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 II Summary

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

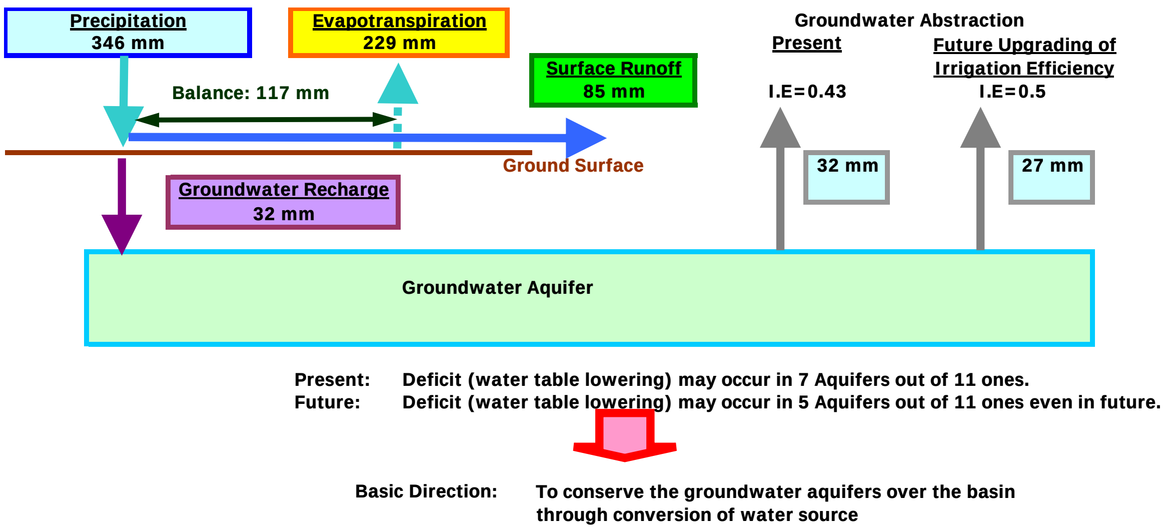


Figure 1 Water Balance and Water Resources Potential

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

<table>
<tr><td></td><td></td><td colspan="2">Overwhelming in Agriculture and Stock Raising</td><td colspan="2">Industries and Commerce Developed</td></tr>
<tr><td>Majority is Non-Persian Speaking Ethnicities</td><td>Upper Reaches</td><td colspan="2">Ardebil, Kordestan, Zanjan</td><td colspan="2">East-Azarbaijan</td></tr>
<tr><td rowspan="2">Majority is Persian Speaking Ethnicities</td><td>Lower Reaches</td><td colspan="2">Gilan</td><td colspan="2">—</td></tr>
<tr><td>Others</td><td>-</td><td colspan="2">Qazvin</td><td>Tehran</td></tr>
</table>

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.

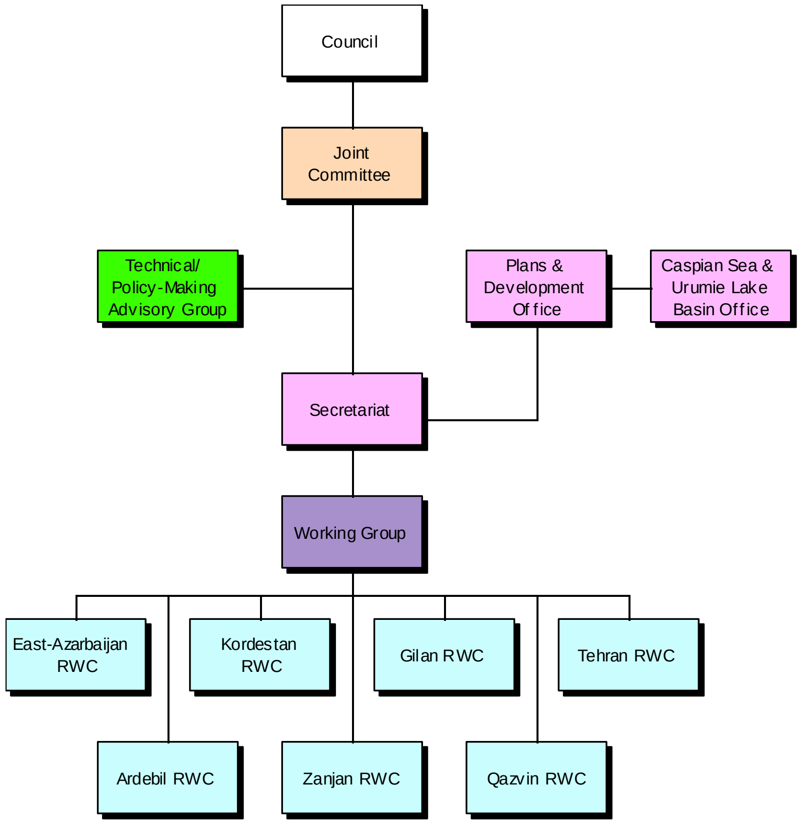


Figure 3 Organizational Structure of the RBO

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

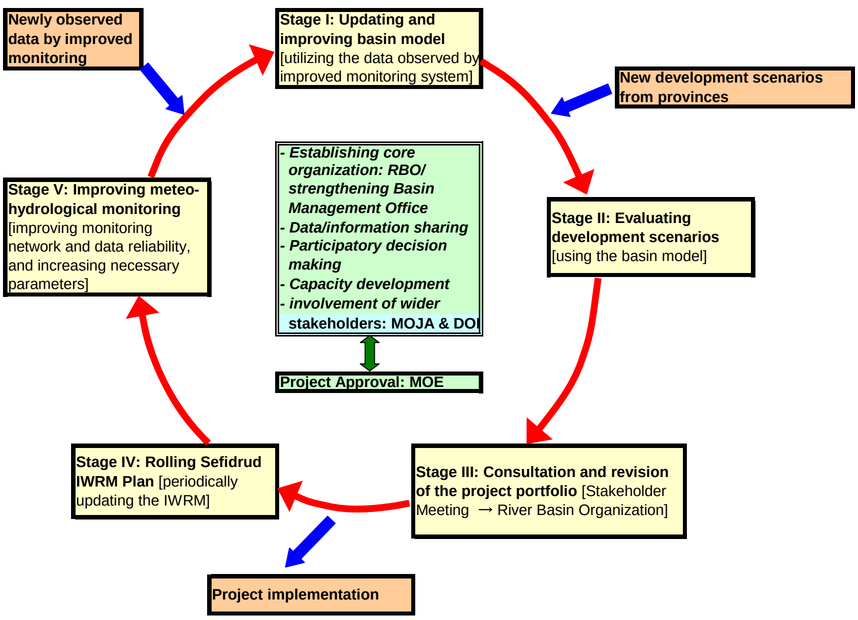


Figure 4 Conceptual Management Process in the Sefidrud IWRM

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.

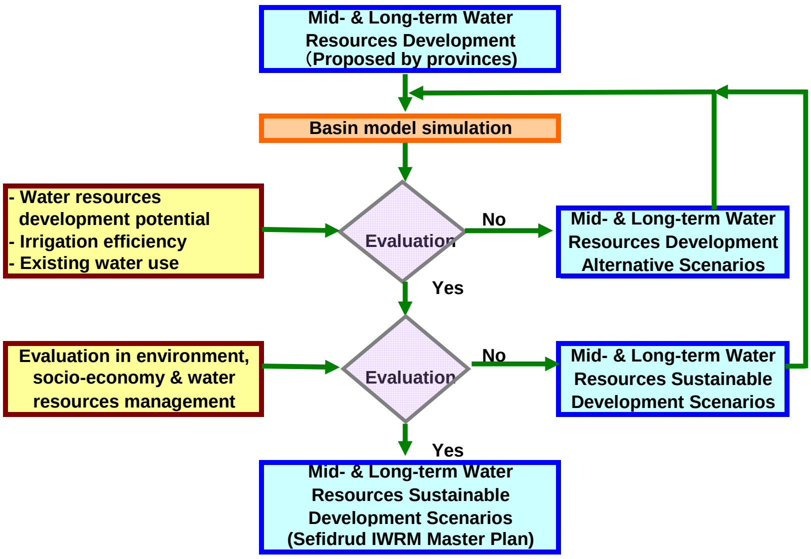
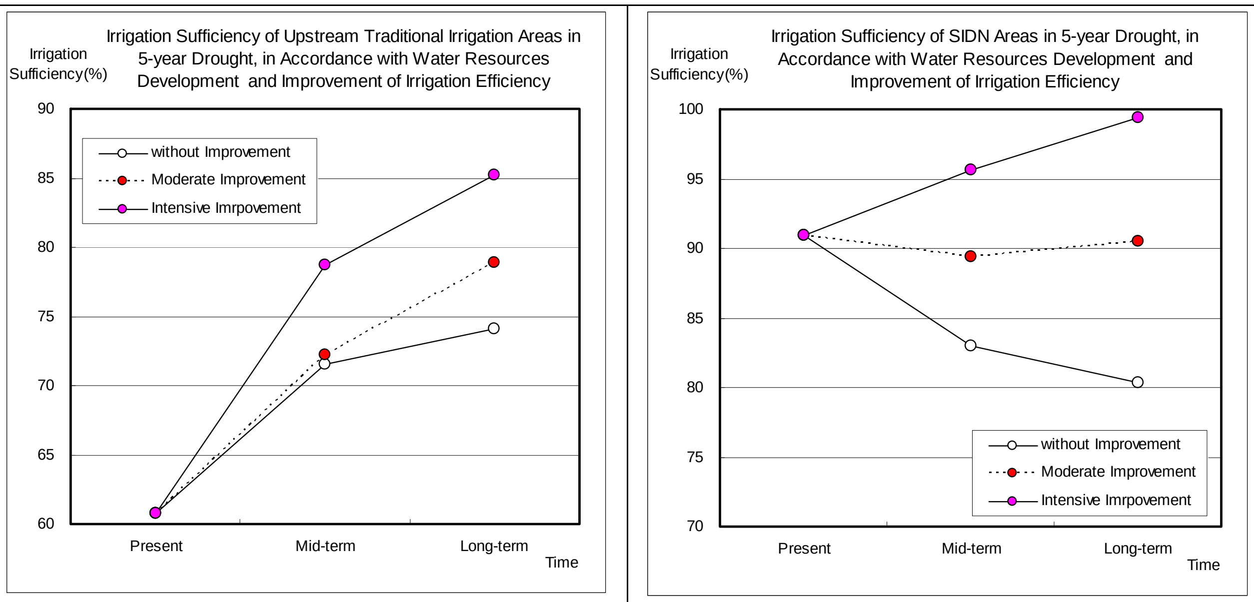


Figure 5 Planning Approach for the Formulation of a Sustainable Sefidrud IWRM

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.



Traditional Irrigation Areas : 5-year Drought SIDN : 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.

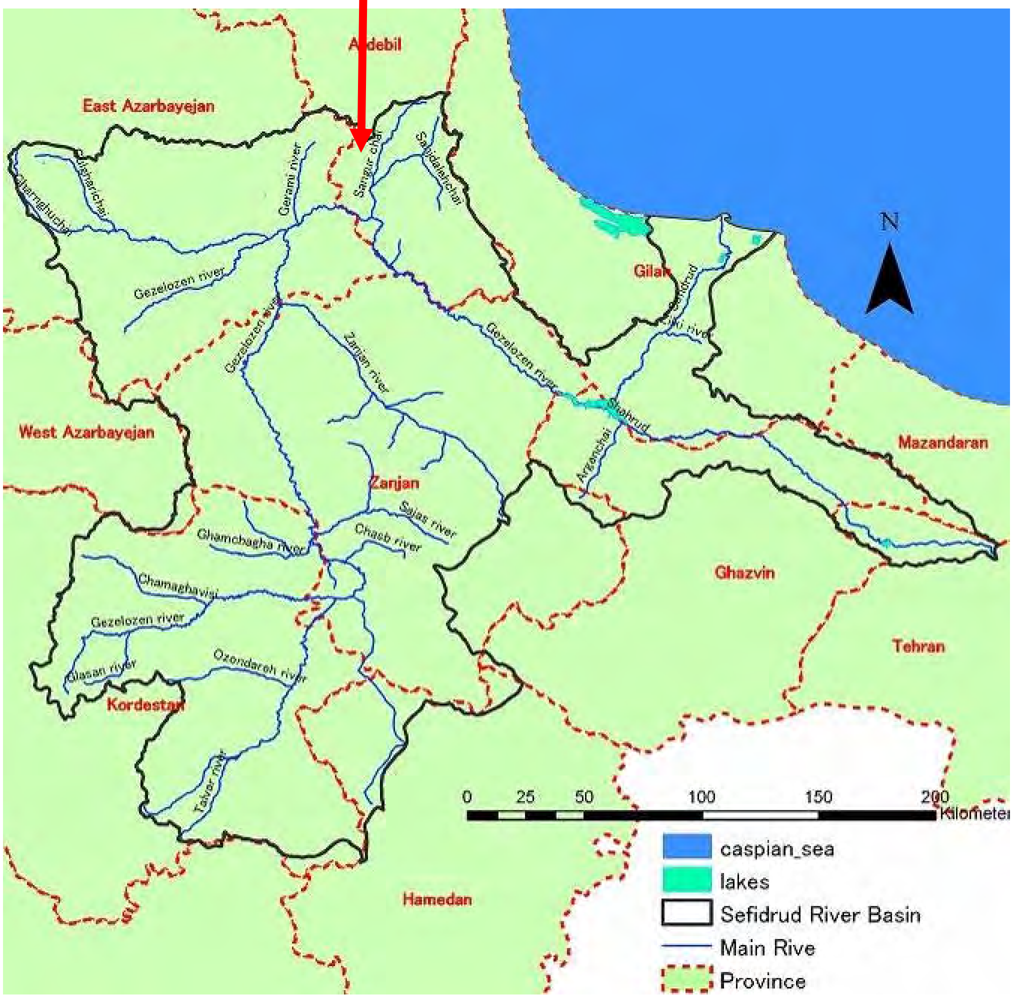
Regarding environmental flow, since flow regime at the major monitoring points would be improved in parallel with water resources development projects, the environmental flow could be secured in comparison between 10% of AAF as tentative criteria proposed by WRMC and the improved flow regimes of 90% 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.

GENERAL MAP



LOCATION MAP OF THE STUDY AREA

ABBREVIATIONS

C/P	:	Counterpart Personnel
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	:	Ministry of Energy
MOJA	:	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 in 2002)
WRM	:	Water Resources Management
WRMC	:	Water Resources Management Company
WUA	:	Water User Association
WWC	:	Water and Wastewater Company

Units of Measurement

(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

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1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

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 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.

The Government of Iran officially requested technical assistance from the Government of Japan for the formulation of an integrated water resources management plan for the Sefidrud River Basin in 2004. In response to this request, the Government of Japan dispatched a Preparatory Study Team in February 2007 and, based on the Scope of Work (S/W) agreed upon and the Minutes of Meeting (M/M) between both sides, the JICA Study Team was dispatched to Iran to start the Study from August 9, 2007.

1.2 OBJECTIVES OF THE STUDY

The objectives of the Study are:

(i) To formulate a Master Plan (hereinafter called as "the M/P") of water resources management for the Sefidrud River Basin in Northwest Iran; and

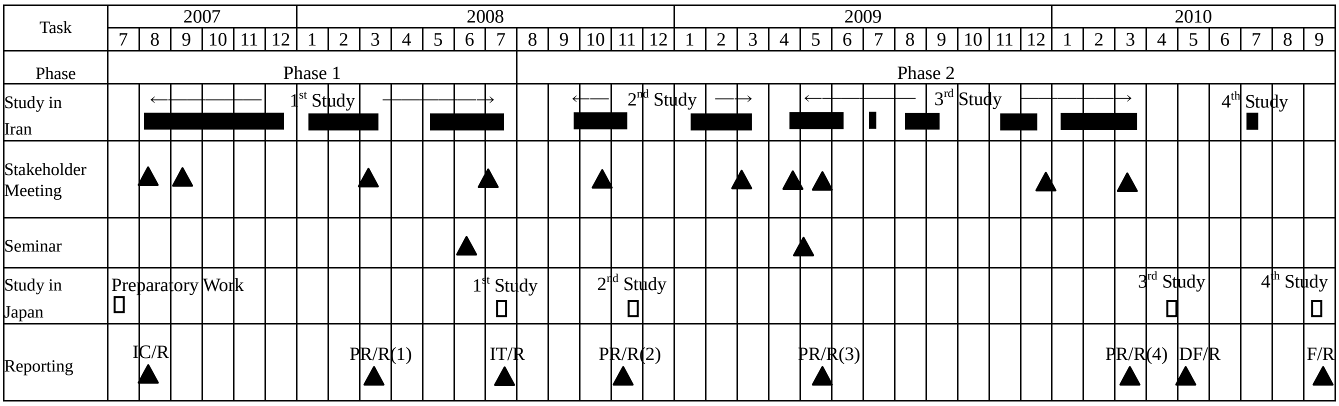
(ii) To transfer technology and conduct training on integrated water resources management to the counterpart personnel in the course of the Study.

1.3 STUDY AREA

The Study Area is the Sefidrud River Basin of 59,090km^2 covering the eight (8) provinces of Zanjan, Kordestan, East Azarbaijan, Gilan, Qazvin, Ardabil, Hamedan and Tehran.

1.4 STUDY SCHEDULE

The Study Schedule is as shown in Figure 1.1.



Legend: IC/R: Inception Report; P/R: Progress Report; IT/R: Interim Report; DF/R: Draft Final Report; F/R: Final Report
Phase 1: Basic Study
Phase 2: Formulation of Integrated Water Resources Management M/P

Figure 1.1 Study Schedule

2. SOCIO-ECONOMY IN IRAN

2.1 POPULATION

According to statistics, the population of Iran had increased drastically from 1958 when the first Census was taken, until 1993. However, population growth had slowed down from 1993 up to the present. Since the population of Iran was projected to be 70.5 million in 2006, the average increase for 10 years from 1996 to 2006 could be 1.62% per annum, and the population of Iran will likely increase at a similar rate in the future.

2.2 VALUE-ADDED AND GROSS DOMESTIC PRODUCT (GDP)

Iran is now in the course of its Fourth Economic, Social and Cultural Development Plan for 2005 to 2009 (hereinafter referred to as "the 4th Development Plan"). The growth of GDP had progressed at quite a high rate, i.e., 25.6% of the annual average. However, in case of the 1997 constant price level, the real growth rate changed at only 4.3%. This means that prices have been increasing at quite a high rate up to the present.

Table 2.1 Fluctuation of GDP in Iran and Its Annual Average Growth Rate

(in 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.

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

The inflation rate in Iran during the 1980's to the former half of 1990's was quite high at more than 20% per annum. After the year 2000, it became rather low compared to the 1980's, at around 15%. This rate was, however, considered as a high rate.

2.3 RELATED LAWS, STRATEGY, AND ORGANIZATION FOR WATER RESOURCES MANAGEMENT

2.3.1 Laws and Regulations

Laws and regulations closely relating to water resources management are summarized in Table 2.2.

Table 2.2 Water-Related Laws and Regulations

No.	Name of Law/Regulation	Year Issued
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	Promotion of Investment in Water Projects	2002
6	Preservation and Maintenance of Groundwater Resources	1966
7	Water and its 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

Source: WRMC

Among the above laws and regulations, the Fair Water Distribution Act, Water Allocation Law, Articles of Association of Iran Water Resources Management Specialized Mother Company, Farming Water Fee Law, and the Law on Promotion of Investment in Water Projects in Iran and its enforcing Bylaw are quite significant concerning the fair management of water resources.

<u>Fair Water Distribution Act</u>

The "Iran Water Law and the Manner of Water Nationalization" was enacted in 1968. After the Islamic revolution, the law was amended in 1983 as the "Fair Water Distribution Act." It consists of 52 Articles and 27 Notes, and is the most basic law on water resources management nullifying regulations that disagree with its provision.

<u>Water Allocation Law</u>

The "Water Allocation Law" was promulgated based on Articles 21 and 29 of the "Fair Water Distribution Act" and Article 1 of the "Energy Ministry Establishment Law" in line with the implementation of the 4th National Development Plan in 1983. The law consists of 21 Articles and 5 Notes.

<u>The Articles of Association of Iran Water Resources Management Specialized Mother Company</u>

The objective of establishing this company (WRMC) was to arrange the activities under the management of the Water Affairs Department of the Ministry of Energy, including organization and direction, including technical, engineering, legal, financial and administrative support of the subsidiary companies to recognize, study, develop, conserve and operate water resources and installations efficiently, and to exploit hydropower energy and operate the related systems. The law was enacted in 2003 and consists of 21 Articles and 5 Notes.

<u>Farming Water Fee Law</u>

This is the water fee law for agriculture promulgated in 1980. Water fees vary depending on the condition of the irrigation system. The law consists of 3 Articles and 2 Notes.

<u>The Law of Promotion of Investment in Water Projects in Iran and its Enforcing Bylaw</u>

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

2.3.2 Development Strategy

Among the laws listed in Table 2.2, the "Long-Term Development Strategies of Water Resources" was the basis of national water management. The Master Plan formulated in the Study considered the following basic directions stipulated in the strategies:

(iii) The utilization of Iran's water resources in each basin must be planned in such a way that the volume of 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.

(iv) The irrigation efficiency must be improved up to two times so that agriculture water demand will decrease from 92% to 87% within the coming 20 years. Efficient consumption of water shall be required and crops of economic value shall be allocated. In turn, priority shall be given to (1) drinking and hygiene; (2) industry and service; and (3) gardening and agriculture.

(v) In provincial water resources development plans, basins must be considered as effective territories in the economic and social development of the province.

2.3.3 Organization

1) WRMC

The main task of MOE consists of water resource management, power supply, other energy supply and training of human resources. Eight (8) organizations were established as legal independent entities, and WRMC and WWC are among those organizations.

The WRMC was established as a legal and independent entity in 2003 in accordance with "The Articles of Association of Iran Water Resources Management Specialized Mother Company." Its major task as representative of the Ministry of Energy is to enforce the Fair Water Distribution Law and other rules and regulations related to water, including planning and development, management and control of water resources, basic researches on water resources, and hydropower.

2) RWC

RWCs are established in every provincial capital as the regional organization of WRMC to conduct water resources management for each province, taking over the function of RWA (Regional Water Authority) as the water management organization in each province in 2006.

The major tasks of RWC are: to conduct planning, development, conservation and utilization of water resources (surface water and groundwater); to operate and maintain water utilization facilities; to prepare water distribution plans; to issue permissions on the use of water (water rights) including the construction of wells; and to conduct river protection and maintenance.

RWCs, by themselves, can act on proposals for small-scale projects possible within their budget. In case of important projects and insufficient budget, proposals are endorsed to the WRMC and in case of much more important projects and insufficient budget of WRMC, proposals are further endorsed to MOE, considering technical, economic, social, environmental and political points of view. The processing of applications for water rights is made by RWC, and the final permission is given by MOE.

RWC discusses the proper allocation of water with the related agencies such as MOJA, UWWC and RWWC. The basic demarcation for management is the provincial border. The Sefidrud River Basin encompasses eight (8) provinces and each province maintains and secures its own water resources utilization.

The management of the whole river basin is quite difficult under the present system, and it causes conflicts among the related provinces although WRMC as the representative of MOE coordinates stakeholders to balance the benefit throughout the country.

3) River Basin Management Organization

The Sefidrud River Basin encompasses eight (8) provinces as mentioned before. The organizations placed in each province are as given in Table 2.3. The Office of Watershed Management for the Sefidrud River Basin is placed under MOJA in Zanjan.

Table 2.3 Governmental Organizations of the Water Sector in Iran

Central Government	Responsible Divisions	River Basin Unit	Regional Offices	Branch Organization
Ministry of Energy (MOE)	WRMC, WWC	None	RWC, RWWC	-
Ministry of Jihad Agriculture (MOJA)	FRWMO	Office of Watershed Management for the Sefidrud River Basin	Provincial Jihad Agriculture (PJA)	Water Users Association (WUA)

River basins in the country are managed by the Deputy of Coordination of River Basin Management, WRMC. There are six major river basins in Iran classified into four management divisions. Basin name and divisions are as given below.

Basin 1 & 2 : Caspian Sea and Urumie Lake

Basin 3 & 4 : Gharaghoum and Eastern Boundary

Basin 5 : Central Plateau

Basin 6 : Persian Gulf and Oman Sea

The Sefidrud River Basin belongs to Basin 1 & 2: Caspian Sea and Urumie Lake. The management of Caspian Sea and the Urumie Lake involves two groups, namely; (1) the programming group; and (2) the coordination, evaluation and supervision group. The TOR on river basin management consists of 19 Articles and all of them are useful and effective. Some of these articles are very useful for solving conflicts.

The management responsibilities are as shown below:

- Determination of duties and methods of common surface and groundwater resources management among the RWCs in the river basins;
- Reformation and improvement of water management methods in river basins by the results of technical and social studies, particularly, through nonstructural techniques;
- Combination and integration of results of provincial unit activities in river basins;
- Provision of programs for research development and performance of research plans in integrated management and comprehensive water resources in river basins to coordinate and perform total supervision;
- Formulation of consistent rules for water use rights throughout the basin as integrated water resources management to promote regional development;
- Provision of total aspect of water supply and demand in river basins through clarification of regional potential of water resources and critical regions to further develop and prioritize regions;
- Recommendation and persistence in ratifying laws and new guidelines and reformation of law and current criterion within the framework of integrated water resources management;
- Settlement of confrontations about water allocation in river basins between local managers; and
- Formulation of integrated management concepts in river basins.

4) Operation and 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 industrial water, and water purification plants are constructed by the RWC. Secondary and tertiary canals are constructed by either RWC or MOJA. Quaternary canals are constructed by MOJA. Wells are constructed by the owner after permission by RWC. Although new qanat installations are very rare at present, the qanats are constructed by the owner or MOJA.

Dams, main and secondary canals, water transfer systems for drinking and industrial water, and water purification plants are operated and maintained by RWC. Some small dams and secondary, tertiary and quaternary canals are maintained by MOJA. Water distribution networks are maintained by UWWC or RWWC, and some purification plants are included. Qanat systems and wells are maintained by MOJA and the owners, respectively.

2.3.4 Water Right

Water right is classified into customary and licensed rights.

1) Customary Water Right

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

2) Licensed Water Right

This water right is acquired with the permission of MOE in accordance with Article 21 of the "Fair Water Distribution Act (1983)." The water right application is submitted to RWC and finally approved by MOE. The order of priority of water right is drinking, industry and agriculture, as stated in the "Long-Term Development Strategies for Iran's Water Resources (2003)." The priority of water right in Gilan Province is, however, drinking, agriculture and industry in that order.

Although there is no law that allows people in upstream to take water from the river by priority, the water is advantageously taken from upstream, traditionally. If water right is permitted, taking water from river is possible within an allowable range. Rotating equivalent distribution management is applied in areas where modern facilities are provided. Water fees for drinking, industry and agriculture vary every year and contract with RWC is renewed every year as well.

2.3.5 Environmental Laws and Institutional Frameworks

Iran has established a comprehensive legislative foundation for environmental policy. 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. Headed by the President of Iran, the Environmental High Council (EHC) decides environmental policies and strategies, and approves environmental standards. The Constitution of Iran, domestic laws, regulations and by-laws, as well as international environmental conventions, treaties and agreements comprise the legal framework of environmental protection and management in Iran. The competent body for Environmental Assessment as defined in Decree 138 of December 4, 1994 is the Department of Environment.

1) 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 financially independent corporate body functioning under the supervision of EHC, and the Vice-President of Iran is the Chairman. Along with its provincial environmental offices, the DOE is the principal environmental protection agency with mandate to monitor implementation of environmental policies and to enforce relevant laws and regulations. DOE is also functioning as the Secretariat of EHC.

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 according to "The Environmental Protection and Enhancement Act (1974)." The DOE processes the EIA reports and gives its recommendations to the government directorate responsible for the project. In case project execution is found inconsistent with the recommendations of the DOE, the DOE notifies the ministry concerned and any controversy is resolved by the decision of the President of Iran.

The DOE is the competent authority for approving EIA reports as defined in Decree 138, under the authority of the Environmental High Council (EHC). 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; and
- Controlling pollution and preventing any disturbance in the environmental balance.

2) Environmental Impact Assessment System

As mentioned above, the competent body for Environmental Impact Assessment (EIA) as defined in Decree 138 is the Department of Environment, under the authority of the EHC. EIA in Iran was enabled by Note 82 of the Law for the Second State Economical, Social and Cultural Development Plan of 1994, as amended by Note 105 of the Third Development Plan.

The standard procedures for implementation of EIA were approved by the EHC through a collaborative project with the United Nations Development Programme (UNDP) in July 1997. According to the EHC (1997) guidelines, the following national projects and programs are obliged to prepare and submit environmental evaluation and feasibility studies as well as EIA:

> Petrochemical Plants, Industrial Estates (more than 100 hectares), Forestation 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 Waste Landfills, and Solid Waste Incineration Plants

The standard procedure for national government projects is to submit the EIA report to the DOE, while projects under the provincial government is to submit the EIA report to the provincial office of DOE.

3. PRESENT CONDITIONS

3.1 POPULATION AND WATER TARIFF SYSTEM

3.1.1 Population in the Provinces Concerned

Table 3.1 gives a summary of the last population Census in 2006. As indicated in the table, the population in Tehran Province including the provincial capital, Tehran, overwhelms those of the other provinces.

Table 3.1 Population Trend in Provinces Concerned

Target Area (Province)	Area (km^2)	Population					Population Density as of 2006 ($person/km^2$)
		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 province.

3.1.2 Water Tariff System and Water Sources

Water tariff is regulated under the "Fair Water Distribution Act." The following tariffs are applied, in general.

Table 3.2 Water Tariff System

Agricultural Water	Domestic Water	Industrial Water	Groundwater
Modern Irrigation: 3% Semi-Modern Irrigation: 2% Traditional Irrigation: 1%	Metered Rate; Free for Rural Area	Fixed or Metered Rate	Fixed and Metered Rate; Free for Agriculture

Water use volumes by water source are as tabulated below. Water utilization volume from surface water is equivalent to the one from groundwater.

Table 3.3 Share Rate of Water by Water Source as of 2006

Water Source	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 Groundwater such 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

3.2 TOPOGRAPHY AND GEOLOGY

Iran is located on the Eurasian Plate and borders with the boundary of the Arabian Plate. The Zagros Mountains are the Thrust Mountains formatted on its border and may be the cause of earthquake activities in Iran.

The Study Area (see Figure 3.1) consists of plains facing the Caspian Sea and the plateau between the Alborz and Zagros mountains. This area is composed of the plateau with an elevation of 1,500 to 2,000 m, and the mountain region with an elevation of 2,500 to 3,000 m. As for the geology in this region, fans, terraces and alluvial deposits are distributed, and Pyroclastic rocks of the Karaj Formation in Tertiary are distributed in Zanjan Province, together with a part of intrusive rocks of granites and porphyrite. Tertiary rocks are distributed in the mountains in Kordestan. Topography in the southwestern part of Kordestan is mountainous region with an elevation of 3,000 to 4,000 m, and Various limestone in Mesozoic Era is widely distributed.

The distribution area of limestone and lava has high permeability, and precipitation is easy to infiltrate into the ground compared with the other rocks. This characteristic is the same in the distribution area of recent river, terrace and fan deposits that are composed of sand and gravel with clay.

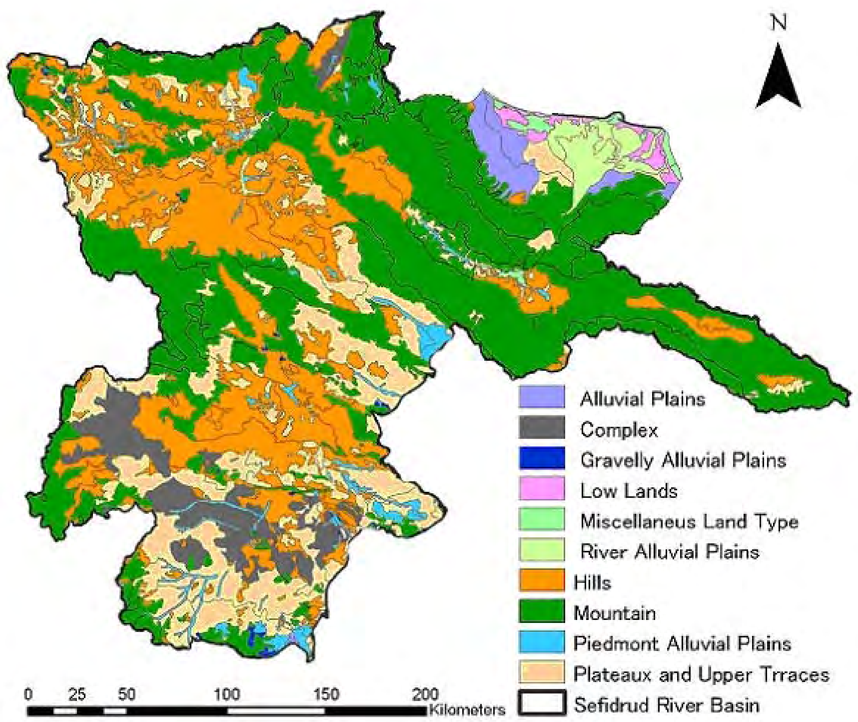


Figure 3.1 Topography of the Sefidrud River Basin

Geology in the Study Area could be divided into four, as shown in Table 3.4 together with the topographic characteristics.

Table 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 2,750 m.	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 elevation of 1,500 to 2,000 m, and the mountain region with elevation of 2,500 to 3,000 m.	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 elevation of 3,000 to 4,000m.	Various limestone in Mesozoic Era is widely distributed.

3.3 METEOROLOGY

The annual average precipitation in areas between the Caspian Sea and the Alborz Range (the northern part of Sefidrud River Basin) is estimated to be more than 1,000 mm, while it is from 200 mm to 400 mm in the southern part. More than 90% of the averaged annual precipitation in the southern part occurs during the seven months between November and May. On the other hand, at the northern Alborz, the seven months from September to March is considered as the pluvial period, although there is no clear variation of precipitation pattern.

The annual evaporation in the south of the Alborz range is approximately 2,000 mm, which is about 4 to 8 times of the annual precipitation, while it is estimated at less than 1,500 mm in the northern area. The value of evaporation measured by pan with the influence of wind and humidity could be equivalent to 70% of that under natural conditions in the semi-arid area such as the Sefidrud basin. Since this evaporation originates from water contained in the ground subsurface, all amounts of precipitation could not change to vapor.

These meteorological features are summarized in Table 3.5.

Table 3.5 Weather Condition in the Sefidrud Basin

Area	Precipitation (mm)	Evapotranspiration (mm)	Temperature (^{o}C)
1) North of Alborz (Facing Caspian Sea)	More than 1000mm; From Sep. to Mar. may be rainy season.	Less than 1,500mm	Min.: around 8^{o}C in February; Max.: around 25^{o}C in August
2) South of Alborz	200～400mm Rainy season：Nov. to May Dry season：Jun. to Oct.	2,000mm	Daily average temperature is less than 1^{o}C

3.4 RIVER AND HYDROLOGY

The Sefidrud River flows in the section 100 km from the Manjil Dam to the river mouth, and two main tributaries, Qezel Ozan River and Shahrud River, merge into the reservoir of the dam. The river system of the Sefidrud is presented in Figure 3.2, and salient features of the river system are summarized in Table 3.6.

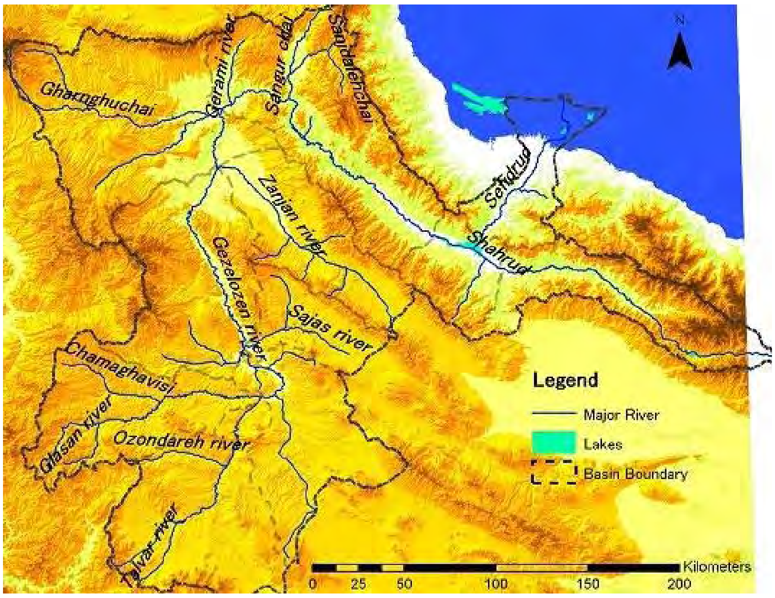


Figure 3.2 River System of the Sefidrud

Table 3.6 Salient Features of Major Rivers in the Sefidrud System

No	River	Catchment Area (km^2)	River Length (km)	Average Slope (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

The flow regime at major rivers is summarized in Table 3.7. The Qezel Ozan and Shahrud rivers are perennial streams, while some tributaries such as Zanjan and Gerami rivers are seasonal streams where no surface water is observed in the dry season.

Table 3.7 Flow Regime of Major Tributaries in the Sefidrud System

(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

The Qezel Ozan and the Shahrud rivers are the major tributaries flowing into Manjil Dam. A hydrograph (see Figure 3.3) was delineated using data collected at the Gilvan and Loshan stations. The river discharge starts to increase in February and reaches its peak in April, as shown below.

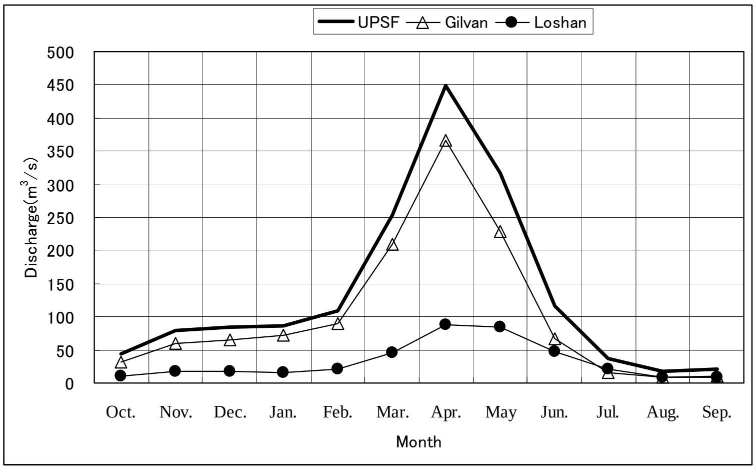


Figure 3.3 Monthly Discharge Hydrograph into Manjil Dam (UPSF: Total Inflow to the Dam)

Annual averaged runoff rate for the past 30 years was estimated at 0.22 as shown in Table 3.8, while it is less than half of the annual averaged runoff rate in the dry year between 1999 and 2001. Compared to the annual rainfall of the whole basin upstream of Manjil Dam, and the annual runoff volume and annual runoff rate, it is noticeable that the runoff rate dropped to a low value compared to the annual average when annual rainfall is below 300 mm.

