	254.8	135.5
Analysis Method	Log normal	Log Pearson	Generalized extreme value	Log Pearson	Log Pearson	Generalized extreme value	Ishihara-Takase	Gumbel

3.5.8 Probability of Discharge

The probable minimum discharge was analyzed by using minimum monthly flows in the dam sites. The results are shown in the Table below.

Table R 3.5.3 Probable Minimum Monthly Discharge

(m^3/s)

Return Period	Talvar Dam	Ostor Dam	Talegan Dam	Manjil Dam (inflow)	Manjil Dam (outflow)
2	0.0	1.6	3.0	12.6	17.1
3	-	0.0	2.7	9.2	10.2
5	-	-	2.4	6.8	6.2
8	-	-	2.2	5.4	4.3
10	-	-	2.1	5.0	3.7
20	-	-	1.9	3.8	2.4
30	-	-	1.8	2.8	1.9

3.6 GROUNDWATER

3.6.1 Outline of Hydrogeology

The possible geological layers to be aquifer in the Sefidrud River Basin are river deposits, fan deposits, and terrace deposit of Quaternary deposits that consists of sand and gravel with clay. Other possible geology is limestone with hole and cavity. The former is called “Granular aquifer” and the latter is “Karst aquifer”. According to the existing data, Almost aquifer is granular aquifer in the Quaternary deposits (so hereinafter called “Quaternary aquifer”) in the Sefidrud River Basin. Limestones are distributed here and there but only Permian Ruteh limestone may have cavity and karst aquifer that details are unknown.

The hydologeological outline of each basin is summarized in the following table from the data of existing study and monitoring results. Monitoring well were constructed 32 wells in 1301 basin, 17 wells in 1302 basin, 59 wells in 1304 basin, 18 wells in 1306 basin, 72 wells in 1308, 13 wells in 1310, and 8 wells in 1311 and total 219 wells. Pumping tests, groundwater level measuring, and water quality test have been conducting in all monitoring wells.

Table R 3.6.1 Outline of Hydrogeology and Monitoring Systems in the Groundwater Basin

Name of Groundwater Basin	Basin code	Outline of basin*1	Pumping test (number)	Water level (number)	Water quality sampling (number)	Type of aquifer	Q*2 (l/s)	T*3	Qp*4 (l/s)
Astaneh-Kuchesfahan	1301	Area: 1000km^2, Depth: 100-250m By electric resistivity survey(ES)	32	9	32	Unconfined Confined	45.1	2,025	5.7
Tarom-Khakhal	1302	Tarom:329km^2 , Depth:30-75m By well, ES 27 lines Khalkhal: 248km^2 , 20-50m. By ES: 42 lines	17	17	17	Unconfined Confined	19.8	1,545	15.7
Miyane	1303	Depth:50-250m. By ES 25 lines Details are unknown.	0	0	0	Unconfined			8.7
Zanjan	1304	East, north-east part: depth 150m Central part: depth 100m Sahrin River: depth 100-200m By ES and wells	59	7	59	Unconfined Confined	78.7	742	11.1
Mahneshan-Anguran	1305	By well. Details are unknown.	0	0	0	Unconfined			5.3
Sujas	1306	By well. Details are unknown	18	6	18	Unconfined	55.9	1,560	6.2
Goltapeh-Zarinabad	1307	GIS database are found. But details are unknown.	0	0	0	Unconfined Confined			6.5
Ghorveh-Dehgulan	1308	Dehgulan: Area; 624km^2 , Depth; 56-140m By ES44 lines and wells	16	107	72	Unconfined	*58.0*	*2,850*	11.2
Divandareh-Bijar	1309	Details are unknown.	0	0	0	Unconfined			6.9
Taleghan-Alamut	1310	Area:243km^2	5	22	13	Unconfined (karst aquifer)	*35.0*	*1036*	15.9
Manjil	1311	Area:226km^2 , Depth: 5-50m By ES 19 lines, wells	8	8	8	Unconfined	38.0	903	16.0
Total		Notes: well means test well	155	176	219	-			

*1: MG Company "Report Vol 2, 2-3Groundwater", Q*2: Yield, T*3: Transmissivity: m^3/day/m, Qp*4: yield of production well
Source: Groundwater data of WRMC(2001)
Cord1308: Only one pumping test data is available in WRMCdata.

Monitoring systems have been established in eight out of the eleven sub-basins as shown in Figure R 3.6.1 Location of Observation Wells. Conducted were measurements of groundwater level, water quality and yield (by pumping test). Table R 3.6.1 summarizes the characteristics of each groundwater basin. Monitoring wells are not established in the groundwater basin of 1303 (East Azarbaijan Province), 1305 (Western part of Zanjan Province), 1309 (Western part of Kordestan Province). Even in the provinces that monitoring wells are installed, it is not enough number and not enough monitoring system.

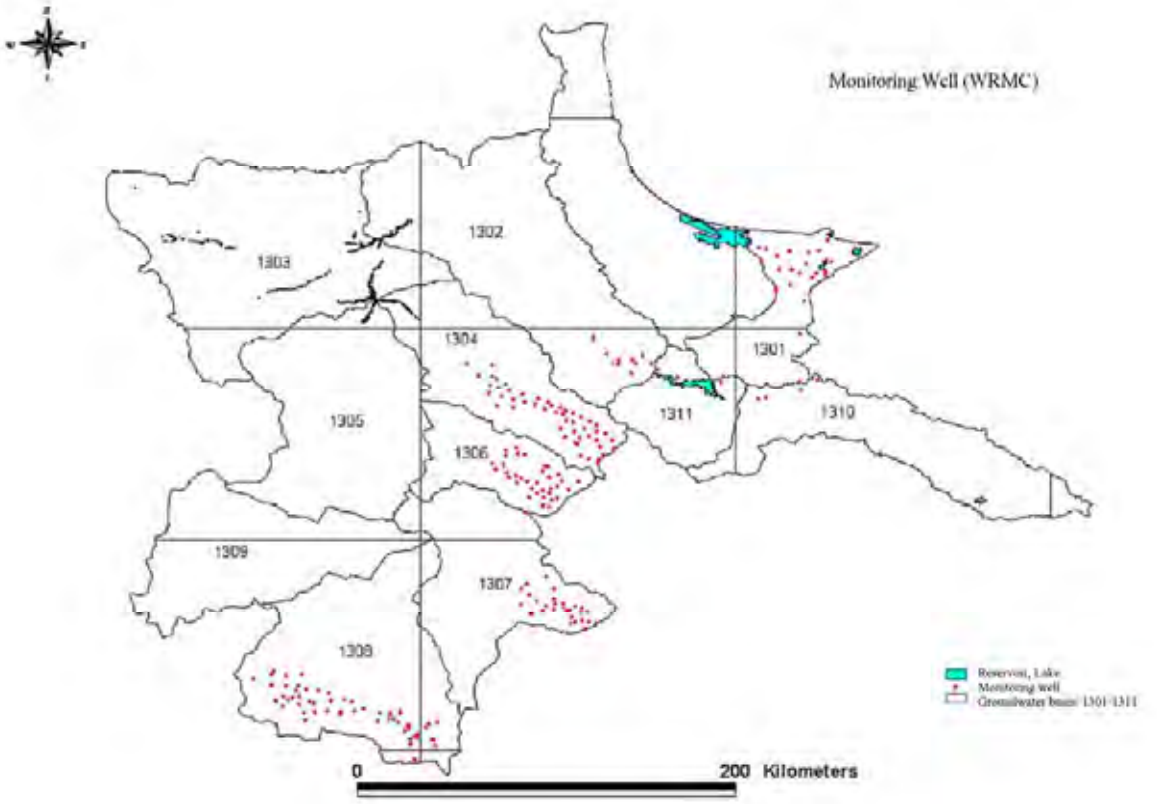


Figure R 3.6.1 Location of Observation Wells in Eight Sub-Basins

It is required to clear the following three elements to know the groundwater basin.

(i) Stretch of aquifer: area, depth, shape

(ii) Essential factor: material of aquifer, permeability, transmissivity, storativity etc

(iii) External factor: meteorological and hydrological data (related with groundwater recharging)

The monitoring quantities shown in Table R3.6.1 are quite a few considering the stretch of its each basin area. The stretch of Quaternary layer that become Quaternary aquifer will be investigated by geological map and GIS. The meteorological and hydrological data are also mostly cleared by hydrological analysis in each basin. But, the shapes of depth are not almost investigated because of insufficient test wells and electric resistivity surveys. It is also not almost investigated the essential factor (material of aquifer, permeability, transmissivity, storativity etc) because of insufficient pumping tests.

On the basis of existing a few survey results, unconfined aquifers are commonly used and averaged values of pumping yield and transmissivity were high. For example, transmissivity of five out of eight aquifers are greater than 1,300 m^3/day/m and are considered to be “good” aquifers. Transmissivity in Zanjan (1304) and Manjil (1311) where mountainous areas are widely distributed are lower than 1300 m^3/day/m, so that they are “not good” aquifers. It is assumed that the aquifer has been over-pumped based on the low transmissivity and high pumping yield.

3.6.2 Facilities and Utilization of Groundwater

Groundwater is utilized by a number of well, spring and qanat facilities as shown in the following table.

Table R 3.6.2 Facilities for Groundwater Utilization (2001)

Groundwater Basin	Basin Code	Province	Well (number)	Spring (number)	Qanat (number)
Astaneh-Kuchesfahan	1301	Gilan	3,758	403	0
Tarum-Khakhal	1302	Ardebil	1,159	1,989	27
Miyane	1303	East Azarbaijan	1,973	419	69
Zanjan	1304	Zanjan	3,252	200	220
Mahneshan-Anguran	1305	Zanjan	184	490	38
Sujas	1306	Zanjan	905	1,373	251
Goltapeh-Zarinabad	1307	Kordestan	44	51	15
Ghorveh-Dehgulan	1308	Kordestan	5,252	2,621	199
Divandareh-Bijar	1309	Kordestan	796	1,645	37
Taleghan-Alamout	1310	Qazvin	607	12,066	13
Manjil	1311	Qazvin	548	6,232	6
Total			18,478	27,489	875

Source: WRMC

The total volume of groundwater utilization is 1,867 million m^3/year, as listed in the following table on the data of WRMC. But data year is scatted and even the latest data is 2001. So, it is unreasonable without reservation.

Table R 3.6.3 Annual Groundwater Utilization Volume

Groundwater Basin	Basin Code	Province	Data year	Well (MCM)	Spring (MCM)	Qanat (MCM)	Total (MCM)
Astaneh-Kuchesfahan	1301	Gilan	1995	50.17	25.9	0	76.07
Tarum-Khakhal	1302	Ardebil	1999	31.93	227.14	27.94	287.01
Miyane	1303	E-Azarbaijan	2001	105.92	87.55	12.04	205.51
Zanjan	1304	Zanjan	1994	226.12	67.21	39.22	332.55
Mahneshan-Anguran	1305	Zanjan	1999	1.20	16.60	3.2	21.00
Sujas	1306	Zanjan	1994	39.87	100.24	38.81	178.92
Goltapeh-Zarinabad	1307	Kordestan	1994	0.40	1.80	0.3	2.50
Ghorveh-Dehgulan	1308	Kordestan	1991	461.00	76.70	13.5	551.2
Divandareh-Bijar	1309	Kordestan	1995	12.70	45.30	2.3	60.30
Taleghan-Alamout	1310	Qazvin	1994	2.58	28.36	1.04	31.98
Manjil	1311	Qazvin	2001	5.23	19.97	2.08	27.28
Total			-	937.12	696.77	140.43	1774.32

Sources: WRMC, Mahab Ghodss (Vol. 2 2-3 Groundwater), JICA Study Team

The groundwater usage will be estimated increase in 2006 but there are not any data. Mahab Ghodss Company updated the WRMC data and 2003 groundwater usage was investigated as shown in Table R 3.6.4. The usage of well and qanat have been decreased a few from WRMC data but spring water usage has slightly increased. The total groundwater usage in 2003 has increased by 204 million m^3/year from WRMC data.

Table R 3.6.4 Annual Groundwater Utilization Volume in 2003

Groundwater Basin	Basin Code	Province	Well (MCM)	Spring (MCM)	Qanat (MCM)	Total (MCM)	Remarks
Astaneh-Kuchesfahan	1301	Gilan	24.57	25.13	0	49.70	It is said groundwater table (GW) has been decreasing.
Tarum-Khakhal	1302	Ardebil	52.50	96.67	2.50	151.67	
Miyane	1303	E-Azarbaijan	61.17	46.86	7.74	115.77	
Zanjan	1304	Zanjan	234.74	65.36	36.60	336.70	GW decreasing -5.2m (1997-2002)
Mahneshan-Anguran	1305	Zanjan	24.27	86.74	5.47	116.48	
Sujas	1306	Zanjan	48.20	97.52	37.23	182.95	GW decreasing -3.0m (1996-2001)
Goltapeh-Zarinabad	1307	Kordestan	56.58	91.06	25.02	172.66	
Ghorveh-Dehgulan	1308	Kordestan	35.50	40.63	11.24	87.37	GW decreasing Ghorveh: -5.0m Dehgulan: -9.0m (1997-2002)
Divandareh-Bijar	1309	Kordestan	35.28	23.00	4.38	62.66	
Taleghan-Alamout	1310	Qazvin	8.74	413.59	2.78	425.11	
Manjil	1311	Qazvin	34.57	59.03	1.15	94.75	
Total			616.12	1045.59	134.11	1795.82	

Sources: Mahab Ghodss (Vol.2, 2-3 Groundwater), JICA Study Team

Monitoring results show that the groundwater table lowered by 5.2 meters from 1997 to 2002 in Zanjan (Code 1304), and by 3.0 meters from 1996 to 2001 in Sujas (1306) in Zanjan Province. The results also show that the groundwater table lowered by 5.0 meters from 1997 to 2002 in Ghorveh, and by 9.0 meters in Dehgulan (1308), Kordestan Province. The lowering is attributed to over-exploitation. The following table listed the area that groundwater table lowered.

Table R 3.6.5 Annual Groundwater Table Lowering

Groundwater Basin	Basin Code	Province	Measuring year	Total amount of lowering	Annual amount of lowering
Zanjan	1304	Zanjan	1997-2002	5.2m	1.0m
Sujas	1306	Zanjan	1996-2001	3.0m	0.6m
Ghorveh	1308	Kordestan	1997-2002	5.0m	1.0m
Dehgulan	1308	Kordestan	1997-2002	9.0m	1.8m

These rapid lowering of groundwater table is caused by over pumping without reservation of groundwater recharge.

The precipitation is key factor for the groundwater recharging and the decrease of groundwater recharging means the decrease of precipitations. 20 years annual average precipitations from 1985 to 2005 is 346 mm/year in spite of its 40 years from 1965 to 2005 is 402 mm/year. It is clear that precipitation after 1985 year has been decreasing and it is easy to estimate the decrease of groundwater recharging in recent. The result of water balance simulation by MIKE-SHE described in Section "5.2 Water Resources Potential", the groundwater recharging volume is 1,862 million m^3/year and 2,388million m^3/year, respectively.

On the other hand, for the abstraction of semi-dry area of most of Sefidrud River Basin, the precipitation of upstream of Manjil dam is analyzed. The annual average precipitation of 36 years from 1969 to 2005 was 375 mm/year, but recent precipitation of drought 3 years of 2001 to 2003 was only 289 mm/year by the Thiessen Method.

On the hydrological examination, it is clear slight rain in recent, and it may decrease the groundwater recharging volume in recent.

Table R 3.6.6 Annual Lowering of Groundwater Table and Groundwater Recharging Volume

Area	Observation year	Annual average precipitation (mm/year)	Groundwater recharging volume (MCM/year)	Remarks
Whole Sefidrud River Basin	1965-2005	402	2,388	Analyzed precipitation: 40 years
	1985-2005	346	1,862	Analyzed precipitation: 20 years
Upstream of Manjil Dam area	1969-2005	375	-	Analyzed precipitation 36 years
	2001-2003	289	-	Precipitation of average drought year (by Thiessen method)

The reason of groundwater table lowering is over pumping and the decrease of groundwater recharging at the basin of 1304(Zanjan), 1306(Sujas), 1308(Ghorveh), 1308(Dehgulan). Consequently, safe yield of groundwater shall be determined severally on the average precipitation year and drought year for the prevention of over pumping and groundwater conservation. The groundwater conservation will be detailed in Clause 9.3.1 "2) Groundwater management Plan."

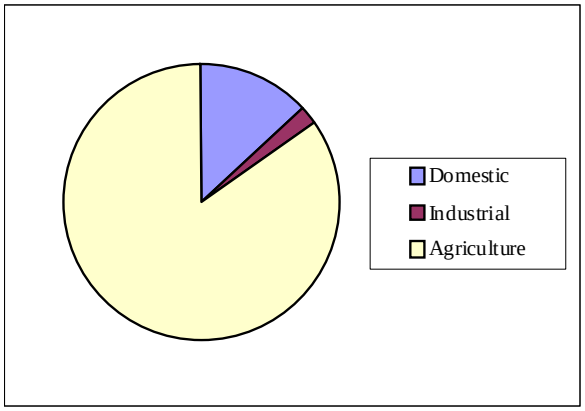
3.6.3 Groundwater Utilization Purpose-wise

Groundwater is utilized as agricultural water, domestic water and industrial water. The following table shows the purpose-wise utilization in each groundwater basin. Groundwater is utilized for agricultural water (84.5%), domestic water (13.3%) and industrial water (2.2%) in the Sefidrud River Basin. The Astaneh-Kuchesfahan Region (Code 1301) and the Manjil Region (1311) highly rely on the groundwater with 21.7% and 33.4% respectively for domestic water compared to the average. On the other hand, the Tarum-Khakhal Region (1302) in Ardebil Province, Sujas Region (1306) in Zanjan Province, and Goltapeh-Zarinabad (1307) in Kordestan Province highly rely on the groundwater for agriculture compared to the average.

Table R 3.6.7 Groundwater Utilization Purpose-wise (2003)

Groundwater Basin		Province	Exploitation Volume (million m^3/year)			
Name	Code		Domestic	Industry	Agriculture	Total
Astaneh-Kuchesfahan	1301	Gilan	10.77	2.91	36.02	49.70
			21.7%	*5.9%*	*72.5%*	*100%*
Tarum-Khakhal	1302	Ardebil	8.75	1.84	141.08	151.67
			5.8%	*1.2%*	*93.0%*	*100%*
Miyane	1303	E-Azarbaijan	15.40	3.40	96.97	115.77
			13.3%	*2.9%*	*83.8%*	*100%*
Zanjan	1304	Zanjan	48.20	6.70	281.80	336.70
			14.3%	*2.0%*	*83.7%*	*100%*
Mahneshan-Anguran	1305	Zanjan	12.20	4.40	99.88	116.48
			10.5%	*3.8%*	*85.8%*	*100%*
Sujas	1306	Zanjan	6.80	1.00	175.15	182.95
			3.7%	*0.5%*	*95.7%*	*100%*
Goltapeh-Zarinabad	1307	Kordestan	7.46	1.30	163.90	172.66
			4.3%	*0.8%*	*94.9%*	*100%*
Ghorveh-Dehgulan	1308	Kordestan	55.60	6.10	285.70	347.40
			16.0%	*1.8%*	*82.2%*	*100%*
Divandareh-Bijar	1309	Kordestan	12.65	4.40	60.86	77.91
			16.2%	*5.6%*	*78.1%*	*100%*
Taleghan-Alamout	1310	Qazvin	65.90	10.56	348.65	425.11
			15.5%	*2.5%*	*82.0%*	*100%*
Manjil	1311	Qazvin	31.60	2.20	60.95	94.75
			33.4%	*2.3%*	*64.3%*	*100%*
Total			275.33	44.81	1,750.96	2,071.10
Ratio			13.3%	2.2%	*84.5%*	*100%*

Sources: WRMC, Mahab Ghodss (Vol. 2 2-3 Groundwater), JICA Study Team



Sources: WRMC, Mahab Ghodss (Vol. 2, 2-3 Groundwater), analyzed by JICA Study Team

Figure R 3.6.2 Groundwater Utilization Purpose-wise（2003)

3.7 WATER QUALITY

3.7.1 Environmental Standards for Waters

General rules for setting standards are established by the Environmental Protection and Enhancement Act (1974). Standards are developed by Iranian Institution of Standards and Industrial Research (ISIRI), the Ministry of Energy and Department of Environment (DOE), and approved by the Environmental High Council. The DOE is responsible for enforcement.

In 2008, there are water quality standards for “drinking water”, “sewage effluent” and “industrial discharge into sewage collection system” which is in force. There is no standard for classification of rivers, lakes and oceans.

1) Drinking Water Standard

The standard for drinking water were previously prepared and published by the Management and Planning Organization (1992, No 116). Iranian drinking water standard have been developed by the Iranian Institute of Standards and Industrial Research.

2) Sewage Effluent Standard

Sewage effluent standards include a long list of contaminants whereby maximum permissible limits are indicated for the quality of wastewater before its discharge into 1) surface water bodies, 2) absorbing wells and 3) irrigation canals for agriculture use.

3) Industrial Discharge into Sewage Collection System Standard

The industrial effluent quality, which is set by the Ministry of Industry, includes a list of contaminants with their corresponding threshold limits. These limits must be respected by the industries that wish to connect to the sewerage system.

The list of contaminants includes the following parameters: Temperature; pH; Total oil & grease; Sulfate; Suspended solids (SS); BOD; Phenol and creosol; heavy metals; and radioactivity.

3.7.2 Surface Water

River water qualities are measured at 99 points by WRMC. This water quality measuring stations are as same as those of flow meter station. Water quality indexes measured by WRMC are mostly positive and negative ion. Common water quality index for rivers and lakes, like BOD, COD, DO, SS, e-coli, Total-N, Total-P and some other harmful materials, are not measured here.

- Water quality index measured by WRMC: Potassium (K^+), Sodium (Na^+), Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Sulfate ion (SO_4^{2-}), Chloride ion (Cl^-), Bicarbonate ion (HCO_3^-), Carbonate ion (CO_3^{2-}), pH, Electric conductivity (EC), Total dissolved solid (TDS).

Table R 3.7.1 shows average and maximum value of Na, Cl, TDS and pH. Minimum value of pH is also listed. Location is selected to be as same as flow meter measuring point. Location of measuring point is shown in Figure R 3.7.1. Duration of data is 1966 to 2004. Frequency of measurement is different from measuring stations, and some stations have monthly data. Minimum/Maximum/Average data are calculated using all the collected data.

Table R 3.7.1 Water Quality in Sefidrud River

Location	Na (mg/L)		Cl (mg/L)		pH			TDS (mg/L)	
	Ave.	Max	Ave.	Max.	Ave.	Max.	Min.	Ave.	Max.
17-001	3.5	21.5	2.7	24.2	7.8	8.6	7.0	774	1,821
17-007	6.4	14.4	3.9	8.9	7.8	9.0	6.4	873	1,252
17-013	8.1	36.5	6.8	28.0	7.8	8.7	6.9	955	1,783
17-015	21.2	60.0	22.2	68.5	7.8	8.4	7.2	2,470	4,769
17-019	3.8	14.1	2.6	13.1	7.7	8.7	7.0	758	1,002
17-021	20.3	47.0	21.0	53.0	7.7	10.0	6.7	2,621	4,114
17-023	11.7	23.2	12.5	27.2	7.7	8.9	6.3	1,415	2,079
17-033	12.6	54.2	12.7	58.8	7.7	8.5	6.6	8,035	161,658
17-037	1.1	2.8	0.9	2.2	7.7	8.4	5.8	-	-
17-041	2.5	11.4	2.1	11.9	7.7	8.4	6.3	461	626
17-428	5.8	25.2	5.5	32.0	7.9	8.5	7.0	-	-
17-517	1.6	6.5	1.2	3.6	7.9	8.4	7.0	357	896

Source: WRMC, Basic Study Office

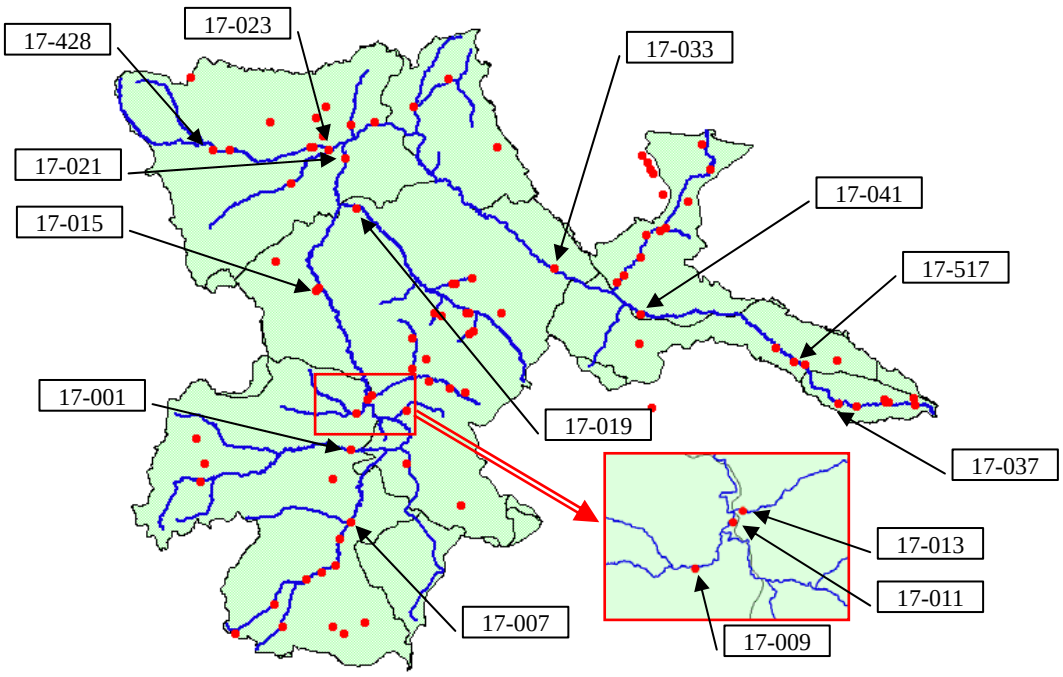


Figure R 3.7.1 Location of Water Quality Measuring Station

1) Chloride (Cl)

Since surface water is used for agricultural use, damage by salt is evaluated by density of Cl ion. In Table R 3.7.1, average density of Cl at measuring station are less than 25 (mg/l). Maximum Cl density is less than 70 (mg/l).

At measuring station No. 17-009 and 17-011, not listed in Table R 3.7.1, Cl density ranges between 250 to 400 (mg/L) twice in each station in all the data. Location is near the border of Zanjan Province and Kordestan Province (Figure R 3.7.1).

According to Kagawa Agricultural Division in Japan, rice or other agriculture product will be affected by salt when irrigation water contains Cl 200 - 250 (mg/l) or more. Since average density is quite lower than the range, and exceeding data is only a few, risk of damage by salt is considered to be low.

2) Sodium (Na)

Na density is restricted by drinking water standard to be less than 200 (mg/l). Average Na density in Table R 3.7.1 is lower than 30 (mg/l) and maximum density is lower than 60 (mg/l). Although this is not standard for river water, it is considered that Na density is low enough.

3) pH

Water is relatively alkaline since average pH value ranges from 7.7 to 7.9. Recommended pH value for irrigation water ranges from 6.0 to 7.5. According to Japanese Standard for Classification of River, as a reference only, river water suitable for drinking water and fishery ranges from pH 6.5 to 8.5, river water suitable for industry ranges from pH 6.0 to 8.5. Sefidrud River water ranges from pH 6.5 to 8.5 in general.

4) Total Dissolved Solid (TDS)

Mean value of total dissolved solids (TDS) exceeds 500 (mg/l). It is hard to specify organic load and inorganic load without BOD measurement data. However, according to the general condition that river valleys are prone to sediment runoff and domestic sewage are discharged to rivers without treatment, both organic and inorganic loads are considered to be high.

According to hearing investigation, in 2008, Gilan and Ardebil Province do not have any sewage treatment plant, and one treatment plant is running in Kordestan Province. One treatment plant is under construction in Gilan Province with World Bank accommodation loan. It is considered that large portions of domestic sewer in our study area are discharged into river without treatment.

Mean value of TDS varies at site; less than 500 (mg/l) in Shah Rood River; less than 1000 (mg/l) in the upper stretch to middle of Gezelozan River; and more than 1000 (mg/l) in the middle stretch to end of Gezelozan River. If water quality is evaluated by index of TDS, water in full stretch of Shah Rood River and upper stretch to middle stretch of Gezelozan River is suitable to irrigation water. Water in middle stretch to end of Gezelozan River contains lots of TDS, which may require some purification like settlement of sand.

3.7.3 Groundwater

Groundwater is measured by WRMC. Location of measuring well is shown in Figure R 3.6.1 and the monitoring systems are shown in Table R 3.6.1. There is some areas to control groundwater by monitoring well, which are divided from 1301 to 1311. Measurement of groundwater quality is done in all areas except for 1303 and 1305.

Water quality indexes for groundwater measured by WRMC are mostly positive and negative ion. Harmful materials which sometimes cause a problem in groundwater, like Cadmium (Cd) and Arsenic (As), are not measured here.

- Water quality index measured by WRMC: Potassium (K^+), Sodium (Na^+), Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Sulfate ion (SO_4^{2-}), Chloride ion (Cl^-), Bicarbonate ion (HCO_3^-), Carbonate ion (CO_3^{2-}), pH, Electric conductivity (EC), Total dissolved solid (TDS).

Table R 3.7.2 shows average and maximum value of Na, Cl and pH. Minimum value of pH is listed, too. Duration of data is 2001 to 2004. Although one control area has some monitoring well, these are summarized as in each control area to calculate average, maximum and minimum value.

Table R 3.7.2 Groundwater Quality at Monitoring Well

No.	Province	Na (mg/l)		Cl (mg/l)		pH		
		Ave.	Max.	Ave.	Max.	Ave.	Min.	Max.
1301	Gilan	3.1	12.3	3.2	11.7	7.6	6.6	8.6
1302	Ardebil	10.0	109.6	9.9	117.6	7.6	6.7	8.3
1304	Zanjan	2.0	8.7	3.4	8.2	-	-	-
1306	Zanjan	2.0	14.0	4.0	8.7	-	-	-
1307	Kordestan	2.4	21.7	4.0	8.8	-	-	-
1308	Kordestan	1.5	13.9	0.6	10.2	7.9	6.1	9.2
1309	Kordestan	2.8	12.2	1.5	14.3	8.0	7.6	8.5
1310	Qazvin	0.6	1.0	0.4	0.8	7.2	6.2	8.2
1311	Gilan	0.4	1.6	0.3	0.7	7.7	7.2	8.3

Source: WRMC, Basic Study Office

1) Chloride (Cl)

Mean values of Cl density are less than 10 (mg/l) in all control area. Maximum values are less than 20 (mg/l) except for area 1302. In area 1302, there is a well named Khalkhal whose Cl density ranges from 100 to 120 (mg/l). In other wells in area 1302, Cl density is lower than 20 (mg/l).

2) Sodium (Na)

Na density is lower than 10 (mg/l) in average and 110 (mg/l) in maximum, which is lower than drinking water standard.

3) pH

Mean value of pH ranges from 7.0 to 8.0. Minimum and maximum value ranges 6.5 to 8.5 in general, except for area 1308 in Kordestan Province which ranges from 6.1 to 9.2. Although we cannot directly compare with river water standard in section 3.7.1, it can be said that water quality in area 1308 is a bit lower than those in other area.

3.8 NATURAL AND SOCIAL ENVIRONMENT

Vast nation of Iran contains a lot of different ecosystem like greenish land, wetland with lots of migratory birds, and semi-arid wild land. However due to human invasion to nature and pollution, good environment of nature is decreasing and living creature is also decreasing in number and diversity. In order to tackle the problem, Iranian government has set the protected area.

In this section, as a basic study for natural environment, details of protected area and protected species are mentioned. For fishes, which are vulnerable to water management and its effect to hydraulic circulation, living species in Sefidrud River and its river mouth or Caspian Sea are mentioned regardless of the risk of extinction.

And, as a basic study for social environment, livelihoods of local people are summarized. Fishermen who are vulnerable to hydraulic circulation and nomad who are one of socially vulnerable are described here.

3.8.1 Protected Areas

1) Classification of Protected Area

In order to protect biodiversity in Iran, four types of protected area have been regulated. These are "National Park", "National Natural Monuments", "Wildlife Refuges" and "Protected Area", which are controlled by Department of Environment (DOE). Total areas were 7,563,983 ha in 1997 (1376 in Iran), and are expanded to 11,791,788 ha now.

a) National Park

National Park is the area to preserve ecosystem and habitat for wildlife and vegetation. Area of each National Park is relatively large. Excellent environment like forests, pastures, grasslands, waters and mountain are selected as National Park. Study and eco-tourism aiming at conservation are allowed.

b) National Natural Monuments

National Natural Monuments is the area to protect exemplary rare flora and fauna, remarkable land formations and landscapes, or even ancient trees. Area of each National Natural Monument is relatively small. Economic activity in this area is not allowed.

c) Wildlife Refuges

Wildlife Refuges is the area to protect wild animals and to regenerate its habitats, like forests, pastures, glass lands, waters and mountains. Area of each Wildlife Refuges is large enough to possess enough area for habitat. Study and eco-tourism aiming at conservation are allowed.

d) Protected Area

Protected Area is wildlife habitat like forests, pastures, grasslands, waters, mountains. According to definition of equivalent area in IUCN, these areas accept settlement of human beings, aiming at protection of landscape with human beings and wildlife. Area of each Protected Area is relatively large. Educational program, study, eco-tourism and other economic activities aiming at conservation are all allowed in these areas.

2) Protected Area in the Study Area

Within the study area, there are four (4) National Natural Monuments, four (4) Wildlife Refugees and five (5) Protected Areas. There is no National Park. Location is shown in Figure R 3.8.1 and details for each protected area are listed in Table R 3.8.1 to 3.8.3.

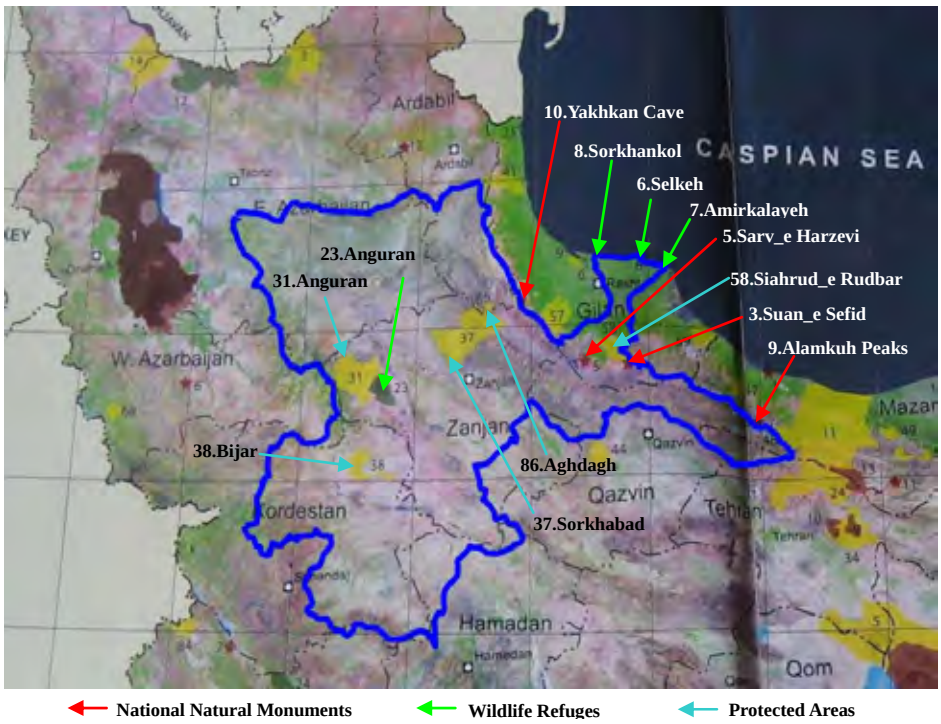


Figure R 3.8.1 Protection Area on Natural Environment in the Sefidrud Basin

Table R 3.8.1 National Natural Monument in Study Area

No.	Name	Area (ha)	Altitude (m)	Temp. (℃)	Rain (mm/y)	Protected Species
3	Susan_e Sefid	0.6	1,750 - 2,000	10	450	Rare ledebour lily
5	Sarv_e Harzevil	-	600	18	300	Old jumper tree (2000 years old)
9	Alamkuh Peaks	4,077	3,950 - 4,850	- 4	800	Wild goat, brown bear, leopard, Caspian snowcock, meadow viper living at the summits of Alamkuh, Siah Kaman and Takht-e Soleiman
10	Yakhkan Cave	1,217	2,200	-	-	Limestone cave

Source: Atlas of Protected Areas of Iran

Table R 3.8.2 Wildlife Refugee in Study Area

No.	Name	Area (ha)	Altitude (m)	Temp. (℃)	Rain (mm/y)	Protected Species
6	Selkeh	366	- 25	16	1600	Wetland near Caspian Sea Birds: whooper swan, mute swan, teal, red-breasted goose, bustard, mallard, lesser white-fronted goose, white-tailed eagle Others: Caspian pond turtle, great cormorant
7	Amirkalayeh	1,084	- 25	16	1160	
8	Sorkhankol	1,214	- 25	16	1600	
23	Anguran	29,812	1,280 - 2,200	10	400	Mountain Animals: wild goat, brown bear, wolf, Eurasian lynx, striped hyena Birds: eagle, falcon Others: meadow viper

Source: Atlas of Protected Areas of Iran

Table R 3.8.3 Protected Area in Study Area

No.	Name	Area (ha)	Altitude (m)	Temp. (℃)	Rain (mm/y)	Protected Species
31	Anguran	91,280	1,240 - 3,320	6	450	Refer to Anguran in Wildlife Refugee
37	Sorkhabad	119,225	500 - 2,900	11	500	Mountain Animals: Goitered gazelle, leopard, wild boar, large-toothed suslik Birds: eagle, falcon, houbara bustard Others: meadow viper
38	Bijar	31,769	1,600 - 2,100	10	350	Mountain Animals: Armenian sheep, wolf, fox, wild cat Birds: chukar partridge Others: spur-thighed tortoise
58	Siahrud_ eRudbar	28,289	220 - 2,220	14	800	Mountain Animals: red deer, roe deer, leopard, brown bear, jackal, common fox, weasel Birds: woodpecker, golden eagle
86	Aghdagh	4,436	500 - 1680	13	500	Mountain Animals: wild goat, Eurasian lynx, wolf, weasel Birds: golden eagle, goshawk Others: meadow viper, spur-thighed tortoise

Source: Atlas of Protected Areas of Iran

3.8.2 Endangered Species

Some endangered species listed in IUCN red list are living in the above mentioned protected area, which are shown in Table R 3.8.4. Category of red list is as below.

- EX as Extinct
- EW as Extinct in the Wild
- CR as Threatened, Critically Endangered
- EN as Threatened, Endangered
- VU as Vulnerable
- LR as Lower Risk

Table R 3.8.4 Endangered Species in Protected Area on Sefidrud River Basin

 Common name: Red-breasted goose Binomial nameBranta ruficollis Category: EN	 Common name: Saker falcon Binomial name: Falco cherrug Category: EN	 Common name: Meadow viper Binomial name: Vipera ursinii Category: EN
 Common name: Lesser white-fronted goose Binomial name: Anser erythropus Category: VU	 Common name: Wild goat Binominal name: Capra aegagrus Category: VU	 Common Name: Houbara bustard Binomial name: Chlamydotis undulata Category: VU
 Common name: Lesser kestrel Binomial name: Falco naumanni Category: VU	 Common name: Goitered gazelle Binomial name: Gazella subgutturosa Category: VU	 Common name: Spur-thighed tortoise Binomial name: Testudo graeca Category: VU

Source of Photo: Wikipedia

In addition to above animals, there is another endangered species written in Etellart Newspaper in Iran, 24-Jun-2008. That is great bustard, or otis tarda in binomial name, whose number has decreased to 40 in entire land of Iran. This great bustard is migratory bird, living in wetland of Caspian Sea. IUCN category of this bird is VU.

3.8.3 Fishes in Sefidrud River

Sefidrud River runs into Caspian Sea. Since water in Caspian Sea contains 6 % of salt (seawater is 35%), freshwater fish and brackish-water fish are living in Sefidrud River and Caspian Sea.

At 100 km upstream of Sefidrud River from Caspian Sea, where Gezelozen River joins Shahrud and change the name into Sefidrud, there is a Manjil Dam. This Manjil dam doesn't have fish-way, which is the obstacle for migration of fish.

1) Fishes in Sefidrud River Downstream of Manjil Dam and Caspian Sea

Fishes living in Sefidrud River downstream of Manjil Dam and Caspian Sea are shown in Table R 3.8.5.

Table R 3.8.5 Fishes in Sefidrud River and Caspian Sea

 Order: Cypriniformes Common name: Common carp Binomial name: Cyprinus carpio	 Order: Cypriniformes Common name: Kutum, Caspian white fish[*1)] Binomial name: Rutilus frisii kutum	 Order: Cypriniformes Common name: Carp bream[*1)] Binomial name: Abramis brama
 Order: Cypriniformes Common name: Roach[*1)] Binomial name: Rutilus rutilus	 Order: Cypriniformes Common name: Barbel Binomial name: Barbus barbus	 Order: Cypriniformes Common name: Tench Binomial name: Tinca tinca
 Order: Mugiliformes Common name: Flathead mullet Binomial name: Liza cephalus	 Order: Mugiliformes Common name: Golden grey mullet Binomial name: Liza auratus	 Order: Mugiliformes Common name: Leaping mullet Binominal name: Liza saliens
 Order: Clupeiformes Common name: Alosa Binomial name: Shad	 Order: Salmoniformes Common name: Brown trout[*1)] Bonomial name: Salmo trutta caspius	 Order: Esociformes Common name: Northern Pike Binomial name: Esox lucius

*1) Endemic in Caspian Sea

a) Cypriniformes (Carps)

Many cypriniformes (hereinafter carps), especially common carp, live in Caspian Sea and Sefidrud River. Although carps normally live in fresh water, they can also live in brackish water of Caspian Sea. Some carps are endemic to Caspian Sea.

Carp is one of the fish eaten by local people. Carp cultured in fish pond is preferred to those in river because of little smell. Especially cultured kutum is tasty and expensive, which is eaten as a banquet. Carps caught in Caspian Sea are eaten by some people, but not by the others because of pollution.

b) Mugilformes (Mullet)

Mugilformes (hereinafter mullet) live in Caspian Sea and river mouth. Flocks of mullet sometimes migrate to rivers regardless of breeding season. Mullet is tasty and many people like to eat. There are many mullet living in Caspian Sea and Sefidrud River.

c) Clupeiformes (Herring)

Alosa, family of clupeiformes, normally lives in Caspian Sea. Alosa migrates to rivers for breeding then come back. It is called cheap fish which is not so tasty.

d) Salmoniformes (Salmon)

Brown trout is one of the salmoniformes (hereinafter trout) which is endemic in Caspian Sea. Brown trout normally lives in Caspian Sea, and many of them migrate to rivers for breeding. Brown trout is not normally eaten by local people. It is cultivated rainbow trout or lake trout which is frequently eaten as trout.

e) Esociformes (Pikes)

Northern Pike is one of the esociformes (hereinafter pikes), which can live in freshwater and brackish water. Northern pike is seen both in Caspian Sea and Sefidrud River and many people like to eat them.

f) Others

Several kinds of sturgeons and wels catfish lives in Caspian Sea. Numbers of sturgeons are drastically decreased due to too much hunting, which is now registered by IUCN red list as category EN (endangered). Sturgeons normally live in Caspian Sea and migrate to Sefidrud River for breeding. Since Manjil Dam prevents migration to upstream, sturgeons breed at downstream of river or at artificial breeding area.

2) Fishes in rivers Upstream of Manjil Dam

Some rivers upstream of Manjil Dam have fewer flow of water than downstream of the dam. Due to fewer flow, number of fish is relatively small. Carps are main creature living in rivers. Catfish lives in rivers, too.

3.8.4 Livelihood of Local People

1) Employed Population

Employed population aged 10 and over is shown in Table R 3.8.6 in 1996 census (1375 in Iran). Populations are listed for each province. Employed population includes both employer and employee.

Agriculture and forestry are active in Gilan and East Azarbaijan with more than 200 thousand employed populations. In other 6 province, nearly 100 thousand people are employed for agriculture and forestry.

Fishery is active in Gilan with more than 3,000 employed populations. In Kordestan and Tehran, 100 to 200 people are working for fishery.

Mining and quarrying are active in Tehran with more than 20 thousand employed populations. In other 7 provinces, 500 to 2000 people are working for mining and quarrying.

Workers other than above, like manufacturing, electricity, construction, wholesale, public administration and others, are active in Tehran.

Table R 3.8.6 Employed Population Aged 10 and Over

(people)

Province	Agriculture, Forestry	Fishing	Mining, Quarrying	Manufacturing	Electricity, Water
East Azarbaijan	233,962	16	1,771	240,980	6,108
Ardebil	96,638	49	420	30,261	1,514
Zanjan	82,826	4	1,128	38,933	1,495
Kordestan	104,637	123	932	35,736	1,690
Gilan	246,005	3,193	916	90,627	6,549
Hamedan	130,716	20	1,106	53,977	3,272
Tehran	81,676	220	20,832	606,831	29,140
Qazvin	62,077	8	588	54,500	2,435

Province	Construction	Wholesale	Public Administration	Others	Total
East Azarbaijan	91,452	104,496	68,741	167,320	914,846
Ardebil	40,097	30,254	19,457	50,169	268,859
Zanjan	23,337	18,215	16,721	35,490	218,149
Kordestan	56,380	35,702	37,435	54,692	327,327
Gilan	31,240	74,806	42,720	135,464	631,520
Hamedan	63,509	45,800	32,843	75,470	406,713
Tehran	245,859	521,768	390,876	783,183	2,680,385
Qazvin	18,394	23,356	18,912	45,356	225,626

Source: National census in 1996 (1375 in Iran)

Numbers of worker in Table R 3.8.6 are shown as a ratio of work category in each province Figure R 3.8.2). Ratio of agriculture and forestry is high in Gilan and Zanjan, which is nearly 40 %. Fishery which is active only in Gilan province is low in ratio, less than 1 % of total employed population. Manufacturing is active in all eight (8) provinces where 10 % or more people are working. As a whole, primary and secondary sector of economy are active in all provinces except for Tehran. Secondary and tertiary sector of economy are active in Tehran.

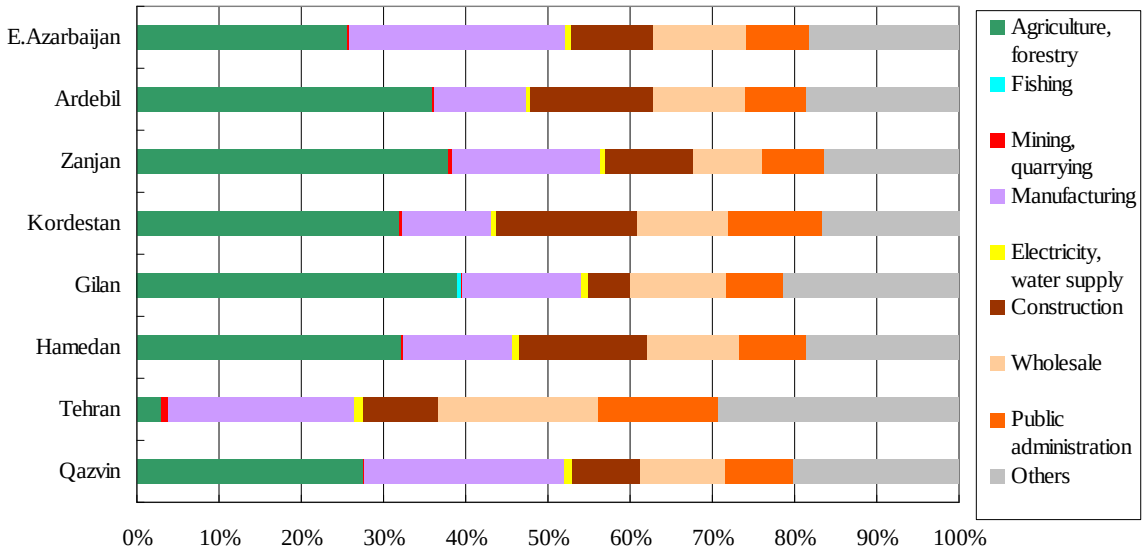


Figure R 3.8.2 Ratio of Employed Population in Each Province

Fishery is one of the works closely related to hydraulic circulation. According to "Fisheries of Iran", fishermen members of cooperatives are more than 6000 in Gilan province in year 2005 (1384 in Iran). Other 7 provinces are not listed in the table, where few fishermen are working.

Number of fishermen in Gilan province is listed in Table R 3.8.7. Number of fishermen is 39624 in 1996 (1375 in Iran), which is doubled to 6555 in 2005 (1384 in Iran). These number are classified into each town, and most of the towns are located within the study area (Sefidrud River basin).

Table R 3.8.7 Fishermen in Gilan Province

Year (Iranian Year)	Area	In or out of study area	Number of fishermen
1991 (1370)	Gilan Province	―	2542
1996 (1375)	Gilan Province	―	3624
2001 (1380)	Gilan Province	―	7356
2005 (1384)	Gilan Province	―	6555
	Astara	Out	100
	Astara Ashrafiye	In	1566
	Bandar Anzali	In	1781
	Talesh	Out	346
	Rasht	In	885
	Rudsar	In	1125
	Lahijan	In	305
	Langarud	In	447
	Within Study Area	―	6109
	Out of Study Area	―	446

Source: Fisheries General Department

3.8.5 Nomads

According to "Iran Nomad Tour", there are 1 million nomadic pastoralists in Iran, organizing over 500 tribes. Nomads change their habitat in summer and winter. They live in cooler mountains in summer season, and moves to foot of mountains or other warmer places in winter season. Livelihood is mainly farming and raising livestock like goats, sheep and camels.

Within the study area, it is said that some nomads live in Zagros Mountain and mountain in East/West Azarbaijan. In the book of "Anthropology of Iran", there is some descriptions of nomads in East /West Azarbaijan and Qazvin. In East/West Azarbaijan, there are nomads named Shettrenlu and Ghalakjanlu, in which 2000 and 150 families live respectively. In Qazvin, there are Chegini, Chisavand, Kakavand, Ilereshvand and Nuohi, in which 1000, 1200, 350, 350 and 600 families live respectively.

3.9 LANDUSE

Landuse in the Study Area is shown in Figure R 3.9.1. This map was obtained updating the landuse map made by MOJA with ALOS satellite map, which was taken in 1997 with the resolution of 15m. Additional study area in the Sefidrud Irrigation Network, Gilan is shown in Chapter 9.

Table R 3.9.1 Landuse Categories in the Study

No.	Categories
1	Irrigation Agriculture
2	Dryfarm Agriculture
3	Dense Forest
4	Forest
5	Dense Scrub
6	Scrub
7	Grass Land
8	Urban
9	Wasteland
10	Water

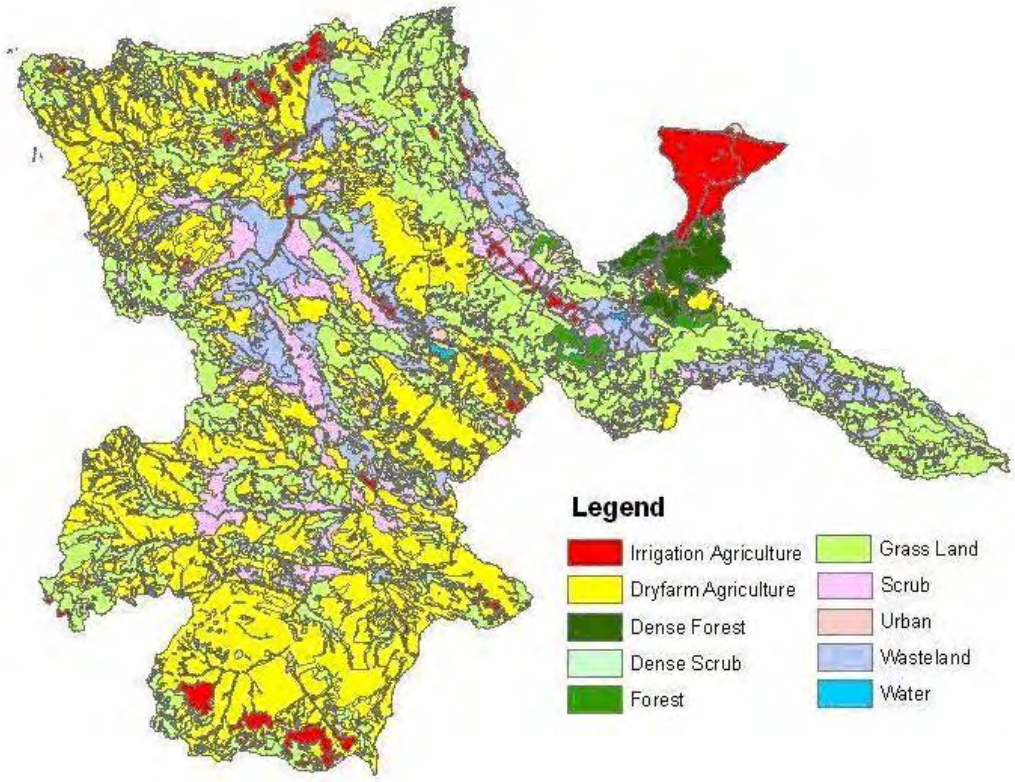


Figure R 3.9.1 Land Use Map

3.10 AGRICULTURE, SOILS AND IRRIGATION

3.10.1 Agriculture in General (Zone-wise)

1) General Description of Agriculture in the Country

Agriculture is the foundation of the Iranian economy which accounts for about 26% of non-oil export. Over 80% of foods are self-supplied and 33 % of the 68.5 million who live in the rural areas worked for the agriculture sector in 2005 (1384) (*Ref: MOJA Website*).

2) Forth National Economic Development Plan (Agriculture Sector)

The Decree of the Fourth Economic, Social and Cultural Development Plan of Iran for 1384-1388 (2005-2009) enacted on September 1, 2004 aims to ensure national food security focusing on the conversion from oil dependent economy to non-oil-dependent economy through promotion of agriculture production and export of the agricultural products. The Plan has the following aims:

- to increases population from 67 million in 1382 (2003) to 72 million at the end of the Plan in 1388 (2009),
- to increase per capita energy supply from 3535 kcal in 1380 (2001) to 3675 kcal by 1388,
- to increase per capita food supply and daily protein intake from 672 kg in 1380 to 743 kg and from 81g to 89.9g by 1388 respectively, and
- to focus on vulnerable groups especially children and young adults growing and suffer from a shortage of micronutrient such as calcium and iron.

In order to accomplish the tasks above, the quantitative goals are presented in the following Table R 3.10.1.

Table R 3.10.1 National Goals of Agricultural Production

('000 ton)

Crop	Increase ('000 ton)		Annual	Actual	
	1382 (2003)	1388 (2009)	increase (%)	1384 (2005)	1386 (2007)
Wheat & Barley	13,406	15,880	2.9	14,300	15,000
Rice	2,931	3,429	2.6		
Cotton	351	522	6.8		
Sugar Beet	5,933	7,000	12.8		
Sugar Cane	5,196	10,014	11.5		
Oil Seeds	393	700	10.0		
Milk Production	6,316	9,556	5.5		
Meat Production	752	921	7.1		
Chicken Production	1,100	1,605	3.4		
Egg Production	628	789	6.5		
Fishery Production	442	763	9.5		

Source: National Document for Natural Resources and Agricultural Sector Development under the Fourth Five-Year National Development Plan

In 2007, the total production of wheat and barley was 15 million tons which not only achieved the national production goal of 15.88 million ton but also satisfied the domestic demand of 11 million tons and allowed export of the surplus 4 million tons (*Tehran Times*, September 23, 2007). Table R3.10.2 shows targets values of the 8 provinces in the Basin.

Table R 3.10.2 Quantitative Goals of 4th Five-Year Development Plan for Agriculture Sector

('000 ton)

Province	Year 1388 (2009)		
	Field Crop	Orchard	Animal Husbandry
East Azarbaijan	3324	1285	745
Ardebil	2225	393	452
Tehran	3173	1174	1291
Zanjan	1274	365	222
Qazvin	1653	683	359
Kordestan	1470	194	278
Gilan	1399	539	471
Hamedan	3230	603	526
Total	17748	5236	4344
Compare to National Target(%)	22	27	34
National Target in 1388 (2009)	79829	19302	12911
Base Year (1382)	62506	14009	8824
Annual average growth rate (%)	4.2	5.5	6.6

Source: National Document for Natural Resources and Agricultural Sector Development under the Fourth Five-Year National Development Plan

All provinces also set their quantitative targets and are making every effort for increase in agricultural production.

3) Agrarian Reform and Agricultural Land Holdings

Through the agrarian reforms commenced first in 1963 and second in 1980, Iranian tenant farmers began to become ownership farmers. The average holding size in 2005 obtained from [entire farm land in Iran / entire number of farm holding] is 5 ha/holding, however, ramification of farmland has also begun since they are allowed for succession of their farmland to their children. According to the Statistic Year Book for 2005, the total number of holders who own the agricultural land with an area less than 1.0 ha accounts 35 percent, and the total area of such land occupies only 2 percent of the total area as shown below:

Table R 3.10.3 Agricultural Land Holding

Ownership (ha)	Number of Owner (%)	Total Area (%)
Less than 1 ha	34.6	2.3
1- 3 ha	25.2	8.2
3- 10 ha	26.8	27.7
10 ha or more	13.3	61.7

Source: Statistical Year Book 1385

An average holding size for the 8 provinces related to the river basin is 5.3 ha which is same level as the national average mentioned above, however, the provincial average shows difference for each other Province as shown table below, in particular for Gilan Province, the average holding is as low as only 0.9 ha/holder, and only 0.65-0.7 ha for paddy cultivation farmer.

Table R 3.10.4 Average Size of Holding

Province	Agricultural Land / Number of Owner (ha/person)
E-Azarbaijan	6.0
Ardebil	8.0
Tehran	3.0
Zanjan	9.9
Qazvin	5.6
Kordestan	9.7
Gilan	0.9
Hamedan	7.0

Source: Statistical Year Book 1385

3.10.2 Agricultural Production (Major crop, Cultivated Area and Production)

1) Crops in the Sefidrud River Basin

A variety of agricultural products is cultivated in the Sefidrud River Basin mainly because of large difference of maximum and minimum temperatures.

The irrigated and rainfed agricultural land is 2,100 thousand ha which consists of wheat and barley (521 thousands ha), paddy (242 thousands ha), pulses (40 thousands ha), alfalfa (593 thousands ha), orchard (237 thousands ha). Wheat & barley and fallow are alternating every year. The agricultural land of each province is given in Table R 3.10.5 below:

Table R 3.10.5 Crops Areas in the River Basin with the Country

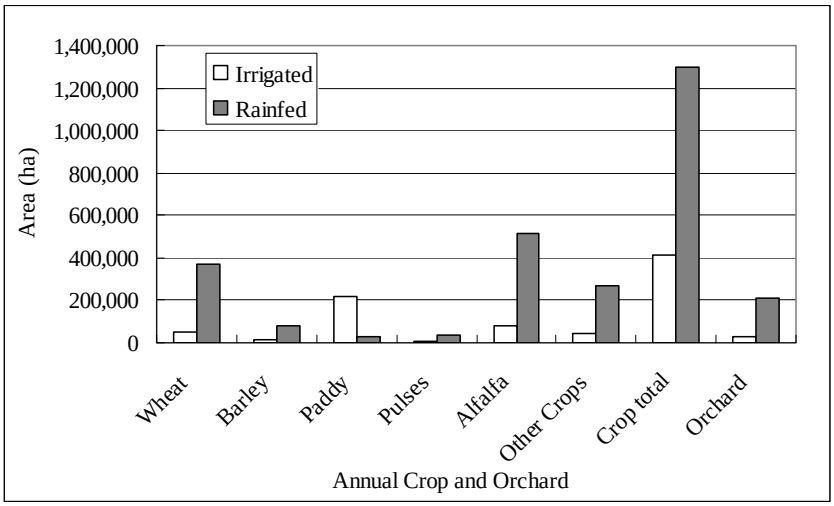
(unit : ha)

	Ardebil		East Azarbaijan		Qazvin		Gilan**		Hamedan	
	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*
Wheat	4,234	16,988	14,720	115,773	1,188	1,549	347	482	1,606	13,308
Barely	1,528	6,124	2,509	17,739	811	1,050	226	304	437	2,560
Paddy	260	1,166	2,076	14,777	895	1,113	209,046	3,475	0	0
Pulses	127	520	1,009	7,634	425	531	117	148	32	247
Alfalfa	7,720	29,961	21,504	166,533	628	901	216	328	1,698	11,987
Other Crops	5,247	21,738	9,662	72,234	3,761	4,708	1,201	38,696	721	6,024
Crop total	19,116	76,497	51,480	394,690	7,708	9,852	211,153	43,433	4,494	34,126
Orchard	2,286	9,125	10,199	80,854	740	977	179	37,609	539	2,949
Total	21,402	85,622	61,679	475,544	8,448	10,829	211,332	81,042	5,033	37,075
Ratio of Irrigated Area		20%		11%		44%		72%		12%

	Zanjan		Kordestan		Tehran		Total		
	I*	R*	I*	R*	I*	R*	I*	R*	Total
Wheat	16,565	224,246	14,818	151,818	115	144	53,593	524,308	577,901
Barely	8,324	34,475	2,121	20,634	94	117	16,050	83,003	99,053
Paddy	1,822	7,460	25	106	108	134	214,232	28,231	242,463
Pulses	4,986	20,749	290	2,949	70	86	7,056	32,864	39,920
Alfalfa	27,293	114,889	18,574	189,056	822	1,022	78,455	514,677	593,132
Other Crops	15,167	58,176	6,415	65,563	630	784	42,804	267,923	310,727
Crop total	74,157	304,547	42,243	430,126	1,839	2,287	412,190	1,451,006	1,863,196
Orchard	11,821	48,948	2,720	26,391	941	1,170	29,425	208,023	237,448
Total	85,978	508,943	44,963	456,517	2,780	3,457	441,615	1,659,029	2,100,644
Ratio of Irrigated Area		14%		9%		45%		21%	

Source: WRMC, Iranian Statistic Center, MOJA, *: I = Irrigated, R = Rainfed, **: Including Sefidrud Irrigation and Drainage Network

The areas for irrigated and rainfed crops in the Basin are summarized in Figure R 3.10.1 below:



Source: "Final Report Vol."5, WRMC & Mahab Ghodss, Statistical Year Book 1385

Figure R 3.10.1 Crop Area in the Basin: Irrigated and Rainfed Areas

In this Study, focusing on the irrigated agriculture, paddy, wheat, barley and alfalfa under irrigation are selected for the representative major crops, and pulses and potato under irrigation are selected for the reference crops.

Table R 3.10.6 summarizes the major crop production areas in the Sefidrud Basin and Iran. Although the geographical area of the Basin is only 4% of the country, the cultivated area of irrigated paddy accounts for as large as 52% of that of country. The paddy in the Basin has been granted particular attention by the Government under its food security strategy by receiving water from Manjil dam for the last 45 years.

Table R 3.10.6 Crop Areas in the River Basin and the Country

Area	Area (km^2)	Wheat (ha)	Barley (ha)	Paddy (ha)
Iran	1,628,750	6,941,286	1,817,572	465,453
Sefidrud River Basin	59,090	422,453	99,053	242,463
%	4	6	5	52

Source: "Final Report Vol."5, WRMC/MG, Statistical Year Book 1385

2) Present Irrigated Crop Areas in the Basin

a) Estimates of Crop Area and Zoning

The river basin includes limited area of Kermanshah, West Azarbaijan and Mazandaran (7,240ha of the rainfed area and 10 ha of the irrigated area). These areas are excluded from the agricultural statistics in this Study because of those small areas as is excluded in the previous study conducted by WRMC/MG.

WRMG/MG collected crop-wise areas data from the Provincial MOJA office, sub-provincial extension offices and determined the area in line with the data as of 1382-83 (2003-04) in Iranian Statistic Center. In addition, net paddy field areas in Gilan was estimated through satellite image interpretation, and obtained from multiplying 88% of reduction factor for canals, roads, etc. (WRMC/P, 2002).

The river basin was divided into 5 zones (zone A to E) from the upstream of Qezel-Ozan River to the downstream of Sefidrud River (or zone E as Gilan), and further sub-divided in 18 sub-zone from the hydrological view points. The major crops areas are distributed into these sub-zone. (Refer to sub-section 6.1.3)

The area of irrigated major crops (wheat, barley rice and alfalfa: 362 thousands ha) occupies 82% of the irrigated area in the basin.

Table R 3.10.7 Major Crops in Irrigated Area in Each Zone

(ha)

Zone	Wheat	Barley	Paddy	Pulses	Alfalfa	Other Crops	Orchard	Total
Zone A	17,482	3,151	0	349	20,802	7,621	3,955	53,360
Zone B	23,075	8,507	2,093	5,703	42,281	14,568	16,492	112,719
Zone C	11,997	3,616	2,145	516	13,966	18,570	7,676	58,486
Zone D	1,013	769	1,212	486	1,377	1,707	1,302	7,866
Zone E	25	7	208,782	0	29	337	0	209,180
Total	53,592	16,050	214,232	7,054	78,455	42,803	29,425	441,611

Source: JICA Study Team, based on WRMC/MG, MOJA and Iranian Statistic Center

Table R 3.10.8 The Ratio of Major Crop in Irrigated Areas in Each Zone

(%)

Zone	Wheat	Barley	Paddy	Pulses	Alfalfa	Other Crops	Orchard	Total
Zone A	33	6	0	1	39	14	7	100
Zone B	20	8	2	5	38	13	15	100
Zone C	21	6	4	1	24	32	13	100
Zone D	13	10	15	6	18	22	17	100
Zone E	0	0	100	0	0	0	0	100

Source: JICA Study Team, based on WRMC/MG, MOJA and Iranian Statistic Center

b) Major Irrigated Crops in Zone

The irrigated major crop areas are summarized hereunder in terms of the zone:

i) Zone A:

The irrigated crop area is 53,360 ha. This zone situates at the most upstream of the river basins. The crop areas of wheat and alfalfa occupy as large as 33 and 39 per cents, respectively. The higher percentage of alfalfa proves that the livestock is essential in this zone.

ii) Zone B:

The irrigated crop area is 112,719 ha which is the secondly largest among all zones. This zone situates in the immediate downstream of the zone A. Alfalfa occupies 38% of the total irrigated crop area followed by wheat (20%).

iii) Zone C:

The irrigated crop area is 58,486 ha. Alfalfa (24%) occupies the largest share of the irrigated crop land and wheat (21%) follows it. Then, Orchard does (13%).

iv) Zone D:

The irrigated crop area is 7,866 ha which is the smallest among all zones. Comparing to other zones, crop area is evenly distributed by crops. (alfalfa (18%), orchard (17%) and paddy (15%)).

v) Zone E:

The irrigated crop area is 209,180 ha which is the largest in the basin. This area includes Sefidrud Irrigation and Drainage Network. The major crop in this zone is rice. This zone extends in the catchment area of the River Basin from Manjil dam to Caspian Sea.

3) Crop Yields

Based on the statistic of MOJA, recent yield of representative crops under irrigation and rainfed conditions was summarized. The average yield of rice in the River Basin was represented by the yield in Gilan, other crops was obtained from average of 3 large provinces (East Azarbaijan, Zanjan and Kordestan) in 2004 and 2005 except apple which was estimated by the average of East Azarbaijan and Zanjan in 2004 and 2005, and olive which was estimated by the data in Zanjan in 2003 as summarized below.

Table R 3.10.9 Major Crop Yields under Irrigation and Rainfed

(kg/ha)

Crop	Rice	Wheat	Barley	Alfalfa	Apple	Olive	Potato	Beans
Irrigated	3736	3655	2818	6125	16332	4050	27201	1478
Dry farm	0	1097	931	2090	0	0	0	423

Source: MOJA

The yield of wheat and barley is affected significantly by the rainfall, however, the yield in the River Basin is higher than the country average as shown in Table R 3.10.10.

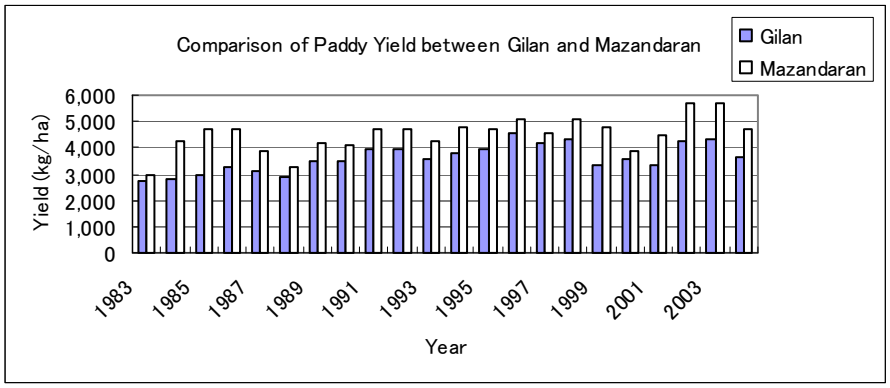
The yield of rice in the Basin is, however, slightly lower than the country average.

Table R 3.10.10 Major Grain Yields under Irrigation and Rainfed

Area	Average Yield (kg/ha)		
	Wheat		Paddy
	Irrigated	Rainfed	Irrigated
Country	3,094	923	3,910
Study Area	3,655	1,097	3.736

Source: MOJA

To clarify the reason of lower yield in Gilan, the rice yield in Gilan was compared with yield in adjoining province of Mazandaran in the following Figure R 3.10.2



Source: MOJA

Figure R 3.10.2 Comparison of Rice Yield between Gilan and Mazandaran

The rice yield in Mazandaran is 25% higher on average than that of Gilan. However, the market prices of rice per kg are 3,247 Rials in Mazandaran and 4,421 Rials in Gilan in 1384 (2004) (*Statistic Year Book of 2005*).

This is mainly because of that the high yield variety (HYV) is dominantly selected by farmers in Mazandaran, while, tasty and local variety is mainly selected by farmers in Gilan. The rice variety is selected by the farmers who are well aware of this difference in each province since long time. The roles of quality in Gilan and quantity in Mazandaran are, therefore, projected to remain unchanged in the near future.

4) Projection of Potential Irrigation Area in the River Basin

a) Upstream Provinces

The upstream provinces (East-Azarbaijan, Ardebil, Kordestan, Zanjan, Hamedan) have few to more than 10 times of rainfed area compared with the present irrigated area. Therefore, it can be said that there are large potential for expansion of the future irrigation area. However, recent tight supply-demand situation for irrigation water allows, in principle, that the new area can be developed by the water developed through the improvement of the existing traditional irrigation area. It is also recommended that higher priority may be considered to provinces such as Kordestan with a low irrigation rate through reallocation of a part of the newly developed water, when the tight water situation become relax.

b) Qazvin and Teheran Provinces

There are no large agriculture potential in Tehran area in the Basin because of only 753 ha of crop area at present.

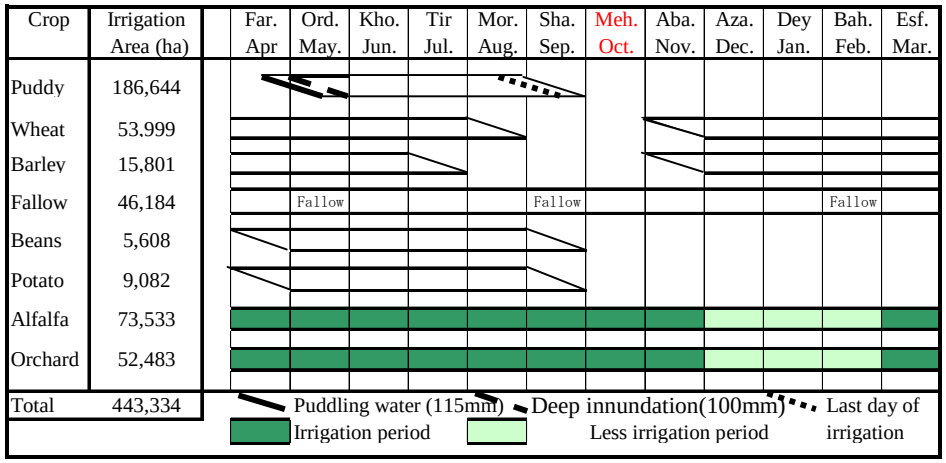
However in Qazvin Province, in the outside area of Basin, there are irrigated area by Taleghan river for about 30 thousands ha at present, which is expected to be increased in future by a plan of trans-basin Alamout project.

c) Gilan Province

The most of the irrigation facilities for rice areas in Gilan are under completion, construction or study. There are less potential to develop new field in future except limited tea area and outside areas (WRMC/MG). However, RWC is responsible to supply considerable inland fishery water to the River mouth and hatchery station for sturgeon with higher priority than irrigation water supply from the national level strategy (according to WRMC).

3.10.3 Cropping Pattern

The cropping patterns for the major crops was summarized as illustrated in Figure R 3.10.3 based on the WRMC/MG report and the interview at the sites. The cropping patterns in the upstream provinces, in particular, the patterns in Zanjan, Kordestan and East-Azarbaijan are mostly the same. The cropping pattern for the rice is represented by the one in Gilan.



Source: WRMC and interview at the Site

Figure R 3.10.3 Representative Cropping Patterns

1) Cropping Pattern

a) Cropping Pattern for Rice

The rice variety in Iran is classified in long, medium and short grains, early and late mature, and local and high yield. However, farmers in Gilan which occupies 40% of the total rice field area of the country mainly select tasty “Sadri”, i.e. name of local variety, long grain and late mature with average growing period of 120-130 days. Annual water requirement of this rice is slightly more compared with the less tasty variety as high yield variety which is minority in Gilan (MOJA statistic in 2005).

b) Cropping Pattern for Wheat and Barley

Wheat and barley are not planted in the same field in every year, and planted alternatively with equivalent fallow area. The fallow area is, thus, prerequisite in the area with limited water resources. The yields of the rainfed wheat and barley vary year by year depending on the amount of the precipitation. Wheat and barley are planted in November and wheat is harvest mostly in July and August and barley is harvested one month before the wheat.

c) Cropping Pattern for Alfalfa

Alfalfa, i.e., major feed crop in the Basin, distributes in the related 8 provinces. Alfalfa is annual crop and 85% of the crop is irrigated and is harvested 3 to 4 times annually.

d) Cropping Pattern for Beans and Potato

Potato and beans, excluding rainfed chick pea, are irrigated annual crop. They are planted in April and harvested in September. Crop calendar for other pulses and vegetable are mostly same as the one for potato and beans.

e) Cropping Pattern for Orchard

Orchard including fruits is perennial crop, however, replant is necessary in every 20 years in general because of the yield reduction and difficulty in harvest. The irrigated orchards are apple, apricot, pear, cherry, peach, pomegranate, grape, etc. Orange, tea, mulberry, nuts, etc. are rainfed.

2) Agricultural Machinery

Agricultural machinery is essential to support the cropping pattern. According to the statistic in the related 8 provinces, 1 tractor is deployed for 4 ha in Gilan, 5 ha in 3 provinces (East-Azarbaijan, Qazvin and Tehran), and 6-8 ha in the rest of provinces.

Tiller is dominant in Gilan and deployed with an average rate of 1 tiller per 1 ha. One combine is deployed for 10 ha in Ardebil and 29 ha in Zanjan. Combines of other provinces are in between these two provinces. Agricultural mechanization in Gilan is relatively ahead, while those in other provinces are relatively behind.

3.10.4 Irrigation

1) General Description of Irrigation in Iran

Iran has a long history of irrigation because of the scarcity of water resources and precipitation. The existing irrigation facilities are mostly traditional types e.g. earth canal, traditional weir and flood/border irrigation in the field. Although these irrigation systems are still functional they are not efficient. Mainly due to low application efficiency in the field, overall irrigation efficiency in Iran is estimated as low as 33 to 37%. In other words 65% of irrigation water is wasted without being used for plant growth. A modern irrigation system has been recently introduced, however, it counts only 2 % of the entire irrigation system in Iran (Working Paper No. 118, IWMI, 2007). A study was made to compare the unit water supply per hectare between the world and Iran averages in the Table R 3.10.11 Water consumption for irrigation in Iran is about 1.2 to 2.4 times larger than world's average.

Table R 3.10.11 Average amount of water applied to different crops for irrigation in Iran

Crop	World average (m^3/ha)	Iran (m^3/ha)
Wheat	4500-6500	6400
Rice	4500-7000	10000-18000
Sugar beet	5500-7500	10000-18000
Sugar cane	15000-25000	20000-30000
Corn	5000-8000	10000-13000

Source: Keshabarz et al, 2003 (Working Paper 118, IWMI)

2) Long Term Irrigation Plan

The Ministry of Energy formulated long-term strategies for water resources development in 2003 which declare a reduction of agricultural water consumption from 92% to 87% in 20 years time. In order to accomplish the goals to increase irrigated farming areas with drainage systems to 2 million ha during the 4th Five-Year Plan period, a pressurized irrigation system should be promoted taking into account preservation, restoration, improvement, development and optimized use of fundamental natural resources. Optimum improvement and development of irrigation facilities in the Sefidrud River Basin is, thus, essential for reformation of irrigation water use.

3) Irrigated Area Ratio in the River Basin

The overall irrigated area ratio against the entire cultivated area including fallow in the river Basin is as low as 21% (or 29% excluding fallow) as shown in Table R 3.10.12. The province-wise over all irrigated area ratio is 74% for Gilan (the highest), while, in provinces in the upstream of Manjil dam are as low over all irrigation ratio as 18% for East-Azarbaijan, 26% for Zanjan and 12% for Kordestan mainly due to delay in introduction of the modern irrigated agriculture and limited water resources.

Table R 3.10.12 Irrigated Area Ratio in the River Basin

Area	River Basin	Ardebil	East-Azarbaijan	Zanjan	Kordestan	Hamedan	Gilan	Qazvin	Tehran
Fallow included (%)	21.1	21.1	13.9	19.2	8.7	6.2	72.8	44.5	70.4
Fallow excluded (%)	28.6	31.0	18.1	26.0	11.8	8.6	74.0	53.6	69.2

Source: WRMC/MG

4) Grouping of Irrigation Area by Reach for Water Balance Study

The Sefidrud River Basin was divided into 14 basins and 54 sub-basins by TAMAB (Water Research Center). WRMC/MG has sub-divided the basin into 62 river reaches as a minimum unit for its water balance study. The 62 river reaches were decided taking into account agriculture, water sources, and discharge points. Each reach is bound by a dam and/or a hydrometric station (HMS).

5) Present Irrigation Area of Each Reach

The present irrigation area of each reach in the Basin is investigated and compiled by Mahab Ghodss based on the information given by the Statistic Center of the Ministry of Agriculture, excluding the following areas:

- 167,053 ha area irrigated by Manjil Dam under the Sefidrud Irrigation & Drainage Network (SIDN) in Gilan Province (same area is applicable to future area)
- 30,000 ha area irrigated by the Taleghan River under the Qazvin Plain Irrigation Project. There is a trans-basin diversion plan from Alamout river.

The total areas of SIDN (189,833 ha for single cropping of rice) consist of:

- East Gilan (54,556 ha),
- Central Gilan (78,503 ha), and
- Fumanat (56,775 ha).

The total area of 167,053 have been obtained through satellite image interpretation and application of the reduction factor of 88% as afore-mentioned considering the area for canals, roads, etc.

The east and west ends of the system are bounded by the following 2 on-going projects which are outside of the SIDN.

- the Shafarud Dam Project (irrigation area is 12,000 ha) in the North-West end of SIDN, and
- the Polerud Dam Project (irrigation area is 27,172 ha) in the South-East end of SIDN.

6) Net Irrigation Water Requirement

MOJA has issued a national water document which was prepared by MOJA in line with the CROPWAT software developed by FAO about 10 years ago based on the Penman-Montheith method. The national document is convenient because it contains the various meteorological data

and crop data for all representative area of the nation. The reference crop evapotranspiration (ETo) and net irrigation water requirement considering effective rainfall are automatically calculated in the national water document. WRMC, in principal, employs this software and determines the gross irrigation water requirement considering the irrigation efficiency. The FAO method was developed in response to the international opinions that the most of the previous methods were suspected over-estimate of the water requirement.

In this study period, input/output data for rice water requirement has been collected. The study team has applied these input date (maximum and minimum temperatures, relative humidity, wind velocity, sunshine hours, solar radiation, etc.) into FAO program and obtained same output. This result clarified the Iranian practice and the national water document employs same practice as the FAO practice.

7) Definition of Traditional and Modern Irrigation System

The most of the existing irrigation systems in the River Basin consist of the traditional system only a part of the system are being converted to the modern system which are defined as follows:

(i) Traditional irrigation system:

- Intake weir: temporary structure made of earth and stone,
- Canal: earth canal, and
- On farm: border, basin, furrow.

(ii) Modern irrigation system:

- Intake weir: permanent gated concrete structure or pumping station,
- Canal: paved by concrete or pipeline in case of upland field irrigation, and
- On farm: sprinkler and drip in case of upland field irrigation, and basin in case of rice field.

Semi-Modern irrigation system is mixed system of the above two system, for example, weir is permanent but canal is earth made.

8) Irrigation Efficiency

The irrigated upland field in the most of the upstream of the River Basin is covered by the traditional system. This fact means that there is high potential to develop new water volume through improvement of the irrigation efficiency by the conversion of the existing traditional system to the modern pressurized system.

WRMC/MG estimated the present over all irrigation efficiencies (which consist of intake, conveyance, distribution and field application efficiencies) at 0.30-0.37 for the annual crops and perennial crops (orchard) in the upstream of Sefidrud Dam based on information of ILRI (International Land and Reclamation Institute in the Netherlands), data obtained by actual measurement, irrigation method, and soil conditions.

Irrigation efficiencies in the future after improvement by modern irrigation systems are estimated at 0.50-0.71 after review of those data proposed by the various project consultants with correction if deemed to be necessary. The study team observes these results.

The present and future irrigation efficiencies in the downstream of Sefidrud dam (single crop of rice cultivation) are reviewed, compared and estimated by WRMC/P at:

- 43% for the East Gilan and Fumanat Sub-Systems
- 38% for the traditional network in Central Gilan, and
- 47% for the modern network in Central Gilan.

WRMC conceives a plan to improve the low efficiency of the traditional system with a total irrigation area of 52 thousands ha in the central Gilan from 0.38 at present to about 0.50 in future. The newly developed water is expected to be reallocated to the downstream rice field where irrigation water is difficult to reach. The improvement work is under construction. Eight small dams are also proceeded by WRMC at the minor local streams.

In order to expect such future irrigation efficiencies, proper irrigation management through the establishment and strengthening the farmer's Water Users' Association (WUA) is prerequisite, in addition to modernization of the existing traditional irrigation systems.

9) Present status of Development and Improvement of Irrigation Facilities

Most of the irrigation facilities in the Basin are traditional systems except those constructed under SIDN, QPIP and other projects recently completed or ongoing pressure irrigation systems. In Zanjan, for example, modern pressurized irrigation systems are being completed recently to irrigate about 1,500 ha per year and another system that covers about 8,000 ha has been already converted to modern pressurized system as well. Efficiency of modern irrigation systems has been improved.

The large scale irrigation facilities other than dam in the River Basin are rice irrigation facilities in Gilan. At the downstream of Manjil dam, 3 large weirs are under operation, namely, Tarik weir with Fumanat tunnel (L=17 km, Qmax is 32 m^3/s), Galerud weir (design intake discharge=25m^3/s) and Sangar weir (design intake discharges are 113 m^3/s for left main canal and 75 m^3/s for right main canal).

Most of the existing traditional irrigation facilities which require rehabilitation of earth and stone intake weirs and earth canals every year and employ the border, basin and furrow irrigation shall be improved promptly. Stake holders are requested to recognize the fact that the new development of the rainfed area is possible only after obtaining new water volume through improvement of irrigation efficiency by conversion of the traditional system to modern system.

10) Drought Record

A record of drought for the Basin is available at Gilan RWC in terms of the reservoir storage volume of Sefidrud dam at the beginning of the irrigation season. The Basin's irrigation area has been suffering from a drought for the last 8 years as Table R 3.10.13 shows.

Table R 3.10.13 Drought in Sefidrud (Manjil) Dam

Year	Reservoir storage volume (MCM)	Situation
1378 (1999)	830	Drought
1381 (2002)	931	Drought
1385 (2006)	1,450	Sangar East Main Canal only *1

*1: Main canal discharge capacity was reduced from 67 to 40 m^3/s due to landslide after an earthquake. RWC and OMC requested farmers to introduce rotation irrigation, however, they did not cooperative, and use violence to the OMC personnel.

3.10.5 Soils and Soil Potential

1) Soils

MOJA and FAO conducted a nation wide soil study and prepared soil maps in 1961. This soil map reveals that soils in the Sefidrud River Basin consists mainly of 2 different groups which distribute northern area and southern area bounded at the immediate upstream of Manjil dam. Namely Brown Soils, Brown Soils – Lithosols, and Chest Nuts Soils distribute almost entire areas of Plateaus in the upstream Basin of Manjil dam (Zanjan, Kordestan, East Azarbaijan, Ardebil, Hamedan, Qazvin and Tehran).

While, Fine textured alluvial soils, Low humic gley, humic gley and half bog soils distribute in the alluvial plain (or Gilan plain) at downstream of Manjil dam.

Soils in the upstream of Manjil dam are suitable for various upland crops such as wheat and orchard, and soils in the Gilan plain are suitable for rice cultivation.

Saline alluvial soil distributes along the right bank of the downstream of the confluence of Qezel-Ozan River and Zanjan River with an approximate size of 25 km long and 15 km wide. This area situates at the provincial boundary of East-Azarbaijan and Zanjan. Both Provinces are requested to continue careful observation and measures, if deemed necessary.

2) Soil Potential

Based on the above mentioned soil map, MOJA and FAO conducted nation wide soil potential study and prepared soil potential maps. MOJA and FAO classified the soil potentials of Iran as follows.

(i) Soil with no or slight and isolated limitations,

(ii) Soil with slight to moderate limitations by moderate deficit of water, undulation and drainage,

(iii) Soil with moderate to severe limitations by moderate to strong deficit of water, erosion and shallow depth,

(iv) Soil with severe to very severe limitations by severe deficit of water, erosion, salinity and shallow depth, and

(v) Soil with almost no potentiality by sand dunes, salt marshes, and saliferous and gypsiferous marls.

The Sefidrud Basin is covered mainly by soils with few limitation (higher potential) but not by the soils with high limitation (severe to very severe limitation or no potentiality). Gilan Plain where rice production is dominant consists mainly of soil classes (i) and (ii) above with higher potential. The other mountainous 7 provinces consist mostly of (ii) and (iii).

Mahab Ghodss conducted soil surveys for 1.27 million ha or 20% of the entire Basin of 6.46 million ha, and classified 88% (1.12 million ha) of the surveyed area into moderately to highly irrigable area while the total irrigated area within the Basin is 0.46 million ha.

3.10.6 Livestock

Livestock is actively practiced in the related 8 provinces. The livestock population in the River Basin was estimated at about 5 million livestock for meat and 2 million for milk production (Iranian Statistic Center, 2005) in accordance with the geographical area ratio of entire provincial area and provincial area in the Basin. The population consists of sheep (69%), goats (16%) and cattle (15%). There are same number of chicken as above livestock, and limited number of buffalo and camel. These livestock are mainly fed on pasture and irrigated feed crop represented by alfalfa.

Provincial population of meat and milk livestock in the Basin was estimated at 2 million heads each for province of East-Azarbaijan, Zanjan and Kordestan, 0.4 million heads for Ardebil, and more ore less 0.1 million for other provinces (Hamedan, Gilan, Qazvin and Tehran) in accordance with average area ratio of pasture and alfalfa in the Basin.

Total number of livestock for meat and milk per ha of pasture or alfalfa was estimated at 4 heads per ha of pasture or 90 heads per ha of alfalfa. This means that the livestock are mainly fed on pasture supplemented by alfalfa. A part of barley and some pulses are mixed with the feed crops.

The population of the milk livestock is estimated at 43% of the meat livestock in the Basin and 37% in the nation. This means that the conversion from meat livestock (pasture type) to milk livestock

(settlement type) is being proceeded well ahead compared with the national average and in line with the national policy, which is favorable for watershed conservation. The populations of meat livestock per human population in rural area are 2.2 heads/person in the Basin and 2.2 heads/person in the nation, respectively.

The annual gross unit irrigation water requirement for alfalfa is as large as 24,000 m^3/ha compared with 14,000 m^3/ha for wheat and 12,000 m^3/ha for rice in the Basin.

In general, construction of drinking facilities for livestock is appreciated by the livestock holders. The total volume of drinking water for livestock in the basin is estimated at the order of only 10 million m^3 per annum (4 ltr./head in average).

3.10.7 Inland Fishery

The annual harvest of fish is 343,500 tons and 134,200 tons for marine fish harvested mainly in Persian Gulf and freshwater fish respectively. The freshwater fish is produced mainly in the Caspian Sea region including Gilan.

There are numbers of water pools in Gilan with a total area of 3,458 ha where warm water fishculture (carp, grass fish, etc.) is actively practiced. In the upstream provinces and hilly area of Gilan, cold water fishculture (mainly rainbow trout) is practiced.

Iran is reputed to export quality caviar, however, annual harvest of caviar reduced with 15% in one year from 2003 to 2004. WRMC concerned about recent rapid degradation of water quality and quantity of Sefidrud River, local streams and drainage canals.

In response to the request from MOJA, WRMC supplies considerable water to the Sefidrud River mouth where sturgeons lay eggs (from Sangar weir) and hatchery station for sturgeon, etc. (from Galerud weir) with higher priority than irrigation.

The water discharge released for these purpose is at 2.4 m^3/s to hatchery station for sturgeon and 15-50 m^3/s to the river mouth of Sefidrud River as tabulated below:

Table R 3.10.14 Water Supply for Caviar and Sturgeon

	To Hatchery Station	To River Mouth
Name of Weir	Galerud Weir Intake	Sangar Weir Release
Discharge (m^3/s)	2.4	15-50
Supply Period	12 months	End of May - July

Source: WRMC and Gilan RWC

Fishery in Gilan Province is shown in Table R 3.10.15. Half of fishery is catch in Caspian Sea, remaining half is inland fishery, which are 18 thousand tons and 19.9 thousand tons respectively. Most of inland fishery is fish culture in warm fish pond, which shears 86% of inland fishery. Catch in national resources like rivers and lakes are relatively small, which is 1.8 thousand ton and 9% of inland fishery, 5 % of all fisheries in Gilan.

Table R 3.10.15 Fishery in Gilan Province

Year	Total (t)	Caspian Sea (t)	Inland Fishery (t)			
			Total	Fish Culture-Warm Water	Fish Culture-Cold Water	Natural Resource in River & Lake
2005	37,914	18,002	19,900	17,199	866	1,835

In addition, other provinces are also conducting the fish culture. For instance, Aidagmush dam releases water of 2m^3/s for fish culture in the East Azerbaijan.

3.11 DOMESTIC AND INDUSTRIAL WATER

3.11.1 Water

1) Unit Water Consumption

Unit Water Consumption (liter per person per day) will be affected by the following element:

- Weather condition,
- Economic condition and life style,
- Health and sanitation condition,
- Water quality and quantity,
- Water pressure of distribution pipes,
- Water tariff,
- Management system of water supply

Unit water consumption of Iran is reported by the State Organization for Management and Planning as follows.

Table R 3.11.1 Unite Water Consumption of Iran

Item	Low Consumption (L/C/d)	High Consumption (L/C/d)
Drinking	2	5
Cocking	5	10
Shower	25	50
Washing	10	20
Cleansing machine	5	15
Flush toilet	20	30
Vegetable gardening	3	10
For air conditioner	2	5
Others	3	5
Total	75	150

Source: Standard Press, issued No. 117-3, State Organization for Management and Planning

Iranian Development Study determined the unit water consumption each region in the Sefidrud River basin in the following table on the basis of Unit Water Consumption of Iran.

Table R 3.11.2 Unit Water Consumption in the Sefidrud River Basin

Province	Climate	Unit Water Consumption			
		Rural	Small town	Middle town	Large town
Gilan	Temperate	145	200 (Paresar)	230 (Astara)	260 (Rasht)
Kordestan	Cold	120	175 (Divandareh)	200 (Bijar)	
Zanjan	Cold	120	175 (Soltanieh)		225 Zanjan)
E-Azarbaijan	Cold	120	175 (Torkmanchai)	200 (mianeh)	
Ardebil	Cold	120	175 (Kivi)	200 (Khalkhal)	

Source: Mahab Ghodss Report vol.3

2) Water Demand of Domestic Water

Water consumption of present water demand are summarized in table below.

Table R 3.11.3 Water Consumption Projection

('000m^3/year)

Province	Category	2006
Gilan	Urban	91,864
	Rural	73,479
	Sub-total	165,343
Zanjan	Urban	25,828
	Rural	22,138
	Sub-total	47,966
Kordestan	Urban	8,010
	Rural	13,750
	Sub-total	21,760
Ardebil	Urban	3,627
	Rural	4,541
	Sub-total	8,168
East Azarbaijan	Urban	7,537
	Rural	13,497
	Sub-total	21,035
Tehran & Qazvin	Urban	0
	Rural	4,131
	Sub-total	4,131
Hamedan	Urban	0
	Rural	2,617
	Sub-total	2,617
Total	Urban	136,866
	Rural	134,154
	Sub-total	271,020

3) Reservoir for Domestic Water

The reservoir for domestic water is listed in the following table based on the WRMC data.

Table R 3.11.4 Reservoir for Domestic Water

No.	Stage	Name	Province	Storage Volume (MCM)	Supply Volume	Beneficiaries	Remarks
1	Operating	Manjil	Gilan	1,150.0	4～5m^3/s	Rasht	
2	"	Taleghan	Tehran	420.0	150MCM/y	Tehran	
3	"	Golblakh	Kordestan	8.1			
4	"	Salmanlu	Zanjan				
5	"	Sidler	Zanjan				
6	"	Mianaj	Zanjan				
7	"	Taham	Zanjan	87.0	30MCM/y	Zanjan	only Domestic Water Purpose
8	Constructing	Ostor	East Azarbaijan	700.0			
8	"	Sahand	East Azarbaijan	165.0	3MCM/y	Hashtrud, Ghara	
9	"	Germichay	East Azarbaijan	40.3	0.3～0.8m^3/s	Mianeh	
10	"	Siyazakh	Kordestan	265.0			
11	"	Givi	Ardabil	53.1			
12	"	Talvar	Zanjan	500.0	89MCM/y	Hamadan, Ghorve, Khoda Bande	only Domestic Water Purpose
13	"	Shahre Bijar	Gilan	104.6		Rasht	
14	"	Golabar	Zanjan	116.0			
15	Investigating	Ramin	Zanjan	9.8			only Domestic Water Purpose
16	"	Hasankhan	Kordestan	76.5			
17	"	Sheikh Besharat	Kordestan	30.0			
18	"	Mushampa	Zanjan	700.0		Mahneshan, Ejrud	
19	"	Befrajerd	Ardabil	6.8			only Domestic Water Purpose
20	"	Marash	Zanjan	36.8			
21	"	Ghareh Darangh	Zanjan	42.9			

4) Outline of Water Supply Facilities

Water supply facilities of provinces are listed below based on the Iran Statistical Year Book 1385 (2006).

Table R 3.11.5 Outline of Water Supply Facilities

No.	Province	Supply (lit/s)	Production (x1,000m^3)	Selling (x1,000m^3)	Capacity of reservoirs (m^3)	Length of the network with a diameter of 80 mm or more (km)	Extensions (number)
1	East Azarbaijan	10,327	204,466	162,422	877,050	5,494	580,935
2	Ardebil	2,415	55,263	40,480	185,184	2,062	173,753
3	Tehran	49,871	1,456,626	1,067,551	2,606,532	17,846	1,627,743
4	Zanjan	2,465	54,961	37,389	91,140	1,456	130,483
5	Qazvin	3,189	72,443	55,180	119,470	1,565	165,634
6	Kordestan	3,290	82,370	30,520	198,890	1,721	170,647
7	Gilan	7,399	112,293	79,884	248,720	4,483	291,366
8	Hamedan	4,078	90,746	56,396	248,060	2,447	199,164
Total		83,034	2,129,168	1,529,822	4,575,046	37,074	3,339,725

Source: Iran Statistical Year Book 1385

Outline of rural water supply facilities is listed the following table.

Table R 3.11.6 Outline of Rural Water Supply Facilities

No.	Province	Supply Volume (lit/s)	Production Volume (x1,000m^3)	Selling Volume (x1,000m^3)
1	East Azarbaijan	1,902	48,500	32,000
2	Ardebil	563	17,190	12,000
3	Tehran	3,187	82,000	40,900
4	Zanjan	698	18,000	14,600
5	Qazvin	698	19,900	13,100
6	Kordestan	617	15,300	11,080
7	Gilan	1,078	30,800	20,500
8	Hamedan	1,142	26,280	18,400
Total		9,885	257,970	162,580

Source: Iran Statistical Year Book 1385

3.11.2 Industrial Water

1) Unit Requirement of Industrial Water

Iranian development study estimated the unit water consumption of industrial water as follows.

Table R 3.11.7 Average Water Consumption of Industries

Industry	Type of Industries	Average daily water Consumption (m^3/ha)
High water consumption industries	Chemical	60
	Textile	60
Low water consumption industries	Metal	10
	Non-metal minerals	10
	Electricity	10

Source: Mahab Ghodss Study Report

2) Prediction of Present Industrial Water Demand

Present industrial water demands for the main industrial areas in the Study Area that were studies by Mahab Ghodss and summarized in Table R 3.11.8.

Table R 3.11.8 Provincial Industrial Water Demand in the Study Area

Province		2006	Main Industrial Area
Gilan	('000m3)	3,200.0	Loshan, Some Sara, Anzari
	(L/s)	218.0	
Ardevil	('000m3)	10,000.0	
	(L/s)	317.5	
Qazvin	('000m3)	2,678.0	Khorramdasht, Lia, Caspian
	(L/s)	84.9	
Hamedan	('000m3)	3,879.0	Kabodarahang, Bahag, Lajin
	(L/s)	123.0	
East Azerbayjan	('000m3)	5,676.0	Mianeh, Hashtroud
	(L/s)	180.0	
Kordestan	('000m3)	28.0	Divandareh, Bijar
	(L/s)	0.9	
Zanjan	('000m3)	9,334.0	Zanjan
	(L/s)	296.0	
Tehran	('000m3)	8,700.0	Eshtehard&Nazarabad
	(L/s)	276.2	
Total	('000m3)	43,495.0	
	(L/s)	1,179.0	

Source: Mahab Ghodss study report

3.12 FACILITIES OF WATER RESOURCES DEVELOPMENT

3.12.1 Small Scaled Facilities of Water Resources Development

There are a lot of small-scaled facilities for water resources development in the Study Area as showing in Table R 3.12.1. Most of these facilities are utilized for irrigation purpose and the water of 3.6 billion m^3 has been developed during year. Total water volume of 1.9 billion m^3/year (53%) is taken from groundwater and 1.7 billion m^3/year (47%) from surface water. The distribution situation of each facilities is as follows.

Table R 3.12.1 Number of Facility for Water resources Development

Zone	Groundwater			Surface Water		
	Qanat	Well	Spring	Weir	Canal	Pump
A	237	2,708	2,737	116	215	618
B	638	6,813	6,115	368	1,768	43
C	37	2,340	8,218	0	2,203	140
D	13	603	12,085	0	1,424	48
E	0	3,577	404	26	2	117
Total	925	16,041	29,559	510	5,612	966

Annual exploitation water and ratio of water resources in the reach are shown in Figure R 3.12.1. The using ratio of groundwater is high in the basin of Talvar river, and the using ratio of the surface water is high in the East Azarbaijan province and the Qezel Ozan river.

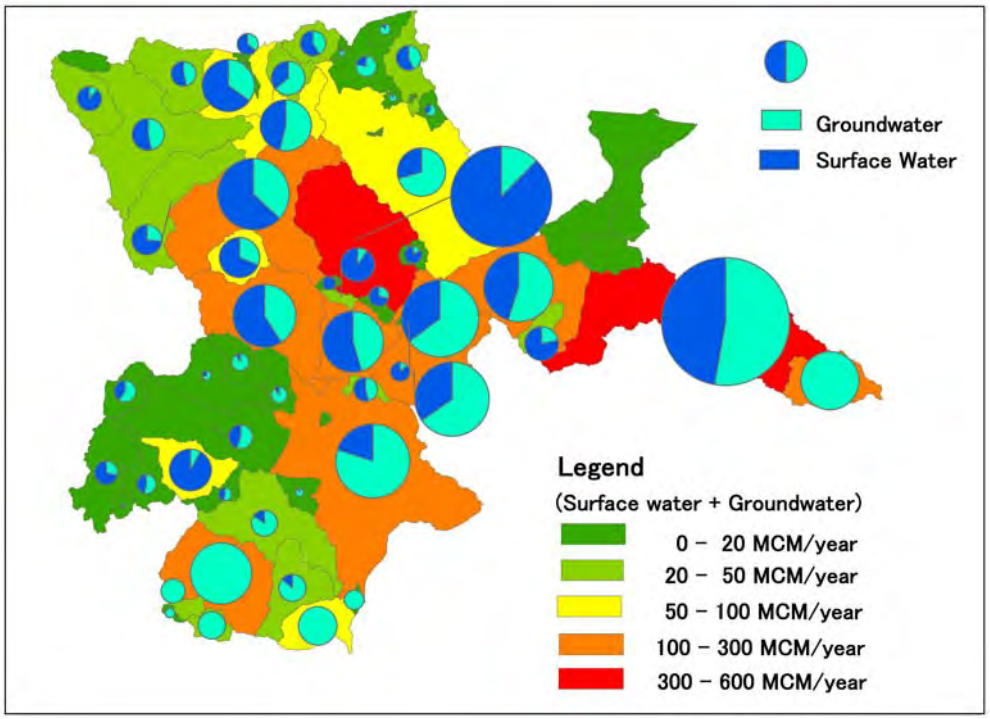


Figure R 3.12.1 Annual Exploitation Water and Ratio of Water Resources

1) Qanat

Qanats have concentrated on A and B zone in upper and the middle basin. Annual exploitation volume by qanat is about 181 MCM. Average development water of qanat is 195,000m^3/year (370 liters/min). In recent years, the deteriorated and abandoned qanats have increased by superannuation of facilities and illegal deep well development.

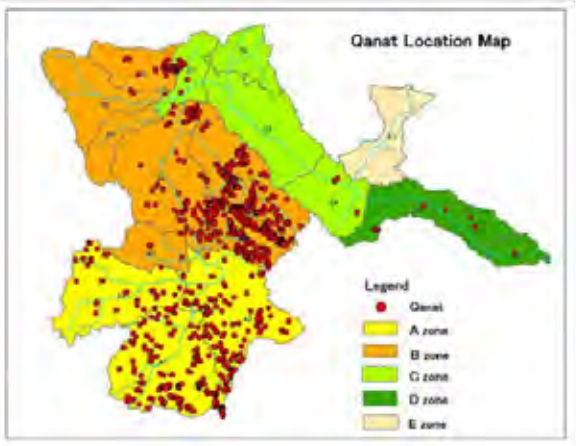


Figure R 3.12.2 Location Map of the Qanat

2) Well

The wells are widely distributed in the Study Area except lower basin of Qezel Ozan river (C zone) and Shahrud river basin (D zone). Annual exploitation volume by well is about 859 MCM. Average development water of well is 54,000 m^3/year (101 liters/min). In the Zanjan province, the well development in recent years sets the region where the new well development is restricted in a situation near the limit.

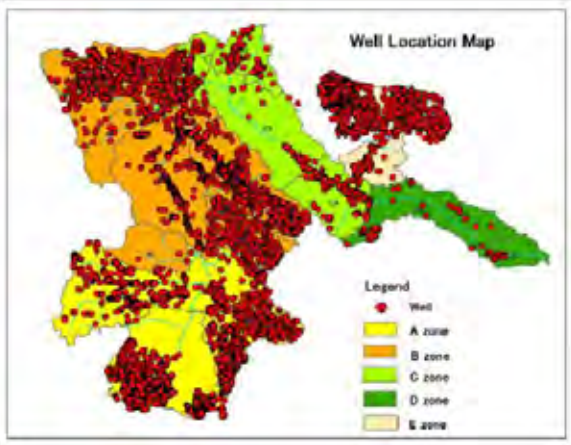


Figure R 3.12.3 Location Map of the Well

3) Spring

The springs are distributed in whole of the Study Area. In specially, the distribution density of D zone located in the Shahrud river valley is high. Annual exploitation volume by spring is about 827 MCM. Average development water of well is 28,000 m^3/year (53 liters/min).

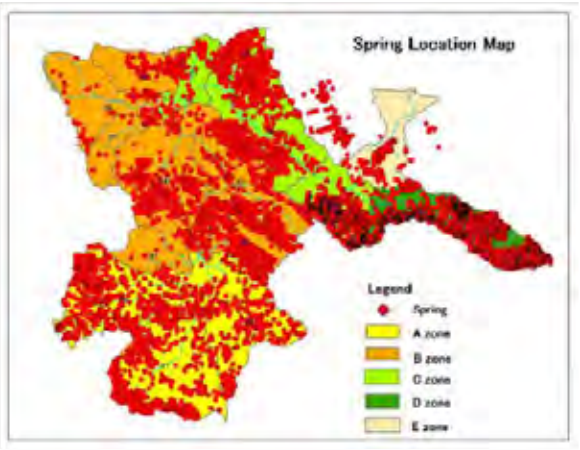


Figure R 3.12.4 Location of the Spring

4) Weir

The weirs are many distributed in the B zone and outside of D zone (Gilan province). Annual exploitation volume by spring is about 9 MCM. Average development water of weir is 18,000 m^3/year (34 liters/min).

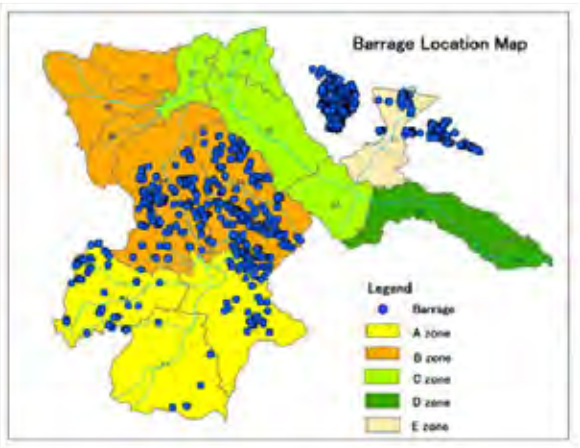


Figure R 3.12.5 Location Map of the Weir

5) Canal

The canals are widely distributed in whole of the Study Area. However, the distribution density of A zone in the upper basin of the Study Area is a little low. Annual exploitation volume by canals is about 1,502 MCM. Average development water of weir is 267,700 m^3/year (510 liters/min).

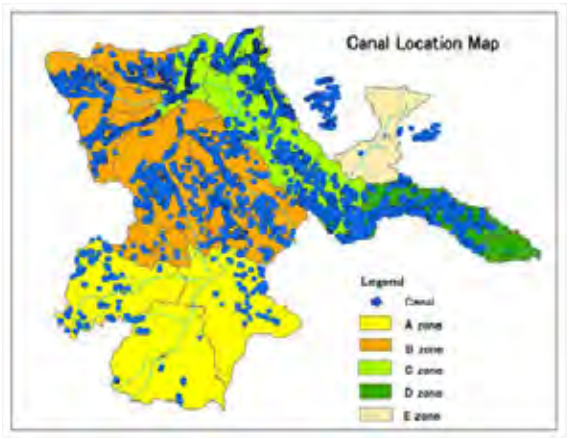


Figure R 3.12.6 Location Map of Canal

6) Pump

A lot of pumps are set up along the Qezel Ozan and Talvar rivers. Comparatively a lot in A zone in the upper basin of the Study Area. Annual exploitation volume by pump is about 205 MCM. Average development water of weir is 211,800 m^3/year (403 liters/min).

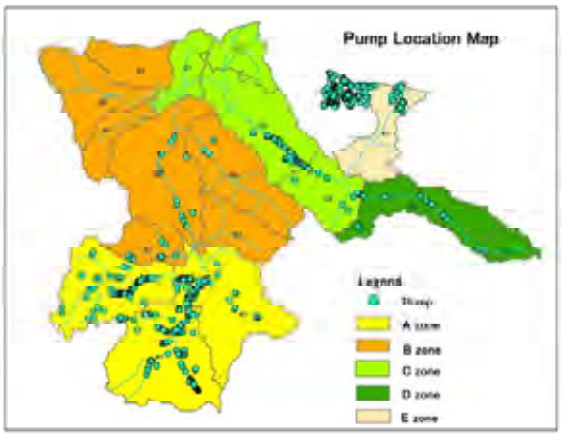


Figure R 3.12.7 Location Map of Pump

3.12.2 Large Scaled Facilities of Water Resources Development

There are 38 large scaled dams/reservoirs with to 5MCM or more of a total reservoir volume including under construction and under planning in the Study Area. Dams/reservoirs operating now are three dams such as Manjil, Taleghan, and Golbolagh. The Taham dam is classified into under construction because the treatment plant facilities in the downstream are not incompletely at a practical stage though the dam construction has completed. Dams under planning are 20 dams. The parameter of each dam is as shown in table R 3.12.2. Details in the main dam which operates and is under construction are as follows.

Table R 3.12.2 Parameter of the Large Scaled Dams in the Study Area

No.	Province	Upper Reach	Dam	Lower Reach	Stage	Dam Type	Dam Height (m)	Basin Area (km^2)	Purpose			Irrigation Area			Annual Irrigation Demand		Reservoir Volume			Water Level		H-V Curve	Consultant
									I	D	P	Development (ha)	Improvement (ha)	Total (ha)	(MCM)	(m^3/ha)	Gross (MCM)	Effective (MCM)	Dead (MCM)	N.W.L (m)	L.W.L (m)		
1	Kordestan	R43	Golblagh	R44	O	Earth	74.00	250	●	●		800	0	800	6.59	8,234	8.10	6.30	1.80	1,813.90	1,807.70	●	MOJA
2	"	R40	Siazakh	R41	C	Rock fill	84.00	1,058	●	●		21,246	754	22,000	142.39	6,472	265.00	245.00	20.00	1,828.80	1,780.00	●	Ab-Niroo
3	"	R52	Sange Siah	R47	C	Earth	41.00	255	●			3,400	0	3,400	32.24	9,481	49.30	32.30	0.50	1,840.50	1,819.00	●	Parab fars
4	"	R51	Sural	R47	C	Rock fill	45.00	48	●			1,008	192	1,200	8.12	6,766	11.00	10.50	0.50	2,026.70	2,000.00	●	Ab-Niroo
5	"	R65	Sir	R37	S	Earth	58.00	444	●			5,400	500	5,900	62.70	10,627	95.00	90.00	5.00	1,925.90	1,883.40	●	Aban Pazhouh
6	"	R64	Babakhan	R35	S	Rock fill	59.00	924	●			5,950	50	6,000	49.39	8,732	64.70	38.20	16.50	1,570.00	1,553.70	●	Abdanfraz
7	"	R42	Zardekamar	R37	S	Earth	40.00	2,075	●			5,000	2,500	7,500	48.54	6,472	62.00	50.00	12.00	1,684.00	1,672.00	●	Abdanfraz
8	"	R47	Hasankhan	R44	S			2,487		●		Domestic					76.50	17.50	20.00	1,720.70	1,712.70	●	
9	"	R34	Sheikh Besharat	R35	S	Earth	39.00	451	●	●		0	1,500	1,500	12.35	8,232	30.00	18.00	12.00	1,588.90	1,578.60	●	Abdanfraz
10	"	R46	Alehdare (Saral)	R41	S	Rock fill	44.50	96	●			0	2,100	2,100	20.05	9,549	19.70	19.00	0.70	1,960.40	1,936.60	●	Pooyab
11	E. Azerbayjan	R11	Ostor (Shahriar)	R61	C	Arch C.	135.00	42,600	●		●	6,500	0	6,500	72.58	11,168	700.00	451.00	249.00	1,035.00	1,020.00	●	Mahab Ghodss
12	"	R10	Sahand	R60	C	Rock fill	46.00	820	●	●		10,300	600	10,900	70.83	6,498	165.00	135.00	30.00	1,600.30	1,580.00	●	Bandab
13	"	R18	Aydughmush	R11	C	Rock fill	67.00	1,625	●			13,700	1,300	15,000	149.90	9,994	228.00	136.60	9.00	1,341.50	1,307.00	●	Mahab Ghodss
14	"	R02	Germichay	R06	C	Earth	60.00	344	●	●		2,300	1,200	3,500	37.00	10,012	40.30	33.80	6.50	1,457.00	1,428.00	●	Ashenab
15	"	R08	Kalghan	R60	C	Earth	65.00	203	●			1,500	1,090	2,590	18.12	6,995	18.80	18.50	0.30	1,870.00	1,835.00	●	Nehadab
16	Zanjan	R63	Golabar	R30	C	Rock fill	82.00	1,131	●	●		7,900	1,400	9,300	57.54	6,187	116.00	105.00	11.00	1,704.50	1,682.00	●	Mahab Ghodss
17	"	R24	Taham	R20	C	Earth	118.00	161	●	●		0	450	450	3.29	8,225	87.00	82.00	5.00	1,886.00	1,832.00	●	Mahab Ghodss
18	"	R22	Mushampa	R17	S	Earth	124.00	24,860	●	●	●	26,000	4,000	30,000	323.19	10,773	700.00	328.00	372.00	1,267.00	1,250.00	●	Tamavan
19	"	R45	Talvar	R66	C	Rock fill	85.00	6,441	●	●		29,500	0	29,500	243.33	8,248	500.00	403.40	96.60	1,642.00	1,618.00	●	Mahab Ghodss
20	"	R39	Mendagh	R66	S	Earth	40.00	33	●			9,000	0	9,000	78.05	8,672	43.00	38.00	5.00	1,518.00	1,498.00	●	Iran Zemik
21	"	R31	Mehtar	R20	S	Earth	40.00	128	●			900	100	1,000	7.68	7,677	14.00	13.60	0.40	1,675.00	1,647.00	●	Tamavan
22	"	R29	Songhor	R30	S	Earth	42.00	102	●			900	900	1,800	8.45	4,694	10.40	9.05	1.35	1,873.00	1,854.00	●	Yekom
23	"	R38	Chesb	R66	S	Earth	45.50	135	●			912	270	1,182	10.35	8,756	9.90	8.10	1.80	1,561.00	1,547.00	●	Yekom
24	"	R28	Ghezel Tapeh	R20	S	Earth	57.00	75	●			450	108	558	4.32	7,742	6.00	3.80	2.20	1,812.40	1,798.00	●	Tmavan
25	"	R33	Ramin	R27	S	Rock fill	63.00	67	●	●		0	196	196	2.01	10,255	9.80	9.40	0.40	1,865.00	1,838.00	●	Mahab Ghodss
26	"	R26	Marsh	R26	S	Earth	75.00	397	●	●		4,226	259	4,485	48.32	19,744	36.77	34.32	2.45	1,651.00	1,621.00	●	Arkanrahab
27	"	R30	Ghareh Darangh	R30	S	Earth	65.00	2,093	●	●		4,214	926	5,140	31.80	6,187	42.90	32.90	10.00	1,589.00	1,569.00	●	
28	Ardabil	R59	Givi	R03	C	Earth	79.00	600	●	●	●	6,300	927	7,227	83.86	11,603	53.14	48.86	4.28	1,556.00	1,513.00	●	Mahab Ghodss
29	"	R01	Sangabad	R03	S	Earth	57.00	61	●			1,625	600	2,225	24.18	10,867	14.60	13.80	0.80	1,406.00	1,373.00	●	Aban Pazhouh
30	"	R12	Niakhoram	R61	S	Earth	57.00	76	●			675	225	900	9.78	10,867	11.70	10.33	1.37	1,636.00	1,610.00	●	Aban Pazhouh
31	"	R07	Tabrirzak	R03	S	Earth	51.00	66	●			450	150	600	6.52	10,868	8.96	7.90	1.06	1,592.00	1,568.00	●	Aban Pazhouh
32	"	R14	Befrajerd	R61	C	Earth	45.35	39		●		Domestic					6.80	6.30	0.50	108.00	92.00	●	Farazab
33	"	R16	Khoresh Rostam (Hashtjin-2)	R61	S	Earth	53.00		●			5,100	0	5,100	55.42	10,867	42.35	42.00	0.35	1,346.30	1,303.30	●	Aban Pazhouh
34	Gilan	R21	Manjil (Sefidrud)	R19	O	Concrete	86.00	56,200	●	●	●	-	-	101,583	1,321.61	13,010	1,750.00	1,150.00	600.00	271.80	258.50	●	
35	"	R62	Bijar	R53	C	Rock fill	94.50	242		●	●	Domestic and Hydro Power					104.60	99.40	5.20	211.50	160.60	●	Yekom
36	Qazvin	R32	Burmanak	R21	S	Earth		282	●			1,079	1,201	2,280	29.53	12,953	18.50	18.31	0.19	590.00	532.00	●	Kamandab
37	Tehran	R36	Taleghan	R25	O	Rock fill	103.00	828	●	●	●	-	-	30,000	310.00	10,333	420.00	329.00	91.00	1,780.00	1,740.20	●	
38	Hamedan	R49	Alan	R66	S	Earth	33.00	67	●			90	310	400	3.29	8,225	6.35	5.85	0.50	2,003.00	1,986.80	●	
Total												176,425	23,808	331,816	3,393.30		5,846.17	4,101.02	1,597.25				

O: Operation, C: Construction, S: Study

1) Manjil Dam (Under operation)

The Manjil (Sefidrud) dam was constructed at the confluence point of the Qezel Ozan and Shahrud rivers for flood control and irrigation purpose in 1962. Maximum and minimum inflows from Qezel Ozan River to Manjil reservoir are 2,000 m^3/s and 50 liters/s, respectively. Maximum and minimum inflows from Shahrud River to Manjil reservoir are 800m^3/s and 4.2 liters/s, respectively. The dam parameters are shown in Table R 3.12.3. The upper part of the dam body is damaged due to the Gilan earthquake in 1990, and its damage was restored by grouting.

Table R 3.12.3 Parameters of Manjil Dam

Purpose	Irrigation, domestic and power generation
Basin area	56,200 km^2
Total storage capacity	1,750 MCM
Active storage capacity	1,150 MCM
Dead water capacity	600 MCM
Dam type	Butress type concrete dam
Dam height	86 m
Dam crest length	425 m
Crown of embankment	277.06 m
Type of spillway	Glory hole type
Capacity of power generation	17.5MW/Hx5 =87.5 MW/H

There are five dynamos, and the total power generation capacity is 87.5MW/H. Operation units of power generation are as follows:

- April to September (Irrigation period): 5 units
- October to December (for maintenance): 0 unit
- January to March (Conditions of snowfall): 1-3 units

The water level – reservoir storage volume (H-V) curve of Manjil Dam is shown in Figure R 3.12.8. Annual average inflow to Manjil dam based on the records of Gilvan and Loshan gauging stations is about 45 billion m^3 in as shown in Table R 3.12.4. On the other hand, 18 billion m^3 on annual average has been discharged from the dam of ten years as shown in Table R 3.12.4 the discharge record recently. The water shortage tendency in recent years is clear.

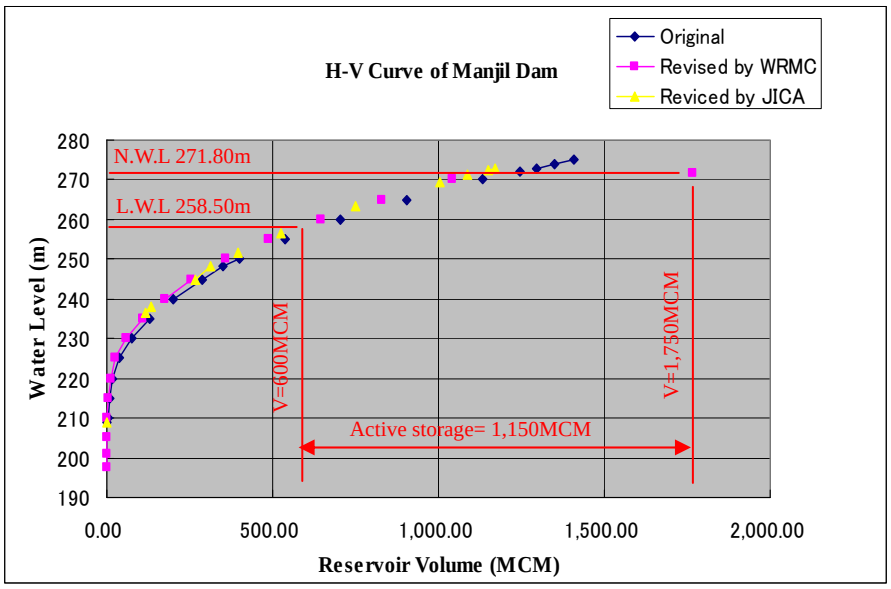


Figure R 3.12.8 Water Level – Reservoir Storage Volume (H-V) Curve of Manjil Dam

Table R 3.12.4 Inflow to Manjil Dam based on the Guaging Station Record

Year		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total (MCM)
		30	30	30	30	30	29	31	31	31	31	31	31	
		Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	
1963	1964	87.70	200.45	219.02	195.61	257.73	733.28	1,899.50	2,374.10	542.51	125.45	61.90	64.39	6,761.63
1964	1965	77.48	123.72	169.78	212.63	258.16	466.56	621.21	1,089.25	435.63	136.60	56.44	51.61	3,699.08
1965	1966	198.17	352.94	167.18	164.76	254.79	339.81	628.13	873.76	349.89	119.81	67.05	51.57	3,567.88
1966	1967	149.76	152.92	108.00	138.24	144.55	203.82	505.96	1,274.83	495.42	114.07	42.70	30.25	3,360.52
1967	1968	66.18	124.33	184.59	162.44	169.78	537.32	1,081.47	1,219.10	1,325.20	244.30	75.57	62.13	5,252.41
1968	1969	84.08	380.39	399.69	348.19	366.16	2,544.13	4,011.29	3,975.78	1,651.97	700.62	249.78	218.77	14,930.87
1969	1970	265.98	496.64	294.71	351.46	350.02	458.24	823.47	678.35	211.27	81.11	53.61	52.55	4,117.42
1970	1971	85.55	116.83	182.25	189.52	180.88	421.29	708.74	990.58	405.22	115.18	63.20	35.87	3,495.11
1971	1972	60.44	110.45	175.15	166.45	183.60	366.66	2,004.83	2,282.06	1,320.62	354.94	115.53	84.22	7,224.95
1972	1973	100.78	240.76	254.93	204.72	286.30	817.59	907.04	910.23	394.17	122.53	55.83	50.54	4,345.43
1973	1974	83.04	110.65	156.12	166.32	165.23	656.06	2,374.14	967.29	284.50	163.21	92.79	126.60	5,345.94
1974	1975	114.59	126.96	186.44	184.38	183.18	362.41	877.29	1,199.54	385.48	98.55	41.15	48.52	3,808.49
1975	1976	80.05	91.28	131.91	196.70	223.02	305.81	1,376.95	1,341.44	633.67	146.41	46.84	66.46	4,640.56
1976	1977	76.69	145.42	152.39	160.54	235.45	463.04	680.23	536.93	733.54	63.13	34.93	28.21	3,310.49
1977	1978	61.47	223.40	237.95	231.45	323.25	523.33	804.05	565.50	280.44	116.79	25.61	21.18	3,414.42
1982	1983	246.12	266.61	362.04	358.75	322.74	489.14	1,345.68	1,484.28	831.25	132.95	39.13	48.20	5,926.89
1983	1984	85.73	138.34	229.97	198.70	251.02	320.49	586.46	1,032.28	463.49	106.08	41.16	35.44	3,489.17
1984	1985	84.86	211.16	406.62	390.28	572.30	464.68	2,132.58	1,276.44	449.60	152.15	66.39	40.64	6,247.69
1985	1986	89.00	159.34	231.71	231.89	245.56	325.29	914.87	1,049.27	474.36	116.41	32.89	38.29	3,908.89
1986	1987	75.42	179.32	253.98	224.77	255.15	475.94	835.70	907.65	267.23	77.95	46.36	28.24	3,627.70
1987	1988	116.29	569.26	249.07	385.48	421.93	1,202.34	1,920.00	2,016.40	564.67	259.98	106.03	87.35	7,898.81
1988	1989	130.85	200.57	214.09	205.50	202.04	642.65	1,076.78	568.62	125.93	39.75	23.29	43.98	3,474.04
1989	1990	51.72	139.48	174.80	180.52	202.42	456.60	878.17	678.10	165.78	61.45	41.17	37.35	3,067.56
1990	1991	55.19	114.22	157.84	172.73	206.07	351.72	1,318.23	517.86	114.93	52.84	29.18	32.10	3,122.91
1991	1992	61.83	116.04	239.64	172.23	206.00	335.35	1,442.54	2,341.53	1,274.66	375.42	88.28	82.88	6,736.39
1992	1993	122.42	170.28	239.78	241.19	273.15	484.60	1,121.87	1,129.47	525.99	124.72	59.31	65.57	4,558.35
1993	1994	82.92	365.56	593.26	827.33	600.20	960.81	1,803.85	1,382.40	479.13	193.60	56.10	87.24	7,432.40
1994	1995	157.26	533.40	840.21	408.01	450.56	574.86	981.86	1,369.68	769.64	228.81	63.79	53.81	6,431.92
1995	1996	114.14	182.27	193.74	211.87	273.21	369.12	1,578.02	1,621.30	497.00	143.53	91.29	55.69	5,331.18
1996	1997	112.27	194.36	212.02	207.70	211.33	250.75	501.54	559.85	229.36	90.17	18.51	19.08	2,606.93
1997	1998	44.18	153.92	151.38	151.69	232.47	557.79	1,627.15	916.08	275.35	72.76	51.15	31.54	4,265.45
1998	1999	70.62	109.58	125.84	131.97	166.36	154.96	214.95	130.56	21.85	15.56	20.91	10.87	1,174.02
1999	2000	18.90	80.24	98.52	98.20	119.31	161.28	637.61	257.98	40.49	18.06	6.78	9.14	1,546.51
2000	2001	27.02	52.05	91.67	118.37	123.68	186.02	255.92	106.77	23.18	8.62	2.33	5.18	1,000.81
2001	2002	19.34	30.29	98.88	148.73	148.20	186.68	493.06	559.23	160.34	33.89	22.01	15.91	1,916.56
2002	2003	16.65	31.57	94.63	183.36	183.35	389.96	1,411.12	1,279.77	453.20	101.65	35.11	27.06	4,207.43
2003	2004	41.65	88.09	123.00	153.41	188.68	393.86	470.19	680.93	275.14	102.71	31.94	17.84	2,567.43
2004	2005	28.38	56.08	138.73	120.41	154.75	713.18	718.07	588.14	221.93	50.30	26.99	20.85	2,837.81
Total		90.65	187.87	224.78	226.22	252.44	517.04	1,146.59	1,124.56	477.74	138.47	54.82	49.66	4,490.84

Table R 3.12.5 Discharge Record from Manjil Dam for Last Decade

Month		Monthly Discharge (MCM)									
		1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Average
Oct.	Meh	0.0	0.1	0.0	0.5	-	77.0	167.7	39.4	20.5	38.1
Nov.	Aba.	-	4.4	0.0	1.1	-	81.1	52.6	43.4	28.6	30.2
Dec.	Aza	146.6	5.6	0.0	0.2	-	84.4	99.0	72.6	13.1	52.7
Jan.	Dey	68.9	4.4	0.0	0.0	-	155.5	9.7	20.4	59.3	39.8
Feb.	Bah	10.9	2.7	0.0	0.0	-	54.5	39.2	25.4	133.5	33.3
Mar.	Esf	5.8	0.0	0.0	0.0	-	0.0	353.1	18.2	60.6	54.7
Apr.	Far	75.9	124.7	12.3	8.0	600.2	280.0	358.8	143.8	317.1	213.4
May	Ord.	292.1	405.9	415.8	336.9	371.0	356.3	387.9	306.1	409.7	364.6
Jun.	Kho.	242.2	437.5	264.0	374.4	383.8	457.2	438.8	508.9	394.3	389.0
Jul.	Tir	15.1	318.7	168.5	401.9	401.2	406.0	481.7	437.4	405.5	337.3
Aug.	Mor.	33.0	50.4	2.5	171.3	222.8	355.7	310.3	180.4	309.9	181.8
Sep.	Sha.	16.9	1.0	1.0	12.8	71.0	149.1	122.3	60.6	177.8	68.1
Total		907.4	1,355.3	864.1	1,307.0	2,050.1	2,456.8	2,821.2	1,856.5	2,329.9	1,803.0

Source: WRMC

2) Taleghan Dam (Under operation)

The Construction of Taleghan dam is begun at the upstream of the Shahrud River in 2002 and has been completed in 2006. The dam parameter is shown in Table R 3.12.6. The water distribution of present is 310MCM/year (67%) for Qazvin's irrigation water and 150MCM/year (33%) for Tehran's domestic water.

However, to correspond to a population increase in the Teheran city, the following water allocation plan was proposed in past JICA development study.

- Tehran's domestic water will be increased from 150MCM/year to 310MCM/year by 2016
- Qazvin's irrigation water will be decreased from 310MCM/year to 135MCM/year.

Table R 3.12.6 Parameters of Taleghan Dam

Purpose	Irrigation, domestic and power generation
Basin area	828 km^2
Total storage capacity	420 MCM
Active storage capacity	329 MCM
Dead water capacity	92 MCM
Dam ty e	Rockfill
Dam height	103m
Dam crest length	1,111m
Discharge maximum spillway	2,040m^3/s
Capacity of power generation	8.9MW/Hx2 =17.8 MW/H

It is expected that the feasibility is high in the situation with a scarce alternative water resources

For the achievement of a new water allocation plan of the above-mentioned, "The Qazvin Diversion Project" with the following component was proposed in the above-mentioned JICA development study.

- New weir construction at the Alamout River: 1 site Q=22.5m^3/s
- New tunnel construction: 34 km
- Construction cost: US$123,600,000

For the realization of the Qazvin Diversion Project, the mediation between three provinces of Qazvin, Teheran, and Gilan is needed so that the amount of the inflow to the Manjil dam may decrease. The water level – reservoir storage volume (H-V) curve of Taleghan Dam is shown in Figure R 3.12.9.

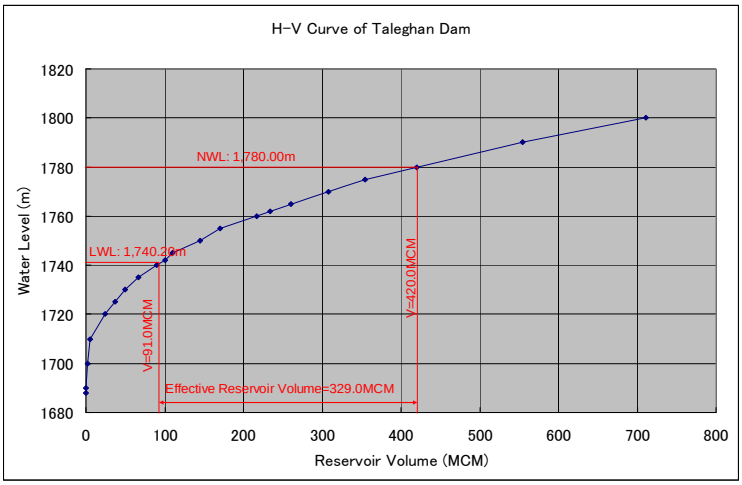


Figure R 3.12.9 Water Level – Reservoir Storage Volume (H-V) Curve of Taleghan Dam

3) Taham Dam (Under construction)

Taham dam is completed at the Taham River in 2003. Main purpose of this dam is to supply of domestic water for Zanjan city.

Though dam construction have already completed, Taham dam classify into under construction category because the treatment plant and pipe line are still under construction.

It is worried that reservoir capacity is bigger than basin area. Therefore, four years are required to be filled with water from beginning of storing water in June, 2003.

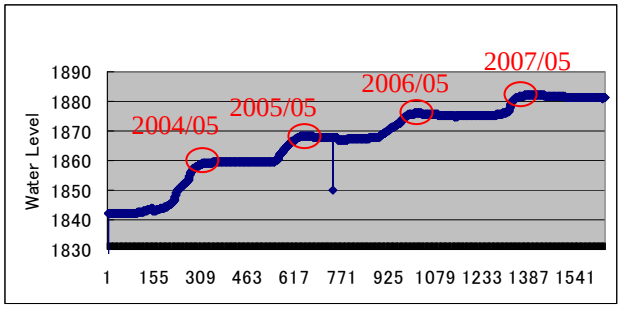


Figure R 3.12.10 Water Level in the Reservoir of Taham Dam

Table R 3.12.7 Parameters of Taleghan Dam

Purpose	Domestic & Irrigation
Basin area	161 km^2
Total storage capacity	87 MC
Active storage capacity	82 MCM
Dead water capacity	5 MCM
Dam type	Earth Dam
Dam height	118m
Dam crest length	m

The water level – reservoir storage volume (H-V) curve of Taham Dam is shown in Figure R 3.12.11.

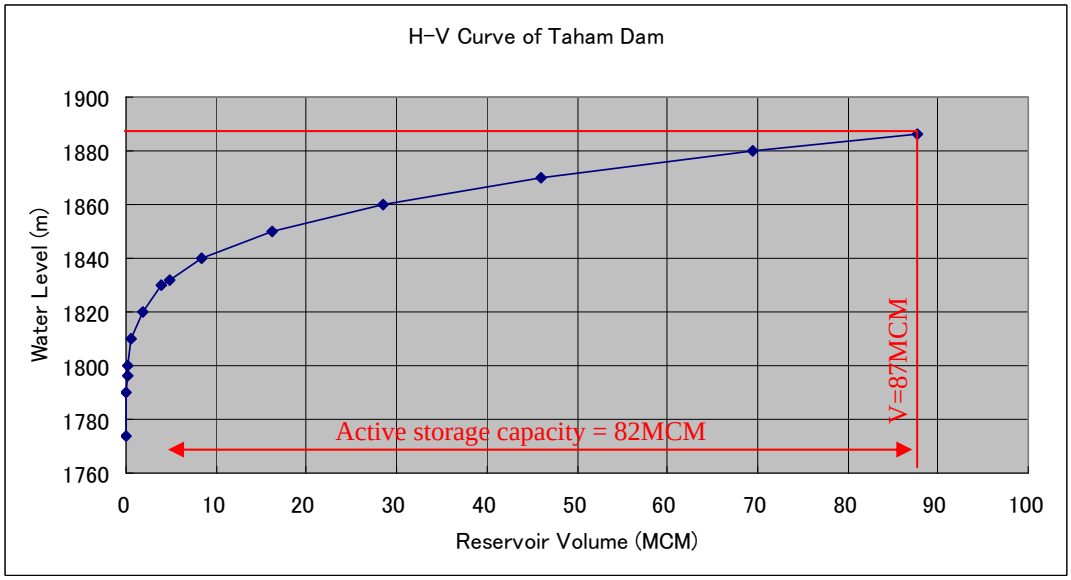


Figure R 3.12.11 Water Level – Reservoir Storage Volume (H-V) Curve of Taham Dam

4) Ostor Dam (Under construction)

The Ostor dam is constructing in vicinity of Ostor village of the Qezel Ozan River from 2001. Completion is forecast fiscal year 2009. It is called alias Shahriyar dam.

Though the Ostor dam is located in East Azarbaijan province, the Ostor dam is scheduled to be discharged 375m^3/s or less to Manjil dam for Gilan's irrigation water.

Table R 3.12.8 Parameters of Ostor Dam

Purpose	Irrigation, power ge eration & Flood control
Basin area	42,600 km^2
Total storage capacity	700 MCM
Active storage capacity	451 MCM
Dead water capacity	249 MCM
Dam type	Arch type concrete dam
Dam height	135 m
Dam crest length	m

Moreover, the pump station is newly established on the dam upstream side, and the Mianeh's irrigation project (6,500ha) in East Azarbaijan is planned.

The power generation of 168GWH is scheduled to be done by average 52.5m^3/s by the amount of the power generation discharge.

The water level – reservoir storage volume (H-V) curve of Ostor Dam is shown in Figure R 3.12.12. Low water level is high to secure water head for power generation.

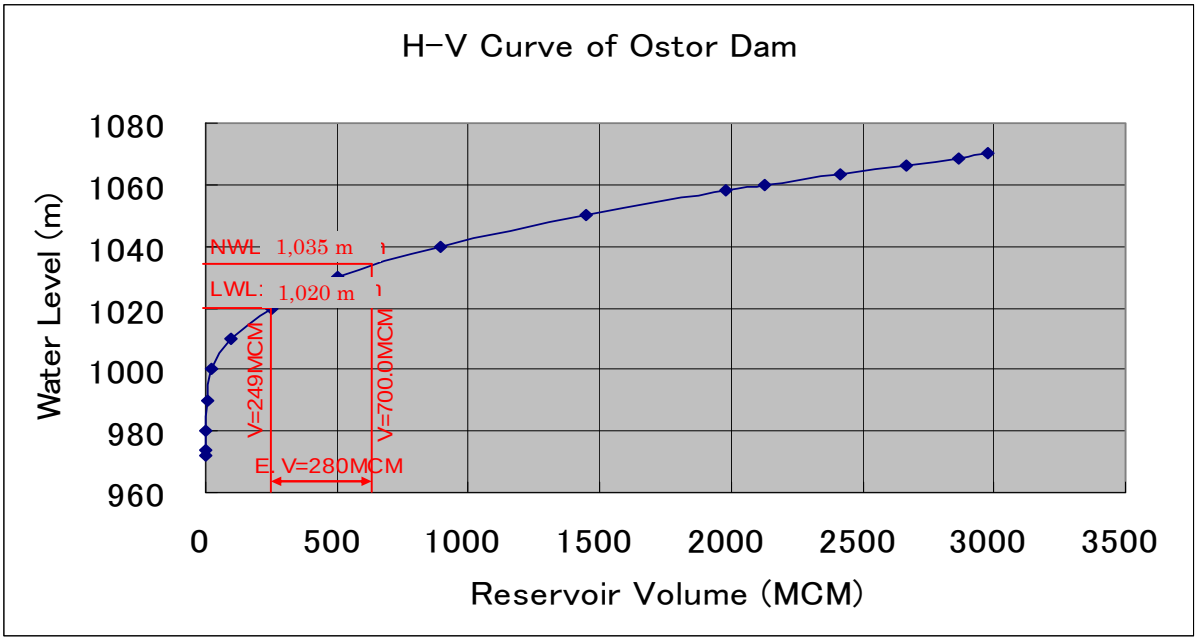


Figure R 3.12.12 Water Level – Reservoir Storage Volume (H-V) Curve of Ostor Dam

3.13 WATERSHED MANAGEMENT

3.13.1 Activities of MOJA in Watershed Management

The Sefidrud River Basin Management Bureau (SRMB) of MOJA in Zanjan province is taking charge of the business which affects the watershed management in the basin. SRMB is the oldest River Basin Management Bureau in MOJA and established in 1973.

Number of SRMB's stuff are 43 peoples and annual total budget is US$ 25 million which donated from central government (US$ 15 million) and from provincial government (US$ 10 million). The activities of SRMB are as follows:

- Investigation, monitoring and update of GIS database regarding basin management
- Planning and implementation of erosion control, landslide and flood control projects
- Construction of basin management dam, recharge facilities for groundwater and forestation

Basin management dam

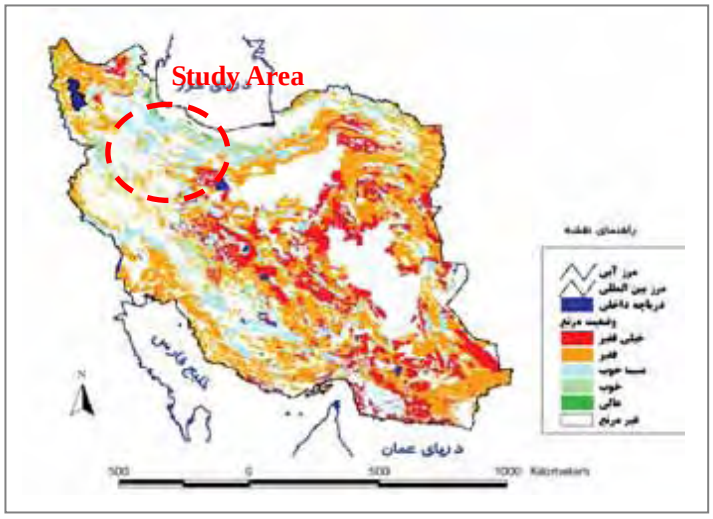
Problems holding by SRMB are as follows:

- Low awareness of rural people against river basin management
- Shortage of experts and budgets
- No formulation of effective and economic countermeasures for basin management

Forestation Project by SRMB

3.13.2 Situation of Basin Management in the Country

On a nationalwide scale, basin management situation in the Study Area is classified from Fair into Good as shown in Figure R 3.13.1.



Legend

- : Very poor
- : Poor
- : Fair
- : Good
- : Very good

Source:
The National Action Programme To Combat Desertification and Mitigate the Effects of Drought by FRWMO

Figure R 3.13.1 Basin Management Classification Map

3.13.3 Soil Erosion in the Study Area

Soil erosion is accounted one of the most important elements of watershed management in the Study Area because the Study Area have the following problems:

- There are a lot of rapid inclination ground in the Study Area as showing in Figure R 3.13.2.
- Marl, having weak resistivity against erosion, is widely distributed in the Study area.
- There are many thin vegetation and bare ground in the Study Area
- There are many over-grazing of goats and sheep in the Study Area

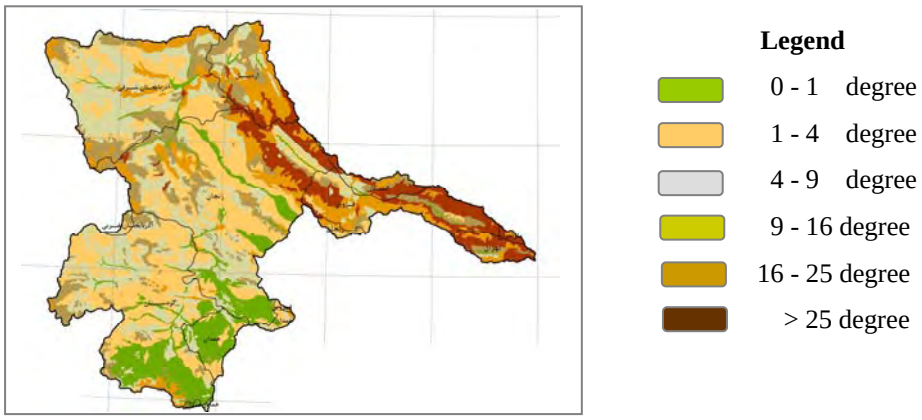


Figure R 3.13.2 Slope Map in the Study Area

Soil erosion classification map in the Study Area sourced from SRMB is shown in Figure R 3.13.3. The soil erosion of the middle basin of the Qezel Ozan River from Ostor dam to Mushampa dam is high. Marl is widely distributed in this area.

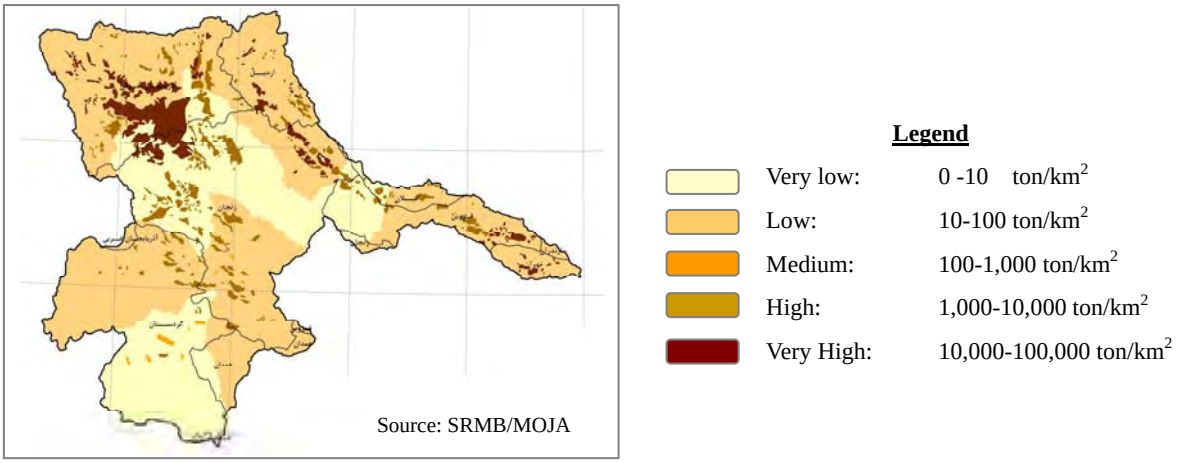


Figure R 3.13.3 Land Degradation Map by Soil Erosion

Based on the above-mentioned classification, soil erosion classification are divided into two categories by SRMB/MOJA as shown in Figure R 3.13.4.

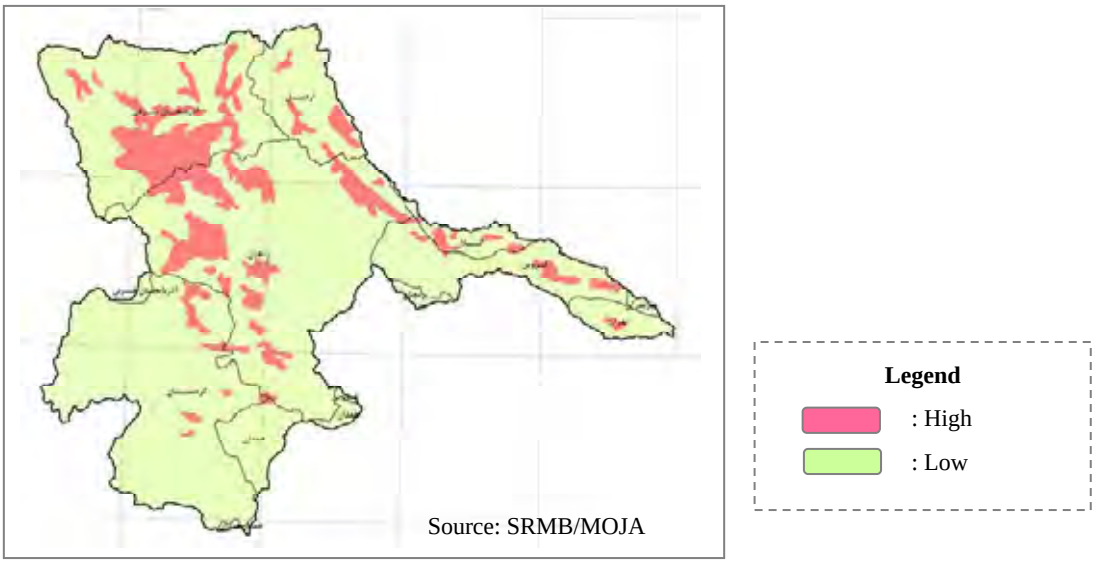


Figure R 3.13.4 Soil Erosion Classification Map in the Study Area

3.14 SATELLITE IMAGE ANALYSIS AND GIS

The Advanced Land Observing Satellite (ALOS) satellite image is used in this project. The ALOS has three remote-sensing instruments. In order to precise land use data, the AVNIR-2 image is used in this project. It is also adopted in order to generate a high quality Digital Elevation Model data in the project, a high resolution DEM data which come from Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER DEM) is used.

3.14.1 GIS Database

Considering the data freshness, covering area, and adaptation for regional planning, the 1:250,000 GIS data is suitable as basic data to establish the GIS database in this project.

Table R 3.14.1 GIS data characteristics

GIS data (Scale)	Map data	Covered Area	Suitable for Regional Planning
Small Scale	Revised 1990's	O	X
Middle Scale (1:250,000)	Revised 2007	O	O
Middle Scale (1:50,000)	Old data	O	O
Big Scale (1/25,000)	New	X	X

3.14.2 GIS Database Design

According to above research, JICA study team designed a GIS database in the study. The contents of the GIS database are shown in following table.