Table 3.8 Annual Runoff Rate (Upstream of Manjil Dam)

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

3.5 HYDROGEOLOGY - GROUNDWATER

The possible geological layers to be aquifer in the Sefidrud River Basin are river deposits, fan deposits, and terrace of Quaternary deposits that consist of sand and gravel with clay. Other possible geology is limestone with holes and cavities. The former is called “Granular aquifer” and the latter is “Karst aquifer.” According to the existing data, most of the aquifers are granular aquifers in the Quaternary deposits (hereinafter called “Quaternary aquifer”) in the Sefidrud River Basin. Limestone is distributed here and there, but only the Permian Ruteh limestone may have cavities. Details of the Karst aquifer are unknown.

The hydro-geological outline of each basin is summarized in Table 3.9 from the data of existing study and monitoring results. Location of monitoring wells and aquifers is as shown in Figure 3.4.

Table 3.9 Outline of Hydrogeology and Groundwater Monitoring System

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 Kalka: 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. However, 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*	*1,036*	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			155	176	219	-			

*1: MG Company "Report Vol. 2, 2-3 Groundwater", Q*2: Yield, T*3: Transmissivity: m^3/day/m, Qp*4: yield of production well
Source: Groundwater data of WRMC (2001)
Code 1308: Only one pumping test data is available from the WRMC data.
Note: Well means Test Well

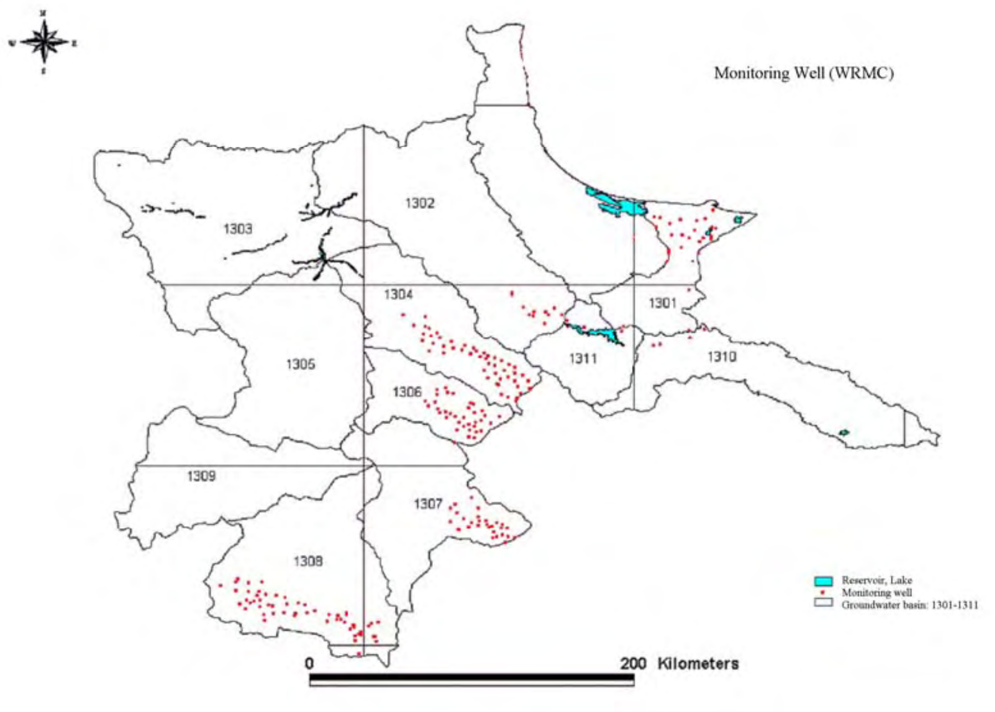


Figure 3.4 Location of Aquifers and Observation Wells

Clarification of the following three elements is required to grasp the groundwater basin:

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

(ii) Essential factors: material of aquifer, permeability, transmissivity, etc.

(iii) External factor: meteorological and hydrological conditions (related to groundwater recharging)

The monitoring quantities shown in Table 3.9 are quite few considering the stretch of each basin area. The stretch of Quaternary layer that becomes Quaternary aquifer has to be investigated by geological map and GIS. The meteorological and hydrological data are also mostly clarified by hydrological analysis in each basin, but the shapes of depth were hardly investigated because of insufficient test wells and electric resistivity surveys. The essential factors (material of aquifer, permeability, transmissivity, etc.) were also hardly investigated because of insufficient pumping tests.

Groundwater usage has to be broadly divided into three intake facilities, namely; well, spring and qanat. The WRMC data and groundwater usage updated by Mahab Ghodss Company in 2003 was investigated, and the results are shown in Table 3.10. The usage of wells and qanats has decreased slightly from the WRMC data, but spring water usage has slightly increased. The total groundwater usage from the WRMC data in 2001 had increased to 204 million m^3/year.

Table 3.10 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 has been reported that the groundwater table (GW) is 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 decrease: -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 decrease: -3.0m (1996-2001)
Goltapeh-Zarinabad	1307	Kordestan	56.58	91.06	25.02	172.66	
Ghorveh-Dehgulan	1308	Kordestan	35.5	40.63	11.24	87.37	GW decrease - Ghorveh: -5.54m Dehgulan: -9.61m (1997-2002)
Divandareh-Bijar	1309	Kordestan	35.28	23.00	4.38	62.66	
Taleghan-Alamut	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	

Source: Mahab Ghodss (Vol. 2, 2-3 Groundwater) and the JICA Study Team

3.6 WATER QUALITY

3.6.1 River Water Quality

River water quality is monitored by WRMC at 99 points. The water quality monitoring stations are located at the same points as the hydrological monitoring stations. Water quality indexes monitored by WRMC are mostly positive and negative ions. Common water quality index for rivers and lakes like BOD, COD, DO, SS, coliform, Total-N, Total-P and some other harmful materials are not examined.

Water quality index monitored by WRMC:
Potassium ion (K^+), Sodium ion (Na^+), Magnesium ion (Mg^{2+}), Calcium ion (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)

Water is relatively alkaline since average pH value ranges from 7.7 to 7.9. This is beyond the recommended pH value of 6.0 to 7.5 for irrigation water.

Since surface water is used for agriculture, damage by salt is evaluated by the density of Cl ion. The average concentration of Cl at the monitoring stations normally ranges at less than 10 mg/l although 25 mg/l was observed as high data. Furthermore, the maximum Cl concentration at all of the stations is less than 70 mg/l. According to Kagawa Agricultural Division in Japan, rice or other agricultural products will be affected by salt when irrigation water contains Cl of 200-250 mg/l or more. Since the average concentration is lower than such range, even the maximum data could be regarded as low risk of damage by salt.

The mean value of total dissolved solids (TDS) exceeds 500 mg/l, and it is difficult to specify the organic load origin or the inorganic load origin without BOD data. Based on the general condition that river valleys are prone to sediment runoff and domestic wastewater is discharged to rivers without treatment, both organic and inorganic loads are considered to be high.

In addition, the stations observing high concentration of Cl show, simultaneously, high TSD concentration of more than 2,000 mg/l, for instance. This phenomenon might be caused by the geological feature of Marl.

3.6.2 Groundwater Quality

Water quality indexes for groundwater measured by WRMC are mostly positive and negative ions. Harmful materials, which sometimes cause a problem in groundwater like Cadmium (Cd) and Arsenic (As), are not monitored in the Sefidrud River Basin. Sodium and Chloride of all samples are lower than the drinking water standard of WHO.

3.7 NATURAL AND SOCIAL ENVIRONMENT

3.7.1 Natural Environment

There are four (4) National Natural Monuments, four (4) Wildlife Refugees, and five (5) Protected Areas, as indicated below.

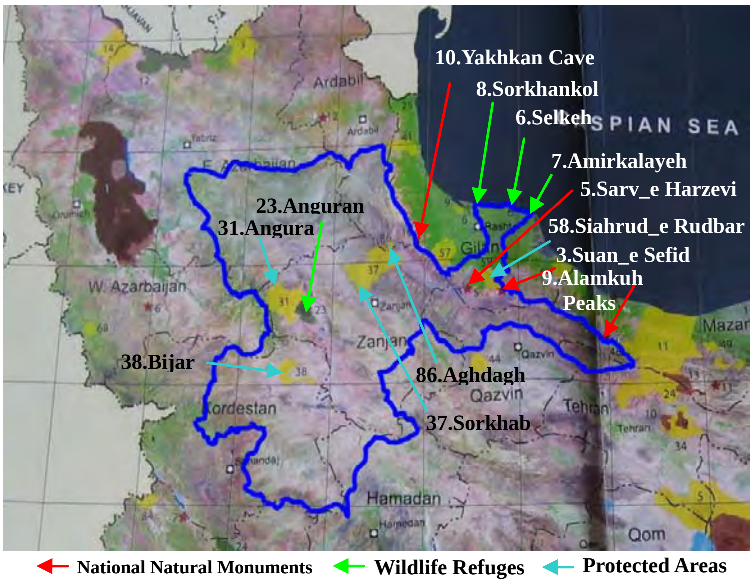


Figure 3.5 Protection Areas on Natural Environment in the Sefidrud Basin

Most of the endangered species in the basin are birds, snakes and wild animals. Only the Spur-thighed tortoise living in the Aghdagh protected area is designated as vulnerable species.

At 100 km upstream of Sefidrud River from the Caspian Sea where Gezelozen and Shahrud rivers join and change the name into Sefidrud, there is Manjil Dam. Manjil Dam has no fish-ladder, which deters the migration of fish. Thus fish species change drastically at the boundary of Manjil Dam.

In the lower reaches of the dam, many kinds of Carps, Mullet, Herring, Salmon and Pikes, which are dominant species in the Caspian Sea, make their habitat. Furthermore Sturgeons and other fishes living in the Caspian Sea go upstream on the Sefidrud for spawning. On the other hand, some rivers upstream of Manjil Dam have fewer flow of water than those downstream of the dam. Due to insignificant flow, the number of fishes is remarkably smaller than in the downstream of the dam. Carps and Catfish are the main creatures living in the upstream rivers.

3.7.2 Social Environment

Number of workers as the ratio of work category in each province is presented in Figure 3.6. 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 work. As a whole, primary and secondary sectors of economy are predominant in all provinces except Tehran, while secondary and tertiary sectors of economy are predominant in Tehran.

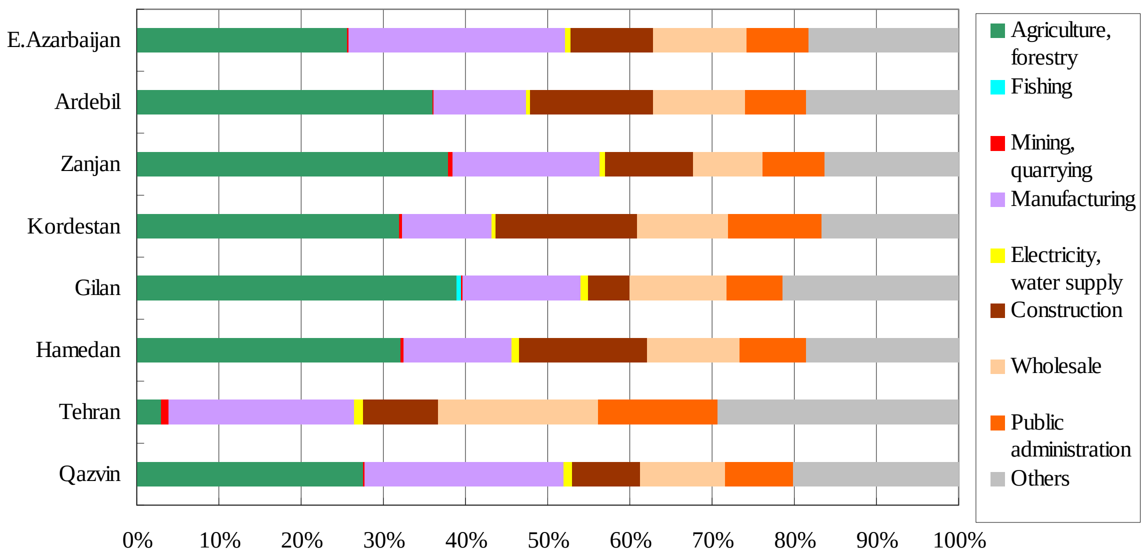


Figure 3.6 Ratio of Employed Population in Each Province

According to "Iran Nomad Tour," there are about 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, and move to the foot of mountains or other warmer places in winter. Livelihood is mainly farming and raising livestock like goat, sheep and camel. In the study area, it is said that some nomads live in the Zagros Mountains and in the mountainous areas of East/West Azarbaijan.

3.8 LAND USE

Land use map (see Figure 3.7) is prepared to analyze the satellite imagery of ALOS based on MOJA's land use map.

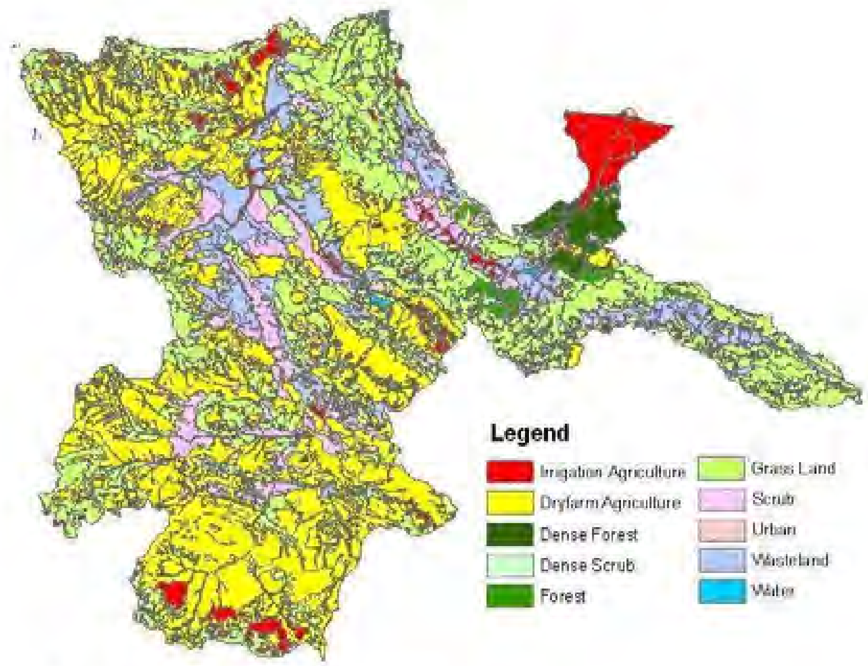


Figure 3.7 Land Use Map

3.9 AGRICULTURE

Agriculture is the fundamental economic sector in Iran, which accounts for about 26% of non-oil exports. Over 80% of foods are self-supplied, and 33% of the entire Iranian population or 68.5 million lived in the rural areas and worked for the agriculture sector in 2005.

3.9.1 Agricultural Area and Crops

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

Irrigated and rain-fed agricultural land is 2,101 thousand ha planted with wheat and barley (677 thousand ha), paddy (243 thousand ha), pulses (40 thousand ha), alfalfa (593 thousand ha), orchard (237 thousand ha). Wheat and barley are alternately cultivated with fallow every year. The cropping areas in each province are as given below.

Table 3.11 Cropping Areas in the Sefidrud River Basin and the Country

('000 ha)

	Ardebil		East Azarbaijan		Qazvin		Gilan**		Hamedan		Zanjan		Kordestan		Tehran		Total		
	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*	I*	R*	Total
Wheat	4.2	17.0	14.7	115.8	1.2	1.5	0.3	0.5	1.6	13.3	16.6	224.2	14.8	151.8	0.1	0.1	53.6	524.3	577.9
Barley	1.5	6.1	2.5	17.7	0.8	1.1	0.2	0.3	0.4	2.6	8.3	34.5	2.1	20.6	0.1	0.1	16.1	83.0	99.1
Paddy	0.3	1.2	2.1	14.8	0.9	1.1	209.0	3.5	0.0	0.0	1.8	7.5	0.03	0.1	0.1	0.1	214.2	28.2	242.5
Pulses	0.1	0.5	1.0	7.6	0.4	0.5	0.1	0.1	0.03	0.2	5.0	20.7	0.3	2.9	0.1	0.1	7.1	32.9	39.9
Alfalfa	7.7	30.0	21.5	166.5	0.6	0.9	0.2	0.3	1.7	12.0	27.3	114.9	18.6	189.1	0.8	1.0	78.5	514.7	593.1
Other Crops	5.2	21.7	9.7	72.2	3.8	4.7	1.2	38.7	0.7	6.0	15.2	58.2	6.4	65.6	0.6	0.8	42.8	267.9	310.7
Crop Total	19.1	76.5	51.5	394.7	7.7	9.9	211.2	43.4	4.5	34.1	74.2	304.5	42.2	430.1	1.8	2.3	412.2	1.451.0	1.863.2
Orchard	2.3	9.1	10.2	80.9	0.7	1.0	0.2	37.6	0.5	2.9	11.8	48.9	2.7	26.4	0.9	1.2	29.4	208.0	237.4
Total	21.4	85.6	61.7	475.5	8.4	10.8	211.3	81.0	5.0	37.1	86.0	508.9	45.0	456.5	2.8	3.5	441.6	1,659.0	2.100.6

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

Table 3.12 summarizes the major crop production areas in the Sefidrud basin and the whole 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 the whole 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 3.12 Cropping Areas in the Sefidrud River Basin and the Whole 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	577,901	99,053	242,463
%	4	8	5	52

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

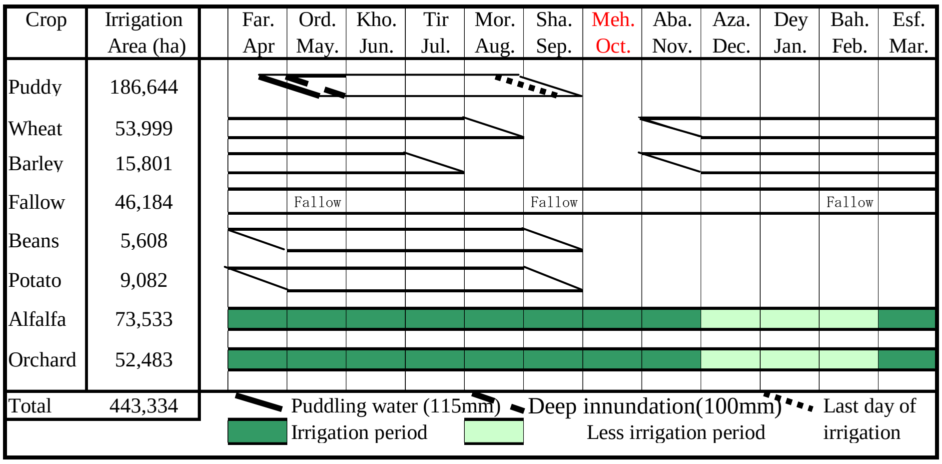
3.9.2 Cropping Pattern

The cropping pattern for major crops is summarized in Figure 3.8 based on the WRMC/MG report and the on-site interview. The cropping pattern in the upstream provinces, in particular, the patterns in Zanjan, Kordestan and East-Azerbaijan are mostly the same. The cropping pattern for rice is represented by the one in Gilan.

1) Cropping Pattern

a) Cropping Pattern for Rice

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



Source: WRMC and on-site interview

Figure 3.8 Representative Cropping Patterns

b) Cropping Pattern for Wheat and Barley

Wheat and barley are not planted in the same field every year, and are planted alternately with an equivalent fallow area. The fallow area is thus a prerequisite in areas with limited water resources. The yield of rain-fed wheat and barley varies year by year depending on the amount of precipitation. Wheat and barley are planted in November; wheat is harvested mostly in July and August, while barley is harvested one month before the wheat.

c) Cropping Pattern for Alfalfa

Alfalfa, i.e., the major feed crop in the basin, distributes in the eight provinces concerned. Alfalfa is an annual crop, and 85% of the crop is irrigated and harvested 3 to 4 times a year.

d) Cropping Pattern for Beans and Potato

Potato and beans, excluding the rain-fed chick pea, are irrigated annual crops. They are planted in April and harvested in September. Cropping calendar for other pulses and vegetables are mostly the same as the one for potato and beans.

e) Cropping Pattern for Orchard

Orchards including fruits are perennial crops, but replanting is necessary in every 20 years in general because of yield reduction and difficulty in harvesting. The irrigated orchards are apple, olive, apricot, pear, cherry, peach, pomegranate, grape, etc., while oranges, tea, mulberry, nuts, etc. are rain-fed.

2) Agricultural Machinery

Agricultural machinery is essential to support the cropping pattern. According to the statistics in the 8 provinces concerned, one tractor is deployed for every 4 ha in Gilan, 5 ha in 3 provinces (East-Azarbaijan, Qazvin and Tehran), and 6-8 ha in the remaining provinces.

Tiller is dominant in Gilan and deployed at an average rate of one tiller per 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.

3.9.3 Current Situation of Irrigation and Its Improvement

1) Long-Term Irrigation Plan

The Ministry of Energy formulated long-term strategies for water resources development in 2003 which declares a reduction of agricultural water consumption from 92% to 87% in the 20-year plan. 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 introduced, 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 the reformation of irrigation water use.

2) 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 3.13. The province-wise overall irrigated area rate is 74% for Gilan (the highest), while the rate in the upstream provinces is remarkably low, for instance, 18% for East-Azarbaijan, 26% for Zanjan and 12% for Kordestan due to the late introduction of modern irrigated agriculture and the limited water resources.

Table 3.13 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

3) Definition of Traditional and Modern Irrigation Systems

The traditional and modern irrigation systems are defined as follows:

(i) Traditional Irrigation System:

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

(ii) Modern Irrigation System:

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

4) Irrigation Efficiency

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

WRMC/MG estimated the present overall irrigation efficiencies (which consist of intake, conveyance, distribution and field application efficiencies) at 0.30-0.37 for the annual and perennial crops (orchard) in the upstream of Manjil Dam. Future irrigation efficiencies after improvement with a modern irrigation system are expected to be 0.50-0.71.

The present irrigation efficiencies in the downstream of Manjil Dam (single crop of rice cultivation) were reviewed and compared by WRMC/PANDAM, resulting in the following estimations:

- 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 had conceived a plan to improve the low efficiency of the traditional system with a total irrigation area of 52 thousand has in Central Gilan from 0.38 at present to about 0.50 in the future. The newly developed water is expected to be reallocated to the downstream rice fields which are difficult for irrigation water to reach. The improvement work is under construction. Eight small dams are also planned to be constructed by WRMC along the local rivers.

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

5) 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 pressurized irrigation systems. In Zanjan, modern pressurized irrigation systems installation has recently been going on at about 1,500 ha per year, and the total area improved has aggregated to about 8,000 ha. The efficiency of modern irrigation systems has thus improved.

The large scale irrigation facilities other than dams in the river basin are the irrigation facilities in Gilan. At the downstream of Manjil Dam, three large weirs are operational, namely; Tarik Weir with Fumanat Tunnel (L: 17 km, Qmax: 32 m^3/s); Gelerud Weir (design intake discharge: 25 m^3/s); and Sangar Weir (design intake discharges: 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. Stakeholders shall recognize the fact that development of new irrigated areas is possible, only after creating surplus water volume through improvement of irrigation efficiency by conversion of the traditional system to the modern one. The necessary costs for the improvement of irrigation efficiency are as summarized below.

Table 3.14 Costs for Improvement of Irrigation Efficiency

Farmland	Trunk Facilities	End Facilities	Operation and Maintenance
Upland Farming	4,000 USD/ha	2,000 USD/ha	90 USD/ha
Rice Farming	1,500 USD/ha	500 USD/ha	40 USD/ha

Source: WRMC

6) Drought Records

Records of drought in the basin are available at Gilan RWC in terms of reservoir storage volume of Manjil Dam at the start of the irrigation season, as tabulated in Table 3.15.

Table 3.15 Drought in Manjil Dam

Drought 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.

3.9.4 Livestock

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

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) has progressed 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 the rural area are 2.2 heads/person in the basin and 2.8 heads/person in the nation. The annual gross unit irrigation water requirement for alfalfa in the basin is considerably 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.

3.9.5 Inland Fishery

The annual harvest of fish is 343,500 tons and 134,200 tons for marine fish harvested mainly in the Persian Gulf and for freshwater fish, respectively. The freshwater fish is produced mainly in the Caspian Sea region including Gilan. There are a number of water ponds in Gilan with the total area of 3,458 ha where warm water fish culture (carp, grass carp, etc.) is actively practiced. In the upstream provinces and hilly areas of Gilan, cold water fish culture (mainly rainbow trout) is practiced. Iran is reputed to export high quality caviar, but annual harvest of caviar decreased by more than 15% in one year from 2003 to 2004. WRMC is apprehensive about the recent rapid degradation of water quality in the Caspian Sea as well as the Sefidrud mainstream and local streams.

In response to the request from MOJA, WRMC had supplied considerable water to the Sefidrud River for sturgeons' spawning with higher priority than irrigation since 2005. The water discharges released were 2.4 m^3/s and 15-50 m^3/s for the sturgeons' hatching and for spawning, respectively. These are summarized below.

Table 3.16 Water Requirements for Sturgeon

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

Source: WRMC and Gilan RWC

Fishery in Gilan Province is shown in Table 3.17. Half of fishery is catch in Caspian Sea and the 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 or cold fishponds, which shares 91% of inland fishery. Fish catch in natural rivers and lakes is relatively small at 1.8 thousand tons, which is 9% of inland fishery and 5% of all fish catch in Gilan.

Table 3.17 Fishery in Gilan Province

(ton)

Year	Total	Caspian Sea	Inland Fishery			
			Total	Fish Culture -Warm Water	Fish Culture -Cold Water	Fish Catch 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.

3.10 DOMESTIC WATER AND INDUSTRIAL WATER

3.10.1 Water for Domestic Use

Domestic water consumption in 2006 has been estimated, as follows:

Table 3.18 Domestic Water Consumption in the Sefidrud River Basin

(MCM)

Category	Gilan	Zanjan	Kordestan	Ardabil	East Azarbaijan	Tehran Qazvin	Hamedan	Total
Urban	91.9	25.8	8.0	3.6	7.5	0	0	136.8
Rural	7.4	22.1	13.8	4.5	13.5	4.1	2.6	68.1
Sub-Total	99.3	48.0	21.8	8.1	21.0	4.1	2.6	204.9

Source: WRMC

3.10.2 Water for Industrial Use

The present consumption of industrial water for the main industrial areas studied by Mahab Ghodss is shown in Table 3.19.

Table 3.19 Industrial Water Consumption in Sefidrud River Basin

(MCM)

Gilan	Zanjan	Kordestan	Ardabil	East Azarbaijan	Qazvin	Hamedan	Tehran	Total
3.20	9.33	0.03	10.00	5.68	2.68	3.88	8.70	43.5

3.11 WATER RESOURCES DEVELOPMENT FACILITIES

There are a lot of small-scaled facilities for water resources development in the basin, as shown in Table 3.20. Most of these facilities utilize water for irrigation purposes, and the water of 3.6 billion m^3 per year has been developed. The total water volume of 1.9 billion m^3 per year (53%) is taken from groundwater including subsurface water, and 1.7 billion m^3 per year (47%) is taken from surface water. Qanat locations are indicated in Figure 3.9, as the example.

Table 3.20 Small-Scaled Facilities of Water Resources Development as of 2006

Zone	Surface Water			Groundwater		
	Weir	Canal	Pump	Qanat	Well	Spring
A	116	215	618	248	3,162	2,621
B	368	1,768	43	668	7,956	5,856
C	0	2,203	140	39	2,733	7,870
D	0	1,424	48	14	704	11,574
E	26	2	117	0	4,177	387
Total	510	5,612	966	925	16,041	29,559
Intake Volume (MCM)	9	1,502	205	181	859	827

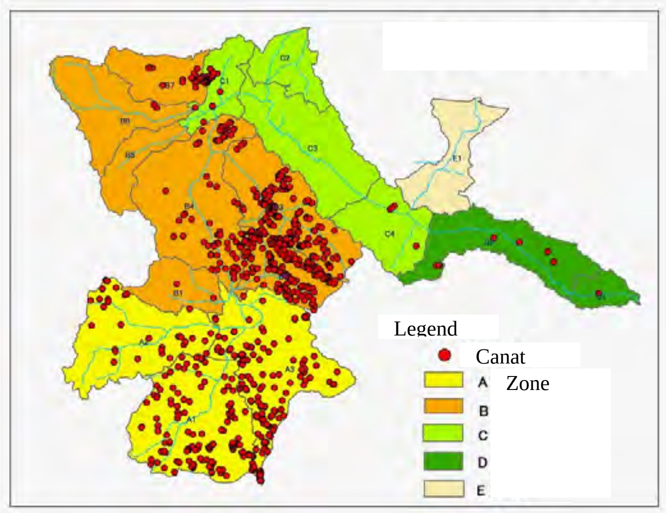


Figure 3.9 Locations of Qanat

There are 36 large-scaled dams/reservoirs with 5MCM of total reservoir volume or more in the basin including those under construction and planning. Dams/reservoirs currently operational are the three dams of Manjil, Taleghan, and Golbolagh. The Taham Dam is classified as under construction although construction is completed, since the treatment plant facilities in the downstream are still not in the operational stage. Dams under planning are 19 in number.

The large-scaled dams are summarized in Table 3.21. Among the effective storage of reservoirs, the Manjil Dam reservoir has a large effective volume of 1,150 MCM, followed by Ostor (451 MCM, under construction), Talvar (403 MCM, under construction), Taleghan (329 MCM, existing) and Mushampa (328 MCM, planning) in the order of reservoir capacity.

Table 3.21 Large-Scaled Dams in the Sefidrud River Basin

Existing		Under Construction		Under Planning		Total	
Number	Effective Storage (MCM)	Number	Effective Storage (MCM)	Number	Effective Storage (MCM)	Number	Effective Storage (MCM)
3	1,485.3	14	1,807.7	19	720.5	36	4,013.4

There are numerous existing small-scaled dams with the storage capacity of less than 5 million m^3. As tabulated below, the number of large dams makes up only 3%, while the total gross storage volume makes up almost 97%. Thus the specific features of water resources development in the basin could be understood by focusing on the large dams.

Table 3.22 Operational Dams in the Sefidrud River Basin

Large Dams		Small Dams		Total	
Number	Gross Storage (MCM)	Number	Gross Storage (MCM)	Number	Gross Storage (MCM)
3	2,228.1	89	65.2	92	2,293.3

3.12 WATERSHED MANAGEMENT

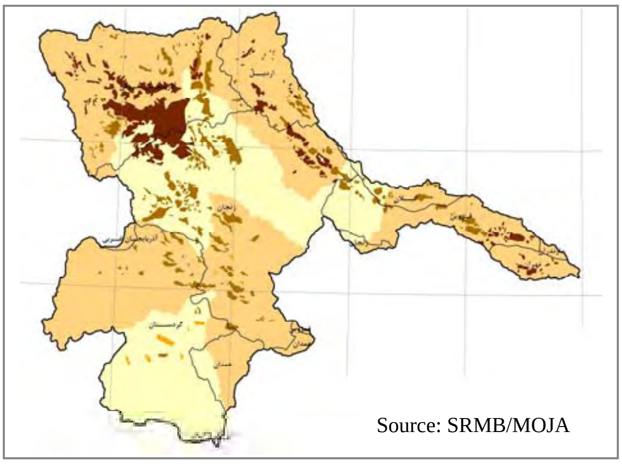
The Sefidrud River Basin Management Bureau (SRMB) of MOJA in Zanjan Province is taking charge of business relating to watershed management in the basin. Established in 1973, SRMB is the oldest river basin management bureau in MOJA. The tasks of SRMB are as follows:

- Investigation, monitoring and update of GIS database regarding watershed management;
- Planning and implementation of erosion control, landslide and flood control; and
- Construction of watershed management dam, recharge facilities for groundwater and afforestation;

Issues concerning the SRMB activities are as follows:

- Low awareness of rural people against river basin management;
- Shortage of experts and budget; and
- Lack of effective and economical countermeasures against watershed management.

The soil erosion classification map of the basin obtained from SRMB is shown in Figure 3.10. Soil erosion in the middle basin of the Qezel Ozan River from Ostor Dam to Mushampa Dam is high, ranging from 10,000 to 100,000 tons/km^2. Marl is widely distributed in this area.



Source: SRMB/MOJA

Legend

- Very low: 0 -10 ton/km^2
- Low: 10-100 ton/km^2
- Medium: 100-1,000 ton/km^2
- High: 1,000-10,000 ton/km^2
- Very High: 10,000-100,000 ton/km^2

Figure 3.10 Classification of Soil Erosion by Intensity

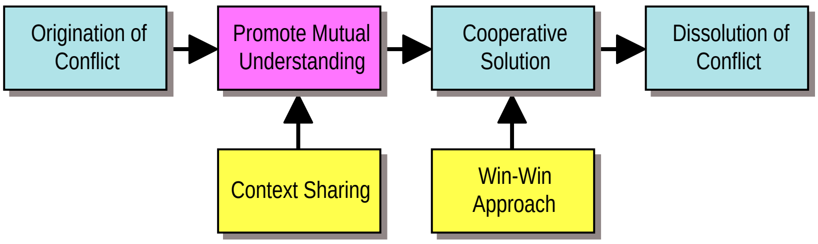
4. CONFLICT MANAGEMENT

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, 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 4.1 Mutual Understanding and Conflict Solution

4.1.2 Approach of Conflict Management in This Study

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 management. Considering such background of water resources management in general, the following approach is applied to this Study:

(i) Background of conflicts is grasped by conducting workshops with related organizations, users and others including stakeholders;

(ii) 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; and

(iii) 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.

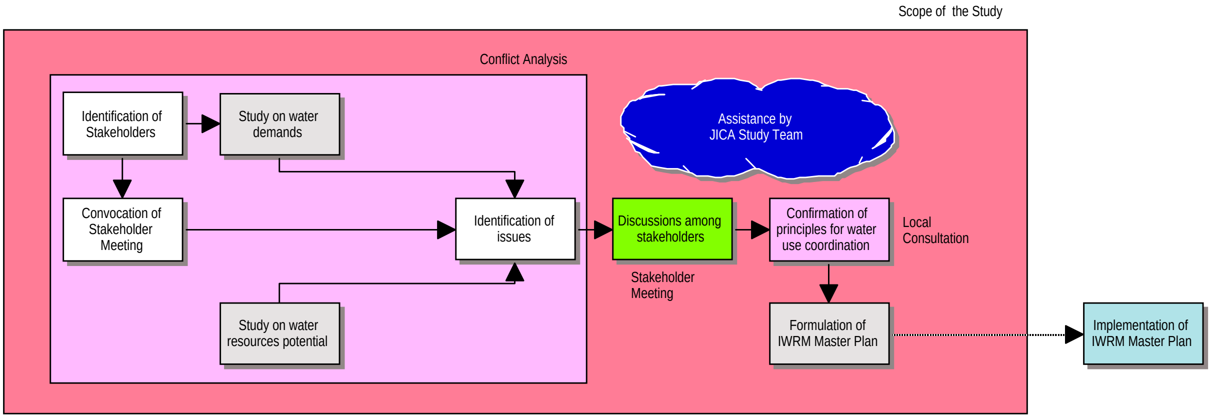


Figure 4.2 Flow of Conflict Management in the Study

4.2 CONFLICTS AMONG PROVINCES

The related Provinces can be grouped as follows:

Table 4.1 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	— Qazvin	Tehran

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.

4.3 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 cannot accept the argument of other Provinces. Key points of such confrontation can be further analyzed as follows:

Table 4.2 Analysis of the Confrontation and Measures

Key Points of Confrontation	Opinions of Upper Reach Provinces	Opinions of Lower Reach Province	Solvable Measures
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 coordination of water use described below.
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.
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.

Tehran and Qazvin stand and see the confrontation because they have different topographical conditions and prioritized water allocation conventionally.

4.4 PROPOSAL OF COORDINATION PRINCIPLES TO BE INCORPORATED IN WATER RESOURCES MANAGEMENT PLAN

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.

4.5 POINTS FOR FUTURE CONFLICT MANAGEMENT

4.5.1 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.

4.5.2 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.

5. WATER RESOURCES DEVELOPMENT PLAN AND ITS POTENTIAL

5.1 WATER RESOURCES DEVELOPMENT PLAN

5.1.1 Dam Development Plan in the Basin

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 5.1. 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 5.1.

Table 5.1 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 5.1 Location of 36 Large Dams in the Sefidrud Basin

5.1.2 Development Phase for Large Dams in Iran

According to the Water Engineering Standard of the Ministry of Energy (MOE), the development phase of large dams is divided into five stages, as shown in Figure 5.2.

Table 5.2 Development Phase of Large Dams in Iran

No.	Phase		Main Activities
1	Phase-0	Project Finding/ Identification Study	Specification of dam site based on the review of existing data and field survey; 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 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 contracting; Construction supervision
5	Phase-4	Operation and Maintenance	Operation of constructed dam facilities; Maintenance of constructed dam facilities

Source: WRMC

According to the information from WRMC, as of the end of May 2008, there are 38 large dam projects whose development phases are as shown in Table 5.3, namely; 6 constructed dams (Phase-4); 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 under Phase-4, these 3 dams are categorized as under construction in this Study, because the water treatment and irrigation facilities of these dams are still under construction.

Table 5.3 Development Phase of Large Dams in the Basin (as 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)KhoreshRostam(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

The development progress of dams of 5 million m^3 or more is arranged by the amount of reservoir storage for each province, as shown in Figure 5.2. At present, Gilan is predominantly superior to the other provinces, but the total storage volume for the three upstream provinces of Zanjan, East Azerbaijan and Kordestan will increase remarkably in the future.

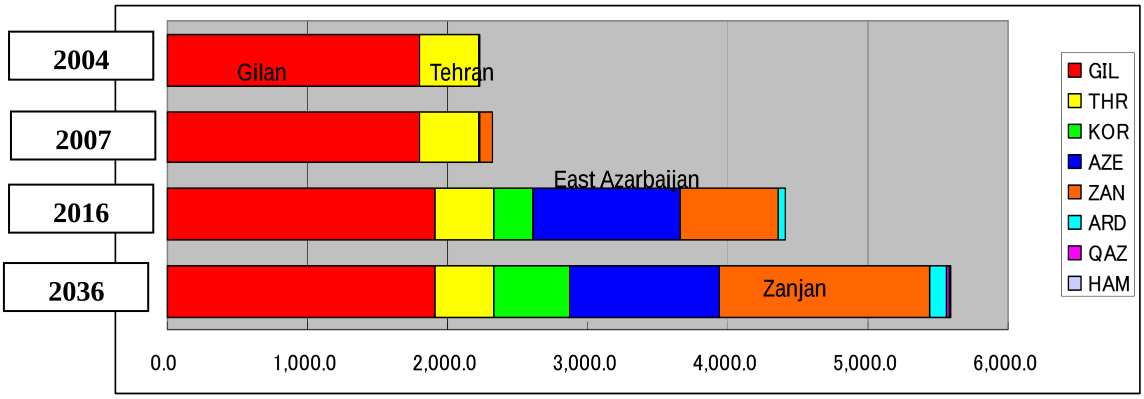


Figure 5.2 Development Progress of Large Dams in Iran

5.2 WATER RESOURCES DEVELOPMENT POTENTIAL

Surface water potential is obtained from rainfall. 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.

Table 5.4 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)	117mm (= 6.9 billion m^3)

Note: Data from 1985 to 2005

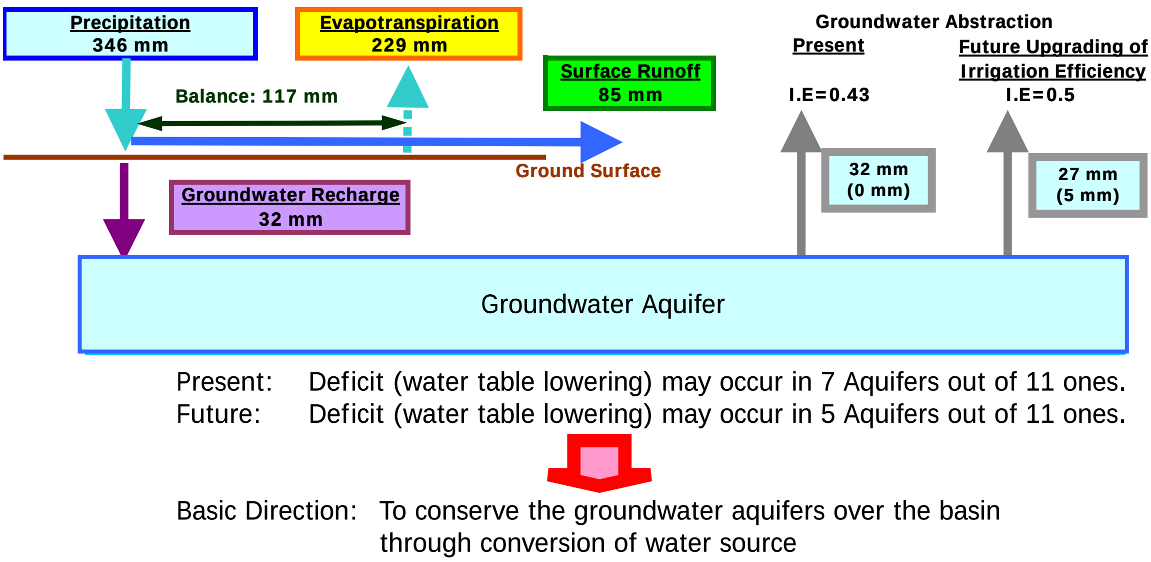


Figure 5.3 Water Balance and Water Resources Potential

6. WATER DEMAND PROJECTION

6.1 PROJECTION OF SOCIO-ECONOMIC FRAMEWORK

6.1.1 Target Year of Development

The development target year of the Master Plan is set as follows:

(i) Medium-Term Target: 2016 (Iranian Calendar: 1395)

(ii) Long-Term Target: 2031 (Iranian Calendar: 1410)

6.1.2 Projection of Socio-Economic Framework

The projection of socio-economic framework is as described below based on the past trend of several socio-economic indices, taking into account the "4th Five-Year Development Plan" and the "Long-Term Development Strategies for Iran's Water Resources," as well as the results of discussion with WRMC. These results are summarized in Table 6.1.

1) Population

Population in the basin is projected based on the past trend of population.

2) Gross Domestic Products (GDP) and Gross Regional Domestic Products (GRDP)

The annual average growth rate of GDP in Iran in the 4th Five-Year Development Plan is set at 8% as the numerical target for 2009. The basis of the 4th Five-Year Development Plan is the socio-economic status in 2004, and the actual annual growth rate in 2004 against that in the previous year is 8.03%, so that the said numerical target may be reflected as the actual growth in that year. However, it may not be expected that this numerical target will be continued up to the target year of the Medium-Term development plan of 2016, or to the target year of the long-term development plan of 2031. Therefore, the growth rate against the previous year at the time of 2031 in case of the long-term plan is assumed conservatively at 7% on average in the most optimistic case, while it is 5% in the medium case and 3% in the most pessimistic case.

Assuming that the growth rate against the previous year at the target year of the Medium-Term development plan is the intermediate growth between the numerical target of growth mentioned above and that of the long-term development plan, the growth rate is conservatively assumed at 7.5% in the most optimistic case, while it is 6.5% in the medium case and 5.5% in the most pessimistic case.

The growth pattern of GRDP must be different from that of the GDP in the whole of Iran because it reflects the economic activities in each province under the medium development term and the long development term. However, the growth is assumed to trace the same pattern as the GDP, as illustrated in Figure 6.1.

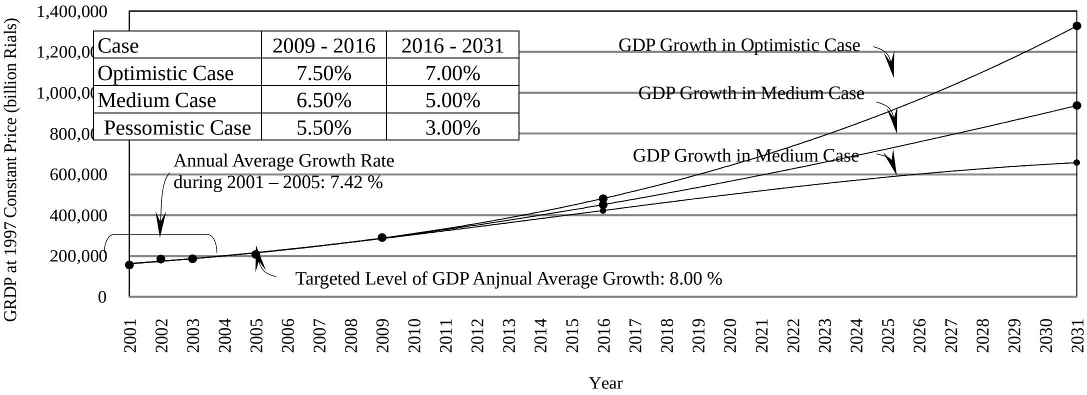


Figure 6.1 Growth Pattern of GRDP to the Target Years in the Eight Provinces Concerned

3) Growth of GRDP in the Industrial Sector

The increase in share of the industrial sector consisting of “Mining”, “Manufacturing” and “Construction” to the total GRDP means that the economic activities in the sector have activated and based on the trend of industrial production in the recent years, it is assumed that the share of the industrial sector to the total GRDP in 2031, the target year of the long-term development plan, will be 40% in the most optimistic case, 34% in the medium case, and 31% in the most pessimistic case. In addition, it is assumed that these will become 35% in the most optimistic case, 31% in the medium case, and 29% in the most pessimistic case at the target year of the medium-term development plan. Under these assumptions, the annual growth rate is determined to be 1.86% in the long-term plan and 2.06% in the medium-term plan, considering the medium case.

4) Growth of GRDP in the Agricultural Sector

As in the industrial sector, the increase in share of the agricultural sector consisting of “Agriculture,” “Hunting,” “Forestry” and “Fishery” to the total GRDP means that the economic activities in this sector have activated.

The area of seven among the eight provinces concerned except Tehran is one of the important farming belts in Iran ranking with the Mazandaran and Gorestan provinces where dry land shares almost 80% of the whole territory of the nation. Paddy is a strategic crop in Gilan Province, while the main cash crops are wheat in Ardebil Province together with potatoes, animal husbandry with pasture like alfalfa, and apiculture (large-scale beekeeping), and the share rates of both the provinces show high ones to the total GRDP . Between the two, the share rate of the agricultural sector in Ardebil Province shows that it reached 30% in the total GRDP in 2003. It means that all the target provinces have the potential to develop the agricultural sector in case of realization of proper water distribution in the future.

With the development of the agricultural sector, the “Transportation and Communication Sector” including warehousing business and the “Trading Sector” including marketing activities may also be activated. Therefore, only the agricultural sector will remain undeveloped without limitation. However, it may be expected that the share of the agricultural sector will grow by around 35% in the total GRDP. Also expected are some results of the measures of the Government showing the numerical target of the investment growth in the 4th Five-Year Development Plan.

Based on the above considerations, it is assumed that the share of the agricultural sector to the total GRDP in 2031 as the target year of the long-term development plan will be 35% in the most optimistic case, 31% in the medium case, and 29% in the most pessimistic case. In addition, it is assumed that these will become 31% in the most optimistic case, 28% in medium case, and 27% in the most pessimistic case at the target year of the medium-term development plan. Under these assumptions, the annual growth rate is determined to be 2.06% in the long-term plan and 2.29% in the medium-term plan, considering the medium case.

5) Improvement of Loss of Water Distribution and Improvement of Irrigation Efficiency

The growth of the industrial and agricultural sectors greatly depends upon suitable water distribution. It also depends upon effective water utilization. According to the survey made by WRMC, the loss in distribution of domestic and industrial water is 30%. Therefore, the distribution shall be improved up to 25% in the long-term plan without any improvement in the medium-term plan due to difficulties in the short period.

Furthermore, irrigation efficiency is reported as 33% in the traditional irrigation system and 50-76% in the modern pressurized irrigation system. Although the improvement of irrigation efficiency in the traditional irrigation system can be an effective measure for efficient water use, enormous costs has to be invested in the system. Thus improvement of irrigation efficiency has been studied as one of the parameters in the development scenarios in Chapter 9, Master Plan Study.

Table 6.1 Socio-Economic Framework for the Target Year

No.	Item			Target Year		
				Present	Mid-Term	Long-Term
				2006 (1385)	2016 (1395)	2031 (1410)
1	Population	Urban	Population	1,959,778	2,339,086	3,016,174
			Annual Growth Rate		(1.79～1.78%)	(1.74～1.67%)
		Rural	Population	2,767,549	3,384,897	4,560,110
			Annual Growth Rate		(2.04～2.02%)	(2.01～1.99%)
		Total	Population	4,727,327	5,723,983	7,576,284
			Annual Growth Rate		(1.94～1.92%)	(1.90～1.83%)
2	Annual Growth Rate of GDP			8.0	6.5	5.0
3	Annual Growth Rate in Industry			1.1	2.1	1.9
4	Annual Growth Rate in Agriculture			1.7	1.6	1.4
5	Water Loss of Domestic and Industrial Water			0.30	0.30	0.25
6	Irrigation Efficiency	Traditional	0.33	0.33	Scenario Analysis	
		Modern	0.50～0.76	0.50~0.76	0.50～0.76	0.50～0.76

6.2 WATER DEMAND PROJECTION

6.2.1 Zoning

The analysis of water demand in the target area was performed dividing the area into 5 zones and 67 reaches (sub-basins), as shown in Table 6.2 and Figure 6.2. These data do not contain the main part of the SIDN (Sefidrud Irrigation and Drainage Network), which will be described in Chapter 8 as the additional survey results.

Table 6.2 Zones and Enclosed Reaches in the Target Area

Zone	Sub-zone	Area (km²)	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									

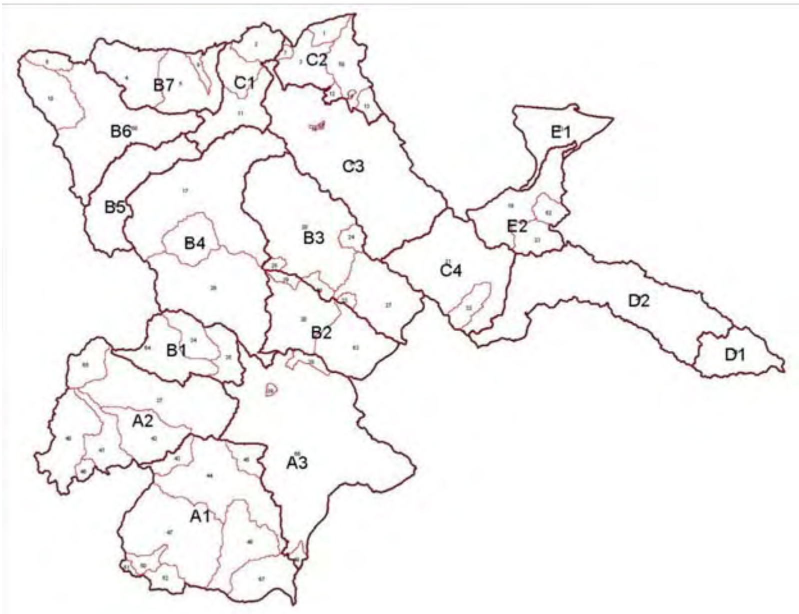


Figure 6.2 Zoning in the Sefidrud Basin

6.2.2 Irrigation Area

For water demand projection, the irrigation area is estimated under the following basic concepts:

(i) Based on the revised version of the Mahab Ghodss Study Report (November, 2008), the irrigation area of each reach in the upper basin of Manjil Dam is estimated.

(ii) Based on the revised version of the Pandam Study Report, the irrigation area of each reach in Gilan Province is estimated.

(iii) The irrigation area is divided into four beneficial areas: 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) Beneficial areas of the large-scaled dams/reservoirs.

(iv) Based on the actual consumption of water in the Mahab's revised version, the irrigation area by surface water and groundwater is distributed using ratios of water intake volumes from each water source.

(v) For the estimation of irrigation area in the medium-term target year (2016), the development areas of 14 dams under construction are considered.

(vi) For the estimation of irrigation area in the long-term target year (2031), the development areas of the 19 dams adopted for the master plan in addition to the 13 dams under construction are considered.

(vii) There are no new irrigation development areas other than those of the dam development plan.

Table 6.3 shows the projected irrigation areas at the development target years based on the basic concepts mentioned above.

Table 6.3 Projected 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

6.2.3 Basic Conditions and Water Demand Projection

Based on the comment from RWC, the conference with the Iranian side, and the additional study in Gilan Province (see Chapter 8), the calculation conditions are set up. The major conditions to project water demand are arranged as follows:

- In connection with the basic conditions of the irrigation area, irrigation efficiency, etc., data in Gilan Province are based on the Pandam Study Report, while data in other areas are based on the Mahab Ghodss Study Report (Revised Version: November, 2008) provided by WRMC.
- The resulting values might have been over-estimated and unrealistic, although the net water requirement in the Mahab Ghodss revised version is calculated based on the National Water

Document. Therefore, a correction coefficient was set, and the necessity of making changes in the reach having an excessive value disappeared.

- 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 6.4.

Table 6.4 Irrigation Efficiency in the Future

Area	Present (2006)	Medium-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 Table 6.5 is adopted for adjusting the difference among provinces.

Table 6.5 Unit Water Consumption in Urban Water Supply

Population in Target City	Unit Water Consumption (lpdc)		
	Present (2006)	Medium-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

- There was a comment that it is necessary to calculate population based on the 2006 Census. However, the calculation of future population adopts the population forecast in the 1998 Census, because data concerning population and growth rate in local cities are not obtainable from the 2006 Census.
- The water sources for urban water supply in local cities are basically surface water, but they are assumed to be groundwater for small towns without any information.
- The water sources for rural water supply and industrial water are assumed to be groundwater, and the total water supply loss is set at 35%.
- Additionally, there were correction requests from RWCs, and the JICA Study Team reflected the acceptable ones in the report.

Based on the calculation conditions given above, the water demand at present and those of the medium-term target year and the long-term target year were examined. It is considered that 14 dams under construction are completed in the medium-term target year, and 21 dams and the Qazvin inter-basin transfer project are completed in the long-term target year. The summary of calculation results is presented in Table 6.6. In this projection, the future irrigation efficiency proposed by WRMC is employed for the projection of agricultural water demand.

Table 6.6 Summary of Water Demand Prediction

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%
Medium-Term (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%

1) Water Demand for Agriculture

The demand for agriculture water in traditional irrigation is forecast on the premise that the present irrigation efficiency of 33% will be improved up to 40% by the medium-term target year 2016 and 50% by the long-term target year 2031. The demand forecast by zone and water source are aggregated, as shown in Table 6.7 and Table 6.8, respectively.

Table 6.7 Agricultural Water Demand by Zone

(million m^3)

Zone	Present (2006)	Medium-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 6.8 Agriculture Water Demand by Water Source in Zone

Target Year	Water Resources	Item	Irrigation Area in Zone (ha)					
			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

2) Water Demand for Domestic Use

The water demand for domestic use is calculated based on the population projection and unit water requirement in the Mahab Ghodss Study Report provided by WRMC. Total water loss from the water sources to the beneficiaries is set, as shown in Table 6.9.

Table 6.9 Water Loss in Domestic Water Supply

Water Resources	Treatment Loss	Distribution Loss	Total Loss
Surface Water	0.20	0.35	0.48
Groundwater	-	-	0.35

Water demands by zone are as summarized in Table 6.10.

Table 6.10 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

3) Water Demand for Industry

The water demand for industry with 0.35 of the total delivery loss is forecast based on the information provided by the WRMC (see Chapter 3). Water demands by zone are summarized in Table 6.11.

Table 6.11 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

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. 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 water distribution under the conditions of various cases and to propose the appropriate water allocation plans. The outline of the Sefidrud Model is given below.

7.1.1 Outline of Simulation Model

The water balance simulation model for the 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 water 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 2,040 m. 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 60 m 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 runtime, 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. The sub-catchments limit the lateral extent of interflow and overland flow in the Sefid-WBSM and Sefid-WASM. That is, interflow and overland flow is discharged only to river links located within the sub-catchment.

Each of the processes mentioned above 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 practicable to use simplified process descriptions. In case of the Sefid-WBSM, it takes about 6 hours to simulate the water balance in the 65 reaches for a 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 in the Sefid-WASM, the tank parameters which express the conveyance from underground water (the recharge) to river flow, should be verified.

7.1.2 Flowchart of Model Establishment

The flowchart for the establishment of Sefid-models is shown in Figure 7.1.

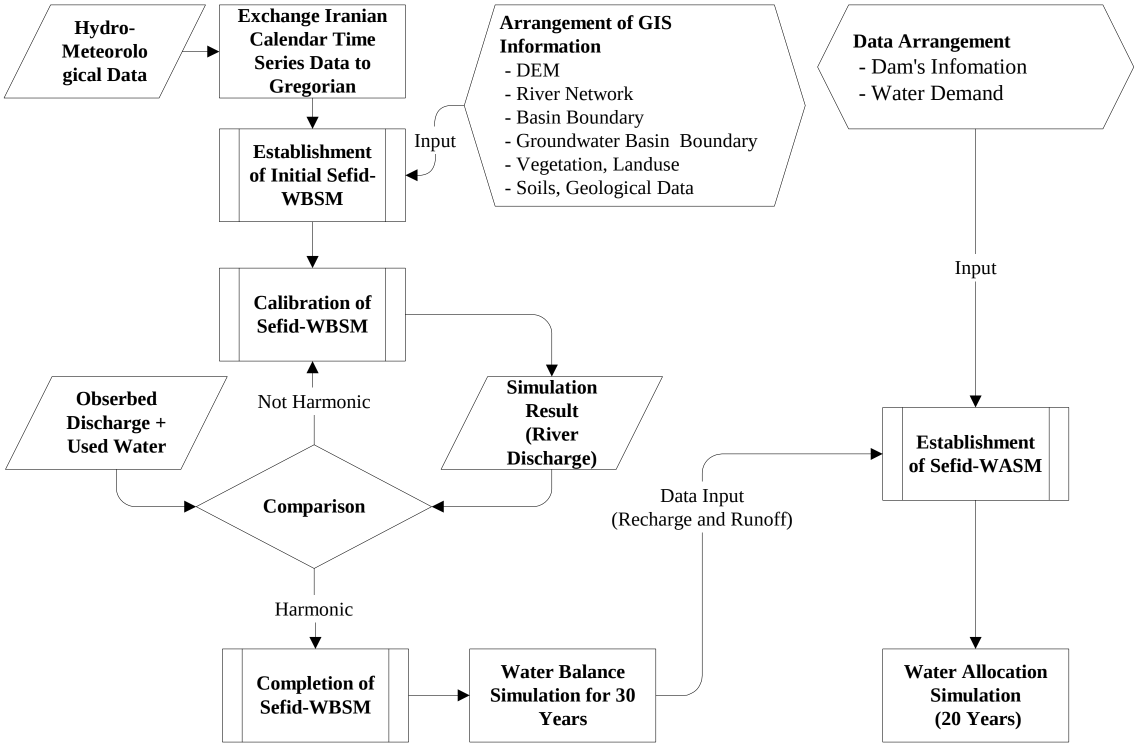


Figure 7.1 Flowchart of Model Establishment

7.2 SIMULATION MODEL BUILDING

7.2.1 Boundary Conditions

The time series data such as evaporation, temperature, river discharge, and the land coverage information such as vegetation and geological information are collected to initially build the Sefid-WBSM. These data are entered into the database mounted on the MIKE SHE software.

Table 7.1 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, building, planned dams
	Groundwater Aquifer Boundary	Delineated based on aquifer boundary	Redefined during model calibration
	River Network	Major Rivers	Defined by topographic map and DEM
	Position of Station	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 SIDN. The model domain is 210 grid cells East-to-West and 165 grid cells North-to-South. The square grid cell size is 2,040 m. The grid size and grid origin have been selected so that the model grid would correspond to the 60 m DEM (Digital Elevation Model from Aster Satellite). That is, each model cell contains exactly an even number of 60 m DEM cells.

2) Delineation of Sub-basins (Reaches)

The sub-basins in the Sefid-WBSM are defined based on the information of Reaches supplied by WRMC. The sub-basins are identical to the catchments used in the Sefid-WASM (by MIKE BASIN software). In this model, the sub-basins limit the lateral extent of interflow and overland flow. That is, interflow and overland flow is discharged only to river links located within the sub-basin. A MIKE 11 branch name and chainage range is specified for each sub-basin. This prevents any ambiguity with respect to the river links where the interflow and overland flow will discharge.

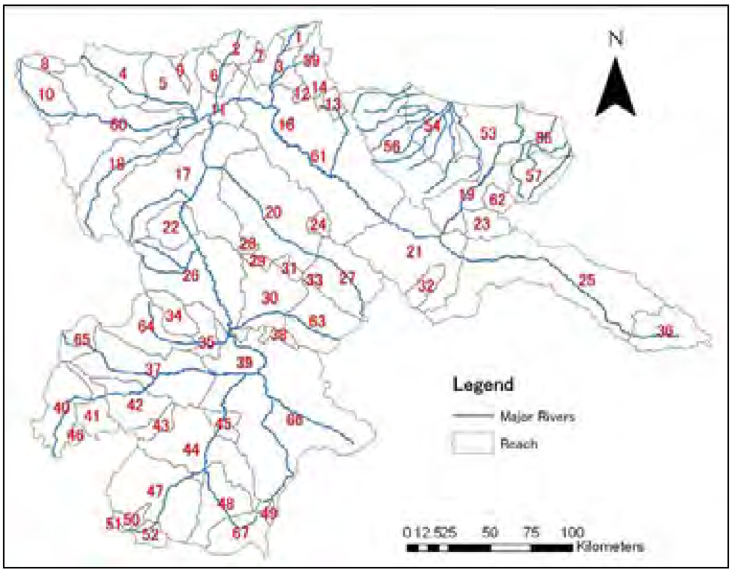


Figure 7.2 Delineation of Sub-Basins (Reaches)

3) Topography (Elevation Distribution)

The model topography is based on the 60 m DEM (Aster Satellite). The topography is used for calculation of the cell elevation for the temperature, precipitation elevation correction and surface flow direction.

4) Meteo-Hydrology

As a result of the Study, the available climate information consists of measured precipitation, evapotranspiration and temperature in the viewpoint of situation of arrangement of climatology data in the Sefidrud River Basin. Each of these data sets was analyzed to find the stations with long, continuous data records. These data stations were extracted and the remaining gaps were statistically filled from correlated stations. For each data set, a Thiessen polygon 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.

5) Snow Melt

The Sefidrud model considers the accumulation and melting of snow as a function of air temperature. When the temperature is below 0^oC (threshold melting temperature), precipitation accumulates as snow. Accumulated snow begins to melt at the rate of 2 mm/^oC/day (Degree-Day melting coefficient) when the temperature is above 0^oC.

6) Land Use

Land use in the basin could be broadly classified into eight categories: Grass, Scrub, Urban, Agriculture, Water, Forest, Dense Forest, and Orchard.

7) Leaf Area Index (LAI) and Root Depth Values

Each vegetation class requires a Leaf Area Index (LAI), which is the area of leaves per m^2 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. More detailed evaluation of the LAI and root depths based on actual crop/plant types and growing seasons would likely improve the model, but only if better land-use and soil maps are also used.

8) River Network

The main branches are selected from a detailed line shape file with all tertiary streams. The network is defined such that most of the large sub-catchments are connected to the river network. The stream nodes are imported to MIKE 11 from the shape file and a MIKE 11 network is routed through the points. The resulting MIKE 11 network consists of 37 branches that closely follow the actual meanderings of the river network.

7.2.2 Calibration of Sefid-WBSM

The model is calibrated focusing on the conformity of volume and wave shape between the simulation result and the observed discharge. Table 7.2 presents the calibration result at the major station of the Sefidrud River system. These outputs of natural flow and recharge capacity without control structures such as dam reservoirs and weirs would be inputs to the water allocation simulation model (Sefid-WASM).

Table 7.2 Calibration Result of Sefid-WBSM

(Volume: MCM/year)

Station	Simulation Result	Simulated Natural Flow	Upstream Used Water	Observed Flow	Observed Duration (Year)
Gilvan	4,759	4,414	1,147	3,267	20
Ostor	4,376	3,926	1,132	2,794	20
Pole. D.M.	2,877	2,705	956	1,749	20
Mah. N.	2,305	1,467	411	1,056	9
Ghare G.	1,680	1,282	139	1,143	19
Loshan	1,328	1,185	245	943	20

7.3 WATER ALLOCATION SIMULATION MODEL BUILDING

7.3.1 Basic Conditions for the Model

The following are the basic conditions for building the water allocation simulation model. The calibration results are described in Subsection 7.3.2.

1) Duration of Simulation for Model Calibration

To calibrate the water allocation simulation model, the duration of simulation is set at 20 years from 1985 to 2005, the same as the period for calibration of the Sefid-WBSM.

2) Minimum Unit of Simulation and Catchment

The minimum unit of calculation is the reach (sub-basin), the area and location of which are the same as those of the Sefid-WBSM. In other words, the runoff and recharge data calculated by Sefid-WBSM are input to each reach in the Sefid-WASM.

3) Quantity of Intake Water

The quantity of intake water from the 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, the sources of which are 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 Manjil and Golbolagh dams are set as dam modules for the initial model because these dams were constructed within the simulation period for calibration. The initial water level of dam reservoirs is decided to input the water level corresponding to 70% of reservoir storage. In addition, evaporation data are also set to calculate the amount of evaporation from the dam storage volume.

7.3.2 Model Calibration

Since the Sefid-WASM draws a certain quantity of the water demand on the groundwater and the surface water form the underground tank and river module, the water balance is calculated between runoff and recharge in each reach (sub-basin). The inflow into 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 Manjil Dam, the annual average total inflow is calculated as 4,000 MCM by Sefid-WASM on the present condition, which is highly consistent with the actual flow amount into Manjil Dam. Furthermore, the shape of simulated hydrograph at the Loshan and the Gilvan stations correspond to the actual one. Figure 7.3 presents the calibration results for 20 years. The model shows reproducible results between observed and simulated data.

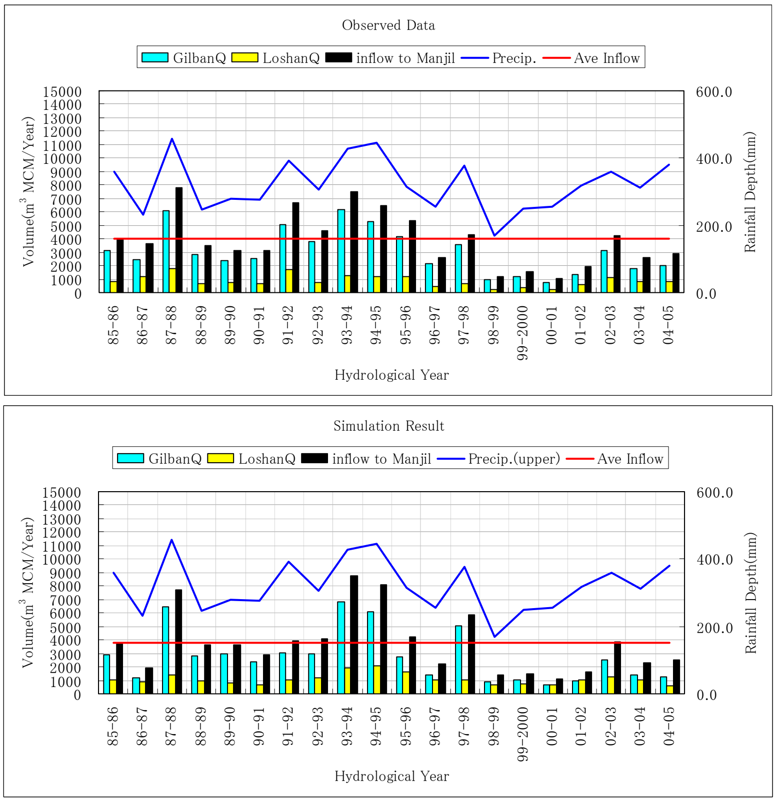
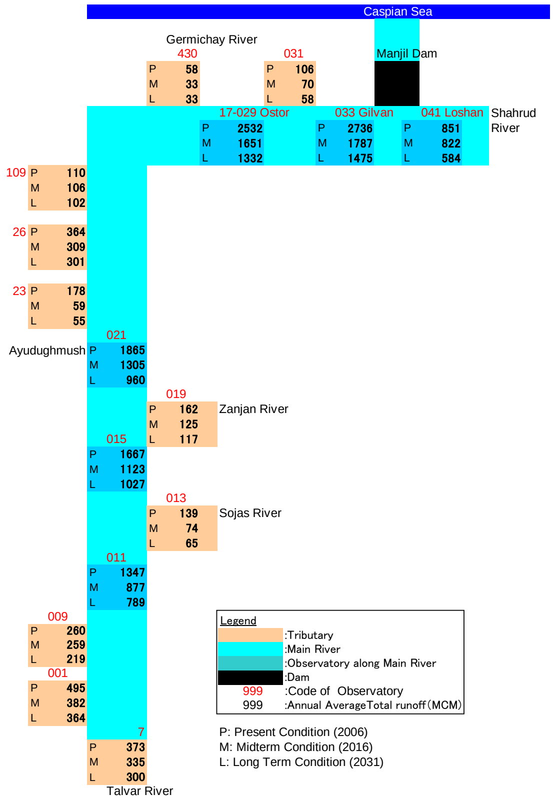


Figure 7.3 Comparison of Inflow Volume between Simulated and Observed Data at Manjil

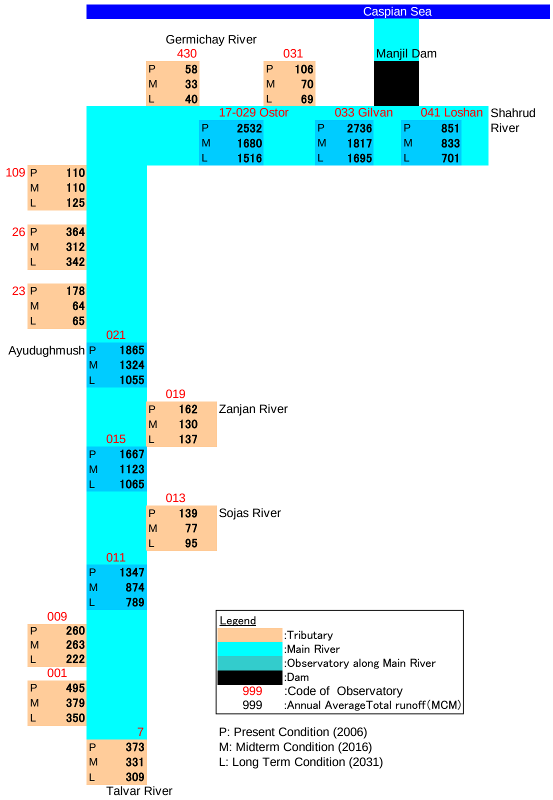
7.3.3 Schematic Flow Diagram

The schematic flow diagrams were prepared corresponding to irrigation efficiency variations in next figure. Each figure includes simulation results on the condition of three target years.

(Case: Present irrigation efficiency)



(Case: Intermidiate irrigation efficiency)



(Case: WRMC irrigation efficiency)

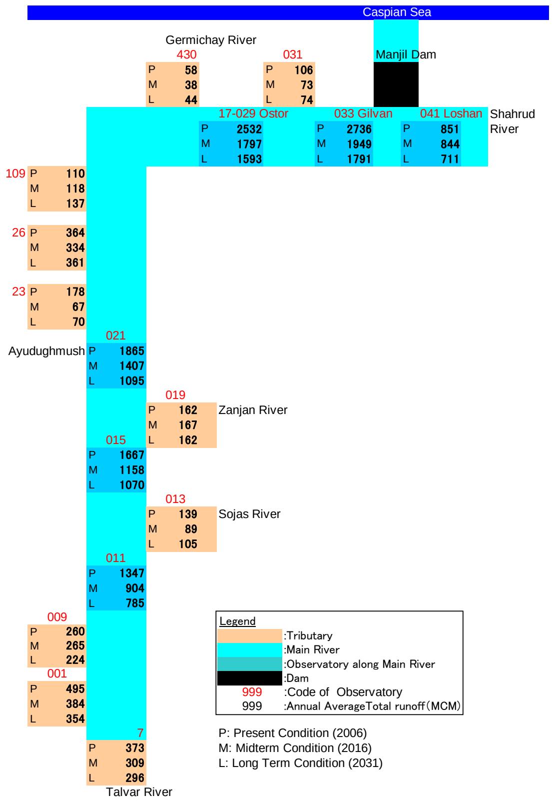


Figure 7.4 Comparison of Inflow Volume between Simulated and Observed Data at Manjil

8. ADDITIONAL SURVEY IN GILAN PROVINCE

8.1 BACKGROUND OF THE SURVEY

The main part of the Sefidrud Irrigation and Drainage Network (SIDN), which is a typical rice farming region in Gilan Province, comes off directly from the JICA Study Area (the Sefidrud River Basin). Therefore, the Government of Iran requested JICA, on June 5, 2008, to examine the modeling and water balance simulation of the whole area of SIDN. In response to this request, the additional survey was conducted from September to November 2008. The survey area and location of water intake structures (weirs) are as indicated in Figure 8.1.

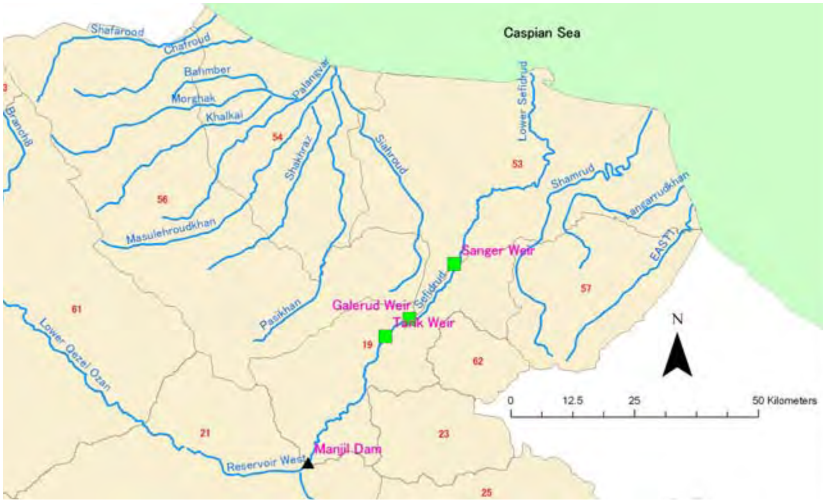


Figure 8.1 Water Intake Structures (Weir) and the Local River System in the SIDN Area

8.2 LANDUSE

The whole area of SIDN is divided into 17 development units of about 284,000 has according to the Pandam Study Report. Land use in SIDN is summarized in Table 8.1, and rice field areas total about 190,000 has (Gross). Out of this area, the modern irrigation area is 100,000 ha, while the traditional irrigation area is 90,000 ha.

Table 8.1 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

8.3 WATER RESOURCES IN GILAN PROVINCE

8.3.1 Surface Water in the Sefidrud River

There are three intake weirs (Tarik, Gelerud, and Sangar) along the Sefidrud River in the downstream of Manjil Dam, and the irrigation water of the SIDN district is taken from these weirs. The intake water volume at each weir is as shown in Table 8.2. The table indicates that the total volume of annual average intake from the three weirs accounts for about 80% of the planned intake.

Table 8.2 Water Intake Volume of Existing Three Weirs in SIDN

Water Intake	Tarik Weir	Gelerud Weir	Sangar Weir		Total
			Left Bank	Right Bank	
Annual Average Intake Volume (1988 to 2006)	304.6	115.7	823.5	470.0	1,679.0
Planned Intake Volume in 2006	437.4	94.2	955.3	589.4	2,076.3
	69.6%	122.8%	86.2%	79.7%	80.9%

Source: WRMC, unit: MCM. The lowest row indicates the percentile of annual average intake volume by the planned intake volume in 2006.

Annual average flow in the remnant basins which discharge into the Sefidrud River from Manjil Dam up to Sangar Weir is estimated at 470 MCM. It is only the Bijar Dam in the Zilkirud River that is being constructed in such remnant basins at present. These Sefidrud remnant basins could receive rainfall of more than 1,500 mm a year. Therefore, even if their drainage areas are relatively small, the development potential of water resources is quite high compared with the upper basin of Manjil Dam which has the annual rainfall amount of about 300 mm.

As illustrated in Figure 8.2, a certain amount of water estimated at 4,170 MCM per year on average is released from Sangar Weir to the Caspian Sea without being utilized. There are various factors to be considered for this water release, such as environmental flow requirements for spawning and migration of Sturgeons and hydropower generation release out of Manjil Dam in the non-irrigation period. At least necessary is the integrated water management for dam and weir operation, so as to minimize the emptying of unutilized water into the Caspian Sea.