Table R 3.14.2 Specification of GIS Database

Data		Data Type	Data Source	Attributions
Satellite Image Data	ALOS Satellite Image	Raster	Satellite 2007	15m resolution
	ASTER DEM	Raster	Satellite 2007	15m elevation
Data of topographical map	Administration boundaries	Polygon	Scale 1:250,000	Name and Type
	Road	Line	Scale 1:250,000	Road Name and Payment Condition Code
	River	Line	Scale 1:250,000	River Name, River lass Code
	Water Body	Polygon	Scale 1:250,000	Name
	Villages	Point	Scale 1:250,000	Name, Type and Statistic Data
	Contour Line	Line	Scale 1:250,000	Elevation
River Infrastructure data	Irrigation Network	Polygon	WRMC	Name Classification
	Ditch	Point	WRMC	Type
	Well, Dam, Qanat, Discharge Station, Rainfall Station, Spring, Pump	Point	WRMC	Type and Name
Other Data	Land Use	Polygon	Land Use Map (1:100,000) MOJA	Type and Name
	Geology	Polygon, Line	Geological Map (1/250,000)	Geological Classification
	Soil classification	Polygon	Soil Map (1:250,000)	Soil Type
	Precipitation Data	Line	Isohyetal Map	Precipitation

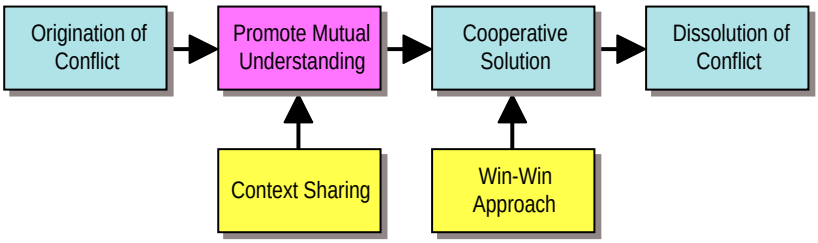
CHAPTER 4. CONFLICT MANAGEMENT

4.1 INTRODUCTION

4.1.1 Conflict Analysis and Mutual Understanding

Differences of the stakeholders are the origin of the conflict. As each stakeholder sticks to his/her own values, objectives, viewpoints, profits, thoughts, etc. conflicts are originated and it makes the conflict solution difficult as well. Therefore, the first step to the conflict solution is mutual understanding of stakeholders through communication. It should be noted that not only information but also context (background of each stakeholder) which exists behind the conflict should be shared by all the stakeholders with this communication. Information is interpreted through the background of a person. So, information has different meaning when the person has different background. That is why conflict analysis which grasps the background of the stakeholders is indispensable for conflict management. Thus, the conflict analysis was held to grasp the background.

In addition, it should also be noted that conflict is not necessary be solved when the stakeholders come to understand mutually. If resources are scarce or objectives of stakeholders compete against each other (water allocation problem is a typical case), mutual understanding by itself has little power for solution. In such case, stakeholders should find a solution by taking so called Win-Win Approach (See the boxed article below), where stakeholders cooperate each other to maximize each stakeholder's gain. Otherwise, the conflict would continue for a long-time and the total sum of gains as well as one's own gain would be likely decreased. In the Win-Win Approach, stakeholders can foster confidence each other through cooperative communication and then build up an idea of creative solutions.



Source: Hori, Kimitoshi *"Facilitation Skill Training"* 2003, p.113; Modified by JICA Study Team

Figure R 4.1.1 Mutual Understanding and Conflict Solution

[Five Modes to be Taken by Human Beings in the Situations of Confrontation]

- Competitive ·····To solve the confrontation with sacrificing (persuading) the opponent and concentrating the benefit to oneself,
- Receptive ·····To solve the confrontation with inhibiting one's request and accept the opponent's request,
- Evasive ·····No to solve the confrontation in the situation with avoiding the situation,
- Compromising ·····To solve the confrontation with reducing the request levels mutually and realizing the benefit partially, and
- Cooperative ·····To solve the confrontation with giving the opponent's standpoint serious consideration mutually and make cooperation. (Win-Win Approach can be applied.)

Appropriateness depends on the situation for each mode. "Cooperative Mode" may be appropriate for water resources management with applying Win-Win Approach in order to realize more preferable benefits.

4.1.2 Approach of Conflict Management

Water resources are becoming scarce more and more due to demand increase accompanying with social development. Conditions of surface water runoff and groundwater recharge differ in each basin due to meteorological (precipitation) and geological / topographical conditions. Historically, water conflicts have been continuing between upper and lower reaches or between urban and rural areas, as well as between provinces and countries in the world. Such conflicts have been coordinated with concluding agreements or promoting integrated water resources development. Considering such background of water resources management in general, the following approaches is applied to this Study:

(iv) Background of conflicts is grasped by conducting workshops with related organizations, users and others including stakeholders (Conflict Analysis)

(v) Actual conditions and solutions of the conflict are discussed with presenting case examples on conflict management in foreign countries. In addition, it is proposed and discussed that how the coordination rules among stakeholders are conducted.

(vi) Coordination principles, which are incorporated in the water resources management plan, are proposed.

With applying this approach, conflict analysis for (i), some of stakeholder meetings for (ii) and local consultation for (iii) were planned and executed in the Study. The flow of these activities in the Study is illustrated below.

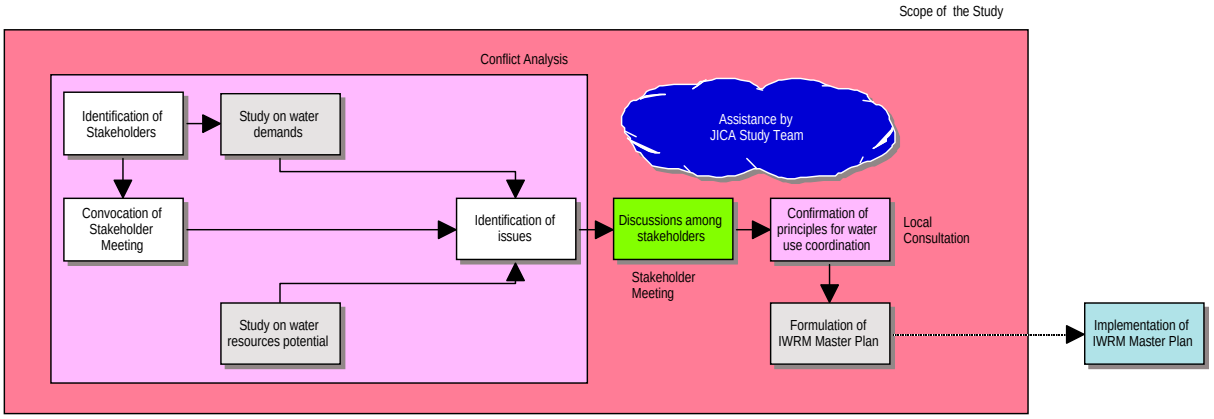


Figure R 4.1.2 Flow of Conflict Management in the Study

4.2 ACTIVITIES OF CONFLICT MANAGEMENT IN THIS STUDY

4.2.1 Activities in Each Stage of Conflict Management

Based on the above-mentioned ideas, consensus among the related Provinces has been pursued with the following stages:

Table R 4.2.1 Stages of the Conflict Management

Stages	Study Activities for Conflict Management	Time Frame
First Stage: Confirmation of the will to formulate an IWRM To present clearly the image of what water resources would be without an IWRM	It could be thought that there existed a tacit agreement on the necessity for the formulation of the plan because the stakeholder meetings have been held for nine times and each member joined the meeting every time (See **4.2.2 Stakeholder Meetings**). Although the image of the future water resources was presented in the results of the simulation, such will was not confirmed as a explicit agreement. Then, representatives of the Provinces were required to express their ideas of the necessity for an IWRM when JICA Study Team visited each Province for the workshop for conflict analysis (See **4.2.3 Workshop for the Conflict Analysis**).	Workshop for the conflict analysis: Jun. - Jul. 2008
Second Stage: Confirmation on the relation between water resources potential and design water demands in the river basin To present water resources potential as a result of scientific estimation in the river basin To present acceptable water demand estimations	Simulation results of the relation between water resources potential and design water demands were presented as the results of the simulation in the stakeholder meetings. It is very difficult to get a simple agreement on water demands because each Province has doubts about the data provided by other Provinces. It was fully explained that the Study has been conducted from the impartial standpoint and the model should be improved by the engineers of the Provinces themselves later in order to be accepted.	Stakeholder Meetings: Feb. and May 2009 Workshop for technical training on the simulation model for the engineers of the Provinces: May 2009
Third Stage: Confirmation on the principles of water allocation	Water use coordination based on the simulation and the setup of the improvement in irrigation efficiency in the future were discussed in the Local Consultation and Stakeholder Meetings (See **4.2.4 Local Consultation**). It can be a very starting point of the "tentative" agreement among the Provinces. It was reported that legal discussion on water use rights be put on a shelf. (Legal discussions take a long time to be settled and lead a win or loss, resulting in an obstacle in the way of agreement.) An RBO (River Basin Organization) is considered as a place for the discussions for the tentative agreement. It is assumed that periodical discussions will be continued in the RBO after a tentative agreement is made in order to make new agreements.	Stakeholder Meetings: May 2009 Local Consultation in each Province for hearing comments on the draft of the M/P: May 2009

4.2.2 Stakeholder Meetings

1) Outline of Stakeholder Meetings

a) Objectives

As it is expected that stakeholder meetings (SHMs) promote mutual understanding among the stakeholders by making them gather in one room, and face and discuss each other, not only the contents but also the meeting itself gives important opportunities for conflict management.

b) Methodology/Membership

SHMs were held for discussing the progress of the Study occasionally when the Study reached at some important points. They were chaired by the representatives of WRMC. JICA Study Team assisted holding of SHMs. The members of the SHMs are the representatives of RWCs of target Provinces except Hamedan due to its minimal impacts on the whole water uses in the Study Area in accordance with the initiative of the WRMC. Non-members such as local consultants are invited to the meetings for providing experts' information.

2) Main Discussions

The following were main matters on conflict management discussed in SHMs.

- When the Study on the conflict is carried out, the local specialty of each target Province should be fully kept in mind. (August 20, 2007)
- JICA Study Team remains impartial to all the stakeholders in the Study. (September 12, 2007)
- The workshop for conflict analysis is to be held in each stakeholder Province sequentially from June 12 to July 6. The word "conflict" in this study should be considered neither as "fight" nor "battle" but as "water use coordination among water users." (May 31, 2008)
- The workshop for conflict analysis finished successfully. JICA Study Team collected hundreds of opinions and ideas of solutions for water related issues in each Province. (July 12, 2008)
- The results from the workshop for conflict analysis were presented. (February 14, 2009)

4.2.3 Workshop for the Conflict Analysis

1) Outline of Workshop for Conflict Analysis

a) Objectives

The workshop was held for grasping the situations of water uses in the target Provinces,

(i) To find the background of the conflicts on the water allocation among the target Provinces,

(ii) To make each water users increase the knowledge of other water users in the Province to foster confidence among the water users, and

(iii) To develop the agenda of the stakeholder meetings.

b) Methodology

A group discussion was conducted by the representatives of organizations/groups related to water use in each Province. The representatives were selected by RWC. Although the selection would affect matters of the discussion, the selection was not strictly controlled by JICA Study Team in order to avoid the reduction of the participants because the time and place of the workshop were limited. It can be said that the discussion was developed more actively with clarifying consciousness on problems and trends of interests in each Province as a result.

The workshop was coordinated by the facilitator team (two Iranian specialists with a conflict management specialist of JICA Study Team). The facilitator team visited the target Provinces for the workshop and its coordination form the previous day. The Iranian specialists were the members of an NGO which had experience of similar workshops. Although the length of workshop time was planned to be a half day so that all the participants would be able to join up to the end of the workshop, the workshop lasted until afternoon. The discussion was carried out with employing the method of Stakeholder Analysis of Project Cycle Management (PCM) revised by the Study Team.

In the workshop, participants were required to discuss problems concerning water use, proposals for their solution and other issues related to water use such as:

- What do you think of the Master Plan for Integrated Water Resources Management of

Sefidrud River Basin?

- What do you think are the problems on water use and their importance/priority?
- What do you think are the solutions for such problems on water use?
- What do you think are the criteria of water allocation among Provinces?
- What rule should be established for water use?

The participants were required to observe the following rules in order to carry out the discussion in a well-organized manner. These rules conform to those of group discussion in PCM workshops.

WORKSHOP RULES

1. If you have an opinion, write it down on a small piece of paper with the felt pen and put the small piece of paper on the designated place.
2. Write only one opinion on one small piece of paper. If you have more than one opinion, write them separately on different pieces of paper.
3. The total number of your opinion may be capped at a certain number because of the time limitation. In such case, you have to prioritize your opinions.
4. Opinions put on the designated place should be removed only when all the participants agree to remove.
5. **It should be definitely noted that the results of this workshop will solely be used for the drafting of the Integrated Master Plan of Water Resources Management for Sefidrud River Basin.**
6. **It should also be definitely noted that you will NOT acquire any rights nor bear any duties for the reason of the opinions expressed in this workshop.**

c) Program of the Workshop

The workshop was planned to last for about a half day or about four hours for each stakeholder Province with the following program.

_____ Province Regional Water Company (RWC)

PROGRAM OF CONFLICT ANALYSIS WORKSHOP FOR SEFIDRUD RIVER BASIN WATER RESOURCES MANAGEMENT

Date: 2008
Time: 8:30 - 13:30
Place: Conference room of RWC

1.	8:30 - 8:50	Registration
2.	8:50 - 9:00	Opening by the Representative of RWC
3.	9:00 - 9:15	Explanation about JICA Project and the Workshop of Conflict Analysis by the Facilitator Team
4.	9:15 - 9:30	Introduction of the Participants
5.	9:30 - 11:30	Workshop
6.	11:30 - 11:45	(Break)
7.	11:45 - 13:15	Workshop (continued)
8.	13:15 - 13:30	Confirmation of the Workshop Results by the Facilitator Team

d) Schedule of the Workshop

The workshop sessions were held at each RWC of target Provinces following the preparation meeting with the persons in charge of the RWC of the Province in the following schedule. Program, method and workshop place were discussed and confirmed in detail in the preparation meeting.

Table R 4.2.2 Schedule of Workshop

Date	Day of Week	Activity
June 10, 2008	Tue	Preparation meeting in East Azarbaijan
June 11, 2008	Wed	Workshop session in East Azarbaijan
June 17, 2008	Tue	Preparation meeting in Ardebil
June 18, 2008	Wed	Workshop session in Ardebil
June 21, 2008	Sat	Preparation meeting in Kordestan
June 22, 2008	Sun	Workshop session in Kordestan
June 24, 2008	Tue	Preparation meeting in Qazvin
June 25, 2008	Wed	Workshop session in Qazvin
June 28, 2008	Sat	Preparation meeting for Tehran
June 29, 2008	Sun	Workshop session in Tehran
July 1, 2008	Tue	Preparation meeting in Gilan
July 2, 2008	Wed	Workshop session in Gilan
July 5, 2008	Sat	Preparation meeting in Zanjan
July 6, 2008	Sun	Workshop session in Zanjan

2) Results of the Workshop

a) Outline of the Participants

Although about 20 persons had been requested at maximum to join the workshop in each Province in order to deepen the discussions in the planning stage, around 30 persons actually participated in the workshop in each Province.

In classification by organizations, numbers from RWCs are devastating and some came joined from MOJA and DOE. Other than governmental organizations, universities and private consulting firms are noticeable. In addition, although very limited, some persons from Agricultural organizations, NGOs, a news agency joined in some Provinces.

Considering by Province, the number of participants in Kordestan is relatively large. Since such occasions as public hearing or something like that coming from Tehran are very limited there, they prepared for the workshop very ardently.

Table R 4.2.3 Breakdown of Participants

Organizations	East-Azarbaijan	Ardebil	Kordestan	Zanjan	Gilan	Qazvin	Tehran
RWC	16	12	20	13	16	13	21
MOJA	2	2	5	5		1	1
DOE	3	3	1	1			
M of Natural Resources	1	1			2	1	
Rural Water and Wastewater Company	1	4	5	2		2	
Organization of Industries and Mines	1	1		1			
Meteorological Organization				1	1		
Office of Governor		1	2		1	3	
University/ Institute	1	1	1		2	2	1
Consultant		2		1	6	2	1
NGO				1	1		
Agricultural Organization				1		2	
News Agency						1	
Unknown			1	1		3	2
Total	25	27	35	27	29	30	36

b) Outline of the Discussions

i) Opinions on IWRM

In general, participants expressed the similar ideas on IWRM in each Province. Namely, water resources are shared in efficiency and equity with considering environment and ecological conservation. Efficiency here means realization of the maximized productions with optimal resource allocations. It is relatively easy to decide since the results can be grasped quantitatively in a single measure. On the other hand, equity does not mean the allocation of equal amount of resources but the realization of social justice with considering social and cultural situations. What the social justice is depends on the social and cultural backgrounds. As mentioned in the characteristics of the Provinces, each Province has its own social and cultural conditions. It is very difficult to reach a consensus of this matter by the Provinces.

Environmental consideration was presented as a key to IWRM in all the Provinces, which corresponds to the fact that the environment is itemized in the discussions of water related problems in all the Provinces.

In addition, those opinions are proposed as information sharing, cooperation of related organizations among the Provinces, requirement for the establishment of an integrated organization, which show the participants' concern that the present situations where relevant authorities manage water resources without coordination among the Provinces from the viewpoints of organizations and functions.

ii) Issues on Water

Firstly, participants were required to individually propose water problems as much as possible. Then, such problems are categorized into some groups and finally, such groups were prioritized in the group discussion.

Noticeable issues presented, which relate to the whole basin, are as follows:

- Lack of appropriateness in water management due to intervention of politicians
- Lack of reliability in data and statistics
- Lack of an organization for integrated management
- Abandonment of cultivation and migration to cities by a large number of farmers
- Inefficient water use in the lower reach Province / Excess water use in the upper reaches
- Lack of appropriate function in the environmental impact assessment system
- Lack of reflection of user opinions on decision-making
- Impact on the lower reaches due to the pollution in the upper reaches
- Decrease in the level of water table and water quality of the groundwater
- Inappropriate water price setting

The results of categorization and prioritization of proposed water issues are as follows.

Table R 4.2.4 Priorities of Water Related Problems

Order	East-Azarbaijan	Ardebil	Kordestan	Zanjan	Gilan	Qazvin	Tehran
1	Policy-Making and Management	Water Needs -Drinking, -Industry, -Environment. -Agriculture	Policy-Making and Management	Surface and Ground W	Agriculture, Fishery, Aquaculture	W Supply	Policy-Making and Management
2	Social and Economic Issues	Social and Economic Problems	W Supply -Surface W -Ground W	Drinking W and Hygiene	Drinking W and Sanitation	Environment	W Resources Development
3	Environment	Water Resources -Surface W -Ground W	Agriculture and Natural Resources	Environment	Economic and Social Problems	Policy-Making and Management	Environment
4	Natural Resources	Management and Policy Making -Laws and Regulations -Management and Decision Making	Economic and Social Issues	Agriculture	Industry and Development	Economic, Social and Cultural Problems	Water Supply
5	Laws and Regulations		Environment	Industry	Security	Laws and Regulations	Laws and Regulations
6	Information and Data Infrastructure		Laws and Regulations	Social and Economic Issues	Management and Policy Making		Economic and Technical Issues
7	Industry and Mining Sector			Management and Policy Making	Environment and Natural Resources		
8				Drought and Climate Change			
9				Natural Resources, Irrigation and Food			

iii) Proposals of the Solutions for Water Issues

Solutions of the noticeable water issues mentioned above were proposed as follows:

Table R 4.2.5 Proposals of the Solutions for Water Issues

Noticeable Water Issues	Proposals for Solutions
Inappropriate water management resulted from politicians' intervention	To establish an integrated water management body in which representatives of stakeholders and NGOs participate To employ public opinions
Unreliability of data and statistics	To establish a data collection network and a information exchange center To produce accurate statistics data
Lack of integrated management body	To establish an administrative organization for integrated management To train engineers working for integrated management To formulate an integrated river basin management plan
Farmers' abandonment of cultivation and migration to cities	To implement poverty reduction programs to reduce poverty of farmers (Example: construction of dams to supply enough water and to create employment) To formulate a strategic plan for the development of Province
Inefficient water use	To employ a trans-Provincial approach in water resources management To change to agricultural products requiring less amount of water use To improve irrigation efficiency To construct a comprehensive data bank for water demand To hold workshop for optimal water consumption To implement water recycle
Malfunctioning of the EIA system	To clarify the responsibilities of related administrative agencies and their legal framework To change laws into more realistic ones / to improve methods To prioritize EIA over project implementation
Closed decision-making	To promote resident participation and raise awareness To provide information through mass media To organize users' associations To revise laws for promoting participation
Water pollution in the upper reaches and its affect on the lower reaches	To construct a full-fledged water treatment plant for wastewater To implement water quality monitoring and establish a data bank To secure the minimum water flow in the lower reaches
Decrease in the level of water table and water quality of the groundwater	To limit the exploitation of wells To implement water quality monitoring and establish a data bank To change the uses of groundwater to surface water
Inappropriate water tariffs	To make water tariff based on costs for water supply To consider economic value (opportunity cost) of water

iv) Proposed Criteria of Water Allocation

Criteria proposed in each Province are basically categorized to (1) focus on water demand, (2) focus on water supply, (3) economic efficiency of water use, (4) relation to the national plan (objective), (5) social consideration, (6) environmental consideration, and (7) others. Representatives of each category are as shown below.

Table R 4.2.6 Proposed Criteria of Water Allocation

Category	Proposed Criteria
(1) Focus on water demand	Population, structure of industries, land use, agricultural/livestock products, cultivated area
(2) Focus on water supply	Water resource potential, topography, climate, alternative water resources
(3) Economic efficiency of water use	Agricultural productivity, efficiency of water use
(4) Relation to the national plan (objective)	Production of national strategic products, Long-Term Development Strategies for Iran's Water Resources
(5) Social consideration	Severity of poverty, problems on employment/society
(6) Environmental consideration	Conservation of environment/ecology

v) Proposal of Necessary Rules on Water Resources Management

The following proposals are noticeable through the discussions, especially those on water problems in all the Provinces.

- To develop laws and regulations for integrated water management and to establish an organization to implement them,

- To develop rules for promoting cooperation or resolving confrontation among the Provinces, and
- To examine measures for effective implementation of laws and regulations.

4.2.4 Local Consultation

The Local Consultation was held in each Province with taking much time. Details are explained below.

1) Outline of Local Consultation

a) Objectives

The local consultation was held for explaining the outline of the draft Master Plan of Integrated Water Resources Management for Sefidrud River Basin prepared by JICA Study Team and hearing comments on the draft Master Plan from representatives of related organizations in order to finalize the Master Plan with such comments. The results of this consultation will solely be used for the finalization of the Master Plan, and the participants do not acquire any rights nor bear any duties for the reason of the opinions expressed in this consultation.

b) Participants invited

Representatives of organizations related to water including governmental authorities, NGOs, universities, agricultural associations and so on in the Province were invited to the consultation. The number of participants in each Province was required not to exceed 30 in order to make discussions effective. A participant list was prepared by the Regional Water Company of the Province.

c) Place for the consultation

The place for the consultation was prepared by the RWC of the Province. A representative of JICA Study Team and the expert of conflict management visited each related Province to hold the consultation session.

d) Schedule

Though each consultation session was planned to take a half day (morning), it was extended to the afternoon or held again on the next day in some Provinces. The schedule is shown below:

Table R 4.2.7 Schedule of Local Consultation

Date	Day of Week	Province
May 2, 2009	Sat	Kordestan
May 4, 2009	Mon	East Azarbaijan
May 5, 2009	Tue	Qazvin
May 9, 2009	Sat	Gilan
May 11, 2009	Mon	Ardebil
May 13, 2009	Wed	Zanjan
May 16, 2009	Sat	Teheran

2) Results of the Local Consultation

a) Participants

The reason why the number of participants in Kordestan is a few is that the date was changed with East-Azarbaijan in a few days before due to the latter's schedule. It is noticeable that the number of consultant is many in Qazvin.

Table R 4.2.8 Breakdown of Participants

Organizations	East-Azarbaijan	Ardebil	Kordestan	Zanjan	Gilan	Qazvin	Tehran
RWC	18	26	17	17	23	20	28
MOJA				3		3	
DOE				1		1	
University/ Institute	2	5		2			
Consultant	1	1		1		11	1
Unknown						1	
Total	21	32	17	24	23	36	29

b) Discussions

Main discussion points are presented by Province in the following table. These points were incorporated into the final plan as much as possible.

Table R 4.2.9 Main Discussion Points by Province (1/2)

Province	Main Discussion Points
East-Azarbaijan	• Agreement by politicians is necessary for the establishment of RBO. It is important to show the benefit to the local area when the lobbying is made to the politicians. • Various criteria for the selection of water resources development plans were proposed. They should be decided with the agreement by the related Provinces. • Irrigation efficiency cannot be improved due to socio-economic conditions. Such conditions should be informed to WRMC by each Province. • Estimation of industrial and municipal water demands were presented by Mahab Ghodss through WRMC. • Irrigation is assumed to be modernized at once where the plan had been made in the model. • Five-year drought is employed since five-year or ten-year is generally employed in the world and it is efficient to employ five-year here. • Accuracy of groundwater examination is not so high because of the shortage of data. • Participation of users in planning should be considered in the RBO which is proposed to establish.
Ardebil	• It was understood that the improvement of irrigation efficiency takes huge cost. • Study results were reported not on Provincial basis but on reach basis. • Improvement of irrigation efficiency was examined not only with high rates designated by WRMC but also with lower rates which are more realistic. • As the river system is too much complicated near the river mouth at Caspian Sea, it is difficult to set the checkpoint of the simulation there. • Social factors (abandonment of cultivation by farmers) were not included in the model as the data are not enough. • Since the proposal of Ardebil water transfer plan was too late, it was not included in the Master Plan but the examination of its effects will be made.
Kordestan	• Sensitive analyses with various conditions in simulation should be made by the proposed RBO. • Assumptions of irrigation efficiency were made with the consultation with agricultural experts. • As the scope of work is to prepare the maser plan of water resources management, a detailed plan of irrigation efficiency improvement is not included. • As the simulation model was constructed with a macro approach, its results do not necessarily applicable to a local situation. • Demand of the Province does not seem to be underestimated in the national document.

Table R 4.2.10 Main Discussion Points by Province (2/2)

Province	Main Discussion Points
Zanjan	• As the river system is too much complicated near the river mouth at Caspian Sea, it is difficult to set the checkpoint of the simulation there. • There are rich water resources including groundwater in the lower reaches, which were considered in the Study. • Zanjan has a water quality problem- salinization, which is very difficult to solve. • On setting the environmental flow, water use abandonment caused by it should be fully considered. • Improvement of irrigation efficiency should be monitored every year with a systematic setup. • Each Province is preparing a new water resources development plan even now. Such plans should be examined by the proposed RBO after JICA Study.
Gilan	• Improvement of irrigation efficiency was examined not only with high rates designated by WRMC but also with lower rates which are more realistic. • Details of the simulation model were explained for enough time in the technology transfer seminar. • As the simulation model was constructed with a macro approach, its result does not necessarily applicable to a local situation. • Distortion of plans due to the interference by politicians is expected to be avoided by the proposed RBO. • (Selection of drought year / statistical approach of the planning was explained.) • Water quality problem coming from the upper reaches (salinization) should be examined by the proposed RBO.
Qazvin	• SEA and IEE were made in the Study and the results were reflected in the Master Plan. • Participation of farmers in RBO will be proposed. • Accuracy of groundwater examination is not so high because of the shortage of data. • Alamout water transfer plan was incorporated in the Master Plan. • Gilan Province has rich water resources. It should be considered that their water needs be fulfilled by their resources first. • Demand for municipal water was presented by Mahab Ghodss through WRMC. • Participation of MOJA is necessary for the improvement of irrigation efficiency. • Improvement of irrigation efficiency was examined not only with high rates designated by WRMC but also with lower rates which are more realistic. • Reuse of water was included at 10% in the plan.
Tehran	• All the local rivers were taken into consideration. • Improvement of irrigation efficiency was examined not only with high rates designated by WRMC but also with lower rates which are more realistic. • Although MOE does approval work of water resources development, RBO is necessary for reaching consensus by each Province. • In drought period, dams in the upper reaches cannot impound enough water so that does not effect the lower reaches according to the simulation results. • As the simulation model was constructed with a macro approach, its result does not necessarily applicable to a local situation. • Relation with RBO and the Caspian Sea and Ulmie Lake Basin Office should be clarified. • Participation of MOJA is necessary for the improvement of irrigation efficiency. • Participation of related Authorities (DOE and MOJA) in RBO is necessary. • In terms of water quality, EC and salinity concentration was examined but other parameters were not examined due to lack of data. • IEE was conducted in the Study, which considered wild lives which use water sources. • Use of treated water was not included in the Study but its necessity will be proposed.

c) Summary of Results

This is the second time of JICA Study Team visiting each Province for collecting comments so that it was conducted smoothly by officials of RWCs. In addition, it can be said that participants understood the meaning and significance of the Study to a large extent since they did ardent discussions and gave us questions and requests. The participants made detailed technical questions especially on the simulation model, which they have much interest in.

4.3 BACKGROUND AND MATTERS OF CONFLICT

4.3.1 Characteristics of the Related Province

The related seven Provinces can be divided into the upper reach group (East-Azarbaijan, Ardebil, Kordestan, Zanjan), Gilan which is located in the lower reaches, and others (Qazvin and Tehran) from the geographical viewpoint. Provinces in the upper reach group have the common characteristics about ethnicity and languages that non-Persian speaking ethnicities including Azarbaijani or Kurdish share the majorities in the Provinces as well as their natural characteristics such as highlands or mountainous area. On the other hand, Persian speaking ethnicities share the majority in the other Provinces.

However, the upper reach group in turn can be divided into East-Azarbaijan, where industries and commerce have relatively developed, and the Provinces where agriculture and stock raising are dominant, including Ardebil, Kordestan and Zanjan. Also, the non-upper reach can be divided into Gilan where agricultural production, especially rice is highly large, Tehran where industry is overwhelming, and Qazvin which is located between of the two. Recently, a large number of factories and people have been moving from Tehran to Qazvin.

Gilan Province shows some distinguishable characteristics among the related Provinces. It is located in the lower reaches as well as the largest production area of rice which is a principal food and a strategic agricultural product of Iran. (It was seen that a large amount of rice produced in Gilan was stocked in the cafeteria of RWC in East-Azarbaijan.) Its climate is mild and moist and its scenery of paddy fields resembles very much that of rural areas in Japan.

Zanjan and Kordestan were established by being separated from Gilan, where they originally belonged. Zanjan expressed most strongly their disbelief of the data which are used in the Study and aggrieved feelings against Gilan. Although Kordestan expressed dissatisfaction against other Province, undisguised feelings naming Gilan were not presented there.

Although the autonomy of Provinces is not high as Governors and high government officials are appointed by the central government, non-Persian speaking ethnicities dominate in population in some Provinces and a couple of Provinces had history of becoming independent even for a very short time. In addition, the Provinces think that they have received smaller investment and economic development so far. It can be deemed that the Provinces have potential dissatisfaction about the policy of the central government. The central government needs prudence on deciding a policy which affects the Provinces. It should be absolutely avoided that a decision ignites a flame of nationalism.

Considering above-mentioned characteristics of the Provinces, they can be grouped as follows:

Table R 4.3.1 Grouping of the Related Provinces

		Overwhelming in Agriculture and Stock Raising	Industries and Commerce Developed
Majority is Non-Persian Speaking Ethnicities	Upper Reaches	Ardebil, Kordestan, Zanjan	East-Azarbaijan
Majority is Persian Speaking Ethnicities	Lower Reaches	Gilan	—
	Other	—	Tehran
		Qazvin	

In the conflict analysis, participants were required to individually propose water problems as much as possible. Then, such problems are categorized into some groups and finally, such groups were prioritized in the group discussion. There cannot be seen any noticeable relations between the priority of water problems and geographical positions (upper/lower reaches).

"Policy-Making and Management" is itemized as a big issue of water problems in all the Provinces but its priority order differs by Province. Although it is ranked at the first in three Provinces (East-Azarbaijan, Kordestan and Tehran), some Provinces ranked at lower orders. Five Provinces itemized "Laws and Regulations" but they ranked it at the lower order. Three out of the five Provinces

ranked "Policy Making and Management" at the first priority. It can be analyzed that the participants think that problems should be solved flexibly in the field of political administration because the legislation of necessary management or regulation would take a longer time.

"Environment" was itemized in all the Provinces. Environmental problems seem to be recognized significant by the participants.

"Fisheries and Aquaculture" and "Security" were itemized in Gilan, and "Information and Data Infrastructure" in East-Azarbaijan. These titles are not seen in other Provinces and show that the characteristics of those Provinces.

4.3.2 Conflicts among Provinces

Provinces in the upper reaches require water allocation based on the potential of future development on one hand. The lower reach Province expressed that the existing use of water should be highly esteemed on the other hand. The confrontation about the water allocation is clarified in this point. If the upper reach Provinces implement the water resources development plans to increase the water use without taking any measures, the inflow to Manjil Dam will be reduced and the irrigation water also will be reduced in the lower reach Province. Thus, it is quite obvious that the agricultural production in turn will be reduced in the lower reach Province. In addition, it is also concerned that the water quality in the lower reaches would be degraded due to the reduction of river flow in the lower reaches. As industries have not been developed so much in the surrounding areas of the upper reaches, the most serious problem on water quality is the increase in salinization. Its cause is marlite lying in the upper reaches. The water quality problem, however, is not so serious comparing with the water allocation problem for the time being and it can be a clue for leading the Provinces to cooperation among them or IWRM. Sedimentation of the river is not recognized so much as a problem among Provinces.

As a result of the conflict analysis, it is clarified that the Provinces do not take a cooperative actions because they think that water resources are not allocated fairly among themselves. The reasons why they feel unfair are as follows:

- Each Province insists different criteria of fairness to justify its argument; and
- Each Province has some mistrust in other Provinces so that it cannot accept the argument of other Provinces.

It is necessary to making coordination from the viewpoint of IWRM to solve the confrontation and promote water resources development plans with cooperation.

4.4 IDEAS OF CONFLICT SOLUTION

4.4.1 Basis of Analysis

Before going to examine conflict solution, basic ideas are to be confirmed here. Firstly, the conflicts among the Provinces are those discussed in the above section. Secondly, what the minimum requirement in the process of solving the confrontation is "At least no one positively insists disagree in a condition where interests of parties are confronted." This is required to guarantee that the stakeholders have seats at the negotiation table whatever the negotiation results in. If the stakeholders still continue to join the negotiation hereafter, it can be expected that the results would improve thanks to the development of the discussion as well as the change in internal or external situations. As is mentioned in **4.1.1 Conflict Analysis and Mutual Understanding**, if the allocation of scarce resources is the objective of the confrontation, mutual understanding by itself has little power for solution. In such case, stakeholders should find a solution by taking so called Win-Win Approach where stakeholders cooperate each other to maximize each stakeholder's gain (or to minimize the expected reduction of gain for each stakeholder).

Thirdly, what the agreement is made about is going to be considered. It is no meaning to agree about a water allocation plan among relevant Provinces without clarifying the conditions where the

plan is reasonable or sustainable. Each Province should agree how it uses water under such conditions. In this meaning, what the agreement is made about is the "coordination" of fair water use, which is not just an "allocation" among Provinces; the reduction of Province A's water use does not necessarily mean the increase of Province B's water use. In other words, it is the rule of water use (especially agricultural water) coordination with fulfilling various constraints including the national objectives and sustainability. This has a high affinity for an "IWRM" plan as a result. As each Province insisted the necessity of an IWRM plan in the workshop held in 2008, a water use coordination plan which is logically incorporated in the IWRM seems to be less resistible by the Provinces.

Finally, a characteristics or cause of the conflict of Sefidrud River Basin is going to be considered. Although stakeholders normally consist of water users in various fields including Provincial consumers as well as relevant governmental agencies, they are limited to RWC of relevant Provinces. RWC has various authorities for water use and it can be deemed as a representative of the Province for the matter of coordination of water allocation among Provinces. In such situations, although a water resources development plan of a Province requires an approval of WRMC, it cannot effectively control Provinces as a result. The central government or WRMC should bring the situation under control by doing proper actions such as an advice, persuasion and administrative order if necessary.

Why did such situation come about? As one of important reasons, the leadership of the center may not be necessarily enough and Provinces have some mistrust in the center and other Provinces, which leads to a problem of governance, preventing proper execution of river basin management policy as a result. It is necessary to design an institution which mitigates the mistrust among the stakeholders such as establishment of a permanent consultation body and a mechanism for fostering a sense of community. In addition, it is also required to external assistance for developing capacity to exercise proper leadership of WRMC to Provinces on the basis of an IWRM plan which is to be formulated.

The basis of analysis on consensus building has been confirmed so far. Details of the confrontation are to be confirmed and their measures are to be analyzed hereafter.

4.4.2 Analysis of Confrontation and Measures

As a result of the analysis of issues on water presented in each Province, it is clarified that the Provinces feel that water resources are not allocated fairly among themselves. The reasons why they feel unfair are (1) Each Province insists different criteria of fairness to justify its argument; and (2) Each Province has some mistrust in other Provinces so that it cannot accept the argument of other Provinces. Key points of such confrontation can be analyzed as follows:

Table R 4.4.1 Analysis of the Confrontation

Key Points of Confrontation	Ideas of the Upper Reach Provinces	Ideas of the Lower Reach Province	Example of Validation
1) Equity/Social Justice	It is equitable to increase the income in the upper reaches by developing agriculture and industries because its income is lower than the national average.	The income of the farmers in Gilan has already decreased due to water shortage. Further decrease in the income would lead to social unrest.	According to par capita GRDPs of the Provinces, they are lower than the average of the Country, and there is a difference among them, but it is not necessary due to the difference between the upper and the lower reaches.
2) Rights of Water Use	Those who have water sources have the right to use the water primarily.	Those who have been using the water for more than 40 years have a vested right for the water use.	The UN International Watercourse Convention does not clarify the priority of vested right. A theory insists that a vested right can be violated with the condition of compensation for pursuing equity.
3) Economic Efficiency (Productivity)	The land in the upper reach area is fertile and has the potential for developments. Water use in the lower reach area is inefficient.	Gilan is the optimum land for producing rice, which is a strategic agricultural product.	There is a large difference in productivity due to the difference of products.
4) Reliability of Information/ Data	Information and data provided by the lower reach Province are not reliable.	Information and data provided by the upper reach Provinces are not reliable.	Present water demands based on the analysis of satellite imagery is about 10% larger than those based on the statistics but the sufficiency rate in each area has no significant difference.

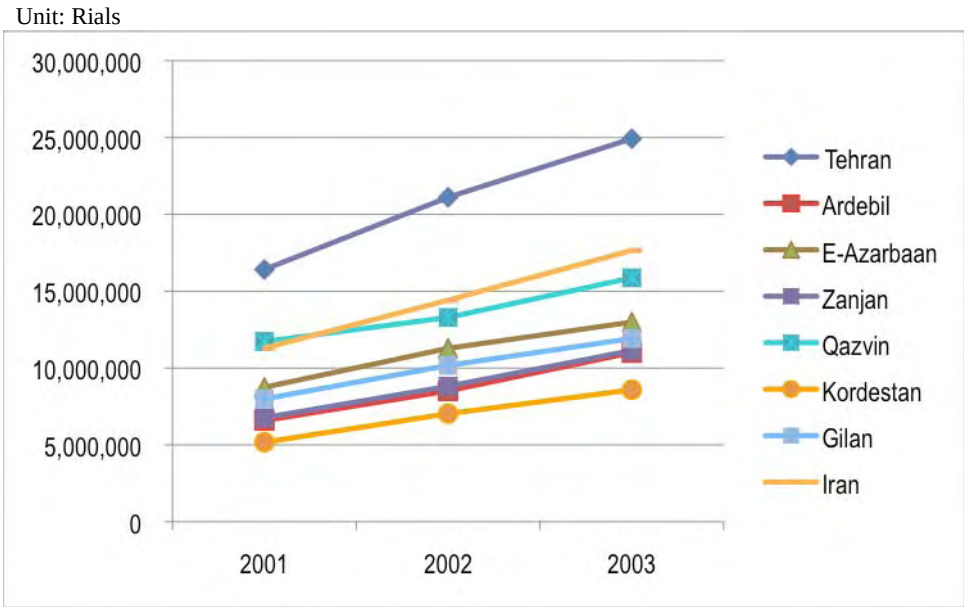
Tehran and Qazvin stand and see the confrontation because they have different topographical conditions and prioritized water allocation conventionally.

Measures for coping with such points of confrontation are examined in the following sections.

1) Equity/Social Justice

As mentioned in **2) Rights of Water Use**, the objective of the requirement of equity is not to attain a formal equality but to realize the social justice. The confrontation comes about because each party insists its own justice only. Is it called a justice that you have to harm someone else's justice to attain your justice? You have to rethink whether you have other ways to attain your justice which do not harm someone else's. All the parties have to consent with each other to progress together while the severity of this point come to be actually mitigated in the water use coordination which is reasonable or sustainable.

Per capita GRDP for each Province is shown below. No Province exceeds per capita GDP of Iran except Teheran. With excluding Tehran and Qazvin which surrounds it, per capita GRDP of East-Azarbaijan, the largest one is 1.5 time larger than that of Kordestan, the smallest one. But it can not necessarily be said that there is clear difference between that of the upper reaches and the lower reaches.



Source: Iran Statistical Year Book 1385 and statistics of each Province

Figure R 4.4.1 Per Capita GRDP of Each Province

2) Rights of Water Use

It is exactly the confrontation between the priority of upper reaches and the vested right. It is inevitable that such confrontation on rights be put on the shelf in order to improve the situations with avoiding very difficult matters and all the parties start discussions aiming at improving situations better than present ones (or reducing deterioration) for all of them as much as possible. However, as such ideas that reduce the allocation to the lower reach Province unilaterally cannot be accepted by them, compensating measures would be required if such ideas are discussed.

Table R 4.4.2 Compensating Measures

Measures	Example
Substantive conservation of the present allocation	• To keep the same amount of production with less water by implementing projects which improve irrigation efficiency • To introduce kinds of crops or cropping methods which require less water • To implement projects which develop water sources within the Province
Cover of the reduction with other things/forms	• To provide subsidies from the national treasury • To promote public works and industries to create employment and cover the reduction of the income • To levy water charge on the upper reach area (It is very difficult for the upper reach Provinces to accept this idea but it is worth considering because they allege that the economic efficiency of water be higher there.) • To transfer the products from the upper reaches to the lower (ditto)

For the allocation of scarce resources whose total endowment is reducing, keeping *status quo* is rather difficult. Each member enters cooperation in order to minimize the deterioration from the present situation in such case.

"Convention on the Law of the Non-navigational Uses of International Watercourses" (hereinafter referred to as "International Watercourse Convention" or IWC) can be a good reference for the consideration of the rights on water use coordination among Provinces located in Sefidrud River Basin. This convention is adopted by the General Assembly of the United Nations in 1997. It is not yet in force as the number of the ratifying countries has not reached to the designated number.

IWC stipulates the following principles for the utilization (including water resources development, the same shall apply hereinafter) of water in an international river:

1) Equitable and reasonable utilization (Article 5, IWC)
2) Participation in utilization (Article 5)
3) Obligation not to cause significant harm (Compensation shall be made if significant harm is caused) (Article 7)
4) Promotion of cooperation among related countries (Article 8)
5) Regular exchange of data and information (Article 10)

Principle 1) is always questioned about the confrontation with Principle 3). It is a typical case that the water resources development in the upper reaches based on the request of equity affects the flow of the lower reaches. Although in the course of drafting IWC it was disputed which should prioritized between Principle 1) and 3), the final settlement was that either one can be prioritized from the standpoint you take. Prof. Stephen McCaffrey, Pacific University, views that the conditions such as compensation for Principle 3) result in that Principle 1) shall be prioritized. (Stephen McCaffrey. *The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: Prospects and Pitfalls*, World Bank Technical Paper, 1998) Therefore, pursuing equity can be preferred to vested right with fulfilling the conditions such as compensation from the viewpoint of Prof. McCaffrey

The word "Equitable" or "Equity" does not mean a pro forma equality, but means a balanced situation where conditions of each country are taken into consideration. In terms of water utilization, it does not require that each country use the same amount of water, but that each country can utilize an amount of water based on its conditions. IWC requires taking into account all relevant factors and circumstances, including (Article 6):

a) Natural conditions (geography, hydrology, climate, etc.)
b) Social and economic needs
c) Population
d) Effects of water use
e) Existing and potential use
f) Cost of conservation, protection, development and economic use
g) Availability of alternatives

(These examples were presented in the workshop of stakeholder analysis.)

Now it's time for examining "Equity" as a criterion which was strongly insisted in all the Provinces. Water allocation cannot be justified only with an agreement among relevant Provinces. The agreement should consider various conditions which constraint water utilization. For example in an extreme case, an agreement that each province can use water indiscreetly was made, it would obviously cause depletion of water resources, destruction of ecosystem, resulting in the losses of users (including future generations, in the broad sense of the term). Therefore, such constraint should be considered at the same time on discussing "Equity." Otherwise, it would be nonsense. That's why Article 5 of IWC requires "reasonable" (especially, optimum or sustainability). It can be said that Principles 2) to 5) are the means (institutions) for securing principle 1) in effect.

Therefore, constraints, which make water allocation reasonable, should be clarified when water allocation is made. Provinces should reach an agreement on water utilization based on such constraints. What should be agreed is the "coordination" of water utilization in this sense. (It is not an "allocation" among relevant Provinces because the reduction of water allocation to Province A is not automatically an increase to Province B.) Establishment of a river basin organization (RBO) is necessary to secure such coordination. Important functions of the RBO should include Principles 2), 4) and 5). The constraints clarified in JICA Study so far are sustainability (water resources potential, conservation of water environment, etc.) and the national objectives

(designation of strategic product, priority set in Long-Term Development Strategies for Iran's Water Resources).

After constraints are clarified, then indicators of equity will be the issue. Indicators will be used for the evaluation of equity. As employed indicators differ, evaluation results will differ. Therefore, matters on water utilization will be changed to the matters on employment of indicators. Then, Principle 3) and factors itemized in Article 5 are examples of the indicators. It should be noticed that IWC does not stipulates the order of priority for the factors.

Criteria proposed in the workshop for conflict analysis by each Province are basically categorized to (1) focus on water demand, (2) focus on water supply, (3) economic efficiency of water use, (4) relation to the national plan (objective), (5) social consideration, (6) environmental consideration, and (7) others.

Since categories (4) Relation to the national plan (objective) and (6) Environmental consideration are considered to be constraints for water use coordination, criteria are narrowed to (1) Focus on water demand, (2) Focus on water supply, (3) Economic efficiency of water use and (5) Social consideration.

In terms of category (2) Focus on water supply, the area size of the river basin which falls in Provincial area, for example, is not suitable from the viewpoint of integrated water resources management which treats water cycle in the river basin as a whole. In addition, (5) Social consideration is not easy to quantify. On the other hand, categories (1) Focus on water demand and (3) Economic efficiency of water use are easy to quantify and suitable for the purpose of water use coordination in the integrated water resources management. Thus, applicable criteria are (1) and (3) for the purpose of the Study.

In addition, which item is the most suitable one in category (1) should not be discussed by relevant Provinces because they cannot reach an agreement. Such discussions can be avoided by fulfilling their water demands of Provinces and the criteria is satisfied as a result. In this case, discussions on (5) Social consideration can also be avoided.

Resulting from the discussions so far, the applicable basic rule of the water use coordination can be presented as follows:

Under the constraints including sustainability, water should be allocated in a manner that i) demand of each Province are fulfilled as much as possible or ii) productivity is maximized as a whole.

It should be confirmed that water has a physical characteristic that it flows basically from upstream to downstream. So, water cannot allocate so discretely as a pie can be cut into pieces. Although it can be allocated discretely if water is pumped up and transmitted, it is not realistic. Therefore, water should be allocated between upper reaches and lower reaches first and then it is allocated among upper reaches; there is only Gilan Province in the lower reaches.

Now the above underlined basic rule is to be examined. In terms of ii) productivity, the maximum production cannot necessarily be achieved due to the reason described in the previous paragraph. Additionally, the rule should be decided among the Provinces in the second step for how the maximized products should be allocated among the Provinces. It means that the issue on how to allocate water will be changed to how to allocate products. Thus, this rule presents a reference on how much the value will be produced as a whole river basin when all the related Provinces enter a full cooperation.

As of i) demand fulfillment, water demands are categorized into a) municipal b) industrial and c) agricultural water and National Water Resources Development Strategy requires the water allocation with the priority of a), b) and c). This can be deemed as constraint to allocate water this order. As the volumes of a) and b) is extremely small compared to c), the issue becomes a coordination to fulfill the agricultural demand as much as possible; the environmental flow for the spawning of sturgeon is included in the constraint. Finally, the realistic rule for water use coordination came to be as follows:

Principally, agricultural water demand is fulfilled as much as possible with fulfilling several constraints including the national objectives and sustainability.

JICA Study Team explained a basic idea of the results of the Study to the participants of the local consultation as follows:

Water use in the upstream of the Manjil as well as in the downstream could be balanced with its potential until long-term target year of 2031 due to improvement of irrigation efficiency. In other words, the development potential could already reach the development limits unless water conveyance and distribution system in the existing irrigation areas are improved.

Many participants in Provinces insisted that the improvement of irrigation efficiency set by WRMC was very severe, considering their present conditions. JICA Study Team replied that the Study employed not only the scenario with a target set by WRMC but also a scenario with an intermediate level target, which deemed more realistic and showed that it is indispensable to implement the water resources development projects as well as irrigation efficiency improvement at least in the intermediate level in order to utilize sufficient water by both sides, downstream and upstream areas of the Manjil Dam, without severe conflicts. This result was basically accepted by all the relevant Provinces and they will make an effort to attain the target.

In case that the water saving target including improvement of irrigation efficiency is not attained, targeted sufficiency rates cannot be fulfilled. In such case, cooperation among the Provinces is required to minimize the deterioration from the present conditions and also required are establishment of a river basin organization for securing the said cooperation and the efforts toward confidence building by accumulation of cooperative actions in every day matters.

3) Economic Efficiency (Productivity)

The scope where the criterion is applied is different since the upper reach Provinces apply it within the river basin while the lower reach Province applies it to the whole nation. If the production of rice is based on the national strategy, it should be prioritized within a reasonable extent. However, the upper reach Provinces would never accept it if the lower reach Province makes no effort to improve the efficiency of water use with resting on the fact "national strategy." In addition, if the rice production is a national strategy, provision of subsidies from the national treasury should be considered. Compensating measures discussed above may also be useful for this point.

By comparison of estimated agricultural productivities in irrigation area, that in the upper reaches is more than 10 million Rials per ha and that in the lower reaches is around 0.6 million Rials. This is because that the upper reaches produces much alfalfa which can sell in high price while the lower reaches produces much rice which is relatively low price. The same thing resulted for the productivity for water use per MCM.

Table R 4.4.3 Estimated Agricultural Productivity of Irrigation Area in the River Basin

Zone	A	B	C	D	E	Total
Provinces in Zone	Kordestan	Zanjan, East-Azarbaijan	Ardebil, Upper Reaches of Gilan	Qazvin, Tehran	Lower Reaches of Gilan	—
Rice Production Area (ha)	0	2,093	2,145	1,212	208,782	214,232
Alfalfa Production Area (ha)	20,802	42,281	13,966	1,377	29	78,455
Estimated Productivity per ha* (million Rials/ha)	13.2	14.7	13.9	12.0	0.6	7.6
Estimated Productivity per MCM* (million Rials/MCM)	705.6	840.0	969.9	996.3	45.7	508.7

Note) *: Estimation by JICA Study Team. Other figures are quoted from statistics of Iran.
Estimated net income: Paddy 0.57 million Rials/ha, Alfalfa 22.78 million Rials/ha.
Source: Table 3.2.6 Estimated Current Amount of Agricultural Production by Crops, Irrigated and Rain-fed Farm Lands and Zones, Supporting Report Paper 7 Socioeconomic Conditions and Project Evaluaiton

4) Reliability of Information/Data

It is very difficult to reach consensus because each party has doubts about the data provided by the other party. The following should be explained enough to the related Provinces to accept.

- Each province shall make an effort to get its own data understood by other Provinces;
- It is planned that the simulation model is provided to WRMC at the end of the Study and trainings on the operation of the model were implemented to engineers of the related Provinces in May 2009. The related Provinces are to be required to improve the model with using data which they think reliable by themselves after the completion of the Study; and
- It is strongly recommended that a statistic agency independent from any Provinces be established in order that the statistical data including agricultural land use is fairly produced. Otherwise, it can be recommended that the river basin organization (RBO), which is proposed in the Study, verify the data provided by the Provinces.

Present water demand based on the analysis of satellite imagery and sufficient rates are presented in **Chapter 10**.

4.5 COORDINATION RULE AMONG STAKEHOLDERS

4.5.1 Majority Rule and Consensus Building

Majority rule has been widely used in a decision-making process of a group as a democratic way. This rule, however, may leave forty-nine percent of the people unsatisfied with the decision in the worst case. On the other hand, consensus building approach aims at gaining approval from the people as many as possible, although not necessarily a unanimous one. The table below compares the two methods.

Table R 4.5.1 Majority Rule and Consensus Building

	Majority Rule	Consensus Building
Decision Rule	Approval by the majority (= 51%) of the members	Approval by the members as many as possible. (Not necessarily a unanimous one to avoid a disturbance of the process by a minimum number of members)
Typical Tool of Decision	Voting / Debate	Facilitation / Win-Win approach
Time for Decision	Voting time itself does not take a long time. But it may take a long time to reach voting as majority rule presupposes discussions and agreement to decide between proponents and opponents before voting, to secure the democratic process. In addition, implementation of the decision may take a long time if the number of opponents is large.	It takes a long time to reach a decision. Implementation of the decision is expected to be smooth and quick because the number of opponents is small.
Cost for Decision	Cost for decision-making itself is low but it may cost a lot when the decision is implemented.	Its initial cost is high because a specialist of facilitation is required.
Applicability	Widely applicable	Its applicability is limited. For example, it cannot be applied to such issues related to one's belief and human rights.

As it is mentioned before, Win-Win approach is recommended to apply for solving the confrontation among the Provinces.

4.5.2 Analysis of Consensus Building Applying Win-Win Approach with Simple Model

Here is an example of Win-Win approach by which it is presented how a confrontation can be overcome utilizing a simple model. It should be noticed that the conditions of the discussion is simplified to make the logic understood easily. It is needless to say that various conditions should be considered for the application to an actual case.

Conditions of the Model

- Players: (1) Upper reaches and (2) Lower reaches
- Options of the players' action: (1) To agree and (2) To disagree
- A water resources development plan and an IWRM Plan can progress only when the both players choice to agree. Thus, if at least one player choices to disagree, the water resources development plan is not implemented and the water allocation is kept at the same as before, and also the IWRM Plan is not implemented which presupposes cooperation and collaboration between the both players.

1) No Compensation Case

In order to get the stakeholders have seats at the negotiation table, it is necessary to convince them that they will get the same or larger benefit with building consensus than those without the consensus. Profit/loss is summarized for with-consensus case and without-consensus case as follows:

Table R 4.5.2 No Compensation Case

Player	Agree/Disagree	Profit/Loss
Upper Reaches	Agree	The dam constructions will progress and the water allocation will increase.
Upper Reaches	Disagree	The dam constructions stay halted and the water allocation stays the same.
Lower Reaches	Agree	The dam constructions will progress and the water allocation will decrease.
Lower Reaches	Disagree	The dam constructions stay halted and the water allocation stays the same.

As is shown in the table above, it is difficult to get the lower reach stakeholders at the negotiation table without giving compensation to them as they suffer losses one-sidedly. Therefore, it is necessary to give compensation to the losses the lower reaches suffers. There are two types of compensation; that made internally and that by a third party. Profit/loss is summarized for with-consensus case and without-consensus case considering internal compensation in the following section.

2) Internal Compensation Case

Table R 4.5.3 Internal Compensation Case

Player	Agree/Disagree	Profit/Loss
Upper Reaches	Agree	The dam constructions will progress and the water allocation will increase. **They will give compensation.**
Upper Reaches	Disagree	The dam constructions stay halted and the water allocation stays the same.
Lower Reaches	Agree	The dam constructions will progress and the water allocation will decrease. **They will get compensation.**
Lower Reaches	Disagree	The dam constructions stay halted and the water allocation stays the same.

In the case above, the lower reaches can reach an agreement easily. On the other hand, it is difficult to get the upper reaches to the negotiation table since they will not accept the compensation from the upper reaches to the lower reaches, considering that there exists a confrontation between them. Profit/loss is summarized for with-consensus case and without-consensus case, considering external compensation in the following section.

3) External Compensation Case

Table R 4.5.4 External Compensation Case

Player	Agree/Disagree	Profit/Loss
Upper Reaches	Agree	The dam constructions will progress and the water allocation will increase.
Upper Reaches	Disagree	The dam constructions stay halted and the water allocation stays the same.
Lower Reaches	Agree	The dam constructions will progress and the water allocation will decrease. **They will get compensation from the third party.**
Lower Reaches	Disagree	The dam constructions will progress and the water allocation will increase.

In the case above, both parties can easily get the negotiation table since nobody in the river basin will not suffer losses. The third party who makes compensation is usually the central government. If its financial condition cannot allow compensation, external donors can support it.

In addition, compensation is not necessary pecuniary one. It can be one that something finally compensates the income of the lower reaches and can be accepted by them. For example:

- Implementation of a development plan (attraction or modernization of industrial/commercial business)
- Investment in improvement of agricultural productivity (construction of irrigation facilities, etc.)
- Technical assistance (efficient water use, examination of alternative water sources, and water balance simulation)

The compensations mentioned above are not only benefits of the lower reaches but also of the upper reaches, so they promote the consensus building further. This JICA Study can be interpreted as a kind of such compensation which has been implemented by the third party on ahead.

Since the lower reaches are the most important area which produces rice that is the strategic product of Iran, investment in improvement of agricultural productivity can be a first compensation. In addition, such indirect measure can also be an idea that increase in tax revenue resulting from the implementation of a development plan, which in turn will be invested in improvement of agricultural productivity.

4) Time Factor

It has been assumed so far that water allocation stays the same if no agreement reaches. However, if they make no agreement and the comprehensive water resources management is not implemented, water allocation will virtually reduces for both parties because they suffer losses of time benefit and environmental damages including progress of water pollution, destruction of ecosystem and soil erosion will increase as time passes. If it is widely known that the river basin has such time bomb, the lower reaches will have more and more disadvantages as time passes although the upper reaches also have some environmental problems. Profit/loss is summarized for with-consensus case and without-consensus case, considering a time factor as follows:

Table R 4.5.5 Considering Time Factor

Player	Agree/Disagree	Profit/Loss
Upper Reaches	Agree	The dam constructions will progress and the water allocation will increase.
Upper Reaches	Disagree	The dam constructions stay halted and **the substantive water allocation will gradually decrease (smaller)**.
Lower Reaches	Agree	The dam constructions will progress and the water allocation will decrease.
Lower Reaches	Disagree	The dam constructions stay halted and **the substantive water allocation will gradually decrease (larger)**.

In the case above, it would be possible to encourage the both parties to reach an agreement early with avoiding loss of time value and implementing an IWRM including environmental management as the driving force. A combination of the time factor and compensation examined before may encourage the lower reaches to reach an agreement much earlier. How early the lower reaches select the agreement option depends on that how they evaluate or recognize the speed of the effective reduction comparing with the reduction of water allocation. Thus, the environmental management of the integrated river basing management is very important for the consensus building.

5) Conclusion

The optimum choice for the lower reaches is to reach an agreement in earlier time. (The same can be applied to the upper reaches considering the time factor even though it is not so urgent to them.) It should be noticed that this choice does not mean a one-sided compromise for

the lower reaches. They would rather take a tactics of winning better conditions where they will take an initiative of the negotiation and realize better conditions in the agreement by applying this choice as soon as possible before the lower reaches finish a preparation for the negotiation. In addition, if an agreement is made at an earlier stage, the upper reaches would compromise to the extent of the loss of time value and effective reduction of water use due to environmental deterioration. On the other hand, it is advisable that the upper reaches do not blame the lower reaches but take a tactics of leading the negotiation by making a proposal which the lower reaches can easily agree with. It should be noticed that an important thing is not whether the Win-Win Approach is applied but how the initiative can be demonstrated in such negotiation on terms and conditions.

4.6 PROPOSAL OF COORDINATION PRINCIPLES TO BE INCORPORATED IN WATER RESOURCES MANAGEMENT PLAN

As is mentioned before, it was clarified that water use in the upstream of the Manjil Dam as well as in the downstream could be balanced with its potential until long-term target year of 2031 due to improvement of irrigation efficiency. Thus, in order to implement water resources development without the confrontation among the Provinces, the basic rule is that the proposal of new water resources development plan should be accompanied by the plan of water saving including an irrigation efficiency improvement plan, which keeps the water resources development within the water resources potential. Thus,

- New water resources development plan should be accompanied by a plan for water saving;
- Above-mentioned plan should be verified not to reduce present sufficient rates of other Provinces significantly in association with the water saving plan by the simulation model, etc. with involving all the relevant Provinces.
- Each Province shall continuously make an effort to save water including the improvement of irrigation efficiency and the results shall be monitored every year.

Detailed capable volume of water resources development should be examined by the simulation model built by JICA Study Team, which is expected to be elaborated by engineers gathered from each Province. From this viewpoint, a cooperative system among Provinces is required to be strengthened in the future.

4.7 POINTS FOR FUTURE CONFLICT MANAGEMENT

4.7.1 Major Achievements

As the foregoing study funded by Gilan had faced strong criticism from other Provinces, it was expected that JICA Study to be conducted by the third party which is neutral toward all the Provinces would promote cooperation among them. At the beginning of JICA Study, however, the Study team was misunderstood as private consultants hired by WRMC because the stakeholders were not familiar with ODA granted by a foreign country. Thus, the meetings held at Provinces were started with the explanation on Japanese ODA and JICA to be understood properly in addition to the Study itself. In stakeholder meetings, JICA Study Team tried to make easy-to-understand explanation to every Province and respond carefully to each question presented by the representatives. Other members of the Study Team than the conflict management specialist went to each Province and made interviews directly to persons in charge as well as conducted field surveys with local engineers. Additionally, in terms of the simulation model, technology transfer workshop was held in a concentrated manner for the invited engineers from all the relevant Provinces. It was kept in mind that the Study activities as a whole would be conducted to improve relationship with local persons concerned. It can be judged that the Study Team earned confidence that they were impartial to the stakeholders to a certain extent. Further, satellite imagery data were provided by JICA. They were strongly requested by the Iranian side because they can exclude arbitrariness of Provinces on land use survey. That such neutral data could be reflected to the Study contributed to the results of the conflict management.

More than three years have passed since the Study started and stakeholder meetings were held for many times. Discussions were made with the attendance of all the relevant Provinces except a rare case that a very important event was held coincidently in the Province.

Activities of conflict management include earning confidence as neutral for each member of the Study Team with carrying out his/her responsibility continuously as well as those conducted directly to the stakeholders by the conflict management specialist. It is deemed that earning confidence of the stakeholders contributed to the results of continuous attendance by all the stakeholders. Neutral data is surely important, considering that the provision of satellite imagery data for clarifying the land use surely contributed to the results. But it should also be noticed that the Iranian side finished the data processing in the deadline although it had been concerned that it would be delayed very much as the shooting by the satellite had been delayed due to bad weather. Since the both sides had already established confidence, it can be said that the Iranian side tried to keep and promote such relationship. Such achievements mentioned above as well as other major ones can be summarized as follows::

- The Study succeeded in gaining confidence from the stakeholders;
- Such momentum has been gathered that each Province tries to cooperate for solving the problem;
- Background and matters of the conflict has been clarified;
- Solution of the conflict was examined and proposed: water use in the upstream of the Manjil Dam as well as in the downstream could be balanced with its potential until long-term target year of 2031 due to improvement of irrigation efficiency; and
- Coordination rule among the stakeholders has been proposed.

4.7.2 Recommendations

As mentioned above, the confidence of the Japanese and the Iranian side has been established and the stakeholders began to develop a confidence at present. At least no members proposed to dissolve the stakeholder meeting. In addition, some Provinces are making new water resources development plans, which requires an opportunity for coordination among Provinces hereafter. The stakeholder meeting can still play a significant role for solving the conflict on water resources. Thus, considering the Study results, it is recommended that the stakeholder meeting be developed for promoting cooperation among the stakeholders as a mechanism of water use coordination among the Provinces and promotion of consensus building as well as a core of the future river basin organization which will be a main body of IWRM. The enhanced stakeholder meeting will be held quarterly for example to debate policies, strategies, data-sharing protocols, basin-wide modeling, and other systems issues and operating procedures that have impacts across administrative boundaries, as well as any existing or potential areas of conflict. The future river basin organization will be developed by making the stakeholder meeting as a nucleus. Although details of organization are discussed in later Chapter, basic directions of development, namely vertical and horizontal ones are mentioned below.

Vertical development means the deepening of discussion matters. Following matters should be discussed for implementing the IWRM plan, going beyond proposals and coordination for the Study as done before.

- To collect and analyze the data on water, other resources and environment
- To prepare hydrological/water quality monitoring
- To examine a water resource development plan
- To examine necessary fund
- To formulate an implementation plan for the Master Plan
- To operate the simulation model
- To build consensus on tentative rule for water use coordination among relevant Provinces

- To review urgent cooperation system in drought period and its provisional implementation
- To plan and execute capacity development for government officials tentatively

Horizontal development means the expansion of participants. Presently, official members are representatives of RWCs and some local consultants are invited to present technical information. Improvement of irrigation efficiency was found to be a very important factor as a result of the Study. Therefore MOJA is required to participate in the meeting, which is a main body of tertiary or lower irrigation channels. In addition, Ministry of Environment from the viewpoint of environmental flow maintenance and Ministry of Health from the viewpoint of water quality would be necessary for the meeting. Further, representatives of users such as farmers should be considered.

CHAPTER 5. WATER RESOURCES DEVELOPMENT PLAN AND POTENTIAL

5.1 WATER RESOURCES DEVELOPMENT PLAN

5.1.1 Summary of Dam Development Projects

Since the groundwater development in the Sefidrud River Basin has been reaching its capacity, the surface water has become a subject for further water resources development. There are 174 dam projects in the basin, as shown in Table R 5.1.1. Among them, 92 sites are under operation with a total volume of about 2.24 billion m^3. The total number of dams under construction and planning is 82, with the total storage capacity of about 3.74 billion m^3. Thirty eight (38) "Larger Dams" with a storage capacity greater than 5 million m^3 is 21.8% of all the dams, while their total storage capacity is about 5.85 billion m^3 or 98% of the entire reservoir volume in the basin. Locations of the 38 large dams are as indicated in Figure R 5.1.1.

Table R 5.1.1 Dam Development Projects in the Study Area

Development Stage	Large dam		Small dam		Total	
	(sites)	(million m^3)	(sites)	(million m^3)	(sites)	(million m^3)
Under operation	3	2,178.1	89	65.2	92	2,243.3
Under construction	14	2,344.9	13	21.6	27	2,366.5
Under planning	21	1,323.2	34	52.6	55	1,375.8
Total	38	5,846.2	136	139.4	174	5,985.6

Source: WRMC Report (2007)

Figure R 5.1.1 Location of 36 Large Dams

5.1.2 Situation of Large Dam Development in the Study Area

1) Development Phase for Large Dams in Iran

According to the "Water Engineering Standard of Ministry of Energy (MOE)", the development phases for large dams have been divided into five shown in Table R 5.1.2.

Table R 5.1.2 Development Phases for Large Dam in Iran

No.	Phase		Main Activities
1	Phase-0	Project finding/ Identification Study	• Based on the review of existing data and field survey, the dam site is specified. • Rough cost estimation and initial project evaluation • Identification of project priority and importance by comparison with other dam projects • Examination of the plan for future study
2	Phase-1	Feasibility Study (F/S)	• Execution of feasibility study • Examination of the optimum project scale and construction method • Cost estimation in F/S level • Environmental impact study and economic evaluation in F/S level
3	Phase-2	Detailed Design (D/D)	• Detailed design of each plan • Examination of construction method plan • Quantity and cost estimation • Preparation of technical specification and tender documents
4	Phase-3	Tendering and Construction	• Pre-qualification, tendering and contract • Construction supervision
5	Phase-4	Operation and Maintenance	• Operation of constructed dam facilities • Maintenance of constructed dam facilities

Source: WRMC

2) Dam Development Phase in the Study Area

According to the information of WRMC as of the end of May, 2008, there are 38 large dam projects whose development phases are shown in Tables R 5.1.3. There are 6 constructed (Phase-4) dams, 11 under construction (Phase-3), 8 under D/D study (Phase-2) and 13 under F/S (Phase-1).

Though Taham, Aydughmush, and Sahand dams are classified in Phase-4, these 3 dams should be categorized as under construction dam in JICA study because water treatment facilities and irrigation facilities of these dams are still under construction.

Moreover, the Mushampa dam entered one higher stage (Phase-3) according to the latest information by WRMC.

Table R 5.1.3 Development Phase of Large Dams in the Study Area (as of the end of May, 2008)

Phase	Name of Dam				
4	1) Manjil	2) Golblagh	3) Taleghan	4) Taham	5) Aydughmush
	6) Sahand				
3	1) Shahre-Bijar	2) Germichay	3) Golabar	4) Givi	5) Ostor
	6) Talvar	7) Sange-siah	8) Sural	9) Siyazakh	10) Kalghan
	11) Befrajerd				
2	1) Sheikhe besharat	2) Alan	3) Ghezel Tapeh	4) Babakhan	5) Mehtar
	6) Ramin	7) Mushampa	8) Alehdare		
1	1) Chesb	2) Khoresh Rostam(Hst2)	3) Tirtizak	4) Niakhoram	5) Sangabad
	6) Sir	7) Burmanak	8) Mendagh	9) Zardekamar	10) Songhor
	11) Hasankhan	12) Marash	13) Ghareh Darangh		

Source: WRMC

5.1.3 Problems with Water Resources Development Plans

1) Difference of Dam Development Progress among Provinces

The development progress of the dams of 5 million m^3 or more is arranged by the amount of reservoir storage for each Province in Table R 5.1.4 and Figure R 5.1.2. If all the dams under construction as of now were completed by 2016, the development volume of water would become 4,436MCM, and become twice larger than the present condition (2007). However, the development of three provinces of Zanjan, Kordestan and Ardebil is delayed comparing with that of Gilan and East Azarbaijan Provinces.

Table R 5.1.4 Development Progress of Large Dams by Each Province

Year	Gilan	Tehran	Kordestan	East Azarbaijan	Zanjan	Ardebil	Qazvin	Hamedan	Total
2004	1	1	1	0	0	0	0	0	3
	1,750.0	420.0	8.1	0	0	0	0	0	2,178.1
2007	1	1	1	0	1	0	0	0	4
	1,750.0	420.0	8.1	0	87.8	0	0	0	2,265.9
2016	2	1	4	5	3	2	0	0	17
	1,854.6	420.0	333.4	1,152.1	703.0	59.9	0	0	4,523.0
2036	2	1	10	5	12	6	1	1	38
	1,854.6	420.0	681.3	1,152.1	1,575.8	137.5	18.5	6.4	5,846.2

Note) Upper row: number of dams' Lower row: total reservoir storage (MCM)

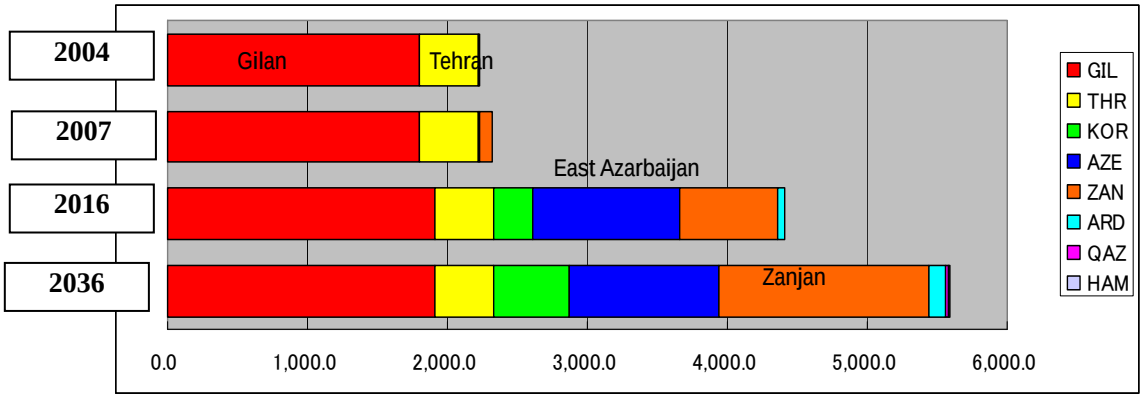


Figure R 5.1.2 Development Progress of Large Dams

Dams under investigation (Phase-1 and 2) are arranged for each Province in Table R 5.1.5. From the water resources management's viewpoint, careful review, adjustment and redesigning of 19 under planning dams would be crucial in the future, especially for Zanjan, Kordestan and Ardebil Provinces.

Table R 5.1.5 Dams Under Investigation

Province	Zanjan	Kordestan	Ardebil	Qazvin	Hamedan
Name of Dam	Mushampa	Sir	Sangabad	Burmanak	Alan
	Mendagh	Babakhan	Niakhoram		
	Mehtar	Zardekamar	Tirtizak		
	Songhor	Hasankhan	Khoresh Rostam (Hst2)		
	Chesb	Sheikh besharat			
	Ghezel Tapeh	Alehdare			
	Ramin				
	Marash				
	Ghareh Darangh				
Total	9 dams	6 dams	4 dams	1 dam	1 dam

2) Provincial Accomplishment Rate in Large Dam Projects

The volume ratios of constructed dams to the planned dams are calculated for the dams with the storage capacity greater than 5 million m^3 (Table R 5.1.6). In this calculation the dams that are already under construction were considered to be accomplished. Dams in Zanjan, Kordestan, and Ardebil are behind schedule.

Table R 5.1.6 Provincial Accomplishment Rate of Large Dam Projects

No.	Province	All dams scheduled for construction		Dams completed or Under construction		Accomplishment Rate: **B/A** (%)
		Number of dams (sites)	Total storage capacity: **A** (million m^3)	Number of dams (sites)	Total storage capacity: **B** (million m^3)	
1	Zanjan	12	1,575.8	3	703.0	44.6
2	East Azarbaijan	5	1,152.1	5	1,152.1	100.0
3	Kordestan	10	681.3	4	333.4	48.9
4	Ardebil	6	137.5	2	59.9	43.6
5	Gilan	2	1,854.6	2	1,854.6	100.0
6	Tehran	1	420.0	1	420.0	100.0
7	Qazvin	1	18.5	0	0.0	0.0
8	Hamedan	1	6.4	0	0.0	0.0
Total		38	5846.2	17	4,523.0	77.8

3) Relation between Design Storage Capacity and Annual Discharge

Relation between design storage capacities and annual discharge of the dams in the Study Area, which were studied by WRMC, are summarized in Table R 5.1.7. More than 10 dams are designed to store more water than a cumulative amount of annual discharge. Hence, it is anticipated that those dams that are still under investigation might be reviewed, redesigned, and altered to be an optimum size with the results of water balance simulation.