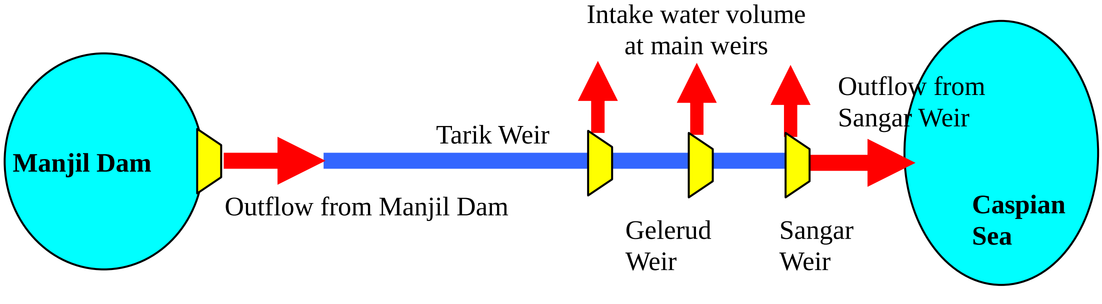


Figure 8.2 Schematic Diagram of Flow Intake System Downstream of Manjil Dam

8.3.2 Surface Water in Local River System

According to the JICA Study on the Anzali Wetland, the water of about 2,400 MCM annually flows into the wetland, as shown in Figure 8.3. If the local rivers located at the right side of the Sefidrud river course are also considered, the development potential can be assumed as 3,000 MCM or more.

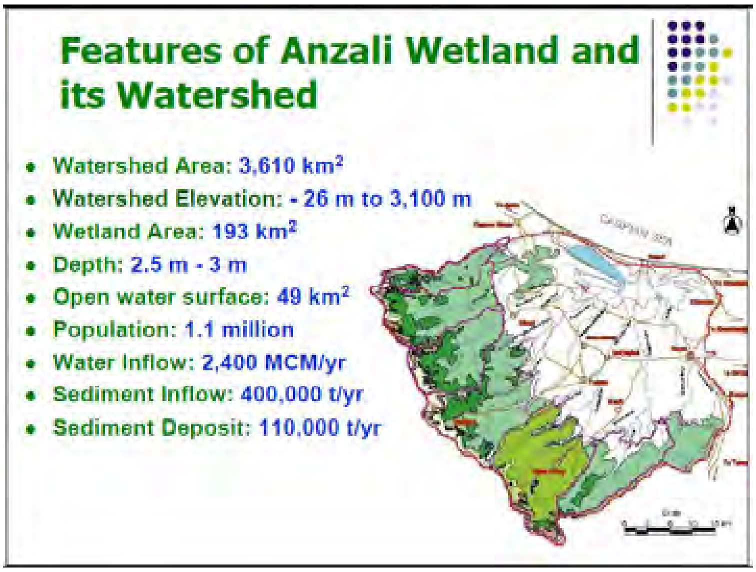


Figure 8.3 Salient Features of Anzali Wetland and its Watershed

The water resources development facilities in the local rivers which flow into the SIDN area were confirmed by field investigation. Weirs of more than the medium scale are only three, as shown in Table 8.3. Their intake water volumes are relatively small.

Table 8.3 Existing Weirs in Local Rivers

Name of Weir	Name of River	Beneficiary Area (Reach)	Design Water Intake Volume (m^3/s)	Type of Weir
Pasikhan	Siah Mazgi	R53	4.0	Fixed Concrete
Shakhazar	Shakhazar	R54	2.0	Fixed Concrete
Ghavam	Disam	R55	40.0	Gate

Source: Pandam Study Report

In addition, the water resources development plans under implementation confirmed from Gilan RWC are as given in Table 8.4. Since both projects are located at both eastern and western ends of the SIDN, and the irrigation water is designed to supply outside of the SIDN, these projects are excluded from the Master Plan.

Table 8.4 Water Resources Development Projects under Implementation

No.	Project	River	Purpose
1	Shafarud Dam	Shafarud	Irrigation, Domestic, Environment
2	Polerud Dam	Polerud	Irrigation, Domestic

Furthermore, the dam development plans for irrigation as shown in Table 8.5 were confirmed. From the viewpoint of water resources development, these plans are attractive. These plans are, however, still in the basic investigation stage (only hydrological study at the dam sites) and require environmental consideration to conserve the Anzali Wetland. Thus these plans are also excluded from the components of the Master Plan.

Table 8.5 Water Resources Development Projects in the Planning Stage

No.	Name of Dam	River	Basin Area (km^2)	Annual Rainfall (mm)	Specific Discharge ($L/s/km^2$)	Annual Discharge (MCM)	Beneficiary Area (Reach)
1	Lasak	Chubarrud/Pasikhan	112	1,780	37.64	132.9	R53
2	Agha Rabi	Siahrud	125	1,572	17.51	69.0	R53
3	Aziz Kian	Gohar Rud	119	1,500	46.22	173.5	R53
4	Shalkeh II	Siah Mazgi	170	2,135	45.15	242.1	R53
5	Pirsara	Gasht Rudkhan	79	1,900	29.61	73.8	R54
6	Nazar Alat	Ghaleh Rudkhan	82	2,068	30.28	78.3	R54
7	Sholem	Gazrudbar	44	1,268	66.66	92.5	R54
8	Sakheh Bon	Masoleh Rudkhan	178	953	19.66	110.4	R54
9	Maleki Nesa	Masal	197	647	22.17	137.7	R54
10	Shahrvar	Morghak	216	713	18.41	125.4	R54
Total						1,235.5	

Source: Hydrological Study Report in Gilan Province/ Pandam Consultant

8.3.3 Rehabilitation of Irrigation Facilities

1) Rehabilitation Project of SIDN Irrigation Facilities

Being thought as indirect water resources development is the improvement of irrigation efficiency by the rehabilitation of irrigation and drainage facilities of SIDN which had become superannuated. To improve the irrigation efficiency, Gilan RWC conducted the investigation for the rehabilitation works of the main and secondary canals and related facilities in SIDN. According to the Pandam Consultant which took charge of the investigation, it is forecast that the irrigation efficiency of 42% at present could be improved by 15-20% and become 48-50% after the rehabilitation works. As a result, the water demand in the SIDN is reduced from 2,045 MCM to 1,740-1,640 MCM, and 300-400 MCM per year could be saved.

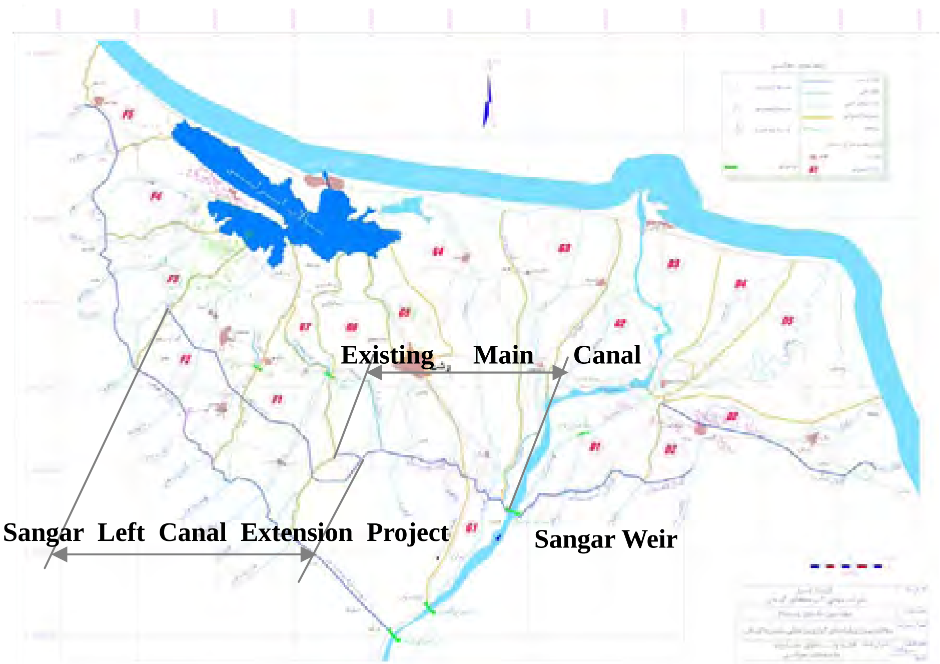


Figure 8.4 Sangar Left Canal Extension Project

2) Sangar Left Canal Extension Project

Some of the Fumanat irrigation areas (R54) have not been supplied with irrigation water in peak seasons due to the limitation of tunnel flow capacity from the Tarik Weir. To improve this situation, Gilan RWC planned to extend the left main canal from the Sangar Weir as shown in Figure 8.4, and the Sangar left canal extension project is being conducted to change the supply of a part of the Fumanat irrigation area from Tarik Weir to Sangar Weir.

8.3.4 Groundwater Utilization in SIDN

According to the Pandam Study Report (Vol. 4), groundwater utilization in SIDN could be arranged as shown in Table 8.6. Net paddy field area supplied from groundwater is presumed as 1,945 has. This area corresponds to about 1.2% of the total paddy field area in SIDN.

Table 8.6 Agricultural Water Consumption of Groundwater in SIDN

Irrigation Area	Consumption of Groundwater ('000m^3)						Gross Water Requirement (m^3/ha)	Estimated Irrigation Area (ha)
	Apr.	May	Jun.	Jul.	Aug.	Total		
Fumanat (R54)	1,670.1	2,337.8	4,453.4	4,340.9	2,337.8	15,140.0	11,392	1,329.0
Central Gilan (R53)	488.1	714.0	1,773.1	1,391.5	714.0	5,080.7	10,480-12,780	473.9
East Gilan (R55)	20.1	175.4	641.1	641.1	175.4	1,653.1	11,645	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 Study Report, Vol. 4

8.4 AGRICULTURAL WATER CONSUMPTION BY WATER SOURCE

The total agricultural water consumption in SIDN is shown in Table 8.7. The SIDN area of 93.1% (about 155,600 ha) depends on the surface water of the Sefidrud River. Additionally, 3.4% depends on the local rivers, 1.9% on the small reservoirs, and 1.5% on groundwater.

Table 8.7 Agricultural Water Consumption in SIDN

(Unit:'000m^3)

Water Source	Fumanat (R54)	Central Gilan (R53)	East Gilan (R55)	Total	Ratio (%)	Equivalent 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
Small Reservoirs	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

8.5 WATER DEMAND IN SIDN

8.5.1 Agricultural Water Demand

1) Irrigation Efficiency

Based on the Pandam Study Report, the irrigation efficiencies in SIDN are as shown in Table 8.8. The irrigation efficiency of 42.0% for the entire SIDN area has been estimated by the area-weighted average.

Table 8.8 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 Study Report

2) Gross Water Requirement

The gross water requirement was obtained by dividing the net water requirement by the irrigation efficiency. The gross water requirements in the SIDN are as shown in Table 8.9.

Table 8.9 Gross Water Requirements 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 Study Report, Vol. 4

8.5.2 Fish Culture Water Demand

Based on unit water demand, fish culture water demand in SIDN was estimated, and the results are as shown in Table 8.10.

Table 8.10 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

8.5.3 Domestic Water Demand

In the SIDN area, there is the Sangar Water Treatment Plant which supplies domestic water to eight cities/towns including the provincial capital, Rasht. The following defines the present situation of domestic water supply:

- Water to the Sangar Water Treatment Plant is supplied originally from the Shahr Bijar Weir and the Gelerud Weir.
- Eight cities are supplied from the Sangar Water Treatment Plant at present. If the extension plan is carried out, five cities will be added to the coverage area of the Sangar Water Treatment Plant. The extension works is scheduled to be completed by 2016.
- Raw water of 3,750 liters/s is supplied to the Sangar Water Treatment Plant at present, and treated water is produced at 3,000 liters/sec.
- Treatment loss at the Sangar Water Treatment Plant is 20% and water supply loss from the plant to each house is 35%.
- Water source for the coverage area of the Sangar Water Treatment Plant is groundwater.
- As for the water processing of deep well, necessary processing is carried out depending on the quality of raw water. The water supply loss from deep well to each house is 35%.

8.6 ADDITIONAL BUILDING OF SIMULATION MODEL FOR GILAN SIDN

To examine the water balance of the area located on both sides of Sefidrud River as additionally requested by the Government from JICA, SIDN was mounted into the Sefid-WBSM (MIKE SHE) and the Sefid-WASM (MIKE Basin). Currently, the thirteen local rivers flowing into SIDN, which are expected to affect the water balance, are embedded as the river modules to grasp the amount of surface water flow.

9. TOWARD REALIZATION OF INTEGRATED WATER RESOURCES MANAGEMENT

9.1 IDEAL SITUATION OF INTEGRATED WATER RESOURCES MANAGEMENT IN THE SEFIDRUD RIVER BASIN

Integrated Water Resources Management (IWRM) as defined by the Global Water Partnership, is “a process which promotes the coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”.

Sustainable development through IWRM aims at the sustained improvement in the living conditions of all citizens in an environment characterized by equity, security and freedom of choice. IWRM necessitates the integration both of natural and human systems and of land and water management. Thus, IWRM could be regarded as a coordinating process to achieve the above development, and a dynamic process to establish the sustainable management on water resources through coordination among various stakeholders.

Prior to deliberating the IWRM in the Sefidrud River basin, issues surrounding the basin are enumerated below at first. Based on these issues, preferable and ideal IWRM is discussed in this section.

9.1.1 Issues on Water Resources Development and Management

Through field reconnaissance and related data examination and analysis, the following issues could be found on the water resources development and management in the Sefidrud River basin.

1) Limited Water Resource Development Potential

Although the detailed water resources development potential has not been made clear yet by the water balance simulation, future serious water shortage for limited water resources in the basin can be apprehensive about due to numerous proposals of water resources development projects in accordance with increase of demand in various water uses. Particular attention should be paid to the water resources development and management since the water resources development potential is limited due to semiarid areas extending in the middle and upper reaches of the basin.

Historical annual inflows into the Manjil reservoir, which is located at the outlet into the lowermost alluvial plains in the Gilan province, clearly decrease to 2,500 MCM for the recent nine years from 4,500 MCM for the entire period as shown in Figure 9.1. It might be due to a recent sequence of dry weather.

So far serious conflicts or problems do not appear on the water resources development since the development projects utilizing surface water are not progressed due to their high cost. Numerous development projects, however, are already proposed so that their expected development water quantities exceed the potential in the natural water resources.

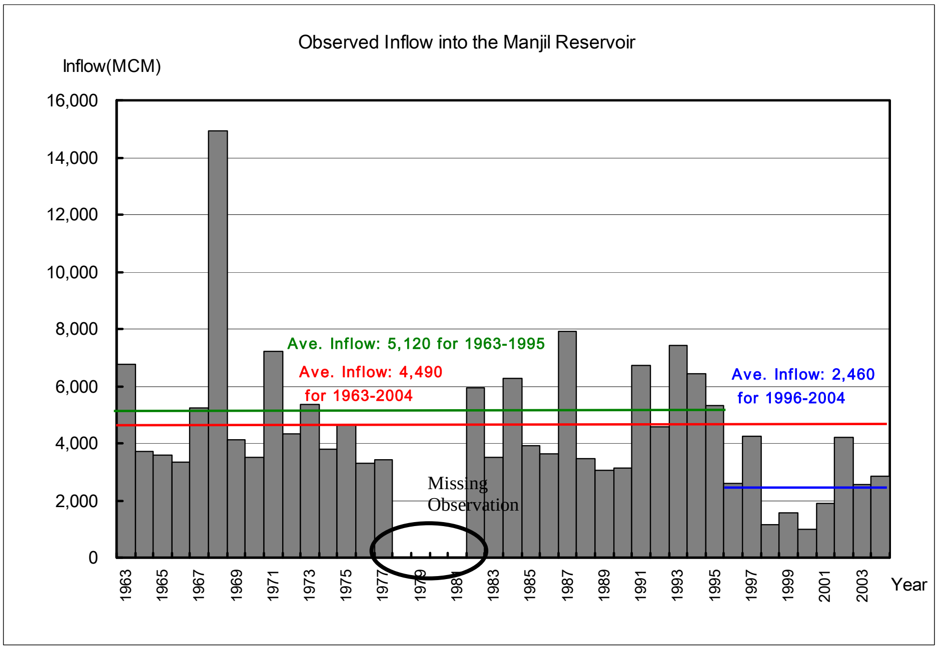


Figure 9.1 Historical Change of inflows into the Manjil Reservoir

From viewpoints of water resources potential, entire water consumption in the upper stretch and water demand in the lower stretch of the Manjil are computed in comparison with natural inflow to the Manjil which is simulated without any water uses and related facilities. Figure 9.2 presents the flow situations in 5-year drought (year 1998/1999) and average year (year 1991/1992) based on 30-year flow simulation. Figure on the left shows simulation results in the case of improved irrigation efficiency up to the level proposed by WRMC, while figure on the right shows the results without such improvement.

From the figure, natural water resources potential of the Manjil inflow without any water uses and related facilities could be computed at 3,892 MCM in 5-year drought and at 6,865 MCM in an average year, while water demands in the areas upstream of the Manjil could be simply summed up at 4,712 MCM in 2006, at 5,097 MCM in 2016 and at 5,354 MCM in 2031. Even at present, the total water demands exceed the water resources potential in 5-year drought. Furthermore, more serious water shortage could be anticipated in the case without the improvement of irrigation efficiency even in an average year in 2031. Thus the conflicts on water resources will occur between concerned provinces or between the upstream and downstream areas in the very near future.

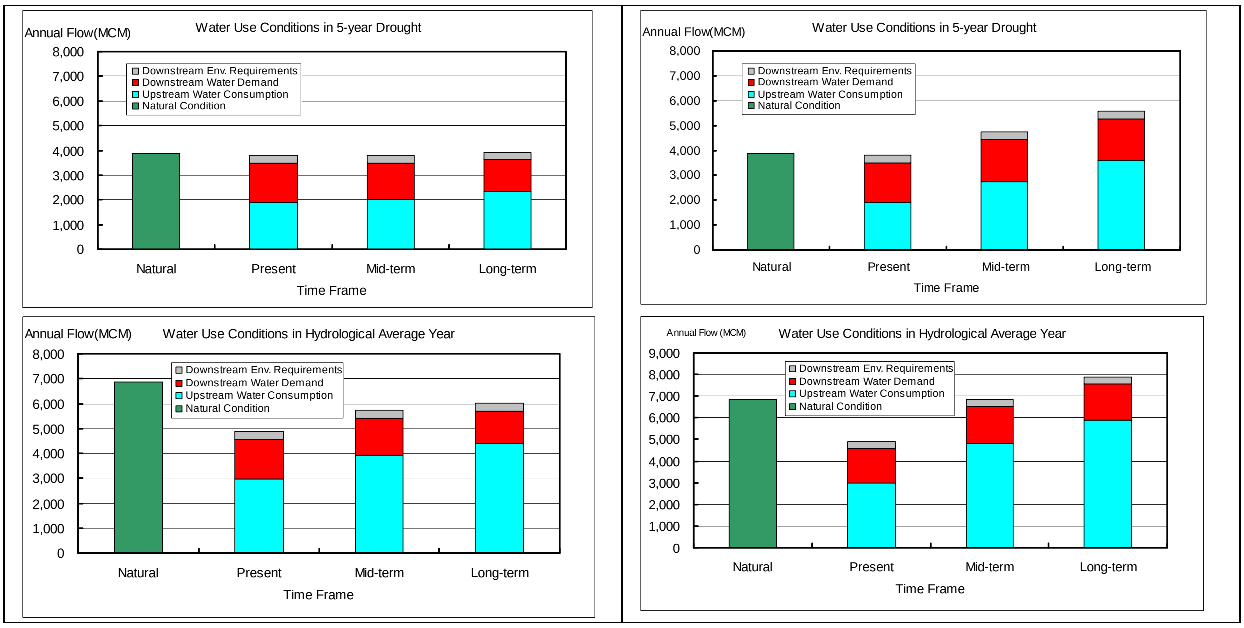


Figure 9.2 Water Resources Potential and Water Consumption/Demand up- and down-stream of the Manjil Reservoir (Left Figure: Improvement of Irrigation Efficiency proposed by WRMC, Right Figure: without Improvement of Irrigation Efficiency)

In the above figure, water consumption is calculated following the water resources projects on a mid-term and long-term basis, which were proposed by provinces concerned. The figure implies that 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.

Regarding groundwater resources, the groundwater tables have lowered by 3.2 m to 9.0 m for recent five years in some areas of the Zanjan and Kordestan provinces. These phenomena of groundwater lowering could be caused by over-extraction of groundwater beyond its potential.

2) Inexistence of Properly Functioning Institutions and Systems for Coordination

RWCs in the related seven provinces have proposed and implemented their water resources development plans/projects. Although “Long-Term Water Resources Development Strategy” in Iran prescribes that the water shall be managed in a macroscopic viewpoint, basin-wide coordination has not been made among the proposed plans/projects, and a technical tool to estimate the necessity for the coordination has not been developed. Furthermore, basin-wide coordination body has not existed to manage the basin in a macroscopic viewpoint.

3) Differences of Stakeholders’ Interests

Stakeholders in this study are RWCs in the related provinces, and they have been developing the water resources to fulfill the demand for their social and economic developments. Since their developments proceed without any coordination among the RWCs, no RWCs could notice the fact that their water resources have been already exhausted even in the last serious end. It might be the apprehensive worst scenario. Some preferable management directions of “Win-win approach”, in which all stakeholders in the basin can receive benefits, or “Fifty-fifty approach”, in which they meet their demands halfway each other, can not be taken to avoid occurrence of the worst scenario.

4) Low Reliability of Monitoring System and Data Observed

Although numbers of dam reservoirs will be constructed in the basin in a little more than two decades, an integrated data/information management system has not been established covering observed data of meteorology, hydrology and water quality, and real-time information of dam reservoirs such as reservoir water level and water release. Furthermore, it is necessary to monitor and archive high reliable meteorological and hydrological data.

9.1.2 Basic Concept for the Integrated Water Resources Management

In due consideration of the definition of IWRM and the emerging issues surrounding IWRM of the Sefidrud River basin, ideal and preferable IWRM shall be deliberated following the basic concepts below. To achieve properly objectives of IWRM, the following three pillars are setup as main supportive actions. The various active measures derived from these could mutually boost up to realize the IWRM process.

Three Pillars of the IWRM of the Sefidrud

(1) To formulate reasonable water allocation plan for sustainable water resources development for groundwater as well as surface water, through clarification of water resources development potential, correlated effects of the development projects and effects of irrigation efficiency improvement utilizing the basin model simulation.

(2) To formulate water resources management plan for monitoring the progress of sustainable water resources development, for revising them based on the evaluation, and for timely and prompt drought management using meteo-hydrological monitoring network.
To formulate watershed management plan following MOJA efforts for water harvesting, erosion control and flood control.

(3) To formulate institutional strengthening plan on water resources management and coordination for proper water resources management in the efforts to consult on water allocation, coordination of the projects and coordination of drought management among the provinces, for capacity building to manage the above activities, and for sustainable operation and maintenance of the new RBO.

The conceptual relationship among the goals, main activities and planning components is schematized in Figure 9.3.

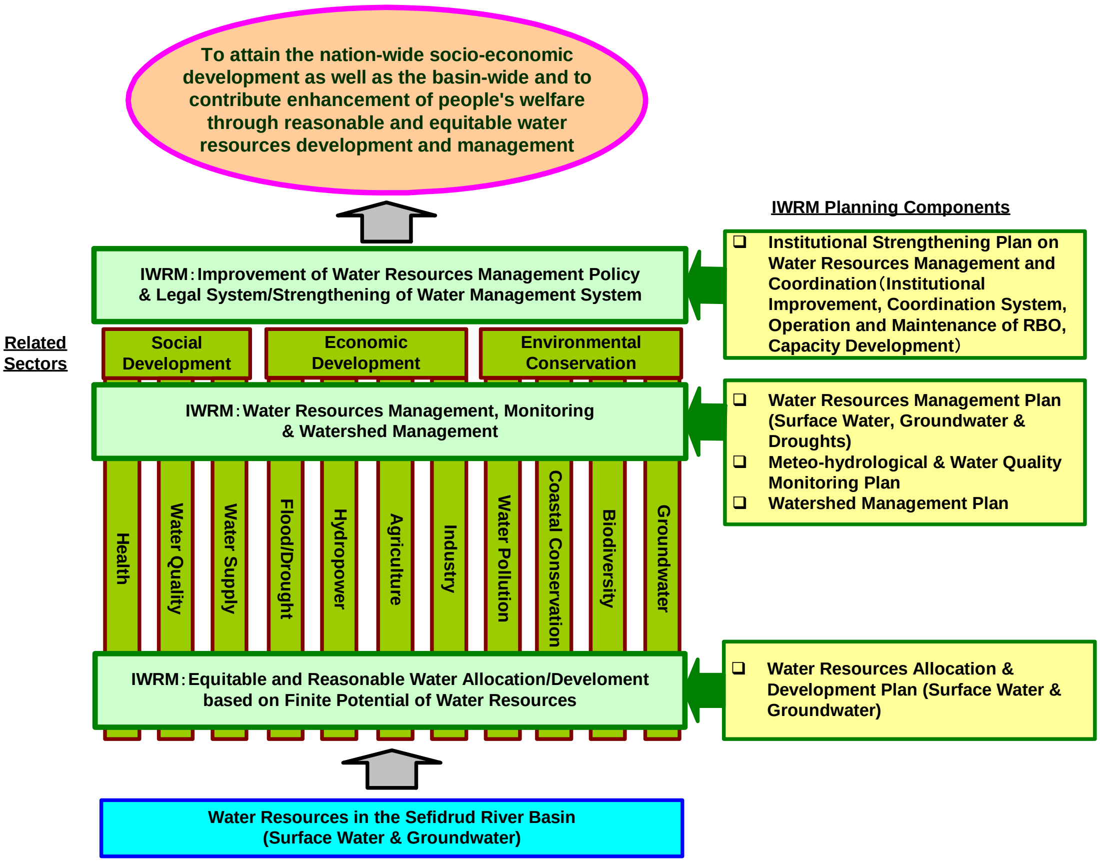


Figure 9.3 Integrated Water Resources Management Concept of the Sefidrud

As presented in the above figure, management system of IWRM could be established through the following process.

1) Water demands and water resources development plans to fulfil their demands shall be evaluated from development/improvement plans proposed by the sectors concerned in the basin. It would be most important that water resources potential and water balance among newly proposed water use and existing ones should be examined in a basin-wide manner. The basin simulation model, in which contains complex water balance including groundwater, water uses and water resources development facilities, could play a requisite role for this purpose.

2) In the water resources management, the first stage would be establishment of meteo-hydrological and water quality monitoring system to store monitored data in the database system as basic data/information. Based on the activities the basin simulation model could be upgraded or improved in parallel. In addition, further difficult issues of sediment runoff and salinity dissolution should be tackled in IWRM involving organization in watershed management, and management plan should consist of necessary activities and measures in a drought time as well as quantitative and quality management on surface water and groundwater.

3) In order to attain IWRM in proper functioning, establishment of a basin organization in the center of the coordination and management and improvement of legal system should be necessary. Consultation and coordination system, including target items to be consulted and approaches and methodologies on consultation and coordination, should be established. Administrative plans about management of the basin organization, its mandates and capacity development on its personnel should be established.

In addition, relationship among the components (sub-plan), which are composed of engineering intervention level and policy coordination one, is illustrated in Figure 9.4. Details of the components are described in the section of 9.3.

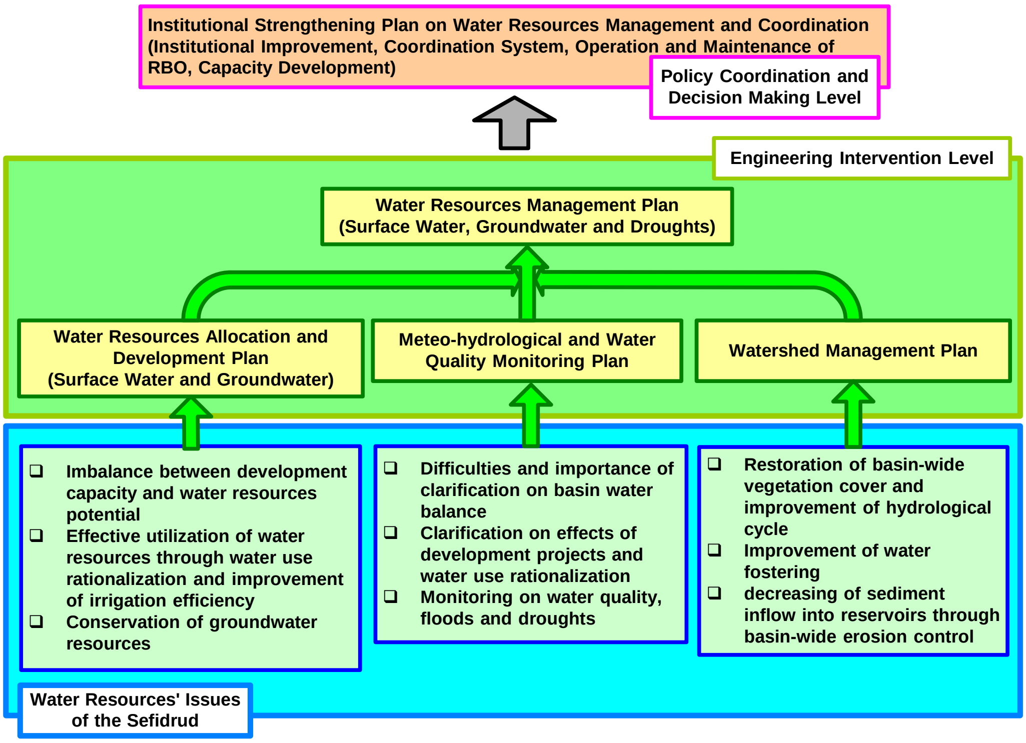


Figure 9.4 Structures of IWRM Components of the Sefidrud

The following are planning conditions of the Sefidrud IWRM, and each component shall follow those conditions.

1) Target Year of the IWRM

The phased plan shall be setup with target years of 2016 in the mid-term plan and 2031 in the long-term plan. Implementation period could be divided into two parts; namely phase I for 10 years from 2007 to 2016, and phase II for 15 years from 2016 to 2031. In accordance with the two periods, phased plan shall be proposed.

2) Basic Directions of Water Resources Development

Groundwater resources are usually utilized for domestic and industrial purposes due to their suitable water quality, while they are generally depending on the localities such as geological structures, precipitation, soil cover and so on. In many areas, groundwater resources are suffered from over-extraction resulting in declining the groundwater table so that groundwater shall be preserved in those areas.

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

3) Prioritization of Water Supply and their Safety Level

Following the priorities given to water usage in the long-term water resources development strategy of MOE, the 1st, 2nd and 3rd priorities shall be given to domestic, industrial and irrigation water uses, respectively. Furthermore, the safety level of water uses could be given by drought recurrence period; 5-year for all of the water uses.

4) Management of Irrigation Water

Irrigation water makes up around 95 % among the water uses at present. In fact irrigation water requirements widely depend on irrigation efficiencies, which are composed of conveyance, field canal and field application efficiencies. In the long-term strategy of MOE, it is stipulated that the irrigation efficiency shall be upgraded up to around 2 times of present one within 20 years (until 2023). The irrigation system improvement in the traditional irrigation area, however, requires large investment and is not easy according to the comments through the local consultation among the seven provinces. Thus the irrigation system improvement including upgrading irrigation efficiencies of traditionally irrigated areas, which are presently estimated at 0.33 on average, shall be set as one of the future improvement scenarios in the succeeding study.

IWRM Process

Through a series of simulation, optimum development scenario could be formulated following the above approach. In addition, Figure 9.5 could illustrate integrated water resources management process in the future.

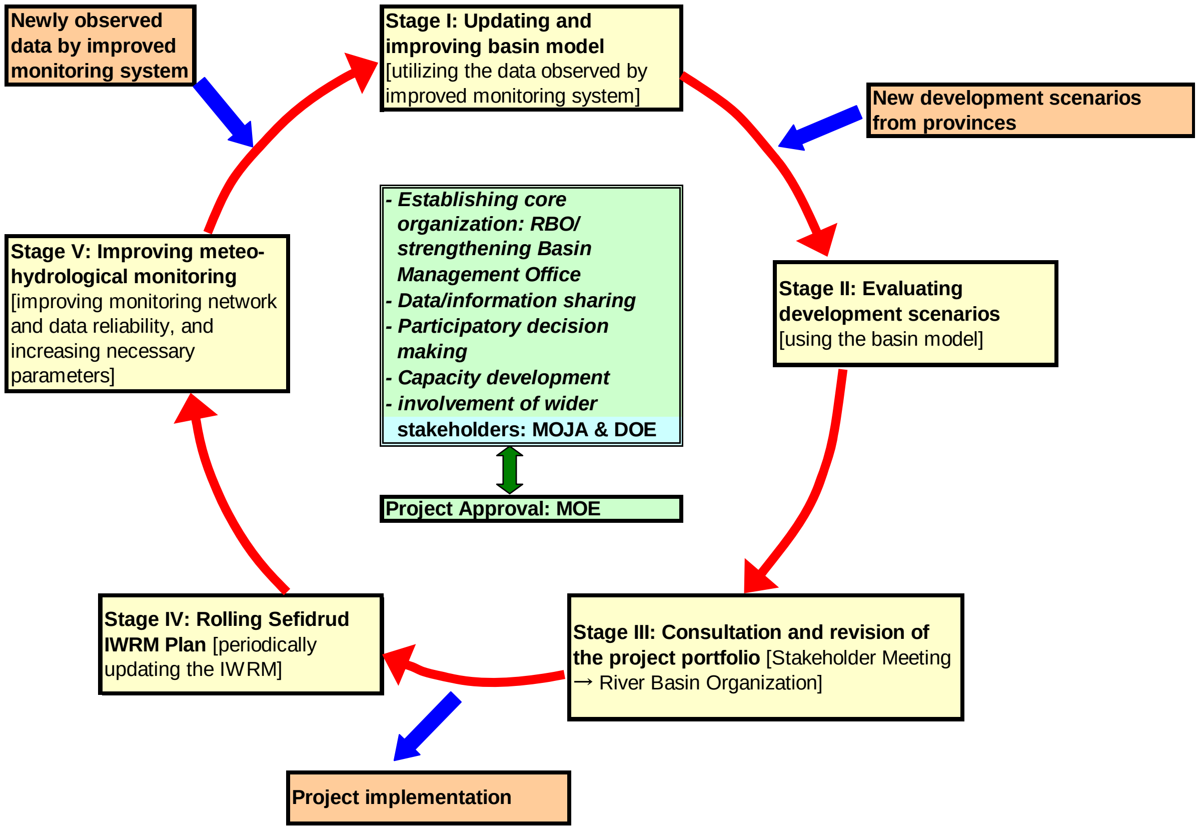


Figure 9.5 Conceptual Management Process in the Sefidrud IWRM

As illustrated in Figure 9.5, key process/cycle on the IWRM in the Sefidrud basin could be enumerated as follows:

- In the future, some projects adjustment or modification would be expected as long-term water resources development projects reaches to implementation stages.
- For such adjustment or modification, some organization like River Basin Organization (RBO) of which members are consisted by central/provincial governmental staff, should be established to discuss and coordinate the issues.
- The RBO will evaluate the water resources development projects proposed by the provinces utilizing basin model, and will revise the IWRM program, if necessary.

- Approved projects will proceed towards their implementation.
- The RBO and RWCs in the provinces will work together for improvement of meteo-hydrological monitoring network and upgrading the basin model by utilizing the monitored data.

This continuous process itself is an integrated management work on the Sefidrud water resources.

<u>Issues for IWRM Realization</u>

A base of the evaluation criteria in the IWRM process is how minimum flow requirements at control points can be set up. In general, minimum flow requirements are defined as water demands downstream of a control point consisting of water uses and environmental needs. In particular, the requirements are seasonally set up in accordance with periodical demands in agriculture water. The setting-up of requirements, however, usually accompanies the following difficulties.

- Control points should be selected among major hydrological stations and important water utilization facilities such as large dams along the mainstream. It would be difficult in many cases to estimate minimum flow requirements at any control points due to complex mechanism of hydrological cycle and water use including return flow.
- In the basin in which a lot of water resources development projects are under construction or designing/planning, water balance would change in parallel with progress of the development projects as well as progress of irrigation system improvement. Thus its setting-up of the requirements would be much more difficult.

In addition to the above difficulties, the minimum flow requirements could be sequentially set up from the downstream end towards the upstream points based on water demand and environmental needs, as illustrated below. The following issues, however, could be pointed out.

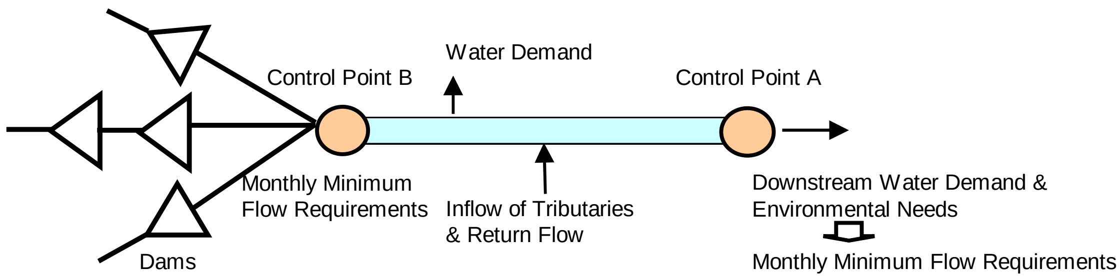


Figure 9.6 Setting-up Concept of Monthly Minimum Flow Requirements

- An estimation would be made including uncertain factors of intake possibility and return flow in the traditional irrigation areas.
- Dam development schemes are planned to fulfill water demands of the related development areas, while they are not planned to fulfill the minimum flow requirements in the downstream stretch. The planned dam reservoirs would store stream flow into their reservoirs as much as possible, following their own purposes and disregarding water release for the water demand in the far downstream areas. Thus, minimum flow requirements at the downstream control points could be only functioned as after-the-fact check in the water resources management.
- Dam reservoirs are allocated in series or parallel in the basin, while reasonable and rational operational rules of them are not examined in their water resources development plans. Thus establishment of the integrated operational rules of dam reservoirs could be easily considered as a hard challenge.
- If the minimum flow requirements at the many control points are set up, it may be expected that conflicts among the stakeholders would come out into the open and discussion among

them could become uncontrollable resulting in obliging them to continue the long-lasting coordination.

Furthermore, the following data/information are too shortage to formulate properly IWRM in the Sefidrud River basin.

- Water resources development plan: F/S reports of dam development plans including regional hydrology, water supply and distribution, dam reservoir operation, and principle features of dam and reservoirs
- Irrigation development plan: (1) irrigation areas, (2) water utilization facilities such as dams and/or weirs, (3) irrigation canal network, (4) crops to be irrigated
- Aquifer information: (1) geological structures of aquifers such as extent, depth and cross-sections, (2) historical data for a long time on intake volumes and groundwater table

Hydrological designs in the dam drainage areas and dam reservoir operation plans could not be made clear due to inaccessibility of F/S reports of dam development plans, resulting in difficulties of evaluating individual dam planning. Meanwhile relationship among dam reservoirs, intake weirs and their command areas could not be made clear due to inaccessibility of extent of irrigation areas and irrigation canal networks. Furthermore, inaccessibility of groundwater information might lower the reliability of water balance simulation. In the future, better accessibility on the data/information can improve and upgrade the basin simulation model.

Due to the above-mentioned inaccessibility on necessary information, it make much difficult to evaluate of individual dam planning and to set up of minimum flow requirements. Thus the study approach shall be taken as described in the following clause.

9.1.3 Approach in Integrated Water Resources Management of the Sefidrud Basin

Provinces related to the Sefidrud basin are planning and implementing their own water resources development projects towards the year 2016 as a mid term target and the year 2031 as a long term target. The mid- and long term water resources development scenario fully covering the above-mentioned projects shall be as a first step for further analysis. The following criteria and process for evaluation of future development scenario shall be taken, as illustrated in Figure 9.7.

(i) Water resources potential shall be evaluated at the Manjil dam, where the most serious conflict exists, how its release would fulfill or affect the downstream demand. Instead of setting-up of minimum flow requirements, it will be evaluated using sufficiency rate (= dam release water and inflow from a remnant basin/downstream water demand) comparing with monthly release water from the Manjil dam and monthly water demand in the SIDN areas.

(ii) At first step, all of the water resources development projects proposed by the provinces concerned will be evaluated through basin model simulation, since those development projects could be regarded as fully meeting with their provincial development demands until long-term target year of 2031. In other words, those could be approximate to the future full development in every province until 2031.

(iii) On the other hand, Sefidrud Irrigation and Drainage Network (SIDN) is located in the downstream areas of the Manjil dam, Gilan Province. From the water resources potential over the Sefidrud basin, its demand is one of the important indicators to manage the entire water resources of the Sefidrud basin.

(iv) As an initial condition for scenario development, the irrigation system improvement in accordance with upgrading irrigation efficiency will be remained as present status. After examination of effects of irrigation efficiency, the irrigation system improvement shall be dealt with one of the alternative scenarios.

(v) Keeping a balance between upstream demands and downstream ones of the Manjil dam, alternative coordinative scenarios shall be developed in due consideration of equitable and socio-economically reasonable developments over the basin.

(vi) Furthermore, considering socio-economic and environmental issues, in particular seriously lowering groundwater table and environmental flow requirements, the mid- and long-term development scenario shall be finally modified as a sustainable one.

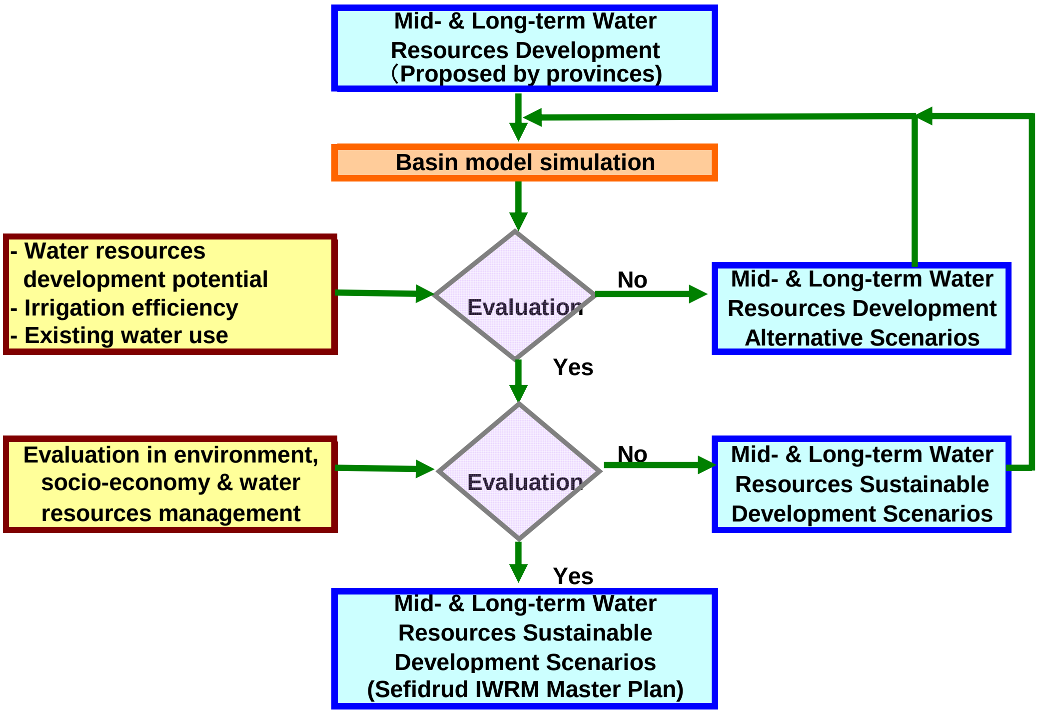


Figure 9.7 Planning Approach for Formulation of the Sustainable Sefidrud IWRM

The study approach is selection of the optimum scenario on a basis of trial run through a series of simulation.

9.2 STUDY ON INTEGRATED WATER RESOURCES MANAGEMENT

9.2.1 Planning Frame and Basic Conditions

Setting the target year of 2016 as a mid-term and 2031 as a long-term, the following planning frame and conditions will be considered for the study on the Sefidrud IWRM.

1) Water Demand

Water demand should be basically estimated through the study on expected usage for various purposes of domestic, industry and agriculture considering the proposed development program and socio-economic frame in the target years. In this study, however, the water demand is given by Mahab Ghodss Company in principle and it will be used for the study through examination by the study team. The water demand is described in the Chapter 6 in detail.

2) Irrigation Efficiency

Agriculture is the largest water user in the basin so that improvement of irrigation system such as canal improvement and changes of irrigation methods will strongly influence the water demand in the basin. In due consideration to the above, improvement of irrigation efficiency shall be incorporated into one of the development scenarios in this study. The first step of the study starts at the present efficiencies and they are assumed to continue until the mid- and long-term target year. The present values are enumerated below as described in the Chapter 6.

- Traditional irrigation areas: 0.33
- Sefidrud Irrigation and Drainage Network in Gilan: 0.42
- Irrigation areas supplied water by newly constructed dams: 0.60

3) Dam Planning

The objective dams in the study are the 3 existing dams, the 14 dams under construction in the mid-term, and the additional 19 dams (later on added 2 dams) planned in the long-term targets. Preliminary evaluation on these dams is made as presented in Figures 9.8 and 9.9. Table 9.1 summarizes the results. Several dams have too big effective storage compared with their drainage areas and annual inflows. This fact implies suitable dam sites are limited in the basin, in particular in the middle and upper basins, as well as in time lapse up to the long-term target.

A year-to-year long-term storage is usually considered in dam planning in Iran. Nearly half of dams, of which reservoir storage exceeds annual inflow, exist as illustrated in Figure 9.9. It is apprehensive that the dam reservoirs, of which storage efficiency to annual inflow is low and storage could not be filled with stream flow for a long time, would increase in future.

Table 9.1 Preliminary Evaluation of the Existing and Planning Dams

Dam	Status	Specific Effective Storage (equivalent rainfall)	Effective Storage compared with Annual Inflow
Taleghan	existing	around 400mm	
Shahreh	mid-term	around 400mm	
Taham	do	more than 400mm	exceeding annual inflow
Siazakh	do	200-400mm	
Sural	do	200-400mm	
Mendagh	long-term	more than 400mm	exceeding annual inflow
Sangabad	do	around 400mm	exceeding annual inflow
Sir	do	around 200mm	exceeding annual inflow
Alebdare	do	around 200mm	
Ramin	do		exceeding annual inflow

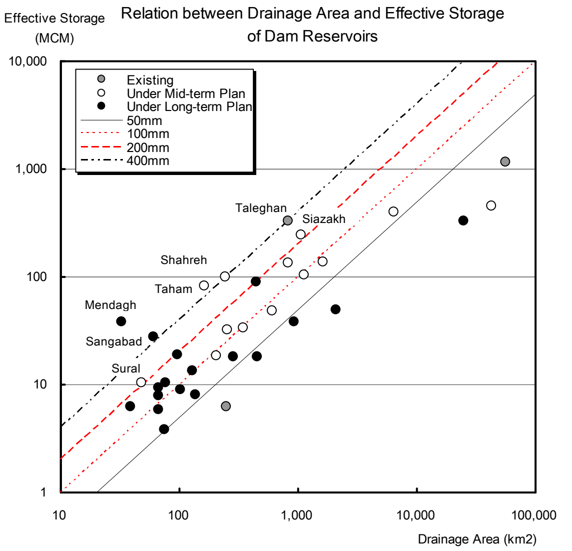


Figure 9.8 Relationship between Drainage Area and Effective Storage of Target Dams

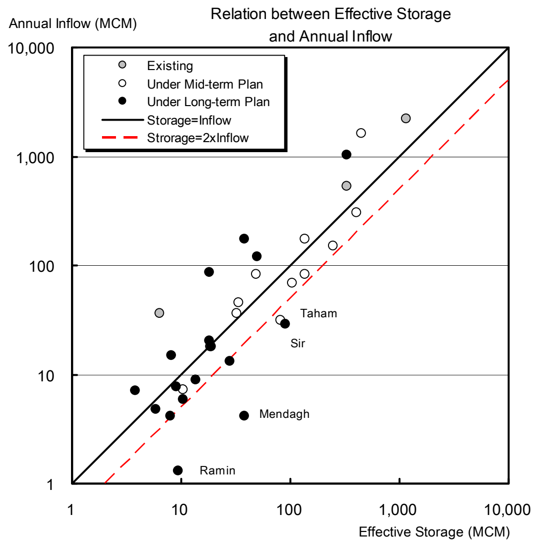


Figure 9.9 Relationship between Effective Storage and Annual Inflow of Target Dams

9.2.2 Study on Medium and Long-Term Integrated Water Resources Management Scenarios

Scenario evaluation shall be conducted in the following criteria:

(i) To meet the water demand downstream of Manjil Dam, which consists of domestic water, agricultural water and environmental needs for Sturgeon's spawning and hatch; and

(ii) To meet the water demand for traditional irrigation areas upstream of Manjil Dam.

For the above purposes, the following three development scenarios shall be examined:

(i) Scenario 1: Irrigation efficiency in the traditional irrigation areas and SIDN areas will not be improved, and water resources development plan proposed by the provinces will be implemented;

(ii) Scenario 2: Irrigation efficiency in the traditional irrigation areas and SIDN areas will not be improved in an intermediate manner between Scenarios 1 and 3, and water resources development plan proposed by the provinces will be implemented; and

(iii) Scenario 3: Irrigation efficiency in the traditional irrigation areas and SIDN areas will be improved as WRMC proposed, and water resources development plan proposed by the provinces will be implemented.

1) Irrigation Efficiency Setting

In each scenario and target year, irrigation efficiency is set up as tabulated below.

Table 9.2 Irrigation Efficiency Setting

Scenarios	Year	Irrigation Efficiency		Remarks
		Traditional Irrigation Area	SIDN in Gilan Province	
1	2007 (Present)	0.33	0.42	Without improvement of efficiency
	2016 (Medium-Term)	0.33	0.42	
	2031 (Long-Term)	0.33	0.42	
2	2007 (Present)	0.33	0.42	Intermediate level between Scenarios 1 and 2
	2016 (Medium-Term)	0.37	0.45	
	2031 (Long-Term)	0.44	0.51	
3	2007 (Present)	0.33	0.42	Improvement plan proposed by WRMC
	2016 (Medium-Term)	0.40	0.48	
	2031 (Long-Term)	0.50	0.55	

2) Comparative Study on Irrigation Efficiency Improvement Scenarios

Interactive effects between dam development schemes and improvement of irrigation efficiency are as shown in Table 9.3 and Figure 9.6.

Table 9.3 Agricultural Water Demand Sufficiency by Irrigation Efficiency Improvement Scenarios

Irrigation Efficiency Improvement Scenario		Without Improvement	Intermediate Improvement	Improvement proposed by WRMC
Irrigation Efficiency	T.I. Area	0.33	0.37 (Mid); 0.44 (Long)	0.40 (Mid); 0.50 (Long)
	SIDN	0.42	0.45 (Mid); 0.51 (Long)	0.48(Mid); 0.55 (Long)
Hydrologic Conditions	Time/Area	Water Demand Sufficiency in Traditional Irrigation Area and SIDN (%)		
5-Year Drought	Present			
	T.I. Area	60.8	60.8	60.8
	SIDN Area	90.9	90.9	90.9
	Medium-Term			
	T.I. Area	71.5	72.2	78.7
	SIDN Area	83.0	89.4	95.6
	Long-Term			
	T.I. Area	74.1	78.9	85.2
	SIDN Area	80.3	90.5	99.4
Average Year	Present			
	T.I. Area	89.7	89.7	89.7
	SIDN Area	100.0	100.0	100.0
	Medium-Term			
	T.I. Area	90.9	91.6	94.3
	SIDN Area	100.0	100.0	100.0
	Long-Term			
	T.I. Area	89.9	93.0	95.4
	SIDN Area	83.3	100.0	100.0

T.I Area: Traditional Irrigation Area

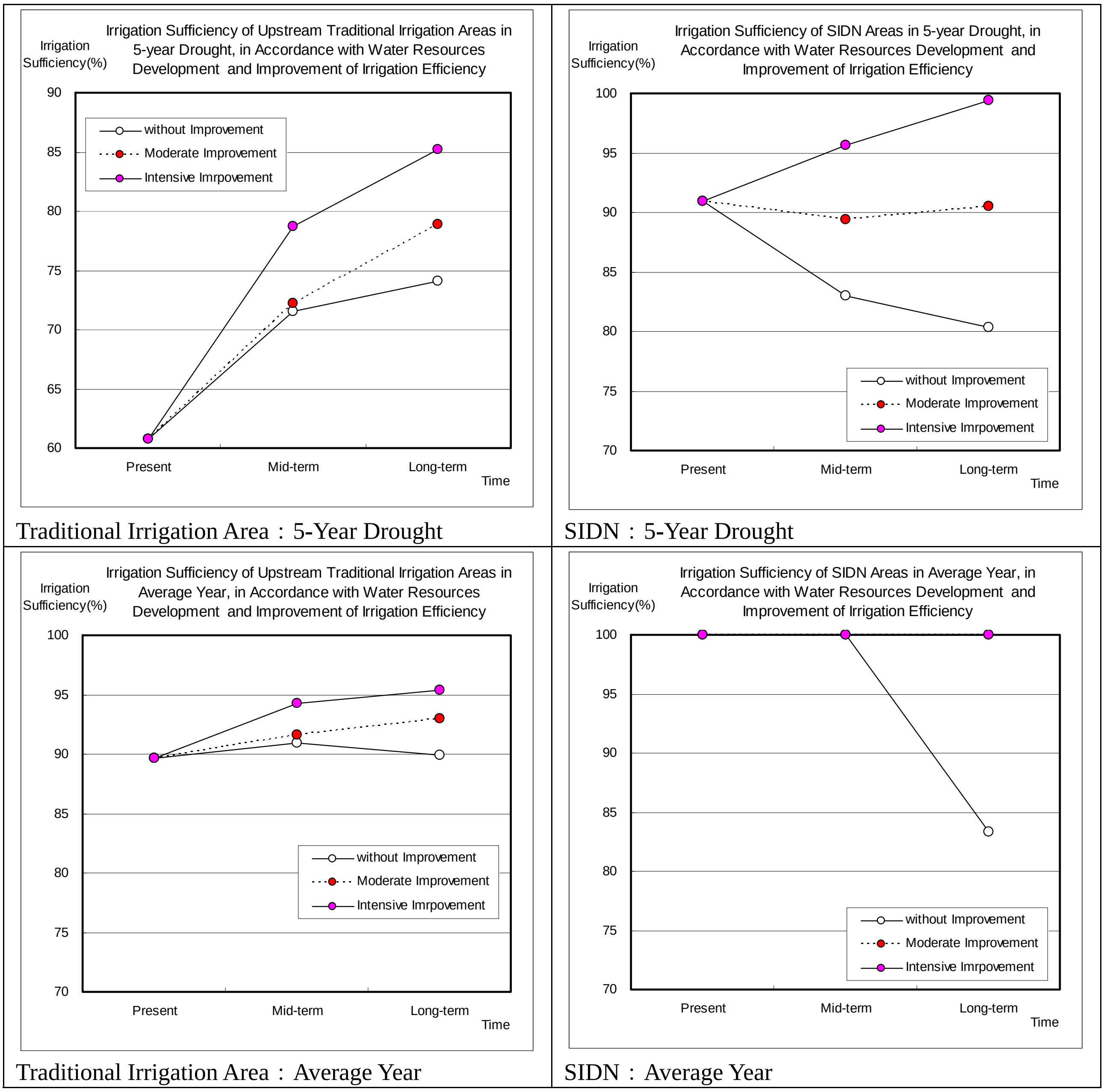


Figure 9.10 Agricultural Water Demand Sufficiency
by Irrigation Efficiency Improvement Scenarios

Based on the above results, interaction effects between water resources development and irrigation efficiency improvement could be as summarized below.

- Water demand sufficiency of 90 to 95% in the traditional irrigation areas could be secured from present to future in an average hydrological year.
- Water demand sufficiency of 60% in the traditional irrigation areas could be upgraded to 72 to 79% in the medium-term and 74 to 85% in the long-term targets. The upgrading is due to contribution of water resources development as well as irrigation efficiency improvement. The contribution ratios of these two factors are considered almost equivalent.
- Water demand sufficiency of 100% in the SIDN area could be secured from present to future in an average hydrological year. Unless the improvement is carried out, the sufficiency would be degraded to 83% in the long-term target.

- Similarly, in 5-year drought, water demand sufficiency in the SIDN area strongly depends on future irrigation efficiency improvement. For instance, unless the improvement is done, the sufficiency would be degraded to 83% in the medium-term, and 80% in the long-term targets. On the other hand, if the irrigation efficiency is improved, the sufficiency could be upgraded to 89 to 96% in the medium-term, and 91 to 99% in the long-term targets.

Based on the above observations, obvious are the following principal features of water resources development and irrigation efficiency improvement, and basic future directions:

(i) 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 drought time. Furthermore the sufficiency could be upgraded much more through irrigation efficiency improvement.

(ii) 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 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. In other words, although the water resources development projects could improve the water situation in the upstream areas, adverse effects would take place to the water uses in the downstream areas of Manjil Dam due to degradation of flow regime in the lower reaches. To remedy the situation, further upgrading of sufficiency in the upper reaches to secure the sufficiency in the lower reaches is indispensable for the improvement of irrigation efficiency.

9.2.3 Study on Medium and Long-Term Sustainable Integrated Water Resources Management Scenarios

The results studied in the preceding section are as summarized below.

- All of the water resources development projects proposed by the provinces concerned are fully incorporated into both medium and long-term development scenarios.
- In addition, it is indispensable to improve irrigation efficiency to 0.37 in the medium-term and 0.44 in the long-term for the traditional irrigation area, and to 0.45 in the medium-term and 0.51 in the long-term for the SIDN area, at least, up to the intermediate improvement level as described in the preceding section.

The integrated water resources management scenario proposed in the preceding section shall be elaborated in a sustainable manner by adding the following environmental factors/issues. This study shall proceed based on the intensive improvement scenario on the irrigation efficiency proposed by WRMC.

(i) Remedial measures for aquifers where groundwater table has been lowering.

(ii) Environmental flow in the upper reaches of the Manjil Dam reservoir.

1) Remedial Measures for Aquifers where Groundwater Table has been Lowering

The following table summarizes the lowering of groundwater table and water balance in aquifers. Locations of aquifer are as indicated in Figure 9.11.

Table 9.4 Lowering of Groundwater Table and Water Balance in Aquifers

Zone	Sub-Zone	Area (km^2)	Code of Aquifer	Province	Annual Precipita-tion*1 (mm/y)	Annual Evapotran-spiration (mm/y)	Groundwater Recharge*2 (MCM/y)	Present Groundwater Demand (MCM/y)	Water Balance (MCM/y)
A	A-1	6,445.5	1308	Kordestan	285	195	220	468	-248
	A-3	6,004.0	1307	Kordestan	251	177	163	182	-19
B	B-2	2,395.4	1306	Zanjan	324	221	39	100	-61
	B-3	4,590.6	1304	Zanjan	324	228	73	314	-241
	B-4	6,527.1	1305	Zanjan	268	196	128	206	-78
C	C-1	1,761.2	1302	Ardabil	378	247	29	109	-80
	C-2	1,679.3		Ardabil	522	371	39	71	-32
	C-4	2,763.3	1311	Gilan (upstream)	259	222	9	44	-35
Total		32,166.4					700	1,494	-794

*1 Data observation period is 20 years from 1985 to 2005.
*2: Estimation from the results of simulation

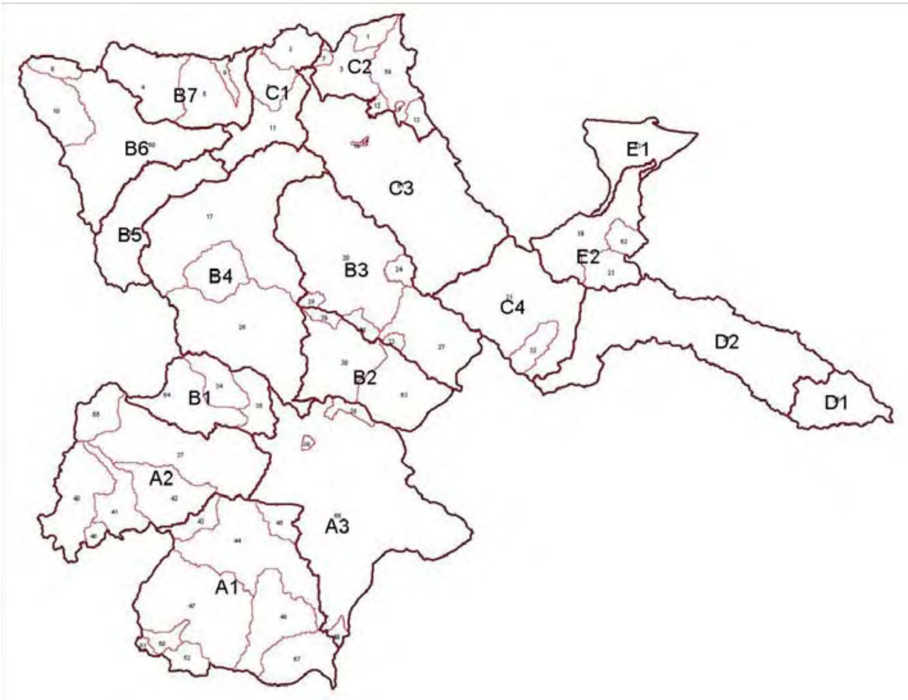


Figure 9.11 Zone and Sub-Zone Divisions for Basin and Groundwater Aquifer

Compared with groundwater demands and groundwater recharge potentials, the possibility of conversion to the surface water sources is examined, focusing on the water demands exceeding the recharge potentials. The necessary conversion volumes to prevent the lowering of groundwater table are tabulated in Table 9.5.

Table 9.5 Requirements of Conversion of Demand from Groundwater to Surface Water

Zone	Sub-Zone	Area (km²)	Code of Aquifer	Province	Groundwater Recharge (MCM/y)	Groundwater Demand (MCM/y)			Conversion Volume from Groundwater to Surface Water (MCM/y)		
						2006	2016	2031	2006	2016	2031
A	A-1	6,445.5	1308	Kordestan	220	468	446	371	248	226	151
	A-3	6,004.0	1307	Kordestan	163	182	178	174	19	15	11
B	B-2	2,395.4	1306	Zanjan	39	100	78	67	61	39	29
	B-3	4,590.6	1304	Zanjan	73	314	279	285	241	206	212
	B-4	6,527.1	1305	Zanjan	128	206	170	144	78	42	16
C	C-1	1,761.2	1302	Ardabil	29	109	95	82	80	66	53
	C-2	1,679.3		Ardabil	39	71	61	44	32	22	5
	C-4	2,763.3	1311	Gilan (upstream)	9	44	44	44	35	35	35
Total		32,166.4			700	1,494	1,351	1,211	794	652	511

To materialize the conversion works, additional irrigation facilities such as intake and canal network to intake surface water and to distribute the water to the fields will be required. Thus immediate actions are difficult so that simulation is made only in the medium and long-term targets. From the simulation results, the target aquifers could be categorized into two types resulting in different difficulties to take remedial measures.

Areas with Surface Water Potential for the Conversion: A3, B2, B4, C1, C2, C4

Although both potentials of surface water and groundwater are not completely sufficient for the existing groundwater demand in these sub-zones, the demand could be nearly fulfilled so that the conversion could be achieved. Figure 9.12 shows the simulation results of Sub-Zone C1 as an example.

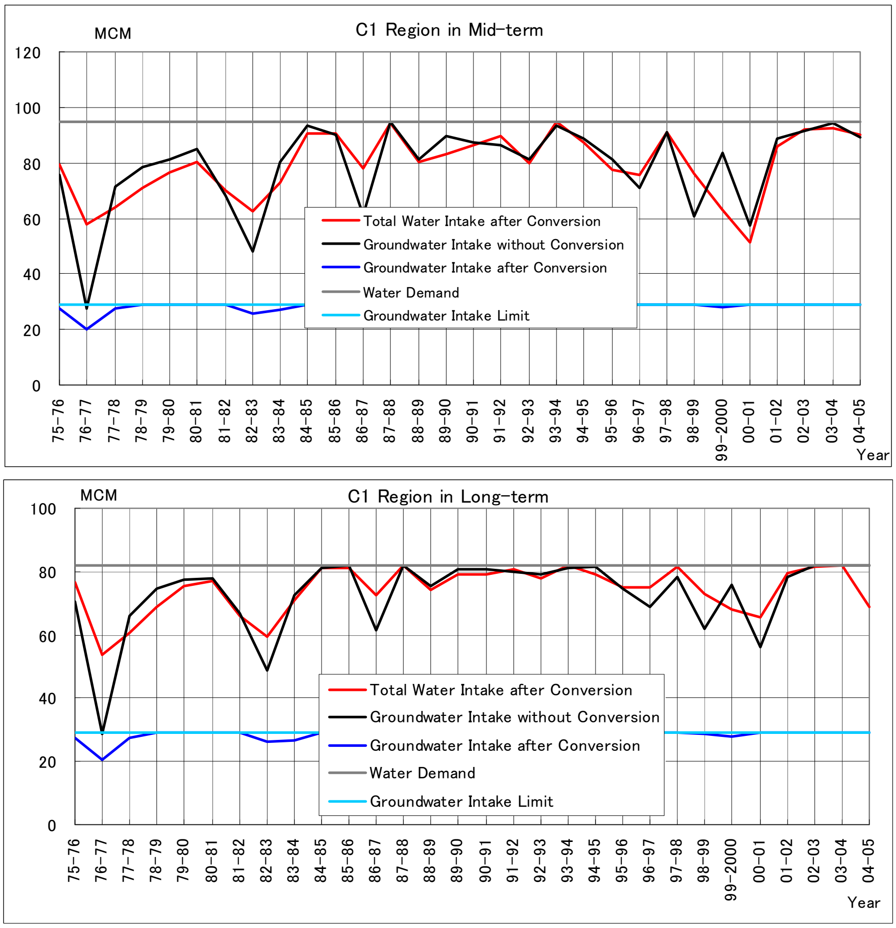


Figure 9.12 Simulation Results of Conversion of Groundwater Intake to Surface Water (C1 Sub-zone: Upper: Medium-Term; Lower: Long-Term)

Areas with Insufficient Surface Water Potential for the Conversion: A1, B3

Physically, development potentials in both groundwater and surface water are not sufficient for water demand in these sub-zones so that it shall be difficult to convert water source from groundwater to surface water. Figure 9.13 shows the simulation results of Sub-Zone B3 as an example.

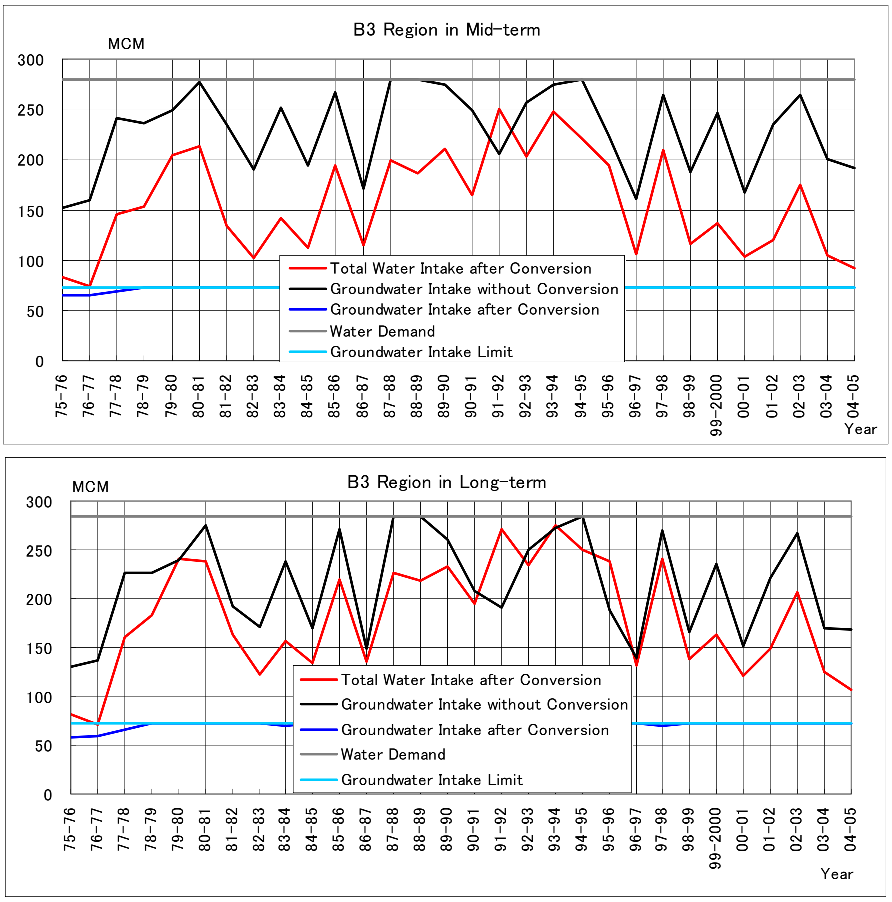


Figure 9.13 Simulation Results of Conversion of Groundwater Intake to Surface Water (Sub-Zone B3: Upper: Medium-Term; Lower: Long-Term)

As a conclusion of this simulation, concrete remedial measures, for instance, designing and installation of surface water intake and its distribution system, shall be carried out in Sub-Zones A3, B2, B4, C1, C2, C4 where conversion of groundwater intake to surface water could be possible due to sufficient water resources potential. On the other hand, the following measures shall be examined as to applicability in the areas of Sub-Zone A1, upstream of Talvar Dam, and Sub-Zone B3 of the Zanjan River Basin.

(i) Water demand control by changes of water-thirsty crops to water-saving crops and improvement of irrigation method;

(ii) Upgrading of irrigation efficiency through improvement of irrigation system; and

(iii) Water conveyance by inter- or intra-basin water transfer system.

2) Examination on Environmental Flow in the Upper Reaches of the Manjil Dam Reservoir

Regarding environmental flow in the lower reaches of the Manjil Dam reservoir, environmental flow for Sturgeons' spawning is incorporated in the simulation. The environmental flow is thus examined in the upper reaches of the Manjil Dam reservoir. In the upper stretch, there are no indicative flora and fauna to set-up the environmental flow, or no precious species to be conserved. Thus the study on environmental flow will be made using hydrological approach as a simple method.

Examined are how low-flow situations will change from the present via medium-term until long-term in parallel with development progress, using 90% probability discharge in the flow duration curves of a 5-year drought and average year as a hydrological parameter. The results are as tabulated in Table 9.6 and illustrated in Figure 9.14 and Figure 9.15.

Table 9.6 Future Changes of 90% Flow Discharge at Representative Stations

Hydrological Station	Q_{90} in 5-Year Drought (m^3/s)			Q_{90} in Average Year (m^3/s)		
(Station Code: Drainage Area)	Present	Medium-Term	Long-Term	Present	Medium-Term	Long-Term
Talvar (17-007: 5,920 km^2)	0.06	0.10	0.11	1.07	1.08	0.99
Ghare Goony (17-011: 19,340 km^2)	2.48	3.20	1.47	6.45	5.93	3.65
Mah Neshan-lailan (17-015: 24,219 km^2)	2.19	1.47	0.73	5.89	5.69	4.85
Pole Dokhtar Mianeh (17-021: 32,853 km^2)	0.13	0.20	0.16	0.66	1.89	2.83
Ostor upstream (17-029: 41,980 km^2)	1.46	1.75	1.97	7.48	7.68	8.63
Ostor downstream (17-029: 42,600 km^2)	0.12	10.34	10.34	2.11	10.34	10.34
Gilvan (17-033: 48,629 km^2)	0.01	5.35	5.68	0.53	8.00	10.82
Loshan (17-041: 4,852 km^2)	10.73	13.43	5.56	17.63	18.03	12.46

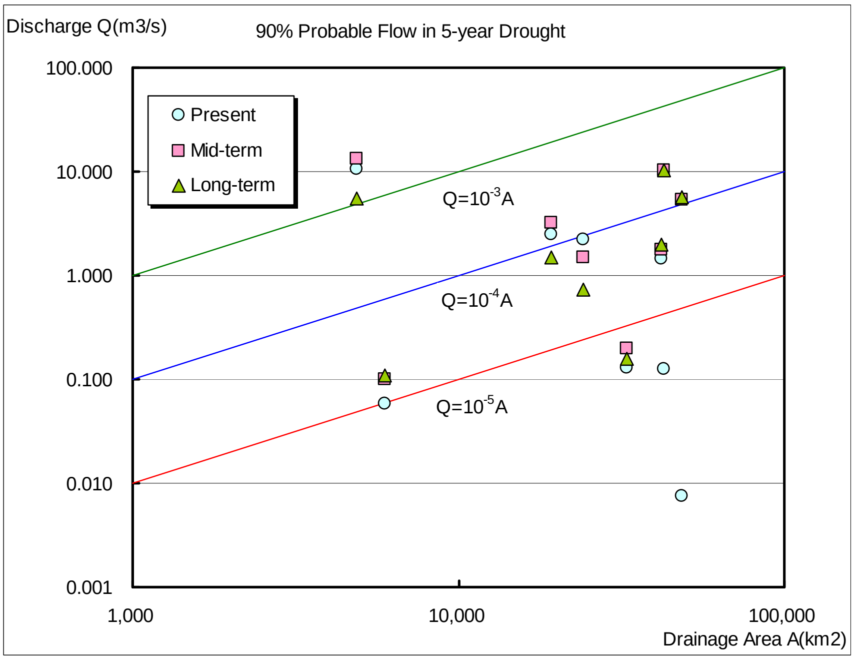


Figure 9.14 Future Changes of 90% Flow Discharge at Representative Stations in 5-Year Drought

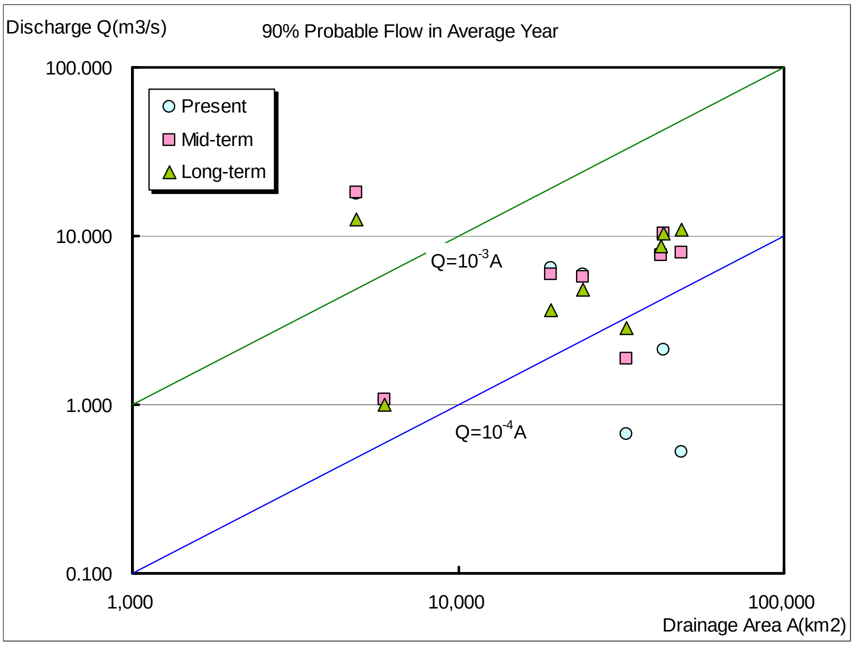


Figure 9.15 Future Changes of 90% Flow Discharge at Representative Stations in Average Year

These results indicate the following facts and predictions:

- At present the low flows at the lower stretch, such as Pole Dokhtar Mianeh, Ostor and Gilvan, are insufficient compared with the ones at stations in the upper stretch.
- In the medium-term, the low flow conditions at Ostor and Gilvan will improved after construction of Ostor Dam, since these locations will receive release water of the Ostor for hydropower generation.
- On the other hand, low flow conditions at Pole Dokhtar Mianeh will not drastically improve in a 5-year drought, but in an average year.

Future water resources development may contribute to improve the low flow conditions closely related to environmental needs. Furthermore, it is not recommendable to set up concrete environmental flows and to incorporate some storage for this purpose into the reservoir storage volume because of the following reasons:

- The water use demand in the downstream reaches of Manjil Dam is almost fulfilled.
- If some environmental flow is released from the dam reservoirs, the flow of unusable water into Caspian Sea will accelerate resulting in the loss of precious water resources.

In addition, the environmental flow setting needs detailed local survey on ecological conservation of water quality and fauna and flora along the river courses, opinion research from wide stakeholders and consensus-building among them, clarification of deteriorated flow regime segments and impacts to the surrounding environment.

9.2.4 Evaluation of the Plan on Environment, Socio-Economy and Water Resources Management

1) Environment

It becomes clear that water resources development projects could improve the flow regime from water environmental aspects. In the downstream of Manjil Dam, it has been confirmed that the environmental flow for Sturgeon's spawning was secured seasonally through hydrological simulation. On the other hand, the environmental flow setting shall be determined deliberately since the detailed study in the localities and water resources utilization potential would reach its limits.

Closely related to water resources management, another issue to conserve the groundwater aquifers exists where the groundwater tables have been lowering for a long time due to excessive water withdrawal beyond rechargeable capacity. The possibility to convert water sources from groundwater to surface water has been clarified except for the aquifer of A1 in Kordestan Province and the aquifer of B3 in Zanjan Province. For these aquifers, the possible conversion of water sources as well as the following measures shall be taken into consideration to conserve the aquifers:

- Improvement of the groundwater withdrawal and distribution system to upgrade the irrigation efficiency;
- Promotion of understanding the necessity for water source conversion from groundwater to surface water, and consensus-building among the groundwater users;
- Construction of intake and distribution facilities in the surface water utilization system; and
- Establishment of groundwater monitoring and checking system.