Table R 5.1.7 Relation Between Design Storage Capacity and Annual Discharge (in volume)

No.	Province	Dam/ Reservoir	Stage	Reservoir Volume				Annual Runoff Volume Estimated by Rainfall						Annual Runoff Record			Runoff/Riservoir	
				V1	V2		V3	Catchment Area	Annual Rainfall		Runoff Coefficient	Annual Runoff: V4		ave.	max.	min.	V4/V1	V4/V3
				(10^6m^3)	Sites	(10^6m^3)	(10^6m^3)	(km^2)	(mm)	(10^6m^3)		(10^6m^3)	($l/s/km^2$)	(10^6m^3)	(10^6m^3)	(10^6m^3)		
1	Ardebil	Givi	C	53.1	1	6.8	59.9	600	479	287.4	0.38	109.2	5.8	99.7	197.1	22.7	2.1	1.8
2	"	Befrajerd	"	6.8			6.8	39	444	17.3	0.50	8.7	7.1	11.0	19.2	3.5	1.3	1.3
3	"	Sangabad	S	14.6			30.9	61	390	23.8	0.20	4.8	2.5	4.7	11.4	0.6	0.3	0.2
4	"	Niakhoram	"	11.7			11.7	76	379	28.8	0.26	7.5	3.1	7.6	12.9	2.5	0.6	0.6
5	"	Tabrizak	"	9.0			9.5	66	400	26.4	0.20	5.3	2.5	4.1	9.5	0.3	0.6	0.6
6	"	Khoresh Rostam	"	42.35	1		42.35	88	380	33.4	0.20	6.7	2.4	-	-	-	0.2	0.2
7	East Azarbaijan	Ostor (Shahriar)	C	700.0	25	2,420.6	3,120.6	42,600	330	14,058.0	0.28	3,936.2	2.9	2,726.6	7,601.1	645.5	5.6	1.3
8	"	Sahand	"	165.0	1	18.8	183.8	820	384	314.9	0.50	157.4	6.1	141.9	259.2	53.9	1.0	0.9
9	"	Aydughmush	"	228.0			145.7	1,625	343	557.4	0.29	161.6	3.2	142.9	380.3	20.5	0.7	1.1
10	"	Garmichay	"	40.3			40.0	344	404	139.0	0.33	45.9	4.2				1.1	1.1
11	"	Kalghan	S	18.8			20.2	203	414	84.0	0.51	42.9	6.7	43.8	77.9	18.0	2.3	2.1
12	Gilan	Manjil	O	1,750.0	35	3,680.1	5,430.1	56,200	358	20,119.6	0.26	5,231.1	3.0	0.0	0.0	0.0	3.0	1.0
13	"	Bijar	C	104.6			105.0	242	1,016	245.9	0.50	122.9	16.1	220.8	310.9	83.6	1.2	1.2
14	Hamedan	Alan	S	6.4			6.0	78	350	27.3	0.21	5.7	2.3	5.7	5.7	5.7	0.9	1.0
15	Kordestan	Golblakh	O	8.1			8.1	250	292	73.0	0.11	8.0	1.0	7.9	17.7	1.6	1.0	1.0
16	"	Siazakh	C	265.0			232.0	1,058	465	492.0	0.50	246.0	7.4	213.2	431.1	75.1	0.9	1.1
17	"	Sange Siah	"	49.3			32.3	255	389	99.2	0.25	24.8	3.1	24.9	68.7	5.0	0.5	0.8
18	"	Sural	"	11.0			11.0	48	400	19.2	0.25	4.8	3.2				0.4	0.4
19	"	Sir	S	95.0			73.8	444	287	127.4	0.25	31.9	2.3	29.0	58.0	11.4	0.3	0.4
20	"	Babakhan	"	64.7			64.7	924	301	278.1	0.22	61.2	2.1	61.8	156.4	17.3	0.9	0.9
21	"	Zardekamar	"	62.0	1	232.0	294.0							323.9	632.6	130.9	0.0	0.0
22	"	Hasankhan	"	76.5	2	43.3	119.8	2,487	329	818.2	0.18	147.3	1.9	149.8	350.0	44.2	1.9	1.2
23	"	Sheikh Besharat	"	30.0			19.0	451	328	147.8	0.22	32.5	2.3	34.1	84.2	10.7	1.1	1.7
24	"	Aleh Dare	"	19.7			12.0	96	360	34.6	0.50	17.3	5.7	20.5	40.7	7.9	0.9	1.4
25	Qazvin	Burmanak	S	18.5			19.0	282	340	95.9	0.18	17.3	1.9	30.3	59.9	9.1	0.9	0.9
26	Tehran	Talaghan	O	420.0			420.0	828	685	567.2	0.50	283.6	10.9	1,027.1	4,303.4	258.9	0.7	0.7
27	Zanjan	Golabar	C	116.0			116.1	1,131	357	403.8	0.28	113.1	3.2	93.3	166.2	53.0	1.0	1.0
28	"	Taham	"	87.0			87.8	161	412	66.3	0.49	32.5	6.4	26.2	66.2	6.3	0.4	0.4
29	"	Mushampa	S	700.0	16	1,229.7	1,929.7	24,905	323	8,044.3	0.20	1,608.9	2.0	1,318.8	3,293.6	356.7	2.3	0.8
30	"	Talvar	"	500.0	4	84.5	584.5	6,441	310	1,996.7	0.13	259.6	1.3	255.4	617.2	70.0	0.5	0.4
31	"	Mendagh	"	43.0			43.0	33	300	9.9	0.13	1.3	1.2	1.3	3.5	0.3	0.0	0.0
32	"	Mehtar	"	14.0			14.0	129	345	44.5	0.45	20.0	4.9	12.0	34.4	0.3	1.4	1.4
33	"	Songhor	"	10.4			10.4	102	367	37.4	0.28	10.5	3.3	4.7	8.2	3.2	1.0	1.0
34	"	Chasb	"	9.9			9.9	135	355	47.9	0.12	5.8	1.4	3.8	12.0	1.3	0.6	0.6
35	"	Gheze Tapeh	"	6.0			8.4	75	300	22.5	0.45	10.1	4.3	9.5	24.0	1.9	1.7	1.2
36	"	Ramin	"	9.8			9.8	67	350	23.5	0.50	11.7	5.5	9.8	24.9	1.3	1.2	1.2
37	"	Marsh	"	36.8			36.8	397	350	139.0	0.20	27.8	2.2	-	-	-	0.8	0.8
38	"	Ghareh Darangh	"	42.9			42.9	2,093	350	732.6	0.20	146.5	2.2	-	-	-	3.4	3.4
				5,846.1			13,411.5					12,968.4		7,066.1	19,338.1	1,923.2		

Note: O: Operation, C: Construction, S: Study, V1: Design Storage Volume, V2: Sum of Design Storage Volumes in its own basin, V3=V1+V2

5.1.4 Maintaining Normal River Discharge

Maintaining normal river discharge is an important issue in water resources development by dam construction. Presently, WRMC does not set a numeric rule for maintaining normal river discharge. Considering the following points, maintaining normal river discharge is proposed for major rivers whose river flows do not dry up through the year in this study:

- Maintaining intake by traditional irrigation systems at the downstream
- Maintaining the habitat of fishes

WRMC assumes maintaining normal river discharge at 10% of the average river discharge on the results of the hydrological analysis and the environmental study done by WRMC. In this case, maintaining normal river discharge can be set as shown in Figure R 5.1.6

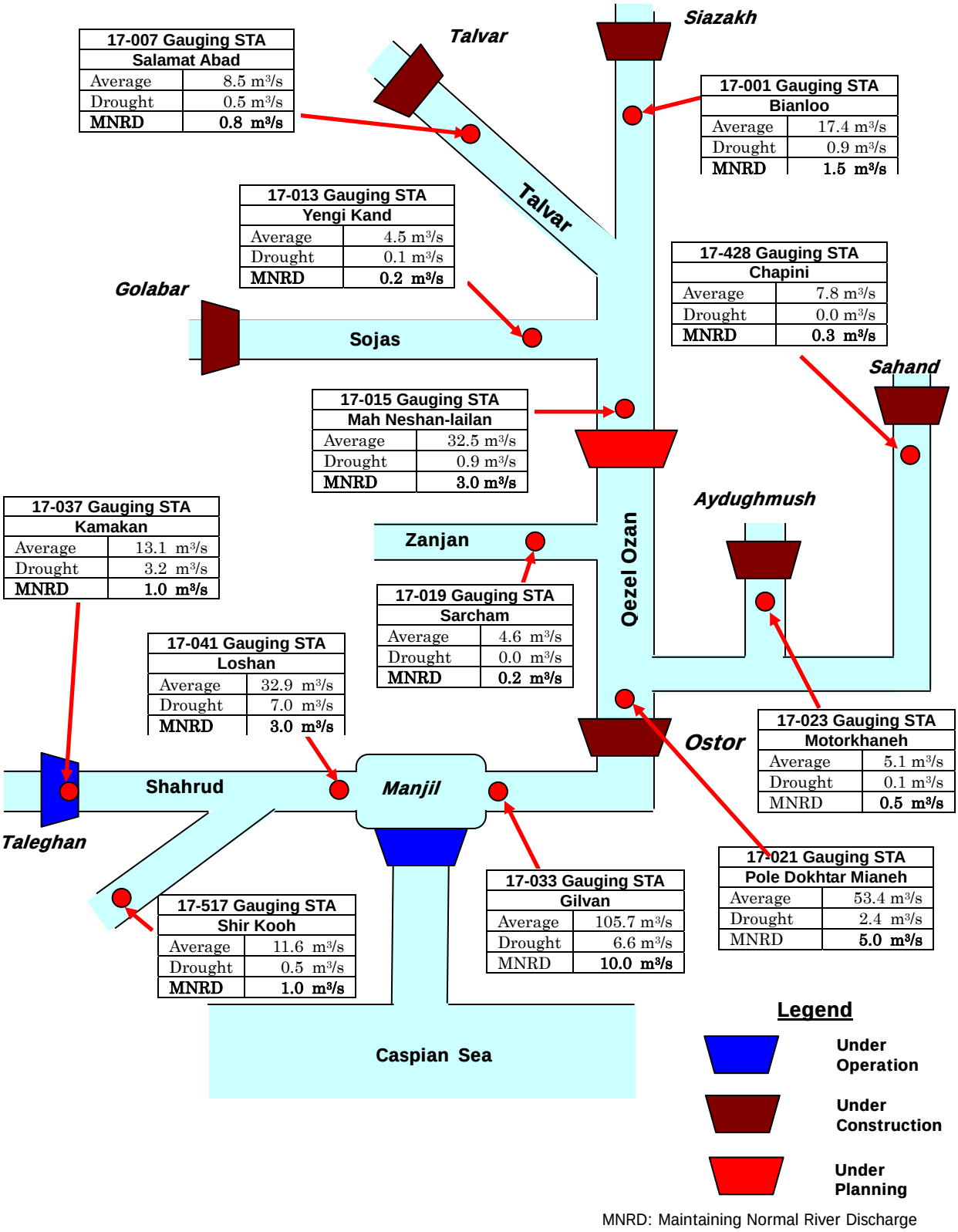


Figure R 5.1.3 Maintaining Normal River Discharge for Major Rivers (Example)

5.1.5 Qazvin Inter-Basin Transfer Project

To meet the rapidly increasing urban water demand in the metropolitan area, "The Study on Water Management in the Western Area of the Capital Tehran in the Islamic Republic of Iran" was examined by JICA in 2001. In this study, supply of water from Taleghan dam to Tehran city will be designed to be increased from 150MCM/year to 310MCM/year.

In this Study, a weir and a tunnel with the length of 33km were newly designed in the Almout River in order to secure alternative irrigation water for Qazvin plains from the Taleghan dam .Almout River is one of the Shahrud River branch as shown in Figure R 5.1.4.

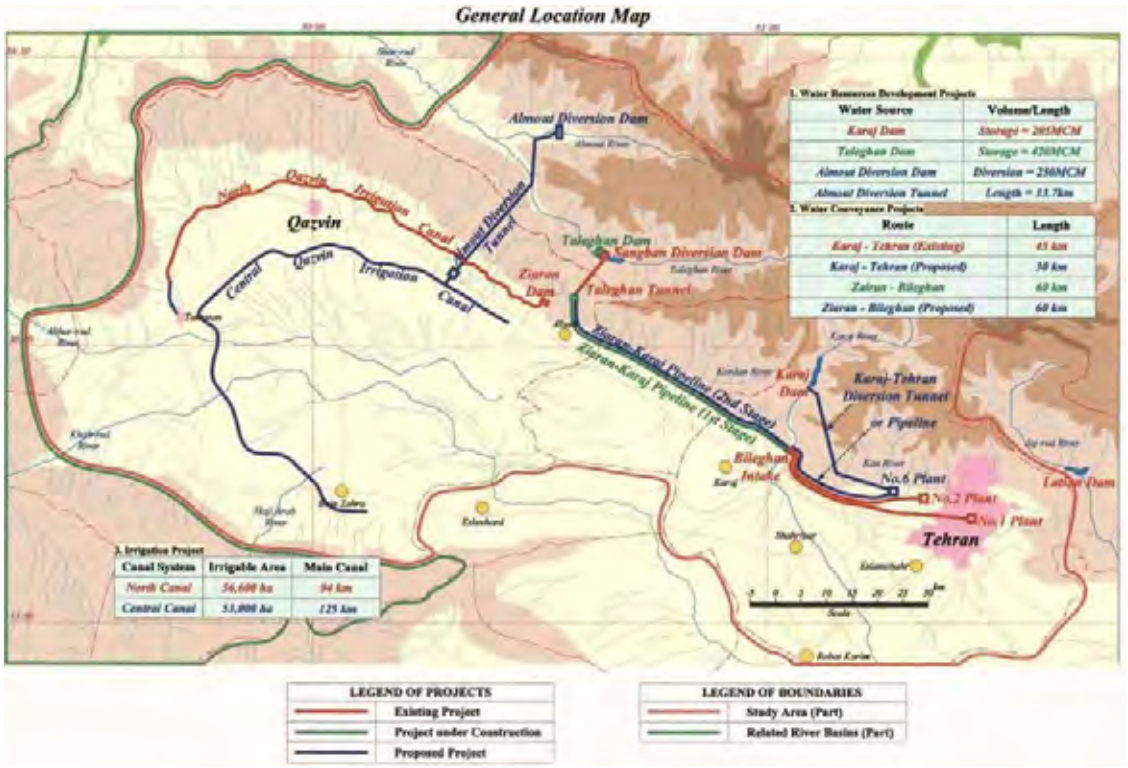


Figure R 5.1.4 Location Map of Qazvin Inter-Basin Transfer Project

When the Qazvin Inter-Basin Transfer Project is completed, the water distribution plan is changed as shown in Table R 5.1.8. With this project, the inflow to Manjil Dam will be reduced by 250MCM. This fact makes the conflict among three states, not only Qazvin and Teheran provinces but also the Gilan province which depends on the Manjil Dam as water source. In order to solve this problem, political determination will be required. In this study, the Qazvin Inter-basin Transfer Project is put in to the water balance simulation of long term target year (2031), and then the influence on the Manjil Dam is examined.

Table R 5.1.8 Water Distribution Plan for Qazvin Inter-Basin Transfer Project

(Unit: MCM)

Water Resources	Present (2006)		Long Term Target Year (2031)	
Taleghan Dam	Domestic	150	Domestic	310
	Agriculture	310	Agriculture	135
	Sub-total	460	Sub-total	445
Almout Weir	Agriculture	0	Agriculture	250
Total		460		695

Source: WRMC

Main facilities of the Qazvin Inter-Basin Transfer Project are shown in Table R 5.1.9.

Table R 5.1.9 Main Facilities of Qazvin Inter-basin Transfer Project

No.	Facilities	Item	Type or Dimension	Remarks
1	Almout Weir	Basin Area	475km2	
		Annual Inflow	250MCM	not include inflow of Andah-rud weir
		Type	Concrete Floating Type	
		Height	10m	
		Length	56m	
		Concrete Volume	40,000m3	
		Normal Water Surface	El 1,299m	
		Annual Water Supply	250MCM/年	include 40MCM from Andah-rud weir
		Design Flood	230m3/s	
2	Andah-rud Weir	Basin Area	112km2	
		Annual Inflow	60MCM	
		Height	5m	
		Length	20m	
3	Pipeline	Main	φ2,000mm x 3rows, L=6km	between Almout weir to tunnel inlet
		Basin Area	φ1,800mm x 1row, L=2.5km	between Andah-rud weir to main pipeline
4	Tunnel	Tunnel Section	Circle and Standard Horse Shoe Types	
		Internal Diameter	3.9-4.4m	
		Length	33.8km	
		Max. Design Capacity	22.5m3/s	
		Water Level at Downstream End	EL 1,250m	
		Regulating Pond	Concrete lined pond : 2 places	

Source: The Study Report on Water Management in the Western Area of Capital Tehran by JICA

5.2 WATER RESOURCES POTENTIAL

5.2.1 Surface Water

The potential of surface water is obtained from rainfalls. The annual average precipitation from 1985 to 2005 is 346 mm which consists of evaporation of 229 mm, ground water recharge of 32 mm and the surface water potential of 85 mm. Converting the surface water potential into volume in the Sefidrud basin, it is about 5 billion m^3/year.

5.2.2 Groundwater

The water resources potential of groundwater was estimated at about 1.9 billion m^3/year.

Table R 5.2.1 The Potential and the Water Balance of Groundwater

Zone	Sub-Zone	Area (km^2)	Groundwater Sub-basin Code	Province	Annual Precipitation *1 (mm/y)	Annual Evaporation (mm/y)	Groundwater Recharge (MCM/y)	Pumping Discharge*2 (MCM/y)	Water Balance (MCM/y)	Remarks
A	A-1	6,445.5	1308	Kordestan	285	195	220.16	402.18	-182.03	*3
	A-2	5,072.9	1309	Kordestan	339	206	319.11	48.94	270.17	
	A-3	6,004.0	1307	Kordestan	251	177	162.75	169.76	-7.01	
	小計	17,522.4	-		289	192	702.01	620.88	81.13	
B	B-1	1,817.6	1305	Zanjan	262	194	35.25	107.09	56.25	
	B-2	2,395.4	1306	Zanjan	324	221	38.57	178.93	-140.36	*3
	B-3	4,590.6	1304	Zanjan	324	228	72.89	332.55	-259.66	*3
	B-4	6,527.1	1305	Zanjan	268	196	128.08	—	—	
	B-5	1,628.5	1303	East Azarbaijan	399	237	42.22	205.50	-4.76	?
	B-6	3,540.0		East Azarbaijan	409	223	98.65			
	B-7	2,145.1		East Azarbaijan	334	213	59.88			
	小計	22,644.3			323	214	475.53	824.07	-348.54	
C	C-1	1,761.2	1302	Ardabil	378	247	29.38	287.01	-144.65	?
	C-2	1,679.3		Ardabil	522	371	39.10			
	C-3	5,020.6		Ardabil	293	226	73.88			
	C-4	2,763.3	1311	Gilan (Upper reach of the Dam)	259	222	8.92	27.28	-18.36	
	小計	11,224.4			332	250	151.28	314.29	-163.01	
D	D-1	942.8	1310	Qazvin, Tehran (Taleghan River)	617	422	62.75	31.97	286.84	?
	D-2	3,909.3			409	252	256.06			
	小計	4,852.1			449	285	318.81	31.97	286.84	
E	E-1	1,042.6	1301	Gilan (Caspian sea side)	1,105	486	136.36			?
	E-2	1,805.0		Gilan (Lower reach of the Dam)	554	358	77.83	76.07	1.76	
	Subtotal	2,847.6			756	405	214.19	76.07	138.12	
Total		59,090.8			346	229	1861.82	1,867.28	-5.46	

Note) *1: twenty years from 1985 to 2005, WRMC Report 2006 *2 WRMC monitoring report, *3 Groundwater table lowering area (1996-2002) from WRMC, ?: Details are unknown.

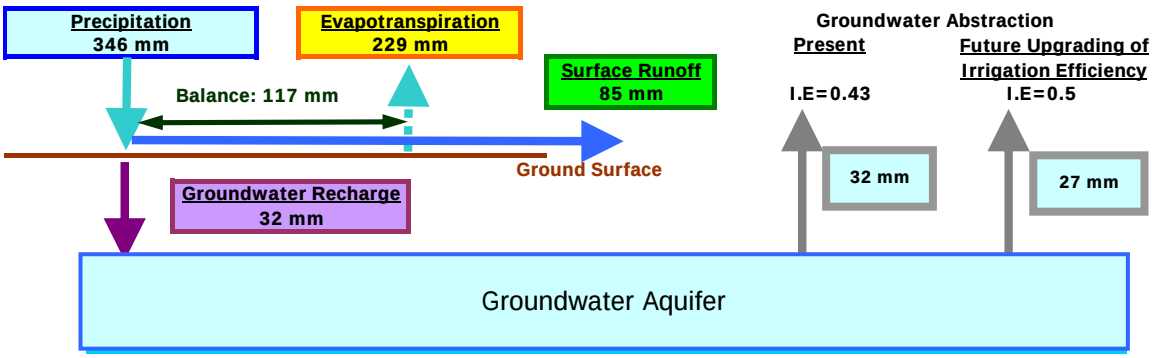
5.2.3 Water Resources Potential

The water resources potential was computed through water balance simulation with MIKE-SHE. The result is summarized below.

Table R 5.2.2 Water Resources Potential

Annual Precipitation	Evapotranspiration	Water Resources Potential		
		Surface Runoff	Groundwater Recharge	Total
346 mm (= 20.4 billion m^3)	229 mm (= 13.5 billion m^3)	85 mm (= 5.0 billion m^3)	32 mm (= 1.9 billion m^3)	117mm (= 6.9 billion m^3)

Note: Data from 1985 to 2005



Present: Deficit (water table lowering) may occur in 7 Aquifers out of 11 ones.
Future: Deficit (water table lowering) may occur in 5 Aquifers out of 11 ones.

Basic Direction: To conserve the groundwater aquifers over the basin through conversion of water source

Figure R 5.2.1 Water Balance and Water Resources Potential

CHAPTER 6. WATER DEMAND

6.1 PROJECTION OF SOCIO-ECONOMIC FRAMEWORK TO THE TARGET YEAR

6.1.1 Target Year of Development

Target years of the development in this study are as follows that those are discussed with the party of the counterpart organization of Iran.

(i) Target year for medium term for development: 2016 (1395 in Iranian Calendar)

(ii) Target year of long development term: 2031 (1410 in Iranian Calendar).

6.1.2 Projection of Socio-Economic Framework to the Target Year

Project of socio-economic framework are made as mentioned hereunder based on past trend of several socio-economic indices, taking "the 4th Five Year Development Plan" and "Long-Term Development Strategies for Iran's Water Resources" into account, as well as taking a result of discussion with WRMC into consideration.

1) Population in Target Areas

Population in target areas are projected as shown in the Table R 6.1.1 based on the past trend of population in target areas.

Table R 6.1.1 Population Growth in Target Areas

Areas	Present (2006/1385)	At the Year of Medium Development Term (2016/1395)	At the Year of Long Development Term (2031/1410)
Population in Urban Areas	1,959,778	2,339,086	3,016,174
Annual Average Growth Rate		(1.79～1.78 %)	(1.74～1.67 %)
Population in Rural Areas	2,767,549	3,384,897	4,560,110
Annual Average Growth Rate		(2.04～2.02 %)	(2.01～1.99 %)
Total	4,727,327	5,723,983	7,576,284
Annual Average Growth Rate		(1.94～1.92 %)	(1.90～1.83 %)

2) Gross Domestic Products (GDP) and Gross Regional Domestic Products (GRDP)

According to statistics, annual average growth rates of GDP in Iran in recent year are 4.47% during the period from 1991 to 1996, 3.61% from 1996 to 2001, and 6.97% from 2001 to 2005 by 1997-constant price, namely, the actual growth rate). On the other hand, the rate of 8% has been set in 2009 in the 4th Five Year Development as a numerical target.

The basis of the 4th Five Year Development Plan is a socio-economic status in 2004, and the actual annual growth rate in this year against that in previous year is 8.03%, so that the said numerical target may be reflected the said actual growth in that year. However, it may not be expected that this numerical target will be continued to the target year of the medium development term of 2016, or to the target year of the long development term of 2031. Because of this, the growth rate against previous year at the time of 2031 in case of long development term in average is assumed at (1) 7 % in case of most optimistic case conservatively, (2) 5 % in case of medium case, and (3) 3 % in most pessimistic case.

Assuming that the growth rate against previous year at the target year of medium development term is that of intermediate growth between the said numerical target of growth and that of long development term of those for the long development term, they are assumed at (1) 7.5 % in case of most optimistic case conservatively, (2) 6.5 % in case of medium case, and (3)

5.5 % in most pessimistic case. Following figure shows a growth pattern to each target year of GDP in each case based on the said assumption in whole Iran.

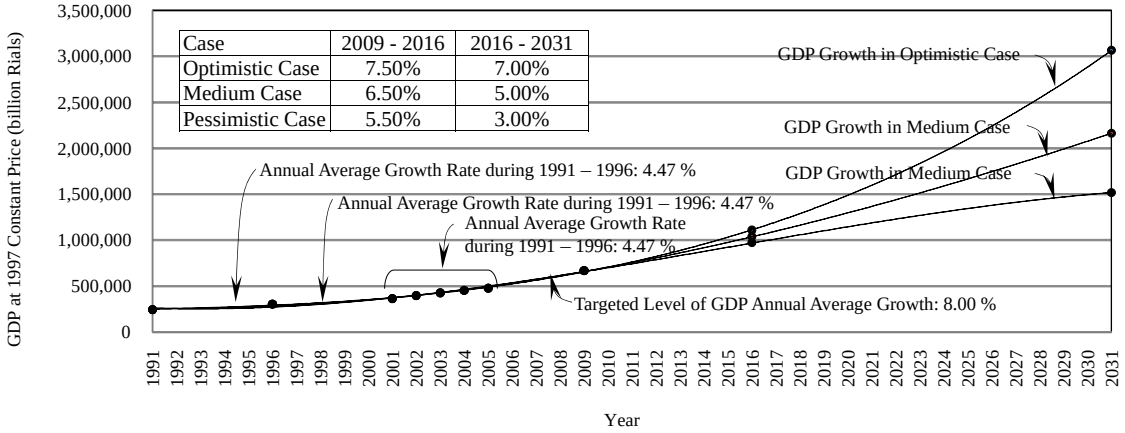


Figure R 6.1.1 Growth Pattern of GDP to Target Years in Whole Iran

On the other hand, GRDP in target 8 provinces have been fluctuated in recent years as shown in the following table.

Table R 6.1.2 GRDP in Target 8 Provinces in Recent Years

(billion Rials)

	2001	2002	2003
GRDP at Market Price in Total	287,494	376,899	454,551
East Azarbaijan	30,287	39,378	45,691
Ardebil	7,884	10,246	13,315
Tehran	193,374	255,350	309,426
Zanjan	6,315	8,279	10,532
Qazvin	12,339	14,216	17,261
Kordestan	7,203	9,853	12,118
Gilan	18,548	23,778	28,078
Hamedan	11,543	15,800	18,131
Conversion Rate	1.84051	2.03624	2.44698
GRDP at 1997 Constant Price	156,203	185,095	185,760

Sources: Statistics of each Province.

Strictly speaking, the growth pattern of GRDP must be different with GDP in the whole Iran because of reflecting the economic activities in each province itself medium development term and of long development term. However, it is assumed to trace the same growth pattern of GDP.

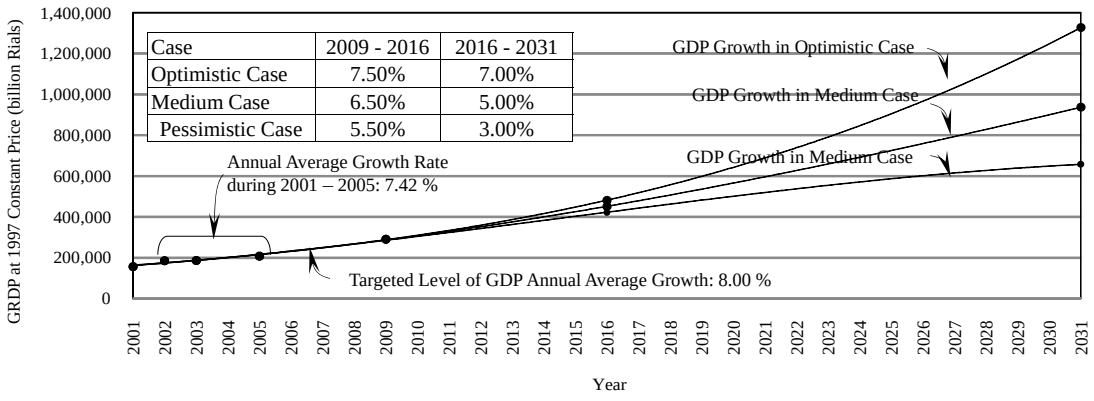


Figure R 6.1.2 Growth Pattern of GRDP to Target Years in Target 8 Provinces

3) Growth of GRDP in Industrial Sector

In the case that a share rate of the GRDP of the industrial sector consisting of "Mining", "Manufacturing", and "Construction" increase to the GRDP in total, it means that the economic activities in this sector would be activated. Following table shows a fluctuation of the share rate in this sector.

Table R 6.1.3 Fluctuation of Share Rate of Industrial Sector to GRDP in Total

(billion Rials)

	GRDP in Industrial Sector			Share Rate to Total GRDP		
	2001	2002	2003	2001	2002	2003
GRDP at Market Price in Total	67,439	83,440	103,290	23.46%	22.14%	22.72%
Detail:						
East Azarbaijan	7,994	10,374	12,718	26.39%	26.35%	27.83%
Ardebil	992	1,479	2,205	12.58%	14.43%	16.56%
Tehran	45,421	56,095	69,184	23.49%	21.97%	22.36%
Zanjan	1,758	2,074	2,905	27.83%	25.04%	27.58%
Qazvin	4,868	5,078	6,209	39.45%	35.72%	35.97%
Kordestan	928	1,408	1,531	12.88%	14.29%	12.63%
Gilan	3,668	4,358	5,408	19.78%	18.33%	19.26%
Hamedan	1,810	2,574	3,130	15.68%	16.29%	17.27%
Conversion Rate	1.84051	2.03624	2.44698			
GRDP at 1997 Constant Price	36,641	40,977	42,211			

Sources: Statistics of each Province

The share rates of industrial sector in target provinces fluctuated ranging from 22 – 23% as shown in the above table. However, it shows that the share rate has strictly been fallen 0.74% from 23.46% in 2001 to 22.72% in 2003. On the other hand, from the viewpoint of the whole Iran, in case of counting backward using the share rate by industrial origin as shown in Table R 2.1.10 in sub clause of 2.1.6 "Value Added and Gross Domestic Product (GDP)" in Chapter 2 of this report, those are high rates as 37.71% in 2001, 36.42% in 2002, 37.39% in 2003, 37.19% in 2004, and 40.17% in 2005.

In the target provinces, they have no any oil resources, so that the share rate in these provinces cannot be reached to that in Khuzestan Province which it has a oil resources. Nevertheless, the share rate in Qazvin Province as one of the target provinces are approaching the level ranging from 36% to 40%. In the country, they have almost of mineral resources except diamond in general speaking. From this viewpoint, it may be expected to promote industrial local development for the future.

On the other hand, as shown in Tables from Table R 2.2.1 to Table R 2.2.4 in sub-clause of 2.2 "National and Regional Development Plans" in Chapter 2, the Government has set a numerical target as 12.2% for investment growth in the said 4th Five Development Plan. It means to show the will of the Government for making to develop the industrial sector for the future. Of course, it should be included the other sectors as agricultural sector, but it must be highly shared to invest to the industrial sector consisting of mining, manufacturing and construction.

Accordingly, it is assumed that the share rates of industrial sector to the total GRDP in 2031 as the target time of long development term will be (1) 40 % in the most optimistic case, (2) 34 % in medium case, and (3) 31 % in the most pessimistic case. And, it is assumed that those will become at (1) 35 % in the most optimistic case, (2) 31 % in medium case, and (3) 29 % in the most pessimistic case at the target time of the medium development term. In other words, as a result of the growth rates of industrial sector in target provinces as (1) 2.71%, (2) 1.86%, (3) 1.34% at the target time of the long development term, and (1) 3.13%, (2) 2.06%, (3) 1.82% at the target time in the medium development term. Following table show a summary of these projections.

Table R 6.1.4 Projection of Growth in Industrial Sector in Target Provinces

Description	2001	2002	2003	2005	2009	2016	2031
Share Rate							
Optimistic Case	23.46%	22.14%	22.72%	25.00%	30.00%	35.00%	40.00%
Medium Case	23.46%	22.14%	22.72%	24.50%	28.00%	31.00%	34.00%
Pessimistic Case	23.46%	22.14%	22.72%	24.00%	26.50%	29.00%	31.00%
Annual Average Growth Rate							
Optimistic Case				1.61%	4.66%	3.13%	2.71%
Medium Case				1.09%	3.39%	2.06%	1.86%
Pessimistic Case				0.57%	2.51%	1.82%	1.34%

Here in the above table, the share rates in 2005 are assumed rather conservatively because that the time is just starting year of the said 4th Five Year Development Plan. However, those in 2009 as the ending year of the said Plan are assumed rather greater than those in 2005 because that the measure of the Government would take some effect.

4) Growth of GRDP in Agricultural Sector

As same as the case for the industrial sector, in the case that a share rate of the GRDP of the agricultural sector consisting of "Agriculture", "Hunting", "Forest", and "Fishery" increase to the GRDP in total, it means that the economic activities in this sector would be activated. Following table shows a fluctuation of the share rate in this sector.

Table R 6.1.5 Fluctuation of Share Rate of Agricultural Sector to GRDP in Total

(billion Rials)

GRDP in Agricultural Sector				Share Rate to Total GRDP		
	2001	2002	2003	2001	2002	2003
GRDP at Market Price in Total	21,682	29,286	34,136	7.54%	7.77%	7.51%
- ditto - (excl. Tehran)	17,607	23,170	27,689	18.71%	19.06%	19.08%
Detail:						
East Azarbaijan	4,417	5,673	6,249	14.58%	14.41%	13.68%
Ardebil	2,282	3,019	3,992	28.95%	29.46%	29.98%
Tehran	4,075	6,117	6,448	2.11%	2.40%	2.08%
Zanjan	1,374	1,942	2,565	21.76%	23.45%	24.36%
Qazvin	2,238	2,555	2,973	18.13%	17.97%	17.22%
Kordestan	1,118	1,573	2,169	15.52%	15.97%	17.90%
Gilan	3,058	4,484	4,811	16.49%	18.86%	17.14%
Hamedan	3,120	3,924	4,930	27.03%	24.84%	27.19%
Conversion Rate	1.84051	2.03624	2.44698			
GRDP at 1997 Constant Price	11,781	14,383	13,950			

Sources: Statistics of each Province.

The share rates of agricultural sector in target provinces are remaining on the same level ranging only from 7.5 – 7.8% as shown in the above table. However, in the case of only watching those in Tehran Provision which has overwhelming share rates of "Transportation and Communication Sector", "Commercial Sector", "Public Services Sector", the share rate of Agricultural Sector in Tehran is only reached by only a level of 2 %, and it is obviously the share rate of Tehran Province put a stop to the share rate of agricultural sector in the target 8 provinces to GRDP as a whole. Here, in case of trying to except Tehran Province, the share rates of other 7 provinces are changing at a level of around 19 % as shown in the second column of the above table.

On the other hand, from the viewpoint of the whole Iran, in case of counting backward using the share rate by industrial origin as shown in Table R 2.1.10 in sub clause of 2.1.6 "Value Added and Gross Domestic Product (GDP)" in of this report, those are slightly higher rate of

10 % as 11.75% in 2001, 11.15% in 2002, 11.06% in 2003, 11.00% in 2004, and 10.24% in 2005. Comparing with these figures, the share rates of 7 provinces excepting Tehran Province shows almost 2 times of GDP in Iran as a whole.

The area of 7 provinces except Tehran Province from target 8 provinces in total is on of the important farm belt to rank with Mazandaran Province and Gorestan Province in Iran in where dry land has shared at almost 80 % of the whole territory of the nation. Paddy is a strategic crops in Gilan Province, the main cash crops are wheat in Ardebil Province together with potatoes, animal husbandry with pasture as alfalfa, and apiculture (= large scale beekeeping), and the share rates of both the provinces show high ones to GRDP in total. Between the two, the share rate of agricultural sector in Ardebil Province shows to reach to the level of 30 % to GRDP in total in 2003. It means that all the target provinces have potentialities to develop the agricultural sector in case of realization of suitable water distribution in the future.

Accompanying with the development of the agricultural sector, "Transportation and Communication Sector" which includes warehousing business and "Trading Sector" which includes marketing activities may also be activated. Therefore, only the share rate of agricultural sector will not be developed without limitation. However, it may be expected that the share rate of agricultural sector will be grown by around 35 % to the GRDP in total. Also it is expected some results of the measures of the Government showing the numerical target of the investment growth in 4th Five Year Development Plan. Following table shows a projection of growth of agricultural sector in target provinces as a whole.

Table R 6.1.6 Projection of Growth in Agricultural Sector in Target Provinces

Description	2001	2002	2003	2005	2009	2016	2031
Share Rate							
Optimistic Case	18.71%	19.06%	19.08%	20.00%	25.00%	31.00%	35.00%
Medium Case	18.71%	19.06%	19.08%	20.00%	25.00%	28.00%	31.00%
Pessimistic Case	18.71%	19.06%	19.08%	20.00%	25.00%	27.00%	29.00%
Annual Average Growth Rate							
Optimistic Case				1.68%	5.74%	4.40%	2.46%
Medium Case				1.68%	5.74%	2.29%	2.06%
Pessimistic Case				1.68%	5.74%	1.55%	1.44%

Here, the share rate in 2005 is set at 20 % assuming that it should be on the extension of the past trend line. And, the share rate in 2009 is set assuming some results of the Government following the numerical target in 4th Five Year Development Plan.

5) Improvement of Loss of Water Distribution and Improvement of Irrigation Efficiency

The growth of industrial sector and agricultural sector are greatly depending upon the suitable water distribution. Furthermore, it is also depending upon effective water utilization.

According to the survey made by WRMC, the loss of distribution of domestic and industrial water is 30 %. The rates of irrigation efficiency are at 33 % in traditional irrigation system, and from 50 to 76 % in modernized irrigation systems. Considering the large effect of the rate of irrigation efficiency in the traditional irrigation area and the large project cost required for the development project, the improvement of the rate of irrigation efficiency is considered as a parameter in the scenario in Chapter 9.

Table R 6.1.7 Projection of Improvement of Water Distribution

Item to Be Improved on Water Distribution and Irrigation Efficiency	At Present *: (2006)	Target Year 2016 in Medium Development Term	Target Year 2031 in Long Development Term
Improvement of Domestic and Industrial Water Distribution	0.30	0.30	0.25

Source: WRMC

According to the said survey report, the irrigation efficiency is currently at 0.34 in case of traditional irrigation system. However, it has been made clear that the rate should be at 0.43 for covering the existing irrigation water demand according to the study made by the JICA Study Team as indicated in the above table. And, improved irrigation efficiencies in the traditional irrigation system indicated in the above table is not in the case of keeping the traditional irrigation system, but in the case of assuming the improvement of it to be modernized.

6.1.3 Zoning

The analysis of the water demand in the target area was performed dividing the area into 5 Zones as shown in Table R 6.1.8.

Table R 6.1.8 Zones and Enclosed Reaches

Zone	Sub-zone	Area (km^2)	Reach								
A	A-1	6,445.5	R43	R44	R45	R47	R48	R50	R51	R52	R67
	A-2	5,072.9	R37	R40	R41	R42	R46	R65			
	A-3	6,004.0	R38	R39	R49	R66					
	Sub-total	17,522.4									
B	B-1	1,817.6	R34	R35	R64						
	B-2	2,395.4	R29	R30	R63						
	B-3	4,590.6	R20	R24	R27	R28	R31	R33			
	B-4	6,527.1	R17	R22	R26						
	B-5	1,628.5	R18								
	B-6	3,540.0	R08	R10	R60						
	B-7	2,145.1	R04	R05	R09						
	Sub-total	22,644.3									
C	C-1	1,761.2	R02	R06	R11						
	C-2	1,849.7	R01	R03	R07	R12	R13	R14	R59		
	C-3	4,850.4	R15	R16	R61						
	C-4	2,763.3	R21	R32							
	Sub-total	11,224.6									
D	D-1	942.8	R36								
	D-2	3,909.3	R25								
	Sub-total	4,852.1									
E	E-1	1,042.6	R53								
	E-2	1,805.0	R19	R23	R62						
	Sub-total	2,847.6									
Total		59,091.0									

Figure R 6.1.3 Target Area and Zoning

6.1.4 Irrigation Area

When the water demand was forecasted, the irrigation area was presumed by the following basic concepts.

(i) Based on the revision version of the Mahab Ghodss Study Report (November, 2008), the irrigation area of each Reach in upper basin of Manjil dam is estimated.

(ii) Based on the revision version of the Pandam Study Report the irrigation area of each Reach in Gilan province is estimated

(iii) The irrigation area was divided into the four beneficial areas as follows; 1) Reaches in the upper basin of Manjil dam, 2) Reaches in SIDN (R53, R54 and R55), 3) Reaches in the upper basin of SIDN (R56 and R57) and 4) Benefit area of the large-scaled dams/reservoirs

(iv) Based on the actual consumption water in the Mahab's revision version, the irrigation area by surface water and groundwater was distributed.

(v) In middle term target year's (2016) irrigation area, a development area of 14 dams under construction was considered.

(vi) In long term target year's (2031) irrigation area, the development area of the new 19 dams adopted for the master plan in addition to 13 dams under construction is considered.

(vii) The new irrigation development areas other than the dam development plan were assumed to be the one which not was.

When the irrigation area at the development target year is arranged based on the above-mentioned basic concepts, it is as shown in Table R 6.1.9.

Table R 6.1.9 Irrigation Area in Target Year

Target Year	Water Resources	Item	Irrigation Area in Zone (ha)					
			A	B	C	D	E	Total
Present (2006)	Surface Water	Reaches	11,991	74,393	31,909	1,209	8,253	127,755
		Reaches in Gilan	0	0	0	0	22,997	22,997
		SIDN	0	0	0	0	155,963	155,963
		from Dams	800	0	0	30,000	0	30,800
		Sub-total	12,791	74,393	31,909	31,209	187,213	337,515
	Groundwater	Reach	41,306	45,261	21,261	6,815	562	115,205
		Reach in Gilan	0	0	0	0	21,405	21,405
		Sub-total	41,306	45,261	21,261	6,815	21,967	136,610
	Total		54,097	119,654	53,170	38,024	209,180	474,125
Middle Term (2016)	Surface Water	Reaches	11,045	70,903	28,482	1,209	8,253	119,892
		Reaches in Gilan	0	0	0	0	22,997	22,997
		SIDN	0	0	0	0	155,963	155,963
		from Dams	56,900	23,190	32,227	30,000	0	142,317
		Sub-total	67,945	94,093	60,709	31,209	187,213	441,169
	Groundwater	Reach	41,306	45,261	21,261	6,815	562	115,205
		Reach in Gilan	0	0	0	0	21,405	21,405
		Sub-total	41,306	45,261	21,261	6,815	21,967	136,610
	Total		109,251	139,354	81,970	38,024	209,180	577,779
Long Term (2031)	Surface Water	Reaches	9,482	64,992	26,156	1,209	8,253	110,092
		Reaches in Gilan	0	0	0	0	22,997	22,997
		SIDN & Alamut	0	0	0	24,194	155,963	180,157
		from Dams	83,082	64,244	39,732	13,065	0	200,123
		Sub-total	92,564	129,236	65,888	38,468	187,213	513,369
	Groundwater	Reach	38,000	45,254	21,261	6,815	562	111,892
		Reach in Gilan	0	0	0	0	21,405	21,405
		Sub-total	38,000	45,254	21,261	6,815	21,967	133,297
	Total		130,564	174,490	87,149	45,283	209,180	646,666

6.2 WATER DEMAND

Based on the comment from RWC, the conference with the Iranian side, and the additional study in Gilan province, the calculation conditions has been changed. When the main change points are arranged as follows:

- As for basic conditions of the irrigation area and the irrigation efficiency, etc., data in Gilan province are based on the Pandam Study Report and data in other area are based on the Mahab Ghodss Study Report (revised version: November, 2008) offered from WRMC.
- It is over estimation than the realities though the net water requirement in the Mahab Ghodss revised version is calculated based on National Water Document. Therefore, the correction coefficient is set, and changes about Reach of which an excessive value has gone out. (Refer to Tables R 6.2.6-R 6.2.10.)
- The future irrigation efficiency is set as one of the parameters in the future scenarios. The lower figures are without improvement, and upper figures are based on the targets proposed by WRMC as shown in Table R 6.2.1.

Table R 6.2.1 Irrigation Efficiency in the Future

Area	Present (2006)	Mid-term Target Year (2016)	Long-term Target Year (2031)
SIDN area (Paddy field in Gilan)	42 %	42-45-48 %	42-51-55 %
Traditional Irrigation Area (Upper Basin of Manjil dam)	33 %	33-37-40 %	33-44-50 %

- The total distribution loss from water resource to beneficiaries in urban water supply with water treatment plant is assumed to be 48%. The total distribution loss in water supply from groundwater is assumed to be 35%.
- The unit water consumption in urban water supply in the table below was adopted for adjustment the difference among provinces.

Table R 6.2.2 Unit Water Consumption in Urban Water Supply

Population in Target City	Unit Water Consumption (lpdc)		
	Present (2006)	Middle Term Target Year (2016)	Long Term Target Year (2031)
Over 300,000	230	245	260
50,000～300,000	200	215	230
Under 50,000	175	188	200

- The future population based on census is adopted about the population forecast in 1998's census though there was a comment that it is necessary to calculate based on 2006's census because data concerning the population in local cities and its population growth rate in 2006's census was not obtained though it claimed to WRMC.
- The water resources for urban water supply in local cities changed to groundwater from surface water though assumed all to be surface water in Interim Report.
- The water resource for rural water supply and industrial water was made groundwater as well as Interim Report, and the total water supply loss corrected to 35% from 30%.
- Additionally, there is a correction request from each RWC, and the one accepted as JICA Study Team is reflected.

Based on the above-mentioned calculation condition, the water demand in present, middle term target year, and long term target year's three cases was examined. It is considered that 14 dams on under construction are completed in middle term target year, and 19 dams and Qazvin inter-basin transfer project are completed in long term target year. The summary of calculation result is as shown in Table R 6.2.3 and Figure R 6.2.1. In this projection, the future irrigation efficiency proposed by WRMC is employed for projection of agricultural water demand.

Table R 6.2.3 Summary of Water Demand Prediction

Target Year	Irrigation Area (ha)	Target Irrigation Efficiency by WRMC (%)	Water Demand (MCM)			
			Irrigation	Domestic	Industry	Total
Present (2006)	474,100	33.4	7,074	609	43	7,726
			91.6%	7.9%	0.6%	100.0%
Middle Term (2016 年)	577,800	40.0	7,068	859	121	8,048
			90.1%	11.0%	1.5%	102.6%
Long Term (2031 年)	646,700	50.0	6,714	1,268	204	8,186
			83.9%	15.8%	2.5%	102.3%

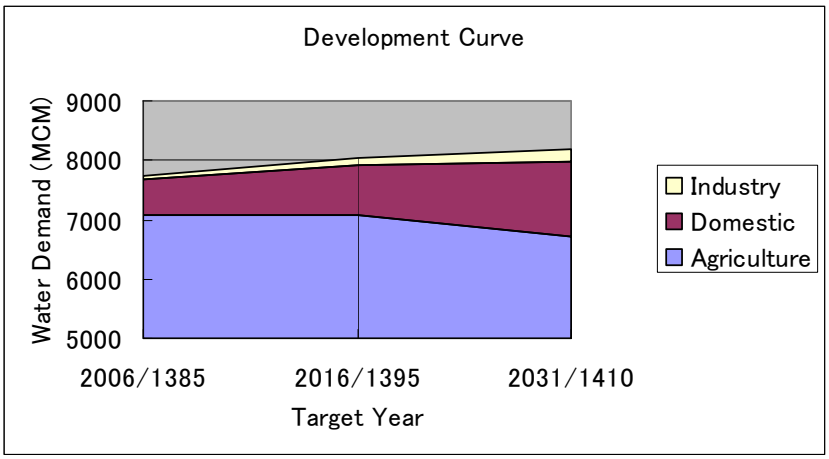


Figure R 6.2.1 Development Curve

The agricultural water demand decreases from 7,074 MCM/year to 6,532 MCM/year according to the effect of the improvement of the irrigation efficiency though irrigation area increases to 646,000ha in long-term target year from 474,000 ha in present conditions. The ratio occupied agricultural water demand to the total water demand becomes from 91.6 to 81.6%, and achieves one of targets of the Long-term Water Development Strategy of Ministry of Energy. The long-term domestic water demand increases to about twice as much as the present conditions and the long-term industrial water demand increases to about five times as much as the present conditions.

The water demand is arranged according to the water resources and the zone in Table R 6.2.4.

Table R 6.2.4 Water Demand Prediction by Water Resources and Zone

(Unit: MCM)

Target Year	Water Resources	Item	Zone					Total
			A	B	C	D	E	
Present (2006)	Surface Water	Agriculture	235	1,322	460	333	2,482	4,832
		Domestic	0	55	14	150	125	344
		Industry	0	0	0	0	0	0
		Sub-total	235	1,377	474	483	2,607	5,176
	Groundwater	Agriculture	777	772	302	125	266	2,242
		Domestic	56	48	22	4	135	265
		Industry	7	17	9	4	6	43
		Sub-total	840	837	333	133	407	2,550
	Total	Agriculture	1,012	2,094	762	458	2,748	7,074
		Domestic	56	103	36	154	260	609
		Industry	7	17	9	4	6	43
		Sub-total	1,074	2,214	807	616	3,014	7,726
Middle Term (2016)	Surface Water	Agriculture	628	1,152	689	328	2,372	5,169
		Domestic	95	70	18	150	165	498
		Industry	0	0	0	0	0	0
		Sub-total	723	1,222	707	478	2,537	5,667
	Groundwater	Agriculture	708	605	254	100	232	1,899
		Domestic	82	70	31	5	173	361
		Industry	24	57	17	14	9	121
		Sub-total	814	732	302	119	414	2,381
	Total	Agriculture	1,336	1,757	943	428	2,604	7,068
		Domestic	177	140	49	155	338	859
		Industry	24	57	17	14	9	121
		Sub-total	1,537	1,954	1,009	597	2,951	8,048
Long Term (2031)	Surface Water	Agriculture	790	1,289	687	400	2,060	5,226
		Domestic	95	80	25	310	321	831
		Industry	0	0	0	0	0	0
		Sub-total	885	1,369	712	710	2,381	6,057
	Groundwater	Agriculture	519	484	203	80	202	1,488
		Domestic	125	103	36	8	237	509
		Industry	42	108	24	18	12	204
		Sub-total	686	695	263	106	451	2,201
	Total	Agriculture	1,309	1,773	890	480	2,262	6,714
		Domestic	220	183	61	318	558	1,340
		Industry	42	108	24	18	12	204
		Sub-total	1,571	2,064	975	816	2,832	8,258

6.2.1 Water Demand for Agricultural Water

The demand for the agricultural water in traditional irrigation is forecasted on the presupposition that the present irrigation efficiency (33%) will be improved to 40% on the middle term target year 2016 as well as 50% on the long term target year 2031. The forecasted demands by zones and water sources are aggregated as shown in Table R 6.2.5 and Table R 6.2.6 respectively.

Table R 6.2.5 Agricultural Water Demand in Zone

(million m^3)

Zone	Present (2006)	Middle Term (2016)	Long Term (2031)
A	1,012	1,336	1,309
B	2,095	1,757	1,773
C	762	943	890
D	457	428	480
E	2,748	2,604	2,262
Total	7,074	7,068	6,714

Table R 6.2.6 Agricultural Water Demand by Water Resources in Zone

Target Year	Water Resources	Item	Irrigation Area in Zone (1000m3)					
			A	B	C	D	E	Total
Present (2006)	Surface Water	Reaches	228,050	1,322,471	460,356	22,544	164,963	2,198,384
		Reaches in Gilan	0	0	0	0	298,146	298,146
		SIDN	0	0	0	0	2,019,037	2,019,037
		from Dams	6,586	0	0	310,000	0	316,586
		Sub-total	234,636	1,322,471	460,356	332,544	2,482,146	4,832,153
	Groundwater	Reach	776,886	772,423	302,098	124,578	11,190	1,987,175
		Reach in Gilan	0	0	0	0	254,980	254,980
		Sub-total	776,886	772,423	302,098	124,578	266,170	2,242,155
	Total		1,011,522	2,094,894	762,454	457,122	2,748,316	7,074,308
Middle Term (2016)	Surface Water	Reaches	195,624	1,001,627	346,019	18,312	136,211	1,697,793
		Reaches in Gilan	0	0	0	0	260,878	260,878
		SIDN	0	0	0	0	1,974,980	1,974,980
		from Dams	432,653	149,776	343,338	310,000	0	1,235,767
		Sub-total	628,277	1,151,403	689,357	328,312	2,372,069	5,169,418
	Groundwater	Reach	707,592	605,234	253,755	100,035	9,245	1,675,861
		Reach in Gilan	0	0	0	0	223,107	223,107
		Sub-total	707,592	605,234	253,755	100,035	232,352	1,898,968
	Total		1,335,869	1,756,637	943,112	428,347	2,604,421	7,068,386
Long Term (2031)	Surface Water	Reaches	134,196	732,193	257,002	14,648	108,967	1,247,006
		Reaches in Gilan	0	0	0	0	227,675	227,675
		SIDN & Alamut	0	0	0	250,045	1,723,619	1,973,664
		from Dams	655,638	557,155	429,650	135,005	0	1,777,448
		Sub-total	789,834	1,289,348	686,652	399,698	2,060,261	5,225,793
	Groundwater	Reach	518,985	484,098	203,004	80,025	7,395	1,293,507
		Reach in Gilan	0	0	0	0	194,712	194,712
		Sub-total	518,985	484,098	203,004	80,025	202,107	1,488,219
	Total		1,308,819	1,773,446	889,656	479,723	2,262,368	6,714,012

When the detailed various calculation tables for the agricultural water demand in Reaches are arranged for the simulation input as shown in Table R 6.2.7.

Table R 6.2.7 Table Directory for Agricultural Water Balance Simulation

No.	Target Year	Description	Irrigation Efficiency	Water Resources		Table Number
				Surface Water	Groundwater	
1	Present (2006)	Water Demand by Reach	0.33	●		R 6.2.8
2		Water Demand by Reach	0.33		●	R 6.2.11
3		Water Demand in Gilan	0.42	●		R 6.2.14
4		Water Demand in Gilan	0.42		●	R 6.2.17
5		Water demand from Weirs*	0.42	●		R 6.2.20
6		Water demand from Dams	0.60	●		R 6.2.23
7	Middle Term (2016)	Water Demand by Reach	0.40	●		R 6.2.9
8		Water Demand by Reach	0.40		●	R 6.2.12
9		Water Demand in Gilan	0.48	●		R 6.2.15
10		Water Demand in Gilan	0.48		●	R 6.2.18
11		Water demand from Weirs*	0.48	●		R 6.2.21
12		Water demand from Dams	0.60	●		R 6.2.24
13	Long Term (2031)	Water Demand by Reach	0.50	●		R 6.2.10
14		Water Demand by Reach	0.50		●	R 6.2.13
15		Water Demand in Gilan	0.55	●		R 6.2.16
16		Water Demand in Gilan	0.55		●	R 6.2.19
17		Water demand from Weirs*	0.55	●		R 6.2.22
18		Water demand from Dams	0.60	●		R 6.2.25

*: Weirs: Tarik, Galerud and Sangar

Table R 6.2.8 Present Irrigation Demand from Surface Water by Reach (2006)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m^3)												Total	Unit Requirement (m^3/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.		
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	340	1.00	294	213	0	0	0	0	315	603	974	896	839	629	4,763	13,993
2	2	2,040	1.00	2,056	310	0	0	0	0	753	2,764	6,348	7,608	7,448	5,178	32,465	15,911
3	3	1,732	1.00	1,059	1,087	0	0	0	0	1,573	2,890	4,954	4,540	4,096	2,550	22,749	13,134
4	4	1,871	0.85	2,503	343	0	0	0	0	1,536	3,853	6,889	7,502	7,416	4,645	34,687	18,544
5	5	8,421	0.90	9,148	1,231	0	0	0	0	6,998	18,714	29,976	35,988	35,442	16,483	153,980	18,286
6	6	2,429	1.00	1,182	1,085	0	0	0	0	1,441	3,731	6,877	7,718	7,201	3,881	33,116	13,635
7	7	97	1.00	109	20	0	0	0	0	56	143	305	362	353	253	1,601	16,567
8	8	0	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	19,049
9	9	2,293	0.94	2,768	376	0	0	0	0	2,726	5,805	9,052	9,194	7,904	3,591	41,416	18,058
10	10	4,452	0.76	6,417	1,411	0	0	0	0	3,800	8,435	15,026	18,895	19,050	12,986	86,020	19,323
11	11	3,941	0.98	3,175	1,462	0	0	0	0	3,866	7,592	15,057	14,443	13,504	7,805	66,904	16,974
12	12	350	1.00	396	96	0	0	0	0	234	542	1,085	1,263	1,230	896	5,742	16,388
13	13	209	0.95	279	62	0	0	0	0	172	349	694	819	801	598	3,774	18,095
14	14	96	1.00	105	41	0	0	0	0	82	160	288	310	298	221	1,505	15,704
15	15	17	1.00	9	4	0	0	0	0	10	26	55	70	58	28	260	15,158
16	16	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	6,263
17	17	10,229	0.88	14,980	3,743	0	0	0	0	13,948	26,022	41,032	34,170	31,259	23,620	188,774	18,456
18	18	4,816	0.89	7,938	1,416	0	0	0	0	6,542	12,753	18,862	15,599	14,785	9,747	87,642	18,198
19	20	8,123	1.00	12,317	1,770	0	0	0	0	10,910	15,210	28,836	22,965	18,218	12,804	123,030	15,146
20	21	4,880	1.00	3,796	1,919	0	0	0	0	2,823	5,492	11,514	12,183	11,363	7,985	57,075	11,697
21	22	2,396	0.99	3,461	1,118	0	0	0	0	3,492	6,490	8,601	6,713	6,112	4,824	40,811	17,035
22	24	784	1.00	1,336	243	0	0	0	0	1,024	1,391	2,713	2,239	2,085	1,576	12,607	16,075
23	25	458	0.96	532	35	0	0	0	0	495	834	1,897	1,885	1,549	1,060	8,287	18,080
24	26	1,850	0.87	1,846	601	0	0	0	0	1,556	4,436	6,169	7,452	7,324	4,570	33,954	18,354
25	27	8,304	1.00	12,421	2,085	0	0	0	0	11,749	13,469	30,536	28,458	21,602	14,096	134,416	16,188
26	28	303	0.98	415	114	0	0	0	0	248	357	940	1,140	1,102	829	5,145	16,980
27	29	540	0.91	945	85	0	0	0	0	529	1,166	1,993	1,889	1,754	1,385	9,746	18,041
28	30	4,433	0.92	7,420	668	0	0	0	0	4,099	9,449	16,035	15,905	15,419	11,646	80,641	18,191
29	31	836	1.00	1,354	261	0	0	0	0	1,090	1,527	2,776	2,456	2,282	1,659	13,405	16,028
30	32	81	1.00	63	56	0	0	0	0	81	146	220	165	121	96	948	11,704
31	33	572	0.97	873	218	0	0	0	0	558	800	1,938	2,131	2,076	1,564	10,158	17,771
32	34	763	0.66	1,242	533	0	0	0	0	906	1,796	2,688	2,901	2,816	2,345	15,227	19,966
33	35	607	0.73	967	362	0	0	0	0	902	1,739	2,335	2,056	1,971	1,528	11,860	19,526
34	36	751	0.78	1,047	137	0	0	0	0	437	1,070	2,814	3,216	3,062	2,474	14,257	18,973
35	37	975	0.72	1,556	646	0	0	0	0	1,292	2,481	3,496	3,436	3,260	2,721	18,888	19,363
36	38	318	0.82	530	132	0	0	0	0	422	637	1,173	1,191	1,120	808	6,013	18,900
37	39	7	0.89	3	1	0	0	0	0	4	9	29	43	34	15	138	18,700
38	40	852	0.74	1,382	554	0	0	0	0	1,224	2,314	3,145	2,839	2,653	2,226	16,337	19,174
39	41	1,152	0.72	1,907	807	0	0	0	0	1,666	3,066	4,133	3,875	3,663	3,077	22,194	19,263
40	42	564	0.69	900	382	0	0	0	0	729	1,379	1,945	1,954	1,864	1,556	10,709	18,971
41	43	192	0.70	351	131	0	0	0	0	264	498	673	621	615	505	3,658	19,021
42	44	1,085	0.75	1,917	683	0	0	0	0	1,454	2,833	3,923	3,658	3,625	2,933	21,026	19,380
43	45	32	0.84	53	15	0	0	0	0	50	97	125	97	93	64	594	18,575
44	46	58	0.77	98	38	0	0	0	0	95	172	224	181	165	140	1,113	19,177
45	47	3,921	0.81	6,619	1,746	0	0	0	0	5,892	11,751	14,996	12,258	11,783	8,999	74,044	18,886
46	48	1,234	0.86	2,033	469	0	0	0	0	1,920	3,808	4,972	3,599	3,335	2,499	22,635	18,349
47	49	0	0.85	0	0	0	0	0	0	0	0	0	0	0	0	0	18,543
48	50	615	0.79	1,070	320	0	0	0	0	928	1,789	2,331	1,958	1,893	1,472	11,761	19,110
49	51	175	0.77	305	106	0	0	0	0	261	493	675	599	544	400	3,383	19,357
50	52	234	0.83	421	115	0	0	0	0	378	717	912	709	681	523	4,456	19,076
51	59	3,126	1.00	3,477	1,016	0	0	0	0	2,325	4,957	9,525	10,966	10,555	7,675	50,496	16,153
52	60	8,958	0.81	13,555	2,812	0	0	0	0	9,705	19,931	32,198	33,830	33,495	22,552	168,078	18,762
53	61	12,571	1.00	8,044	3,840	0	0	0	0	9,482	15,886	35,703	41,946	39,535	24,522	178,958	14,236
54	63	3,092	0.93	5,263	442	0	0	0	0	3,091	6,563	11,438	11,211	10,426	7,758	56,192	18,171
55	64	750	0.68	1,240	481	0	0	0	0	968	1,896	2,748	2,673	2,549	2,127	14,682	19,573
56	65	375	0.67	612	282	0	0	0	0	470	882	1,266	1,358	1,307	1,110	7,287	19,415
57	66	190	0.80	330	70	0	0	0	0	294	463	770	647	607	426	3,607	18,947
58	67	12	0.94	18	3	0	0	0	0	21	42	50	30	26	17	207	18,001
Sub-total		119,502		154,137	38,196	0	0	0	0	127,886	242,418	415,929	412,810	384,368	257,677	2,033,421	17,016
Lower Basin of Manjil Dam																	
59	19	7,852	0.56	113	48	0	0	1	6	20,531	52,903	29,300	29,291	24,647	163	157,003	19,996
60	23	218	0.68	27	15	0	0	0	1	523	1,348	874	794	662	46	4,290	19,669
61	62	183	0.48	0	0	0	0	0	0	480	1,239	686	685	580	0	3,670	20,005
Sub-total		8,253		140	63	0	0	1	7	21,534	55,490	30,860	30,770	25,889	209	164,963	19,988

Source: WRMC

Table R 6.2.9 Irrigation Demand from Surface Water by Reach in the Middle Term (2016)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m^3)													Unit Requirement (m^3/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total	
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	340	1.00	244	176	0	0	0	0	260	499	809	746	699	523	3,956	11,633
2	2	2,040	1.00	1,773	256	0	0	0	0	622	2,383	5,516	6,625	6,488	4,499	28,162	13,805
3	3	805	1.00	412	417	0	0	0	0	604	1,119	1,927	1,775	1,604	1,000	8,858	11,004
4	4	1,871	0.85	2,063	274	0	0	0	0	1,231	3,153	5,716	6,282	6,219	3,899	28,837	15,413
5	5	8,421	0.90	7,438	985	0	0	0	0	5,601	15,116	24,447	29,427	29,005	13,577	125,596	14,915
6	6	1,229	1.00	513	453	0	0	0	0	602	1,585	2,945	3,314	3,097	1,680	14,189	11,545
7	7	97	1.00	92	17	0	0	0	0	46	122	261	310	302	216	1,366	14,072
8	8	0	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	15,261
9	9	2,293	0.94	2,234	300	0	0	0	0	2,182	4,668	7,307	7,444	6,415	2,934	33,484	14,603
10	10	4,452	0.76	5,204	1,129	0	0	0	0	3,041	6,816	12,234	15,410	15,539	10,589	69,962	15,715
11	11	2,641	0.98	1,707	784	0	0	0	0	2,073	4,081	8,104	7,786	7,283	4,208	36,026	13,641
12	12	350	1.00	331	79	0	0	0	0	194	455	916	1,068	1,041	756	4,840	13,830
13	13	209	0.95	232	52	0	0	0	0	142	291	581	686	671	500	3,155	15,095
14	14	96	1.00	86	34	0	0	0	0	68	133	239	259	248	184	1,251	13,031
15	15	17	1.00	7	3	0	0	0	0	9	22	47	60	49	24	221	13,000
16	16	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	5,421
17	17	10,229	0.88	12,043	2,995	0	0	0	0	11,163	20,897	33,024	27,568	25,235	19,072	151,997	14,859
18	18	4,816	0.89	6,383	1,133	0	0	0	0	5,235	10,246	15,226	12,664	12,017	7,909	70,813	14,704
19	20	7,723	1.00	8,894	1,262	0	0	0	0	7,786	10,954	21,042	16,948	13,551	9,513	89,950	11,647
20	21	4,880	1.00	3,297	1,578	0	0	0	0	2,339	4,602	9,750	10,415	9,744	6,876	48,601	9,959
21	22	2,396	0.99	2,782	895	0	0	0	0	2,795	5,221	6,952	5,451	4,968	3,909	32,973	13,761
22	24	784	1.00	1,016	182	0	0	0	0	769	1,056	2,092	1,747	1,630	1,227	9,719	12,396
23	25	458	0.96	421	27	0	0	0	0	385	661	1,508	1,506	1,243	850	6,601	14,412
24	26	1,850	0.87	1,496	481	0	0	0	0	1,247	3,588	5,026	6,065	5,959	3,726	27,588	14,912
25	27	8,304	1.00	9,372	1,564	0	0	0	0	8,816	10,160	23,155	21,645	16,496	10,771	101,979	12,281
26	28	303	0.98	317	85	0	0	0	0	186	273	727	882	853	639	3,962	13,076
27	29	540	0.91	713	64	0	0	0	0	397	882	1,518	1,443	1,343	1,057	7,417	13,735
28	30	3,033	0.92	3,836	343	0	0	0	0	2,106	4,901	8,392	8,344	8,097	6,102	42,121	13,887
29	31	836	1.00	1,026	196	0	0	0	0	817	1,156	2,128	1,898	1,766	1,281	10,268	12,282
30	32	81	1.00	50	45	0	0	0	0	66	117	176	132	98	77	761	9,395
31	33	572	0.97	667	164	0	0	0	0	420	613	1,506	1,661	1,619	1,214	7,864	13,748
32	34	763	0.66	1,000	426	0	0	0	0	725	1,446	2,176	2,350	2,281	1,896	12,300	16,122
33	35	607	0.73	775	290	0	0	0	0	721	1,400	1,896	1,677	1,607	1,239	9,605	15,822
34	36	751	0.78	850	106	0	0	0	0	342	871	2,318	2,653	2,528	2,043	11,711	15,594
35	37	975	0.72	1,454	597	0	0	0	0	1,195	2,313	3,288	3,245	3,079	2,565	17,736	18,190
36	38	318	0.82	415	102	0	0	0	0	327	502	938	959	904	646	4,793	15,073
37	39	7	0.89	2	0	0	0	0	0	3	7	22	33	26	11	104	14,800
38	40	852	0.74	1,291	512	0	0	0	0	1,132	2,156	2,953	2,678	2,504	2,097	15,323	17,985
39	41	398	0.72	612	258	0	0	0	0	533	984	1,333	1,252	1,184	993	7,149	17,965
40	42	564	0.69	840	353	0	0	0	0	674	1,285	1,825	1,839	1,754	1,462	10,032	17,785
41	43	192	0.70	328	121	0	0	0	0	244	463	631	585	580	475	3,427	17,849
42	44	1,085	0.75	1,796	631	0	0	0	0	1,346	2,657	3,734	3,519	3,493	2,818	19,994	18,428
43	45	32	0.84	50	14	0	0	0	0	46	91	119	93	89	62	564	17,634
44	46	58	0.77	91	35	0	0	0	0	88	160	209	169	155	132	1,039	17,915
45	47	3,729	0.81	5,843	1,536	0	0	0	0	5,185	10,360	13,252	10,860	10,442	7,975	65,453	17,552
46	48	1,234	0.86	1,921	434	0	0	0	0	1,778	3,578	4,756	3,531	3,293	2,469	21,760	17,634
47	49	0	0.85	0	0	0	0	0	0	0	0	0	0	0	0	0	14,864
48	50	615	0.79	992	296	0	0	0	0	858	1,657	2,165	1,823	1,762	1,370	10,923	17,761
49	51	175	0.77	285	98	0	0	0	0	242	459	631	562	511	376	3,164	18,080
50	52	234	0.83	393	106	0	0	0	0	351	669	856	671	645	495	4,186	17,881
51	59	3,126	1.00	2,893	838	0	0	0	0	1,918	4,134	7,979	9,196	8,853	6,425	42,236	13,511
52	60	7,268	0.81	8,876	1,825	0	0	0	0	6,301	13,027	21,179	22,341	22,131	14,884	110,564	15,212
53	61	12,571	1.00	6,967	3,189	0	0	0	0	7,891	13,442	30,344	35,763	33,760	21,041	152,397	12,123
54	63	3,092	0.93	3,970	332	0	0	0	0	2,319	4,964	8,711	8,557	7,970	5,920	42,743	13,824
55	64	750	0.68	1,000	385	0	0	0	0	774	1,528	2,228	2,172	2,072	1,726	11,885	15,846
56	65	375	0.67	569	261	0	0	0	0	434	818	1,179	1,267	1,219	1,035	6,782	18,089
57	66	190	0.80	267	56	0	0	0	0	235	376	639	546	515	357	2,991	15,738
58	67	12	0.94	18	3	0	0	0	0	20	41	49	30	26	17	204	16,799
Sub-total		111,639		118,147	28,777	0	0	0	0	96,884	185,158	318,681	317,932	296,662	199,341	1,561,582	13,988
Lower Basin of Manjil Dam																	
59	19	7,852	0.56	105	43	0	0	1	5	16,945	43,657	24,195	24,189	20,355	150	129,645	16,511
60	23	218	0.68	23	13	0	0	0	1	431	1,113	722	657	547	39	3,546	16,266
61	62	183	0.48	0	0	0	0	0	0	395	1,020	564	564	477	0	3,020	16,502
Sub-total		8,253		128	56	0	0	1	6	17,771	45,790	25,481	25,410	21,379	189	136,211	16,504