2) Socio-Economy

Since regional economy in the basin strongly depends on agriculture, and agriculture water demand makes up to 95% in all of the existing water demands, the distribution and increase of irrigated areas in sub-zones is examined from the socio-economy aspects. Figure 9.16 shows their occupancy rate to the sub-zone's area. The highest rate is found in the SIDN area of Gilan Province, indicating that agricultural development in the area has already reached the high level.

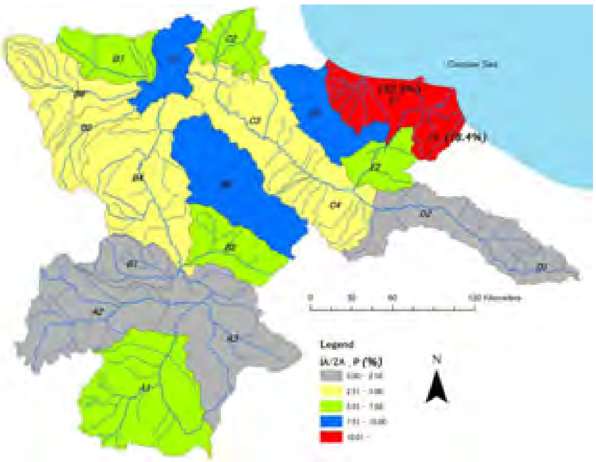


Figure 9.16 Occupancy Rate of Existing Irrigation Area to Sub-Zone

Figure 9.17 presents the increase of existing irrigation areas in the future, namely; the direct effects of water resources development projects. Furthermore, the figure indicates that 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.

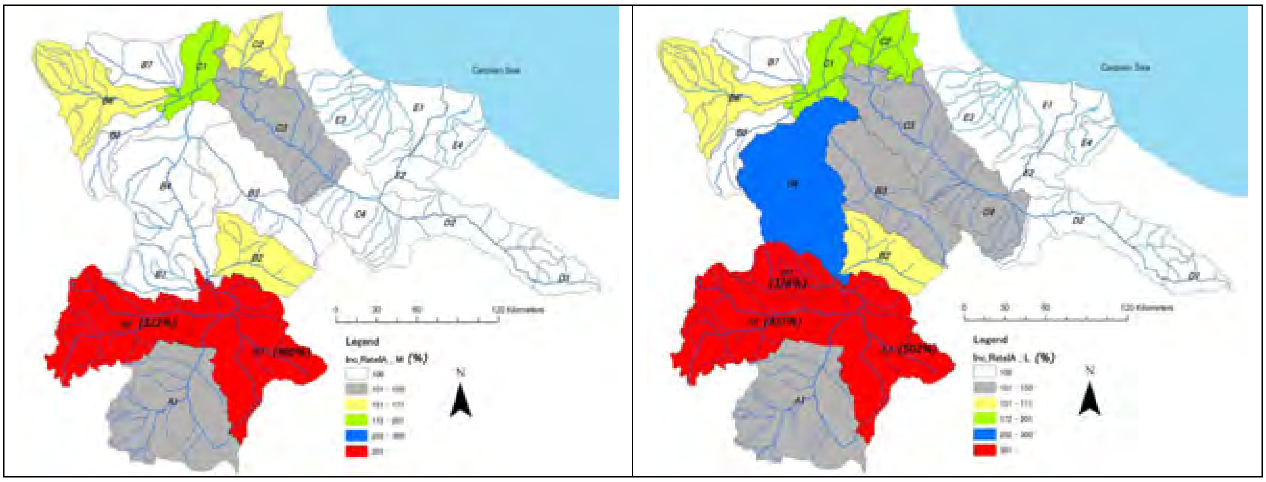


Figure 9.17 Incremental Rate of Future Irrigation Area (Left: Medium-Term; Right: Long-Term)

In parallel with the increase of irrigation areas, the increase of agricultural productivity through the increase of irrigation water supply could be considered as another factor of socio-economy. Figure 9.18 indicates an existing agricultural productivity of the irrigation area defined by the agricultural production output in unit irrigation area. Since rice has been traditionally cultivated as a national strategic product, the agricultural productivity in Gilan Province is relatively lower. On the other hand, alfalfa or fruit trees as high-cash crops have been cultivated in the upper reaches in the recent years resulting in the show of high productivity.

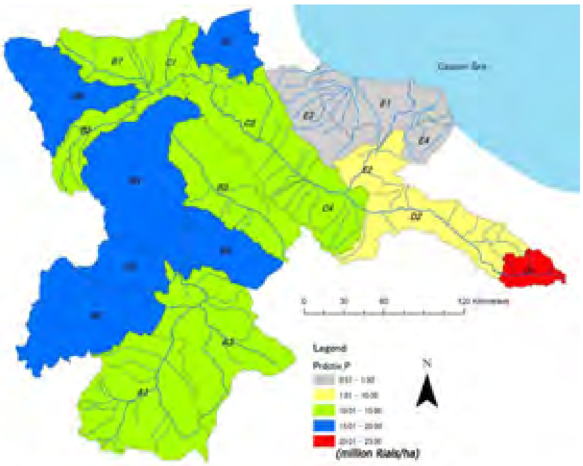


Figure 9.18 Present Agricultural Productivity in Unit Irrigation Area

Using the above unit agricultural productivity, Figure 9.19 illustrates how its rate would be upgraded in the medium-term and long-term targets. As water supply capacity increases, the productivity will also increase. The area of Sub-Zone A1, however, which is located upstream of Talvar Dam, shows difficulty of improvement of productivity due to lack of available water sources. This area also shows difficulty of water source conversion from groundwater to surface water as described in 9.2.3, and is located in the uppermost part of the Sefidrud basin in Kordestan Province. Further detailed study in boosting its regional economy would be needed.

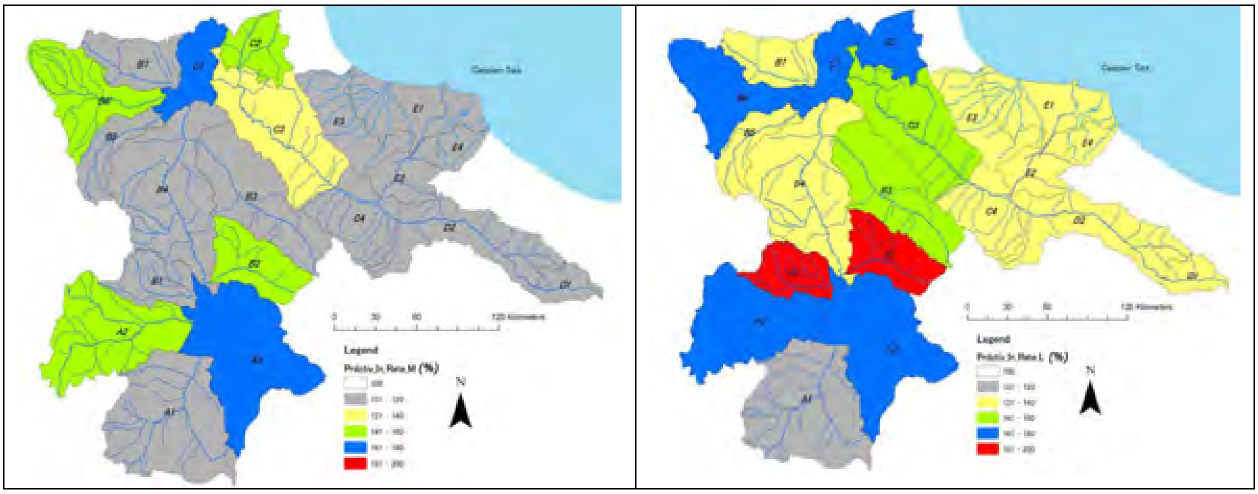


Figure 9.19 Future Increase of Agricultural Productivity in Unit Irrigation Area
(Left: Medium-Term; Right: Long-Term)

3) Water Resources Management

From the water resources management aspects, the first study subject was to clarify how the agricultural water demands in the traditional irrigation areas would be fulfilled at present, and how its fulfillment would be upgraded in parallel with the progress of water resources development projects and irrigation system improvement. Figure 9.20 presents the study results on irrigation water sufficiency by sub-zone. More than 75% of sufficiency could be secured in an average year except for the sub-area upstream of Talvar Dam, while some sub-zones would still remain under 75% of sufficiency in spite of improvement against a 5-year drought.

As a whole, the sufficiency in traditional irrigation areas would be upgraded in the medium-term 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.

In addition, examined was the next subject, namely; how the planned dams including the existing ones could sufficiently supply necessary water to their command areas. Based on the results of hydrological and water use simulation for the recent 30 years, Table 9.7 enumerates dams where irrigation water could only fulfill less than 75% of water demand for their command areas, and the frequency of occurrence in such situation. As mentioned in 9.2.1, there are several dam plans under unsuitable hydrological conditions which were found through the preliminary examination. Detailed examination shall be carried out, and improvement works shall be taken, if necessary.

Table 9.7 Irrigation Water Sufficiency to Command Areas

Target Year	Less than 75% Frequency of Irrigation Water Sufficiency	Number of Dams	Dam Name
Medium-Term	less than 1/5	6	Golbolagh, Manjil, Ostor, Sange Siah, Sahand, Taleghan
	1/5 to 1/2	8	Aydughmush, Givi, Golabar, Kalghan, Shahreh Bijar, Siazakh, Sural, Talvar
	more than 1/2	3	Germichay, Befrajerd, Taham
Long-Term	less than 1/5	14	Alan, Aydughmush, Chesb, Ghezel Tapeh, Golabar, Golbolagh, Manjil, Mushampa, Ostor, Sahand, Shahreh Bijar, Sheikh Bashara, Taleghan
	1/5 to 1/2	14	Germichay, Givi, Hasankhan, Kalghan, Mahtar, Niakhoram, Ramin, Sange Siah, Siazakh, Songhor, Sural, Tabrirzak, Talvar, Zardekamar
	more than 1/2	8	Alehdare, Befrajerd, Burmanak, Hashtjin-2, Mendagh, Sangabad, Sir, Taham

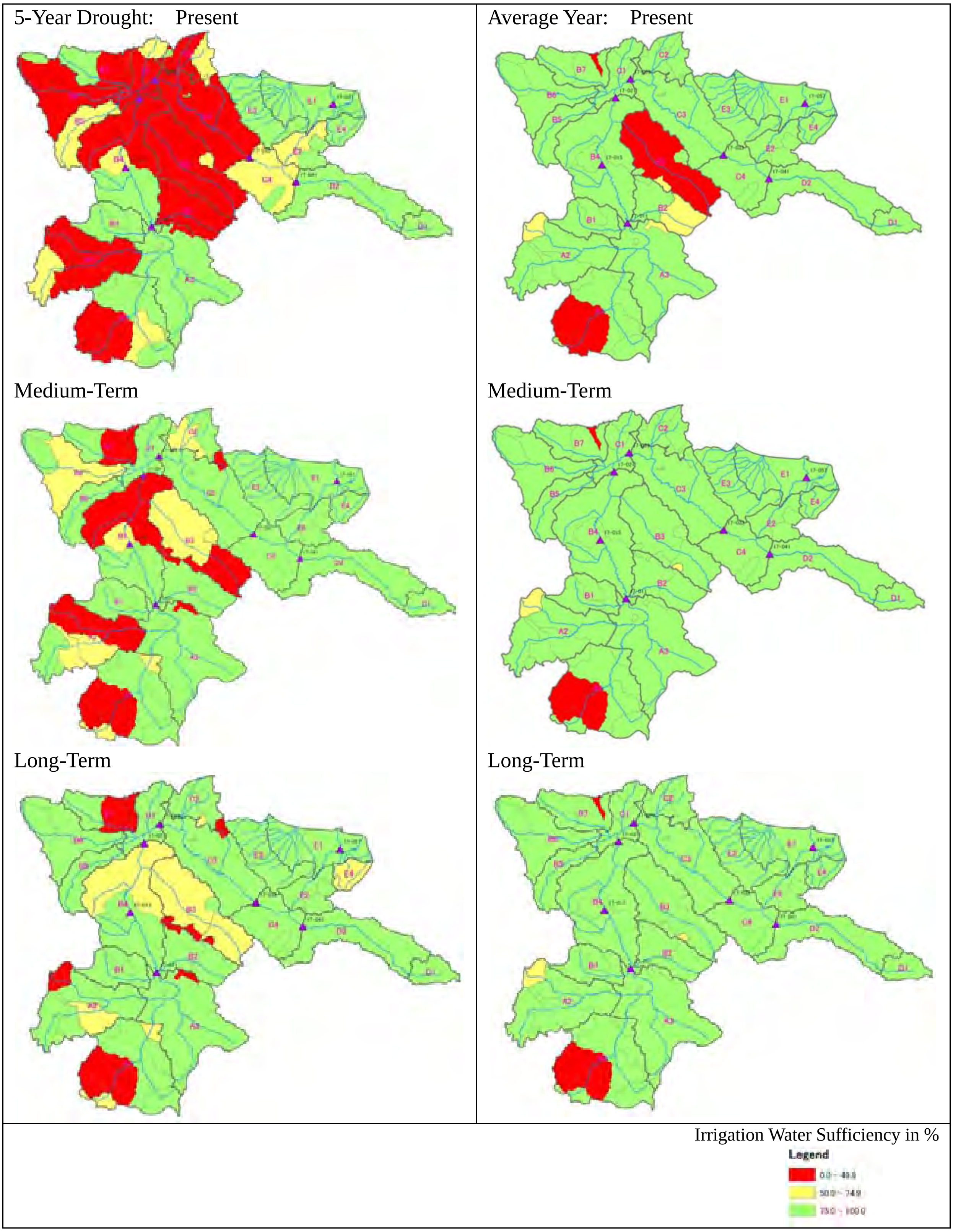


Figure 9.20 Changes of Irrigation Water Sufficiency in Traditional Irrigation Areas

9.3 SUBCOMPONENTS OF MASTER PLAN

9.3.1 Water Resources Management Plan

1) Management Plan for Surface Water

As regards surface water management in the Sefidrud River, the highest interest is placed on the environmental flow. Furthermore, when several large dams will be constructed in future, drought management will be a major subject in the surface water management. The following are basic directions on these issues.

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. In general, 60 to 100% of AAF is considered an optimum range, while 10% of AAF, which is proposed by WRMC, is considered a poor or minimum one. Since the major part of Iran is under semi-arid climate conditions and numerous seasonal rivers exist, this figure, 10% of AAF, could be considered adequate in Iran.

Based on the improvement effects of flow regime in parallel with water resources development projects as examined in 9.2.3, Table 9.8 presents comparison between improved flow regimes of 90% flow and 10% of AAF. Although flow of 10% of AAF could not be secured in a 5-year drought, it could be almost secured in an average hydrological year.

Table 9.8 Comparison between 10% of AAF and 90% Flow at Major Hydrological Stations

Major Hydrological Station (Station Code：Drainage Area)	10% AAF (m^3/s)	5-Year Drought (m^3/s)			Average Year (m^3/s)		
		Present	Medium-Term	Long-Term	Present	Medium-Term	Long-Term
Talvar (17-007: 5,920 km^2)	0.8	0.06	0.10	0.11	1.07	1.08	0.99
Mah Neshan-lailan (17-015: 24,219 km^2)	3.0	2.19	1.47	0.73	5.89	5.69	4.85
Pole Dokhtar Mianeh (17-021: 32,853 km^2)	5.0	0.13	0.20	0.16	0.66	1.89	2.83
Gilvan (17-033: 48,629 km^2)	10.0	0.01	5.35	5.68	0.53	8.00	10.82
Loshan (17-041: 4,852 km^2)	3.0	10.73	13.43	5.56	17.63	18.03	12.46

As shown in the table above, the flow of 10% of AAF could be secured in a 2-year drought and until 90% in flow duration. Generally, safety level of environmental flow is set at a level lower than the one of water uses. Since the target safety level of water uses is set at 5-year drought, the safety level of 2-year might be appropriate for environmental flow. Furthermore, 75% flow, which is defined as low flow in Japan, is being utilized for low flow management of water quality improvement in Japan. Since 90% flow is much safer than the low flow level, the 90% flow could be considered adequate for environmental flow.

The above consideration is for environmental flow in the mainstream. In the local consultation meetings, several provinces requested environmental flow setting in their river tributaries. To fulfill the requests based on the local needs, the following detailed studies shall be necessary.

- Evaluation on importance and sensitivities of local ecology;
- Data on local meteorology and hydrology;

- Hydraulic effects to aquatic and riparian ecology;
- River morphological features to manage aquatic and riparian ecology; and
- Mutual interaction effects between rivers and water quality, plants, aquatic lives, and groundwater.

Drought Management

More than 30 dams will be constructed until the year 2031. Among them, there will be nine large dams with effective storage of more than 100 MCM, including the two existing dams. For drought management, these nine dams as tabulated below shall be targeted in a practical manner due to significant effects to surface water.

Table 9.9 Dams with Effective Storage of more than 100 MCM

Name of Dam	Timetable	Catchment Area (km^2)	Purposes of Water Use*	Effective Storage (MCM)	Province
Siazakh	Medium-Term	1,058	I&D	245	Kordestan
Talvar	Medium-Term	6,441	I&D	403	Zanjan
Golabar	Medium-Term	1,131	I&D	105	Zanjan
Mushampa	Long-Term	24,860	I&D&P	328	Zanjan
Sahand	Medium-Term	820	I&D	135	E. Azerbaijan
Aydughmush	Medium-Term	1,625	I	137	E. Azerbaijan
Ostor	Medium-Term	42,600	IFP	451	E. Azerbaijan
Taleghan	Operational	828	I&D&P	329	Tehran
Manjil	Operational	56,200	I&D&P	1,150	Gilan

* Purposes of Water Use: I = Irrigation; D = Domestic; P = Hydroelectric Power Generation; F = Flood Mitigation

From the present situation, efforts to establish a river basin organization (RBO) shall be necessary as one of the measures for strengthening water resources management and the related coordination system. Drought management shall be included into the major activities/functions of RBO. Since the nine dams will belong to five provinces, there might be remarkable difficulties on the integrated management of the large dams in drought time. Although a long time shall be necessary to progress this process, an integrated system of water management as enumerated below shall be solved/built step by step.

- Establishment of online meteo-hydrological monitoring system: rainfall, water level and stream flow;
- Information sharing of reservoir operation in the major dams: reservoir water level, storage volume and reservoir release;
- Information of water supply released from the major dams: for agriculture, domestic and hydropower purposes;
- Stream flow forecast at major hydrological stations; and
- Establishment of coordination and operation rules for drought management: definition of drought, organization of committee, coordinating rules, etc.

2) Management Plan for Groundwater

It has been reported that groundwater tables have lowered in the Zanjan and Sujan areas of Zanjan Province and the Ghorveh Dehgalan area of Kordestan Province. In the recent five years, these groundwater tables have lowered in a range of 3 m to 9 m. In addition to this report, the tables might have lowered in Ardebil City of Ardebil Province and Qazvin Plain of Qazvin Province. There are, however, no clear data available since groundwater aquifers extend widely and groundwater monitoring networks are not dense. Thus it is urgently necessary to establish the reliable groundwater monitoring system for formulating the groundwater management plan. Table 9.10 tabulates the management framework, in which priority means implementation order.

Table 9.10 Groundwater Management Framework

Management Process		1st Action (Urgent and 1st Priority)	2nd Action (2nd Priority)
1.	Urgent Measures (for groundwater lowering area)	- Restriction of new development - Control of pumping yield up to recovering water table Applicable Basin Codes: 1304, 1306 & 1308	- Safety yield should be determined by pumping test and logical control of pumping yield should be done. - Alternative water resources should be examined: surface water, water conveyance, artificial recharge to groundwater - Investigation of Karst aquifer
2.	Preparation of Well Inventory: (Well specification, well log, water level, water quality, results of pumping test)	Subject to large-scale wells	- Subject to the other wells - Management of illegal wells
3.	Investigation of Aquifer:		
	(1) Stretch of aquifer	Already investigated	Already investigated
	(2) Depth and shape of aquifer	- Geological structure by electric resistivity survey - Geology by well inventory - Investigation of Karst aquifer	- Test wells shall be constructed in data shortage areas and these wells shall be converted to monitoring wells in future. - Karst aquifer should also be investigated.
(3)	Essential Factors: (permeability, transmissivity, etc)	Examination of existing results of pumping test	Investigation of pumping test for new test wells
(4)	External Factors: (meteorological-hydrological data)	Almost collected 20 to 40-year periods	Almost collected 20 to 40-year periods
4.	Installation of Monitoring Well	Diverting monitoring wells from existing production wells. - Existing monitoring well: 271 wells - Diverting wells: 200	New installation: about 250 wells Arrangement: see Figure 9.22
	Parameters to be monitored/Monitoring schedule: - Level: Every month; - Other items: Every dry and rainy seasons)	Water level, water quality, pumping yield for each unconfined and confined aquifer	Water level, water quality, pumping yield for each unconfined and confined aquifer
5.	Institutional Strengthening	- Institution in each aquifer and capacity building - Monitoring and data collection	Basin-wide institution: Monitoring system in RBO (River Basin Organization)
6.	Database Construction	Database processing, analyzing	Database processing, analyzing
7.	Groundwater Simulation	- Computation of groundwater storage capacity - Computation of recharged volume - Renewable every year based on the latest collected data	- Computation of groundwater storage capacity - Computation of recharged volume - Renewable every year based on the latest collected data
8.	Designation of Regulative Areas of Groundwater Pumping Yield	Measures in the regulation areas for groundwater lowering area	Strengthening monitoring system in areas where much groundwater is used
9.	Setup of Water Use Regulation Order in Groundwater Lowering Areas	Irrigation water	Irrigation and industrial water
10.	Measures for Drought Year: (1) Average annual precipitation year (2) Drought year: Regulation 1 (3) Severe drought year: Regulation 2	Regulation for well pumping yield (1) No pumping regulation (2) 25% for irrigation well (3) 50% for irrigation/industry well	Regulation for well pumping yield (1) No pumping regulation (2) No pumping regulation (3) 10% for domestic well
11.	Revision of law and penalty system	Revision of existing law	Strengthening of penalty system
12.	Enhancement of water users' consciousness on saving water	Enhancement of consciousness on saving water, rationalization of industrial water use, and saving irrigation water	Recycling use of industrial water; reuse of treated wastewater

3) Water Quality Monitoring Plan

The first and second priority water quality monitoring plans are summarized in Table 9.11. The First Priority Plan is for the monitoring of irrigation water, while the Second Priority Plan is for harmful and health-related matters.

Table 9.11 Water Quality Monitoring Plans

Priority	First Priority	Second Priority
Purpose	Saline damage on agriculture	Harmful matters; health-related matters
Water Quality Index	(Already established)	BOD, SS, heavy metals; etc., to be determined for the purpose and water system
Water Quality Standard	(Already established)	To be determined for the purpose and water system
Monitoring	Development of additional monitoring well; Continuance of river water monitoring	Twice in a year (dry season and rainy season), 10 locations for river; 50 to 100 for groundwater, main dams and drinking-water dams
Capacity Building	Improvement of accuracy of instrumental analysis, especially for groundwater	Improvement of accuracy for instrumental analysis; Evaluation of analysis result; Knowhow on maintenance
Coordination with Related Organization	Coordination with WRMC, MOJA and agricultural associations on the sharing of monitoring results and the necessary actions for irrigation	Coordination with related organizations; Sharing of reliability
Database	Development of database to share the monitoring results with MOJA, agricultural associations, etc.; Development of alert system especially for high-density brackish water	Centralization of information; Data management in unified format, Recording data with its unit
Action	Irrigation water-saving; leaching of salt	Development of sewage treatment plant; Management of land use in urban planning; Control by strengthening penalties
Environmental Flow	Comprehensive management of environmental flow considering flow regime and natural ecosystem, as well as hydrological control	

9.3.2 Meteo-Hydrological Monitoring Plan

1) Surface Water Monitoring Plan

The meteo-hydrological and water quality monitoring plan aims at providing the basic data/information to support activities of the RBO (River Basin Organization), providing reliable and prompt data enough to coordinate the provinces concerned during drought time and emergency such as water pollution accidents. The basic concept of the plan consists of: (1) selecting representative monitoring stations from those located in strategic locations; and (2) improving their monitoring instruments.

In the light of present conditions, the establishment of surface water monitoring system is proposed, as follows:

Sharing of Monitoring Information

For the sharing of information, the monitoring system is expected to be improved, namely; (1) monitoring stations for the telemetry system should be improved step by step; (2) the telemetry stations should be able to send the monitored data to the newly proposed RBO on the real-time basis; and (3) the RBO should be able to send the collected and processed data to WRMC in Tehran. With regard to the sharing of related data/information, it is essential for RBO, WRMC and RWC to have a similar understanding of encountered situations to initiate prompt and coordinated actions during drought and other emergency situations. Thus, the final goal of the proposed monitoring system is the real-time telemetry system with the following objectives:

- To assist WRMC and RWC in properly making decisions for the coordination of drought management and emergency actions against accidents through real-time data/information sharing; and
- To assist in the integrated water management of dam reservoir operation for the most efficient water utilization by supplying timely and reliable data, since the materialization of integrated water management of dam reservoir operation will be much more imminently necessary in parallel with the progress of dam construction.

Selection of Monitoring Stations

Monitoring stations shall be selected as shown in Figure 9.21, satisfying the following conditions:

- Monitoring stations for water management shall be situated at strategic locations, such as downstream end of zone or sub-zone, upstream and downstream points of confluence with major tributary, and inflow and outflow measuring points of large-scale dam reservoir.
- In principle, monitoring stations shall be selected from among the existing hydrological stations with observed records as long as possible.

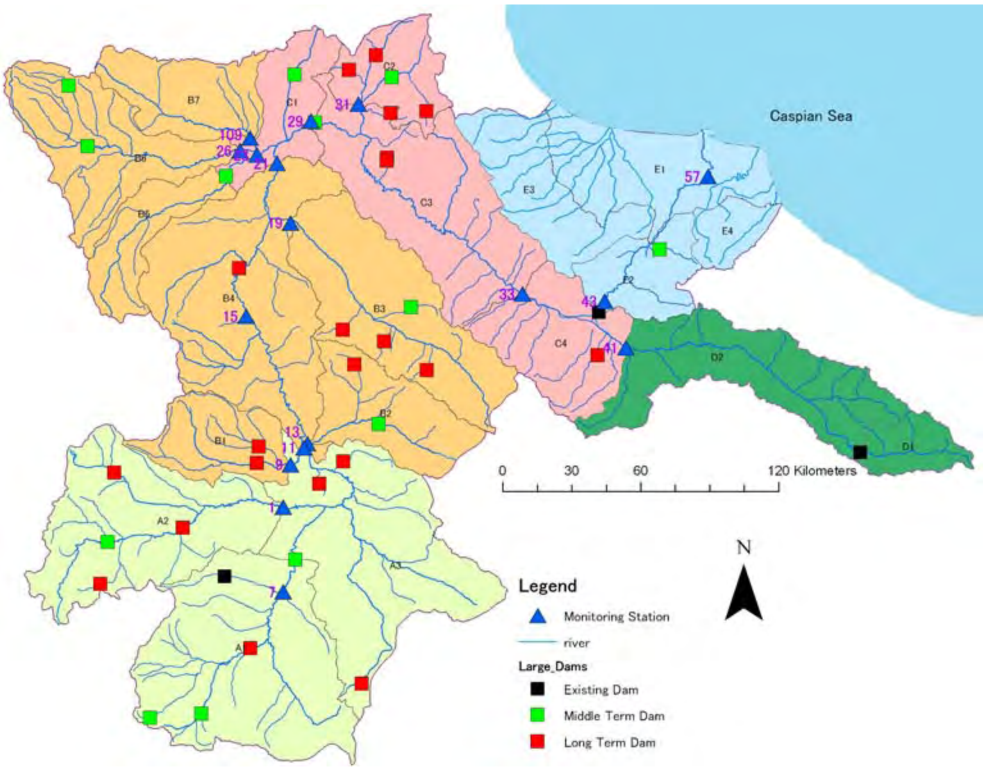


Figure 9.21 Selected Monitoring Stations

With the development of mobile telephone services and radio communication regulations in Iran, the VHF/UHF radio communication system and GSM (Global System for Mobile Communications) are suggested to establish the telemetry system for monitoring stations.

2) Groundwater Monitoring Plan

The number of monitoring wells is few in relation to the 59,090 km^2 area of the Sefidrud River Basin. The installation of monitoring wells has been limited to only the plain area of 18,039 km^2 which is equivalent to about 31% of the total basin area and where production wells are distributed. The installation of a number of monitoring wells had sometimes encountered difficulty, but it is herein recommended to look into the case of Kanto Plain in Japan which has the same scale but a successful example of regulating pumping yield.

The Kanto Plain has an area of about 17,000 km^2 which suffered from land subsidence due to the over-pumping of groundwater. A total of 450 monitoring wells were installed in about 30 years from 1955 to 1986. A database was constructed, and groundwater simulation was conducted. Also determined and implemented was the safety yield of groundwater and, finally, the project was successfully completed.

Referring to this example, it is recommended that the number of monitoring wells shall be about 450 in total, allocated in proportion to the area of each basin as shown in Table 9.12. One monitoring well has to be installed for each 40 km^2, but since the existing monitoring wells in Basin Code 1308 are too much, a total of 254 new monitoring wells are finally recommended, as shown in Table 9.12.

The new monitoring wells shall be installed in the area shown in Figure 9.22 (Additional Monitoring Area) and if the area of a production well is used, it should be diverted as much as possible. It is, however, required that geological logs are prepared, together with the results of pumping tests of diverted wells. It is also required that electric resistivity survey is conducted and the geological structure around the new monitoring wells investigated.

Monitoring Parameters

The monitoring parameters shall be as follows:

- Measuring parameters: Water level, water quality, pumping yield
- Measuring aquifer: Each unconfined aquifer and confined aquifer
- Measuring schedule: Every month for water level; Every dry and rainy season for others

Table 9.12 Recommended Monitoring System of Groundwater

Name of Groundwater Basin	Basin Code	Area (km^2)	Plain Area (km^2)	**Existing Monitoring Well**	*Pumping Test*	*Water Level Measure-ment*	*Water Quality Test*	Proper No. of Wells in Basin	**New Additional Well**
Astaneh-Kuchesfahan	1301	1,923	991	**32**	32	9	32	25	**0**
Tarom-Khakhal	1302	8,604	1,085	**17**	17	17	17	27	**10**
Miyane	1303	9,226	1,607	**0**	0	0	0	40	**40**
Zanjan	1304	4,672	2,368	**59**	59	7	59	59	**0**
Mahneshan-Anguran	1305	7,172	2,598	**0**	0	0	0	65	**65**
Sujas	1306	2,497	1,715	**18**	18	6	18	43	**25**
Goltapeh-Zarinabad	1307	5,131	2,093	**0**	0	0	0	52	**52**
Ghorveh-Dehgulan	1308	7,284	2,807	**134**	1*	1*	134	*70*	***0***
Divandareh-Bijar	1309	5,385	2,225	**0**	0	0	0	56	**56**
Taleghan-Alamut	1310	4,864	358	**3**	3	0	3	*9*	***6***
Manjil	1311	2,261	192	**8**	8	8	8	5	**0**
Others	-	71	0	**0**	0	0	0	-	**-**
Total		59,090	18,039	**271**	138	48	271	450	**254**

Source: WRMC (2001)
* Basin Code 1308: There is only one record of results of pumping and water quality tests.

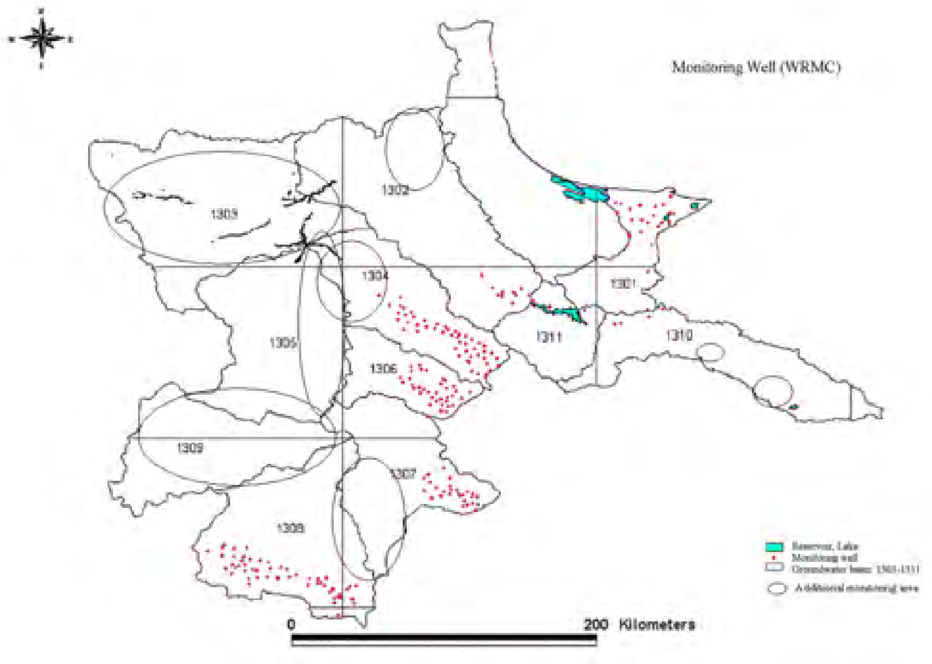


Figure 9.22 Area of Additional Monitoring Well for Groundwater

9.3.3 Watershed Management Plan

Watershed management where river basin conservation involves various countermeasures such as terracing, banquet, and reforestation/afforestation is to be conducted for regional economic development targeting the devastated sub-catchments. After the completion of management, sediment yield from the watershed would be reduced and sediment inflow to the reservoirs also would be reduced, prolonging the lifetime of reservoirs. The Ministry of Jihad-e-Agriculture (MOJA) is mandated to conduct the watershed management in Iran.

1) Erosion in the Basin

The Sefidrud River Basin Management Bureau of MOJA located in Zanjan Province takes charge of the watershed management of the Sefidrud basin in an integrated manner. Figure 9.23 shows the erosion sensitivity of the basin. In particular, the area in which Marl extends widely in the middle reaches of the basin is susceptible to soil erosion.

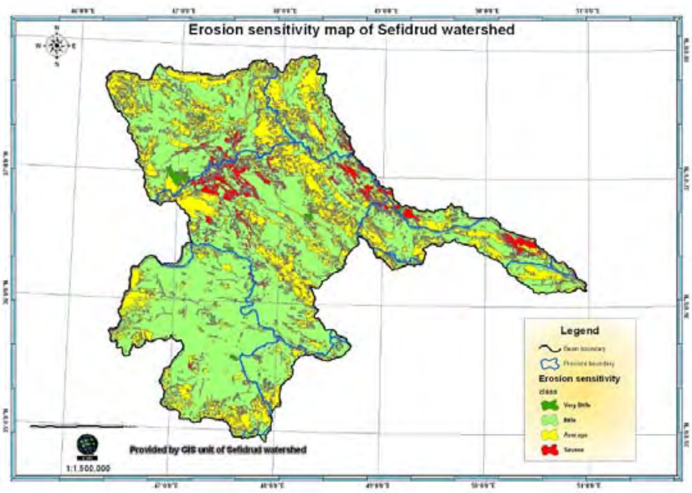


Figure 9.23 Soil Erosion Sensitivity in the Sefidrud Basin

2) Watershed Management Project

Watershed management projects concentrate in the sensitive areas around Manjil Dam. On the other hand, study and implementation have never been carried out in the Marl areas as mentioned before, due to difficulties in applying remedial measures.

As gathered from the discussion with MOJA about the countermeasures for erosion and water quality control in the middle reaches, watershed management projects could not be adapted in such geologically vulnerable wide areas. If watershed management measures could not be applied, channeling works shall be considered for preventing salinity intrusion, utilizing the surface water in accordance with the severity of this issue.

9.3.4 Institutional Strengthening Plan on Water Resources Management and Coordination

1) Objectives of Establishment of the RBO for Sefidrud River Basin

Fundamental issues regarding the present situation of the Sefidrud River Basin identified from the study results are the necessity of: 1) Basin-wide coordination of water resources management including water resources development, utilization and conservation in accordance with the master plan authorized by all of the provinces concerned; 2) Water use coordination reasonably accepted among all of the provinces concerned in accordance with the master plan; and 3) Enhancement of reliability of data and information used in the master plan. Thus, establishment of the RBO for Sefidrud River Basin shall be proposed with the following objectives:

- Coordination and formulation of the implementation program of the IWRM;
- Utilization, upgrading of the basin model as the decision-making support tool, and evaluation of the newly proposed plan using the model;
- Coordination of the water allocation plan and consensus building; and
- Coordination of conflicts including drought and water-related accidents, and taking prompt actions with remedial/countermeasures.

2) Road Map of the RBO

It should be clarified how the organizational arrangements be established and evolved for the starting point of the discussion on the RBO. An example of road map of the establishment and evolution of the RBO is shown in the following table.

Table 9.13 Road Map of the RBO

Number of Years after JICA Study	Organizational Set-up	Objective of Activities	Detailed Activities
0 - 5	Expansion of Stakeholder Meeting (Initial)	Preparation of River Basin Coordinating Committee	• To include representatives of MOJA, Ministry of Environment and Ministry of Health in the members • 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 execute capacity development for government officials tentatively
5 - 15	Establishment of River Basin Coordinating Committee (Adult)	Consensus building on a permanent rule for water use coordination among relevant Provinces and preparation of River Basin Commission	• To include representative of users such as farmers • To examine water resource management with a participatory approach • To execute dissemination for users • To execute hydrological/water quality monitoring • To examine cost share among relevant Provinces • To study establishment of the fund • To review the Master Plan • To modify the simulation model • To establish and execute urgent cooperation system in drought period and its provisional implementation • To review capacity development for government officials
15 -	Establishment of River Basin Commission (Mature)	Implementation of IWRM	• To formulate common strategies for economic, social and environmental problems in the river basin and to monitor its joint implementation • To implement water resource management with a participatory approach • To establish a fund • To upgrade the simulation model • To review the permanent agreement on water use coordination among relevant Provinces • To review urgent cooperation system in drought period

3) Organizational Setup of the River Basin Coordinating Committee

It would be very difficult to start with the basin commission with considering the present conditions of related organizations and the policy of the streamlining of the Government. Therefore, the RBO for Sefiedrud should start with the coordinating committee by changing the name of the Steering Committee/Stakeholder Meeting.

The organizational structure of the RBO is proposed in the following figure. In terms of the central government, representatives of MOJA, Ministry of Environment and Ministry of Health will join in addition to WRMC.

As of local level, it is necessary to add representatives of MOJA, Ministry of Environment, Ministry of Health and farmers as important user in addition to RWCs.

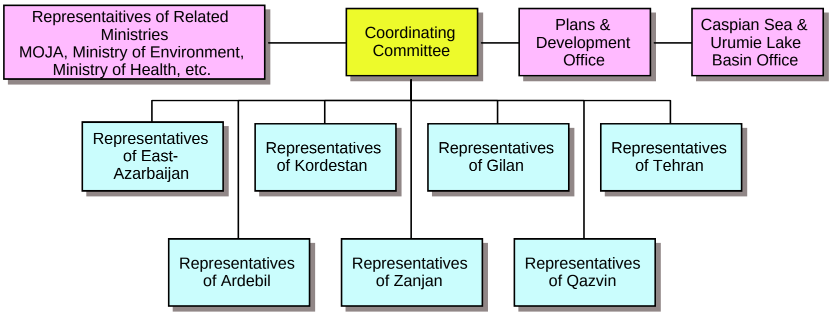


Figure 9.24 Organizational Structure of the Coordinating Committee

4) Transformation of the RBO to the River Basin Commission

In enough years after the establishment of the Coordinating Committee RBO, its transformation to the Basin Commission type should be considered in the Coordinating Committee.

It is preferable that the RBO agreement is concluded by the governors of the related provinces and the Minister of MOE. The proposed organizational structure of the RBO is as follows:

Table 9.14 Components of the RBO with Basin Commission

Components	Functions	Membership
Council	- To setup policies and strategies of the RBO and IWRM for Sefidrud River Basin; - To authorize significant decisions of the Joint Committee that will affect the majority of the provinces concerned.	Governors of related provinces and Minister of MOE
Joint Committee	- To decide on matters that will affect the situation of two or more provinces; - To authorize significant decisions of the Working Group; - To authorize the budget of RBO.	Heads of RWCs and WRMC, Ministry of Environment, Ministry of Health and WRMC
Secretariat	- To support and coordinate activities of other components; - To draft the budget of RBO; - To coordinate capacity development of RWC staff for IWRM; - To serve as contact point of RBO.	Staff designated from RWCs and WRMC
Working Group	- To prepare the implementation schedule of the Master Plan in cooperation with RWCs in the related provinces; - To coordinate the implementation of the Master Plan; - To utilize and upgrade the simulation model; - To coordinate the water use of related provinces; - To improve the data and information systems for IWRM.	Basically, the same members as the Coordinating Committee with expanded number of members.
Technical/ Policy-Making Advisory Group	To provide advice on other components from the experts' viewpoint.	Academic experts from universities or research institutes for water resources management

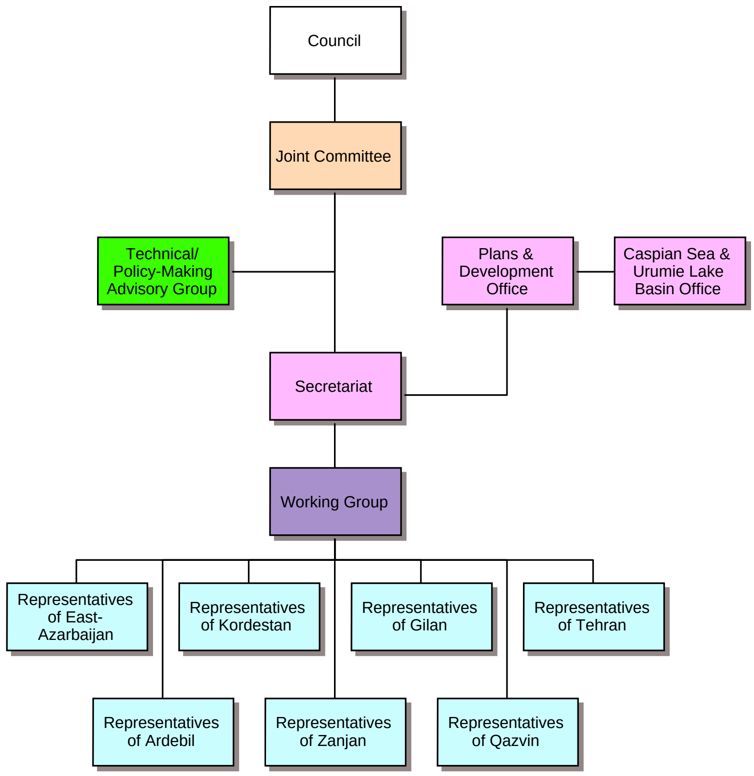


Figure 9.25 Organizational Structure of the RBO with Basin Commission

10. WATER BALANCE ANALYSIS BASED ON SATELLITE IMAGE

The modification of the Landuse map was recorded as a pending issue on Minutes of Meetings on 21st July 2008 between WRMC and JICA Study Team. However, as a result of a series of mutual consultation about the issue, both of them achieve at an agreement on a solution: the Study Team would provide WRMC with the satellite image which enable WRMC to conduct himself to make the 1:25000 scale landuse map. In fact, in order to improve the data quality of water requirement estimation, WRMC and JICA agreed to use new and high resolution satellite image to make more accurate and scientific-based landuse data, which is recognized as a solution for the confliction among stakeholders. In Chapter 10, the study procedure and the result are explained in respect to the satellite image analysis, the water demand estimation and the water allocation simulation.

10.1 SATELLITE IMAGE ANALYSIS

As a result of several discussions between the Team and WRMC including relative agencies, the SPOT5 with 5-meter resolution in two seasons' data was selected in consideration of constraint conditions such as cropping patterns, the required accuracy and the limited work schedule.

10.1.1 Range and Time Period of Satellite Image Shooting

The SPOT satellites can also be tasked to meet customs' specific time and place requirements. In the Study, the SPOT satellite images were taken shots at the range delineated by green square cells as Figure 10.1, which was conducted within two seasons: (1) 16th April 2009 to 30th June 2009 and (2) 1st July 2009 to 30th September 2009.

The shooting area is not covered the whole river basin. The shooting area was decided in consideration of the biased distribution of irrigated farmland and the condition of archive data. The landuse of the outside area of shooting was made by using the archive data which has been stored by WRMC. Incidentally, the blue boundary in the figure expresses the study area (Sefidrud River basin).

Figure 10.1 Shooting Area

10.1.2 Schedule for Satellite Image Analysis

The process of the analysis was scheduled as follows. According to the schedule below, the satellite images were ordered in April and had been taken shots by the middle of August 2009.

No.	Processing Items	Responsible Party	2009									2010		
			4	5	6	7	8	9	10	11	12	1	2	3
1	SPOT Image Order, Simulation Work	Study Team	■	■ ▲	■	▲ ■	▲ ■	■			■	■	■	■
2	Pre-analysis Activities	Study Team and WRMC		■										
3	GPS Sampling Survey	WRMC		■										
4	Data Analysis for Land Use	WRMC			■	■	■							
5	Improving Quality and Distribute Land Use Map	WRMC			■				■	■	■			
6	Crops Water Reqirement Study	WRMC			■									
7	Agricultural Field Trips and Questionaires	WRMC		■				■						
8	Water Reqirement Estimation	WRMC		■				■						
9	Submit Water Reqirement	WRMC				■			■					

▲ Satellite Image Submission

Figure 10.2 Schedule for Satellite Image Analysis

10.1.3 Specification of Satellite Image

Actually, a single SPOT scene covers a footprint of 3,600 km² at resolutions of 20 m to 2.5 m, which is ideal for applications at regional and local scales from 1/100,000 to 1/10,000. In this study, the 5 m resolution images are utilized for producing 1:25000 scale land use data.

10.1.4 Landuse Data Generation by Remote Sensing

1) Design of Work and Methodology

As the study area is as wide as about 65,000 km^2, the work was divided into two stages to get a better output. In the first stage, a land-use map of Level 2, according to USGS definitions, was created with the following 11 objectives: 1) Rocks and outcrops Regions, 2) Weak Pastures, 3)Medium pastures, 4)Forests, 5) Rain feed lands, 6) Irrigated farms, 7) Buildings, 8) Rivers, 9) Orchards, 10) Industrial complexes, and 11) Water bodies both Natural and man made.

For the second stage, investigations of Landuse Level 4 would be focused on the irrigated lands that are the most important part of the study. In this part, all different major types of crops would be extracted out of satellite imageries to determine amount of water consumption in the irrigated farming. The items of Landuse Level 4 are listed as follows: 1) Paddy, 2) Wheat and barley, 3) Alfalfa & Forage plants, 4) Vegetables, 5) Industrial Cultivation, 6) Corn, and 7) Orchards.

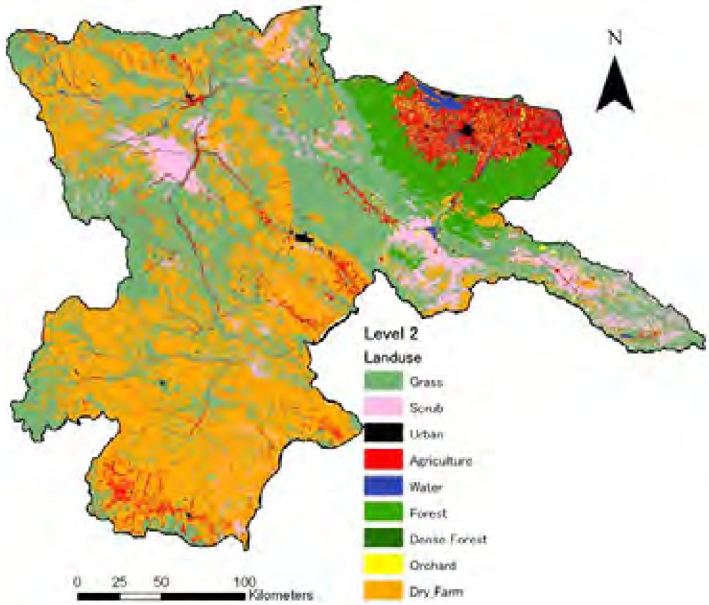


Figure 10.3 Landuse Map (Level 2)

10.2 WATER REQUIREMENT

Firstly, using the newly obtained landuse and its series of areas by the satellite image analysis, new net water requirement of Crop and Orchard for each reach in each month is calculated by WRMC. Those water requirements were calculated for each category of Crops and Orchards such as a wheat, a barely, an alfalfa, an apple and more, then summarized into Crop and Orchard. Secondary, new net water requirement is divided by the irrigation efficiency, which is the same value with the one used in the analysis in Chapter 6 and new gross water requirement is obtained. Finally, applying the correction coefficient following the same concept in Chapter 6, agricultural water requirement in the upper reach of Manjil dam is obtained.

Figure 10.4 shows the calculation flow of agricultural water requirement and Table 10.1 summarizes agricultural water requirement categorized by Zone.

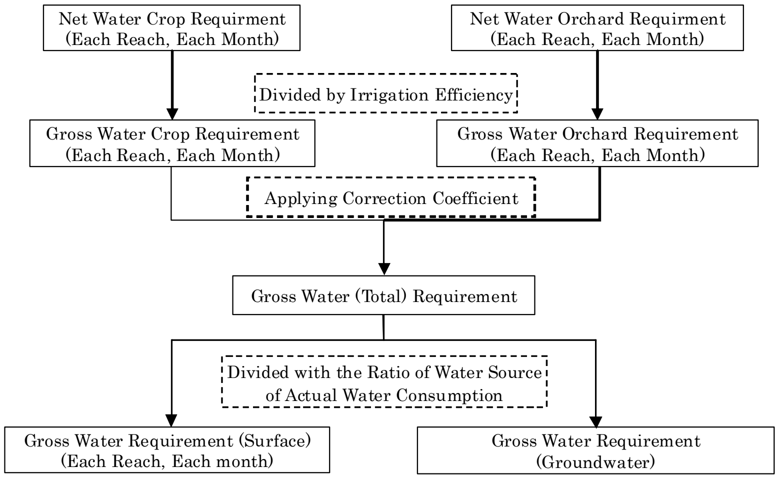


Figure 10.4 Flow of Calculation of Agricultural Water Requirement

Table 10.1 Irrigation Water Demand and Requirement from Surface Water, Weir and Dam by Zone (Left: Surface Water, Right: Groundwater)

Zone	Sub-Zone	Water Demand in Chapter 6 Area (ha)	Water Demand in Chapter 6 Total ('000m^3)	Water Requirment Area (ha)	Water Requirment Total ('000m^3)	Remarks
Intake from Sefidrud River						
A	A-1	7,500	141,764	12,353	211,867	
	A-2	3,976	76,528	2,612	51,211	
	A-3	515	9,758	716	13,113	
Total in A		11,991	228,050	15,681	276,191	
B	B-1	2,120	41,769	3,385	65,354	
	B-2	8,065	146,579	8,441	156,889	
	B-3	18,922	298,761	15,640	283,162	
	B-4	14,475	263,539	12,142	226,123	
	B-5	4,816	87,642	3,051	55,790	
	B-6	13,410	254,098	11,619	226,863	
	B-7	12,585	230,083	13,003	242,779	
Total in B		74,393	1,322,471	67,281	1,256,960	
C	C-1	8,410	132,485	7,671	139,864	
	C-2	5,741	86,856	4,559	76,485	
	C-3	12,797	182,992	15,157	286,011	
	C-4	4,961	58,023	9,478	169,884	
Total in C		31,909	460,356	36,865	672,244	
D	D-1	751	14,257	1,727	29,280	
	D-2	458	8,287	1,656	28,316	
Total in D		1,209	22,544	3,383	57,596	
E	E-2	8,253	164,963	21,690	214,632	
Total in E		8,253	164,963	21,690	214,632	
Total (Reach)		127,755	2,198,384	144,900	2,477,623	
Intake from Sefidrud River (Dam)						
A	A-1*	800	6,586	800	6,586	
D	D-1*	30,000	310,000	30,000	310,000	Out of the Basin
Total (Dam)		30,800	316,586	30,800	316,586	
Intake from Sefidrud River (Weir)						
E	E-1*	113,474	1,581,583	113,474	1,581,583	
	E-2*	42,489	437,454	42,489	437,454	
Total (Weir)		155,963	2,019,037	155,963	2,019,037	
Intake from Other Rivers						
E	E-1	8,706	119,426	8,706	119,426	
	E-3	12,904	161,360	12,904	161,360	
	E-4	1,387	17,360	1,387	17,360	
Total (Other Rivers)		22,997	298,146	22,997	298,146	
Grand Total		337,515	4,832,153	354,660	5,111,392	

Source: WRMC *Sub-Zone indiates intake point

Zone	Sub-Zone	Water Demand in Chapter 6 Area (ha)	Water Demand in Chapter 6 Total ('000m^3)	Water Requirment Area (ha)	Water Requirment Total ('000m^3)	Remarks
Intake from Sefidrud River						
A	A-1	26,461	494,199	39,796	676,276	
	A-2	5,595	107,597	4,017	74,961	
	A-3	9,250	175,090	16,127	285,465	
Total in A		41,306	776,886	59,940	1,036,702	
B	B-1	36	709	51	983	
	B-2	5,753	104,531	6,162	112,251	
	B-3	21,174	332,005	17,559	318,485	
	B-4	12,009	217,962	10,047	184,167	
	B-5	130	2,364	82	1,499	
	B-6	3,280	62,069	2,801	52,233	
	B-7	2,879	52,783	3,365	62,813	
Total in B		45,261	772,423	40,067	732,431	
C	C-1	7,467	114,381	6,303	114,809	
	C-2	5,458	77,158	4,633	72,292	
	C-3	4,982	71,322	5,961	112,116	
	C-4	3,354	39,237	6,010	107,965	
Total in C		21,261	302,098	22,907	407,182	
D	D-1	1,540	29,210	3,540	60,020	
	D-2	5,275	95,368	19,068	326,056	
Total in D		6,815	124,578	22,608	386,076	
E	E-1	2,385	34,398	2,385	34,398	
	E-2	562	11,190	1,380	14,491	
	E-3	5,890	56,244	5,890	56,244	
	E-4	13,130	164,338	13,130	164,338	
Total in E		562	11,190	1,380	14,491	
Grand Total		125,908	2,114,665	157,605	2,704,372	

Source: WRMC

10.3 WATER ALLOCATION SIMULATION

In the preceding chapter, the master plan was established by using the result of water allocation simulation with the water demand provided by WRMC. In this chapter, the water allocation simulation is carried out to examine the sufficient level of water supply for the new demand based on the result of satellite image analysis and the simulation result was compared with the previous result summarized in Chapter 9.

10.3.1 Conditions of Water Allocation Simulation

The conditions of the simulation are described as follows:

Table 10.2 Condition of Water Allocation Simulation

Item	Contents
Basic Condition	The previous water demand of the traditional irrigation area on the simulation model is replaced by the demand based on the satellite image analysis; meanwhile, the other water demands are not changed.
Duration of Simulation and Natural Flow	The water allocation simulation is carried out using the natural flow data from Sefid-WBSM for 20 years from 1985 to 2005 year.
Irrigation Efficiency	The present condition of the irrigation efficiency is selected to calculate the gross agricultural water demand from net demand for each Reach.
Water Demand	Although the water demand is categorized into three representative sectors such as agriculture, industrial and domestic water in the Study, the agricultural demand is the only data that is revised by using the result of satellite image analysis. On the other hand, the remaining two sector's data are kept the former state. In addition, each sector's demand is divided into the surface water portion and the groundwater portion when the data input into the simulation model.
Initial Condition and Physical Condition of Dams	The three dams: Manjil, Taleghan and Golbragh Dam, are mounted into the Sefid-WASM on present condition. The initial water level of dam lake is set the value corresponding to the 70% storage volume of the lake. In addition, the surplus water shall be released from the spill way on the condition that the inflow volume equals to the outflow, when the water level rise up over the flood control level. In addition, the evaporation data also set to calculate the amount of evaporation from the dam storage volume.
Environmental Flow	The environmental flow at the downstream of Sangar weir is considered in the Sefid-WASM for the spawning of sturgeon
Setting of Control Point	According to the WRMC, the Manjil dam is operated in consideration of the quantity of intake water from Tarik, Galerud and Sangar weir as well as the environmental flow for the sturgeon. In the Sefid-WASM, instead of realizing the actual operation rule of dam gates, the dam module for Manjil dam releases the water from outlet in consideration of the condition of flow discharge at the control point which is set at three weir. In fact, the module decides at instance to release the difference volume between the demand and supply when the deficit of water is found at the control points. Off course, the difference is estimated by such an algorism including the lateral flow volume from tributaries.

10.3.2 Water Allocation Simulation

The water allocation simulation is carried out. In this subsection, the result of simulation is explained in the view of: 1) sufficiency level of water supply to demand in the traditional agricultural area and 2) sufficiency level of SIDN.

1) Sufficiency Level of Traditional Irrigation Area

As shown in the table, the sufficiency level of the traditional irrigation area calculated by the new model increases slightly compared with the result by previous model. In addition, as to the sufficiency level by zone, the level of C zone reduces caused by the largest increase of demand; meanwhile, the level of the other zones rises slightly.

Table 10.3 Sufficiency Level by Zone

Zone	5-year Drought (1998/99)		Average Year (1991/92)	
	Previous Model	New Model	Previous Model	New Model
A	57.8	62.1	85.8	87.0
B	56.1	59.2	87.5	89.3
C	58.0	54.6	96.0	93.6
D	100.0	100.0	100.0	100.0
Sum	60.8	62.7	89.7	90.4

2) Sufficiency Level of SIDN

The sufficiency level of SIDN on the drought year is reduced by 3.5 % compared with the previous result in consequence of the increase of water demand of upper basin, as illustrated in Table 10.4. On the other hand, the water supply satisfies 100% of the demand on average year in both results. In addition, another case of the simulation is executed to confirm that the surface water, which flows in Gilan province inside Study Area, enables to utilize for filling the water demand deficit of SIDN. As a result of the simulation, it reveals that there is a possibility of the surplus surface water in Gilan province to satisfy the water demand deficit of SIDN.

Table 10.4 Sufficiency Level in SIDN

Case	Condition	Previous Model	New Model
1	5-year Drought	90.9%	87.4%
2	Average Year	100%	100%
3	5-year Drought (in consideration of Gilan surface water)	100%	100%

10.4 CONCLUSION

Although the water demand based on the satellite image analysis totally increases about 10 % in whole basin in comparison with the demand based on the agricultural inventory, the sufficiency level in the traditional area differs only slightly. This condition may be caused by the realistic distribution of the revised water demand in monthly basis based on the cropping pattern gained from the satellite image. The revised demand distributes throughout the year and the demand concentrating from April to October are totally decreased compared with the old one at the same period but the yearly demand increases because of the added distribution from December to March. This revised distribution can be given for the reason. For the future, the precise water demand distribution should be continuously researched whether the revised distribution is reflected the realistic water demand condition in the light of the agricultural inventory.

It leads to solve the confliction between stakeholders that they hold a same view about the practical present water demand with the confirmation by not only a way of agricultural inventory but also in an objective manner on scientific ground (for example by using the result of satellite image). Therefore, for the future, it is important for stakeholders to establish the appropriate method to grasp and confirm the water demand condition considering the merit and demerit of both ways: the interview or questionnaire way in an agricultural inventory, and the satellite image analysis on scientific ground.

11. RECOMMENDATIONS

11.1 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.

As described in '4. Conflict Management', conflict structure for water use among the provinces concerned are summarized through local consultations in the respective provinces. The followings are the conclusions from the study on conflict management.

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 should 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 system 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. 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.

Furthermore, practical view of RBO and roadmap for the establishment are described in ‘9.3.4 Institutional Strengthening Plan on Water Resources Management and Coordination in 9. Toward Realization of IWRM’.

11.2 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.

Future ideal features of basin-wide water resources management are presented in ‘Chapter 9 Toward Realization of IWRM’. In order to achieve effective water use as limited resources, both efforts on supply side such as flow regime modification by dam reservoirs and efforts on consumption side such as water saving through improvement of water utilization efficiency are closely connected with each other. In the long-term strategy of MOE, it is stipulated that the irrigation efficiency shall be upgraded up to around 2 times of present one within 20 years (until 2023). The irrigation system improvement in the traditional irrigation area following such manner, however, requires large investment and is not easy according to the comments through the local consultation among the provinces.

In order to attain modern water-saving agricultural system through improvement of irrigation efficiency, not only close cooperation between MOE and MOJA but also various technical assistances from Japan would be necessary.

11.3 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.

Major local issues in the basin could be divided into the following three items:

1) Evaluation on individual dam planning

The feasibility study report on individual dam planning could not collected and analyzed in the study as described in '9.1.2 Basic Concept for IWRM Scenarios in 9. Toward Realization of IWRM'. For further study detailed information/data shall be collect from the individual dam planning reports.

2) Evaluation on newly proposed water resources development projects

As described in 'Annex 1 Supplemental Study' of the Main Report, two water resources development projects were proposed in the course of the study, namely hydropower development projects in which three dams would be constructed in the mainstream between Manjil and Ostor dams, and Ardebil inter-basin transfer project in which water to be stored in Ostor dam would be transferred to Ardebil plain beyond the basin boundary. Hydrological effects of both projects were evaluated in the study. In near future further various projects might be proposed so that timely evaluation shall be necessary for IWRM.

3) Evaluation on environmental issues

As described in '9.3.1 Water Resources Management Plan in 9. Toward Realization of IWRM', preliminary study on environmental flow was conducted. Some provinces, however, proposed detailed study on environmental flow to meet local needs in the local consultations. For this purpose, the following detailed data collection and studies would be necessary in the future.

- Evaluation on importance and sensitivities of local ecology,
- Data on local meteorology and hydrology,
- Hydraulic effects to aquatic and riparian ecology,
- River-morphological features to manage aquatic and riparian ecology, and
- Mutual interaction effects between rivers and water quality, plants, aquatic lives and groundwater.

11.4 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.

Problems on serious lowering of groundwater tables has occurred in most groundwater aquifers in the basin as described in '3.5 Groundwater in 3. Present Conditions in the Basin'. Recovery of groundwater tables and prevention of groundwater resources depletion are considered important in sustainable water resources development. Thus, in order to remedy the problems, possibility of conversion to surface water sources from groundwater sources was examined in the problematic aquifers in '9.2.3 Study on Medium and Long-term Sustainable IWRM Scenarios in 9. Toward Realization of IWRM'. Following the macro approach from potential of basin water resources, concrete water resources conversion program shall be required. For this purpose, detailed data/information on present demand areas of groundwater, planning points of surface water intakes, and water conveyance plan and facilities' plan shall be necessary. These are also local issues.

Furthermore, basic data on groundwater aquifers are practically lacking so that preparation of well inventory, investigation of groundwater aquifers, groundwater monitoring system, etc. were proposed in '2) Management Plan for Groundwater in 9.3.1 Water Resources Management Plan'.

Scope of Work

Minutes of Meetings

SCOPE OF WORK

FOR

THE STUDY

ON

INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIDRUD RIVER BASIN

IN THE ISLAMIC REPUBLIC OF IRAN

AGREED UPON BETWEEN

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

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Tehran, February 10, 2007

Mr. Ali R. Daemi
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I. INTRODUCTION

In response to the official request of development studies from the Government of Islamic Republic of Iran (hereinafter referred to as "the Government of Iran"), the Government of Japan decided to conduct technical cooperation for the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of the Government of Iran.

The present document sets forth the scope of work with regard to the Study and will be valid after the notification of approval by the JICA headquarters through the JICA Iran office to the Government of Iran.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. to formulate a master plan for integrated water resources management for Sefidrud River Basin, and;
2. to transfer relevant skills and technologies to personnel concerned with the Study

III. STUDY AREA

The Study will cover the Sefidrud River basin extending to the eight provinces of Tehran, Qazvin, Zanjan, Gilan, Kordestan, Azarbayjan-e Sharghi, Ardabil and Hamedan in Iran. The location of the Study Area is shown in Annex-1.

IV. SCOPE OF THE STUDY

The Study is divided into the following two (2) phases; Phase 1 is for the basic study to understand present and future conditions, and Phase 2 is for formulation of a master plan for integrated water resources management.

The scope of work for the Study shall cover the following items:

Phase 1: Basic Study

1. Collection and review of existing data (incl. site reconnaissance)

Water Resources Management Company (hereinafter referred to as "WRMC") collected the data and information about the items with the mark "*", and will provide those data and information to JICA. Thus, those data and information will be reviewed and additional data collection would be conducted if necessary. The other data and information with no marks will be newly collected in the Study.

(1) Socio-economic conditions (administrative division, population, industry, etc.)
(2) Socio-economic development plans and other development policies/plans
(3)* Natural conditions (topography, geology, meteorology, hydrology, hydrogeology, environment, etc.)
(4) Topographical maps, geological maps, land use and vegetation maps, satellite photographs, etc.
(5)* Meteorological and hydrological data and their monitoring system
(6)* Water resources potential of surface water and groundwater (quantity and quality)
(7)* Soil erosion, transportation and deposition
(8)* Water use conditions and water demand, water rights allocation, facilities and problems/issues
  - ✓ by sector: agriculture (incl. irrigation and fishery), domestic water, industry water, hydropower generation, etc.
  - ✓ by water resources: surface water and groundwater
(9)* Agriculture: soil reference data, farm product, water users' association, farmer's water use and consciousness on water issue
(10)* Urban/Rural water services: facilities, water supply amount, organization, operation and maintenance, financial conditions, etc.
(11)* Existing/on-going/planned projects and studies concerning with water sector
(12) Existing legal framework for water resources development and management as well as water supply and sanitation
(13) Existing institutional framework for operation, maintenance and management relevant to water resources
(14)* Existing database related to water resources management

2. Field survey (if necessary)

(1) Survey for socio-economic and environmental conditions
(2) Survey of water facilities such as irrigation works, water supply works, flood protection facilities, groundwater development facilities, etc.

3. Analysis

(1) Satellite image analysis on land use, surface water, groundwater, etc.
(2) Rainfall analysis

(3) Runoff analysis
(4) Groundwater flow analysis
(5) Conflict analysis on water resources

4. Water demand projection

(1) Socio-economic projection
(2) Study for possibility on saving of domestic, agricultural and industrial water
(3) Water demand projection for domestic, agricultural and industrial use

5. Water resources potential

(1) Available surface water and groundwater (quantity and quality)
(2) Hydrological water balance (rainfall, evapotranspiration, surface flow, groundwater flow)
(3) Sustainable water resources potential

6. Water balance study between water demand and potential

7. Establishment of GIS data base system for integrated water resources management

8. Evaluation of present laws, institutions and systems for water resources management

9. Stakeholder meetings

(1) Problems and issues on water resources management
(2) Present water balance and future water resources management policy
(3) Causes of conflict on water resources

Phase 2: Formulation of a Master Plan

1. Identification of problems and issues on water resources development and management

(1) Surface water development and management
(2) Groundwater development and management
(3) Operation and maintenance for water facilities
(4) Laws, institutions and systems for water resources management

2. Basic policy for water resources development and management

(1) Water resources development and management (surface water and groundwater)
(2) Water supply and sanitation for urban and rural areas
(3) Irrigation water management
(4) Water resources conservation
(5) Coordination system of water resources development and management
(6) Public participation into water resources management

3. Formulation of the master plan

   (1) Surface water development and management plan
   (2) Groundwater development and management plan
   (3) Monitoring plan for surface water and groundwater
   (4) River basin management plan
   (5) Plan for laws, institutions and systems for water resources management
   (6) Evaluation of priority of the above plans based on the criteria to be proposed
   (7) Operation and maintenance plan
   (8) Water utilization / allocation plan in drought period and usual period
   (9) Initial environmental examination (IEE)
   (10) Design of water facilities
   (11) Implementation plan
   (12) Cost estimate

4. Evaluation of the master plan

   (1) Technical evaluation
   (2) Economic and financial evaluation
   (3) Environmental and social evaluation

5. Stakeholder meetings

   (1) Alternatives of projects to be proposed
   (2) Water resources allocation plan
   (3) Projects of the master plan

V. SCHEDULE OF THE STUDY

The Study will be carried out in accordance with the tentative schedule as attached in Annex-2. The schedule is tentative and subject to be modified when both parties agree upon any necessity that will arise during the course of the Study.

VI. REPORTS

JICA shall prepare and submit following reports in English to the Government of Iran.

1. Inception Report:

   Twenty (20) copies will be submitted at the commencement of the phase 1 work period. This report will contain the schedule and methodology of the Study.

2. Progress Report I:

   Twenty (20) copies will be submitted at the time of fourth (4th) month after the commencement of the phase 1 work period.

3. Interim Report:

   Twenty (20) copies will be submitted at the end of the phase 1 work period. This report will summarize the findings of the phase 1 of the Study. The discussion on it will be held at the beginning of the phase 2 work period.

4. Progress Report II:

   Twenty (20) copies will be submitted at the time of about fourth (4th) month after the commencement of the phase 2 work period.

5. Draft Final Report:

   Twenty (20) copies will be submitted at the end of the phase 2 work period. The Government of Iran shall submit its comments within two (2) month after the receipt of the Draft Final Report.

6. Final Report:

   Thirty (30) copies will be submitted within one (1) month after the receipt of the comments on the Draft Final Report.

VII. UNDERTAKINGS OF THE GOVERNMENT OF IRAN

1. To facilitate the smooth conduct of the Study; the Government of Iran shall take necessary measures:

   (1) to secure safety of the Japanese study team (hereinafter referred to as "the Team");

   (2) to permit the members of the Team to enter, leave and sojourn in Iran for the duration of their assignments therein, and exempt them from foreign registration requirements and consular fees;

   (3) to exempt the members of the Team from taxes, duties and any other charges on equipment, machinery and other material brought into and out of Iran for the implementation of the Study;

   (4) to exempt the members of the Team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Team for their services in connection with the implementation of the Study;

   (5) to provide necessary facilities to the Team for the remittance as well as utilization of the funds introduced into Iran from Japan in connection with the implementation of the Study;

   (6) to secure permission for the Team to enter into private properties or restricted areas for the implementation of the Study;

(7) to secure permission for the Team to take all data and documents including photographs and maps related to the Study out of Iran to Japan;

(8) to provide medical services as needed. Its expenses will be charged on the members of the Team.

2. The Government of Iran shall bear claims, if any arises, against the members of the Team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the Team.

3. On the parts of the Government of Iran, the Ministry of Energy shall act as the counterpart agency to the Team for the Study and also as the coordinating body in relation to other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

4. Ministry of Energy of Iran shall, at its own expense, provide the Team with the following, in cooperation with other organizations concerned:

(1) Security-related information on as well as measures to ensure the safety of the Team;

(2) Information on as well as support in obtaining medical service;

(3) Available data (including maps and photographs) and information related to the Study;

(4) Counterpart personnel;

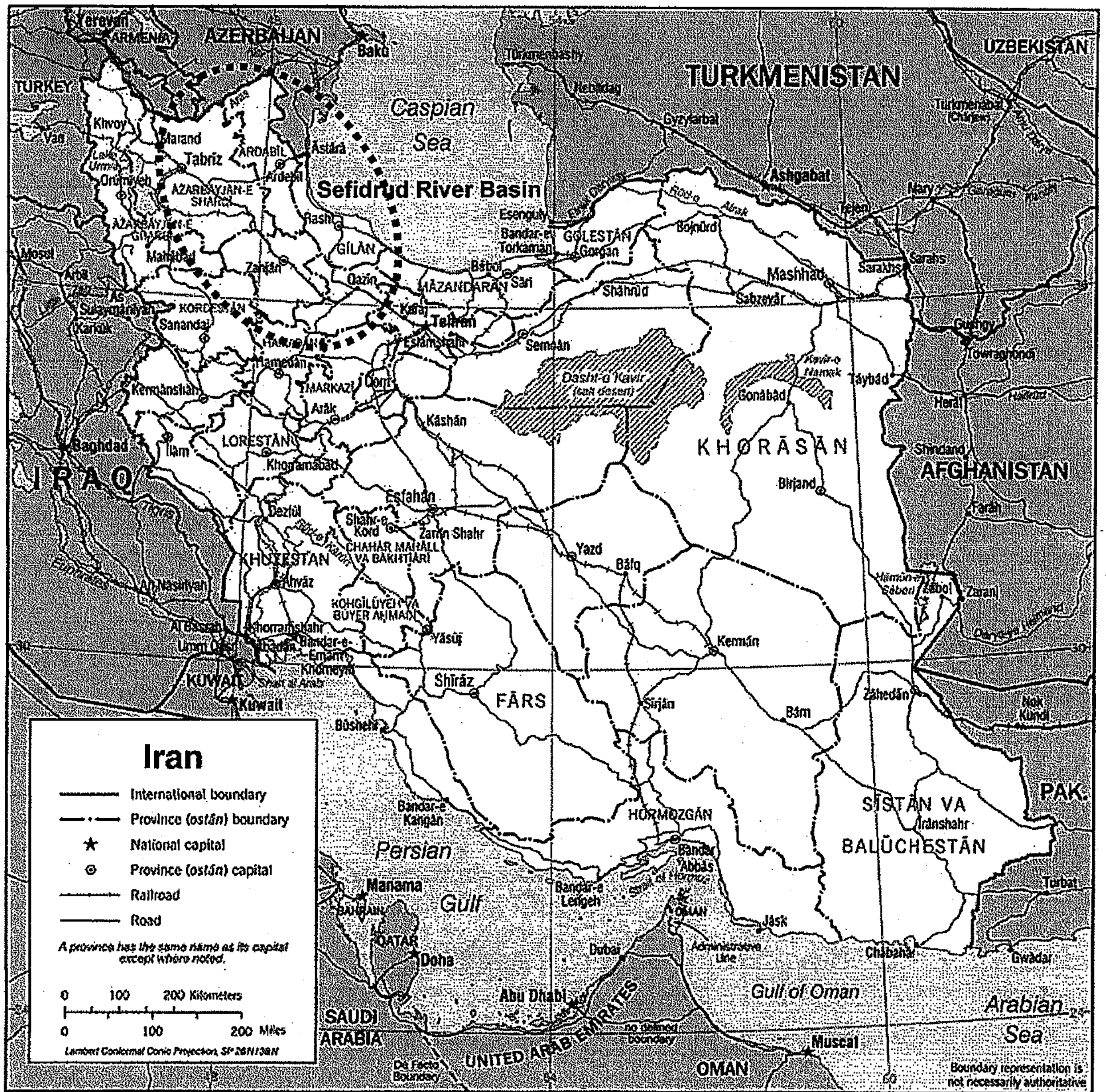
(5) Suitable office space with necessary equipment; and

(6) Credentials or identification cards.

VIII. CONSULTATION

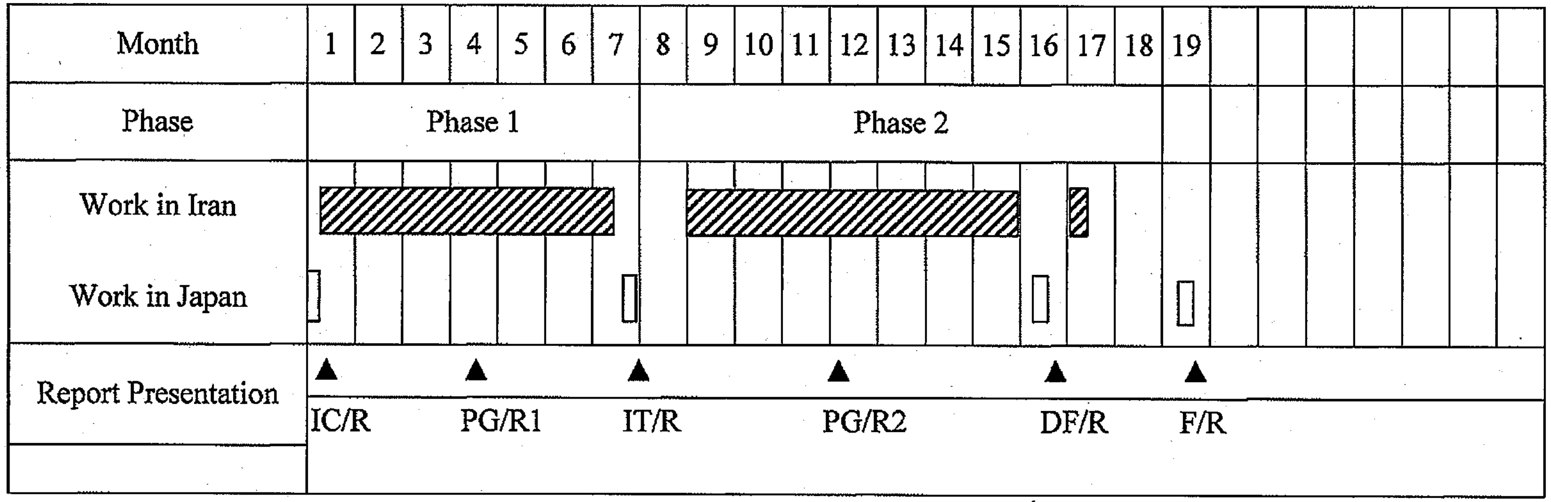
JICA and the Ministry of Energy shall consult with each other in respect of any matter that may arise from or in connection with the Study.

Annex 1: Study Area



Annex-2: Tentative Schedule of the Study

Tentative Schedule of the Study



IC/R: Inception Report
PG/R1: Progress Report I
IT/R: Interim Report
PG/R2: Progress Report II
DF/R: Draft Final Report
F/R: Final Report

MINUTES OF MEETINGS

ON

SCOPE OF WORK

FOR

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

AGREED UPON BETWEEN

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

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Tehran, February 10, 2007

Mr. Ali R. Daemi
Deputy of Planning and Economies Affairs
Water Resources Management Company
Ministry of Energy
(WRMC)

Mr. Kenji Nagata
Leader of the Preparatory Study Team
Japan International Cooperation Agency
(JICA)

I. INTRODUCTION

In response to the official request of development studies from the Government of Islamic Republic of Iran (hereinafter referred to as "the Government of Iran"), the Government of Japan decided to conduct technical cooperation for the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, dispatched a preparatory study team headed by Mr. Kenji NAGATA (hereinafter referred to as "the Team"), from 2nd February to 1st March 2007 to Iran for discussions on the contents of the Study.