Source: WRMC

Table R 6.2.10 Irrigation Demand from Surface Water by Reach in the Long Term (2031)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m^3)													Unit Requirement (m^3/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total	
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	340	1.00	195	141	0	0	0	0	208	399	647	597	559	418	3,164	9,306
2	2	2,040	1.00	1,418	205	0	0	0	0	497	1,906	4,413	5,300	5,191	3,599	22,529	11,044
3	3	55	1.00	23	23	0	0	0	0	33	61	105	97	88	55	485	8,803
4	4	1,871	0.85	1,650	219	0	0	0	0	985	2,522	4,573	5,025	4,975	3,119	23,068	12,329
5	5	8,421	0.90	5,950	788	0	0	0	0	4,480	12,092	19,558	23,542	23,204	10,862	100,476	11,932
6	6	1,229	1.00	410	362	0	0	0	0	481	1,268	2,356	2,651	2,478	1,344	11,350	9,236
7	7	97	1.00	74	13	0	0	0	0	37	97	209	248	242	173	1,093	11,260
8	8	0	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	12,209
9	9	2,293	0.94	1,787	240	0	0	0	0	1,746	3,735	5,845	5,955	5,132	2,347	26,787	11,682
10	10	4,452	0.76	4,163	903	0	0	0	0	2,433	5,453	9,787	12,328	12,431	8,471	55,969	12,571
11	11	2,641	0.98	1,366	627	0	0	0	0	1,658	3,265	6,483	6,229	5,826	3,366	28,820	10,912
12	12	350	1.00	265	64	0	0	0	0	155	364	733	855	833	604	3,873	11,062
13	13	209	0.95	185	41	0	0	0	0	114	233	465	548	536	400	2,522	12,066
14	14	96	1.00	69	27	0	0	0	0	54	107	191	207	199	147	1,001	10,418
15	15	17	1.00	6	2	0	0	0	0	7	18	37	48	39	20	177	10,421
16	16	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	4,368
17	17	6,229	0.88	5,867	1,459	0	0	0	0	5,438	10,180	16,088	13,430	12,293	9,291	74,046	11,887
18	18	4,816	0.89	5,106	906	0	0	0	0	4,188	8,196	12,180	10,132	9,613	6,327	56,648	11,762
19	20	7,515	1.00	6,924	982	0	0	0	0	6,061	8,527	16,380	13,193	10,548	7,405	70,020	9,317
20	21	3,679	1.00	1,988	952	0	0	0	0	1,411	2,775	5,880	6,281	5,877	4,147	29,311	7,967
21	22	2,396	0.99	2,225	716	0	0	0	0	2,236	4,176	5,561	4,360	3,974	3,127	26,375	11,008
22	24	784	1.00	813	146	0	0	0	0	615	844	1,673	1,398	1,304	982	7,775	9,918
23	25	458	0.96	337	21	0	0	0	0	308	529	1,206	1,204	994	680	5,279	11,529
24	26	1,850	0.87	1,197	385	0	0	0	0	997	2,870	4,021	4,852	4,767	2,980	22,069	11,930
25	27	8,108	1.00	7,321	1,221	0	0	0	0	6,886	7,936	18,087	16,908	12,886	8,414	79,659	9,825
26	28	303	0.98	253	68	0	0	0	0	149	218	582	706	682	511	3,169	10,459
27	29	540	0.91	570	51	0	0	0	0	317	705	1,215	1,155	1,074	846	5,933	10,988
28	30	2,133	0.92	2,158	193	0	0	0	0	1,185	2,757	4,721	4,695	4,556	3,433	23,698	11,110
29	31	836	1.00	821	157	0	0	0	0	654	925	1,703	1,518	1,413	1,024	8,215	9,826
30	32	81	1.00	40	36	0	0	0	0	52	93	141	106	78	62	608	7,506
31	33	572	0.97	533	131	0	0	0	0	336	490	1,205	1,329	1,295	971	6,290	10,995
32	34	763	0.66	800	341	0	0	0	0	580	1,157	1,741	1,880	1,825	1,517	9,841	12,898
33	35	0	0.73	0	0	0	0	0	0	0	0	0	0	0	0	0	-
34	36	751	0.78	680	85	0	0	0	0	274	697	1,855	2,122	2,022	1,634	9,369	12,474
35	37	0	0.72	0	0	0	0	0	0	0	0	0	0	0	0	0	-
36	38	318	0.82	332	82	0	0	0	0	262	401	750	768	723	517	3,835	12,057
37	39	7	0.89	1	0	0	0	0	0	2	5	17	26	21	9	81	11,600
38	40	852	0.74	1,032	410	0	0	0	0	906	1,725	2,363	2,143	2,003	1,678	12,260	14,390
39	41	0	0.72	0	0	0	0	0	0	0	0	0	0	0	0	0	-
40	42	564	0.69	672	282	0	0	0	0	539	1,028	1,460	1,471	1,403	1,170	8,025	14,228
41	43	192	0.70	262	97	0	0	0	0	195	371	505	468	464	380	2,742	14,281
42	44	1,085	0.75	1,436	505	0	0	0	0	1,077	2,126	2,987	2,815	2,794	2,254	15,994	14,742
43	45	32	0.84	40	11	0	0	0	0	37	73	95	75	72	49	452	14,099
44	46	58	0.77	73	28	0	0	0	0	70	128	167	135	124	105	830	14,326
45	47	3,729	0.81	4,675	1,229	0	0	0	0	4,148	8,288	10,601	8,688	8,354	6,380	52,363	14,042
46	48	1,234	0.86	1,537	347	0	0	0	0	1,422	2,863	3,805	2,825	2,634	1,975	17,408	14,107
47	49	0	0.85	0	0	0	0	0	0	0	0	0	0	0	0	0	11,889
48	50	615	0.79	794	237	0	0	0	0	687	1,326	1,732	1,458	1,410	1,096	8,740	14,209
49	51	175	0.77	228	78	0	0	0	0	194	367	505	450	409	301	2,532	14,464
50	52	234	0.83	314	85	0	0	0	0	280	535	684	536	516	396	3,346	14,304
51	59	3,126	1.00	2,314	670	0	0	0	0	1,535	3,307	6,383	7,357	7,082	5,140	33,788	10,809
52	60	7,268	0.81	7,101	1,460	0	0	0	0	5,041	10,422	16,943	17,873	17,705	11,907	88,452	12,170
53	61	12,196	1.00	5,407	2,475	0	0	0	0	6,125	10,433	23,551	27,757	26,202	16,331	118,281	9,698
54	63	3,092	0.93	3,176	265	0	0	0	0	1,856	3,971	6,969	6,846	6,376	4,736	34,195	11,059
55	64	750	0.68	800	308	0	0	0	0	619	1,222	1,783	1,738	1,658	1,380	9,508	12,679
56	65	375	0.67	455	208	0	0	0	0	347	655	944	1,014	976	828	5,427	14,471
57	66	0	0.80	0	0	0	0	0	0	0	0	0	0	0	0	0	12,591
58	67	12	0.94	14	2	0	0	0	0	16	32	39	24	21	13	161	13,439
Sub-total		101,839		85,857	20,284	0	0	0	0	69,933	133,873	231,924	233,366	217,881	144,921	1,138,039	11,175
Lower Basin of Manjil Dam																	
59	19	7,852	0.56	84	34	0	0	0	4	13,556	34,926	19,356	19,351	16,284	120	103,715	13,209
60	23	218	0.68	18	10	0	0	0	1	345	890	578	525	438	31	2,836	13,008
61	62	183	0.48	0	0	0	0	0	0	316	816	451	451	382	0	2,416	13,202
小計		8,253		102	44	0	0	0	5	14,217	36,632	20,385	20,327	17,104	151	108,967	13,203

Source: WRMC

Table R 6.2.11 Present Irrigation Demand from Groundwater by Reach (2006)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m³)												Total	Unit Requirement (m³/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.		
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	1,149	1.00	993	720	0	0	0	0	1,063	2,033	3,288	3,023	2,830	2,123	16,073	13,993
2	2	1,214	1.00	1,223	185	0	0	0	0	448	1,643	3,776	4,524	4,430	3,080	19,309	15,911
3	3	2,854	1.00	1,744	1,791	0	0	0	0	2,593	4,763	8,162	7,480	6,748	4,201	37,482	13,134
4	4	937	0.85	1,254	172	0	0	0	0	770	1,931	3,452	3,760	3,717	2,328	17,384	18,544
5	5	1,477	0.90	1,605	216	0	0	0	0	1,228	3,283	5,258	6,313	6,217	2,891	27,011	18,286
6	6	3,314	1.00	1,614	1,480	0	0	0	0	1,966	5,092	9,384	10,532	9,828	5,296	45,192	13,635
7	7	111	1.00	126	23	0	0	0	0	64	165	351	417	407	292	1,845	16,567
8	8	1,788	0.71	2,625	514	30	0	0	122	1,631	3,556	6,029	7,451	7,273	4,828	34,059	19,049
9	9	465	0.94	561	76	0	0	0	0	552	1,176	1,833	1,862	1,601	727	8,388	18,058
10	10	26	0.76	38	8	0	0	0	0	23	50	89	112	113	77	510	19,323
11	11	2,939	0.98	2,367	1,090	0	0	0	0	2,882	5,660	11,226	10,768	10,068	5,819	49,880	16,974
12	12	233	1.00	263	64	0	0	0	0	156	359	720	838	817	595	3,812	16,388
13	13	138	0.95	185	41	0	0	0	0	114	232	461	543	532	397	2,505	18,095
14	14	2	1.00	2	1	0	0	0	0	2	4	6	7	7	5	34	15,704
15	15	2	1.00	1	0	0	0	0	0	1	3	6	8	6	3	28	15,158
16	16	19	1.00	13	19	0	0	0	0	12	21	21	20	13	0	119	6,263
17	17	4,011	0.88	5,875	1,468	0	0	0	0	5,470	10,206	16,092	13,401	12,259	9,263	74,034	18,456
18	18	130	0.89	214	38	0	0	0	0	176	344	509	421	399	263	2,364	18,198
19	20	10,365	1.00	15,717	2,258	0	0	0	0	13,921	19,407	36,794	29,304	23,247	16,337	156,985	15,146
20	21	3,354	1.00	2,609	1,320	0	0	0	0	1,941	3,775	7,916	8,375	7,812	5,489	39,237	11,697
21	22	2,177	0.99	3,146	1,016	0	0	0	0	3,174	5,899	7,817	6,101	5,555	4,384	37,092	17,035
22	24	71	1.00	121	22	0	0	0	0	92	125	245	202	188	142	1,137	16,075
23	25	5,275	0.96	6,121	398	0	0	0	0	5,693	9,604	21,829	21,695	17,827	12,201	95,368	18,080
24	26	5,821	0.87	5,808	1,892	0	0	0	0	4,895	13,957	19,410	23,449	23,044	14,381	106,836	18,354
25	27	10,617	1.00	15,882	2,665	0	0	0	0	15,022	17,223	39,046	36,389	27,622	18,025	171,874	16,188
26	28	0	0.98	0	0	0	0	0	0	0	0	0	0	0	0	0	16,980
27	29	121	0.91	211	19	0	0	0	0	118	261	446	422	392	310	2,179	18,041
28	30	1,229	0.92	2,057	185	0	0	0	0	1,136	2,619	4,445	4,409	4,274	3,229	22,354	18,191
29	31	82	1.00	132	26	0	0	0	0	106	149	271	240	223	162	1,309	16,028
30	32	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	11,704
31	33	39	0.97	60	15	0	0	0	0	38	55	134	147	143	108	700	17,771
32	34	21	0.66	35	15	0	0	0	0	25	50	75	81	79	66	426	19,966
33	35	7	0.73	11	4	0	0	0	0	10	19	25	22	21	17	129	19,526
34	36	1,540	0.78	2,145	281	0	0	0	0	895	2,192	5,766	6,589	6,273	5,069	29,210	18,973
35	37	1,479	0.72	2,359	979	0	0	0	0	1,958	3,761	5,299	5,208	4,941	4,123	28,628	19,363
36	38	242	0.82	403	100	0	0	0	0	321	485	891	905	852	614	4,571	18,900
37	39	3	0.89	1	0	0	0	0	0	2	4	10	15	12	5	49	18,700
38	40	596	0.74	967	387	0	0	0	0	856	1,618	2,200	1,986	1,856	1,557	11,427	19,174
39	41	1,437	0.72	2,378	1,006	0	0	0	0	2,078	3,824	5,155	4,833	4,568	3,837	27,679	19,263
40	42	1,223	0.69	1,950	827	0	0	0	0	1,578	2,987	4,212	4,232	4,037	3,370	23,193	18,971
41	43	192	0.70	350	130	0	0	0	0	263	496	671	619	613	504	3,646	19,021
42	44	1,028	0.75	1,816	647	0	0	0	0	1,378	2,685	3,718	3,466	3,435	2,779	19,924	19,380
43	45	241	0.84	398	114	0	0	0	0	378	731	944	731	699	482	4,477	18,575
44	46	83	0.77	140	54	0	0	0	0	136	246	320	258	236	201	1,591	19,177
45	47	11,565	0.81	19,526	5,151	0	0	0	0	17,380	34,664	44,234	36,160	34,756	26,546	218,417	18,886
46	48	1,704	0.86	2,809	648	0	0	0	0	2,653	5,261	6,869	4,972	4,608	3,453	31,273	18,349
47	49	352	0.85	711	102	0	0	0	0	706	1,025	1,594	981	833	575	6,527	18,543
48	50	1,796	0.79	3,122	934	0	0	0	0	2,708	5,218	6,801	5,714	5,522	4,294	34,313	19,110
49	51	161	0.77	281	98	0	0	0	0	241	455	623	552	502	369	3,121	19,357
50	52	2,857	0.83	5,151	1,402	0	0	0	0	4,623	8,777	11,156	8,674	8,328	6,397	54,508	19,076
51	59	1,109	1.00	1,233	360	0	0	0	0	825	1,758	3,379	3,890	3,744	2,723	17,912	16,153
52	60	1,466	0.81	2,218	460	0	0	0	0	1,588	3,261	5,268	5,535	5,480	3,690	27,500	18,762
53	61	4,823	1.00	3,086	1,474	0	0	0	0	3,638	6,096	13,700	16,096	15,170	9,410	68,670	14,236
54	63	4,403	0.93	7,492	630	0	0	0	0	4,400	9,343	16,284	15,961	14,843	11,045	79,998	18,171
55	64	8	0.68	13	5	0	0	0	0	10	20	29	28	27	22	154	19,573
56	65	777	0.67	1,267	583	0	0	0	0	972	1,825	2,619	2,811	2,704	2,298	15,079	19,415
57	66	8,653	0.80	15,017	3,171	0	0	0	0	13,347	21,060	35,005	29,389	27,595	19,359	163,943	18,947
58	67	6,917	0.94	10,978	1,668	0	0	0	0	12,643	25,202	30,053	18,166	15,715	10,095	124,520	18,001
Sub-total		114,643		158,424	38,952	30	0	0	122	140,899	256,658	415,916	380,087	345,041	239,856	1,975,985	17,236
Lower Basin of Manjil Dam																	
59	19	407	0.56	6	3	0	0	0	0	1,065	2,745	1,520	1,520	1,279	8	8,146	19,996
60	23	135	0.68	16	9	0	0	0	1	323	834	541	491	410	28	2,653	19,669
61	62	20	0.48	0	0	0	0	0	0	51	132	73	73	62	0	391	20,005
Sub-total		562		22	12	0	0	0	1	1,439	3,711	2,134	2,084	1,751	36	11,190	19,911

Source: WRMC

Table R 6.2.12 Irrigation Demand from Groundwater by Reach in the Middle Term (2016)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m^3)													Unit Requirement (m^3/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total	
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	1,149	1.00	823	594	0	0	0	0	877	1,686	2,735	2,522	2,361	1,768	13,366	11,633
2	2	1,214	1.00	1,055	153	0	0	0	0	370	1,418	3,283	3,942	3,861	2,677	16,759	13,805
3	3	2,854	1.00	1,462	1,478	0	0	0	0	2,140	3,966	6,833	6,294	5,687	3,544	31,404	11,004
4	4	937	0.85	1,033	137	0	0	0	0	617	1,579	2,863	3,146	3,114	1,953	14,442	15,413
5	5	1,477	0.90	1,305	173	0	0	0	0	982	2,651	4,288	5,161	5,087	2,381	22,028	14,915
6	6	3,314	1.00	1,383	1,221	0	0	0	0	1,622	4,275	7,941	8,937	8,351	4,530	38,260	11,545
7	7	111	1.00	105	19	0	0	0	0	53	139	298	354	346	247	1,561	14,072
8	8	1,788	0.71	2,102	411	24	0	0	97	1,305	2,847	4,831	5,971	5,829	3,870	27,287	15,261
9	9	465	0.94	453	61	0	0	0	0	443	947	1,482	1,510	1,301	595	6,792	14,603
10	10	26	0.76	30	7	0	0	0	0	18	40	71	90	91	62	409	15,715
11	11	2,939	0.98	1,900	872	0	0	0	0	2,306	4,542	9,018	8,664	8,104	4,682	40,088	13,641
12	12	233	1.00	221	53	0	0	0	0	129	303	610	711	693	503	3,223	13,830
13	13	138	0.95	153	34	0	0	0	0	94	192	384	453	443	330	2,083	15,095
14	14	2	1.00	2	1	0	0	0	0	1	3	5	5	5	4	26	13,031
15	15	2	1.00	1	0	0	0	0	0	1	3	5	7	6	3	26	13,000
16	16	19	1.00	11	16	0	0	0	0	10	18	19	18	11	0	103	5,421
17	17	4,011	0.88	4,722	1,174	0	0	0	0	4,377	8,194	12,949	10,810	9,895	7,478	59,599	14,859
18	18	130	0.89	172	31	0	0	0	0	141	277	411	342	324	213	1,911	14,704
19	20	10,365	1.00	11,937	1,693	0	0	0	0	10,450	14,701	28,240	22,746	18,186	12,767	120,720	11,647
20	21	3,354	1.00	2,266	1,085	0	0	0	0	1,607	3,163	6,701	7,158	6,697	4,726	33,403	9,959
21	22	2,177	0.99	2,528	813	0	0	0	0	2,540	4,743	6,316	4,952	4,514	3,552	29,958	13,761
22	24	71	1.00	92	16	0	0	0	0	70	96	189	158	148	111	880	12,396
23	25	5,275	0.96	4,849	309	0	0	0	0	4,440	7,614	17,368	17,341	14,311	9,789	76,021	14,412
24	26	5,821	0.87	4,708	1,514	0	0	0	0	3,923	11,289	15,815	19,083	18,750	11,723	86,805	14,912
25	27	10,617	1.00	11,983	1,999	0	0	0	0	11,272	12,990	29,605	27,675	21,091	13,771	130,386	12,281
26	28	0	0.98	0	0	0	0	0	0	0	0	0	0	0	0	0	13,076
27	29	121	0.91	160	14	0	0	0	0	89	198	340	323	301	237	1,662	13,735
28	30	1,229	0.92	1,554	139	0	0	0	0	853	1,986	3,400	3,381	3,281	2,472	17,066	13,887
29	31	82	1.00	101	19	0	0	0	0	80	113	209	186	173	126	1,007	12,282
30	32	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	9,395
31	33	39	0.97	45	11	0	0	0	0	29	42	103	113	110	83	536	13,748
32	34	21	0.66	28	12	0	0	0	0	20	40	60	65	63	52	340	16,122
33	35	7	0.73	9	3	0	0	0	0	8	16	22	19	19	14	110	15,822
34	36	1,540	0.78	1,743	218	0	0	0	0	702	1,785	4,754	5,440	5,183	4,189	24,014	15,594
35	37	1,479	0.72	2,205	905	0	0	0	0	1,812	3,509	4,987	4,922	4,671	3,891	26,902	18,190
36	38	242	0.82	315	78	0	0	0	0	249	382	714	730	688	492	3,648	15,073
37	39	3	0.89	1	0	0	0	0	0	1	3	9	14	11	5	44	14,800
38	40	596	0.74	903	358	0	0	0	0	792	1,508	2,066	1,873	1,752	1,467	10,719	17,985
39	41	1,437	0.72	2,211	931	0	0	0	0	1,924	3,554	4,813	4,522	4,275	3,587	25,817	17,965
40	42	1,223	0.69	1,822	765	0	0	0	0	1,461	2,785	3,956	3,987	3,803	3,170	21,749	17,785
41	43	192	0.70	328	121	0	0	0	0	244	463	631	585	580	475	3,427	17,849
42	44	1,028	0.75	1,701	598	0	0	0	0	1,276	2,518	3,538	3,334	3,309	2,670	18,944	18,428
43	45	241	0.84	373	106	0	0	0	0	350	684	894	703	674	466	4,250	17,634
44	46	83	0.77	131	50	0	0	0	0	126	229	299	242	222	188	1,487	17,915
45	47	11,565	0.81	18,122	4,764	0	0	0	0	16,080	32,130	41,099	33,679	32,385	24,733	202,992	17,552
46	48	1,704	0.86	2,652	600	0	0	0	0	2,455	4,941	6,568	4,876	4,547	3,409	30,048	17,634
47	49	352	0.85	555	79	0	0	0	0	547	805	1,274	808	693	471	5,232	14,864
48	50	1,796	0.79	2,898	865	0	0	0	0	2,506	4,839	6,321	5,323	5,146	4,001	31,899	17,761
49	51	161	0.77	262	90	0	0	0	0	223	422	580	517	471	346	2,911	18,080
50	52	2,857	0.83	4,799	1,296	0	0	0	0	4,280	8,166	10,446	8,187	7,870	6,041	51,085	17,881
51	59	1,109	1.00	1,026	297	0	0	0	0	681	1,467	2,831	3,263	3,141	2,279	14,985	13,511
52	60	1,466	0.81	1,790	368	0	0	0	0	1,271	2,628	4,272	4,506	4,464	3,002	22,301	15,212
53	61	4,823	1.00	2,673	1,223	0	0	0	0	3,027	5,157	11,642	13,721	12,952	8,073	58,468	12,123
54	63	4,403	0.93	5,654	472	0	0	0	0	3,303	7,069	12,405	12,185	11,350	8,431	60,869	13,824
55	64	8	0.68	11	4	0	0	0	0	8	16	24	23	22	18	126	15,846
56	65	777	0.67	1,179	540	0	0	0	0	899	1,696	2,444	2,626	2,527	2,145	14,056	18,089
57	66	8,653	0.80	12,142	2,537	0	0	0	0	10,685	17,130	29,110	24,886	23,452	16,242	136,184	15,738
58	67	6,917	0.94	10,208	1,543	0	0	0	0	11,697	23,381	27,992	17,054	14,793	9,530	116,198	16,799
Sub-total		114,643		132,897	32,870	24	0	0	97	117,466	217,338	350,063	320,143	292,134	203,584	1,666,616	14,537
Lower Basin of Manjil Dam																	
59	19	407	0.56	5	2	0	0	0	0	878	2,263	1,254	1,254	1,055	8	6,719	16,511
60	23	135	0.68	14	8	0	0	0	1	267	689	447	407	339	24	2,196	16,266
61	62	20	0.48	0	0	0	0	0	0	43	111	62	62	52	0	330	16,502
Sub-total		562		19	10	0	0	0	1	1,188	3,063	1,763	1,723	1,446	32	9,245	16,450

Source: WRMC

Table R 6.2.13 Irrigation Demand from Groundwater by Reach in the Long Term (2031)

No.	Reach code	Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (Unit: '000m^3)													Unit Requirement (m^3/ha)
				Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total	
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.		
Upper Basin of Manjil Dam																	
1	1	1,149	1.00	659	475	0	0	0	0	702	1,349	2,188	2,017	1,889	1,414	10,693	9,306
2	2	1,214	1.00	844	122	0	0	0	0	296	1,135	2,626	3,154	3,089	2,142	13,408	11,044
3	3	2,854	1.00	1,170	1,182	0	0	0	0	1,712	3,173	5,466	5,035	4,550	2,835	25,123	8,803
4	4	937	0.85	826	110	0	0	0	0	493	1,263	2,290	2,517	2,491	1,562	11,552	12,329
5	5	1,477	0.90	1,044	138	0	0	0	0	786	2,121	3,430	4,129	4,070	1,905	17,623	11,932
6	6	3,314	1.00	1,107	977	0	0	0	0	1,298	3,420	6,353	7,150	6,681	3,624	30,610	9,236
7	7	111	1.00	84	15	0	0	0	0	42	111	239	283	277	198	1,249	11,260
8	8	1,788	0.71	1,681	329	20	0	0	78	1,044	2,278	3,864	4,777	4,663	3,096	21,830	12,209
9	9	465	0.94	362	49	0	0	0	0	354	757	1,185	1,208	1,041	476	5,432	11,682
10	10	26	0.76	24	5	0	0	0	0	14	32	57	72	73	49	326	12,571
11	11	2,939	0.98	1,520	698	0	0	0	0	1,845	3,633	7,215	6,931	6,483	3,746	32,071	10,912
12	12	233	1.00	176	42	0	0	0	0	103	242	488	569	554	402	2,576	11,062
13	13	138	0.95	122	27	0	0	0	0	75	154	307	362	354	264	1,665	12,066
14	14	2	1.00	1	1	0	0	0	0	1	2	4	4	4	3	20	10,418
15	15	2	1.00	1	0	0	0	0	0	1	2	4	6	5	2	21	10,421
16	16	19	1.00	9	13	0	0	0	0	8	15	15	14	9	0	83	4,368
17	17	4,011	0.88	3,778	939	0	0	0	0	3,502	6,555	10,360	8,648	7,916	5,983	47,681	11,887
18	18	130	0.89	138	24	0	0	0	0	113	221	329	273	259	171	1,528	11,762
19	20	10,365	1.00	9,549	1,355	0	0	0	0	8,360	11,761	22,592	18,197	14,549	10,213	96,576	9,317
20	21	3,354	1.00	1,813	868	0	0	0	0	1,286	2,530	5,361	5,726	5,358	3,781	26,723	7,967
21	22	2,177	0.99	2,022	650	0	0	0	0	2,032	3,795	5,053	3,962	3,611	2,841	23,966	11,008
22	24	71	1.00	74	13	0	0	0	0	56	76	152	127	118	89	705	9,918
23	25	5,275	0.96	3,880	247	0	0	0	0	3,552	6,091	13,894	13,872	11,449	7,831	60,816	11,529
24	26	5,821	0.87	3,766	1,211	0	0	0	0	3,138	9,031	12,652	15,267	15,000	9,378	69,443	11,930
25	27	10,617	1.00	9,586	1,599	0	0	0	0	9,017	10,392	23,684	22,140	16,873	11,017	104,308	9,825
26	28	0	0.98	0	0	0	0	0	0	0	0	0	0	0	0	0	10,459
27	29	121	0.91	128	11	0	0	0	0	71	158	272	259	241	190	1,330	10,988
28	30	1,229	0.92	1,244	111	0	0	0	0	683	1,589	2,720	2,705	2,625	1,978	13,655	11,110
29	31	82	1.00	80	15	0	0	0	0	64	91	167	149	139	100	805	9,826
30	32	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	7,506
31	33	39	0.97	36	9	0	0	0	0	23	33	82	91	88	66	428	10,995
32	34	21	0.66	22	9	0	0	0	0	16	32	48	52	50	42	271	12,898
33	35	0	0.73	0	0	0	0	0	0	0	0	0	0	0	0	0	-
34	36	1,540	0.78	1,394	174	0	0	0	0	561	1,428	3,803	4,352	4,146	3,351	19,209	12,474
35	37	0	0.72	0	0	0	0	0	0	0	0	0	0	0	0	0	-
36	38	242	0.82	252	62	0	0	0	0	199	305	571	584	551	393	2,917	12,057
37	39	3	0.89	1	0	0	0	0	0	1	2	7	11	9	4	35	11,600
38	40	596	0.74	722	287	0	0	0	0	634	1,207	1,653	1,499	1,401	1,174	8,577	14,390
39	41	0	0.72	0	0	0	0	0	0	0	0	0	0	0	0	0	-
40	42	1,223	0.69	1,458	612	0	0	0	0	1,169	2,228	3,165	3,189	3,043	2,536	17,400	14,228
41	43	192	0.70	262	97	0	0	0	0	195	371	505	468	464	380	2,742	14,281
42	44	1,028	0.75	1,361	479	0	0	0	0	1,021	2,014	2,830	2,667	2,647	2,136	15,155	14,742
43	45	241	0.84	298	84	0	0	0	0	280	547	715	562	539	372	3,397	14,099
44	46	83	0.77	104	40	0	0	0	0	101	183	239	194	178	151	1,190	14,326
45	47	11,565	0.81	14,498	3,811	0	0	0	0	12,864	25,704	32,879	26,943	25,908	19,786	162,393	14,042
46	48	1,704	0.86	2,122	480	0	0	0	0	1,964	3,953	5,254	3,901	3,637	2,727	24,038	14,107
47	49	352	0.85	444	63	0	0	0	0	438	644	1,019	646	554	377	4,185	11,889
48	50	1,796	0.79	2,318	692	0	0	0	0	2,005	3,871	5,057	4,258	4,117	3,201	25,519	14,209
49	51	161	0.77	209	72	0	0	0	0	178	338	464	414	376	277	2,328	14,464
50	52	2,857	0.83	3,839	1,037	0	0	0	0	3,424	6,533	8,357	6,550	6,296	4,833	40,869	14,304
51	59	1,109	1.00	821	238	0	0	0	0	544	1,173	2,264	2,610	2,512	1,824	11,986	10,809
52	60	1,466	0.81	1,432	294	0	0	0	0	1,017	2,102	3,418	3,605	3,571	2,402	17,841	12,170
53	61	4,823	1.00	2,138	979	0	0	0	0	2,422	4,126	9,314	10,977	10,362	6,458	46,776	9,698
54	63	4,403	0.93	4,523	378	0	0	0	0	2,642	5,655	9,924	9,748	9,080	6,745	48,695	11,059
55	64	8	0.68	9	3	0	0	0	0	7	13	19	19	18	15	103	12,679
56	65	777	0.67	943	432	0	0	0	0	719	1,357	1,955	2,101	2,021	1,716	11,244	14,471
57	66	8,263	0.80	9,276	1,938	0	0	0	0	8,163	13,086	22,238	19,011	17,916	12,408	104,036	12,591
58	67	6,917	0.94	8,167	1,235	0	0	0	0	9,358	18,705	22,394	13,643	11,834	7,624	92,960	13,439
Sub-total		111,330		102,337	24,731	20	0	0	78	90,593	167,587	271,141	247,648	225,689	156,288	1,286,112	11,552
Lower Basin of Manjil Dam																	
59	19	407	0.56	4	2	0	0	0	0	703	1,810	1,003	1,003	844	6	5,375	13,209
60	23	135	0.68	11	6	0	0	0	1	214	551	358	325	271	19	1,756	13,008
61	62	20	0.48	0	0	0	0	0	0	35	89	49	49	42	0	264	13,202
Sub-total		562		15	8	0	0	0	1	952	2,450	1,410	1,377	1,157	25	7,395	13,158

Source: WRMC

Table R 6.2.14 Present Irrigation Demand from Surface Water in Gilan (2006)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	1,520	0	0	0	0	0	0	2,581	6,658	3,666	3,666	3,067	0	19,637	12,919
R54	Fumanat	3,889	0	0	0	0	0	0	7,863	20,266	11,019	11,179	8,728	0	59,055	15,185
R55	East Gilan	3,297	0	0	0	0	0	0	5,355	13,810	7,604	7,604	6,361	0	40,734	12,355
R56	Sefidrud Left	12,904	0	0	0	0	0	0	21,660	55,980	30,510	30,860	22,350	0	161,360	12,505
R57	Sefidrud Right	1,387	0	0	0	0	0	0	2,340	6,020	3,280	3,320	2,400	0	17,360	12,516
Total		22,997	0	0	0	0	0	0	39,799	102,733	56,079	56,629	42,906	0	298,146	12,965

Source: Pandam Study Report/ Vol.4 Note: Water demand from Sefidrud river is not included in this table. Present irrigation efficiency is estimated as 42%

Table R 6.2.15 Irrigation Demand from Surface Water in Gilan in the Middle Term (2016)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	1,520	0	0	0	0	0	0	2,258	5,825	3,207	3,207	2,684	0	17,183	12,906
R54	Fumanat	3,889	0	0	0	0	0	0	6,880	17,733	9,642	9,782	7,637	0	51,673	13,840
R55	East Gilan	3,297	0	0	0	0	0	0	4,686	12,084	6,654	6,654	5,566	0	35,642	11,080
R56	Sefidrud Left	12,904	0	0	0	0	0	0	18,953	48,983	26,696	27,003	19,556	0	141,190	10,942
R57	Sefidrud Right	1,387	0	0	0	0	0	0	2,048	5,268	2,870	2,905	2,100	0	15,190	10,952
Total		22,997	0	0	0	0	0	0	34,824	89,892	49,069	49,550	37,543	0	260,878	11,557

Source: Pandam Study Report/ Vol.4 Note: Water Demand from Sefidrud River is not included in this table. Middle term irrigation efficiency is estimated as 50%

Table R 6.2.16 Irrigation Demand from Surface Water in Gilan in the Long Term (2031)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	1,520	0	0	0	0	0	0	1,971	5,084	2,799	2,799	2,342	0	14,996	11,263
R54	Fumanat	3,889	0	0	0	0	0	0	6,004	15,476	8,414	8,537	6,665	0	45,096	12,079
R55	East Gilan	3,297	0	0	0	0	0	0	4,089	10,546	5,807	5,807	4,857	0	31,106	9,670
R56	Sefidrud Left	12,904	0	0	0	0	0	0	16,540	42,748	23,299	23,566	17,067	0	123,220	9,549
R57	Sefidrud Right	1,387	0	0	0	0	0	0	1,787	4,597	2,505	2,535	1,833	0	13,257	9,558
Total		22,997	0	0	0	0	0	0	30,392	78,451	42,824	43,244	32,765	0	227,675	10,086

Source: Pandam Study Report/ Vol.4 Note: Water Demand from Sefidrud River is not included in this table. Long term irrigation efficiency is estimated as 55%

Table R 6.2.17 Present Irrigation Demand from Groundwater in Gilan (2006)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	553	0	0	0	0	0	0	939	2,421	1,333	1,333	1,115	0	7,141	12,913
R54	Fumanat	1,632	0	0	0	0	0	0	3,300	8,507	4,625	4,693	3,664	0	24,788	15,189
R55	East Gilan	200	0	0	0	0	0	0	325	837	461	461	386	0	2,469	12,344
R56	Sefidrud Left	5,890	0	0	0	0	0	0	7,550	19,512	10,635	10,757	7,790	0	56,244	
R57	Sefidrud Right	13,130	0	0	0	0	0	0	22,152	56,988	31,050	31,429	22,720	0	164,338	
Total		21,405	0	0	0	0	0	0	34,265	88,265	48,104	48,672	35,674	0	254,980	11,912

Source: Pandam Study Report/ Vol.4 Note: Water demand from Sefidrud river is not included in this table. Present irrigation efficiency is estimated as 42%

Table R 6.2.18 Irrigation Demand from Groundwater in Gilan in the Middle Term (2016)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	553	0	0	0	0	0	0	821	2,118	1,166	1,166	976	0	6,248	11,299
R54	Fumanat	1,632	0	0	0	0	0	0	2,888	7,443	4,047	4,106	3,206	0	21,690	13,290
R55	East Gilan	200	0	0	0	0	0	0	284	732	403	403	337	0	2,160	10,801
R56	Sefidrud Left	5,890	0	0	0	0	0	0	6,606	17,073	9,305	9,412	6,817	0	49,213	
R57	Sefidrud Right	13,130	0	0	0	0	0	0	19,383	49,865	27,169	27,500	19,880	0	143,796	
Total		21,405	0	0	0	0	0	0	29,982	77,232	42,091	42,588	31,215	0	223,107	10,423

Source: Pandam Study Report/ Vol.4 Note: Water Demand from Sefidrud River is not included in this table. Middle term irrigation efficiency is estimated as 50%

Table R 6.2.19 Irrigation Demand from Groundwater in Gilan in the Long Term (2031)

(Unit: 000m^3)

Reach		Irrigation Area (ha)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Unit Requirement (m^3/ha)
R53	Central Gilan	553	0	0	0	0	0	0	717	1,849	1,018	1,018	852	0	5,453	9,861
R54	Fumanat	1,632	0	0	0	0	0	0	2,520	6,496	3,532	3,583	2,798	0	18,929	11,599
R55	East Gilan	200	0	0	0	0	0	0	248	639	352	352	294	0	1,885	9,426
R56	Sefidrud Left	5,890	0	0	0	0	0	0	5,765	14,900	8,121	8,214	5,949	0	42,950	
R57	Sefidrud Right	13,130	0	0	0	0	0	0	16,916	43,518	23,711	24,000	17,349	0	125,494	
Total		21,405	0	0	0	0	0	0	26,166	67,402	36,734	37,167	27,242	0	194,712	9,097

Source: Pandam Study Report/ Vol.4 Note: Water Demand from Sefidrud River is not included in this table. Long term irrigation efficiency is estimated as 55%

Table R 6.2.20 Present Irrigation Demand in SIDN from Sefidrud River (2006)

(Unit: '000m^3)

Name of Weir		Irrigation Area (ha)	Oct Meh.	Nov Aba.	Dec Aza.	Jan Dey.	Feb Bah.	Mar Esf.	Apr Far.	May Ord.	Jun Kho.	Jul Tir	Aug Mor.	Sep Sha.	Total
Tarik		42,489	1,354	1,197	1,134	1,117	1,141	1,379	85,709	85,709	85,709	85,709	85,709	1,587	437,454
Gelerud		2,737	280	247	235	231	236	285	4,303	11,848	7,618	6,088	5,142	328	36,840
Sangar	Left Canal	64,272	5,350	4,723	4,483	4,410	4,507	5,442	115,222	311,491	192,398	163,190	137,817	6,265	955,300
	Right Canal	46,465	691	610	579	570	582	703	76,162	198,253	111,863	108,088	90,533	810	589,443
	Sub-total	110,737	6,041	5,333	5,062	4,980	5,089	6,145	191,384	509,744	304,261	271,278	228,350	7,075	1,544,743
Total		155,963	7,675	6,777	6,431	6,328	6,466	7,809	281,396	607,301	397,588	363,075	319,201	8,990	2,019,037

Source: Pandam Consultant and Gilan RWC

Table R 6.2.21 Irrigation Demand in SIDN from Sefidrud River in the Middle Term (2016)

(Unit: '000m^3)

Name of Weir		Irrigation Area (ha)	Oct Meh.	Nov Aba.	Dec Aza.	Jan Dey.	Feb Bah.	Mar Esf.	Apr Far.	May Ord.	Jun Kho.	Jul Tir	Aug Mor.	Sep Sha.	Total
Tarik		42,489	1,185	1,047	992	977	998	1,207	76,373	85,709	85,709	85,709	84,989	1,389	426,284
Gelerud		2,737	245	216	206	202	207	249	3,765	10,367	6,665	5,327	4,499	287	32,235
Sangar	Left Canal	64,272	4,681	4,133	3,923	3,859	3,944	4,762	100,820	386,866	196,067	165,573	120,590	5,482	1,000,697
	Right Canal	46,465	605	534	507	499	509	615	66,641	173,471	97,880	94,577	79,217	709	515,763
	Sub-total	110,737	5,286	4,666	4,429	4,358	4,453	5,377	167,461	560,337	293,947	260,149	199,807	6,191	1,516,460
Total		155,963	6,716	5,930	5,627	5,537	5,658	6,833	247,599	656,413	386,321	351,185	289,295	7,866	1,974,980

Source: Pandam Consultant and Gilan RWC

Table R 6.2.22 Irrigation Demand in SIDN from Sefidrud River in the Long Term (2031)

(Unit: '000m^3)

Name of Weir		Irrigation Area (ha)	Oct Meh.	Nov Aba.	Dec Aza.	Jan Dey.	Feb Bah.	Mar Esf.	Apr Far.	May Ord.	Jun Kho.	Jul Tir	Aug Mor.	Sep Sha.	Total
Alamut River															
Almout		24,194													
Sefidrud River															
Tarik		42,489	1,034	914	866	853	871	1,053	66,653	85,709	85,709	85,709	74,172	1,212	404,755
Gelerud		2,737	214	189	179	176	180	218	3,286	9,048	5,817	4,649	3,927	250	28,133
Sangar	Left Canal	64,272	4,085	3,607	3,423	3,368	3,442	4,156	87,988	326,720	160,205	133,591	105,242	4,784	840,611
	Right Canal	46,465	528	466	442	435	444	537	58,160	151,393	85,422	82,540	69,135	619	450,120
	Sub-total	110,737	4,613	4,072	3,866	3,803	3,886	4,693	146,148	478,113	245,627	216,131	174,377	5,403	1,290,731
Total		155,963	5,861	5,175	4,911	4,832	4,938	5,963	216,087	572,869	337,153	306,489	252,475	6,865	1,723,619

Source: Pandam Consultant and Gilan RWC

Table R 6.2.23 Present Irrigation Demand from Large Dam (2006)

Reach No.	Dam/ Reservoir	Province	Zone	Land Area (ha)			Gross Need (1000m3)														Data Source (M/G Roport)
				Develop.	Improve.	Total	Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.		
							Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Total	
R53	Manjil	GIL	E	Irrigation water demand from Manjil dam calculated in Table R 6.2.20 (Tarik, Gelerud and Sangar weirs)																
R36	Taleghan	THN	D	-	-	30,000	4,606	15,524	0	0	0	0	16,986	60,348	83,003	58,975	41,790	28,768	310,000	WRMC's letter
R43	Golblagh	KOR	A	800	0	800	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586	Table(4-37)
Total				800	0	30,800	5,041	15,537	0	0	0	0	17,022	60,980	84,304	60,628	43,452	29,622	316,586	

Source: WRMC

Table R 6.2.24 Irrigation Demand from Large Dam in the Middle Term (2016)

Reach No.	Dam/ Reservoir	Province	Zone	Land Area (ha)			Gross Need (1000m3)													Data Source (M/G Roport)
				Develop.	Improve.	Total	Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.		
							Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Total	
R53	Manjil	GIL	E	Irrigation water demand from Manjil dam calculated in Table R 6.2.20 (Tarik, Gelerud and Sangar weirs)																
R36	Taleghan	THN	D	-	-	30,000	4,606	15,524	0	0	0	0	16,986	60,348	83,003	58,975	41,790	28,768	310,000	WRMC's letter
R43	Golblagh	KOR	A	800	0	800	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586	Table(4-37)
R59	Givi	ARD	C	6,300	927	7,227	4,566	568	0	0	0	0	967	6,031	15,231	23,896	22,005	10,592	83,856	Table(4-22)
R11	Ostor	EAZ	C	6,500	0	6,500	3,400	460	120	0	0	450	2,790	7,480	14,530	17,840	16,330	9,180	72,580	Table(4-39)
R10	Sahand	EAZ	B	10,300	600	10,900	3,140	1,500	0	0	0	0	2,230	6,460	17,420	26,400	2,463	11,220	70,833	Table(4-39)
R18	Ayudughmush	EAZ	C	13,700	1,300	15,000	6,489	649	433	0	0	0	119	9,625	26,280	43,475	38,392	24,441	149,903	RWC
R02	Germichay	EAZ	C	2,300	1,200	3,500	2,372	185	72	0	0	285	1,593	6,068	7,085	8,126	7,327	3,886	36,999	Table(4-39)
R08	Kalghan	EAZ	B	1,500	1,090	2,590	483	27	0	0	0	0	0	736	3,922	6,054	5,205	1,689	18,116	Table(4-39)
R40	Siazakh	KOR	A	21,246	754	22,000	8,468	2,698	0	0	0	0	8,126	19,061	29,941	29,695	25,633	18,763	142,385	Table(4-37)
R52	Sange siah	KOR	A	3,400	0	3,400	3,110	338	0	0	0	0	858	4,448	9,107	5,673	4,831	3,872	32,237	Table(4-37)
R51	Sural	KOR	A	1,008	192	1,200	707	82	0	0	0	0	142	637	1,543	1,858	1,781	1,369	8,119	Table(4-37)
R63	Golabar	ZAN	B	7,900	1,400	9,300	4,268	57	0	0	0	0	0	3,609	11,017	15,260	15,291	8,034	57,536	Table(4-29)
R24	Taham	ZAN	B	400	0	400	217	6	0	0	0	0	18	316	650	826	831	427	3,291	Ref. Alan
R45	Talvar	ZAN	A	29,500	0	29,500	16,035	475	475	0	0	0	1,332	23,314	47,961	60,951	61,284	31,498	243,326	RWC
Total				104,854	7,463	142,317	58,296	22,582	1,100	0	0	735	35,197	148,765	268,991	300,682	244,825	154,593	1,235,767	

Table R 6.2.25 Irrigation Demand from Large Dam in the Long Term (2031)

Reach No.	Dam/ Reservoir	Province	Zone	Land Area (ha)			Gross Need (1000m3)												
				Develop.	Improve	Total	Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	
							Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Total
R53	Manjil	GIL	E	-	-	-	Irrigation water demand from Manjil dam calculated in Table R 6.2.20 (Tarik, Gelerud and Sangar weirs)												
R36	Taleghan	THN	D	-	-	13,065	2,006	6,761	0	0	0	0	7,397	26,282	36,148	25,684	18,200	12,528	135,005
R43	Golblagh	KOR	A	800	0	800	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586
R59.	Givi	ARD	C	6,300	927	7,227	4,566	568	0	0	0	0	967	6,031	15,231	23,896	22,005	10,592	83,856
R11	Ostor	EAZ	C	6,500	0	6,500	3,400	460	120	0	0	450	2,790	7,480	14,530	17,840	16,330	9,180	72,580
R10	Sahand	EAZ	B	10,300	600	10,900	3,140	1,500	0	0	0	0	2,230	6,460	17,420	26,400	2,463	11,220	70,833
R18	Ayudughmush	EAZ	C	13,700	1,300	15,000	6,489	649	433	0	0	0	119	9,625	26,280	43,475	38,392	24,441	149,903
R02	Germichay	EAZ	C	2,300	1,200	3,500	2,372	185	72	0	0	285	1,593	6,068	7,085	8,126	7,327	3,886	36,999
R08	Kalghan	EAZ	B	1,500	1,090	2,590	483	27	0	0	0	0	0	736	3,922	6,054	5,205	1,689	18,116
R40	Siazakh	KOR	A	21,246	754	22,000	8,468	2,698	0	0	0	0	8,126	19,061	29,941	29,695	25,633	18,763	142,385
R52	Sange siah	KOR	A	3,400	0	3,400	3,110	338	0	0	0	0	858	4,448	9,107	5,673	4,831	3,872	32,237
R51	Sural	KOR	A	1,008	192	1,200	707	82	0	0	0	0	142	637	1,543	1,858	1,781	1,369	8,119
R63	Golabar	ZAN	B	7,900	1,400	9,300	4,268	57	0	0	0	0	0	3,609	11,017	15,260	15,291	8,034	57,536
R24	Taham	ZAN	B	400	0	400	217	6	0	0	0	0	18	316	650	826	831	427	3,291
R45	Talvar	ZAN	A	29,500	0	29,500	16,035	475	475	0	0	0	1,332	23,314	47,961	60,951	61,284	31,498	243,326
R01	Sangabad	ARD	C	1,625	600	2,225	769	125	0	0	0	0	211	1,214	3,310	7,760	7,604	3,185	24,178
R12	Niakhoram	ARD	C	675	225	900	311	51	0	0	0	0	85	491	1,339	3,139	3,076	1,288	9,780
R07	Tabrizak	ARD	C	450	150	600	207	34	0	0	0	0	57	327	893	2,093	2,051	859	6,521
R16	Khoresh Rostan	ARD	C	5,100	0	5,100	1,761	286	0	0	0	0	483	2,781	7,589	17,789	17,428	7,303	55,420
R49	Alan	HAM	A	90	310	400	217	6	0	0	0	0	18	316	650	826	831	427	3,291
R65	Sir	KOR	A	0	0	6,000	2,170	730	120	0	20	510	4,030	9,560	15,480	14,180	11,460	4,440	62,700
R64	Babakhan	KOR	B	5,950	50	6,000	3261	97	0	0	0	0	271	4,742	9,755	12,397	12,465	6,406	49,394
R42	Zardekamar	KOR	A	5,000	2,500	7,500	2,887	920	0	0	0	0	2,770	6,498	10,207	10,123	8,739	6,396	48,540
R34	Sheikh Besharat	KOR	B	0	1,500	1,500	815	24	0	0	0	0	68	1,185	2,439	3,099	3,116	1,602	12,348
R41	Aleh dare	KOR	A	0	2,100	2,100	1,179	159	0	0	0	0	567	2,853	6,003	4,959	2,352	1,980	20,052
R32	Burmanak	QAZ	C	1,079	1,201	2,280	1,917	149	0	0	0	0	1,350	3,091	5,947	7,268	5,968	3,843	29,533
R22	Mushampa	ZAN	B	26,000	4,000	30,000	7,618	2,292	2,508	0	0	1,177	27,190	83,567	86,373	46,898	40,429	25,139	323,191
R26	Marash	ZAN	B	4,226	259	4,485	1,139	343	475	0	0	176	4,065	12,493	12,913	7,011	6,044	3,758	48,417
R39	Mendagh	ZAN	A	9,000	0	9,000	4,993	2,501	2,501	0	0	0	6,613	17,257	21,647	11,930	7,126	3,482	78,050
R31	Mehtar	ZAN	B	900	100	1,000	99	0	0	0	0	0	33	366	1,746	2,581	1,800	1,050	7,675
R29	Songhor	ZAN	B	900	900	1,800	363	23	0	0	0	0	71	464	1,618	2,473	2,088	1,349	8,449
R30	Ghareh Darangh	ZAN	B	4,214	926	5,140	2,359	32	0	0	0	0	0	1,995	6,089	8,434	8,451	4,440	31,800
R38	Chesb	ZAN	A	912	270	1,182	562	43	43	0	0	0	164	688	1,787	2,458	2,616	1,991	10,352
R28	Ghezel Tapeh	ZAN	B	450	108	558	53	0	0	0	0	0	17	210	1,040	1,471	1,017	509	4,317
R33	Ramin	ZAN	B	0	196	196	0	0	0	0	0	0	0	294	508	508	401	294	2,005
Total				171,425	22,858	213,348	88,376	21,634	6,747	0	20	2,598	73,672	265,091	419,469	434,787	366,297	218,095	1,896,785

6.2.2 Water Demand for Domestic Water

The water demand for domestic water was calculated based on the population forecast and unit water requirement in the Mahab Ghodss Study Report which had been offered from WRMC. A comprehensive water loss from the water resources to the beneficiary was set as shown in Table R 6.2.26.

Table R 6.2.26 Water Loss in Domestic Water Supply

Water Resources	Treatment Loss	Distribution Loss	Total Loss
Surface Water	0.2	0.35	0.48
Groundwater	-	-	0.35

The water demands by zones are summarized in Table R 6.2.27.

Table R 6.2.27 Domestic Water Demand in Each Zone

(Unit: MCM)

Target Year	Item	Water Resources	A	B	C	D	E	Total
Present (2006/1385)	Rural	Groundwater	35.2	41.9	12.2	4.1	113.0	206.4
	Urban	Groundwater	20.3	6.1	9.9	0.0	22.2	58.5
		Surface Water	0.0	55.1	14.0	150.0	124.8	343.9
		Sub-total	20.3	61.2	23.9	150.0	147.0	402.4
	Total		55.5	103.1	36.1	154.1	260.0	608.8
Middle Term (2016/1395)	Rural	Groundwater	54.0	62.0	17.8	5.6	150.3	289.7
	Urban	Groundwater	27.7	7.8	13.4	0.0	22.4	71.3
		Surface Water	95.0	70.2	17.9	150.0	164.8	497.9
		Sub-total	122.7	78.0	31.3	150.0	187.2	569.2
	Total		176.7	140.0	49.1	155.6	337.5	858.9
Long Term (2031/1410)	Rural	Groundwater	82.2	92.3	26.1	7.9	206.3	414.8
	Urban	Groundwater	42.4	10.8	9.8	0.0	31.1	94.1
		Surface Water	95.0	8.5	24.6	150.0	320.7	598.8
		Sub-total	137.4	19.3	34.4	150.0	351.8	692.9
	Total		219.6	111.6	60.5	157.9	558.1	1,107.7

In addition, the water demands by the Reaches for the rural water supply and the urban water supply are summarized corresponding to the target years as shown in Tables from Table R 6.2.28 to Table R 6.2.33.

Table R 6.2.28 Present Rural Water Demand in Reach (2006)

Reach Code	Related Dam	Province	Water Demand ('000m^3)												Total
			Meh. 30 Oct.	Aba. 30 Nov.	Aza. 30 Dec.	Dey 30 Jan.	Bah. 30 Feb.	Esf. 29 Mar.	Far. 31 Apr.	Ord. 31 May	Kho. 31 Jun.	Tir 31 Jul.	Mor. 31 Aug.	Sha. 31 Sep.	
R01	Sangabad Dam	ARD	19.2	19.2	19.2	19.2	19.2	18.6	19.8	19.8	19.8	19.8	19.8	19.8	233.5
R02	Garmichay dam	EAZ	58.0	58.0	58.0	58.0	58.0	56.1	60.0	60.0	60.0	60.0	60.0	60.0	706.1
R03		ARD	57.4	57.4	57.4	57.4	57.4	55.5	59.3	59.3	59.3	59.3	59.3	59.3	698.4
R04		EAZ	137.9	137.9	137.9	137.9	137.9	133.3	142.5	142.5	142.5	142.5	142.5	142.5	1,677.8
R05		EAZ	140.3	140.3	140.3	140.3	140.3	135.6	145.0	145.0	145.0	145.0	145.0	145.0	1,706.9
R06		EAZ	59.6	59.6	59.6	59.6	59.6	57.6	61.6	61.6	61.6	61.6	61.6	61.6	725.1
R07	Tabrizak Dam	ARD	4.4	4.4	4.4	4.4	4.4	4.2	4.5	4.5	4.5	4.5	4.5	4.5	53.1
R08	Kalghan Dam	EAZ	28.5	28.5	28.5	28.5	28.5	27.5	29.4	29.4	29.4	29.4	29.4	29.4	346.6
R09		EAZ	14.4	14.4	14.4	14.4	14.4	13.9	14.9	14.9	14.9	14.9	14.9	14.9	175.1
R10	Sahand dam	EAZ	108.3	108.3	108.3	108.3	108.3	104.7	111.9	111.9	111.9	111.9	111.9	111.9	1,317.2
R11	Ostur Dam	EAZ	122.5	122.5	122.5	122.5	122.5	118.4	126.6	126.6	126.6	126.6	126.6	126.6	1,490.4
R12	Niyakhram dam	ARD	6.6	6.6	6.6	6.6	6.6	6.4	6.8	6.8	6.8	6.8	6.8	6.8	80.5
R13		ARD	14.6	14.6	14.6	14.6	14.6	14.1	15.1	15.1	15.1	15.1	15.1	15.1	177.5
R14	Befrajerd dam	ARD	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	15.0
R15		ARD	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.0
R16	Koresh Rostam	ARD	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	12.8
R17		EAZ	469.3	469.3	469.3	469.3	469.3	453.6	484.9	484.9	484.9	484.9	484.9	484.9	5,709.3
R18	Aydughmush Dam	EAZ	222.0	222.0	222.0	222.0	222.0	214.6	229.4	229.4	229.4	229.4	229.4	229.4	2,701.5
R19		GIL	1,112.3	1,112.3	1,112.3	1,112.3	1,112.3	1,075.2	1,149.3	1,149.3	1,149.3	1,149.3	1,149.3	1,149.3	13,532.5
R20		ZAN	495.1	495.1	495.1	495.1	495.1	478.6	511.6	511.6	511.6	511.6	511.6	511.6	6,023.3
R21	Manjil dam	QAZ	169.8	169.8	169.8	169.8	169.8	164.2	175.5	175.5	175.5	175.5	175.5	175.5	2,066.4
R22	Mushampa dam	ZAN	103.6	103.6	103.6	103.6	103.6	100.2	107.1	107.1	107.1	107.1	107.1	107.1	1,260.7
R23		GIL	501.5	501.5	501.5	501.5	501.5	484.8	518.3	518.3	518.3	518.3	518.3	518.3	6,102.0
R24	Taham dam	ZAN	27.8	27.8	27.8	27.8	27.8	26.8	28.7	28.7	28.7	28.7	28.7	28.7	337.9
R25		QAZ	268.1	268.1	268.1	268.1	268.1	259.2	277.1	277.1	277.1	277.1	277.1	277.1	3,262.5
R26		ZAN	427.2	427.2	427.2	427.2	427.2	413.0	441.4	441.4	441.4	441.4	441.4	441.4	5,197.6
R27		ZAN	222.0	222.0	222.0	222.0	222.0	214.6	229.4	229.4	229.4	229.4	229.4	229.4	2,700.7
R28	Ghezel tappe dam	ZAN	12.5	12.5	12.5	12.5	12.5	12.1	12.9	12.9	12.9	12.9	12.9	12.9	151.7
R29	Songhor dam	ZAN	16.5	16.5	16.5	16.5	16.5	16.0	17.1	17.1	17.1	17.1	17.1	17.1	201.2
R30		ZAN	206.2	206.2	206.2	206.2	206.2	199.4	213.1	213.1	213.1	213.1	213.1	213.1	2,509.2
R31	Mehtar dam	ZAN	21.9	21.9	21.9	21.9	21.9	21.2	22.6	22.6	22.6	22.6	22.6	22.6	266.6
R32	Burmanak dam	QAZ	19.7	19.7	19.7	19.7	19.7	19.0	20.4	20.4	20.4	20.4	20.4	20.4	239.7
R33	Ramin dam	ZAN	10.6	10.6	10.6	10.6	10.6	10.2	10.9	10.9	10.9	10.9	10.9	10.9	128.8
R34	Sheikhebesharat dam	KOR	60.0	60.0	60.0	60.0	60.0	58.0	62.0	62.0	62.0	62.0	62.0	62.0	730.2
R35		KOR	58.8	58.8	58.8	58.8	58.8	56.8	60.7	60.7	60.7	60.7	60.7	60.7	715.3
R36	Taleghan dam	THN	64.7	64.7	64.7	64.7	64.7	62.5	66.8	66.8	66.8	66.8	66.8	66.8	786.8
R37		KOR	270.4	270.4	270.4	270.4	270.4	261.4	279.4	279.4	279.4	279.4	279.4	279.4	3,290.0
R38	Chasb dam	ZAN	24.5	24.5	24.5	24.5	24.5	23.7	25.4	25.4	25.4	25.4	25.4	25.4	298.6
R39	Mendagh dam	ZAN	5.3	5.3	5.3	5.3	5.3	5.1	5.5	5.5	5.5	5.5	5.5	5.5	64.4
R40	Siyazakh dam	KOR	140.5	140.5	140.5	140.5	140.5	135.9	145.2	145.2	145.2	145.2	145.2	145.2	1,709.9
R41		KOR	76.6	76.6	76.6	76.6	76.6	74.0	79.1	79.1	79.1	79.1	79.1	79.1	931.8
R42	Zardekamar dam	KOR	115.2	115.2	115.2	115.2	115.2	111.3	119.0	119.0	119.0	119.0	119.0	119.0	1,401.2
R43	Golblakh dam	KOR	33.5	33.5	33.5	33.5	33.5	32.4	34.6	34.6	34.6	34.6	34.6	34.6	407.7
R44		KOR	232.9	232.9	232.9	232.9	232.9	225.1	240.6	240.6	240.6	240.6	240.6	240.6	2,833.1
R45	Talvar dam	ZAN	47.1	47.1	47.1	47.1	47.1	45.6	48.7	48.7	48.7	48.7	48.7	48.7	573.6
R46	Aledareh dam	KOR	13.2	13.2	13.2	13.2	13.2	12.8	13.6	13.6	13.6	13.6	13.6	13.6	160.5
R47	Hassankhan dam	KOR	270.3	270.3	270.3	270.3	270.3	261.3	279.3	279.3	279.3	279.3	279.3	279.3	3,289.1
R48		KOR	125.4	125.4	125.4	125.4	125.4	121.2	129.5	129.5	129.5	129.5	129.5	129.5	1,525.2
R49	Alan dam	HAM	330.9	330.9	330.9	330.9	330.9	319.9	341.9	341.9	341.9	341.9	341.9	341.9	4,026.2
R50		KOR	22.9	22.9	22.9	22.9	22.9	22.1	23.6	23.6	23.6	23.6	23.6	23.6	278.2
R51	Sural dam	KOR	6.5	6.5	6.5	6.5	6.5	6.3	6.7	6.7	6.7	6.7	6.7	6.7	79.0
R52	Sangesiyah dam	KOR	32.9	32.9	32.9	32.9	32.9	31.8	34.0	34.0	34.0	34.0	34.0	34.0	400.8
R53	Central Gilan	GIL	1,247.0	1,247.0	1,247.0	1,247.0	1,247.0	1,205.5	1,288.6	1,288.6	1,288.6	1,288.6	1,288.6	1,288.6	15,172.4
R54	Fumanat	GIL	1,387.3	1,387.3	1,387.3	1,387.3	1,387.3	1,341.0	1,433.5	1,433.5	1,433.5	1,433.5	1,433.5	1,433.5	16,878.5
R55	East Gilan	GIL	1,031.0	1,031.0	1,031.0	1,031.0	1,031.0	996.6	1,065.3	1,065.3	1,065.3	1,065.3	1,065.3	1,065.3	12,543.6
R56	Sefidrud Left	GIL	2,847.1	2,847.1	2,847.1	2,847.1	2,847.1	2,752.2	2,942.0	2,942.0	2,942.0	2,942.0	2,942.0	2,942.0	34,639.8
R57	Sefidrud Right	GIL	904.9	904.9	904.9	904.9	904.9	874.7	935.0	935.0	935.0	935.0	935.0	935.0	11,009.3
R59	Givi dam	ARD	55.1	55.1	55.1	55.1	55.1	53.3	57.0	57.0	57.0	57.0	57.0	57.0	670.6
R60		EAZ	345.9	345.9	345.9	345.9	345.9	334.4	357.4	357.4	357.4	357.4	357.4	357.4	4,208.6
R61		ARD	414.1	414.1	414.1	414.1	414.1	400.3	428.0	428.0	428.0	428.0	428.0	428.0	5,038.8
R62		GIL	260.3	260.3	260.3	260.3	260.3	251.6	268.9	268.9	268.9	268.9	268.9	268.9	3,166.6
R63	Golabar dam	ZAN	189.4	189.4	189.4	189.4	189.4	183.0	195.7	195.7	195.7	195.7	195.7	195.7	2,303.8
R64	Babakhan dam	KOR	123.1	123.1	123.1	123.1	123.1	119.0	127.2	127.2	127.2	127.2	127.2	127.2	1,498.1
R65	Sir dam	KOR	59.4	59.4	59.4	59.4	59.4	57.4	61.3	61.3	61.3	61.3	61.3	61.3	722.1
R66		ZAN	989.6	989.6	989.6	989.6	989.6	956.6	1,022.6	1,022.6	1,022.6	1,022.6	1,022.6	1,022.6	12,040.3
R67		KOR	97.1	97.1	97.1	97.1	97.1	93.9	100.4	100.4	100.4	100.4	100.4	100.4	1,181.6
Total			16,963.5	16,963.5	16,963.5	16,963.5	16,963.5	16,398.0	17,528.9	17,528.9	17,528.9	17,528.9	17,528.9	17,528.9	206,389.2

Source: WRMC Note: 35% of overall loss from water resources to beneficiaries was considered

Table R 6.2.29 Rural Water Demand in Reach in the Middle Term (2016)

Reach Code	Related Dam	Province	Water Demand ('000m^3)												Total
			Meh. 30 Oct.	Aba. 30 Nov.	Aza. 30 Dec.	Dey 30 Jan.	Bah. 30 Feb.	Esf. 29 Mar.	Far. 31 Apr.	Ord. 31 May	Kho. 31 Jun.	Tir 31 Jul.	Mor. 31 Aug.	Sha. 31 Sep.	
R01	Sangabad Dam	ARD	28.2	28.2	28.2	28.2	28.2	27.3	29.2	29.2	29.2	29.2	29.2	29.2	343.2
R02	Garmichay dam	EAZ	84.4	84.4	84.4	84.4	84.4	81.6	87.2	87.2	87.2	87.2	87.2	87.2	1,026.6
R03		ARD	6.4	6.4	6.4	6.4	6.4	6.2	6.6	6.6	6.6	6.6	6.6	6.6	78.1
R04		EAZ	9.7	9.7	9.7	9.7	9.7	9.4	10.1	10.1	10.1	10.1	10.1	10.1	118.4
R05		EAZ	21.4	21.4	21.4	21.4	21.4	20.7	22.2	22.2	22.2	22.2	22.2	22.2	260.9
R06		EAZ	1.8	1.8	1.8	1.8	1.8	1.7	1.9	1.9	1.9	1.9	1.9	1.9	22.0
R07	Tabrizak Dam	ARD	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.7
R08	Kalghan Dam	EAZ	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	18.7
R09		EAZ	81.0	81.0	81.0	81.0	81.0	78.3	83.7	83.7	83.7	83.7	83.7	83.7	985.8
R10	Sahand dam	EAZ	608.8	608.8	608.8	608.8	608.8	588.5	629.1	629.1	629.1	629.1	629.1	629.1	7,406.7
R11	Ostur Dam	EAZ	85.4	85.4	85.4	85.4	85.4	82.6	88.3	88.3	88.3	88.3	88.3	88.3	1,039.4
R12	Niyakhram dam	ARD	203.0	203.0	203.0	203.0	203.0	196.2	209.8	209.8	209.8	209.8	209.8	209.8	2,469.8
R13		ARD	206.5	206.5	206.5	206.5	206.5	199.6	213.4	213.4	213.4	213.4	213.4	213.4	2,512.6
R14	Befrajerd dam	ARD	87.7	87.7	87.7	87.7	87.7	84.8	90.6	90.6	90.6	90.6	90.6	90.6	1,067.3
R15		ARD	41.9	41.9	41.9	41.9	41.9	40.5	43.3	43.3	43.3	43.3	43.3	43.3	510.1
R16	Koresh Rostam	ARD	21.2	21.2	21.2	21.2	21.2	20.5	21.9	21.9	21.9	21.9	21.9	21.9	257.8
R17		EAZ	159.4	159.4	159.4	159.4	159.4	154.1	164.7	164.7	164.7	164.7	164.7	164.7	1,938.9
R18	Aydughmush Dam	EAZ	180.3	180.3	180.3	180.3	180.3	174.3	186.3	186.3	186.3	186.3	186.3	186.3	2,193.9
R19		GIL	690.8	690.8	690.8	690.8	690.8	667.7	713.8	713.8	713.8	713.8	713.8	713.8	8,404.3
R20		ZAN	326.9	326.9	326.9	326.9	326.9	316.0	337.8	337.8	337.8	337.8	337.8	337.8	3,976.7
R21	Sefidrud dam	QAZ	509.2	509.2	509.2	509.2	509.2	492.2	526.2	526.2	526.2	526.2	526.2	526.2	6,195.3
R22	Mushampa dam	ZAN	1,479.2	1,479.2	1,479.2	1,479.2	1,479.2	1,429.9	1,528.5	1,528.5	1,528.5	1,528.5	1,528.5	1,528.5	17,996.9
R23		GIL	667.0	667.0	667.0	667.0	667.0	644.8	689.2	689.2	689.2	689.2	689.2	689.2	8,115.1
R24	Taham dam	ZAN	1,658.5	1,658.5	1,658.5	1,658.5	1,658.5	1,603.2	1,713.7	1,713.7	1,713.7	1,713.7	1,713.7	1,713.7	20,177.8
R25		QAZ	1,844.9	1,844.9	1,844.9	1,844.9	1,844.9	1,783.4	1,906.4	1,906.4	1,906.4	1,906.4	1,906.4	1,906.4	22,446.8
R26		ZAN	1,371.1	1,371.1	1,371.1	1,371.1	1,371.1	1,325.4	1,416.8	1,416.8	1,416.8	1,416.8	1,416.8	1,416.8	16,681.7
R27		ZAN	3,786.4	3,786.4	3,786.4	3,786.4	3,786.4	3,660.2	3,912.6	3,912.6	3,912.6	3,912.6	3,912.6	3,912.6	46,067.5
R28	Ghezel tappe dam	ZAN	1,203.4	1,203.4	1,203.4	1,203.4	1,203.4	1,163.3	1,243.5	1,243.5	1,243.5	1,243.5	1,243.5	1,243.5	14,641.3
R29	Songhor dam	ZAN	346.1	346.1	346.1	346.1	346.1	334.6	357.7	357.7	357.7	357.7	357.7	357.7	4,211.3
R30		ZAN	330.9	330.9	330.9	330.9	330.9	319.9	341.9	341.9	341.9	341.9	341.9	341.9	4,026.2
R31	Mehtar dam	ZAN	131.9	131.9	131.9	131.9	131.9	127.5	136.3	136.3	136.3	136.3	136.3	136.3	1,605.1
R32	Burmanak dam	QAZ	129.2	129.2	129.2	129.2	129.2	124.9	133.5	133.5	133.5	133.5	133.5	133.5	1,572.1
R33	Ramin dam	ZAN	594.3	594.3	594.3	594.3	594.3	574.5	614.2	614.2	614.2	614.2	614.2	614.2	7,231.2
R34	Sheikhebesharat dam	KOR	308.9	308.9	308.9	308.9	308.9	298.6	319.2	319.2	319.2	319.2	319.2	319.2	3,758.3
R35		KOR	168.3	168.3	168.3	168.3	168.3	162.7	174.0	174.0	174.0	174.0	174.0	174.0	2,048.1
R36	Talaghan dam	THN	253.1	253.1	253.1	253.1	253.1	244.7	261.6	261.6	261.6	261.6	261.6	261.6	3,079.8
R37		KOR	73.6	73.6	73.6	73.6	73.6	71.2	76.1	76.1	76.1	76.1	76.1	76.1	896.1
R38	Chasb dam	ZAN	511.8	511.8	511.8	511.8	511.8	494.8	528.9	528.9	528.9	528.9	528.9	528.9	6,227.1
R39	Mendagh dam	ZAN	29.0	29.0	29.0	29.0	29.0	28.0	30.0	30.0	30.0	30.0	30.0	30.0	352.9
R40	Siyazakh dam	KOR	594.2	594.2	594.2	594.2	594.2	574.4	614.0	614.0	614.0	614.0	614.0	614.0	7,229.2
R41		KOR	275.5	275.5	275.5	275.5	275.5	266.4	284.7	284.7	284.7	284.7	284.7	284.7	3,352.4
R42	Zardekamar dam	KOR	50.3	50.3	50.3	50.3	50.3	48.6	51.9	51.9	51.9	51.9	51.9	51.9	611.5
R43	Golblakh dam	KOR	14.3	14.3	14.3	14.3	14.3	13.8	14.7	14.7	14.7	14.7	14.7	14.7	173.6
R44		KOR	72.4	72.4	72.4	72.4	72.4	70.0	74.8	74.8	74.8	74.8	74.8	74.8	881.0
R45	Talvar dam	ZAN	270.6	270.6	270.6	270.6	270.6	261.6	279.7	279.7	279.7	279.7	279.7	279.7	3,292.7
R46	Aledareh dam	KOR	130.5	130.5	130.5	130.5	130.5	126.1	134.8	134.8	134.8	134.8	134.8	134.8	1,587.2
R47	Hassankhan dam	KOR	213.5	213.5	213.5	213.5	213.5	206.3	220.6	220.6	220.6	220.6	220.6	220.6	2,597.1
R48		KOR	234.7	234.7	234.7	234.7	234.7	226.9	242.5	242.5	242.5	242.5	242.5	242.5	2,855.2
R49	Alan dam	HAM	370.5	370.5	370.5	370.5	370.5	358.2	382.9	382.9	382.9	382.9	382.9	382.9	4,507.9
R50		KOR	27.2	27.2	27.2	27.2	27.2	26.3	28.1	28.1	28.1	28.1	28.1	28.1	331.2
R51	Sural dam	KOR	89.4	89.4	89.4	89.4	89.4	86.4	92.3	92.3	92.3	92.3	92.3	92.3	1,087.2
R52	Sangsiyah dam	KOR	731.8	731.8	731.8	731.8	731.8	707.4	756.2	756.2	756.2	756.2	756.2	756.2	8,903.6
R53	Central Gilan	GIL	153.2	153.2	153.2	153.2	153.2	148.1	158.3	158.3	158.3	158.3	158.3	158.3	1,863.6
R54	Fumanat	GIL	41.0	41.0	41.0	41.0	41.0	39.7	42.4	42.4	42.4	42.4	42.4	42.4	499.4
R55	East Gilan	GIL	631.5	631.5	631.5	631.5	631.5	610.4	652.5	652.5	652.5	652.5	652.5	652.5	7,683.0
R56	Sefidrud Left	GIL	328.1	328.1	328.1	328.1	328.1	317.2	339.1	339.1	339.1	339.1	339.1	339.1	3,992.1
R57	Sefidrud Right	GIL	18.4	18.4	18.4	18.4	18.4	17.8	19.0	19.0	19.0	19.0	19.0	19.0	224.2
R59	Givi dam	ARD	24.4	24.4	24.4	24.4	24.4	23.6	25.3	25.3	25.3	25.3	25.3	25.3	297.4
R60		EAZ	304.8	304.8	304.8	304.8	304.8	294.7	315.0	315.0	315.0	315.0	315.0	315.0	3,709.0
R61		ARD	32.4	32.4	32.4	32.4	32.4	31.3	33.5	33.5	33.5	33.5	33.5	33.5	394.1
R62		GIL	15.6	15.6	15.6	15.6	15.6	15.1	16.2	16.2	16.2	16.2	16.2	16.2	190.4
R63	Golabar dam	ZAN	36.3	36.3	36.3	36.3	36.3	35.1	37.5	37.5	37.5	37.5	37.5	37.5	441.5
R64	Babakhan dam	KOR	7.8	7.8	7.8	7.8	7.8	7.6	8.1	8.1	8.1	8.1	8.1	8.1	95.2
R65	Sir dam	KOR	69.7	69.7	69.7	69.7	69.7	67.4	72.0	72.0	72.0	72.0	72.0	72.0	847.9
R66		ZAN	279.9	279.9	279.9	279.9	279.9	270.6	289.2	289.2	289.2	289.2	289.2	289.2	3,405.4
R67		KOR	1,462.8	1,462.8	1,462.8	1,462.8	1,462.8	1,414.1	1,511.6	1,511.6	1,511.6	1,511.6	1,511.6	1,511.6	17,797.8
Total			24,725.1	24,725.1	24,725.1	24,725.1	24,725.1	23,900.9	25,549.2	25,549.2	25,549.2	25,549.2	25,549.2	25,549.2	300,821.5

Source: WRMC Note: 35% of overall loss from water resources to beneficiaries was considered

Table R 6.2.30 Rural Water Demand in Reach in the Long Term (2031)

Reach Code	Related Dam	Province	Water Demand ('000m^3)												Total
			Meh. 30 Oct.	Aba. 30 Nov.	Aza. 30 Dec.	Dey 30 Jan.	Bah. 30 Feb.	Esf. 29 Mar.	Far. 31 Apr.	Ord. 31 May	Kho. 31 Jun.	Tir 31 Jul.	Mor. 31 Aug.	Sha. 31 Sep.	
R01	Sangabad Dam	ARD	41.7	41.7	41.7	41.7	41.7	40.3	43.1	43.1	43.1	43.1	43.1	43.1	507.8
R02	Garmichay dam	EAZ	126.5	126.5	126.5	126.5	126.5	122.3	130.7	130.7	130.7	130.7	130.7	130.7	1,539.3
R03		ARD	124.8	124.8	124.8	124.8	124.8	120.7	129.0	129.0	129.0	129.0	129.0	129.0	1,519.0
R04		EAZ	300.6	300.6	300.6	300.6	300.6	290.6	310.6	310.6	310.6	310.6	310.6	310.6	3,657.6
R05		EAZ	305.8	305.8	305.8	305.8	305.8	295.6	316.0	316.0	316.0	316.0	316.0	316.0	3,720.9
R06		EAZ	129.9	129.9	129.9	129.9	129.9	125.6	134.2	134.2	134.2	134.2	134.2	134.2	1,580.6
R07	Tabrizak Dam	ARD	9.5	9.5	9.5	9.5	9.5	9.2	9.8	9.8	9.8	9.8	9.8	9.8	115.5
R08	Kalghan Dam	EAZ	62.1	62.1	62.1	62.1	62.1	60.0	64.2	64.2	64.2	64.2	64.2	64.2	755.5
R09		EAZ	31.4	31.4	31.4	31.4	31.4	30.3	32.4	32.4	32.4	32.4	32.4	32.4	381.8
R10	Sahand dam	EAZ	236.0	236.0	236.0	236.0	236.0	228.1	243.9	243.9	243.9	243.9	243.9	243.9	2,871.4
R11	Ostur Dam	EAZ	267.0	267.0	267.0	267.0	267.0	258.1	275.9	275.9	275.9	275.9	275.9	275.9	3,249.1
R12	Niyakhram dam	ARD	14.4	14.4	14.4	14.4	14.4	13.9	14.9	14.9	14.9	14.9	14.9	14.9	175.1
R13		ARD	31.7	31.7	31.7	31.7	31.7	30.7	32.8	32.8	32.8	32.8	32.8	32.8	386.0
R14	Befrajerd dam	ARD	2.7	2.7	2.7	2.7	2.7	2.6	2.8	2.8	2.8	2.8	2.8	2.8	32.5
R15		ARD	1.1	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	12.9
R16	Koresh Rostam	ARD	2.3	2.3	2.3	2.3	2.3	2.2	2.4	2.4	2.4	2.4	2.4	2.4	27.7
R17		EAZ	1,023.0	1,023.0	1,023.0	1,023.0	1,023.0	988.9	1,057.1	1,057.1	1,057.1	1,057.1	1,057.1	1,057.1	12,446.1
R18	Aydughmush Dam	EAZ	484.0	484.0	484.0	484.0	484.0	467.9	500.2	500.2	500.2	500.2	500.2	500.2	5,889.3
R19		GIL	2,029.6	2,029.6	2,029.6	2,029.6	2,029.6	1,961.9	2,097.3	2,097.3	2,097.3	2,097.3	2,097.3	2,097.3	24,693.5
R20		ZAN	1,086.9	1,086.9	1,086.9	1,086.9	1,086.9	1,050.6	1,123.1	1,123.1	1,123.1	1,123.1	1,123.1	1,123.1	13,223.6
R21	Sefidrud dam	QAZ	331.9	331.9	331.9	331.9	331.9	320.8	343.0	343.0	343.0	343.0	343.0	343.0	4,038.2
R22	Mushampa dam	ZAN	227.5	227.5	227.5	227.5	227.5	219.9	235.1	235.1	235.1	235.1	235.1	235.1	2,767.8
R23		GIL	915.2	915.2	915.2	915.2	915.2	884.7	945.7	945.7	945.7	945.7	945.7	945.7	11,134.7
R24	Taham dam	ZAN	61.0	61.0	61.0	61.0	61.0	58.9	63.0	63.0	63.0	63.0	63.0	63.0	741.8
R25		QAZ	524.0	524.0	524.0	524.0	524.0	506.6	541.5	541.5	541.5	541.5	541.5	541.5	6,375.7
R26		ZAN	937.9	937.9	937.9	937.9	937.9	906.6	969.1	969.1	969.1	969.1	969.1	969.1	11,410.9
R27		ZAN	487.3	487.3	487.3	487.3	487.3	471.1	503.6	503.6	503.6	503.6	503.6	503.6	5,929.1
R28	Ghezel tappe dam	ZAN	27.4	27.4	27.4	27.4	27.4	26.5	28.3	28.3	28.3	28.3	28.3	28.3	333.0
R29	Songhor dam	ZAN	36.3	36.3	36.3	36.3	36.3	35.1	37.5	37.5	37.5	37.5	37.5	37.5	441.7
R30		ZAN	452.8	452.8	452.8	452.8	452.8	437.7	467.9	467.9	467.9	467.9	467.9	467.9	5,508.6
R31	Mehtar dam	ZAN	48.1	48.1	48.1	48.1	48.1	46.5	49.7	49.7	49.7	49.7	49.7	49.7	585.4
R32	Burmanak dam	QAZ	38.5	38.5	38.5	38.5	38.5	37.2	39.8	39.8	39.8	39.8	39.8	39.8	468.5
R33	Ramin dam	ZAN	23.2	23.2	23.2	23.2	23.2	22.5	24.0	24.0	24.0	24.0	24.0	24.0	282.8
R34	Sheikhebesharat dam	KOR	144.8	144.8	144.8	144.8	144.8	140.0	149.6	149.6	149.6	149.6	149.6	149.6	1,761.7
R35		KOR	141.8	141.8	141.8	141.8	141.8	137.1	146.6	146.6	146.6	146.6	146.6	146.6	1,725.5
R36	Talaghan dam	THN	126.4	126.4	126.4	126.4	126.4	122.2	130.6	130.6	130.6	130.6	130.6	130.6	1,537.6
R37		KOR	652.3	652.3	652.3	652.3	652.3	630.6	674.1	674.1	674.1	674.1	674.1	674.1	7,936.9
R38	Chasb dam	ZAN	53.9	53.9	53.9	53.9	53.9	52.1	55.7	55.7	55.7	55.7	55.7	55.7	655.7
R39	Mendagh dam	ZAN	11.6	11.6	11.6	11.6	11.6	11.2	12.0	12.0	12.0	12.0	12.0	12.0	141.4
R40	Siyazakh dam	KOR	339.0	339.0	339.0	339.0	339.0	327.7	350.3	350.3	350.3	350.3	350.3	350.3	4,125.0
R41		KOR	184.8	184.8	184.8	184.8	184.8	178.6	190.9	190.9	190.9	190.9	190.9	190.9	2,248.0
R42	Zardekamar dam	KOR	277.8	277.8	277.8	277.8	277.8	268.6	287.1	287.1	287.1	287.1	287.1	287.1	3,380.3
R43	Golblakh dam	KOR	80.8	80.8	80.8	80.8	80.8	78.1	83.5	83.5	83.5	83.5	83.5	83.5	983.5
R44		KOR	561.8	561.8	561.8	561.8	561.8	543.0	580.5	580.5	580.5	580.5	580.5	580.5	6,834.7
R45	Talvar dam	ZAN	103.5	103.5	103.5	103.5	103.5	100.1	107.0	107.0	107.0	107.0	107.0	107.0	1,259.3
R46	Aledareh dam	KOR	31.8	31.8	31.8	31.8	31.8	30.8	32.9	32.9	32.9	32.9	32.9	32.9	387.3
R47	Hassankhan dam	KOR	652.2	652.2	652.2	652.2	652.2	630.4	673.9	673.9	673.9	673.9	673.9	673.9	7,934.7
R48		KOR	302.4	302.4	302.4	302.4	302.4	292.3	312.5	312.5	312.5	312.5	312.5	312.5	3,679.5
R49	Alan dam	HAM	806.2	806.2	806.2	806.2	806.2	779.4	833.1	833.1	833.1	833.1	833.1	833.1	9,809.2
R50		KOR	55.2	55.2	55.2	55.2	55.2	53.3	57.0	57.0	57.0	57.0	57.0	57.0	671.2
R51	Sural dam	KOR	15.7	15.7	15.7	15.7	15.7	15.1	16.2	16.2	16.2	16.2	16.2	16.2	190.6
R52	Sangsiyah dam	KOR	79.5	79.5	79.5	79.5	79.5	76.8	82.1	82.1	82.1	82.1	82.1	82.1	966.9
R53	Central Gilan	GIL	2,275.5	2,275.5	2,275.5	2,275.5	2,275.5	2,199.7	2,351.4	2,351.4	2,351.4	2,351.4	2,351.4	2,351.4	27,685.9
R54	Fumanat	GIL	2,531.4	2,531.4	2,531.4	2,531.4	2,531.4	2,447.0	2,615.8	2,615.8	2,615.8	2,615.8	2,615.8	2,615.8	30,799.1
R55	East Gilan	GIL	1,881.3	1,881.3	1,881.3	1,881.3	1,881.3	1,818.6	1,944.0	1,944.0	1,944.0	1,944.0	1,944.0	1,944.0	22,888.9
R56	Sefidrud Left	GIL	5,195.3	5,195.3	5,195.3	5,195.3	5,195.3	5,022.1	5,368.4	5,368.4	5,368.4	5,368.4	5,368.4	5,368.4	63,209.0
R57	Sefidrud Right	GIL	1,651.2	1,651.2	1,651.2	1,651.2	1,651.2	1,596.1	1,706.2	1,706.2	1,706.2	1,706.2	1,706.2	1,706.2	20,089.2
R59	Givi dam	ARD	119.9	119.9	119.9	119.9	119.9	115.9	123.9	123.9	123.9	123.9	123.9	123.9	1,458.5
R60		EAZ	754.1	754.1	754.1	754.1	754.1	728.9	779.2	779.2	779.2	779.2	779.2	779.2	9,174.7
R61		ARD	900.7	900.7	900.7	900.7	900.7	870.7	930.7	930.7	930.7	930.7	930.7	930.7	10,958.6
R62		GIL	474.9	474.9	474.9	474.9	474.9	459.1	490.8	490.8	490.8	490.8	490.8	490.8	5,778.3
R63	Golabar dam	ZAN	415.7	415.7	415.7	415.7	415.7	401.9	429.6	429.6	429.6	429.6	429.6	429.6	5,057.8
R64	Babakhan dam	KOR	297.0	297.0	297.0	297.0	297.0	287.1	306.9	306.9	306.9	306.9	306.9	306.9	3,614.0
R65	Sir dam	KOR	143.2	143.2	143.2	143.2	143.2	138.4	148.0	148.0	148.0	148.0	148.0	148.0	1,742.1
R66		ZAN	2,172.6	2,172.6	2,172.6	2,172.6	2,172.6	2,100.2	2,245.0	2,245.0	2,245.0	2,245.0	2,245.0	2,245.0	26,433.4
R67		KOR	234.3	234.3	234.3	234.3	234.3	226.5	242.1	242.1	242.1	242.1	242.1	242.1	2,850.5
Total			34,090.9	34,090.9	34,090.9	34,090.9	34,090.9	32,954.5	35,227.2	35,227.2	35,227.2	35,227.2	35,227.2	35,227.2	414,772.3

Source: WRMC Note: 35% of overall loss from water resources to beneficiaries was considered

Table R 6.2.31 Present Urban Water Demand in Reach (2006)

Water Resource	Reach code	City	Province	Urban Population (persons)	Consume per Capita (lpdc)	Water Loss Coefficient	Water Requirement ('000m³) Meh. 30.0 Oct.	Aba. 30.0 Nov.	Aza. 30.0 Dec.	Dey 30.0 Jan.	Bah. 30.0 Feb.	Esf. 29.0 Mar.	Far. 31.0 Apr	Ord. 31.0 May.	Kho. 31.0 Jun.	Tir 31.0 Jul.	Mor. 31.0 Aug.	Sha. 31.0 Sep.	Total	Dam/ Treatment Plant
Surface water	R03	Givi	ARD	8,126	175	0.48	82.0	82.0	82.0	82.0	82.0	79.3	84.8	84.8	84.8	84.8	84.8	84.8	998.2	Givi
	R11	Mianeh	EAZ	92,626	200	0.48	1,068.8	1,068.8	1,068.8	1,068.8	1,068.8	1,033.1	1,104.4	1,104.4	1,104.4	1,104.4	1,104.4	1,104.4	13,003.3	Mianeh
	R20	Zanjan	ZAN	341,369	230	0.48	4,529.7	4,529.7	4,529.7	4,529.7	4,529.7	4,378.7	4,680.7	4,680.7	4,680.7	4,680.7	4,680.7	4,680.7	55,111.4	Zanjan
	R53	Rasht	GIL	495,181	230	0.48	6,570.7	6,570.7	6,570.7	6,570.7	6,570.7	6,351.6	6,789.7	6,789.7	6,789.7	6,789.7	6,789.7	6,789.7	79,943.2	Sangar
		Bandar Anzali	GIL	116,809	200	0.48	1,347.8	1,347.8	1,347.8	1,347.8	1,347.8	1,302.9	1,392.7	1,392.7	1,392.7	1,392.7	1,392.7	1,392.7	16,398.2	"
		Khoman	GIL	10,176	175	0.48	102.7	102.7	102.7	102.7	102.7	99.3	106.2	106.2	106.2	106.2	106.2	106.2	1,250.0	"
	R55	Lahijan	GIL	62,969	200	0.48	726.6	726.6	726.6	726.6	726.6	702.3	750.8	750.8	750.8	750.8	750.8	750.8	8,839.9	"
		Langroud	GIL	67,114	200	0.48	774.4	774.4	774.4	774.4	774.4	748.6	800.2	800.2	800.2	800.2	800.2	800.2	9,421.8	"
		Astaneh	GIL	39,659	175	0.48	400.4	400.4	400.4	400.4	400.4	387.1	413.8	413.8	413.8	413.8	413.8	413.8	4,871.6	"
		Kiashahr	GIL	16,752	175	0.48	169.1	169.1	169.1	169.1	169.1	163.5	174.8	174.8	174.8	174.8	174.8	174.8	2,057.8	"
	R57	Siahkol	GIL	16,075	175	0.48	162.3	162.3	162.3	162.3	162.3	156.9	167.7	167.7	167.7	167.7	167.7	167.7	1,974.6	"
		Tehran City from Taleghan Dam					13,374.0	11,748.0	10,374.0	9,997.0	9,750.0	10,374.0	10,626.0	12,126.0	14,124.0	16,253.0	16,002.0	15,252.0	150,000.0	
		Sub-total					29,308.5	27,682.5	26,308.5	25,931.5	25,684.5	25,777.4	27,091.7	28,591.7	30,589.7	32,718.7	32,467.7	31,717.7	343,869.8	
Groundwater	R05	Torkamanchai	EAZ	7,159	175	0.35	57.8	57.8	57.8	57.8	57.8	55.9	59.8	59.8	59.8	59.8	59.8	59.8	703.5	
	R16	Hastjin	ARD	6,048	175	0.35	48.8	48.8	48.8	48.8	48.8	47.2	50.5	50.5	50.5	50.5	50.5	50.5	594.3	
	R19	Roudbar	GIL	14,109	175	0.35	114.0	114.0	114.0	114.0	114.0	110.2	117.8	117.8	117.8	117.8	117.8	117.8	1,386.5	
	R21	Manjil	GIL	17,399	175	0.35	140.5	140.5	140.5	140.5	140.5	135.8	145.2	145.2	145.2	145.2	145.2	145.2	1,709.8	
		Lowshan	GIL	16,376	175	0.35	132.3	132.3	132.3	132.3	132.3	127.9	136.7	136.7	136.7	136.7	136.7	136.7	1,609.3	
		Roudbar	GIL	14,106	175	0.35	113.9	113.9	113.9	113.9	113.9	110.1	117.7	117.7	117.7	117.7	117.7	117.7	1,386.2	
	R27	Soltanieh	ZAN	6,538	175	0.35	52.8	52.8	52.8	52.8	52.8	51.0	54.6	54.6	54.6	54.6	54.6	54.6	642.5	
	R37	Bijar	KOR	56,414	200	0.35	520.7	520.7	520.7	520.7	520.7	503.4	538.1	538.1	538.1	538.1	538.1	538.1	6,335.7	
	R41	Divandareh	KOR	24,342	175	0.35	196.6	196.6	196.6	196.6	196.6	190.1	203.2	203.2	203.2	203.2	203.2	203.2	2,392.1	
	R47	Dehkolan	KOR	19,277	175	0.35	155.7	155.7	155.7	155.7	155.7	150.5	160.9	160.9	160.9	160.9	160.9	160.9	1,894.3	
	R48	Ghorveh	KOR	78,602	200	0.35	725.6	725.6	725.6	725.6	725.6	701.4	749.7	749.7	749.7	749.7	749.7	749.7	8,827.6	
		Serish Abad	KOR	9,108	175	0.35	73.6	73.6	73.6	73.6	73.6	71.1	76.0	76.0	76.0	76.0	76.0	76.0	895.0	
	R53	Kohoshkebijar	GIL	8,001	175	0.35	64.6	64.6	64.6	64.6	64.6	62.5	66.8	66.8	66.8	66.8	66.8	66.8	786.3	
		Lasht Nesha	GIL	12,784	175	0.35	103.3	103.3	103.3	103.3	103.3	99.8	106.7	106.7	106.7	106.7	106.7	106.7	1,256.3	
		Kochesfahan	GIL	10,093	175	0.35	81.5	81.5	81.5	81.5	81.5	78.8	84.2	84.2	84.2	84.2	84.2	84.2	991.8	
		Sangar	GIL	8,229	175	0.35	66.5	66.5	66.5	66.5	66.5	64.2	68.7	68.7	68.7	68.7	68.7	68.7	808.7	
	R54	Some Sara	GIL	34,847	175	0.35	281.5	281.5	281.5	281.5	281.5	272.1	290.8	290.8	290.8	290.8	290.8	290.8	3,424.4	
		Fooman	GIL	37,150	175	0.35	300.1	300.1	300.1	300.1	300.1	290.1	310.1	310.1	310.1	310.1	310.1	310.1	3,650.7	
		Rezvanshahr	GIL	10,520	175	0.35	85.0	85.0	85.0	85.0	85.0	82.1	87.8	87.8	87.8	87.8	87.8	87.8	1,033.8	
		Shaft	GIL	5,970	175	0.35	48.2	48.2	48.2	48.2	48.2	46.6	49.8	49.8	49.8	49.8	49.8	49.8	586.7	
	R56	Masal	GIL	18,612	175	0.35	150.3	150.3	150.3	150.3	150.3	145.3	155.3	155.3	155.3	155.3	155.3	155.3	1,829.0	
		Masoleh	GIL	785	175	0.35	6.3	6.3	6.3	6.3	6.3	6.1	6.6	6.6	6.6	6.6	6.6	6.6	77.1	
	R57	Roudsar	GIL	40,548	175	0.35	327.5	327.5	327.5	327.5	327.5	316.6	338.4	338.4	338.4	338.4	338.4	338.4	3,984.6	
		Amlash	GIL	16,903	175	0.35	136.5	136.5	136.5	136.5	136.5	132.0	141.1	141.1	141.1	141.1	141.1	141.1	1,661.0	
		Komleh	GIL	6,779	175	0.35	54.8	54.8	54.8	54.8	54.8	52.9	56.6	56.6	56.6	56.6	56.6	56.6	666.2	
	R59	Khalkhal	ARD	42,525	175	0.35	343.5	343.5	343.5	343.5	343.5	332.0	354.9	354.9	354.9	354.9	354.9	354.9	4,178.9	
	R60	Hashtroud	EAZ	21,058	175	0.35	170.1	170.1	170.1	170.1	170.1	164.4	175.8	175.8	175.8	175.8	175.8	175.8	2,069.4	
		Gharah Aghaj	EAZ	5,361	175	0.35	43.3	43.3	43.3	43.3	43.3	41.9	44.7	44.7	44.7	44.7	44.7	44.7	526.8	
	R61	Koldar	ARD	4,372	175	0.35	35.3	35.3	35.3	35.3	35.3	34.1	36.5	36.5	36.5	36.5	36.5	36.5	429.6	
	R63	Geidar	ZAN	22,308	175	0.35	180.2	180.2	180.2	180.2	180.2	174.2	186.2	186.2	186.2	186.2	186.2	186.2	2,192.2	
		Sub-total					4,810.7	4,810.7	4,810.7	4,810.7	4,810.7	4,650.3	4,971.1	4,971.1	4,971.1	4,971.1	4,971.1	4,971.1	58,530.2	
		Total					34,119.2	32,493.2	31,119.2	30,742.2	30,495.2	30,427.7	32,062.7	33,562.7	35,560.7	37,689.7	37,438.7	36,688.7	402,400.0	

Note: WRMC

Table R 6.2.32 Urban Water Demand in Reach in the Middle Term (2016)

Water Resource	Reach code	City	Province/ Unit	Urban Population (persons)	Consume per Capita (lpdc)	Water Loss Coefficient	Water Requirement ('000m³) Meh. 30.0 Oct.	Aba. 30.0 Nov.	Aza. 30.0 Dec.	Dey 30.0 Jan.	Bah. 30.0 Feb.	Esf. 29.0 Mar.	Far. 31.0 Apr	Ord. 31.0 May.	Kho. 31.0 Jun.	Tir 31.0 Jul.	Mor. 31.0 Aug.	Sha. 31.0 Sep.	Total	Dam/ Treatment Plant
Surface water	R03	Givi	ARD	9,694	188	0.48	105.1	105.1	105.1	105.1	105.1	101.6	108.6	108.6	108.6	108.6	108.6	108.6	1,279.2	Givi
	R11	Mianeh	EAZ	110,039	215	0.48	1,364.9	1,364.9	1,364.9	1,364.9	1,364.9	1,319.4	1,410.4	1,410.4	1,410.4	1,410.4	1,410.4	1,410.4	16,606.4	Germichay
	R20	Zanjan	ZAN	408,039	245	0.48	5,767.5	5,767.5	5,767.5	5,767.5	5,767.5	5,575.2	5,959.7	5,959.7	5,959.7	5,959.7	5,959.7	5,959.7	70,170.9	Taham
	R53	Rasht	G6	585,527	245	0.48	8,276.2	8,276.2	8,276.2	8,276.2	8,276.2	8,000.3	8,552.1	8,552.1	8,552.1	8,552.1	8,552.1	8,552.1	100,693.8	Sangar
		Bandar Anzali	G4	138,121	215	0.48	1,713.2	1,713.2	1,713.2	1,713.2	1,713.2	1,656.1	1,770.3	1,770.3	1,770.3	1,770.3	1,770.3	1,770.3	20,844.3	"
		Khoman	G4	12,032	188	0.48	130.5	130.5	130.5	130.5	130.5	126.2	134.9	134.9	134.9	134.9	134.9	134.9	1,587.8	"
		Kohoshkebijar	G3	9,460	188	0.48	102.6	102.6	102.6	102.6	102.6	99.2	106.0	106.0	106.0	106.0	106.0	106.0	1,248.4	"
		Lasht Nesha	G3	15,116	188	0.48	164.0	164.0	164.0	164.0	164.0	158.5	169.4	169.4	169.4	169.4	169.4	169.4	1,994.7	"
		Kochesfahan	G3	11,934	188	0.48	129.4	129.4	129.4	129.4	129.4	125.1	133.8	133.8	133.8	133.8	133.8	133.8	1,574.8	"
		Sangar	G4	9,731	188	0.48	105.5	105.5	105.5	105.5	105.5	102.0	109.1	109.1	109.1	109.1	109.1	109.1	1,284.1	"
	R55	Lahijan	D2	74,457	215	0.48	923.6	923.6	923.6	923.6	923.6	892.8	954.3	954.3	954.3	954.3	954.3	954.3	11,236.6	"
		Langroud	D2	79,360	215	0.48	984.4	984.4	984.4	984.4	984.4	951.6	1,017.2	1,017.2	1,017.2	1,017.2	1,017.2	1,017.2	11,976.5	"
		Astaneh	D3	46,895	188	0.48	508.6	508.6	508.6	508.6	508.6	491.7	525.6	525.6	525.6	525.6	525.6	525.6	6,188.3	"
		Kiashahr	D3	19,809	188	0.48	214.9	214.9	214.9	214.9	214.9	207.7	222.0	222.0	222.0	222.0	222.0	222.0	2,614.0	"
	R57	Siahkol	GIL	19,008	188	0.48	206.2	206.2	206.2	206.2	206.2	199.3	213.0	213.0	213.0	213.0	213.0	213.0	2,508.3	"
		Komleh	GIL	8,015	188	0.48	86.9	86.9	86.9	86.9	86.9	84.0	89.8	89.8	89.8	89.8	89.8	89.8	1,057.7	"
		Tehran City from Taleghan Dam					13,374.0	11,748.0	10,374.0	9,997.0	9,750.0	10,374.0	10,626.0	12,126.0	14,124.0	16,253.0	16,002.0	15,252.0	150,000.0	
		Hamedan City from Talvar Dam					7,808.2	7,808.2	7,808.2	7,808.2	7,808.2	7,547.9	8,068.5	8,068.5	8,068.5	8,068.5	8,068.5	8,068.5	95,000.0	
		Sub-total					41,965.7	40,339.7	38,965.7	38,588.7	38,341.7	38,012.7	40,170.8	41,670.8	43,668.8	45,797.8	45,546.8	44,796.8	497,865.8	
Groundwater	R05	Torkamanchai	EAZ	8,505	188	0.35	73.8	73.8	73.8	73.8	73.8	71.3	76.3	76.3	76.3	76.3	76.3	76.3	897.9	
	R16	Hastjin	ARD	7,215	188	0.35	62.6	62.6	62.6	62.6	62.6	60.5	64.7	64.7	64.7	64.7	64.7	64.7	761.7	
	R19	Roudbar	GIL	16,683	188	0.35	144.8	144.8	144.8	144.8	144.8	139.9	149.6	149.6	149.6	149.6	149.6	149.6	1,761.2	
	R21	Manjil	GIL	20,574	188	0.35	178.5	178.5	178.5	178.5	178.5	172.6	184.5	184.5	184.5	184.5	184.5	184.5	2,172.0	
		Lowshan	GIL	19,364	188	0.35	168.0	168.0	168.0	168.0	168.0	162.4	173.6	173.6	173.6	173.6	173.6	173.6	2,044.2	
		Roudbar	GIL	16,683	188	0.35	144.8	144.8	144.8	144.8	144.8	139.9	149.6	149.6	149.6	149.6	149.6	149.6	1,761.2	
	R27	Soltanieh	ZAN	7,816	188	0.35	67.8	67.8	67.8	67.8	67.8	65.6	70.1	70.1	70.1	70.1	70.1	70.1	825.1	
	R37	Bijar	KOR	71,409	215	0.35	708.6	708.6	708.6	708.6	708.6	685.0	732.2	732.2	732.2	732.2	732.2	732.2	8,621.3	
	R41	Divandareh	KOR	30,812	188	0.35	267.4	267.4	267.4	267.4	267.4	258.4	276.3	276.3	276.3	276.3	276.3	276.3	3,252.8	
	R47	Dehkolan	KOR	24,401	188	0.35	211.7	211.7	211.7	211.7	211.7	204.7	218.8	218.8	218.8	218.8	218.8	218.8	2,576.0	
	R48	Ghorveh	KOR	99,494	215	0.35	987.3	987.3	987.3	987.3	987.3	954.4	1,020.2	1,020.2	1,020.2	1,020.2	1,020.2	1,020.2	12,012.0	
		Serish Abad	KOR	11,529	188	0.35	100.0	100.0	100.0	100.0	100.0	96.7	103.4	103.4	103.4	103.4	103.4	103.4	1,217.1	
	R54	Some Sara	F2	41,205	188	0.35	357.5	357.5	357.5	357.5	357.5	345.6	369.5	369.5	369.5	369.5	369.5	369.5	4,350.0	
		Fooman	F2	43,928	188	0.35	381.2	381.2	381.2	381.2	381.2	368.5	393.9	393.9	393.9	393.9	393.9	393.9	4,637.4	
		Rezvanshahr	F5	12,439	188	0.35	107.9	107.9	107.9	107.9	107.9	104.3	111.5	111.5	111.5	111.5	111.5	111.5	1,313.2	
		Shaft	F1	7,059	188	0.35	61.3	61.3	61.3	61.3	61.3	59.2	63.3	63.3	63.3	63.3	63.3	63.3	745.2	
	R56	Masal	GIL	22,008	188	0.35	191.0	191.0	191.0	191.0	191.0	184.6	197.3	197.3	197.3	197.3	197.3	197.3	2,323.4	
		Masoleh	GIL	929	188	0.35	8.1	8.1	8.1	8.1	8.1	7.8	8.3	8.3	8.3	8.3	8.3	8.3	98.1	
	R57	Roudsar	GIL	47,946	188	0.35	416.0	416.0	416.0	416.0	416.0	402.2	429.9	429.9	429.9	429.9	429.9	429.9	5,061.6	
		Amlash	GIL	19,987	188	0.35	173.4	173.4	173.4	173.4	173.4	167.6	179.2	179.2	179.2	179.2	179.2	179.2	2,110.0	
	R59	Khalkhal	ARD	50,730	215	0.35	503.4	503.4	503.4	503.4	503.4	486.6	520.2	520.2	520.2	520.2	520.2	520.2	6,124.7	
	R60	Hashtroud	EAZ	25,017	188	0.35	217.1	217.1	217.1	217.1	217.1	209.8	224.3	224.3	224.3	224.3	224.3	224.3	2,641.0	
		Gharah Aghaj	EAZ	6,369	188	0.35	55.3	55.3	55.3	55.3	55.3	53.4	57.1	57.1	57.1	57.1	57.1	57.1	672.4	
	R61	Koldar	ARD	5,216	188	0.35	45.3	45.3	45.3	45.3	45.3	43.8	46.8	46.8	46.8	46.8	46.8	46.8	550.6	
	R63	Geidar	ZAN	26,664	188	0.35	231.4	231.4	231.4	231.4	231.4	223.6	239.1	239.1	239.1	239.1	239.1	239.1	2,814.9	
		Sub-total					5,864.0	5,864.0	5,864.0	5,864.0	5,864.0	5,668.5	6,059.4	6,059.4	6,059.4	6,059.4	6,059.4	6,059.4	71,345.0	
		Total					47,829.7	46,203.7	44,829.7	44,452.7	44,205.7	43,681.2	46,230.2	47,730.2	49,728.2	51,857.2	51,606.2	50,856.2	569,210.8	

Source: WRMC

Table R 6.2.33 Urban Water Demand in Reach in the Long Term (2031)

Water Resource	Reach code	City	Province/ Unit	Urban Population (persons)	Consume per Capita (lpdc)	Water Loss Coefficient	Water Requirement ('000m³) Meh. 30.0 Oct.	Aba. 30.0 Nov.	Aza. 30.0 Dec.	Dey 30.0 Jan.	Bah. 30.0 Feb.	Esf. 29.0 Mar.	Far. 31.0 Apr	Ord. 31.0 May.	Kho. 31.0 Jun.	Tir 31.0 Jul.	Mor. 31.0 Aug.	Sha. 31.0 Sep.	Total	Dam/ Treatment Plant
Surface water	R03	Givi	ARD	12,555	200	0.48	144.9	144.9	144.9	144.9	144.9	140.0	149.7	149.7	149.7	149.7	149.7	149.7	1,762.5	Givi
	R11	Mianeh	EAZ	141,164	230	0.48	1,873.1	1,873.1	1,873.1	1,873.1	1,873.1	1,810.7	1,935.6	1,935.6	1,935.6	1,935.6	1,935.6	1,935.6	22,789.8	Germichay
	R59	Khalkhal	ARD	65,707	230	0.35	697.5	697.5	697.5	697.5	697.5	674.3	720.8	720.8	720.8	720.8	720.8	720.8	8,486.3	Befrajerd
	R20	Zanjan	ZAN	534,767	260	0.48	8,021.5	8,021.5	8,021.5	8,021.5	8,021.5	7,754.1	8,288.9	8,288.9	8,288.9	8,288.9	8,288.9	8,288.9	97,595.0	Taham
	R53	Rasht	G6	734,068	260	0.48	11,011.0	11,011.0	11,011.0	11,011.0	11,011.0	10,644.0	11,378.1	11,378.1	11,378.1	11,378.1	11,378.1	11,378.1	133,967.4	Sangar
		Bandar Anzali	G4	173,096	230	0.48	2,296.9	2,296.9	2,296.9	2,296.9	2,296.9	2,220.3	2,373.4	2,373.4	2,373.4	2,373.4	2,373.4	2,373.4	27,945.0	"
		Khoman	G4	15,080	200	0.48	174.0	174.0	174.0	174.0	174.0	168.2	179.8	179.8	179.8	179.8	179.8	179.8	2,117.0	"
		Kohoshkebijar	G3	11,856	200	0.48	136.8	136.8	136.8	136.8	136.8	132.2	141.4	141.4	141.4	141.4	141.4	141.4	1,664.4	"
		Lasht Nesha	G3	18,944	200	0.48	218.6	218.6	218.6	218.6	218.6	211.3	225.9	225.9	225.9	225.9	225.9	225.9	2,659.4	"
		Kochesfahan	G3	14,956	200	0.48	172.6	172.6	172.6	172.6	172.6	166.8	178.3	178.3	178.3	178.3	178.3	178.3	2,099.6	"
		Sangar	G4	12,196	200	0.48	140.7	140.7	140.7	140.7	140.7	136.0	145.4	145.4	145.4	145.4	145.4	145.4	1,712.1	"
	R54	Rezvanshahr	F5	15,080	200	0.48	174.0	174.0	174.0	174.0	174.0	168.2	179.8	179.8	179.8	179.8	179.8	179.8	2,117.0	"
	R55	Lahijan	D2	93,311	230	0.48	1,238.2	1,238.2	1,238.2	1,238.2	1,238.2	1,196.9	1,279.4	1,279.4	1,279.4	1,279.4	1,279.4	1,279.4	15,064.3	"
		Langroud	D2	99,455	230	0.48	1,319.7	1,319.7	1,319.7	1,319.7	1,319.7	1,275.7	1,363.7	1,363.7	1,363.7	1,363.7	1,363.7	1,363.7	16,056.2	"
		Astaneh	D3	58,770	230	0.48	779.8	779.8	779.8	779.8	779.8	753.8	805.8	805.8	805.8	805.8	805.8	805.8	9,488.0	"
		Kiashahr	D3	24,828	200	0.48	286.5	286.5	286.5	286.5	286.5	276.9	296.0	296.0	296.0	296.0	296.0	296.0	3,485.5	"
	R57	Siahkol	GIL	23,822	200	0.48	274.9	274.9	274.9	274.9	274.9	265.7	284.0	284.0	284.0	284.0	284.0	284.0	3,344.2	"
		Komleh	GIL	10,045	200	0.48	115.9	115.9	115.9	115.9	115.9	112.0	119.8	119.8	119.8	119.8	119.8	119.8	1,410.2	"
	Tehran City from Taleghan Dam						13,374.0	11,748.0	10,374.0	9,997.0	9,750.0	10,374.0	10,626.0	12,126.0	14,124.0	16,253.0	16,002.0	15,252.0	150,000.0	Talegan
	Hamedan City from Talvar Dam						7,808.2	7,808.2	7,808.2	7,808.2	7,808.2	7,547.9	8,068.5	8,068.5	8,068.5	8,068.5	8,068.5	8,068.5	95,000.0	Hamedan
	Sub-total						50,258.7	48,632.7	47,258.7	46,881.7	46,634.7	46,029.2	48,740.2	50,240.2	52,238.2	54,367.2	54,116.2	53,366.2	598,764.1	
Groundwater	R05	Torkamanchai	EAZ	10,911	200	0.35	100.7	100.7	100.7	100.7	100.7	97.4	104.1	104.1	104.1	104.1	104.1	104.1	1,225.4	
	R16	Hastjin	ARD	9,345	200	0.35	86.3	86.3	86.3	86.3	86.3	83.4	89.1	89.1	89.1	89.1	89.1	89.1	1,049.5	
	R19	Roudbar	GIL	22,726	200	0.35	209.8	209.8	209.8	209.8	209.8	202.8	216.8	216.8	216.8	216.8	216.8	216.8	2,552.3	
	R21	Manjil	GIL	25,784	200	0.35	238.0	238.0	238.0	238.0	238.0	230.1	245.9	245.9	245.9	245.9	245.9	245.9	2,895.7	
		Lowshan	GIL	24,268	200	0.35	224.0	224.0	224.0	224.0	224.0	216.5	231.5	231.5	231.5	231.5	231.5	231.5	2,725.5	
		Roudbar	GIL	20,908	200	0.35	193.0	193.0	193.0	193.0	193.0	186.6	199.4	199.4	199.4	199.4	199.4	199.4	2,348.1	
	R27	Soltanieh	ZAN	10,243	200	0.35	94.6	94.6	94.6	94.6	94.6	91.4	97.7	97.7	97.7	97.7	97.7	97.7	1,150.4	
	R37	Bijar	KOR	102,520	230	0.35	1,088.3	1,088.3	1,088.3	1,088.3	1,088.3	1,052.0	1,124.6	1,124.6	1,124.6	1,124.6	1,124.6	1,124.6	13,240.9	
	R41	Divandareh	KOR	44,236	200	0.35	408.3	408.3	408.3	408.3	408.3	394.7	421.9	421.9	421.9	421.9	421.9	421.9	4,968.0	
	R47	Dehkolan	KOR	35,032	200	0.35	323.4	323.4	323.4	323.4	323.4	312.6	334.2	334.2	334.2	334.2	334.2	334.2	3,934.4	
	R48	Ghorveh	KOR	142,840	230	0.35	1,516.3	1,516.3	1,516.3	1,516.3	1,516.3	1,465.8	1,566.8	1,566.8	1,566.8	1,566.8	1,566.8	1,566.8	18,448.3	
		Serish Abad	KOR	16,553	200	0.35	152.8	152.8	152.8	152.8	152.8	147.7	157.9	157.9	157.9	157.9	157.9	157.9	1,859.0	
	R54	Some Sara	F2	51,639	230	0.35	548.2	548.2	548.2	548.2	548.2	529.9	566.4	566.4	566.4	566.4	566.4	566.4	6,669.4	
		Fooman	F2	55,051	230	0.35	584.4	584.4	584.4	584.4	584.4	564.9	603.9	603.9	603.9	603.9	603.9	603.9	7,110.0	
		Shaft	F1	8,848	200	0.35	81.7	81.7	81.7	81.7	81.7	79.0	84.4	84.4	84.4	84.4	84.4	84.4	993.7	
	R56	Masal	GIL	27,581	200	0.35	254.6	254.6	254.6	254.6	254.6	246.1	263.1	263.1	263.1	263.1	263.1	263.1	3,097.6	
		Masoleh	GIL	1,164	200	0.35	10.7	10.7	10.7	10.7	10.7	10.4	11.1	11.1	11.1	11.1	11.1	11.1	130.7	
	R57	Roudsar	GIL	60,087	230	0.35	637.8	637.8	637.8	637.8	637.8	616.6	659.1	659.1	659.1	659.1	659.1	659.1	7,760.5	
		Amlash	GIL	25,048	200	0.35	231.2	231.2	231.2	231.2	231.2	223.5	238.9	238.9	238.9	238.9	238.9	238.9	2,813.1	
	R60	Hashtroud	EAZ	32,093	200	0.35	296.2	296.2	296.2	296.2	296.2	286.4	306.1	306.1	306.1	306.1	306.1	306.1	3,604.3	
		Gharah Aghaj	EAZ	8,171	200	0.35	75.4	75.4	75.4	75.4	75.4	72.9	77.9	77.9	77.9	77.9	77.9	77.9	917.7	
	R61	Koldar	ARD	6,756	200	0.35	62.4	62.4	62.4	62.4	62.4	60.3	64.4	64.4	64.4	64.4	64.4	64.4	758.8	
	R63	Geidar	ZAN	34,946	200	0.35	322.6	322.6	322.6	322.6	322.6	311.8	333.3	333.3	333.3	333.3	333.3	333.3	3,924.7	
	Sub-total						7,740.7	7,740.7	7,740.7	7,740.7	7,740.7	7,482.6	7,998.7	7,998.7	7,998.7	7,998.7	7,998.7	7,998.7	94,177.9	
Total							57,999.4	56,373.4	54,999.4	54,622.4	54,375.4	53,511.9	56,738.9	58,238.9	60,236.9	62,365.9	62,114.9	61,364.9	692,942.0	

Source: Mahab Ghodss Study Report

6.2.3 Water Demand for Industrial Water Supply

The water demand for industrial water supply with 0.35 in the total delivery loss is forecasted based on the information provided by the WRMC (see Section 3.11). The water demand by zones is summarized in Table R 6.2.34.

Table R 6.2.34 Industrial Water Demand in Each Zone

(Unit: MCM)

Zone	Present (2006)	Middle Term (2016)	Long Term (2031)
A	6.5	24.2	41.9
B	17.0	57.0	107.9
C	9.1	16.6	24.1
D	4.1	13.5	17.8
E	6.2	9.3	12.5
Total	42.9	120.6	204.2

In addition, the water demand by the Reaches is summarized corresponding to the target years as shown in Table R 6.2.35 to Table R 6.2.37.

Table R 6.2.35 Present Industrial Water Demand (2006)

Reach code	Industrial Area	Province	Average Discharge	Water Requirement ('000m³)												Total	Reference: Mahab Ghodss Report
				Autumn (0.8)			Winter (0.8)			Spring (1.2)			Summer (1.2)				
				Meh. 30.0	Aba. 30.0	Aza. 30.0	Dey 30.0	Bah. 30.0	Esf. 29.0	Far. 31.0	Ord. 31.0	Kho. 31.0	Tir 31.0	Mor. 31.0	Sha. 31.0		
			(Lit/sec)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sep.		
R54	Someh Sara	GIL	40	127.6	127.6	127.6	127.6	127.6	123.4	197.8	197.8	197.8	197.8	197.8	197.8	1,948.1	Table3-2
	Shaft	GIL	16	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-2
	Sub-total		56	178.6	178.6	178.6	178.6	178.6	172.7	276.9	276.9	276.9	276.9	276.9	276.9	2,727.4	
R53	Anzali	GIL	20	63.8	63.8	63.8	63.8	63.8	61.7	98.9	98.9	98.9	98.9	98.9	98.9	974.1	Table3-2
R55	Lahijan	GIL	7	22.3	22.3	22.3	22.3	22.3	21.6	34.6	34.6	34.6	34.6	34.6	34.6	340.9	Table3-2
	Langrod	GIL	8	25.5	25.5	25.5	25.5	25.5	24.7	39.6	39.6	39.6	39.6	39.6	39.6	389.6	Table3-2
	Astaneh	GIL	8	25.5	25.5	25.5	25.5	25.5	24.7	39.6	39.6	39.6	39.6	39.6	39.6	389.6	Table3-2
	Sub-total		23	73.4	73.4	73.4	73.4	73.4	70.9	113.7	113.7	113.7	113.7	113.7	113.7	1,120.2	
R56	Masal	GIL	8	25.5	25.5	25.5	25.5	25.5	24.7	39.6	39.6	39.6	39.6	39.6	39.6	389.6	Table3-2
R57	Siahkol	GIL	16	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-2
	Roudsar	GIL	5	16.0	16.0	16.0	16.0	16.0	15.4	24.7	24.7	24.7	24.7	24.7	24.7	243.5	Table3-2
	Sub-total		21	67.0	67.0	67.0	67.0	67.0	64.8	103.8	103.8	103.8	103.8	103.8	103.8	1,022.8	
R21	Loshan	GIL	60	191.4	191.4	191.4	191.4	191.4	185.0	296.7	296.7	296.7	296.7	296.7	296.7	2,922.2	Table3-2
R25	Qazvin	QAZ	85	270.9	270.9	270.9	270.9	270.9	261.9	420.0	420.0	420.0	420.0	420.0	420.0	4,136.4	Table3-3
R66	Hamedan	HAM	123	392.4	392.4	392.4	392.4	392.4	379.3	608.2	608.2	608.2	608.2	608.2	608.2	5,990.5	Table3-5
R11	Mianeh	EAZ	126	400.8	400.8	400.8	400.8	400.8	387.4	621.2	621.2	621.2	621.2	621.2	621.2	6,118.8	Table3-6
R60	Hashtroud	EAZ	54	171.7	171.7	171.7	171.7	171.7	165.9	266.1	266.1	266.1	266.1	266.1	266.1	2,620.8	Table3-6
R41	Divandareh-1	KOR	8	25.2	25.2	25.2	25.2	25.2	24.3	39.0	39.0	39.0	39.0	39.0	39.0	384.5	Table3-7
R37	Bijar	KOR	2	7.3	7.3	7.3	7.3	7.3	7.0	11.3	11.3	11.3	11.3	11.3	11.3	111.2	Table3-7
R20	Zanjan	ZAN	296	944.3	944.3	944.3	944.3	944.3	912.8	1,463.6	1,463.6	1,463.6	1,463.6	1,463.6	1,463.6	14,415.7	Table3-8
Total			881.5	2,812.3	2,812.3	2,812.3	2,812.3	2,812.3	2,718.5	4,359.0	4,359.0	4,359.0	4,359.0	4,359.0	4,359.0	42,934.0	

Source: WRMC note) Ardevil Province offer 10 MCM of Industrial Demand but distribution and industrial area are not clear.

Table R 6.2.36 Industrial Water Demand in the Middle Term (2016)

Reach code	Industrial Area	Province	Average Discharge	Water Requirement ('000m³)												Total	Reference: Mahab Ghodss Report
				Autumn (0.8)			Winter (0.8)			Spring (1.2)			Summer (1.2)				
				Meh. 30.0	Aba. 30.0	Aza. 30.0	Dey 30.0	Bah. 30.0	Esf. 29.0	Far. 31.0	Ord. 31.0	Kho. 31.0	Tir 31.0	Mor. 31.0	Sha. 31.0		
			(Lit/sec)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sep.		
R54	Someh Sara	GIL	60.0	191.4	191.4	191.4	191.4	191.4	185.0	296.7	296.7	296.7	296.7	296.7	296.7	2,922.2	Table3-2
	Shaft	GIL	24.0	76.6	76.6	76.6	76.6	76.6	74.0	118.7	118.7	118.7	118.7	118.7	118.7	1,168.9	Table3-2
	Sub-total		84.0	268.0	268.0	268.0	268.0	268.0	259.0	415.4	415.4	415.4	415.4	415.4	415.4	4,091.1	
R53	Anzali	GIL	30.0	95.7	95.7	95.7	95.7	95.7	92.5	148.3	148.3	148.3	148.3	148.3	148.3	1,461.1	Table3-2
R55	Lahijan	GIL	10.5	33.5	33.5	33.5	33.5	33.5	32.4	51.9	51.9	51.9	51.9	51.9	51.9	511.4	Table3-2
	Langrod	GIL	12.0	38.3	38.3	38.3	38.3	38.3	37.0	59.3	59.3	59.3	59.3	59.3	59.3	584.4	Table3-2
	Astaneh	GIL	12.0	38.3	38.3	38.3	38.3	38.3	37.0	59.3	59.3	59.3	59.3	59.3	59.3	584.4	Table3-2
	Sub-total		34.5	110.1	110.1	110.1	110.1	110.1	106.4	170.6	170.6	170.6	170.6	170.6	170.6	1,680.3	
R56	Masal	GIL	12.0	38.3	38.3	38.3	38.3	38.3	37.0	59.3	59.3	59.3	59.3	59.3	59.3	584.4	Table3-2
R57	Siahkol	GIL	24.0	76.6	76.6	76.6	76.6	76.6	74.0	118.7	118.7	118.7	118.7	118.7	118.7	1,168.9	Table3-2
	Roudsar	GIL	7.5	23.9	23.9	23.9	23.9	23.9	23.1	37.1	37.1	37.1	37.1	37.1	37.1	365.3	Table3-2
	Sub-total		31.5	100.5	100.5	100.5	100.5	100.5	97.1	155.8	155.8	155.8	155.8	155.8	155.8	1,534.1	
R21	Loshan	GIL	130.0	414.7	414.7	414.7	414.7	414.7	400.9	642.8	642.8	642.8	642.8	642.8	642.8	6,331.4	Table3-2
R25	Qazvin	QAZ	277.0	883.7	883.7	883.7	883.7	883.7	854.2	1,369.7	1,369.7	1,369.7	1,369.7	1,369.7	1,369.7	13,490.7	Table3-3
R66	Hamedan	HAM	482.0	1,537.7	1,537.7	1,537.7	1,537.7	1,537.7	1,486.4	2,383.4	2,383.4	2,383.4	2,383.4	2,383.4	2,383.4	23,474.9	Table3-5
R11	Mianeh	EAZ	210.0	669.9	669.9	669.9	669.9	669.9	647.6	1,038.4	1,038.4	1,038.4	1,038.4	1,038.4	1,038.4	10,227.6	Table3-6
R60	Hashtroud	EAZ	88.0	280.7	280.7	280.7	280.7	280.7	271.4	435.1	435.1	435.1	435.1	435.1	435.1	4,285.9	Table3-6
R41	Divandareh-1	KOR	12.0	38.3	38.3	38.3	38.3	38.3	37.0	59.3	59.3	59.3	59.3	59.3	59.3	584.4	Table3-7
R37	Bijar	KOR	3.0	9.6	9.6	9.6	9.6	9.6	9.3	14.8	14.8	14.8	14.8	14.8	14.8	146.1	Table3-7
R20	Zanjan	ZAN	1,083.0	3,454.9	3,454.9	3,454.9	3,454.9	3,454.9	3,339.8	5,355.2	5,355.2	5,355.2	5,355.2	5,355.2	5,355.2	52,745.4	Table3-8
Total			2,477.0	7,902.0	7,902.0	7,902.0	7,902.0	7,902.0	7,638.6	12,248.1	12,248.1	12,248.1	12,248.1	12,248.1	12,248.1	120,637.4	

Source: WRMC

Table R 6.2.37 Industrial Water Demand in the Long Term (2031)

Reach code	Industrial Area	Province	Average Discharge	Water Requirement ('000m³)												Total	Reference: Mahab Ghodss Report
				Autumn (0.8)			Winter (0.8)			Spring (1.2)			Summer (1.2)				
				Meh. 30.0	Aba. 30.0	Aza. 30.0	Dey 30.0	Bah. 30.0	Esf. 29.0	Far. 31.0	Ord. 31.0	Kho. 31.0	Tir 31.0	Mor. 31.0	Sha. 31.0		
			(Lit/sec)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr	May.	Jun.	Jul.	Aug.	Sep.		
R54	Someh Sara	GIL	80.0	255.2	255.2	255.2	255.2	255.2	246.7	395.6	395.6	395.6	395.6	395.6	395.6	3,896.2	Table3-2
	Shaft	GIL	32.0	102.1	102.1	102.1	102.1	102.1	98.7	158.2	158.2	158.2	158.2	158.2	158.2	1,558.5	Table3-2
	Sub-total		112.0	357.3	357.3	357.3	357.3	357.3	345.4	553.8	553.8	553.8	553.8	553.8	553.8	5,454.7	
R53	Anzali	GIL	40.0	127.6	127.6	127.6	127.6	127.6	123.4	197.8	197.8	197.8	197.8	197.8	197.8	1,948.1	Table3-2
R55	Lahijan	GIL	14.0	44.7	44.7	44.7	44.7	44.7	43.2	69.2	69.2	69.2	69.2	69.2	69.2	681.8	Table3-2
	Langrod	GIL	16.0	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-2
	Astaneh	GIL	16.0	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-2
	Sub-total		46.0	146.7	146.7	146.7	146.7	146.7	141.9	227.5	227.5	227.5	227.5	227.5	227.5	2,240.3	
R56	Masal	GIL	16.0	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-2
R57	Siahkol	GIL	32.0	102.1	102.1	102.1	102.1	102.1	98.7	158.2	158.2	158.2	158.2	158.2	158.2	1,558.5	Table3-2
	Roudsar	GIL	10.0	31.9	31.9	31.9	31.9	31.9	30.8	49.4	49.4	49.4	49.4	49.4	49.4	487.0	Table3-2
	Sub-total		42.0	134.0	134.0	134.0	134.0	134.0	129.5	207.7	207.7	207.7	207.7	207.7	207.7	2,045.5	
R21	Loshan	GIL	200.0	638.0	638.0	638.0	638.0	638.0	616.8	988.9	988.9	988.9	988.9	988.9	988.9	9,740.6	Table3-2
R25	Qazvin	QAZ	366.0	1,167.6	1,167.6	1,167.6	1,167.6	1,167.6	1,128.7	1,809.8	1,809.8	1,809.8	1,809.8	1,809.8	1,809.8	17,825.3	Qazvin RWC
R66	Hamedan	HAM	840.0	2,679.7	2,679.7	2,679.7	2,679.7	2,679.7	2,590.4	4,153.6	4,153.6	4,153.6	4,153.6	4,153.6	4,153.6	40,910.5	Table3-5
R11	Mianeh	EAZ	294.0	937.9	937.9	937.9	937.9	937.9	906.6	1,453.8	1,453.8	1,453.8	1,453.8	1,453.8	1,453.8	14,318.7	Table3-6
R60	Hashtroud	EAZ	123.0	392.4	392.4	392.4	392.4	392.4	379.3	608.2	608.2	608.2	608.2	608.2	608.2	5,990.5	Table3-6
R41	Divandareh-1	KOR	16.0	51.0	51.0	51.0	51.0	51.0	49.3	79.1	79.1	79.1	79.1	79.1	79.1	779.2	Table3-7
R37	Bijar	KOR	4.0	12.8	12.8	12.8	12.8	12.8	12.3	19.8	19.8	19.8	19.8	19.8	19.8	194.8	Table3-7
R20	Zanjan	ZAN	2,093.0	6,677.0	6,677.0	6,677.0	6,677.0	6,677.0	6,454.4	10,349.3	10,349.3	10,349.3	10,349.3	10,349.3	10,349.3	101,935.4	Table3-8
Total			4,192.0	13,373.1	13,373.1	13,373.1	13,373.1	13,373.1	12,927.4	20,728.3	20,728.3	20,728.3	20,728.3	20,728.3	20,728.3	204,163.0	

Source: WRMC note) Ardevil Province offer 36 MCM of Industrial Demand but distribution and industrial area are not clear.

6.2.4 Water Demand with Weir and Dam

Including water demand mentioned before, water demand with weirs and dams are arranged from Table R 6.2.38 to Table R 6.2.43.

Table R 6.2.38 Present Water Demand with Weir (2006)

('000m^3)

Name of Weir	Purpose	Meh. Oct.	Aba. Nov.	Aza. Dec.	Dey Jan.	Bah. Feb.	Esf. Mar.	Far. Apr.	Ord. May	Kho. Jun.	Tir July	Mor. Aug.	Sha. Sept.	Total
Tarik	Agriculture	1,354	1,197	1,134	1,117	1,141	1,379	85,709	85,709	85,709	85,709	85,709	1,587	437,454
Shahre Bijar	Domestic	4,711	4,711	4,711	4,711	4,711	4,554	4,867	4,867	4,867	4,867	4,867	4,867	57,311
Galerud	Agriculture	280	247	235	231	236	285	4,303	11,848	7,618	6,088	5,142	328	36,840
	Domestic	4,711	4,711	4,711	4,711	4,711	4,554	4,867	4,867	4,867	4,867	4,867	4,867	57,311
	Sub-total	4,991	4,958	4,946	4,942	4,947	4,839	9,170	16,715	12,485	10,955	10,009	5,195	94,151
Sangar	Left Agriculture	5,350	4,723	4,483	4,410	4,507	5,442	115,222	311,491	192,398	163,190	137,817	6,265	955,300
	Right Agriculture	691	610	579	570	582	703	76,162	198,253	111,863	108,088	90,533	810	589,443
	Environment (Sturgeon)	0	0	0	0	0	0	0	133.920	133.920	40,176	0	0	308,016
	Sub-total	6,041	5,333	5,062	4,980	5,089	6,145	191,384	549,920	344,437	311,454	268,526	7,075	1,852,743

Table R 6.2.39 Water Demand with Weir in the Middle Term (2016)

('000m^3)

Name of Weir	Purpose	Meh. Oct.	Aba. Nov.	Aza. Dec.	Dey Jan.	Bah. Feb.	Esf. Mar.	Far. Apr.	Ord. May	Kho. Jun.	Tir July	Mor. Aug.	Sha. Sept.	Total
Tarik	Agriculture	1,185	1,047	992	977	998	1,207	85,709	85,709	85,709	85,709	85,709	1,389	436,340
Shahre Bijar	Domestic	8,171	8,171	8,171	8,171	8,171	7,899	8,444	8,444	8,444	8,444	8,444	8,444	99,418
Galerud	Agriculture	245	216	206	202	207	249	3,765	10,367	6,665	5,327	4,499	287	32,235
	Domestic	5,448	5,448	5,448	5,448	5,448	5,266	5,629	5,629	5,629	5,629	5,629	5,629	66,280
	Sub-total	5,693	5,664	5,654	5,650	5,655	5,515	9,394	15,996	12,294	10,956	10,128	5,916	98,515
Sangar	Left Agriculture	4,681	4,133	3,923	3,859	3,944	4,762	102,198	397,579	206,780	176,287	130,583	5,482	1,044,210
	Right Agriculture	605	534	507	499	509	615	66,641	173,471	97,880	94,577	79,217	709	515,763
	Environment (Sturgeon)	0	0	0	0	0	0	0	40,176	40,176	40,176	40,176	0	160,704
	Sub-total	5,286	4,666	4,429	4,358	4,453	5,377	168,839	611,227	344,836	311,039	249,976	6,191	1,720,676

Table R 6.2.40 Water Demand with Weir in the Long Term (2031)

('000m^3)

Name of Weir	Purpose	Meh. Oct.	Aba. Nov.	Aza. Dec.	Dey Jan.	Bah. Feb.	Esf. Mar.	Far. Apr.	Ord. May	Kho. Jun.	Tir July	Mor. Aug.	Sha. Sept.	Total
Shahrud River														
Alamut	Agriculture	3,750	12,508	0	0	0	0	13,694	48,678	66,945	47,565	33,702	23,202	250,045
Sefidrud River														
Tarik	Agriculture	1,034	914	866	853	871	1,053	85,709	85,709	85,709	85,709	85,709	1,212	435,348
Shahre Bijar	Domestic	8,171	8,171	8,171	8,171	8,171	7,899	8,444	8,444	8,444	8,444	8,444	8,444	99,418
Galerud	Agriculture	214	189	179	176	180	218	3,286	9,048	5,817	4,649	3,927	250	28,133
	Domestic	10,168	10,168	10,168	10,168	10,168	9,829	10,507	10,507	10,507	10,507	10,507	10,507	123,711
	Sub-total	10,382	10,357	10,347	10,344	10,348	10,047	13,793	19,555	16,324	15,156	14,434	10,757	151,844
Sangar	Left Agriculture	4,085	3,607	3,423	3,368	3,442	4,156	89,191	346,978	180,463	192,422	113,964	4,784	949,883
	Right Agriculture	528	466	442	435	444	537	58,160	151,393	85,422	82,540	69,135	619	450,120
	Environment (Sturgeon)	0	0	0	0	0	0	0	40,176	40,176	40,176	40,176	0	160,704
	Sub-total	4,613	4,072	3,866	3,803	3,886	4,693	147,350	538,548	306,061	315,138	223,274	5,403	1,560,707

Table R 6.2.41 Present Water Demand with Dam (2006)

('000m^3)

Reach	Dam/ Reservoir	Purpose	Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total
			Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	
R53	Manjil	I	Irrigation water demand with Manjil Dam is considered as water demand with lower weirs, or Tarik, Galerud and Sangar.												
R36	Taleghan	I	4,606	15,524	0	0	0	0	16,986	60,348	83,003	58,975	41,790	28,768	310,000
		D	13,374	11,748	10,374	9,997	9,750	10,374	10,626	12,126	14,124	16,253	16,002	15,252	150,000
		Sum	17,980	27,272	10,374	9,997	9,750	10,374	27,612	72,474	97,127	75,228	57,792	44,020	460,000
R43	Golbolagh	I	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586

I: Irrigation, D: Drinking

Table R 6.2.42 Water Demand with Dam in the Middle Term (2016)

('000m^3)

Reach	Dam/ Reservoir	Purpose	Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total
			Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	
R53	Manjil		Irrigation water demand with Manjil Dam is considered as water demand with lower weirs, or Tarik, Galerud and Sangar.												
R36	Taleghan	I	4,606	15,524	0	0	0	0	16,986	60,348	83,003	58,975	41,790	28,768	310,000
		D	13,374	11,748	10,374	9,997	9,750	10,374	10,626	12,126	14,124	16,253	16,002	15,252	150,000
		Sum	17,980	27,272	10,374	9,997	9,750	10,374	27,612	72,474	97,127	75,228	57,792	44,020	460,000
R43	Golbolagh	I	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586
R59.	Givi	I	4,566	568	0	0	0	0	967	6,031	15,231	23,896	22,005	10,592	83,856
		D	105	105	105	105	105	102	109	109	109	109	109	109	1,279
		Sum	4,671	673	105	105	105	102	1,076	6,140	15,340	24,005	22,114	10,701	85,135
R11	Estor	I	3,400	460	120	0	0	450	2,790	7,480	14,530	17,840	16,330	9,180	72,580
		P	23,872	32,841	47,226	59,512	70,036	94,261	111,314	113,966	83,191	41,354	26,945	26,945	731,463
		Sum	27,272	33,301	47,346	59,512	70,036	94,711	114,104	121,446	97,721	59,194	43,275	36,125	804,043
R10	Sahand	I	3,140	1,500	0	0	0	0	2,230	6,460	17,420	26,400	2,463	11,220	70,833
R18	Ayudughmush	I	6,489	649	433	0	0	0	119	9,625	26,280	43,475	38,392	24,441	149,903
R02	Garmichay	I	2,372	185	72	0	0	285	1,593	6,068	7,085	8,126	7,327	3,886	36,999
		D	1,365	1,365	1,365	1,365	1,365	1,319	1,410	1,410	1,410	1,410	1,410	1,410	16,606
		Sum	3,737	1,550	1,437	1,365	1,365	1,604	3,003	7,478	8,495	9,536	8,737	5,296	53,605
R08	Kalghan	I	483	27	0	0	0	0	0	736	3,922	6,054	5,205	1,689	18,116
R62	Shahreh bijar	D	This water demand is considered as the one with the weir.												0
R40	Siazakh	I	8,468	2,698	0	0	0	0	8,126	19,061	29,941	29,695	25,633	18,763	142,385
R52	Sange siah	I	3,110	338	0	0	0	0	858	4,448	9,107	5,673	4,831	3,872	32,237
R51	Sural	I	707	82	0	0	0	0	142	637	1,543	1,858	1,781	1,369	8,119
R63	Golabar	I	4,268	57	0	0	0	0	0	3,609	11,017	15,260	15,291	8,034	57,536
R24	Taham	I	217	6	0	0	0	0	18	316	650	826	831	427	3,291
		D	5,767	5,767	5,767	5,767	5,767	5,575	5,960	5,960	5,960	5,960	5,960	5,960	70,171
		In	778	778	778	778	778	752	804	804	804	804	804	804	9,466
		Sum	6,762	6,551	6,545	6,545	6,545	6,327	6,782	7,080	7,414	7,590	7,595	7,191	82,928
R45	Talvar	I	16,035	475	475	0	0	0	1,332	23,314	47,961	60,951	61,284	31,498	243,326
		D	7,808	7,808	7,808	7,808	7,808	7,548	8,068	8,068	8,068	8,068	8,068	8,068	95,000
		Sum	23,843	8,283	8,283	7,808	7,808	7,548	9,401	31,383	56,030	69,019	69,353	39,567	338,326

I: Irrigation, D: Drinking, In: Industry, P: Electrical Power

Table R 6.2.43 Water Demand with Dam in the Long Term (2031)

('000m^3)

Reach	Dam/ Reservoir	Purpose	Meh. Oct.	Aba. Nov.	Aza. Dec.	Dey Jan.	Bah. Feb.	Esf. Mar.	Far. Apr.	Ord. May	Kho. Jun.	Tir July	Mor. Aug.	Sha. Sept.	Total
R53	Manjil		Irrigation water demand with Manjil Dam is considered as water demand with lower weirs, or Tarik, Galerud and Sangar.												
R36	Taleghan	I	2,006	6,761	0	0	0	0	7,397	26,282	36,148	25,684	18,200	12,528	135,005
		D	27,640	24,279	21,440	20,660	20,150	21,440	21,960	25,060	29,190	33,590	33,071	31,521	310,000
		Sum	29,646	31,040	21,440	20,660	20,150	21,440	29,358	51,342	65,337	59,273	51,270	44,049	445,005
R43	Golbolagh	I	435	13	0	0	0	0	36	632	1,301	1,653	1,662	854	6,586
R59.	Givi	I	4,566	568	0	0	0	0	967	6,031	15,231	23,896	22,005	10,592	83,856
		D	145	145	145	145	145	140	150	150	150	150	150	150	1,763
		Sum	4,711	713	145	145	145	140	1,117	6,181	15,381	24,046	22,155	10,742	85,619
R11	Estor	I	3,400	460	120	0	0	450	2,790	7,480	14,530	17,840	16,330	9,180	72,580
		P	23,872	32,841	47,226	59,512	70,036	94,261	111,314	113,966	83,191	41,354	26,945	26,945	731,463
		Sum	27,272	33,301	47,346	59,512	70,036	94,711	114,104	121,446	97,721	59,194	43,275	36,125	804,043
R10	Sahand	I	3,140	1,500	0	0	0	0	2,230	6,460	17,420	26,400	2,463	11,220	70,833
R18	Ayudughmush	I	6,000	600	400	0	0	0	110	8,900	24,300	40,200	35,500	22,600	138,610
R02	Garmichay	I	2,372	185	72	0	0	285	1,593	6,068	7,085	8,126	7,327	3,886	36,999
		D	847	847	847	847	847	819	875	875	875	875	875	875	10,304
		Sum	3,219	1,032	919	847	847	1,104	2,468	6,943	7,960	9,001	8,202	4,761	47,303
R08	Kalghan	I	483	27	0	0	0	0	0	736	3,922	6,054	5,205	1,689	18,116
R62	Shahreh bijar	D	5,959	5,959	5,959	5,959	5,959	5,760	6,158	6,158	6,158	6,158	6,158	6,158	72,503
R40	Siazakh	I	8,468	2,698	0	0	0	0	8,126	19,061	29,941	29,695	25,633	18,763	142,385
R52	Sange siah	I	3,110	338	0	0	0	0	858	4,448	9,107	5,673	4,831	3,872	32,237
R51	Sural	I	707	82	0	0	0	0	142	637	1,543	1,858	1,781	1,369	8,119
R63	Golabar	I	4,268	57	0	0	0	0	0	3,609	11,017	15,260	15,291	8,034	57,536
R24	Taham	I	217	6	0	0	0	0	18	316	650	826	831	427	3,291
		D	3,681	3,681	3,681	3,681	3,681	3,558	3,803	3,803	3,803	3,803	3,803	3,803	44,781
		In	778	778	778	778	778	752	804	804	804	804	804	804	9,466
		Sum	4,676	4,465	4,459	4,459	4,459	4,310	4,625	4,923	5,257	5,433	5,438	5,034	57,538
R45	Talvar	I	12,552	372	372	0	0	0	1,043	18,250	37,543	47,711	47,972	24,656	190,471
		D	7,808	7,808	7,808	7,808	7,808	7,548	8,068	8,068	8,068	8,068	8,068	8,068	95000
		Sum	20,360	8,180	8,180	7,808	7,808	7,548	9,111	26,318	45,611	55,779	56,040	32,724	285,471
R01	Sangabad	I	769	125	0	0	0	0	211	1,214	3,310	7,760	7,604	3,185	24,178
R12	Niakhoram	I	311	51	0	0	0	0	85	491	1,339	3,139	3,076	1,288	9,780
R07	Tabrizak	I	207	34	0	0	0	0	57	327	893	2,093	2,051	859	6,521
R14	Befrajerd	D	395	395	381	408	408	408	408	408	408	408	408	408	4,843
R23	Alan	I	217	6	0	0	0	0	18	316	650	826	831	427	3,291
R65	Sir	I	2,170	730	120	0	20	510	4,030	9,560	15,480	14,180	11,460	4,440	62,700
R64	Babakhan	I	3261	97	0	0	0	0	271	4,742	9,755	12,397	12,465	6,406	49,394
R42	Zardekamar	I	2,887	920	0	0	0	0	2,770	6,498	10,207	10,123	8,739	6,396	48,540
R47	Hasankhan	D	2,655	2,026	1,875	1,760	1,850	1,900	2,359	3,131	3,986	4,353	3,970	3,394	33,259
R34	Sheikh Besharat	I	815	24	0	0	0	0	68	1,185	2,439	3,099	3,116	1,602	12,348
R41	Aleh dare	I	1,179	159	0	0	0	0	567	2,853	6,003	4,959	2,352	1,980	20,052
R32	Burmanak	I	1,917	149	0	0	0	0	1,350	3,091	5,947	7,268	5,968	3,843	29,533
R22	Mushampa	I,D,P	7,618	2,292	2,508	0	0	1,177	27,190	83,567	86,373	46,898	40,429	25,139	323,191
R39	Mendagh	I	4,993	2,501	2,501	0	0	0	6,613	17,257	21,647	11,930	7,126	3,482	78,050
R31	Mehtar	I	99	0	0	0	0	0	33	366	1,746	2,581	1,800	1,050	7,675
R29	Songhor	I	363	23	0	0	0	0	71	464	1,618	2,473	2,088	1,349	8,449
R38	Chasb	I	562	43	43	0	0	0	164	688	1,787	2,458	2,616	1,991	10,352
R28	Gezel Tape	I	53	0	0	0	0	0	17	210	1,040	1,471	1,017	509	4,317
R33	Ramin	I	0	0	0	0	0	0	0	294	508	508	401	294	2,005
R26	Marash	I	1,139	343	375	0	0	176	4,065	12,493	12,913	7,011	6,044	3,758	48,317
R30	Ghareh Darangh	I	2,359	32	0	0	0	0	0	1,995	6,089	8,434	8,451	4,440	31,799
R16	Khoresh Rostam (Hashtjin-2)	I	1,761	286	0	0	0	0	483	2,781	7,589	17,789	17,428	7,303	55,420

I: Irrigation, D: Drinking, In: Industry, P: Electrical Power

6.3 ISSUES AND DERIVATIONS

Issues described below are identified through the demand projection of water uses so that further examination was made in the phase II stage and some revision of the projection was done. As the problem in the future, irrigation demand of Alfalfa, which is most widely cultivated in traditional irrigation area and has high unit water requirement such as 30,000m^3/ha, should be more further studied.

6.3.1 Differences between Present Water Intake and Irrigation Demand in the Traditional Irrigation Area

According to WRMC's data, present water intake volume and irrigation demand in the traditional irrigation areas are presented in Table R 6.3.1 and Figure R 6.3.1. The water intake volume is estimated at 3,430 MCM/year, while the irrigation demand is estimated at 4,501 MCM/year. Thus difference between them is 1,071 MCM/year. Furthermore, the demands in 31 reaches out of 57 reaches exceed more than two times of the intake volume.

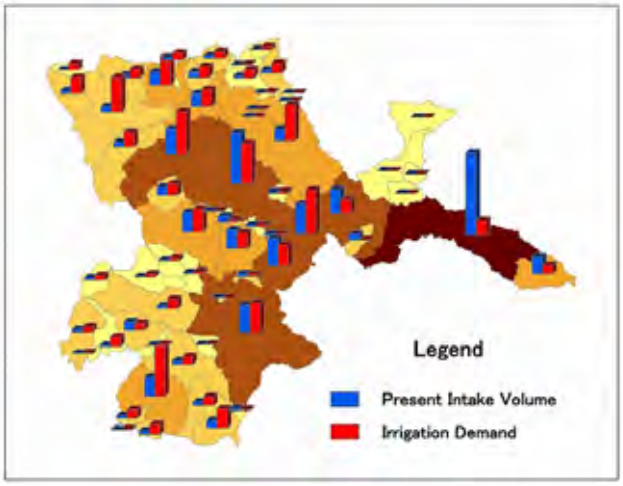


Figure R 6.3.1 Demand and Intake in Traditional Irrigation Area

Some balancing between intake facilities and irrigation areas might be kept even in the traditional irrigation areas. These imbalanced results, however, might originate from two reasons; (1) Gross irrigation areas were used for estimation of the demand instead of net irrigation areas, (2) Irrigation efficiencies were setup at far lower values than the real ones. In due consideration of these situations, modified irrigation efficiencies were setup to keep balance between the demand and the intake volume, and they are used in water balance simulation of the basin model.

6.3.2 Differences of Unit Irrigation Intake Volume among the Areas

Figure R 6.3.2 shows spatial distribution of unit irrigation intake volume of the traditional irrigation areas in the basin. The unit values range widely from 6,211m^3/ha in Reach 16 to 41,473m^3/ha in Reach 62. Average value of 19,840 m^3/ha also significantly exceeds national standard value of 6,400 m^3/ha in wheat fields and 10,000-18,000 m^3/ha in paddy fields.

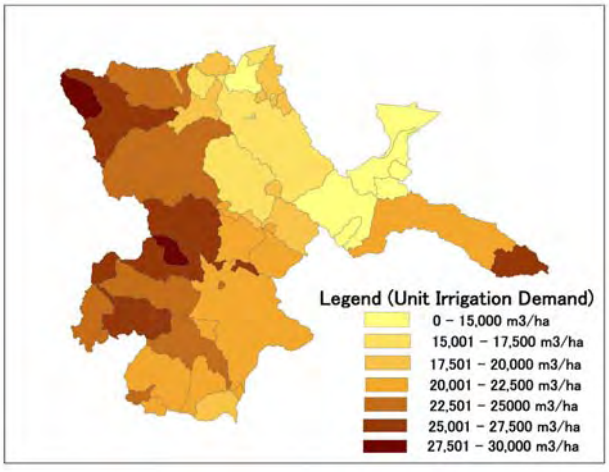


Figure R 6.3.2 Unit Irrigation Demand in Traditional Irrigation Area

Table R 6.3.1 Present Intake and Demand in Traditional Irrigation Area

Reach	Irrigation Area (ha)			Irrigation Efficiency (%)			Present Water Demand			
	Crop	Orchard	Sum	Crop	Orchard	Average	Net ('000m^3)	Gross ('000m^3)	Gross /Net	Unit GrossWater Demand (m^3/ha)
1	1,370	119	1,489	33	36	33.2	6,929	20,836	3.0	13,993
2	1,332	1,922	3,254	33	36	34.8	17,969	51,775	2.9	15,911
3	3,919	667	4,586	33	36	33.4	20,185	60,232	3.0	13,134
4	1,738	1,070	2,808	32	35	33.1	20,264	60,953	3.0	21,707
5	8,064	1,834	9,898	32	35	32.6	65,403	200,466	3.1	20,253
6	4,257	1,486	5,743	33	36	33.8	26,521	78,307	3.0	13,635
7	133	75	208	33	36	34.1	1,171	3,446	2.9	16,567
8	1,760	28	1,788	32	35	32.0	15,404	46,753	3.0	26,148
9	2,508	250	2,758	32	35	32.3	17,078	52,798	3.1	19,144
10	3,639	839	4,478	32	35	32.6	37,177	114,286	3.1	25,522
11	6,592	288	6,880	32	35	32.1	38,157	118,704	3.1	17,253
12	426	157	583	33	36	33.8	3,225	9,554	3.0	16,388
13	303	44	347	33	36	33.4	2,202	6,600	3.0	19,020
14	90	8	98	33	36	33.2	511	1,538	3.0	15,694
15	14	5	19	33	37	34.1	99	288	2.9	15,158
16	13	6	19	33	36	33.9	41	118	2.9	6,211
17	13,419	821	14,240	32	35	32.2	96,337	299,133	3.1	21,007
18	4,438	508	4,946	32	35	32.3	32,510	100,591	3.1	20,338
19	8,039	220	8,259	33	37	33.1	97,490	295,174	3.0	35,740
20	14,247	4,241	18,488	30	33	30.7	86,131	280,015	3.3	15,146
21	2,765	5,469	8,234	32	35	34.0	32,896	96,310	2.9	11,697
22	4,118	455	4,573	32	35	32.3	25,377	78,539	3.1	17,175
23	334	19	353	33	37	33.2	3,355	10,148	3.0	28,748
24	621	234	855	30	33	30.8	4,239	13,744	3.2	16,075
25	4,278	1,455	5,733	31	34	31.8	34,442	108,026	3.1	18,843
26	6,495	1,176	7,671	32	35	32.5	52,565	161,736	3.1	21,084
27	16,828	2,093	18,921	30	33	30.3	92,946	306,290	3.3	16,188
28	209	94	303	30	33	30.9	1,624	5,272	3.2	17,399
29	562	99	661	30	33	30.4	3,986	13,089	3.3	19,802
30	4,688	974	5,662	30	33	30.5	34,223	112,070	3.3	19,793
31	730	188	918	30	33	30.6	4,510	14,715	3.3	16,029
32	78	3	81	32	35	32.1	304	948	3.1	11,704
33	404	207	611	30	33	31.0	3,472	11,223	3.2	18,368
34	692	92	784	32	35	32.4	7,661	23,717	3.1	30,251
35	520	94	614	32	35	32.5	5,303	16,360	3.1	26,645
36	878	1,413	2,291	31	34	32.9	18,287	55,625	3.0	24,280
37	2,157	297	2,454	37	43	37.7	24,637	65,560	2.7	26,716
38	467	93	560	31	37	32.0	4,108	12,878	3.1	22,996
39	7	3	10	31	37	32.8	67	209	3.1	20,900
40	1,292	156	1,448	37	43	37.6	14,060	37,466	2.7	25,874
41	2,425	164	2,589	37	43	37.4	25,962	69,593	2.7	26,880
42	1,598	189	1,787	37	43	37.6	18,361	48,963	2.7	27,400
43	352	32	384	37	45	37.7	3,915	10,429	2.7	27,159
44	1,768	345	2,113	37	45	38.3	20,793	54,669	2.6	25,873
45	238	35	273	37	45	38.0	2,297	6,052	2.6	22,168
46	131	10	141	37	43	37.4	1,320	3,536	2.7	25,078
47	15,120	366	15,486	37	45	37.2	134,944	362,983	2.7	23,439
48	2,398	540	2,938	37	45	38.5	24,030	62,510	2.6	21,276
49	300	52	352	31	38	32.0	2,473	7,710	3.1	21,903
50	2,354	57	2,411	37	45	37.2	21,695	58,356	2.7	24,204
51	320	16	336	37	45	37.4	3,142	8,409	2.7	25,027
52	2,890	201	3,091	37	45	37.5	26,637	71,039	2.7	22,983
59	3,540	695	4,235	33	36	33.5	22,888	68,406	3.0	16,153
60	8,913	1,511	10,424	32	35	32.4	77,941	240,324	3.1	23,055
61	11,304	6,090	17,394	33	36	34.1	84,346	247,627	2.9	14,236
62	203	0	203	33	37	33.0	2,779	8,419	3.0	41,473
63	6,459	1,036	7,495	30	33	30.4	44,702	146,890	3.3	19,598
64	653	105	758	32	35	32.4	7,105	21,942	3.1	28,947
65	1,079	73	1,152	37	43	37.4	12,476	33,475	2.7	29,058
66	6,918	1,925	8,843	32	38	33.3	69,794	210,061	3.0	23,754
67	6,670	259	6,929	37	45	37.3	49,784	133,364	2.7	19,247
Total/Average	200,057	42,903	242,960			33.8	1,610,250	4,820,249	3.0	19,840

CHAPTER 7. WATER BALANCE SIMULATION

7.1 ESTABLISHMENT OF WATER BALANCE SIMULATION MODEL

The MIKE SHE and MIKE BASIN are employed to establish the water balance simulation model and the water allocation simulation model respectively. MIKE SHE, in its original formulation, could be characterized as a deterministic, physics-based, distributed model code. MIKE SHE covers the major processes in the hydrologic cycle and includes process models for evapotranspiration, overland flow, unsaturated flow, groundwater flow, and channel flow and their interactions. The result of the water balance simulation by MIKE SHE such as the time series of runoff water, recharge water as well as water demand are input into the water allocation model (MIKE BASIN) to examine the situation of the water distribution under the condition of various cases and to propose the appropriate water allocation plans. Outline of the Sefidrud Model is described below.

7.1.1 Outline of Simulation Model

The water balance simulation model for Sefidrud River basin by MIKE SHE (hereinafter referred to as The Sefid-WBSM) is established to calculate the natural groundwater recharge and surface runoff to input into the MIKE BASIN allocation simulation model (hereinafter referred to as The Sefid-WASM). The groundwater recharge is equal to the amount of water percolating out through the bottom of the root zone. Runoff and infiltration are surface processes and as such require detailed information on the ground surface and root zone.

The Sefid-WBSM domain is 210 grid cells East-to-West and 165 grid cells North-to-South. The grid cell size is 2040m. Normally, the smaller mesh size is better to increase the accuracy of simulation results. However, considering both the accuracy requirement and the practical use, the grid size is selected so that the model grid would correspond to the 60m DEM and the simulation time could be less than 6 hours. The model data is specified in a variety of formats independent of the model domain and grid, including native GIS formats. At run time, the spatial data is mapped onto the numerical grid, which makes it easy to change the spatial distribution.

The river network is arranged using the collected information such as DEM (ASTER) and topographic maps. In the coupled MIKE 11 river network model, the river discharges are calculated assuming there is no hydrograph transformation along the river network. In the Sefid-WBSM and WASM, the sub-catchments limit the lateral extent of interflow and overland flow. That is interflow and overland flow is only discharged to river links located within the sub-catchment.

Each of above-mentioned processes can be represented at different levels of spatial distribution and complexity, according to the goals of the modeling study, the availability of field data and the modeler's choices. There are, however, important limitations to the applicability of such physics-based models, primarily complexity and computational cost. Therefore, it is often practical to use simplified process descriptions. In case of Sefid-WBSM, it takes about 6 hours to simulate the water balance of the 62 Reaches for 30-year time series data.

As to the Sefid-WASM, the simulation result outputs in each Reach and the water transfers through the river channel in the same way as the Sefid-WBSM. The Sefid-WBSM can be visually established on the screen of a computer using the GIS software "Arc Map". Concretely, the visible figures of module for basins, river lines, dams and water users are pasted on GIS database screen and the data is input through the windows which appear when the modeler clicks the features. After the data input, the Sefid-WASM should be verified its tank parameters which express the conveyance from underground water (the recharge) to river flow.

7.1.2 Basic Conditions

The Sefid-WBSM and WASM is established based on the following basic conditions on which the both the Study Team and C/P agreed in the Phase I. The duration of water allocation simulation

should be for 30 years, however, the data for 20 years is used in the current model due to the unsatisfactory calibration result about the first decade, that is from 1975 to 1984.

Table R 7.1.1 Basic Condition for Model Construction

Model	Contents	Data Format	Duration of Simulation
Sefid-WBSM	The recharge and runoff are calculated. By the model using the hydro-meteorological data, land use, vegetation and so on.	Input and Output -Gregorian Calendar -Daily data -Start from March 21 (Far 1 in Iranian Calendar)	1) 20 years for Calibration -1985/3/21-2005/3/21 -Duration during no dam at the upper basin of Manjil Dam 2) 30 years for Simulation - Output data is to be inputted to Sefid-WASM
Sefid-WASM	The water allocation is considered by the model which are inputted the water demand, dam's information and the result of Sefid-WBSM.	Input (- ditto -) Output -Gregorian Calendar -Monthly Data -Start from March 21 (Far 1 in Iranian Calendar)	1) 30 years for Simulation -1975/3/21-2005/3/21

7.1.3 Flowchart of Model Establishment

The flowchart for the establishment of Sefid-models is shown in Figure R 7.1.1.

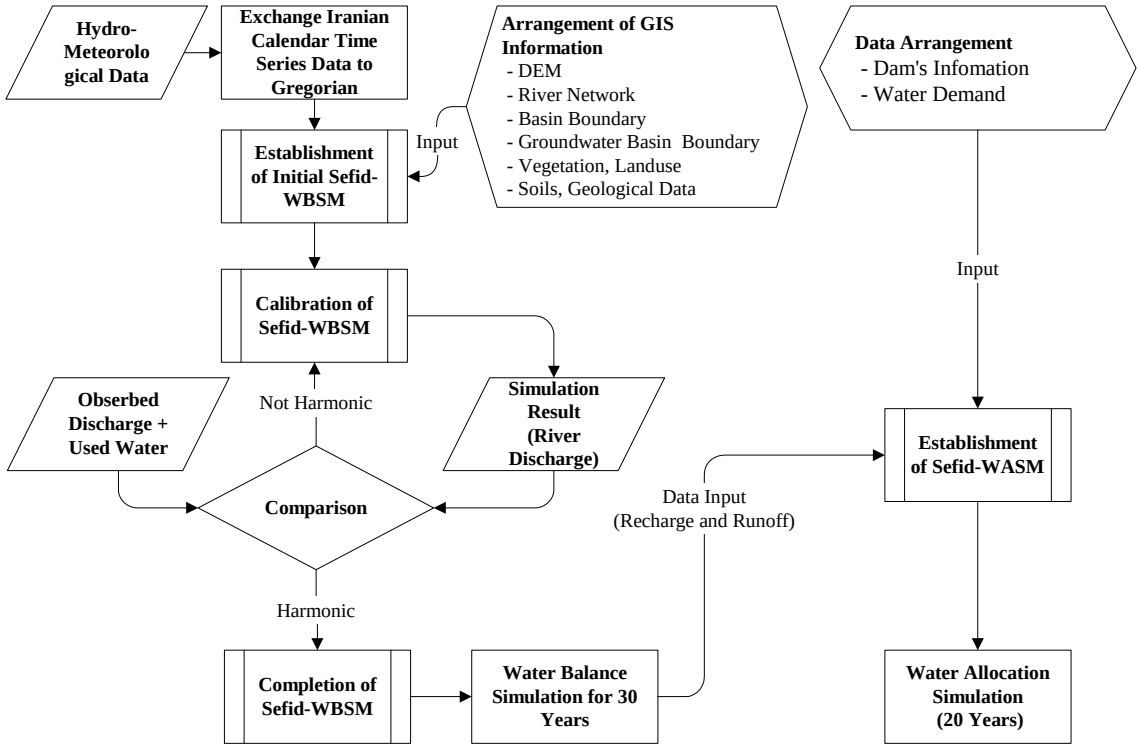


Figure R 7.1.1 Flowchart of Model Establishment

7.2 BOUNDARY CONDITION FOR SEFID-WBSM

The time series data such as evaporation, temperature, used water and river discharge, and the land coverage information such as vegetation and geological information are collected to establish Initial Sefid-WBSM. These data are entered into database mounted on MIKE SHE software.

Table R 7.2.1 Input Data into Sefid-WBSM

Item		Duration, Contents	Remarks
Observed Data	Precipitation (Daily)	1975 - 2005	Selected from 167 WRMC stations and 102 IRIMO stations
	Evaporation (Daily)	1975 - 2005	Selected from 47 WRMC stations
	Temperature (Daily)	1975 - 2005	Selected from IRIMO stations
Geographical Information	Land Use Map	2002	Obtained from MOJA
	Soil, Geological Map	2005	Obtained from MG
	DEM	2007	From ASTER Satellite (purchased by the Study Team)
	Basin Boundary	-	Generated using DEM
	Reach Boundary	Sub-basins based on dam construction plan	Upstream basin of existing, abuilding, planned dams
	Groundwater Aquifer Boundary	Delineated based on aquifer boundary	Re-defined during model calibration
	River Network	Major Rivers	Defined by topographic map and DEM
	Position of Observatories	Hydro-Meteorological Station	For making Thiessen polygon

1) Model Domain and Grid

The MIKE SHE model domain is delineated based on the Sefidrud River basin boundary and Gilan irrigation network drainage area. The model domain is 210 grid cells East-to-West and 165 grid cells North-to-South. The square grid cell size is 2040m. The grid size and grid origin were selected so that the model grid would correspond to the 60m DEM (Digital Elevation Model from Aster Satellite). That is each model cell contains exactly an even number of 60m DEM cells.

2) Delineation of Subbasements (Reaches)

The subcatchments in the Sefidrud WBSM are defined based on the Reaches information supplied by WRMC. The subcatchments are identical to the catchments used in the Sefidrud WAS model (by MIKE BASIN software). In this model, the subcatchments limit the lateral extent of interflow and overland flow. That is interflow and overland flow is only discharged to river links located within the subcatchment. A MIKE 11 branch name and chainage range was specified for each subcatchment. This prevents any ambiguity with respect to the river links where the interflow and overland flow will discharge.

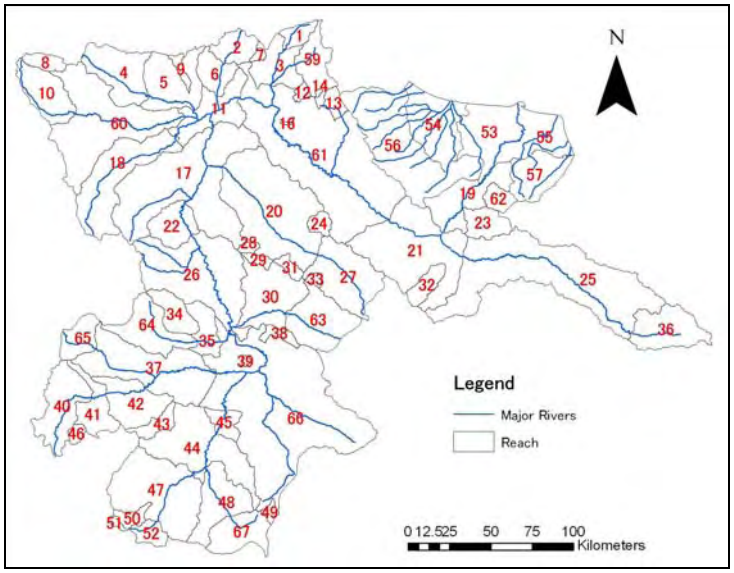


Figure R 7.2.1 Delineation of Subcatchments (Reaches)

3) Topography (Elevation Distribution)

The model topography is based on the 60m DEM. As mentioned in subsection 1.3.2. Since the topography data (60 m mesh) is much denser than the model grid (2,040m mesh), each model grid contains many topography data points. In this case, 34x34, or 1156 data points per grid cell. In the Sefidrud model, the model grid is aligned to the topography grid, which means that the model grid is defined by the topography data that is closest to the mid-point of the cell. The topography is used for calculation of the cell elevation for the temperature and precipitation elevation correction.

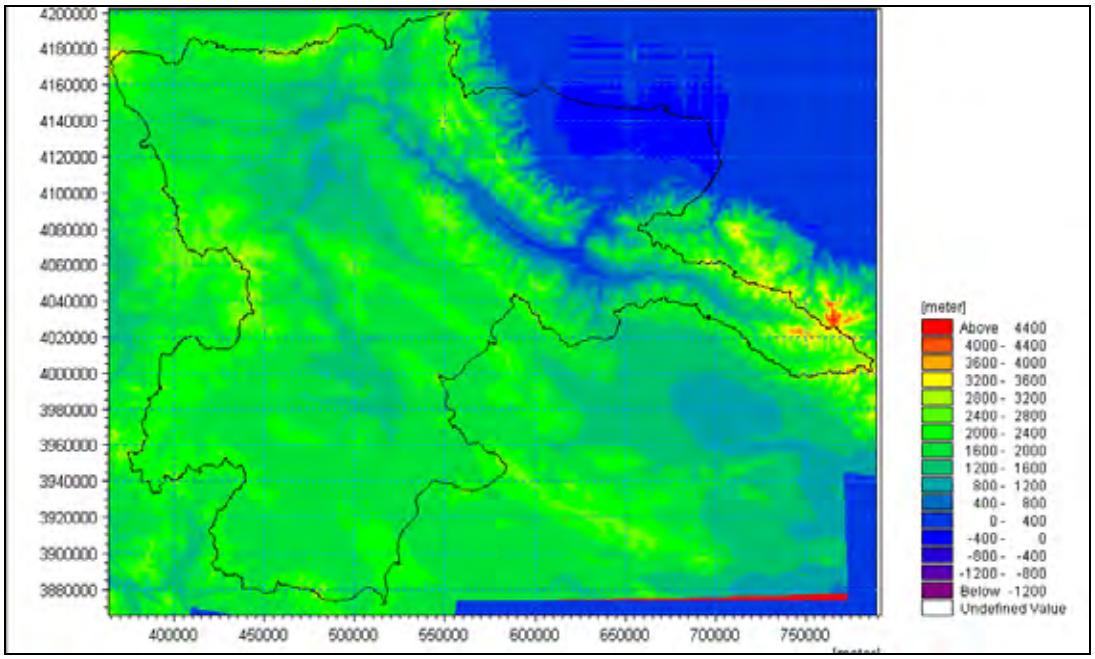


Figure R 7.2.2 Topography

4) Climate

As a result of JICA Study, the available climate information consists of measured precipitation, evapotranspiration, and temperature in the view point of the situation of arrangement of the climatology data in the Sefidrud River Basin. Each of these data sets was analyzed to find the stations with long continuous data records (see JICA Report). These data stations were extracted and the remaining gaps were statistically filled from correlated stations, using MIKE Basin's Temporal Analyst tool in ArcMap. For each data set, a Thiessen polygon map was created based on the selected stations. The Thiessen polygon shape file was used to distribute the measured climate data at each station within its corresponding Thiessen polygon.

a) Precipitation

For precipitation, measurement data from WRMC was used. Thirty-nine measurement stations were selected with long, relatively continuous records. Gaps in the measurement records were filled based on the correlations to neighboring stations. A Thiessen polygon distribution was created based on these 39 stations (see Figure R 7.2.3), which can significantly influence the distribution of rainfall relative to the station measurements.

Figure R 7.2.3 Precipitation Observatory and Thiessen Polygon

b) Evaporation

The evapotranspiration (ET) in the Sefidrud MIKE SHE model was based on daily measurements of pan evaporation at 31 stations from the WRMC (Figure R 7.2.4). The 31 measurements were selected based on their length of record and continuity over time. Gaps in the measurement records were filled based on the correlations to neighboring stations.

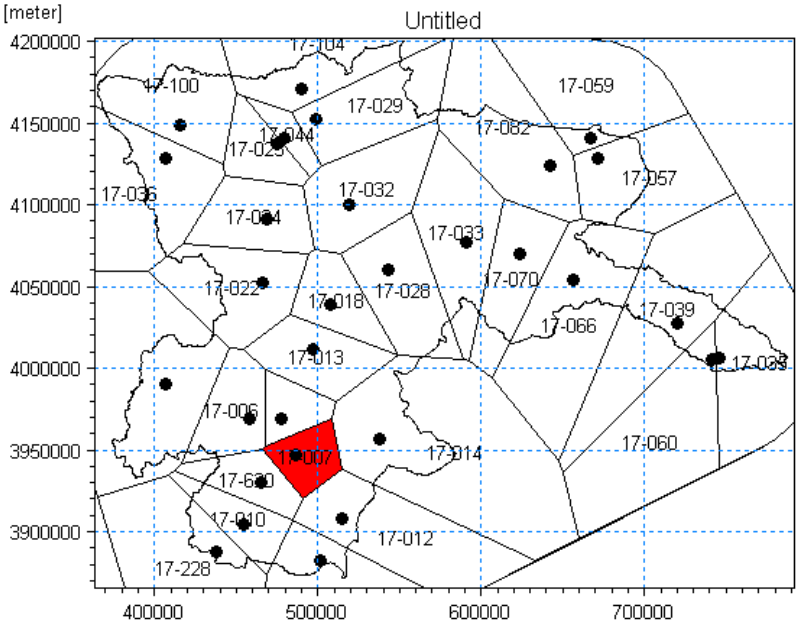


Figure R 7.2.4 Polygon of Evaporation

MIKE SHE calculates actual ET from the available water. This requires crop reference ET as input, which is a standard amount ET expected from a standard reference crop (i.e. a well water grass of a specific species and height). Pan evaporation is, however, significantly greater than crop reference ET. Pan coefficients can be used to convert between pan evaporation and crop reference ET. However, these coefficients depend on the local weather and location of the pan (e.g. upwind vegetation, relative humidity, wind speed, etc). Pan coefficients for sites characteristic of the Sefidrud basin probably range between 0.5 and

0.9. For the Sefidrud MIKE SHE model, a pan coefficient of 0.7 was used. That is, all of the pan evaporation data was multiplied by 0.7.

c) Temperature

The temperature in the Sefidrud MIKE SHE model was based on daily measurements of temperature at 16 stations from the Iran Meteorological Organization (IRIMO). The 18 measurements were selected based on their length of record and continuity over time. Gaps in the measurement records were filled based on the correlations to neighboring stations.

In mountainous areas like the Sefidrud basin, there is a significant and precise elevation influence on actual temperature. The correction factor, known as the lapse rate, used in the Sefidrud MIKE SHE model was -0.649 C per 100m of elevation change from the measurement station. In fact, the temperature lapse rate depends on humidity (wet lapse rate), but this effect has been ignored in this model. This is probably insignificant because the climate is generally dry. The temperature is only used for the snowmelt calculations.

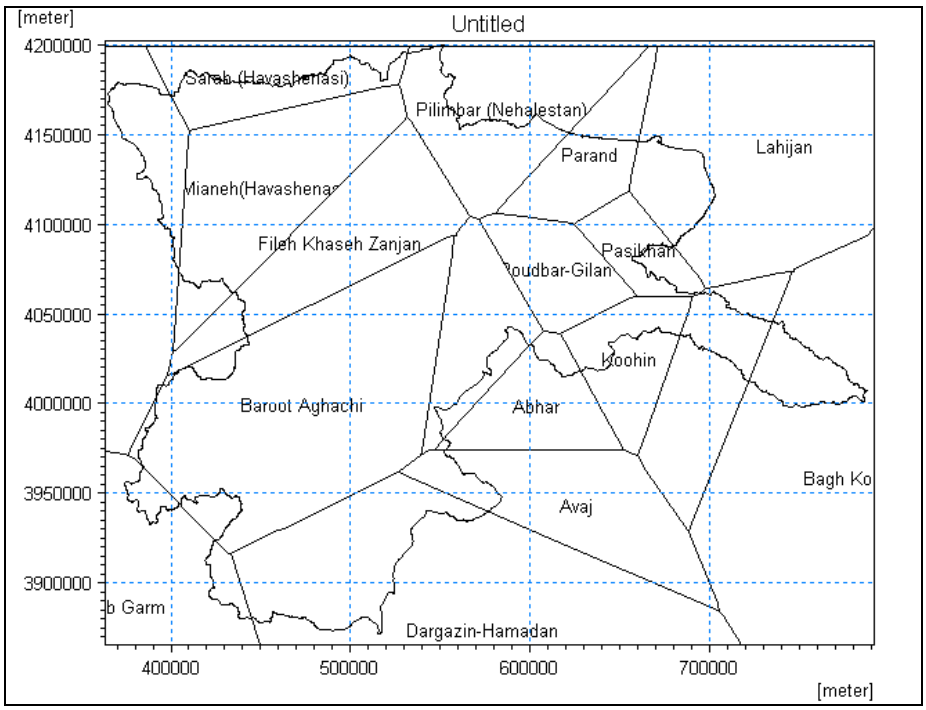


Figure R 7.2.5 Polygon of Temperature

d) Snowmelt

The Sefidrud model considers the accumulation and melting of snow, as a function of air temperature. When the temperature is below 0C (Threshold melting temperature) precipitation accumulates as snow. When the temperature is above 0C, accumulated snow begins to melt at the rate of 2 mm/C/day (Degree-day melting coefficient).

5) Vegetation

a) Land-Use Information

The distribution of vegetation in the Sefidrud BASIN was obtained as a polygon shape file from MOJA thorough WRMC. The shape file contained 76 unique vegetation classes; most of these being compounded mixed vegetation classes. These 76 classes were

reduced to the following eight vegetation classes, based on the predominant class in mixed classes and lumping classes with similar characteristics.

Table R 7.2.2 Dynamic Classification of Land-use

No.	Class	Description
1	Grass	"Grass" includes all of the good and moderate range areas, as well as fallow fields and areas classified as dry farming, which is assumed to be rain-fed grass-like crops
2	Scrub	"Scrub" is a lumping of all the areas that support limited or no vegetation, including all of the rock, bare land, poor range, floodplain and low forest classes
3	Urban	"Urban" includes the urban classes, as well as any other built up classifications, such as the airport class
4	Agriculture	"Agriculture" is the agriculture class, which is assumed to be irrigated crop areas
5	Water	"Water" includes areas of permanent surface water
6	Forest	"Forest" includes the modforest and woodland classes
7	Dense Forest	"Dense Forest" includes the dense forest class, which is predominantly on the coastal size of the mountains surrounding the Caspian Sea, where the precipitation rate is much higher than in the inland areas
8	Orchard	"Orchard" is assumed to be areas predominated by irrigated tree-based agriculture, such as fruit trees

The vegetation polygon shape file with these 8 classes was converted to a dfs2 file with 510 m-grid spacing. This means that each model domain grid (2040 m) includes 16 vegetation classes. The actual vegetation classes in the model are assigned to the model grids based on the dominant vegetation type in the cell, while accounting for the statistical variation of the distribution.

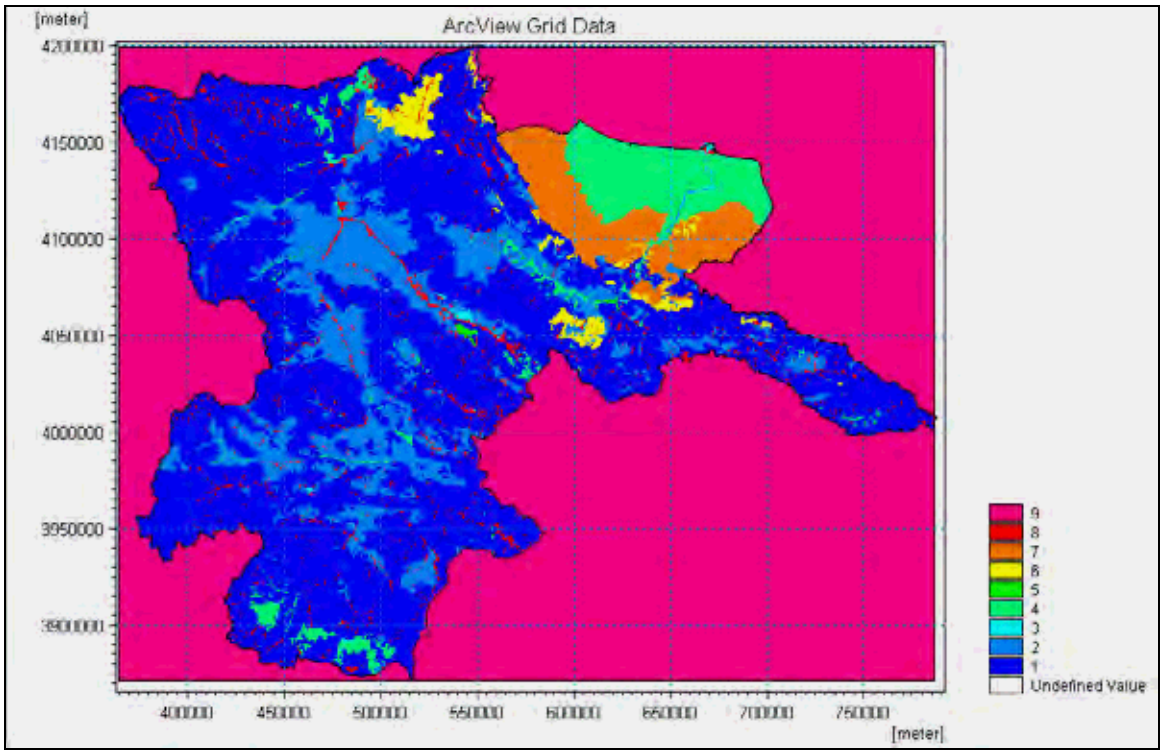


Figure R 7.2.6 Land-Use Information

6) Vegetation

Each vegetation class requires a Leaf Area Index (LAI), which is the area of leaves per m2 of ground surface, and a root depth. Both of these values can vary throughout the growing season depending on the plant and crop type. In the model, the LAI controls the actual amount of evapotranspiration, assuming that evapotranspiration is not limited by the available water. The root depth controls the depth to which water can be extracted from the unsaturated zone, and thus the unsaturated zone water deficit that must be filled before groundwater recharge can occur. Since the actual ET is largely limited by the available water due to the relatively dry climate, little effort was made to adjust these parameters during the calibration. More detailed evaluation of the LAI and root depths based on actual crops/plant types and growing seasons would likely improve the model, but only if better land-use and soils maps are also used.

Table R 7.2.3 Summary of Leaf Area Index and Root depth values

Vegetation Class	LAI	Root depth [mm]
Grass	1	300
Scrub	0.5	600
Urban	0	0
Agriculture	4	1000
Water	0	0
Forest	5	1200
Dense Forest	6	2000
Orchard	5	2000

7) River Network

The main branches were selected from a detailed line shape file with all tertiary streams. The network was defined such that most of the large sub-catchments were connected to the river network. The stream nodes were imported to MIKE 11 from the shape file and a MIKE 11 network was routed through the points. The resulting MIKE 11 network consists of 37 branches that closely follow the actual meanderings of the river network.

Since all the branches are defined without hydrograph transformation, the lateral inflows to MIKE 11 are simply summed and routed down the river network in each MIKE 11 time step. This is a reasonable assumption when we are calculating MIKE 11 with daily time steps. Some timing error is inevitable, since the travel time from the highest upstream areas to the outlet is probably a several days.

7.2.2 Calibration of Sefid-WBSM

The model is calibrated focusing on the conformance of volume and wave shape between the simulation result and the observed discharge. Table R 7.2.4, Figure R 7.2.7 and Figure R 7.2.8 are shown the calibration result at the major station of Gezelozen River.

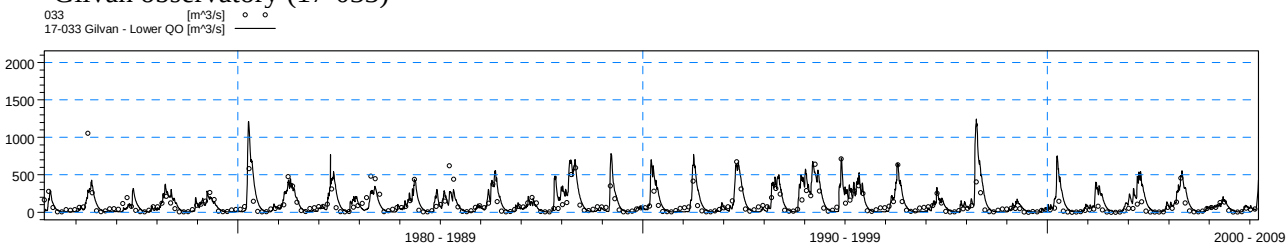
Table R 7.2.4 Calibration Result

(Volume: MCM/year)

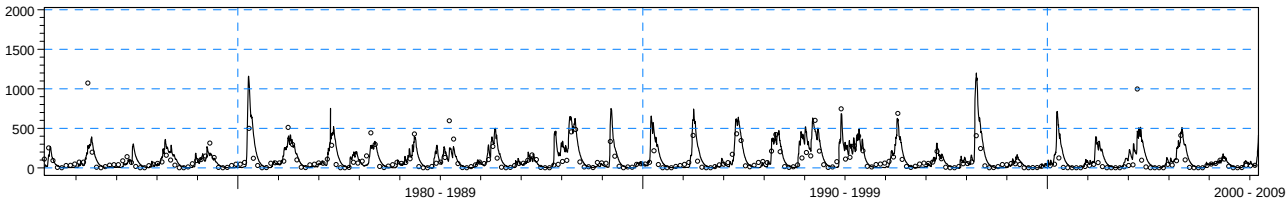
Station	Station No.	Simulation Result	Expected Discharge	Upstream Used Water	Observed Discharge	Observed Duration
Gilvan	17-033	4,759	4,414	1,147	3,267	20
Ostor	17-029	4,376	3,926	1,132	2,794	20
Pole. D.M.	17-021	2,877	2,705	956	1,749	20
Mah. N.	17-015	2,305	1,467	411	1,056	9
Ghare G.	17-011	1,680	1,282	139	1,143	19
Loshan	17-041	1,328	1,185	245	943	20

Figure R 7.2.7 Major Stations of Gezelozen River

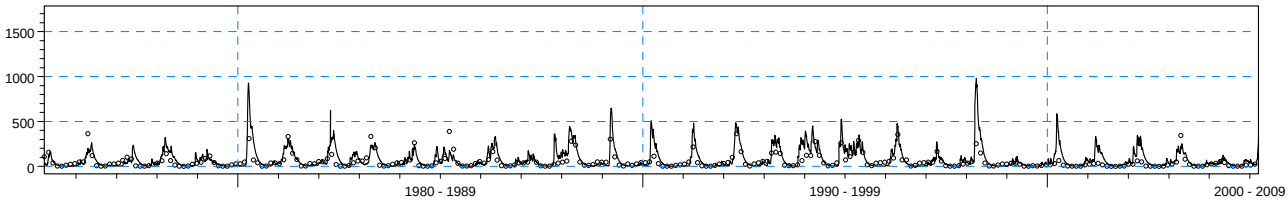
Gilvan observatory (17-033)



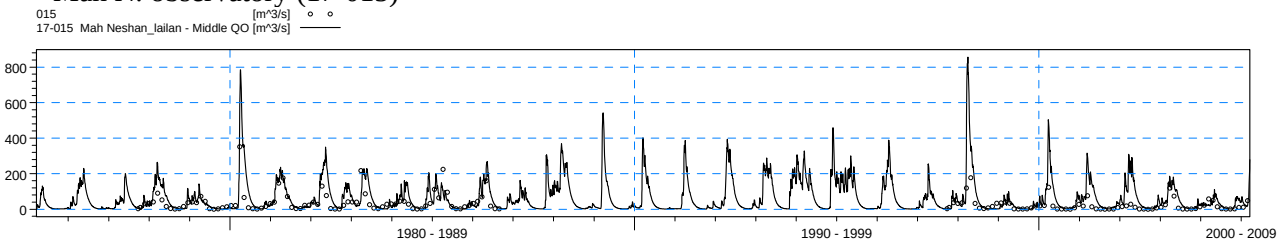
Ostor observatory (17-029)



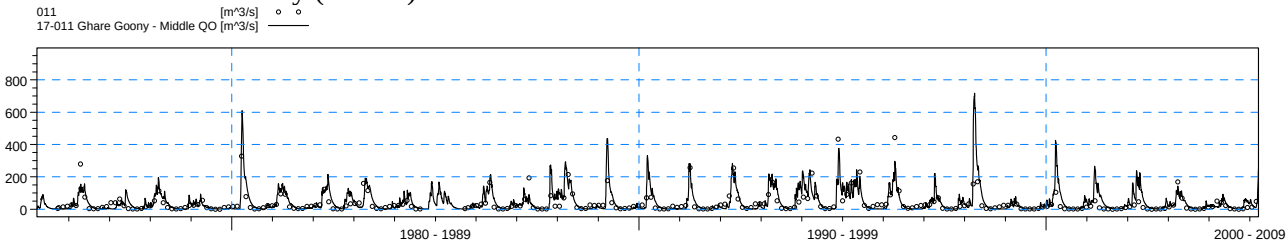
Pole D.M. observatory (17-021)



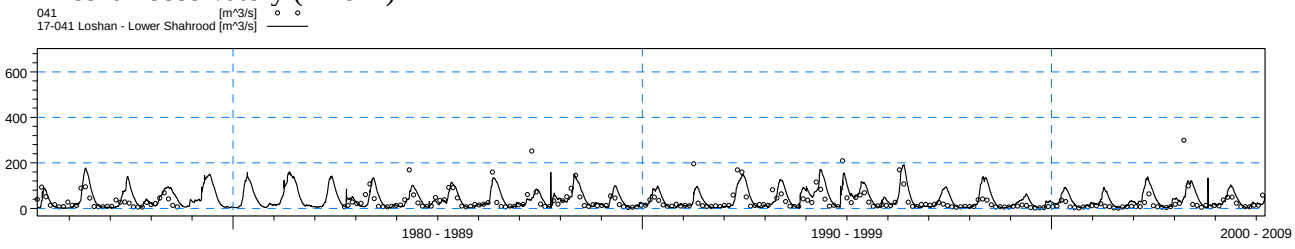
Mah N. observatory (17-015)



Ghare G. observatory (17-011)



Loshan observatory (17-041)



Source: JICA Study Team

Figure R 7.2.8 Calibration Result (Wave Shape)

7.3 ESTABLISHMENT OF WATER ALLOCATION SIMULATION MODEL

As a result of the consultation with the WRMC, the water allocation simulation model is established on the condition as follows:

7.3.1 Condition for Model Calibration

1) Duration of Simulation for Model Calibration

Duration of simulation for 20 years to calibrate the model is set from 1985 to 2005 as same period as the calibration for Sefid-WBSM.

2) Minimum Unit of Simulation and Catchment

Minimum unit of the calculation is Reaches, the area and location of which are the same as Sefid-WBSM. In other words, the runoff and recharge data calculated by Sefid-WBSM are input to each Reach of Sefid-WASM.

3) Quantity of Intake Water

Quantity of Intake water from river on the basis of Information from WRMC is entered into the model at the location of dams, weirs and Reaches. Incidentally, the quantity of intake water, which is separated into surface water and groundwater, is input as the water consumption of traditional irrigation area into water user modules.

4) Initial Condition of Dams

Only the Manjil dam and the Golbolagh dam are set as dam modules for the initial model because these dams had been constructed in the simulation period for calibration. The initial water level of dam reservoirs is decided to input the water level corresponding to the 70% of reservoir storage. In addition, the evaporation data also set to calculate the amount of evaporation from the dam storage volume.

7.3.2 CALIBRATION OF Water Allocation Simulation MODEL

When a certain quantity of the water demand on the ground water and the surface water was drawn form the underground tank and river module in the Sefid-WASM, the water balance is calculated between runoff and recharge in each Reach. Thus, in the Sefid-WASM, the parameters for tanks should be confirmed comparing the hydrograph in shape and quantity between the calculation result and the measured discharge.

The inflow into the Manjil dam is the clue to improve the model accuracy because the surface water in Sefidrud River Basin is finally aggregated at this site. At the upstream of the Manjil dam, the annual average total inflow is calculated as 4,000 mil. m^3 by Sefid-WASM on the present condition, which is highly consistent with the actual flow amount into the Manjil dam. Furthermore, the shape of simulated hydrograph at the Loshan and the Gilvan observatory are corresponding to the actual that.

At the observatory No.17-015 in the middle of Gezelozen River, the reduction of total runoff occurs due to the diverse factors such as geomorphologic features, the high quantity of demand or measurement error. Concretely, the feature of this area shows the wider flood plane with the paddy field on the either side of the river. Therefore, either the infiltration of widely and shallowly spread surface water or the highly demand on the paddy field is considered as a dominating factor of the reduction. Then, the simulation result also expresses the reduction even though not clear appearance of that.

The study team concludes that the Sefid-WASM can be applied for the water allocation simulation in Sefidrud River Basin because of the reasonable accuracy of the model as mentioned above.

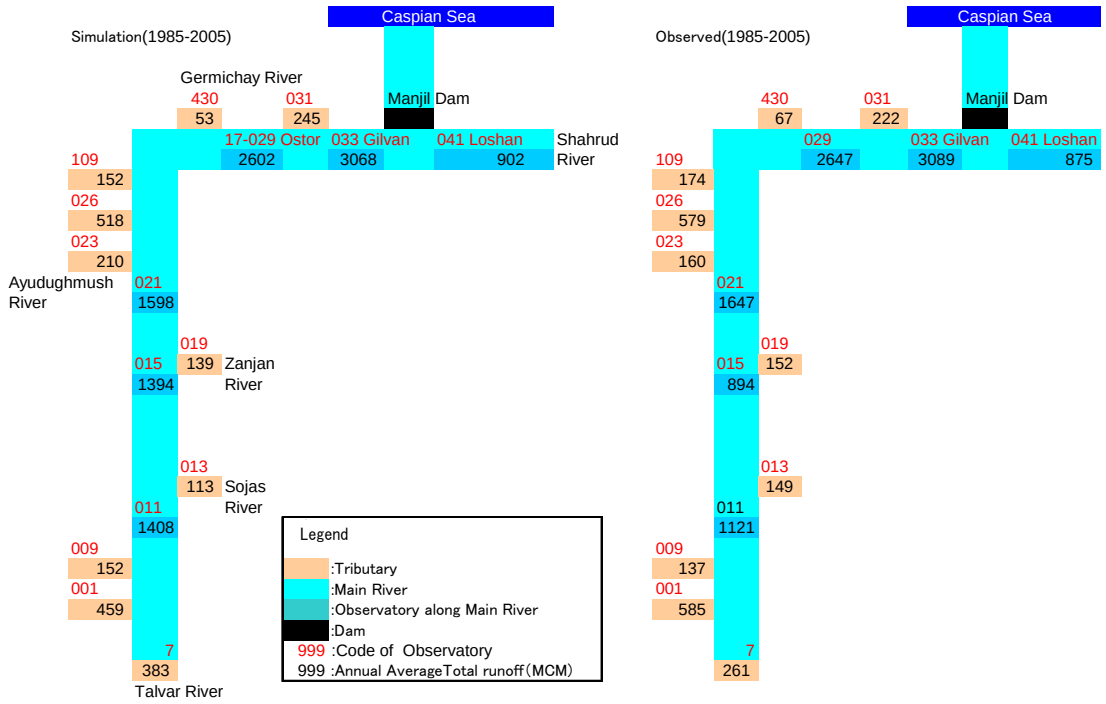


Figure R 7.3.1 Comparison of Total Runoff between Simulation and Observation

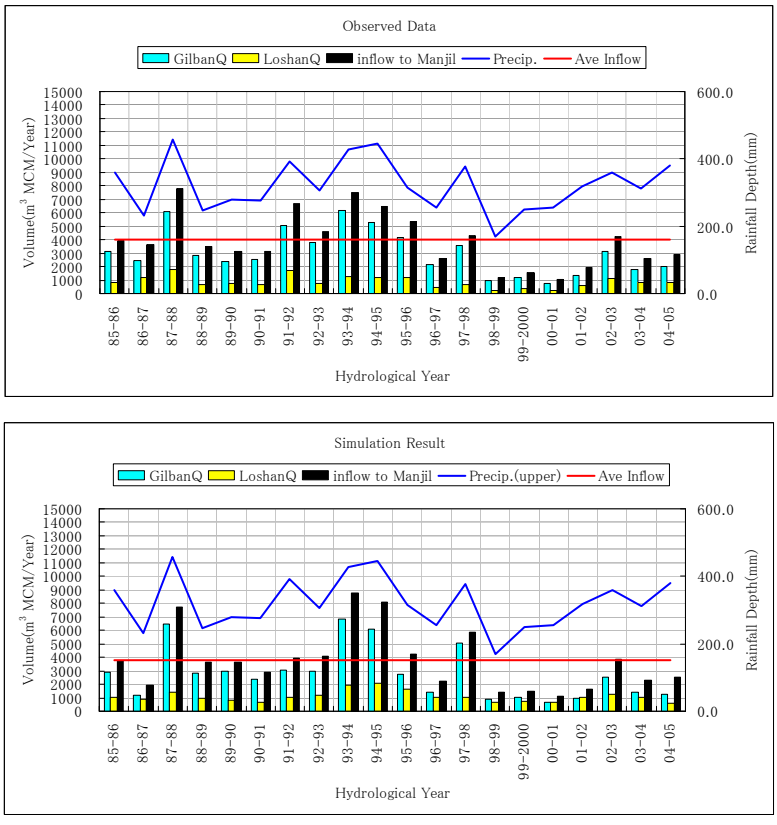


Figure R 7.3.2 Comparison of Inflow Volume between Simulation and Observation at Manjil

7.4 WATER ALLOCATION SIMULATION

Water allocation simulation was carried out setting the target year of 2016 as a mid-term and 2031 as a long-term. Results of simulation is used for formulation of integrated water use management in Chapter 9. The detailed condition of the simulation was explained in Subsection 9.2.1 and as follows:

1) Duration of Model Simulation and Natural Flow

The water allocation simulation was executed using natural flow obtained with MIKE SHE model for 20 years from 1985 to 2005 in hydrological year.

2) Condition of Water Use Facilities

The modules for water use structures and projects such as dams, intake weirs and water transfer projects are mounted as water distribution modules in the simulation model corresponding to target years as follows:

Table R 7.4.1 Condition of Water Use Facilities

Target Year	Dams	Other facilities and projects
Present (2006)	3	Tarik, Bijar, Galerud and Sangar intake weir
Middle-Term (2016)	17	Tarik, Bijar, Galerud and Sangar intake weir
Long-Term (2036)	38	Tarik, Bijar, Galerud and Sangar intake weir, Alamut Interbasin Transfer

Note: Ardebil Interbasin Transfer Project was examined in Supplemental Study

3) Condition of Water Demand

Each sector's demand is divided into the surface water portion and the groundwater portion when the data input into the simulation model. In addition, the water supply is executed through river (Reach), dams and weirs in the model.

a) Water Demand by Reach

The amount of water demand of each Reach for the surface water and the groundwater is summarized in Chapter 6. The demand data for reachs is input dividing into two portions such as surface water and ground water.

b) Water Demand of Dam Command Area

The dam modules are mounted into the Sefid-WASM corresponding to the target years as explained in Table R 7.4.1. The demand for dam command areas are summarized in Subsection 6.2.4.

c) Water Demand Regulated by Weir

The water discharged from Manjil outlet is controlled to distribute to SIDN by the three weirs downstream of Manjil: Tarik, Galerud and Sangar weir. The monthly water demand assigned to weirs is summarized in Subsection 6.2.4.

4) Water Demand and Irrigation Efficiency

The three cases of alternation of irrigation efficiency are considered for execution of the simulation as summarized in Table R 7.4.2. The irrigation efficiency in the traditional irrigation area in each Reach and irrigation area located at the lower stream of Manjil Dam was set as shown in the table, which was used for the calculation of water demand.

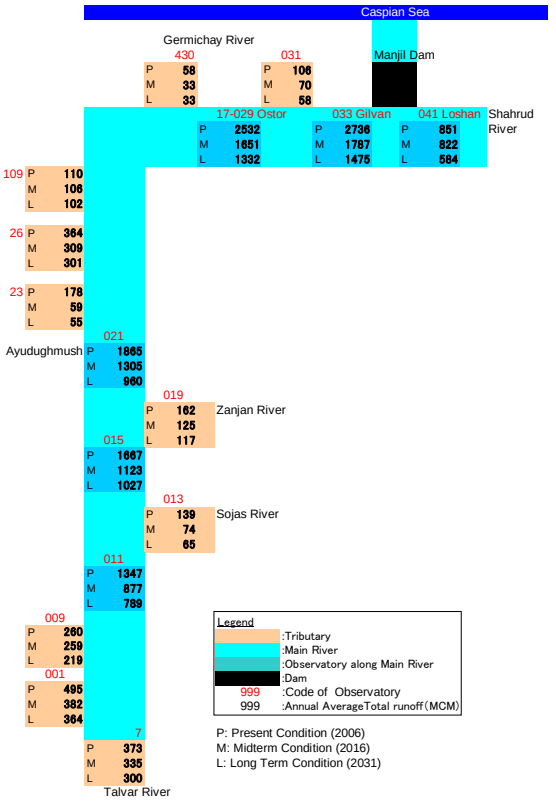
Table R 7.4.2 Irrigation Efficiency in the Simulation

Irrigation Efficiency Variations	Irrigation Area at Lower Stream of Manjil dam			Traditional Irrigation Area in Each Reach		
	Present (2006)	Middle-Term (2016)	Long-Term (2036)	Present (2006)	Middle-Term (2016)	Long-Term (2036)
Present	0.42	0.42	0.42	0.33	0.33	0.33
Intermediate	0.42	0.45	0.51	0.33	0.37	0.44
WRMC Target	0.42	0.48	0.55	0.33	0.40	0.50

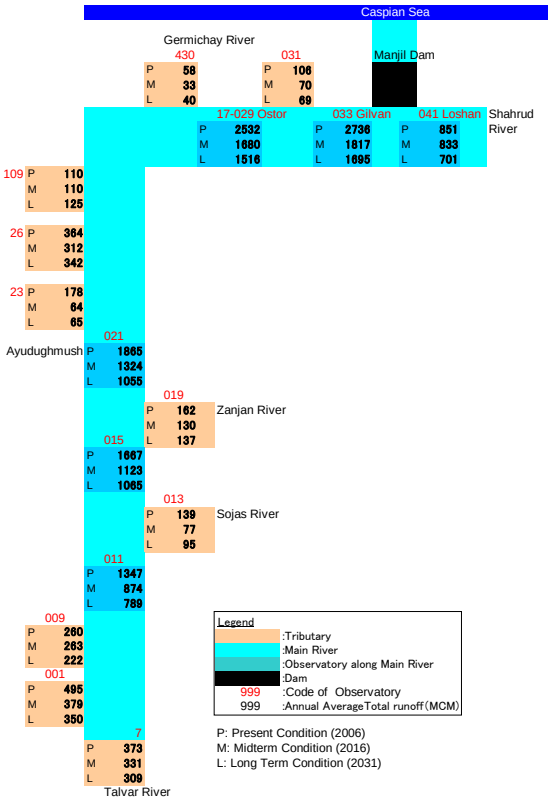
5) Schematic Flow Diagram

The schematic flow diagrams were prepared corresponding to irrigation efficiency variations in Figure R 7.4.3. Each figure includes simulation results on the condition of three target years.

(Case: Present irrigation efficiency)



(Case: Intermediate irrigation efficiency)



(Case: WRMC irrigation efficiency)

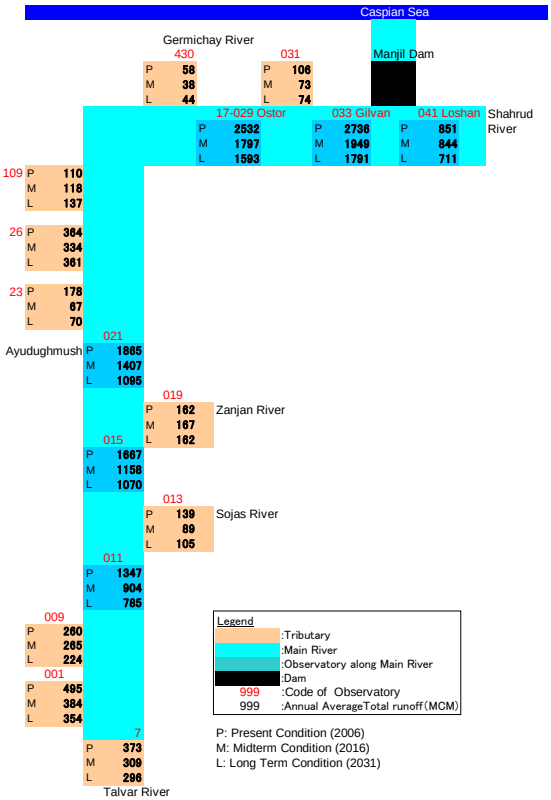


Figure R 7.4.1 Comparison of Inflow Volume between Simulation and Observation at Manjil

CHAPTER 8. ADDITIONAL SURVEY IN GILAN PROVINCE

8.1 GENERAL

Main part of Sefidrud Irrigation and Drainage Network (Hereafter referred to as SIDN) which is the typical rice farming region in the Gilan province has come off from the JICA Study Area (direct Sefidrud River basin) for the investigation. Therefore, the government of Iran requested to JICA on June 5, 2008 to examine the modeling and water balance simulation of the whole area of SIDN. In response to this request, this additional survey was executed from September, 28 to November, 12, 2008.

8.2 COLLECTED DATA

Related reports quoted in the additional survey of Gilan Province and the collected data in the field survey are as shown in Table R 8.2.1.

Table R 8.2.1 List of Related Reports and Collected Data

No.	Report and Data	Publisher	Year	Language	Content
1	Studies on Reform of Sefidrud Irrigation and Drainage Network in Gilan: Vol.26: Summary Report (Pandam study report)	Pandam Consultant	Mar.2004	Persian	Summary report for rehabilitation of SIDN
2	Studies on Reform of Sefidrud Irrigation and Drainage Network in Gilan:Vol.4:Available Water Sources and Requirement (Pandam study report/ Vol.4)	Pandam Consultant	Mar.2004	Persian	Supporting report for water resources and demand in SIDN
3	Sefidrud-Ghezel Ozan Water Resources Planning Coordinate Studies: Vol. 3.3: Drinking and Industry	Mahab Ghodss Consultant	Jul. 2007	Persian	Study of domestic and industrial water in Gilan province
4	Related article of Gilan Province Urban Water & Wastewater Company	Tehran Times	May 2008	English	Present conditions and problems of urban water supply in Gilan province
5	GIS Data of Land Use in Sefidrud Irrigation Network	Gilan RWC		Persian	
6	Related Information of Bijar Dam	Gilan RWC		Persian	PowerPoint file for dam、H-V curve and design parameter
7	Study on Revision of Qazvin Irrigation & Drainage System (Vol.4: Irrigation Efficiency, Cropping Pattern & Water Demand)	Pandam Consultant	Mar.2005	Persian	Irrigation water demand in Qazvin province
8	Hydrological Study Report in Gilan Province	Pandam Consultant	1994	Persian	Hydrological analysis for proposed dam sites at local river in Gilan province

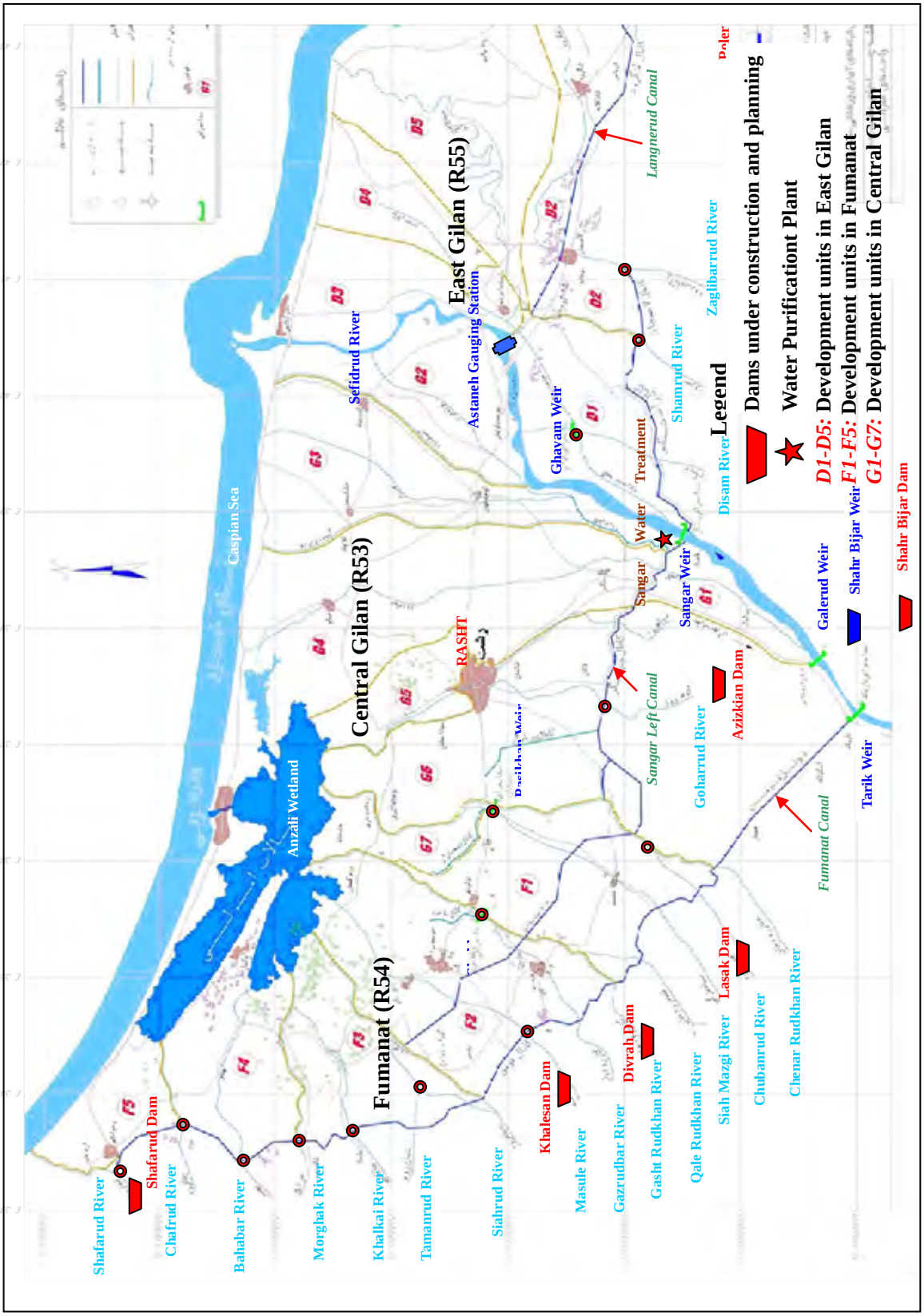


Figure R 8.2.1 Location Map for the Additional Survey in Gilan Province

8.3 LAND USE

A total area of the SIDN is divided into 17 development units with about 284,000 ha according to the Pandam study report. The land use for the SIDN is shown in Table R 8.3.1, and the gross rice field area is about 190,000 ha (Gross).

Table R 8.3.1 Land Use in SIDN

(Unit: ha)

No.	Categories	Fumanat (R54)	Central Gilan (R53)	East Gilan (R55)	Total
1	Paddy	54,556	78,503	56,775	189,833
2	Other crop	1,687	2,700	804	5,191
3	Tea	1,531	725	1,578	3,834
4	Mulberry	12,327	16,040	11,808	40,175
5	Forest	2,082	1,395	7,305	10,783
6	Pasture/Bush	615	3,173	614	4,402
7	Flooding area	1,063	1,085	246	2,393
8	Natural reservoir	3,292	1,466	714	5,472
9	Artificial reservoir	311	2,536	610	3,458
10	Residence area	4,151	10,627	3,665	18,444
Total		81,615	118,250	84,118	283,984

Source: Pandam Study Report

When the paddy field area is totaled with each development unit, it is shown in Table R 8.3.2. Net paddy field area is 88% of gross rice field area.

Table R 8.3.2 Paddy Field Area by Development Unit

Item	Development Unit	Area of Paddy Field (ha)		Note
		Gross	Net	
Modern Irrigation System	D1	12,412	10,923	
	D2	9,286	8,172	
	D3	7,800	6,864	
	F1	16,468	14,492	
	F2	19,684	17,322	
	F3	9,208	8,103	
	G1	3,110	2,737	
	G5	5,666	4,986	
	G6	13,229	11,642	
	G7	4,549	4,003	
	Sub-total	101,412	89,243	
Traditional Irrigation System	D4	6,875	6,050	in Progress
	D5	18,183	16,001	
	F4	7,987	7,029	
	F5	3,427	3,016	
	G2	10,499	9,239	
	G3	17,018	14,976	
	G4	24,431	21,499	
	Sub-total	88,420	77,810	
Total		189,832	167,052	

Source: Pandam Report/ Vol.4

Location of the development unit is shown in Figure R 8.3.1. The land use for each development unit is as shown in Table R 8.3.3.

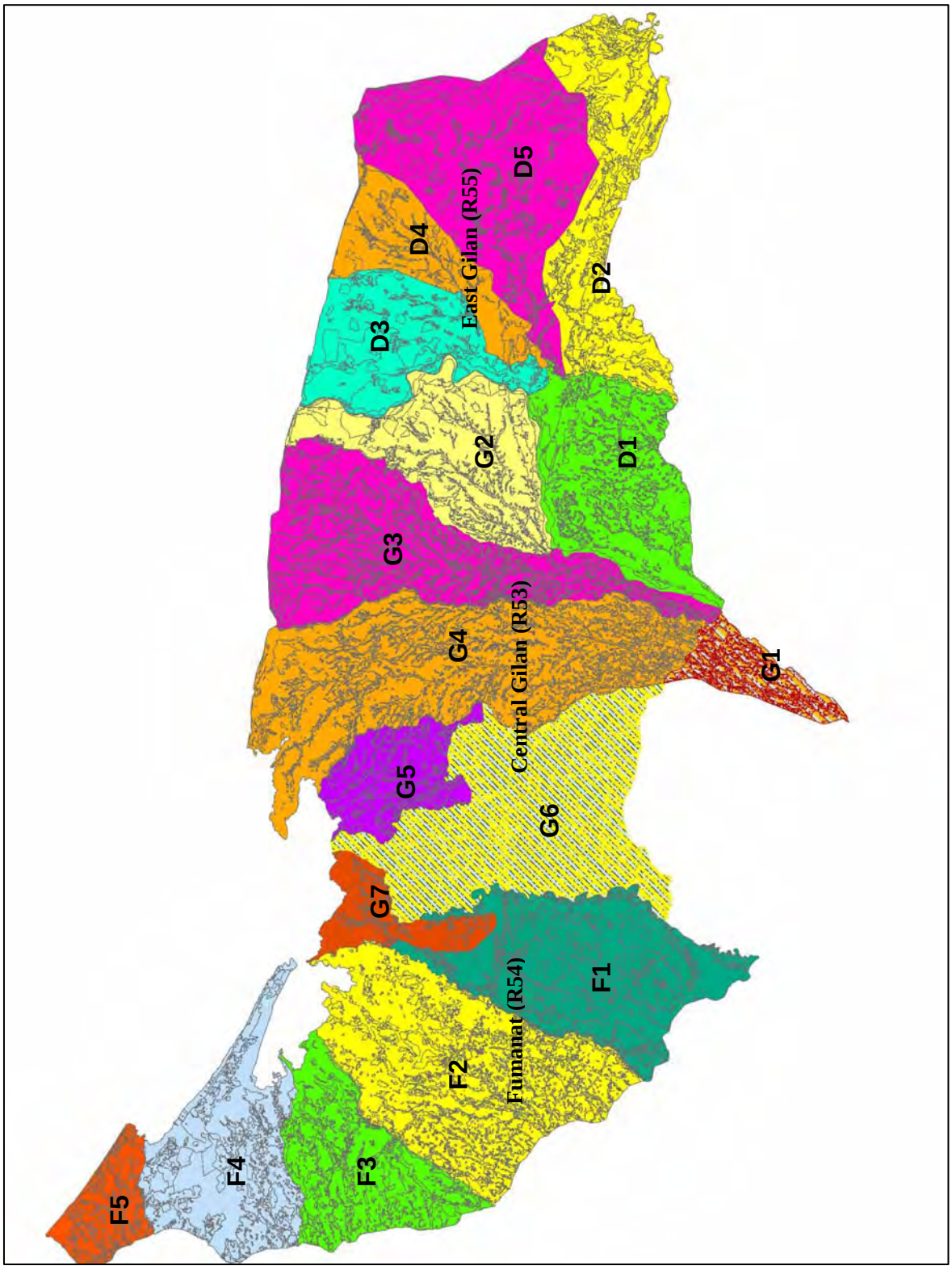


Figure R 8.3.1 Location Map of Development Unit

Table R 8.3.3 Land Use in SIDN based on Satellite Images Analysis

Unit	Paddy		Other Crops		Tea Farm		Mulberry		Forest		Bush/Pasture		Flooding Area		Natural Reservoir		Artificial Reservoir		Residential Area		Total
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	
D1	12,412	71.5	0	0.0	471	2.7	2,963	17.1	0	0.0	276	1.6	878	5.1	0	0.0	0	0.0	360	2.1	17,360
D2	9,286	53.2	0	0.0	1,060	6.1	4,774	27.3	1	0.0	95	0.5	0	0.0	206	1.2	0	0.0	2039	11.7	17,461
D3	7,800	59.7	1,515	11.6	0	0.0	1,076	8.2	1,551	11.9	136	1.0	185	1.4	197	1.5	0	0.0	615	4.7	13,075
D4	6,875	77.5	161	1.8	0	0.0	1,097	12.4	119	1.3	86	1.0	0	0.0	330	3.7	0	0.0	202	2.3	8,869
D5	18,183	73.2	11	0.1	0	0.0	2,416	9.7	411	1.7	22	0.1	0	0.0	2,560	10.3	311	1.3	935	3.8	24,851
Sub-total	54,556	66.8	1,687	2.1	1,531	1.9	12,327	15.1	2,082	2.6	615	0.8	1,063	1.3	3,292	4.0	311	0.4	4,151	5.1	81,615
G1	3,110	65.7	0	0.0	0	0.0	1,184	25.0	0	0.0	9	0.2	0	0.0	9	0.2	126	2.7	294	6.2	4,732
G2	10,499	65.0	1,011	6.3	0	0.0	2,611	16.2	0	0.0	450	2.8	637	3.9	343	2.1	0	0.0	613	3.8	16,164
G3	17,018	72.1	0	0.0	0	0.0	3,207	13.6	605	2.6	288	1.2	439	1.9	637	2.7	0	0.0	1418	6.0	23,612
G4	24,431	73.4	0	0.0	0	0.0	6,485	19.5	326	1.0	61	0.2	0	0.0	11	0.0	91	0.3	1869	5.6	33,275
G5	5,666	73.6	12	0.2	0	0.0	971	12.6	14	0.2	53	0.7	0	0.0	10	0.1	53	0.7	917	11.9	7,697
G6	13,229	48.1	1,660	6.0	725	2.6	1,389	5.1	381	1.4	2,294	8.3	9	0.0	394	1.4	2,197	8.0	5225	19.0	27,504
G7	4,549	86.4	17	0.3	0	0.0	193	3.7	70	1.3	17	0.3	0	0.0	62	1.2	69	1.3	292	5.5	5,268
Sub-total	78,503	66.4	2,700	2.3	725	0.6	16,040	13.6	1,395	1.2	3,173	2.7	1,085	0.9	1,466	1.2	2,536	2.1	10,627	9.0	118,250
F1	16,468	76.3	75	0.4	941	4.4	1,379	6.4	1,258	5.8	103	0.5	125	0.6	34	0.2	287	1.3	898	4.2	21,568
F2	19,684	70.3	368	1.3	637	2.3	4,814	17.2	81	0.3	190	0.7	121	0.4	135	0.5	270	1.0	1713	6.1	28,013
F3	9,208	67.5	14	0.1	0	0.0	3,049	22.4	896	6.6	57	0.4	0	0.0	51	0.4	21	0.2	345	2.5	13,641
F4	7,987	50.1	321	2.0	0	0.0	1,503	9.4	4,815	30.2	249	1.6	0	0.0	370	2.3	18	0.1	688	4.3	15,952
F5	3,427	66.7	25	0.5	0	0.0	1,063	20.7	255	5.0	14	0.3	0	0.0	125	2.4	14	0.3	22	4.2	4,944
Sub-total	56,775	67.5	804	1.0	1,578	1.9	11,808	14.0	7,305	8.7	614	0.7	246	0.3	714	0.8	610	0.7	3,665	4.4	84,118
Total	189,833	66.8	5,191	1.8	3,834	1.4	40,175	14.1	10,783	3.8	4,402	1.6	2,393	0.8	5,472	1.9	3,458	1.2	18,444	6.5	283,984

Source: Study on Rehabilitation of Sefidrud Irrigation Network in Gilan Province, Pandam Consultant 2004

8.4 WATER RESOURCES

8.4.1 Surface Water

1) Sefidrud River

The main water resources in the SIDN is river water discharged from the Manjil dam, and these water is taken from Sefidrud river by three weirs such as Tarik, Galerud, and Sangar. The amount of getting water at the irrigation period (April - September) is as shown in Table R 8.4.1. The maximum 2,390 MCM, average 1,680 MCM, and minimum 760 MCM is supplied from Sefidrud river in the irrigation season.

Table R 8.4.1 Intake Water Volume at Main Weirs

(Unit: MCM)

Year	Tarik Weir	Galerud Weir	Sangar Weir		Total
			Left Canal	Right Canal	
1988	355.1	0.0	835.1	446.5	1,636.7
1989	314.5	0.0	901.2	486.5	1,702.0
1990	347.9	0.0	854.6	443.1	1,645.6
1991	313.1	0.0	931.9	511.8	1,756.8
1992	373.2	0.0	997.5	548.0	1,918.7
1993	406.3	0.0	946.6	619.7	1,972.6
1994	456.0	149.0	1,113.0	672.0	2,390.0
1995	389.2	218.3	882.9	678.0	2,168.4
1996	288.6	88.9	788.9	383.2	1,549.7
1997	378.5	186.1	1,037.9	590.6	2,193.0
1998	142.9	49.1	382.6	184.4	759.1
1999	248.9	86.2	771.0	390.6	1,496.7
2000	146.9	113.6	435.1	269.3	1,651.8
2001	263.7	112.0	682.4	401.6	1,459.7
2002	275.8	142.1	823.7	410.2	1,651.8
2003	249.2	113.8	713.7	408.6	1,485.3
2004	276.6	101.3	803.5	501.6	1,683.1
2005	315.5	126.3	867.9	498.3	1,808.0
2006	245.8	50.0	877.1	486.1	1,659.0
Average	304.6	115.7	823.5	470.0	1,679.0

Source: WRMC

2) Small and Medium-sized Rivers

A small and medium-sized river which flows in the SIDN is from the west such as Shafrud, Morgkak, Khalkai, Palangvar, Masule Rudkhan, Gaz Rudbar, Shakhazar, Pasikhan, Goharrud, Disam, Shamrud it, and Zaklebarrud. Water consumption from these rivers is are shown in Table R 8.4.2. Moreover, according to the information from Gilan RWC, there are some existing water development plans as shown in Table R 8.4.3.

Table R 8.4.2 Utilization Conditions in Small and Medium-sized Rivers

Irrigation Area (Reach)	River Name	Development Unit	Average Use Water Volume (MCM)						Total
			Apr.	May	Jun	Jul	Aug.	Sep	
Fumanat (R54)	Shafarud	F5	3.58	1.96	3.26	2.48	0.00	0.00	11.28
	Chafrud		0.20	0.00	0.00	0.00	0.00	0.00	0.20
	Chafrud	F4	0.50	0.00	0.00	0.00	0.00	0.00	0.50
	Morghak		0.70	0.00	0.00	0.00	0.00	0.00	0.70
	Khalkaei	F3	3.83	0.00	1.79	0.78	0.00	0.00	6.40
	Palangvar		0.11	0.00	0.00	0.00	0.00	0.00	0.11
	Palangvar	F2	0.06	0.00	0.00	0.00	0.00	0.00	0.06
	Masuleh Rudkhan		3.47	0.00	0.00	0.00	0.00	0.00	3.47
	Gazrudbar		0.03	0.00	0.67	0.32	0.00	0.00	1.02
	Ghale-Rudkhan		1.18	0.00	0.26	0.32	0.00	0.00	1.76
	Gasht- Rudkhan		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Gasht- Rudkhan	F1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ghale-Rudkhan		0.98	0.00	0.22	0.27	0.00	0.00	1.47
	Siyamezgi		2.55	0.00	0.27	0.00	0.00	0.00	2.82
	Chobar		2.81	0.47	0.72	2.16	0.00	0.00	6.16
	Sub-total		20.00	2.43	7.19	6.33	0.00	0.00	35.95
Central Gilan (R53)	Siyamezgi	G7	0.71	0.00	0.07	0.00	0.00	0.00	0.78
	Chobar		0.78	0.13	0.20	0.60	0.00	0.00	1.71
	Goharrud	G6	0.58	0.24	0.48	0.64	0.00	0.00	1.94
	Siyahrud	G5	2.14	0.38	0.58	0.57	0.00	0.00	3.67
	Sub-total		4.21	0.75	1.33	1.81	0.00	0.00	8.10
East Gilan (R55)	Disam	D1	2.93	0.02	1.29	2.02	0.00	0.00	6.26
	Shamrud	D2	2.91	0.00	0.46	1.66	0.00	0.00	5.03
	Sub-total		5.84	0.02	1.75	3.68	0.00	0.00	11.29
合計			30.05	3.20	10.27	11.82	0.00	0.00	55.34

Source: Pandam Report Vol.4

Table R 8.4.3 Existing Water Resources Facilities and Plans in SIDN

Name of Plan	Stage	Name of River	Profit Reach	Intake Water Volume	Related Canal
Shakhazar Weir	Existing	Shakhazar	R54	2.5 m^3/s	Shakhazar Channel
Pasikhan Weir	Existing	Pasikhan	R53	4.0 m^3/s	Jomeh Bazar Channel
Ghavam Weir	Existing	Disam	R55	40.0 m^3/s	Heshmat Rod
Shafrud Dam	Tendering	Shafrud	R56	Profit area is outside of SIDN	
Polrud Dam	Planning	Polrud	R57	Profit area is outside of SIDN	
Divrash Weir	Planning	Divrash	No detailed information		
Azizkian Weir	Planning	Goharrud	No detailed information		
Khalesan Weir	Planning	Masule Rudken	No detailed information		
Lasak Dam	Planning	Chubarrud	No detailed information		
Nilrud Weir	Planning	Talesh	No detailed information		

Source: Gilan RWC

8.4.2 Groundwater

Based on the Pandam Study Report (Vol.4), amount of groundwater use in SIDN was arranged as shown in Table R 8.4.4. Net paddy field area supplied from groundwater is presumed as 1,945ha. This area corresponds to about 1.2% of total paddy field area in SIDN.

Table R 8.4.4 Agricultural Water Consumption of Groundwater in SIDN

Irrigation Area	Development Units	Consumption of Groundwater ('000m^3)						Gross Water Requirement (m^3/ha)	Estimated Irrigation Area (ha)
		Apr.	May	Jun.	Jul.	Aug.	Total		
Fumanat (R54)	F1	2.9	54.7	210.1	210.1	54.7	532.5	11,392	46.7
	F2	545.0	672.2	1,053.8	1,053.8	672.2	3,997.0	11,392	350.9
	F3	900.9	928.8	1,125.0	1,012.5	928.8	4,896.0	11,392	429.8
	F4	202.4	623.3	1,886.0	1,886.0	623.3	5,221.0	11,392	458.3
	F5	18.9	58.8	178.5	178.5	58.8	493.5	11,392	43.3
	Sub-total	1,670.1	2,337.8	4,453.4	4,340.9	2,337.8	15,140.0		1,329.0
Central Gilan (R53)	G1	0.0	0.0	0.0	0.0	0.0	0.0	10,480	0.0
	G2	8.3	33.3	108.3	108.3	33.3	291.5	12,780	22.8
	G3	0.0	1.1	4.4	4.4	1.1	11.0	12,780	0.9
	G4	0.0	33.4	133.6	133.6	33.4	334.0	12,780	26.1
	G5	297.2	370.9	591.8	591.8	370.9	2,222.6	10,480	212.1
	G6	102.8	191.7	840.0	458.4	191.7	1,784.6	10,480	170.3
	G7	79.8	83.6	95.0	95.0	83.6	437.0	10,480	41.7
	Sub-total	488.1	714.0	1,773.1	1,391.5	714.0	5,080.7		473.9
East Gilan (R55)	D1	0.9	29.6	115.5	115.5	29.6	291.1	11,645	25.0
	D2	19.2	144.5	520.4	520.4	144.5	1,349.0	11,645	115.8
	D3	0.0	0.3	1.2	1.2	0.3	3.0	11,645	0.3
	D4	0.0	0.4	1.6	1.6	0.4	4.0	11,645	0.3
	D5	0.0	0.6	2.4	2.4	0.6	6.0	11,645	0.5
	Sub-total	20.1	175.4	641.1	641.1	175.4	1,653.1		142.0
Total		2,178.3	3,227.2	6,867.6	6,373.5	3,227.2	21,873.8		1,944.8

Source: Pandam Report Vol.4

8.5 AGRICULTURAL WATER CONSUMPTION BY WATER SOURCES

8.5.1 Fumanat Irrigation Area (R54)

According to the Pandam Study Report (Vol.4), agricultural water consumption by water resources in Fumanat irrigation area (R54) is shown in Table R 8.5.1. The 88.5% of irrigation water depends on the Sefidrud River in Fumanat area (R54). Additionally, 7.4% depends on local rivers, 0.7% depends on the reservoir, and 3.4% depends on groundwater.

Table R 8.5.1 Agricultural Water Consumption in Fumanat Area (R54)

Develop-ment Unit	Water Supply Resources	Consumption (MCM)							Remarks
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Total	
F1	Sefidrud	19.530	37.150	31.760	24.540	12.410	0.000	125.390	
	Local Rivers 1 (A)	6.340	0.470	1.210	2.430	0.000	0.000	10.450	
	Reservoir (B)	0.019	0.037	0.056	0.046	0.028	0.000	0.186	
	A+B	6.359	0.507	1.266	2.476	0.028	0.000	10.636	
	Groundwater	0.003	0.055	0.210	0.210	0.055	0.003	0.535	
	Sub-total	25.892	37.712	33.236	27.226	12.493	0.003	136.561	
F2	Sefidrud	23.350	44.410	37.960	29.340	14.830	0.000	149.890	
	Local Rivers 1 (A)	4.740	0.000	0.930	0.640	0.000	0.000	6.310	
	Reservoir (B)	0.008	0.015	0.023	0.090	0.012	0.000	0.148	
	A+B	4.748	0.015	0.953	0.730	0.012	0.000	6.458	
	Groundwater	0.545	0.672	1.054	1.054	0.672	0.545	4.542	
	Sub-total	28.643	45.097	39.967	31.124	15.514	0.545	160.890	
F3	Sefidrud	10.930	20.770	17.760	13.730	6.940	0.000	70.130	
	Local Rivers 1 (A)	3.950	0.000	1.790	0.780	0.000	0.000	6.520	
	Reservoir (B)	0.028	0.057	0.085	0.071	0.043	0.000	0.284	
	A+B	3.978	0.057	1.875	0.851	0.043	0.000	6.804	
	Groundwater	0.901	0.929	1.013	1.013	0.929	0.901	5.684	
	Sub-total	15.809	21.756	20.648	15.594	7.912	0.901	82.618	
F4	Sefidrud	9.480	18.020	15.400	11.910	6.020	0.000	60.830	
	Local Rivers 1 (A)	1.200	0.000	0.000	0.000	0.000	0.000	1.200	
	Reservoir (B)	0.207	0.414	0.621	0.518	0.311	0.000	2.071	
	A+B	1.407	0.414	0.621	0.518	0.311	0.000	3.271	
	Groundwater	0.202	0.623	1.886	1.886	0.623	0.202	5.423	
	Sub-total	11.089	19.057	17.907	14.314	6.954	0.202	69.524	
F5	Sefidrud	4.070	7.730	6.610	5.110	2.850	0.000	26.370	
	Local Rivers 1 (A)	3.790	1.960	3.260	2.480	0.000	0.000	11.490	
	Reservoir (B)	0.070	0.139	0.209	0.174	0.104	0.000	0.696	
	A+B	3.860	2.099	3.469	2.654	0.104	0.000	12.186	
	Groundwater	0.019	0.059	0.179	0.179	0.059	0.019	0.512	
	Sub-total	7.949	9.888	10.258	7.943	3.013	0.019	39.068	
Total	Sefidrud	67.360	128.080	109.490	84.630	43.050	0.000	432.610	88.5%
	Local Rivers 1 (A)	20.020	2.430	7.190	6.330	0.000	0.000	35.970	7.4%
	Reservoir (B)	0.332	0.662	0.994	0.899	0.498	0.000	3.385	0.7%
	A+B	20.352	3.092	8.184	7.229	0.498	0.000	39.355	8.1%
	Groundwater	1.670	2.338	4.341	4.341	2.338	1.670	16.698	3.4%
	Sub-total	89.382	133.510	122.015	96.200	45.886	1.670	488.663	

Source: Pandam Report Vol.4

8.5.2 Central Gilan Irrigation Area (R53)

According to the Pandam Study Report (Vol.4), agricultural water consumption by water resources in Central Gilan irrigation area (R53) is shown in Table R 8.5.2. The Central Gilan area depends on the Sefidrud river for the agricultural water of 97%. Additionally, 0.9% depends on local rivers, 1.3% depends on the reservoir, and 0.8% depends on groundwater.

Table R 8.5.2 Agricultural Water Consumption in Central Gilan Area (R53)

Develop-ment Unit	Water Supply Resources	Consumption (MCM)							Remarks
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Total	
G1	Sefidrud	3.690	7.020	6.000	4.640	2.340	0.000	23.690	
	Local Rivers 1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.005	0.010	0.014	0.012	0.007	0.000	0.048	
	A+B	0.005	0.010	0.014	0.012	0.007	0.000	0.048	
	Groundwater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Sub-total	3.695	7.030	6.014	4.652	2.347	0.000	23.738	
G2	Sefidrud	12.450	23.690	20.250	15.650	7.910	0.000	79.950	
	Local Rivers 1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.192	0.384	0.576	0.480	0.288	0.000	1.920	
	A+B	0.192	0.384	0.576	0.480	0.288	0.000	1.920	
	Groundwater	0.008	0.033	0.108	0.108	0.033	0.008	0.300	
	Sub-total	12.650	24.107	20.934	16.238	8.231	0.008	82.170	
G3	Sefidrud	20.190	38.400	32.810	25.370	12.830	0.000	129.600	
	Local Rivers 1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.357	0.714	1.071	0.893	0.536	0.000	3.571	
	A+B	0.357	0.714	1.071	0.893	0.536	0.000	3.571	
	Groundwater	0.000	0.001	0.004	0.004	0.001	0.000	0.011	
	Sub-total	20.547	39.115	33.885	26.267	13.367	0.000	133.182	
G4	Sefidrud	28.990	55.130	47.100	36.420	18.420	0.000	186.060	
	Local Rivers 1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.006	0.013	0.019	0.016	0.010	0.000	0.064	
	A+B	0.006	0.013	0.019	0.016	0.010	0.000	0.064	
	Groundwater	0.000	0.033	0.134	0.134	0.033	0.000	0.334	
	Sub-total	28.996	55.176	47.253	36.570	18.463	0.000	186.458	
G5	Sefidrud	6.720	12.780	10.930	8.450	4.270	0.000	43.150	
	Local Rivers 1 (A)	2.140	0.380	0.580	0.570	0.000	0.000	3.670	
	Reservoir (B)	0.006	0.010	0.017	0.014	0.008	0.000	0.055	
	A+B	2.146	0.390	0.597	0.584	0.008	0.000	3.725	
	Groundwater	0.297	0.371	0.592	0.592	0.371	0.297	2.520	
	Sub-total	9.163	13.541	12.119	9.626	4.649	0.297	49.395	
G6	Sefidrud	15.700	29.850	25.510	19.720	9.970	0.000	100.750	
	Local Rivers 1 (A)	0.580	0.240	0.480	0.640	0.000	0.000	1.940	
	Reservoir (B)	0.221	0.442	0.663	0.553	0.332	0.000	2.211	
	A+B	0.801	0.682	1.143	1.193	0.332	0.000	4.151	
	Groundwater	0.103	0.192	0.458	0.458	0.192	0.103	1.506	
	Sub-total	16.604	30.724	27.111	21.371	10.494	0.103	106.407	
G7	Sefidrud	5.400	10.260	8.770	6.780	3.430	0.000	34.640	
	Local Rivers 1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.034	0.069	0.103	0.086	0.052	0.000	0.344	
	A+B	0.034	0.069	0.103	0.086	0.052	0.000	0.344	
	Groundwater	0.080	0.084	0.095	0.095	0.084	0.080	0.517	
	Sub-total	5.548	10.482	9.071	7.047	3.618	0.080	35.845	
Total	Sefidrud	93.140	177.130	151.370	117.030	59.170	0.000	597.840	96.9%
	Local Rivers 1 (A)	2.720	0.620	1.060	1.210	0.000	0.000	5.610	0.9%
	Reservoir (B)	0.821	1.642	2.463	2.054	1.233	0.000	8.213	1.3%
	A+B	3.541	2.262	3.523	3.264	1.233	0.000	13.823	2.2%
	Groundwater	0.488	0.714	1.391	1.391	0.714	0.488	5.188	0.8%
	Sub-total	97.169	180.106	156.284	121.685	61.117	0.488	616.851	

Source: Pandam Report Vol.4

8.5.3 East Gilan Irrigation Area (R55)

According to the Pandam Study Report (Vol.4), agricultural water consumption by water resources in East Gilan irrigation area (R55) is shown in Table R 8.5.3. The East Gilan area (R55) depends on the Sefidrud river for the agricultural water of 93.0%. Additionally, 2.5% depends on local rivers, 4.1% depends on the reservoir, and 0.4% depends on groundwater.

Table R 8.5.3 Agricultural Water Consumption in Central Gilan Area (R53)

Develop-ment Unit	Water Supply Resources	Consumption (MCM)							Remarks
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Total	
D1	Sefidrud	14.730	28.000	23.920	18.500	9.360	0.000	94.510	
	Local Rivers1 (A)	2.930	0.020	1.290	2.020	0.000	0.000	6.260	
	Reservoir (B)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	A+B	2.930	0.020	1.290	2.020	0.000	0.000	6.260	
	Groundwater	0.001	0.029	0.116	0.116	0.030	0.001	0.292	
	Sub-total	17.661	28.049	25.326	20.636	9.390	0.001	101.062	
D2	Sefidrud	11.020	20.950	17.910	13.840	7.000	0.000	70.720	
	Local Rivers1 (A)	2.910	0.000	0.460	1.660	0.000	0.000	5.030	
	Reservoir (B)	0.116	0.232	0.348	0.290	0.174	0.000	1.160	
	A+B	3.026	0.232	0.808	1.950	0.174	0.000	6.190	
	Groundwater	0.019	0.145	0.520	0.520	0.145	0.019	1.368	
	Sub-total	14.065	21.327	19.238	16.310	7.319	0.019	78.278	
D3	Sefidrud	9.250	17.600	15.040	11.630	5.880	0.000	59.400	
	Local Rivers1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.110	0.220	0.330	0.275	0.165	0.000	1.100	
	A+B	0.110	0.220	0.330	0.275	0.165	0.000	1.100	
	Groundwater	0.000	0.000	0.001	0.001	0.000	0.000	0.003	
	Sub-total	9.360	17.820	15.371	11.906	6.045	0.000	60.503	
D4	Sefidrud	8.160	15.510	13.250	10.250	5.180	0.000	52.350	
	Local Rivers1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	0.185	0.370	0.555	0.463	0.278	0.000	1.851	
	A+B	0.185	0.370	0.555	0.463	0.278	0.000	1.851	
	Groundwater	0.000	0.000	0.002	0.002	0.000	0.000	0.004	
	Sub-total	8.345	15.880	13.807	10.715	5.458	0.000	54.205	
D5	Sefidrud	21.570	41.030	35.060	27.100	13.700	0.000	138.460	
	Local Rivers1 (A)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Reservoir (B)	1.433	2.866	4.299	3.583	2.150	0.000	14.331	
	A+B	1.433	2.866	4.299	3.583	2.150	0.000	14.331	
	Groundwater	0.000	0.001	0.002	0.002	0.001	0.000	0.006	
	Sub-total	23.003	43.897	39.361	30.685	15.851	0.000	152.797	
Total	Sefidrud	64.730	123.090	105.180	81.320	41.120	0.000	415.440	93.0%
	Local Rivers1 (A)	5.840	0.020	1.750	3.680	0.000	0.000	11.290	2.5%
	Reservoir (B)	1.844	3.688	5.532	4.611	2.767	0.000	18.442	4.1%
	A+B	7.684	3.708	7.282	8.291	2.767	0.000	29.732	6.7%
	Groundwater	0.020	0.175	0.641	0.641	0.175	0.020	1.673	0.4%
	Sub-total	72.434	126.973	113.103	90.252	44.062	0.020	446.845	

Source: Pandam Report Vol.4

8.5.4 Total Agricultural Water Consumption in SIDN

Total agricultural water consumption in SIDN is Table R 8.5.4. 93.1% of SIDN (about 155,600 ha) depends on the Sefidrud River. Additionally, 3.4% depends on local rivers, 1.9% depends on the reservoir, and 1.5% depends on groundwater.

Table R 8.5.4 Agricultural Water Consumption in SIDN

(Unit:'000m^3)

Water Source	Fumanat (R54)	Central Gilan (R53)	East Gilan (R55)	Total	Ratio (%)	Net Paddy Field (ha)
Sefidrud River	432,610	597,840	415,440	1,445,890	93.1	155,595
Local Rivers	35,970	5,610	11,290	52,870	3.4	5,689
Reservoir	3,385	8,213	18,442	30,040	1.9	3,233
Groundwater	16,698	5,188	1,763	23,559	1.5	2,535
Total	488,663	616,851	446,845	1,552,359	100.0	167,052

Source: Pandam Study Report

8.6 WATER DEMAND IN SIDN

8.6.1 Agricultural Water Demand

1) Net Water Requirement

In the Pandam Study Report, net water requirement is estimated by the Penman Mantis method which FAO recommends in 1992. Net water requirement in SIDN is as shown in Table R 8.6.1

Table R 8.6.1 Net Water Requirement in SIDN

Organization	Item	Net Water Requirement (Unit: mm)						
		Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
Water & Soil Research Institute	Evapotranspiration Crop	0	49	117	134	126	0	426
	Effective Rainfall	0	24	32	44	47	0	147
	Irrigation Requirement	0	25	85	90	79	0	279
National Water Document	Evapotranspiration Crop	0	60	119	128	113	27	447
	Effective Rainfall	0	28	22	30	42	16	138
	Irrigation Requirement	0	32	97	98	71	11	309
Pandam Consultant	Evapotranspiration Crop	0	39	129	148	135	34	485
	Effective Rainfall	0	14	46	39	48	17	164
	Irrigation Requirement	0	25	83	109	87	17	321

Source: Pandam Study Report

2) Irrigation Efficiency

According to the Pandam Study Report, the irrigation efficiency in the SIDN are decided as shown in Table R 8.6.2. The comprehensive irrigation efficiency in SIDN of calculated by the weighted average is 42.0%.

Table R 8.6.2 Irrigation Efficiency in SIDN

Item	Fumanat (R54)	Central Gilan (R53)		East Gilan (R55)	Total
		Modern Irrigation	Traditional Irrigation		
Net paddy field area (ha)	48,009	23,368	45,714	49,961	167,052
Irrigation Efficiency (%)	43.0	47.0	38.0	42.5	42.0

Source: Pandam Report

3) Gross Water Requirement

The gross water requirement is obtained by dividing the net water requirement by the irrigation efficiency. The gross water requirement in the SIDN is shown in Table R 8.6.3.

Table R 8.6.3 Gross Water Requirement in SIDN

Irrigation Area		Irrigation Efficiency (%)	Gross Irrigation Water Requirement(m^3/ha)					
			Apr.	May	Jun.	Jul.	Aug.	Total
Net Irrigation Water Requirement (m^3/ha)			690	1780	980	980	820	5,250
Fumanat (R54)		43.0	1,605	4,140	2,279	2,279	1,907	12,209
Central Gilan (R53)	Modern Irrigation	47.0	1,468	3,787	2,085	2,085	1,745	11,170
	Traditional Irrigation	38.0	1,816	4,684	2,579	2,579	2,158	13,816
East Gilan (R55)		42.5	1,624	4,188	2,306	2,306	1,929	12,353

Source: Pandam Report Vol.4

4) Agricultural Water Demand in Central Gilan Area (R53)

The Reach code of the Central Gilan area is newly set as R53. Agricultural water demand in Central Gilan area (R53) is estimated based on the Pandam Study Report as shown in Table R 8.6.4. The water demand for fish culture is included in agricultural water demand.

Table R 8.6.4 Agricultural Water Demand in Central Gilan Area (R53)

(1) Water Demand by Development Unit ('000m^3)

Development Unit	Item	Area (ha)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Net Water Requirement of Paddy (m^3/ha)			1,468	3,787	2,085	2,085	1,745								11,170
G1	Paddy	2,737	4,018	10,365	5,707	5,707	4,776	0	0	0	0	0	0	0	30,572
	Fish Culture	126	285	1,483	1,911	381	366	328	280	247	235	231	236	285	6,268
	Sub-total		4,303	11,848	7,618	6,088	5,142	328	280	247	235	231	236	285	36,840
G5	Paddy	4,986	7,319	18,882	10,396	10,396	8,701	0	0	0	0	0	0	0	55,694
	Fish Culture	53	118	617	795	159	152	137	117	103	98	96	98	119	2,609
	Sub-total		7,437	19,499	11,191	10,555	8,853	137	117	103	98	96	98	119	58,303
G6	Paddy	11,642	17,090	44,088	24,274	24,274	20,315	0	0	0	0	0	0	0	130,041
	Fish Culture	2,197	4,959	25,816	33,264	6,635	6,732	5,712	4,878	4,306	4,087	4,021	4,109	4,961	109,480
	Sub-total		22,049	69,904	57,538	30,909	27,047	5,712	4,878	4,306	4,087	4,021	4,109	4,961	239,521
G7	Paddy	4,003	5,876	15,159	8,346	8,346	6,985	0	0	0	0	0	0	0	44,714
	Fish Culture	69	156	811	1,045	208	200	179	153	135	128	126	129	156	3,426
	Sub-total		6,032	15,970	9,391	8,554	7,185	179	153	135	128	126	129	156	48,140
Net Water Requirement of Paddy (m^3/ha)			1,816	4,684	2,579	2,579	2,158								13,816
G2	Paddy	9,239	16,778	43,275	23,827	23,827	19,938	0	0	0	0	0	0	0	127,646
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		16,778	43,275	23,827	23,827	19,938	0	0	0	0	0	0	0	127,646
G3	Paddy	14,976	27,196	70,148	38,623	38,623	32,318	0	0	0	0	0	0	0	206,908
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		27,196	70,148	38,623	38,623	32,318	0	0	0	0	0	0	0	206,908
G4	Paddy	21,499	39,042	100,701	55,446	55,446	46,395	0	0	0	0	0	0	0	297,030
	Fish Culture	91	206	1,072	1,381	275	264	237	202	179	170	167	171	206	4,530
	Sub-total		39,248	101,773	56,827	55,721	46,659	237	202	179	170	167	171	206	301,560
Total	Paddy	69,082	117,321	302,619	166,619	166,619	139,428	0	0	0	0	0	0	0	892,605
	Fish Culture	2,536	5,724	29,799	38,396	7,658	7,714	6,593	5,630	4,970	4,718	4,641	4,743	5,727	126,313
	Total		123,045	332,418	205,015	174,277	147,142	6,593	5,630	4,970	4,718	4,641	4,743	5,727	1,018,918

(2) Water Demand by Water Resource ('000m^3)

Water Resources		Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Surface Water	Sefidrud River (97.0%)	Paddy	113,801	293,540	161,620	161,620	135,245	0	0	0	0	0	0	0	865,827
		Fish Culture	5,724	29,799	38,396	7,658	7,714	6,593	5,630	4,970	4,718	4,641	4,743	5,727	126,313
		Sub-total	119,525	323,339	200,016	169,278	142,959	6,593	5,630	4,970	4,718	4,641	4,743	5,727	992,140
	Local Rivers (2.2%)	Paddy	2,581	6,658	3,666	3,666	3,067	0	0	0	0	0	0	0	19,637
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	2,581	6,658	3,666	3,666	3,067	0	0	0	0	0	0	0	19,637
	Total		122,106	329,997	203,682	172,944	146,027	6,593	5,630	4,970	4,718	4,641	4,743	5,727	1,011,777
Groundwater (0,8%)		Paddy	939	2,421	1,333	1,333	1,115	0	0	0	0	0	0	0	7,141
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	939	2,421	1,333	1,333	1,115	0	0	0	0	0	0	0	7,141

(3) Water Demand from Galerud Weir and Sangar Left Intake ('000m^3)

Weir	Benefit Area	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Gelerud	G1	4,303	11,848	7,618	6,088	5,142	328	280	247	235	231	236	285	36,840
Sangar-Left	G2-G7	115,222	311,491	192,398	163,190	137,817	6,265	5,350	4,723	4,483	4,410	4,507	5,442	955,300
Total		119,525	323,339	200,016	169,278	142,959	6,593	5,630	4,970	4,718	4,641	4,743	5,727	992,140

Note: Irrigation efficiency in modern irrigation system (G1, G5, G6 and G7) is estimated as 47.0% and traditional irrigation system (G2, G3 and G4) as 38.0%

The Annual agricultural water demand in Central Gilan area (R53) is about 1,020 MCM. When arranging water demand according to the head of water resources, about 990 MCM(97.0%) is from the Sefidrud river, about 20 MCM (2.2%) is from local rivers and reservoirs, and about 7 MCM(0.8%) of the remainder will be supplied from groundwater. When seeing according to the development unit, the G1 unit is supplied from Galerud and G2 to G7 is being supplied from Sangar weir.

5) Agricultural Water Demand in Fumanat Area (R54)

The Reach code of the Fumanat area is newly set as R54. Agricultural water demand in Fumanat area (R54) is estimated based on the Pandam Study Report as shown in Table R 8.6.5.

Table R 8.6.5 Agricultural Water Demand in Fumanat Area (R54)

(1) Water Demand by Development Unit ('000m^3)

Development Unit	Item	Area (ha)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Net Water Requirement of Paddy (m^3/ha)			1,605	4,140	2,279	2,279	1,907								12,210
F1	Paddy	10,923	17,531	45,221	24,894	24,894	20,830	0	0	0	0	0	0	0	133,370
	Other Crops		4,070	10,371	5,053	5,878	1,446	0	0	0	0	0	0	0	26,818
	Fish Culture	288	649	3,378	4,353	868	834	748	638	564	535	526	538	649	14,280
	Sub-total		22,250	58,970	34,300	31,640	23,110	748	638	564	535	526	538	649	174,468
F2	Paddy	8,172	13,116	33,832	18,624	18,624	15,584	0	0	0	0	0	0	0	99,780
	Other Crops		12,796	32,691	17,366	18,152	10,994	0	0	0	0	0	0	0	91,999
	Fish Culture	270	608	3,167	4,080	814	782	701	598	528	501	493	504	609	13,385
	Sub-total		26,520	69,690	40,070	37,590	27,360	701	598	528	501	493	504	609	205,164
F3	Paddy	6,864	11,017	28,417	15,643	15,643	13,090	0	0	0	0	0	0	0	83,809
	Other Crops		1,075	2,944	1,406	1,543	1,309	0	0	0	0	0	0	0	8,277
	Fish Culture	21	48	249	321	64	61	55	47	42	39	39	40	48	1,053
	Sub-total		12,140	31,610	17,370	17,250	14,460	55	47	42	39	39	40	48	93,140
F4	Paddy	6,050	9,710	25,047	13,788	13,788	11,537	0	0	0	0	0	0	0	73,871
	Other Crops		788	2,117	973	1,206	923	0	0	0	0	0	0	0	6,007
	Fish Culture	18	42	216	279	56	53	48	41	36	34	34	34	42	915
	Sub-total		10,540	27,380	15,040	15,050	12,513	48	41	36	34	34	34	42	80,792
F5	Paddy	16,001	25,682	66,244	36,466	36,466	30,514	0	0	0	0	0	0	0	195,372
	Other Crops	(5%)	1,284	3,312	1,823	1,823	1,526	0	0	0	0	0	0	0	9,769
	Fish Culture	14	31	160	206	41	39	35	30	27	25	25	25	31	675
	Sub-total		26,997	69,716	38,496	38,331	32,079	35	30	27	25	25	25	31	205,816
Total	Paddy	48,010	77,056	198,761	109,415	109,415	91,555	0	0	0	0	0	0	0	586,202
	Other Crops		20,013	51,435	26,622	28,603	16,197	0	0	0	0	0	0	0	142,870
	Fish Culture	611	1,378	7,170	9,239	1,843	1,769	1,587	1,354	1,197	1,134	1,117	1,141	1,379	30,308
	Sub-total		98,447	257,366	145,276	139,861	109,522	1,587	1,354	1,197	1,134	1,117	1,141	1,379	759,380

(2) Water Demand by Water Resource ('000m^3)

Water Resources		Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Surface Water (96.6%)	Sefidrud River (88.5%)	Paddy	68,195	175,904	96,832	96,832	81,026	0	0	0	0	0	0	0	518,789
		Other Crops	17,711	45,520	23,560	25,313	14,335	0	0	0	0	0	0	0	126,440
		Fish Culture	1,378	7,170	9,239	1,843	1,769	1,587	1,354	1,197	1,134	1,117	1,141	1,379	30,308
		Sub-total	87,284	228,594	129,631	123,989	97,130	1,587	1,354	1,197	1,134	1,117	1,141	1,379	675,537
		(m^3/s)	32.6	85.3	48.4	46.3	36.3	0.6	0.5	0.4	0.4	0.4	0.4	0.5	
	Local River (8.1%)	Paddy	6,242	16,100	8,863	8,863	7,416	0	0	0	0	0	0	0	47,482
		Other Crops	1,621	4,166	2,156	2,317	1,312	0	0	0	0	0	0	0	11,572
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	7,863	20,266	11,019	11,179	8,728	0	0	0	0	0	0	0	59,055
	Total		95,146	248,860	140,650	135,168	105,858	1,587	1,354	1,197	1,134	1,117	1,141	1,379	734,591
Groundwater (3.4%)		Paddy	2,620	6,758	3,720	3,720	3,113	0	0	0	0	0	0	0	19,931
		Other Crops	680	1,749	905	972	551	0	0	0	0	0	0	0	4,858
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	3,300	8,507	4,625	4,693	3,664	0	0	0	0	0	0	0	24,788

Note: Irrigation Efficiency in Fumanat is estimated as 43.0%.

The annual agricultural water demand in Fumanat area (R54) is about 760 MCM. When arranging water demand according to the head of water resources, about 675 MCM (88.5%) is from Sefidrud river, about 60 MCM (8.1%) is from local rivers and reservoirs, and about 25 MCM (3.4%) of the remainder will be supplied from groundwater. All water demand from Sefidrud river is supplied from the Tarik weir.

However, the problem is that the canal flow capacity of the Fumanat tunnel is extremely small however compared with 32m^3/s and the maximum water demand (85.3m^3/s). Therefore, the irrigation season of paddy is insufficient water as shown in Table R 8.6.5.

Table R 8.6.6. The paddy field of about 34,500 ha in Fumanat area is not supplied water in land preparation period (May).

Table R 8.6.6 Water Shortage by Capacity Restriction by Tarik Tunnel

No.	Item	Unit	Apr	May	Jun	Jul	Aug
1	Design Water Demand from Tarik Weir	1,000m^3	87,284	228,594	129,631	123,989	97,130
2	Maximum Discharge of Tarik Tunnel	1,000m^3	85,709	85,709	85,709	85,709	85,709
3	Water Shortage (1-2)	1,000m^3	1,575	142,885	43,923	38,280	11,421
4	Monthly Water Demand of Paddy (m^3/ha)	m^3/ha	1,605	4,140	2,279	2,279	1,907
5	Water Shortage's Paddy Field (3÷4)	ha	981	34,513	19,273	16,797	5,989

Note: Maximum Water Discharge of Tarik Tunnel is 32 m^3/s

To solve this problem, Gilan RWC promotes the extension works of Sangar left canal. This extension works will complete by 2016 though construction is interrupting now. Therefore, it is assumed that the extension works of Sangar left canal is completed by 2016. JICA's future water balance simulation will be executed as shown in Table R 8.6.7.

Table R 8.6.7 Basic Concepts for Water Balance Simulation

Target Year	Extension Works of Sangar Left Canal	Basic Concepts
Present (2006)	Incompleteness	The water volume from Tarik weir to Fumanat (R54) of does not give the planned water demand and limit maximum water flow capacity of Fumanat tunnel ($32m^3/s$)
Middle Term Target Year (2016)	Completion	The water volume from Tarik weir to Fumanat (R54) of does not give the planned water demand and limit maximum water flow capacity of Fumanat tunnel ($32m^3/s$) Shortage water volume for Fumanat (R54) is added to intake water volume at the Sangar weir.
Long Term Target Year (2031)	Completion	The water volume from Tarik weir to Fumanat (R54) of does not give the planned water demand and limit maximum water flow capacity of Fumanat tunnel ($32m^3/s$) Shortage water volume for Fumanat (R54) is added to intake water volume at the Sangar weir.

6) Agricultural Water Demand in East Gilan (R55)

The Reach code of the East Gilan area is newly set as R55. Agricultural water demand in East Gilan area (R55) is estimated based on the Pandam Study Report as shown in Table R 8.6.8.

Table R 8.6.8 Agricultural Water Demand in East Gilan Area (R55)

(1) Water Demand by Development Unit ('000m^3)

Development Unit	Item	Area (ha)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Net Water Requirement of Paddy (m^3/ha)			1,624	4,188	2,306	2,306	1,929								12,353
D1	Paddy	14,492	23,535	60,692	33,419	33,419	27,955	0	0	0	0	0	0	0	179,020
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		23,535	60,692	33,419	33,419	27,955	0	0	0	0	0	0	0	179,020
D2	Paddy	17,322	28,131	72,545	39,945	39,945	33,414								213,979
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		28,131	72,545	39,945	39,945	33,414	0	0	0	0	0	0	0	213,979
D3	Paddy	8,103	13,159	33,935	18,686	18,686	15,631								100,096
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		13,159	33,935	18,686	18,686	15,631	0	0	0	0	0	0	0	100,096
D4	Paddy	7,029	11,415	29,437	16,209	16,209	13,559								86,829
	Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total		11,415	29,437	16,209	16,209	13,559	0	0	0	0	0	0	0	86,829
D5	Paddy	3,016	4,898	12,631	6,955	6,955	5,818								37,257
	Fish Culture	311	703	3,659	4,715	940	903	810	691	610	579	570	582	703	15,465
	Sub-total		5,601	16,290	11,670	7,895	6,721	810	691	610	579	570	582	703	52,722
Total	Paddy	49,962	81,138	209,241	115,212	115,212	96,377	0	0	0	0	0	0	0	617,181
	Fish Culture	311	703	3,659	4,715	940	903	810	691	610	579	570	582	703	15,465
	Sub-total		81,841	212,900	119,927	116,152	97,280	810	691	610	579	570	582	703	632,646

(2) Water Demand by Water Resource ('000m^3)

Water Resources		Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Surface Water (99.6%)	Sefidrud River (93.0%)	Paddy	75,459	194,594	107,148	107,148	89,630	0	0	0	0	0	0	0	573,978
		Fish Culture	703	3,659	4,715	940	903	810	691	610	579	570	582	703	15,465
		Sub-total	76,162	198,253	111,863	108,088	90,533	810	691	610	579	570	582	703	589,443
	Local River (6.6%)	Paddy	5,355	13,810	7,604	7,604	6,361	0	0	0	0	0	0	0	40,734
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	5,355	13,810	7,604	7,604	6,361	0	0	0	0	0	0	0	40,734
	Total		81,517	212,063	119,467	115,692	96,894	810	691	610	579	570	582	703	630,177
Groundwater (0.4%)		Paddy	325	837	461	461	386	0	0	0	0	0	0	0	2,469
		Fish Culture	0	0	0	0	0	0	0	0	0	0	0	0	0
		Sub-total	325	837	461	461	386	0	0	0	0	0	0	0	2,469

Note: Irrigation Efficiency in East Gilan is estimated as 42.5%

The annual agricultural water demand in East Gilan area (R55) is about 635 MCM. When arranging water demand according to the head of water resources, about 590 MCM (93.0%) is from Sefidrud river, about 41 MCM (6.6%) is from local rivers and reservoirs, and about 2.5 MCM (0.8%) of the remainder will be supplied from groundwater. All water demand from Sefidrud river is supplied by Sangar right canal from the Sangar weir.

7) Summary of Agricultural Water Demand in SIDN

Agricultural water demand of SIDN in present (2006), in middle term target year (2016), and long term target year (2031) were arranged based on the above-mentioned calculation result as shown in Figure R 8.6.1, Table R 8.6.9, Table R 8.6.10, and Table R 8.6.11. The future irrigation efficiency was assumed to be 0.48 in middle term target year (2016) and 0.55 in long term target year (2031).

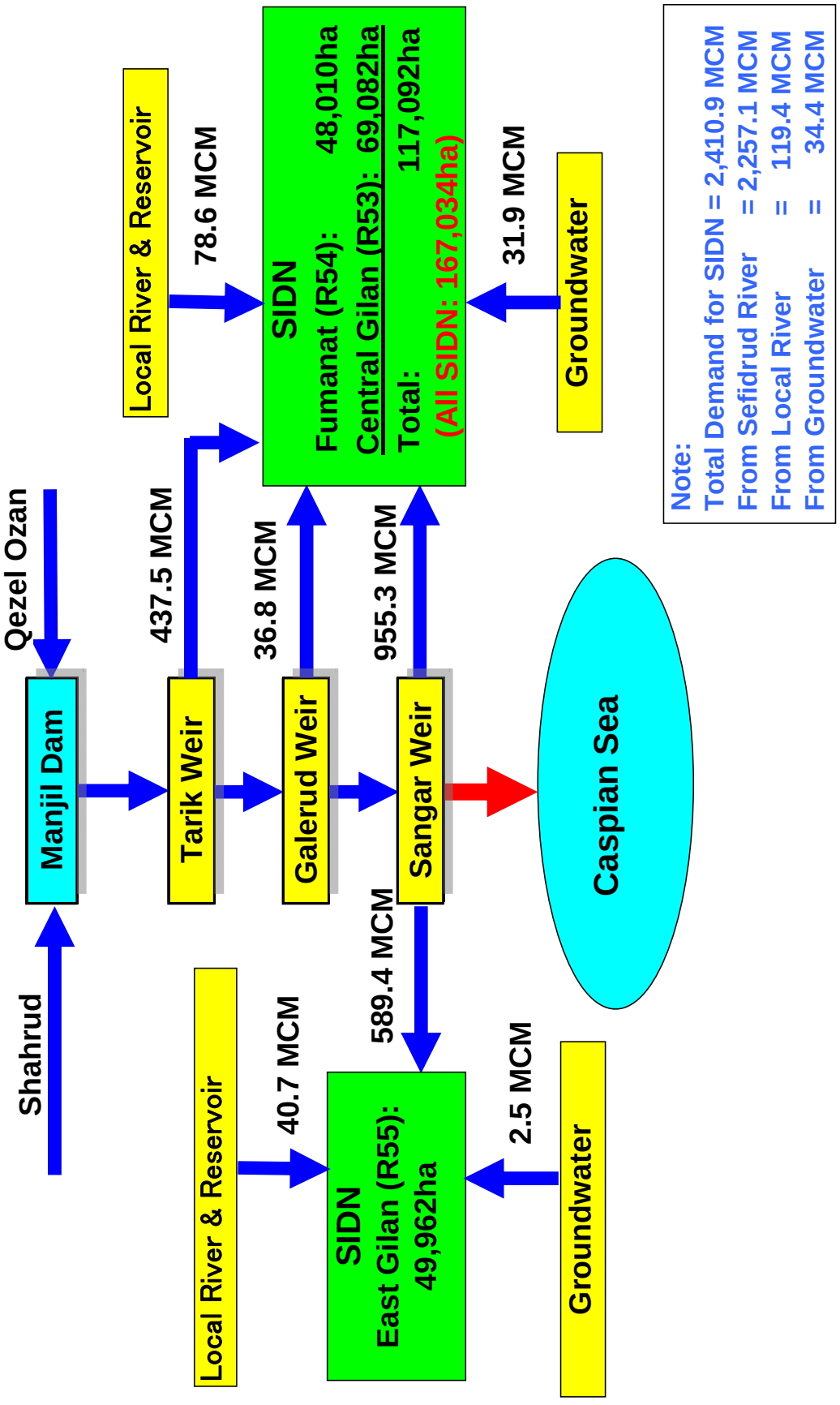


Figure R 8.6.1 Present Agricultural Water Demand in SIDN (2006)

Table R 8.6.9 Present Agricultural Water Demand in SIDN (2006)

(1) Water Demand in All Sefidrud Irrigation and Drainage Network ('000m^3)																
Reach		Area (ha)	(%)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
R53	Central Gilan	69,082	100.0	123,045	332,418	205,015	174,277	147,142	6,593	5,630	4,970	4,718	4,641	4,743	5,727	1,018,918
R54	Fumanat	48,010	100.0	98,447	257,366	145,276	139,861	109,522	1,587	1,354	1,197	1,134	1,117	1,141	1,379	759,380
R55	East Gilan	49,962	100.0	81,841	212,900	119,927	116,152	97,280	810	691	610	579	570	582	703	632,646
Total		167,054		303,333	802,684	470,218	430,290	353,943	8,990	7,675	6,777	6,431	6,328	6,466	7,809	2,410,944
(2) Water Demand from Sefidrud River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	67,009	97.0	119,525	323,339	200,016	169,278	142,959	6,593	5,630	4,970	4,718	4,641	4,743	5,727	992,140
R54	Fumanat	42,489	88.5	87,284	228,594	129,631	123,989	97,130	1,587	1,354	1,197	1,134	1,117	1,141	1,379	675,537
R55	East Gilan	46,465	93.0	76,162	198,253	111,863	108,088	90,533	810	691	610	579	570	582	703	589,443
Total		155,963		282,971	750,186	441,510	401,354	330,622	8,990	7,675	6,777	6,431	6,328	6,466	7,809	2,257,119
(3) Water Demand from Local River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	1,520	2.2	2,581	6,658	3,666	3,666	3,067	0	0	0	0	0	0	0	19,637
R54	Fumanat	3,889	8.1	7,863	20,266	11,019	11,179	8,728	0	0	0	0	0	0	0	59,055
R55	East Gilan	3,297	6.6	5,355	13,810	7,604	7,604	6,361	0	0	0	0	0	0	0	40,734
Total		8,706		15,799	40,733	22,289	22,449	18,156	0	0	0	0	0	0	0	119,426
(4) Water Demand from Groundwater ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	553	0.8	939	2,421	1,333	1,333	1,115	0	0	0	0	0	0	0	7,141
R54	Fumanat	1,632	3.4	3,300	8,507	4,625	4,693	3,664	0	0	0	0	0	0	0	24,788
R55	East Gilan	200	0.4	325	837	461	461	386	0	0	0	0	0	0	0	2,469
Total		2,385		4,563	11,765	6,419	6,486	5,165	0	0	0	0	0	0	0	34,398
(5) Water Demand from Main Weirs ('000m^3)																
Weir		Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	
Tarik (F1-F5)		Design Demand	87,284	228,594	129,631	123,989	97,130	1,587	1,354	1,197	1,134	1,117	1,141	1,379	675,537	
		Shortage Volume	1,575	142,885	43,922	38,280	11,421								238,083	
		For Simulation	**85,709**	**85,709**	**85,709**	**85,709**	**85,709**	**1,587**	**1,354**	**1,197**	**1,134**	**1,117**	**1,141**	**1,379**	**437,454**	
Galerud (G1)		For Simulation	**4,303**	**11,848**	**7,618**	**6,088**	**5,142**	**328**	**280**	**247**	**235**	**231**	**236**	**285**	**36,840**	
Sangar-Left (G2-G7)		Design Demand	115,222	311,491	192,398	163,190	137,817	6,265	5,350	4,723	4,483	4,410	4,507	5,442	955,300	
		Additional Volume	0	0	0	0	0	0	0	0	0	0	0	0		
		For Simulation	**115,222**	**311,491**	**192,398**	**163,190**	**137,817**	**6,265**	**5,350**	**4,723**	**4,483**	**4,410**	**4,507**	**5,442**	**955,300**	
Sangar-Right (D1-D5)		For Simulation	**76,162**	**198,253**	**111,863**	**108,088**	**90,533**	**810**	**691**	**610**	**579**	**570**	**582**	**703**	**589,443**	
Total			**281,396**	**607,301**	**397,588**	**363,075**	**319,201**	**8,990**	**7,675**	**6,777**	**6,431**	**6,328**	**6,466**	**7,809**	**2,019,037**	

Source: Pandam Study Report/ Vol.4

Note: Sangar left canal extension works is incompleteness.

Table R 8.6.10 Target Year Agricultural Water Demand in SIDN in the Middle Term (2016)

(1) Water Demand in All Sefidrud Irrigation and Drainage Network ('000m^3)																
Reach		Area (ha)	(%)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
R53	Central Gilan	69,082	100.0	107,664	290,866	179,388	152,492	128,749	5,769	4,926	4,349	4,128	4,061	4,150	5,011	783,889
R54	Fumanat	48,010	100.0	86,141	225,196	127,116	122,378	95,831	1,389	1,185	1,047	992	977	998	1,207	578,316
R55	East Gilan	49,962	100.0	71,611	186,287	104,936	101,633	85,120	709	605	534	507	499	509	615	481,954
Total		167,054		265,416	702,349	411,440	376,503	309,700	7,866	6,716	5,930	5,627	5,537	5,658	6,833	1,844,159
(2) Water Demand from Sefidrud River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	67,009	97.0	104,585	282,922	175,014	148,118	125,089	5,769	4,926	4,349	4,128	4,061	4,150	5,011	763,538
R54	Fumanat	42,489	88.5	76,373	200,020	113,427	108,490	84,989	1,389	1,185	1,047	992	977	998	1,207	514,721
R55	East Gilan	46,465	93.0	66,641	173,471	97,880	94,577	79,217	709	605	534	507	499	509	615	449,121
Total		155,963		247,599	656,413	386,321	351,185	289,295	7,866	6,716	5,930	5,627	5,537	5,658	6,833	1,727,380
(3) Water Demand from Local River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	1,520	2.2	2,258	5,825	3,207	3,207	2,684	0	0	0	0	0	0	0	14,924
R54	Fumanat	3,889	8.1	6,880	17,733	9,642	9,782	7,637	0	0	0	0	0	0	0	44,793
R55	East Gilan	3,297	6.6	4,686	12,084	6,654	6,654	5,566	0	0	0	0	0	0	0	30,956
Total		8,706		13,824	35,642	19,503	19,643	15,887	0	0	0	0	0	0	0	90,674
(4) Water Demand from Groundwater ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	553	0.8	821	2,118	1,166	1,166	976	0	0	0	0	0	0	0	5,427
R54	Fumanat	1,632	3.4	2,888	7,443	4,047	4,106	3,206	0	0	0	0	0	0	0	18,802
R55	East Gilan	200	0.4	284	732	403	403	337	0	0	0	0	0	0	0	1,876
Total		2,385		3,993	10,294	5,617	5,676	4,519	0	0	0	0	0	0	0	26,105
(5) Water Demand from Main Weirs ('000m^3)																
Weir		Item		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Tarik (F1-F5)		Design Demand		76,373	200,020	113,427	108,490	84,989	1,389	1,185	1,047	992	977	998	1,207	591,094
		Shortage Volume			114,311	27,718	22,781									164,810
		For Simulation		**76,373**	**85,709**	**85,709**	**85,709**	**84,989**	**1,389**	**1,185**	**1,047**	**992**	**977**	**998**	**1,207**	**426,284**
Galerud (G1)		For Simulation		**3,765**	**10,367**	**6,665**	**5,327**	**4,499**	**287**	**245**	**216**	**206**	**202**	**207**	**249**	**28,470**
Sangar-Left (G2-G7)		Design Demand		100,820	272,555	168,349	142,792	120,590	5,482	4,681	4,133	3,923	3,859	3,944	4,762	735,068
		Additional Volume		0	114,311	27,718	22,781	0	0	0	0	0	0	0	0	164,810
		For Simulation		**100,820**	**386,866**	**196,067**	**165,573**	**120,590**	**5,482**	**4,681**	**4,133**	**3,923**	**3,859**	**3,944**	**4,762**	**1,000,697**
Sangar-Right (D1-D5)		For Simulation		**66,641**	**173,471**	**97,880**	**94,577**	**79,217**	**709**	**605**	**534**	**507**	**499**	**509**	**615**	**449,121**
Total				**247,599**	**656,413**	**386,321**	**351,185**	**289,295**	**7,866**	**6,716**	**5,930**	**5,627**	**5,537**	**5,658**	**6,833**	**1,904,573**

Source: Pandam Study Report/ Vol.4

Note: Sangar left canal extension works is complete.

Table R 8.6.11 Target Year Agricultural Water Demand in SIDN in the Long Term (2031)

(1) Water Demand in All Sefidrud Irrigation and Drainage Network ('000m^3)																
Reach		Area (ha)	(%)	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
R53	Central Gilan	69,082	100.0	93,962	253,846	156,557	133,084	112,363	5,035	4,299	3,795	3,603	3,544	3,622	4,373	684,121
R54	Fumanat	48,010	100.0	75,177	196,534	110,938	106,803	83,635	1,212	1,034	914	866	853	871	1,053	504,713
R55	East Gilan	49,962	100.0	62,497	162,578	91,581	88,698	74,286	619	528	466	442	435	444	537	420,614
Total		167,054		231,636	612,959	359,075	328,585	270,284	6,865	5,861	5,175	4,911	4,832	4,938	5,963	1,609,448
(2) Water Demand from Sefidrud River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	67,009	97.0	91,274	246,914	152,740	129,267	109,169	5,035	4,299	3,795	3,603	3,544	3,622	4,373	666,360
R54	Fumanat	42,489	88.5	66,653	174,563	98,991	94,682	74,172	1,212	1,034	914	866	853	871	1,053	449,211
R55	East Gilan	46,465	93.0	58,160	151,393	85,422	82,540	69,135	619	528	466	442	435	444	537	391,960
Total		155,963		216,087	572,869	337,153	306,489	252,475	6,865	5,861	5,175	4,911	4,832	4,938	5,963	1,507,532
(3) Water Demand from Local River ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	1,520	2.2	1,971	5,084	2,799	2,799	2,342	0	0	0	0	0	0	0	13,025
R54	Fumanat	3,889	8.1	6,004	15,476	8,414	8,537	6,665	0	0	0	0	0	0	0	39,092
R55	East Gilan	3,297	6.6	4,089	10,546	5,807	5,807	4,857	0	0	0	0	0	0	0	27,017
Total		8,706		12,064	31,106	17,020	17,143	13,865	0	0	0	0	0	0	0	79,134
(4) Water Demand from Groundwater ('000m^3)																
Reach		Area (ha)	(%)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R53	Central Gilan	553	0.8	717	1,849	1,018	1,018	852	0	0	0	0	0	0	0	4,736
R54	Fumanat	1,632	3.4	2,520	6,496	3,532	3,583	2,798	0	0	0	0	0	0	0	16,409
R55	East Gilan	200	0.4	248	639	352	352	294	0	0	0	0	0	0	0	1,637
Total		2,385		3,485	8,984	4,902	4,953	3,944	0	0	0	0	0	0	0	22,783
(5) Water Demand from Main Weirs ('000m^3)																
Weir		Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	
Tarik (F1-F5)		Design Demand	66,653	174,563	98,991	94,682	74,172	1,212	1,034	914	866	853	871	1,053	515,864	
		Shortage Volume		88,854	13,282	8,973									111,109	
		For Simulation	**66,653**	**85,709**	**85,709**	**85,709**	**74,172**	**1,212**	**1,034**	**914**	**866**	**853**	**871**	**1,053**	**404,755**	
Galerud (G1)		For Simulation	**3,286**	**9,048**	**5,817**	**4,649**	**3,927**	**250**	**214**	**189**	**179**	**176**	**180**	**218**	**24,847**	
Sangar-Left (G2-G7)		Design Demand	87,988	237,866	146,922	124,618	105,242	4,784	4,085	3,607	3,423	3,368	3,442	4,156	641,514	
		Additional Volume	0	88,854	13,282	8,973	0	0	0	0	0	0	0	0		
		For Simulation	**87,988**	**326,720**	**160,205**	**133,591**	**105,242**	**4,784**	**4,085**	**3,607**	**3,423**	**3,368**	**3,442**	**4,156**	**840,611**	
Sangar-Right (D1-D5)		For Simulation	**58,160**	**151,393**	**85,422**	**82,540**	**69,135**	**619**	**528**	**466**	**442**	**435**	**444**	**537**	**391,960**	
Total			**216,087**	**572,869**	**337,153**	**306,489**	**252,475**	**6,865**	**5,861**	**5,175**	**4,911**	**4,832**	**4,938**	**5,963**	**1,662,173**	

Source: Pandam Study Report/ Vol.4

Note: Sangar left canal extension works is complete.

8) Agricultural Water Demand in Upper Basin of SIDN (R56, R57)

Upper basin of SIDN is divided into two Reaches. The left bank side of the Sefidrud river is newly set as R56 and the right bank side is R57. Agricultural water demand in the upper basin of SIDN is estimated based on the Pandam Study Report as shown in Table R 8.6.12.

Table R 8.6.12 Agricultural Water Demand in Upper Basin of SIDN (R56, R57)

Reach Code	Irrigation Area (ha)	Agricultural Water Demand ('000m^3)												
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
R56	12,904	0	0	0	0	0	0	21,660	55,980	30,510	30,860	22,350	0	161,360
R57	1,387	0	0	0	0	0	0	2,340	6,020	3,280	3,320	2,400	0	17,360
Total	14,291	0	0	0	0	0	0	24,000	62,000	33,790	34,180	24,750	0	178,720

Source: Pandam Report

8.6.2 Fish Culture Water Demand

1) Quantities and Areas of Fish Ponds in SIDN

According to the Pandam Study Report, quantities and area of fish ponds in SIDN are shown as in Table R 8.6.13.

Table R 8.6.13 Quantities and Areas of Fish Ponds in SIDN

Irrigation Area	Development Unit	Number of Ponds	Total Reservoir Area (ha)	Total Reservoir Capacity (MCM)
Fumanat (R54)	F1	190	287.5	5.75
	F2	32	269.5	5.39
	F3	4	21.2	0.42
	F4	5	18.4	0.37
	F5	1	13.6	0.27
	Subtotal	232	610.2	12.20
Central Gilan (R53)	G1	4	126.2	2.52
	G2	0	0.0	0.00
	G3	0	0.0	0.00
	G4	71	91.2	1.82
	G5	6	52.5	1.06
	G6	205	2,197.1	43.90
	G7	11	69.0	1.38
	Subtotal	297	2,536.0	50.68
East Gilan (R55)	D1	0	0.0	0.00
	D2	0	0.0	0.00
	D3	0	0.0	0.00
	D4	0	0.0	0.00
	D5	1	311.4	6.23
	Subtotal	1	311.4	6.23
Total		530	3,457.6	69.11

Source: Pandam Report Vol.4

2) Unit Water Demand for Fish Pond

According to the Mahab Ghodss Study Report, unit water demand for fish pond is shown in Table R 8.6.14.

Table R 8.6.14 Unit Water Demand for Fish Pond

(m^3/ha)

Item	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	Total
1. Evaporation	-	1,000	1,640	1,520	1,400	1,100	720	460	360	330	370	-	8,900
2. Seepage	-	750	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	-	14,250
3. Pond Filling	-	10,000	12,000	0	0	0	0	0	0	0	0	-	22,000
Total	2,257	11,750	15,140	3,020	2,900	2,600	2,220	1,960	1,860	1,830	1,870	2,258	49,665

Source: Mahab Ghodss Report/ Table4-14

3) Fish Culture Water Demand

Based on the above-mentioned unit water demand, fish culture water demand in SIDN is estimated as shown in Table R 8.6.15.

Table R 8.6.15 Fish Culture Water Demand in SIDN

Irrigation Area	Development Unit	Pond Area (ha)	Monthly Water Demand ('000m^3)												Total
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
Unit Monthly Water Demand			2,257	11,750	15,140	3,020	2,900	2,600	2,220	1,960	1,860	1,830	1,870	2,258	
Fumanat (R54)	F1	287.5	649	3,378	4,353	868	834	748	638	564	535	526	538	649	14,279
	F2	269.5	608	3,167	4,080	814	782	701	598	528	501	493	504	609	13,385
	F3	21.2	48	249	321	64	61	55	47	42	39	39	40	48	1,053
	F4	18.4	42	216	279	56	53	48	41	36	34	34	34	42	914
	F5	13.6	31	160	206	41	39	35	30	27	25	25	25	31	675
	Sub-total	610.2	1,377	7,170	9,238	1,843	1,770	1,587	1,355	1,196	1,135	1,117	1,141	1,378	30,306
Central Gilan (R53)	G1	126.2	285	1,483	1,911	381	366	328	280	247	235	231	236	285	6,268
	G2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G4	91.2	206	1,072	1,381	275	264	237	202	179	170	167	171	206	4,529
	G5	52.5	118	617	795	159	152	137	117	103	98	96	98	119	2,607
	G6	2,197.1	4,959	25,816	33,264	6,635	6,372	5,712	4,878	4,306	4,087	4,021	4,109	4,961	109,119
	G7	69.0	156	811	1,045	208	200	179	153	135	128	126	129	156	3,427
	Sub-total	2,536.0	5,724	29,798	38,395	7,659	7,354	6,594	5,630	4,971	4,717	4,641	4,742	5,726	125,950
East Gilan (R55)	D1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D4	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D5	311.4	703	3,659	4,715	940	903	810	691	610	579	570	582	703	15,466
	Sub-total	311.4	703	3,659	4,715	940	903	810	691	610	579	570	582	703	15,466
Total		3,457.6	7,804	40,627	52,348	10,442	10,027	8,990	7,676	6,777	6,431	6,327	6,466	7,807	171,722

Source: Pandam Report (Vol.4) and Mahab Ghodss Report

8.6.3 Domestic Water Demand

It turned out to use groundwater excluding the city supplied by the Sangar treatment plant as shown in Table R 8.6.16 though all water resources of urban water supply were assumed to be river water in .the stage of Interim Report.

Table R 8.6.16 Water Resources and Population in Urban Water Supply in Gilan Province

No.	City	Population Prediction by Mahab Ghodss					Reach	Sub-Zone	Water Resources
		2006	2016	2026	2031	2036			
Sangar Water Treatment Plant's Service Area									
1	Rasht	495,181	585,527	687,266	734,068	797,900	R53	E-1	Sangar Water Treatment Plant (River)
2	Bandar Anzali	116,809	138,121	162,121	173,096	188,148	R53	E-1	
3	Astaneh	39,659	46,895	55,044	58,770	63,880	R55	E-1	
4	Lahijan	62,968	74,457	87,394	93,311	101,425	R55	E-1	
5	Langroud	67,114	79,360	93,149	99,455	108,103	R55	E-1	
6	Kiashahr	16,752	19,809	22,251	24,824	26,983	R55	E-1	
7	Khomam	10,176	12,032	14,123	15,080	16,391	R53	E-1	
8	Siahkol	6,075	19,008	22,311	23,822	25,893	R57	E-4	
	Sub-total	814,734	975,209	1,143,659	1,222,425	1,328,723			
Sangar Water Treatment Plant's Service Area after Completion of Extension Works									
1	Khoshkebijar	8,001	9,460	11,104	11,856	12,887	R53	E-1	Deep Well
2	Lasht Nesha	12,784	15,116	17,743	18,944	20,591	R53	E-1	Deep Well
3	Kochesfahan	10,093	11,934	14,008	14,956	16,257	R53	E-1	Deep Well
4	Sangar	8,229	9,731	11,422	12,196	13,256	R53	E-1	Deep Well
5	Komleh	6,779	8,015	9,408	10,045	10,919	R57	E-4	Deep Well
	Sub-total	45,886	54,256	63,685	67,997	73,910			
Other Cities in Study Area									
1	Some Sara	34,847	41,205	48,364	51,639	56,129	R54	E-1	Deep Well
2	Fooman	37,150	43,928	51,561	55,051	59,838	R54	E-1	Deep Well
3	Roudsar	40,548	47,946	56,277	60,087	65,312	R57	E-4	Spring
4	Rezvanshahr	10,520	12,439	14,600	15,588	16,944	R54	E-1	Deep Well
5	Masal	18,612	22,008	25,832	27,581	29,979	R56	E-1	Deep Well
6	Shaft	5,970	7,059	8,286	8,848	9,617	R54	E-1	Deep Well
7	Masoleh	785	929	1,090	1,164	1,265	R56	E-3	Spring
8	Amlash	16,903	19,987	23,460	25,048	27,226	R57	E-4	Well/Spring
9	Roudbar	14,109	16,683	19,582	20,908	22,726	R21	E-2	Deep Well
10	Manjil	17,399	20,574	24,149	25,784	28,026	R21	E-2	Deep Well
11	Loshan	16,376	19,364	22,729	24,268	26,378	R21	E-2	Deep Well
	Sub-total	213,219	252,122	295,930	315,965	343,440			
Outside of Study Area									
1	Astara	36,350	42,982	50,450	53,866	58,550	Outside of Study Area		
2	Hashtpar	69,875	47,150	55,343	59,089	64,227			
3	Parehsar	8,317	9,835	11,544	12,325	13,397			
4	Parehsar	8,317	9,835	11,544	12,325	13,397			
25	Kalachai	16,504	19,516	22,907	24,457	26,584			
26	Vajargah	7,357	8,699	10,211	10,902	11,850			
27	Rahimabad	9,633	11,391	13,370	14,275	15,516			
28	Chaboksar	12,619	14,921	17,514	18,700	20,326			

Source: Gilan RWC and Mahab Ghodss Study Report

Moreover, the services population and water production of Sangar treatment plant collected from Gilan RWC are as shown in Table R 8.6.17. Deference of 2006's population between Table R 8.6.16 and Table R 8.6.17 is the reason which population in Table R 8.6.14 is to quote the population census result in 2006 while Table R 8.6.13 is presumed to the population census in 1998.

Table R 8.6.17 Present Conditions of Urban Water Supply in Gilan Province

Category	No.	City	Total Urban Population (**A**)	Population covered by Sangar Water Treatment Plant	Service Ratio (%)	Water Production	Unit Water Consumption (lpcd)	Reference Population (2006) in Mahab Ghodss Report (**B**)	Error between A and B (%) ((A-B)/A)*100
Inside of JICA Study Area	1	Anzali	110,643	108,651	98.2	7,121,946	179.6	116,809	-5.57
	2	Rezvanshahr	12,453	12,079	97.0	1,117,645	253.5	10,520	15.52
	3	Somesara	37,437	36,276	96.9	3,434,750	259.4	34,847	6.92
	4	Rasht	557,366	555,694	99.7	51,334,525	253.1	495,181	11.16
	5	Kochesfahan	8,402	8,066	96.0	767,837	260.8	10,093	-20.13
	6	Sangar	6,404	6,154	96.1	614,310	273.5	8,229	-28.50
	7	Lashtenesha	10,876	10,474	96.3	1,072,234	280.5	12,784	-17.54
	8	Khoshkebijar	7,485	7,201	96.2	418,840	159.4	8,001	-6.89
	9	Khomam	12,909	12,406	96.1	940,601	207.7	10,176	21.17
	10	Rudsar	35,338	34,667	98.1	3,514,001	277.7	40,548	-14.74
	11	Rudbar	11,558	11,281	97.6	1,324,551	321.7	14,109	-22.07
	12	Lowshan	14,606	14,285	97.8	1,436,741	275.6	16,376	-12.12
	13	Manjil	17,179	16,973	98.8	1,854,495	299.3	17,399	-1.28
	14	Siyahkal	15,658	15,345	98.0	1,417,239	253.0	6,075	61.20
	15	Shaft	6,163	5,916	96.0	48,440	22.4	5,970	3.13
	16	Astaneh	36,363	35,527	97.7	3,116,099	240.3	39,659	-9.06
	17	Kiyashahr	13,772	13,345	96.9	812,343	166.8	16,752	-21.64
	18	Amlash	15,079	14,566	96.6	1,466,117	275.8	16,903	-12.10
	19	Masal	11,021	10,712	97.2	1,109,103	283.7	18,612	-68.88
	20	Lahijan	74,623	73,429	98.4	5,759,210	214.9	62,968	15.62
	21	Langerud	68,362	67,063	98.1	5,171,777	211.3	67,114	1.83
	22	Komleh	5,713	5,462	95.6	607,154	304.5	6,779	-18.66
	23	Fuman	28,014	27,146	96.9	2,325,106	234.7	37,150	-32.61
	24	Masuleh	559	547	97.9	107,657	539.2	785	-40.43
		Sub-total	1,117,983	1,103,265		96,892,721	240.6	1,073,839	3.95
Outside of JICA Study Area	25	Astara	41,062	39,953	97.3	4,674,798	320.6		
	26	Lavandil	6,372	6,130	96.2	212,066	94.8		
	27	Talesh	41,658	40,408	97.0	3,613,893	245.0		
	28	Asalem	9,277	8,943	96.4	208,891	64.0		
	29	Lisar	2,610	2,511	96.2	252,347	275.3		
	30	Havigh	2,612	2,510	96.1	124,295	135.7		
	31	Parehsar	7,893	7,633	96.7	868,621	311.8		
	32	Gurabzarmikh	4,191	4,049	96.6	184,601	124.9		
	33	Tolamshahr	6,804	6,586	96.8	519,140	216.0		
	34	Chaboksar	7,915	7,693	97.2	407,259	145.0		
	35	Rahimabad	7,007	6,755	96.4	893,127	362.2		
	36	Kalachay	11,315	10,896	96.3	1,331,900	334.9		
	37	Vajargah	2,977	2,861	96.1	361,810	346.5		
	38	Barehsar	1,659	1,604	96.7	91,720	156.7		
	39	Rustamabad	12,110	11,735	96.9	1,275,444	297.8		
	40	Jirandeh	2,792	2,700	96.7	310,478	315.0		
	41	Totkabon	1,671	1,609	96.3	200,715	341.8		
	42	Deylaman	1,455	1,426	98.0	159,908	307.2		
	43	Ahmadsargurab	2,278	2,182	95.8	181,231	227.6		
	44	Rankoh	964	921	95.5	167,900	499.5		
	45	Shanderman	3,974	3,847	96.8	319,328	227.4		
	46	Rudbaneh	3,594	3,472	96.6	162,517	128.2		
	47	Shalman	5,655	5,474	96.8	486,801	243.6		
	48	Otaghur	1,542	1,479	95.9	87,640	162.3		
		Sub-total	189,387	183,377	96.8	17,096,430	255.4		
Total			1,307,370	1,286,642		113,989,151	242.7		

Source: Gilan RWC

Additionally, information confirmed in Gilan RWC and Gilan UWWC is as follows.

- The original water supplied to the Sangar water treatment plant is supplied from the Shahr Bijar weir and the Galerud weir. Flowing quantity etc. are being inquired now.
- 8 cities are supplied from Sangar water treatment plant in now. If the extension plan is executed, five cities are newly supplied from Sangar water treatment plant as shown in Table R 8.6.16. The extension works is scheduled to be completed by 2016.
- 3,750 liters/ses of raw water is supplied to Sangar water treatment plant in a present, and 3,000 liters/sec of clean waters are produced.

- Treatment loss at Sangar water treatment plant is 20%. and water supply loss from the treatment plant to each home is 35%.
- As for the water processing of deep well, necessary processing is executed by the water quality of raw water. The water supply loss from deep well to each home is 35%.
- Water resources other than the profit cities in the Sangar water treatment plant are groundwater.
- It is confirmed that the population forecast of the Mahab Ghodss Co. is executed by subcontract consultant, and credibility was low. The error of about 4% has gone out in the region in the Gilan province for the JICA study area as shown in Table R 8.6.17.

8.6.4 Industrial Water Demand

It confirmed from Gilan RWC that the water service water from Sangar water treatment plant is not used for industrial use, and the user obtains the authorization of the well and the river water use. Information on an industrial area, water resources, and water demand was not able to be obtained.

8.7 ESTABLISHMENT OF SIMULATION MODEL FOR GILAN SIDN

SIDN was mounted into Sefid-WBSM (MIKE SHE) and WASM (MIKE Basin) to examine the water balance of the area which is located on both side of Sefidrud River. The boundary conditions and calibration result of the model for SIDN is explained in this section.

8.7.1 Added Reaches and Local Rivers

Three new Reaches are added in the model for the analysis of SIDN, namely, Reach 54, 56, and 57 at downstream of Manjil Dam, changing the shape of Reach 53 and 19. The boundary of these Reaches is shown in Figure R 8.7.1. Concurrently, the thirteen local rivers of SIDN, which are expected to affect the water balance, are embedded as the river modules to grasp the amount of surface flow. The name and location of river streams are also presented in Figure R 8.7.1.

Figure R 8.7.1 Reaches and Rivers for SIDN

8.7.2 Data Collection

The information regarding to hydrology, geology, geography and land use data are especially essential to run the simulation model. Among of these information and data, the rainfall data, flow discharge data and landuse information are collected this time while the geology, DEM and a part of hydrological data (Evaporation depth and Air temperature data) had already collected in the last phase. The contents of additional information are described in the items below.

1) Rainfall Data

There are 40 rainfall observation stations under the jurisdiction of WRMC around SIDN. Among these stations, the 15 key stations were selected to input the data into the simulation model based on the condition that the long-term rainfall observation is carried out and number of missing data is small during the simulation period (1975 to 2005). The location and the code of rainfall observation stations are presented in Figure R 8.7.2

In addition, the influence zone of the selected rainfall stations are determined by using the Thiessen Polygon method to dispose the input data into each grid (2 km by 2 km) of the Sefid-WBSM model (distribution type physical model). On the basis of collected 30 years rainfall time series data, the annual average rainfall depth in SIDN was estimated to about 1,050 mm by this model.

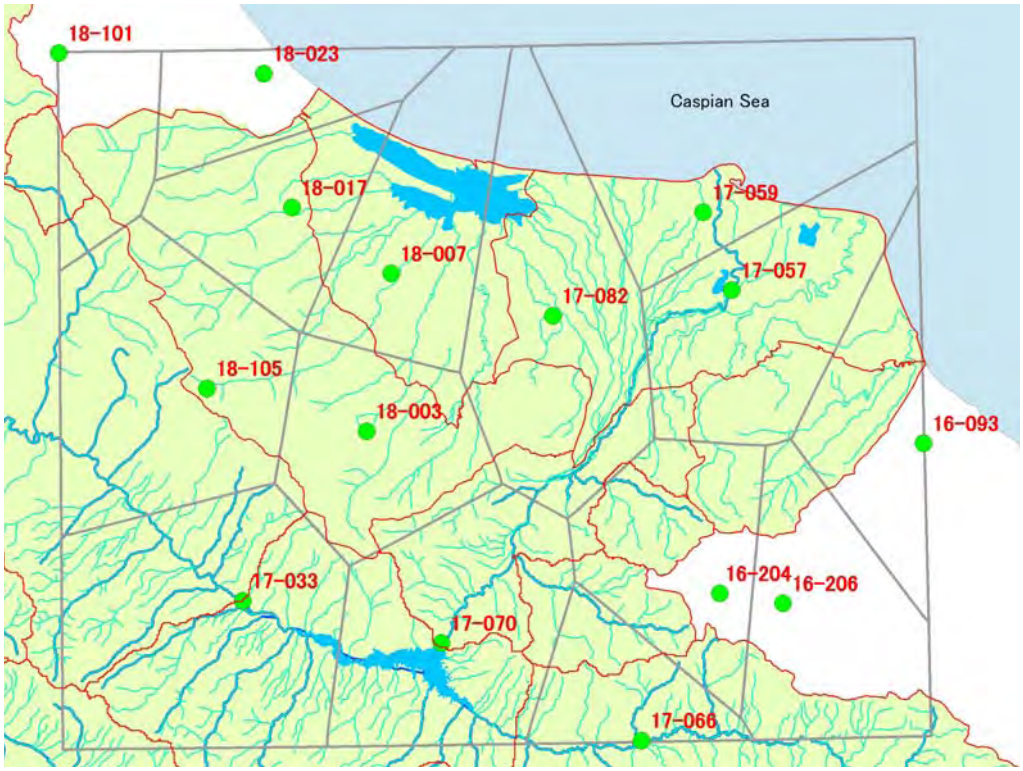


Figure R 8.7.2 Selected Rainfall Observation Station and Thiessen Polygon

2) Flow Discharge

The flow discharge of local thirteen rivers was observed at the stations listed in Table R 8.7.1, which are used for the calibration of the simulation model comparing with the calculated discharge by the model.

Table R 8.7.1 Discharge Observation Station

Area	Code	River	Station Name	Catchment Area (km^2)
Left Side of Sefidrud River	18-083	Shakhraz	Laskar	429.3
	18-081	Pasikhan	Nokhaleh	751.2
	18-021	Shafarood	Ponel	344.3
	18-019	Chafroud	Rudbarsara	131.7
	18-095	Bahmber	Aghamahaleh	150.6
	18-067	Morghak	Imamzadeh Shafi	235.7
	18-065	Khalkai	Toskooh	215.9
	18-089	Palangvar	Kalsar	227.0
	18-063	Masulehroudkhan	Kamadol	223.7
	17-053	Siahroud	Behdan	147.2
Right Side of Sefidrud River	17-055	Nisam/Disam	Pashaky	143.3
	16-063	Shamrud	Golnaran	162.5
	16-099	Langarrudkhan	Anzalimahale	254.0

Based on the observed discharge data, the annual total runoff amount of the SIDN Area located on the left and right side of Sefidrud River are estimated 1,850 MCM and 520 MCM respectively as illustrated in Figure R 8.7.3.

Figure R 8.7.3 Annual Runoff Volume of SIDN

3) Land Use Information

Through WRMC, MOJA provided the Study Team with the land use map of SIDN on GIS database that is the same accuracy as the information of upper basin. The extended area for the analysis of SIDN is delineated by the red colored line in Figure R 8.7.4.

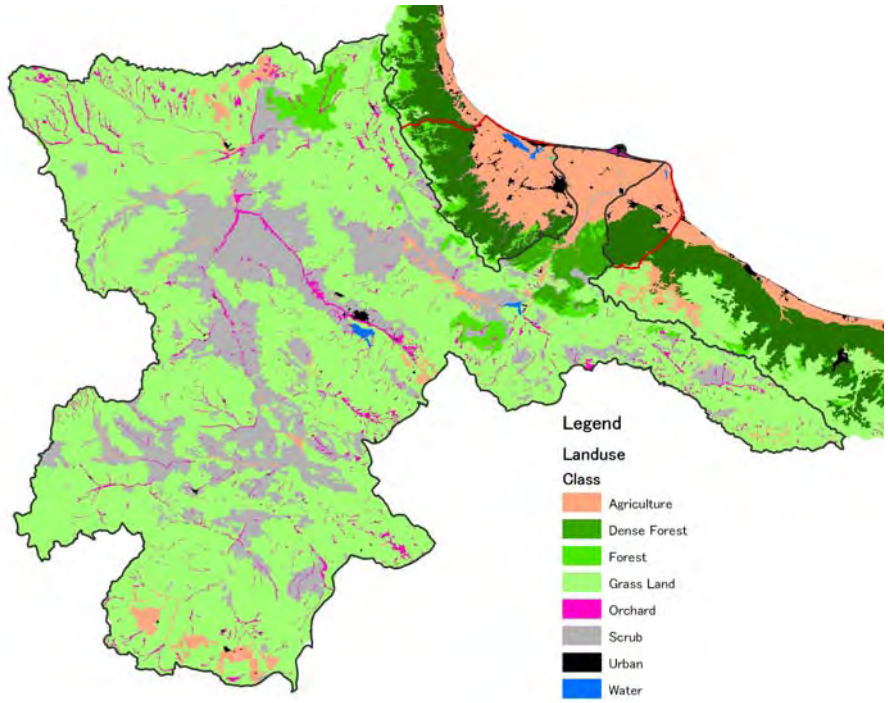


Figure R 8.7.4 Land Use Map of SIDN

8.7.3 Model Calibration

Based on the conditions described in foregoing section, the time series data of runoff and recharge calculated by Sefid-WBSM(MIKE SHE) was input to Sefid-WASM (MIKE BASIN) by which the annual average total runoff of SIDN are estimated matching up to the observed that as shown in Figure R 8.7.5. Although the observed flow discharge time series data is such patchy information that the observed secular change can not compare with the simulation result, the model of SIDN area also keep the equivalent accuracy with the upper basin model because of the high distribution density of rainfall station and small number of missing data compared with the condition of the upper basin.

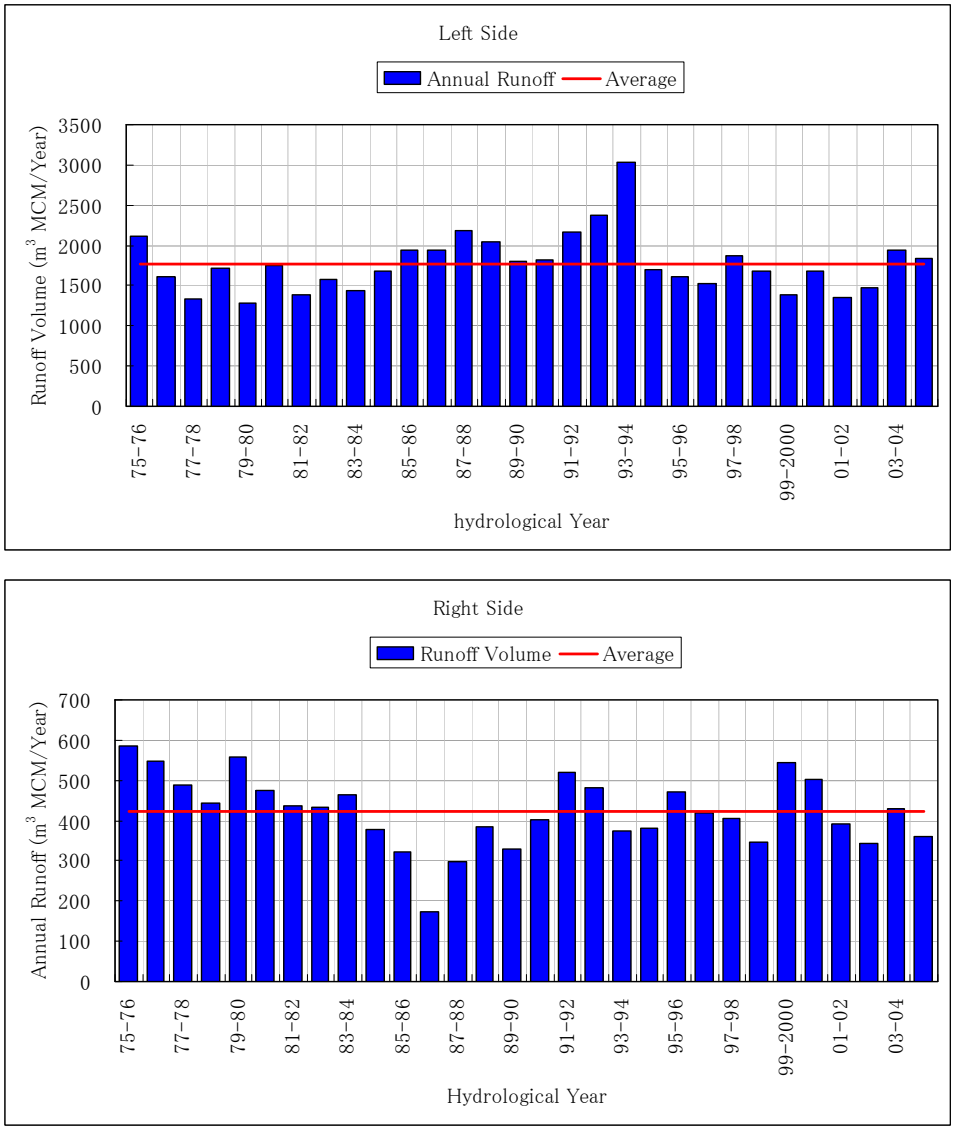


Figure R 8.7.5 Calibration Result

In addition, the simulation result of right side of SIDN is rather smaller than the observed annual average total runoff, which is caused by the complex boundary condition of a hydrological aspect between Gilan alluvial fan and Caspian Sea. To improve of the accuracy of model, the runoff characteristic of surface and ground water condition should be grasped for the arranging the model parameters based on the long term observation at the top and edge of the alluvial fan.