During the stay of the Team in Iran, the Team made a field reconnaissance to the study area, and held a series of meetings with Water Resources Management Company (hereinafter referred to as "WRMC"). The list of participants of the meetings is attached in the Appendix-1.

The Minutes of Meetings have been prepared for the better understanding of the Scope of Work agreed upon between WRMC and the Team (hereinafter referred to as "both sides"). The main items that were discussed and agreed upon between both sides are summarized as follows:

1 Demarcation of the Study

WRMC has been conducting the study for water resources management in Sefidrud River (hereinafter referred to as "the WRMC Study") through subcontracting it to Mahab Ghodss Consulting Engineering Co. (hereinafter referred to as "the Subcontractor"). Both sides agreed the demarcation of the Study as follows:

(1) Collecting data and information in Phase-1

WRMC will provide the JICA Study Team with all the data and information collected through the WRMC Study with no compensation. The JICA Study Team will review those data and information and would conduct additional collection of data and information according to need.

(2) Formulating a master plan in Phase-2

The master plan will be formulated mainly by the JICA Study Team in cooperation with WRMC and the Subcontractor.

(3) Mutual sharing of data and information

WRMC, the JICA Study Team and the Subcontractor will share all the data and information as well as the study/planning process and results concerning with the Study and the WRMC

Study, and will cooperate with each other and make their efforts to formulate the best master plan for Sefidrud River Basin.

The Team requested that the interim report of the WRMC Study be given to the Team before 21st February 2007 to prepare the TOR for the Study immediately, and explained that the preparation of the TOR might be delayed if the submission of the interim report to the Team would be postponed because both sides understood that the interim report was the starting point of the Study. WRMC agreed with it and promised to give the interim report to the Team.

2 Master plan

Both sides confirmed that the master plan included structural and non-structural measures on a master plan level, and would not include detailed plans and designs for particular projects such as rehabilitation of Gilan irrigation facilities and countermeasures for sediment in Manjil Dam Reservoir.

3 GIS database

In response to the WRMC's request, the Team agreed to complete the GIS database that WRMC and the Subcontractor has been preparing, compiling the data and information which would be collected and analyzed in the Study.

4 Simulation models for surface water and groundwater

WRMC strongly requested that simulation models should be developed in the Study for surface water and groundwater analysis in terms of quantity and quality. The Team explained that the first priority should be put on immediate formulation of the master plan, and the simulation models might be developed according to need to formulate the master plan. And the Team explained that the level of the simulation models to be applied in the Study depends on data availability and resources (time and budget), and would be decided based on the survey results by the Team. The Team agreed to convey the request to JICA Headquarters. It is emphasized by WRMC that a type and level of simulation model should be clarified in the inception report.

5 Flood and sediment control measures

WRMC requested that recommendation on flood and sediment control measures be included in the Study. The Team answered that the recommendation on those measures would be made in the Study based on existing data and information as well as previous study reports on flood and sediment.

6 Stakeholder meetings

Both sides confirmed that the master plan should be formulated with consensus building through stakeholder meetings. The Team suggested that stakeholder meetings would be very important to formulate the master plan, and WRMC agreed to hold frequent stakeholder meetings under their responsibility. The Team promised to assist WRMC in holding those stakeholder meetings.

7 Time schedule of the Study

WRMC requested to shorten the time schedule of the Study to complete the master plan immediately. The Team understood the urgency of the formulation of the master plan, and promised to complete the study as soon as possible. The Team added, however, that immediate completion of the Study depended much on data availability and a halfway job would not be conducted to shorten the time schedule. The Team promised to make efforts to start the Study before September 2007.

8 Technology transfer and capacity building

WRMC requested that counterpart personnel should take advantage of training in Japan related to the Study to promote effective technology transfer. The Team agreed to convey the request to JICA Headquarters.

9 Counterpart team

WRMC agreed to assign a counterpart team, and promised to deliver the tentative list of the counterpart team to the Team by 20th February 2007.

10 Steering committee

WRMC will set up a steering committee under the chairmanship of WRMC for the smooth implementation of the Study. Both sides confirmed that the steering committee would consist of responsible persons in WRMC and relevant regional water authorities. Coordination with relevant organizations will be conducted by WRMC. WRMC promised to submit a tentative list of the steering committee to the Team by 20th February 2007.

11 Environmental and social considerations

The Team explained the JICA's environmental and social consideration guidelines. And WRMC understood the policy of the JICA's guidelines. The Study will follow both the laws / regulations of Iran and the JICA's guidelines.

12 Reports

Both sides agreed that the study reports would be open to the public, in principle, in order to achieve maximum use of the Study results.

13 Inception Report

The methodology and policy of the draft inception report will be discussed and finalized by the JICA Study Team and WRMC at the beginning of the Study. Based on the discussion the final inception report will be prepared.

14 Office space

WRMC agreed to provide office space with office furniture, air-conditioning, telephone lines and electricity inside of WRMC in Tehran.

Appendix-1 List of Participants

Iranian Side

Water Resources Management Company, Ministry of Energy

- Mr. Ali R. Daemi, Deputy of Planning and Economies Affairs
- Mr. Majid Sayyari, Director General of Budget and Planning
- Ms. Bahareh Hafez, Expert, Water Planning and Allocation Department

Mahab Ghodss Consulting Engineering Co.

- Mr. Pakdaman Amir Hassan, Head of Water Resources Section
- Mr. Bahman Khayyam, Senior Water Resources Specialist
- Mr. M. A. Taban, Head of Integrated Water Resources Department
- Mr. A. Ghobadi, Senior Expert, Water Resources Department

Japanese Side

The Preparatory Study Team, JICA

- Mr. Kenji NAGATA, Leader
- Ms. Hiromi SAWADA, Cooperation planning
- Mr. Seiichi YAMAKAWA, Water Resources Development and Management (surface water/ groundwater)
- Mr. Takayoshi ITOIGAWA, Water Resources Management Policy and System / environmental and social consideration

JICA Iran Office

- Mr. Hiroshi KURAKATA, Resident Representative
- Mr. Yoshinori NAKAYAMA, Project Formulation Advisor
- Mr. Babak SAMIEI, Program Officer

MINUTES OF MEETINGS

of

The Scoping of Initial Environmental Examination

for

The Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran

AGREED UPON

BETWEEN

Water Resources Management Company

Ministry of Energy

The Islamic Republic of Iran

and

The Study Team of Japan International Cooperation Agency

Tehran,

September 25, 2007

Mr. Majid Sayyari Director General Office of Project and Planning Water Resources Management Company	Mr. Tahara Teruo Leader of the Study Team Japan International Cooperation Agency

I. Introduction

The Government of Japan, in response to the official request of the Government of Islamic Republic of Iran (hereinafter referred to as "the Government of Iran"), decided to conduct the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Study Team to Iran from February 2 to March 1, 2007.

Water Resources Management Company of the Ministry of Energy (hereinafter referred to as "WRMC") and the Preparatory Study Team signed on and exchanged the agreement on the Scope of Work (hereinafter referred to as "S/W") and Minutes of Meetings (hereinafter referred to as "M/M") for the Study.

JICA has prepared the Study according to the S/W and M/M, and dispatched the JICA Study Team, headed by Mr. Tahara Teruo of CTI Engineering International Co., Ltd., to Iran from August 9, 2007.

The Study Team explained the overall activities described in the Inception Report and the Scoping of Initial Environmental Examination (hereinafter referred to as "IEE") to Iranian stakeholder, steering committee, and Environment and Water Resources Quality Office in WRMC (hereinafter referred to as "Iranian Side") in the meeting that were held on 20th of August and 12th of September 2007. Iranian side and the JICA Study Team (hereinafter referred to as "Both Sides") had finally agreed on the scoping of IEE. List of participants are shown in **ATTACHMENT 1** and **ATTACHMENT 2.**

II. Discussions

1. Definition

Both side agreed on that stake holder should be composed of Studies and Evaluation Bureau of WRMC in Ministry of Energy and the representative of Regional Water Company (hereinafter referred to as "RWC") of seven provinces of Zanjan, Kordestan, East Azarbayejan, Gilan, Qazvin, Ardebil, and Tehran.

2. Scoping of IEE

The both sides confirmed that "Environmental Primary Estimate" is required in Iranian regulation. It is synonymous with "IEE" of JICA regulation, so IEE will be conducted in the Study.

IEE would be conducted for getting the environmental condition in the Sefidrud River Basin. Terms of Reference (TOR) of IEE including Scoping are shown in **ATTACHMENT 3.**

Items of reserved area and dangerous plants will be added in "Natural Environment" in TOR 2.2.2 Scoping.

Positive impacts will be also investigated in TOR 2.2.2 Scoping.

It shall be added "objectives", "schedule", and "environmental standards" of Iran in Inception Report in TOR 2.4 Reporting.

3. Report submission

The Final Report of IEE shall be submitted to "Environment and Water Resources Quality Office in WRMC.

ATTACHMENT 1

List of participants in the Meeting on August 20, 2007 at the meeting room of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Davoud Khatib	Expert	Office of Project and Planning, WRMC
Mr. Ahmad Rajaei	Expert	Office of Project and Planning, WRMC
Mr. Yamashita Yoshihiro	JICA Expert	WRMC

List of participants of stakeholder in Stakeholders' meeting on 20th of August

	Full Name	Affiliation	Position	Contact
1	Mr. Mohammad-Ghasem Safiee	Qazvin RWC	Deputy of water resource planning	081-2223-7219
2	Mr. Mohammad-Ali Banisefid	Qazvin RWC	Planning & development	0912-181-7151
3	Mr. Kazem Aziz Moghaddam	Ardebil RWC	Engineering 7 technical office	0914-1529-414
4	Mr.Kourosh Kolahchi	Tehran RWC	Manager / planning office	021-8896-8014
5	Mr. Ali Mozafarian	Tehran RWC	Planning expert	021-8896-8014
6	Mr.Mojtaba jalilzad	East Azerbaijan RWC	Manager/ water resource planning office	041-1338-2410
7	Ms. Soheila mafakheri	Kordestan RWC	Expert / water resources planning	087-1662-2950
8	Mr. Jafar Fahimi	Zanjan RWC	Director general	034-1424-1041
9	Mr. Mohammad-Taghi Talebpoor	Zanjan RWC	Exploitation manager	034-1424-1041
10	Mr. Ali Karimi	Zanjan RWC	Technical consultant	034-1424-1041
11	Mr. Ali Abbasi	Zanjan RWC	Manager / water resources preservation office	034-1424-1041
12	Mr. Majid Akbari	R&D	WRMC	021-8890-1081
13	Mr. Fazl-Ali Jafarian	R&D	WRMC	021-8890-9137
14	Ms. Sanaz Dashti	Mahab Ghodss	Expert of water resources	021-2396-5229
15	Mr. Amir Hassan Pakdaman	Mahab Ghodss	Manager / water resources & demands	021-2396-1221
16	Mr. Abdolali Ghobadi	Mahab Ghodss	Water resources & demands	021-2396-1221
17	Mr. Bahman Khayyam	Mahab Ghodss	Water resources & demands	021-2396-1228
18	Mr.Vahid karami	Mahab Ghodss	Irrigation & drainage	021-2396-1351

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team
Mr. Matsumoto Shinichiro	Deputy Team Leader	JICA Study Team
Mr. Morishita Kanehiro	IWRM Planning Specialist	JICA Study Team
Mr. Yajima Makoto	Conflict Management Specialist	JICA Study Team
Mr. Daisaku Kiyota	Environmental Specialist	JICA Study Team
Mr. Onuma Takashi	Administrative Coordinator	JICA Study Team
Mr. Wakui Junji	Assistant Resident Representative	JICA Iran Office

ATTACHMENT 2

List of participants in the Meeting on 12th of September, 2007 at the meeting room of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Davoud Khatib	Expert	Office of Project and Planning, WRMC
Mr. Ahmad Rajaei	Expert	Office of Project and Planning, WRMC
Mr. Yamashita Yoshihiro	JICA Expert	WRMC

List of participants of stakeholder in Stakeholders' meeting on 12th of September

No.	Full Name	Affiliation	Position	Contact
1	Ms. Soheila Mafakhary	Kordestan RWC	Expert, Water Resources Planning,	087-1662-2949
2	Mr. Iraj Hamidzadeh	East Azarbayejan RWC	Manager, Water Resources Planning Office	0914-1165-975
3	Mr. Kazem Azizmoghaddam	Ardebil RWC	Manager, Water Resources Planning & Development Office	0914-2529-414
4	Mr. Mohammad Ali Banisefid	Qazvin RWC	Deputy, Development & Planning	0912-181-7151
5	Mr. Amir Kakahaji	Qazvin RWC	Engineering Office	028-1223-9662
6	Mr. Mohammad Ghasem Safiee	Qazvin RWC	Manager, Basic Water Resources Studies Office	028-1223-7219
7	Mr. Mohammad Talebpour	Zanjan RWC	Deputy, Exploitation & Subscribers Affairs	0912-2429-608
8	Mr. Ali Abbasi	Zanjan RWC	Manager, Water Resources Protection Office	0912-3425-272
9	Ms. Mandana Abedini	Zanjan RWC	Manager, Coordination	0912-5422-866
10	Ms. Sedigheh Rasouli	Gilan RWC	Manager, Water Resources Planning Office	013-1666-7257
11	Mr. Mojtaba Jalilzadeh	East Azarbayejan RWC	Manager, Water Resources Planning Office	041-1338-2410
12	Mr. Majid Akbary	WRMC	Expert, Water resources Basic Studies Office	021-8890-1819
13	Mr. Fazl --Ali Jafarian	WRMC	Expert, Water resources Basic Studies Office	021-8890-9137
14	Mr. Amir Hassan Pakdaman	Mahab Ghodss	Manager, Water Resources & Demands	021-2396-1221
15	Mr. Abdolali Ghobadi	Mahab Ghodss	Senior Expert	021-2396-1221
16	Ms. Sanaz Dashti	Mahab Ghodss	Groundwater Senior Expert	021-2396-5229
17	Mr. Vahid Karami	Mahab Ghodss	Manager, Irrigation & Drainage	021-2396-1351

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team
Mr. Matsumoto Shinichiro	Deputy Team Leader	JICA Study Team
Mr. Yajima Makoto	Conflict Management Specialist	JICA Study Team
Mr. Takafumi Szuki	Agriculture/Irrigation Specialist	JICA Study Team
Mr. Yasushi Osato	Organization/ Institution Specialist	JICA Study Team
Mr. Daisaku Kiyota	Environmental Specialist	JICA Study Team
Mr. Onuma Takashi	Administrative Coordinator	JICA Study Team

ATTACHMENT 3: Scoping of IEE

TERMS OF REFERENCE (TOR)
FOR
INITIAL ENVIRONMENTAL EXAMINATION (IEE)

1. Implementation Policy of IEE

1.1 General

The objective of the **INITIAL ENVIRONMENTAL EXAMINATION** (hereinafter referred to as **IEE**) is anticipating examining the consequences of Master Plan prior to the project stage and will be applied to the project of "INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIEDRUD RIVER BASIN IN THE ISLAMIC REPUBLIC OF IRAN (hereinafter referred to as **The Study**)"

IEE will be conducted for the generic master plan study proposed by JICA Study Team with the guidelines of Islamic Republic of Iran and/or JICA guidelines.

1.2 Entrusting of IEE

The JICA Study Team will entrust part of **IEE** studies to a local consultant (hereinafter referred to as **Contractor**) on contract basis as described in the "2. Scope of Work for IEE)".

1.3 Study Process of IEE

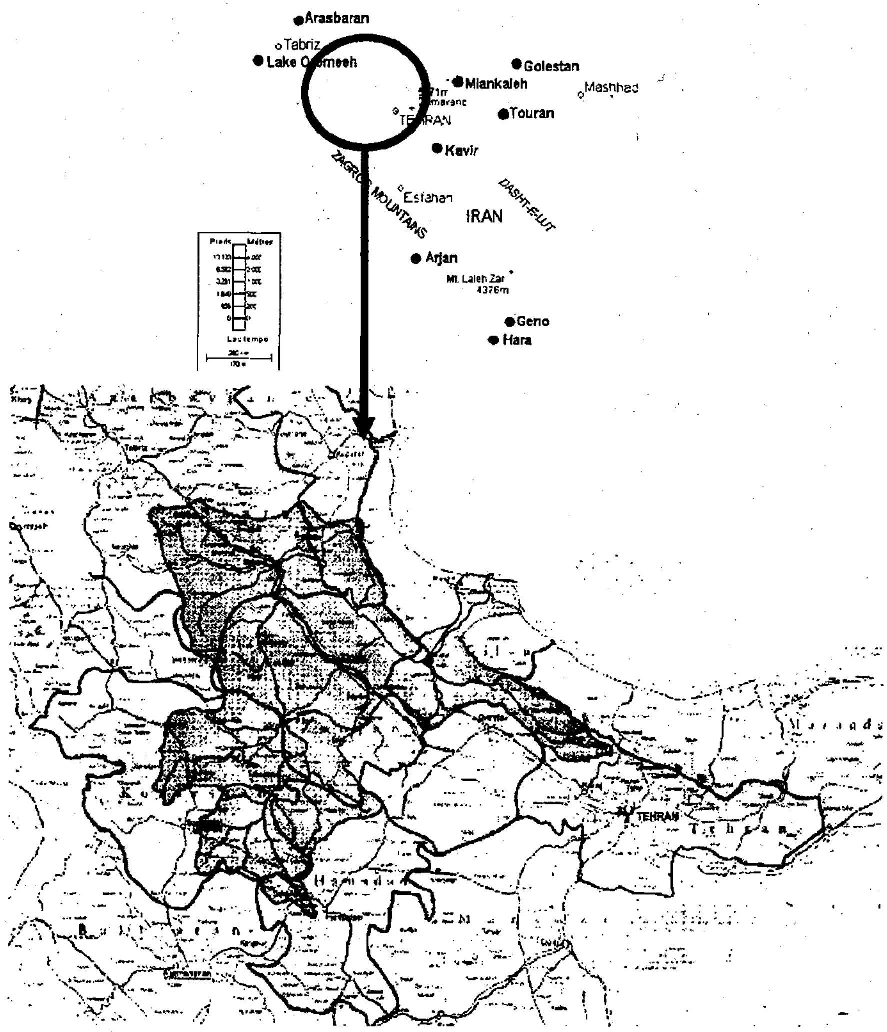
The IEE will be conducted for generic master plan. The study process is shown below.

- Scoping: JICA study team will prepare a scoping report in consultation with the project proponent. The scoping report was discussed with stakeholders in the stakeholder meeting held on 20th of August and 12th of September 2007.
- Implementation of **IEE**: the contractor and the JICA Study Team will conduct the **IEE**, taking into consideration the opinions/recommendations addressed in the first and second stakeholder meeting. In the course of the study, interim results will be discussed with stakeholders in the third stakeholder meeting that will be held in the beginning of December 2007.
- Preparation of **IEE** Report: the contractor and the JICA Study Team will prepare a draft final report, taking into consideration the opinions/recommendations addressed in the above stakeholder meeting. The draft final report will be discussed with stakeholders in the fourth stakeholder meeting that will be held in the beginning of February 2008. The final report will be prepared, taking into consideration the opinions/recommendations addressed in the above fourth meeting.

2. Scope of Work for IEE

2.1 Target Area

The **IEE** shall be conducted for the river basins of SEFIDRUD, and related 8 provinces of East Azerbaijan, Gilan, Hamadan, Kordestan, Qazvin, Tehran, Zanjan, and Ardebir in the Islamic Republic of Iran.



2.2 Study Works

2.2.1 Collection of Relevant Documents and Data

The Contractor shall collect existing baseline data/information related to natural and social environments, environmental regulations/guidelines, and water quality standards. The Contractor shall summarize the documents and regulations for review by the JICA Study Team.

2.2.2 Scoping

Scoping is to identify the extent of possible significant impacts caused by the Study and to establish prediction/evaluation methods of the impacts. In more detail, Scoping shall include the following works:

(i) to identify impact sources of the project activities,

(ii) to identify environmental items which may be subject to significant negative impacts and,

(iii) to establish prediction/evaluation method of the impacts.

JICA Study Team established the scoping in the consultation of stakeholder meeting. The Contractor shall conduct the above scoping works based on scoping of JICA Study Team and shall investigate the following items with the analyses of the collected data/information and field reconnaissance.

(1) Identification of Negative Impact Sources

Negative impacts will be generated by the necessary project activities to implement the generic master plan. The impact sources of each component will be identified for pre-construction stages. The contractor shall identify impact sources to be analyzed.

(2) Item to be investigated

The contractor shall identify environmental items which may be affected by significant negative impacts from among the following ones, but not limited to them.

- Social Environment: (i) resettlement, (ii) economic activities, (iii) land use, (iv) separation of community, (v) transportation and living facilities and services, (vi) poverty and minority, (vii) regional imbalance of project benefits, (viii) historical and cultural assets, (ix) regional conflicts, (x) water right and common right, (xi) public hygiene, (xii) disaster and epidemic.
- Natural Environment: (i) topography and geology, (ii) groundwater, (iii) soil erosion, (iv) hydrological regime, (v) coastal and ocean environment, (vi) fauna/flora and biological diversity, (vii) climate, (viii) landscape, (ix) global warming, (x) preserved area, (xi) dangerous plants
- Public Nuisance: (i) air pollution, (ii) water pollution, (iii) soil pollution, (iv) solid waste, (v) noise and vibration, (vi) land subsidence, (vii) odor, (viii) pollution of riverbed materials, (ix) traffic accident.

The degree/extent of negative impacts shall be shown as much clearly as possible, for example, by matrix system with score, so that really important environmental items can be selected.

(3) Identification of Positive Impacts

Positive impacts will be also investigated by this Master Plan, especially in the social environment.

2.2.3 Implementation of IEE

The Contractor shall prepare **IEE** for the generic master plan, based on the existing data, field reconnaissance, field observation on natural environment (as required), results of social environmental survey for resettlement and engineering studies, and other information.

The **IEE** study shall include the following works:

(i) to predict and evaluate negative impacts caused by master plan,

(ii) to propose mitigation measures of the negative impacts and

(iii) to propose monitoring plan of the negative impacts.

(iv) to investigate positive impacts

2.3 Attendance in Stakeholder Meeting

The Contractor shall attend the stakeholder meetings which will be held in the course of the master plan study, and provide the JICA Study Team and project proponent with necessary technical support in the meeting.

2.4 Reporting

The Contractor shall submit the following reports in English to the JICA Study Team at the designated time. The JICA Study Team will examine them for approval to the next step, after consultation with the project proponent.

(1) Inception Report (3 copies)

The Contractor shall prepare five (5) copies of Inception Report and submit them to the JICA Study Team within 2 weeks after signing of the contract. The Inception Report shall contain the following descriptions.

(a) Objectives

(b) Schedule

(c) Environmental standards in Iran

(d) Environmental Impact Statement System (EIS) and laws/ regulations/ policies related to resettlement of Iran

(e) Scoping

(f) Others, if any

(2) Interim Report (3 copies)

The Contractor shall prepare the Interim Report and submit it to the JICA Study Team by the end of November 2007. The Interim Report shall contain the interim results of the **IEE**.

(3) Draft Final Report (3 copies)

The Contractor shall prepare the Draft Final Report and submit it to the JICA Study Team by the end of January 2008. The Draft Final Report shall contain all the results of **IEE** study. The JICA Study Team will review the report and make comments.

(4) Final Report (10 copies and CD)

The Contractor shall finalize the Draft Final Report based on the comments by the JICA Study Team and submit it to the JICA Study Team by end of February 2008.

4. Equipment, Materials and Labor

All equipment, transportation vehicles, materials and labor required for all the above-mentioned works shall be provided by the Contractor, as defined in the contract. Those costs shall be included in the cost estimate. The contract is based on Lump sum basis.

5. Any Other Issues

Any other issues related to the conduct of the **IEE** not mentioned above shall be settled with mutual agreement between the JICA Study Team and the Contractor.

MINUTES OF MEETINGS

on

The Inception Report

of

THE STUDY

on

Integrated Water Resources Management for Sefidrud River Basin

in the Islamic Republic of Iran

AGREED UPON BETWEEN

Water Resources Management Company

Ministry of Energy

The Islamic Republic of Iran

and

Japan International Cooperation Agency

Tehran, October 2, 2007

Mr. Majid Sayyari
Director General
Office of Project and Planning
Water Resources Management Company

M. Sayyari

Mr. Tahara Teruo
Leader of the Study Team
Japan International Cooperation Agency

Witness

Mr. Ali R. Daemi
Director General
General Planning Department
Ministry of Energy

Mr. Wakui Junji
Assistant Resident Representative
Iran Office
Japan International Cooperation Agency

I. Introduction

The Government of Japan, in response to the official request of the Government of Islamic Republic of Iran (hereinafter referred to as "the Government of Iran"), decided to conduct the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Study Team to Iran from February 2 to March 1, 2007.

Water Resources Management Company of the Ministry of Energy (hereinafter referred to as "WRMC") and the Preparatory Study Team signed on and exchanged agreement on the Scope of Work (hereinafter referred to as "S/W") and Minutes of Meetings (hereinafter referred to as "M/M") for the Study.
JICA has prepared the Study according to the S/W and M/M, and dispatched the JICA Study Team, headed by Mr. TAHARA Teruo of CTI Engineering International Co., Ltd., to Iran from August 9, 2007.

At the commencement of the Study, the Study Team explained the overall activities described in the Inception Report to Iranian stakeholders (composed of the representative of seven provinces of Zanjan, Kordestan, East Azerbaijan, Gilan, Qazvin, Ardebil, and Tehran), steering committee (hereinafter referred to as "Iranian Side") in the meeting that were held on 20th of August and 12th of September 2007. List of participants of the stakeholder meeting are shown in **ATTACHMENT 1** and **ATTACHMENT 2**.
After the stakeholder meetings, Iranian side and the JICA Study Team (hereinafter referred to as "Both Sides") had also a series of discussions on the comments from stakeholders. Both Sides finally agreed upon the study components and study plan contained in the Inception Report. List of participants are shown in **ATTACHMENT 3**.

II. Discussions

1. **The target of accuracy of satellite images will be 1/25,000 scale, if such data available.**

2. **Table 3.12 will be adjusted in accordance with the number of project in the Mahb Ghodss final report.**

ATTACHMENT 1

List of participants in the Meeting on August 20, 2007 at the meeting room of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Davoud Khatib	Expert	Office of Project and Planning, WRMC
Mr. Yamashita Yoshihiro	JICA Expert	WRMC

List of participants of in Steering Committee and Stakeholders' meeting on 20th of August

	Full Name	Affiliation	Position	Contact
1	Mr. Mohammad-Ghasem Safiee	Qazvin RWC	Deputy of water resource planning	081-2223-7219
2	Mr. Mohammad-Ali Banisefid	Qazvin RWC	Planning & development	0912-181-7151
3	Mr. Kazem Aziz Moghaddam	Ardebil RWC	Engineering 7 technical office	0914-1529-414
4	Mr.Kourosh Kolahchi	Tehran RWC	Manager / planning office	021-8896-8014
5	Mr. Ali Mozafarian	Tehran RWC	Planning expert	021-8896-8014
6	Mr.Mojtaba jalilzad	East Azerbaijan RWC	Manage r/ water resource planning office	041-1338-2410
7	Ms. Soheila mafakheri	Kordestan RWC	Expert / water resources planning	087-1662-2950
8	Mr. Jafar Fahimi	Zanjan RWC	Director general	034-1424-1041
9	Mr. Mohammad-Taghi Talebpoor	Zanjan RWC	Exploitation manager	034-1424-1041
10	Mr. Ali Karimi	Zanjan RWC	Technical consultant	034-1424-1041
11	Mr. Ali Abbasi	Zanjan RWC	Manager / water resources preservation office	034-1424-1041
12	Mr. Majid Akbari	R&D	WRMC	021-8890-1081
13	Mr. Fazl-Ali Jafarian	R&D	WRMC	021-8890-9137
14	Ms. Sanaz Dashti	Mahab Ghodss	Expert of water resources	021-2396-5229
15	Mr. Amir Hassan Pakdaman	Mahab Ghodss	Manager / water resources & demands	021-2396-1221
16	Mr. Abdolali Ghobadi	Mahab Ghodss	Water resources & demands	021-2396-1221
17	Mr. Bahman Khayyam	Mahab Ghodss	Water resources & demands	021-2396-1228
18	Mr.Vahid karami	Ghodss	Irrigation & drainage	021-2396-1351

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team
Mr. Matsumoto Shinichiro	Deputy Team Leader	JICA Study Team
Mr. Morishita Kanehiro	IWRM Planning Specialist	JICA Study Team
Mr. Yajima Makoto	Conflict Management Specialist	JICA Study Team
Mr. Daisaku Kiyota	Environmental Specialist	JICA Study Team
Mr. Onuma Takashi	Administrative Coordinator	JICA Study Team
Mr. Wakui Junji	Assistant Resident Representative	JICA Iran Office

ATTACHMENT 2

List of participants in the Meeting on 12th of September, 2007 at the meeting room of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Davoud Khatib	Expert	Office of Project and Planning, WRMC
Mr. Yamashita Yoshihiro	JICA Expert	WRMC

List of participants of in Steering Committee and Stakeholders' meeting on 12th of September

No.	Full Name	Affiliation	Position	Contact
1	Ms. Soheila Mafakhary	Kordestan RWC	Expert, Water Resources Planning,	087-1662-2949
2	Mr. Iraj Hamidzadeh	East Azarbayejan RWC	Manager, Water Resources Planning Office	0914-1165-975
3	Mr. Kazem Azizmoghaddam	Ardebil RWC	Manager, Water Resources Planning & Development Office	0914-2529-414
4	Mr. Mohammad Ali Banisefid	Qazvin RWC	Deputy, Development & Planning	0912-181-7151
5	Mr. Amir Kakahaji	Qazvin RWC	Engineering Office	028-1223-9662
6	Mr. Mohammad Ghasem Safiee	Qazvin RWC	Manager, Basic Water Resources Studies Office	028-1223-7219
7	Mr. Mohammad Talebpour	Zanjan RWC	Deputy, Exploitation & Subscribers Affairs	0912-2429-608
8	Mr. Ali Abbasi	Zanjan RWC	Manager, Water Resources Protection Office	0912-3425-272
9	Ms. Mandana Abedini	Zanjan RWC	Manager, Coordination	0912-5422-866
10	Ms. Sedigheh Rasouli	Gilan RWC	Manager, Water Resources Planning Office	013-1666-7257
11	Mr. Mojtaba Jalilzadeh	East Azarbayejan RWC	Manager, Water Resources Planning Office	041-1338-2410
12	Mr. Majid Akbary	WRMC	Expert, Water resources Basic Studies Office	021-8890-1819
13	Mr. Fazl –Ali Jafarian	WRMC	Expert, Water resources Basic Studies Office	021-8890-9137
14	Mr. Amir Hassan Pakdaman	Mahab Ghodss	Manager, Water Resources & Demands	021-2396-1221
15	Mr. Abdolali Ghobadi	Mahab Ghodss	Senior Expert	021-2396-1221
16	Ms. Sanaz Dashti	Mahab Ghodss	Groundwater Senior Expert	021-2396-5229
17	Mr. Vahid Karami	Mahab Ghodss	Manager, Irrigation & Drainage	021-2396-1351

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team
Mr. Matsumoto Shinichiro	Deputy Team Leader	JICA Study Team
Mr. Yajima Makoto	Conflict Management Specialist	JICA Study Team
Mr. Takafumi Szuki	Agriculture/Irrigation Specialist	JICA Study Team
Mr. Yasushi Osato	Organization/ Institution Specialist	JICA Study Team
Mr. Daisaku Kiyota	Environmental Specialist	JICA Study Team
Mr. Onuma Takashi	Administrative Coordinator	JICA Study Team

ATTACHMENT 3

1. List of participants in the Meeting on 23rd of September, 2007 at the Director's office of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Ahmed Rajaei	Expert	Office of Project and Planning, WRMC

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team

2. List of participants in the Meeting on 24th of September, 2007 at the Deputy's office of WRMC.

[Iranian Side]

Mr. Ali R. Daemi	Deputy	Planning and Economics Affairs, Studies and Evaluation Bureau of WRMC
Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Ahmed Rajaei	Expert	Office of Project and Planning, WRMC

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team

3. List of participants in the Meeting on 25th of September, 2007 at the Director's office of WRMC.

[Iranian Side]

Mr. Majid Sayyari	Director General	Office of Project and Planning, WRMC
Mr. Ahmed Rajaei	Expert	Office of Project and Planning, WRMC

[Japanese Side]

Mr. Tahara Teruo	Team Leader	JICA Study Team

MINUTES OF MEETING

on

The Interim Report

of

THE STUDY

on

Integrated Water Resources Management for Sefidrud River Basin

in the Islamic Republic of Iran

AGREED UPON BETWEEN

Water Resources Management Company

Ministry of Energy

The Islamic Republic of Iran

and

Japan International Cooperation Agency

Tehran, July 13, 2008

Mr. Majid Sayyari
Director General
Office of Project and Planning
Water Resources Management Company

Mr. TAHARA Teruo
Leader of the Study Team
Japan International Cooperation Agency

M. Sayyari

Witness

Mr. Alireza Almasvandi
Deputy
Research and Technical Affairs
Water Resources Management Company

Mr. NAGATA Kenji
Leader of Monitoring Team
Japan International Cooperation Agency

I. Introduction

The Government of Japan, in response to the official request of the Government of Islamic Republic of Iran (hereinafter referred to as "the Government of Iran"), decided to conduct the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Study Team to Iran from February 2 to March 1, 2007.

Water Resources Management Company of the Ministry of Energy (hereinafter referred to as "WRMC") and the Preparatory Study Team signed on and exchanged agreement on the Scope of Work (hereinafter referred to as "S/W") and Minutes of Meetings (hereinafter referred to as "M/M") for the Study. JICA has prepared the Study according to the S/W and M/M, and dispatched the JICA Study Team, headed by Mr. TAHARA Teruo of CTI Engineering International Co., Ltd., to Iran from August 9, 2007.

A meeting on the Interim Report (hereinafter referred to as "the Report") for the Study was held at the WRMC's Office on July 8, 2008. The Report was explained by the Study Team and discussions were made between the Study Team and WRMC. After the meeting, WRMC received the Interim Report from JICA Study Team and will provide the comments to the Study Team by the middle of September. List of Participants is attached herewith.

II. Discussions

General

Prior to the discussion, President requested that the Study Team should pay attention to the fair water allocation, improvement of irrigation efficiency and effective utilization of groundwater as well as surface water.

Socio-economic Consideration

1. WRMC expressed that socio-economic analysis was important for the sustainable development, and that fair economic development should be considered as well as fair water allocation. The Study Team replied that socio-economic expert had already conducted such analysis and would consider the fair economic development through fair water allocation in the phase II stage.
2. WRMC requested that a socio-economic model should be linked to the simulation model that the Study Team had been constructing. The Study Team answered that the water balance between water potential and demand by each Province would be studied through the present simulation model and that the socio-economic effects to the Provinces would be evaluated through the simulation results and the results of socio-economic analysis. Both sides agreed with this matter.

Simulation Modeling

1. WRMC requested that land use change, in particular vegetation cover should be considered for the run-off model construction. The Study Team answered that the effects of land use changes so far were already studied, and found that the effects could be negligibly small.
2. WRMC requested that the accuracy of MIKE-SHE and -BASIN should be examined by comparing with the other simulation software. The Study Team answered that even construction of MIKE-SHE and -BASIN was tough work due to constraint of useful data/information, and thus dual ways of simulation and its comparison were too hard. Both sides agreed with this matter.

Environmental Needs

1. There are draft guidelines on an environmental flow in Iran. Presently, preliminary set up of an environmental flow was applied in the water balance simulation. Both guidelines of Iran and Japan should be examined considering the characteristics of rivers in Iran, and the considered environmental flow should be revised through the discussion of Both Sides in the phase II stage.

Request of Additional Study

1. WRMC requested that the following Study items be implemented in order to encourage all the stakeholders to be able to reach a close consensus on a water resources management in the Sefidrud River Basin:
   1) To include the related area to Sefidrud irrigation network in the Gilan Province in the water balance simulation,
   2) To implement a training on the operation of the simulation model using manuals to be specially edited for Sefidrud River Basin, and
   3) To hold additional stakeholder meetings on alternative plans of the water resources management in order to build the consensus among the stakeholders.

Satellite Imagery Analysis (Pending Issue)

1. Regarding to the scale of land use map, there are different interpretations. WRMC makes more importance on the scale of 1/25,000 with necessary accuracy, whereas the Study Team believes that 1/250,000 would be accurate enough. WRMC believes that this accuracy may affect greatly on cropping pattern, consequently, on water demand. This item is needed to be more discussed between the Study Team and WRMC.

List of Participants

List of participants in the Meeting on July 8, 2008 at the meeting room of WRMC.

[Iranian Side]

Mr. Sattar Mahmudi	WRMC	President
Mr. Alireza Almasvandi	WRMC	Deputy of Research and Technical Affairs
Mr. Majid Sayyari	WRMC	Director General of Office of Project & Planning
Mr. Taghi Ebadi	WRMC	Office of Project & Planning
Mr. YAMASHITA Yoshihiro	WRMC	JICA Expert
Mr. Ali R Daemi	MOE	Director General of Macro Planning of Water & Wastewater

[Japanese Side]

Mr. NAGATA Kenji	JICA Headquarters	Leader of Monitoring Team
Ms. YOSHIDA Sanae	JICA Headquarters	Cooperation Planning, Monitoring Team
Mr. HIRANO Takahiro	JICA Iran Office	Project Formulation Advisor
Mr. TAHARA Teruo	JICA Study Team	Team Leader
Mr. MATSUMOTO Shinichiro	JICA Study Team	Deputy Team Leader
Mr. MORISHITA Kanehiro	JICA Study Team	IWRM Planning Specialist
Mr. GOTO Toshihiro	JICA Study Team	Water Balance Modeling Specialist
Mr. YAJIMA Makoto	JICA Study Team	Conflict Management Specialist
Ms. INOUE Tomomi	JICA Study Team	Environmental Specialist
Mr. TAKATA Satoshi	JICA Study Team	Design/Cost Estimation Specialist
Mr. OSATO Yasushi	JICA Study Team	Organization/ Institution Specialist

MINUTES OF DISCUSSIONS

ON

THE STUDY

ON

INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIDRUD RIVER BASIN

IN THE ISLAMIC REPUBLIC OF IRAN

AGREED UPON BETWEEN

WATER RESOURCE MANAGEMENT COMPANY

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Tehran, April 15, 2009

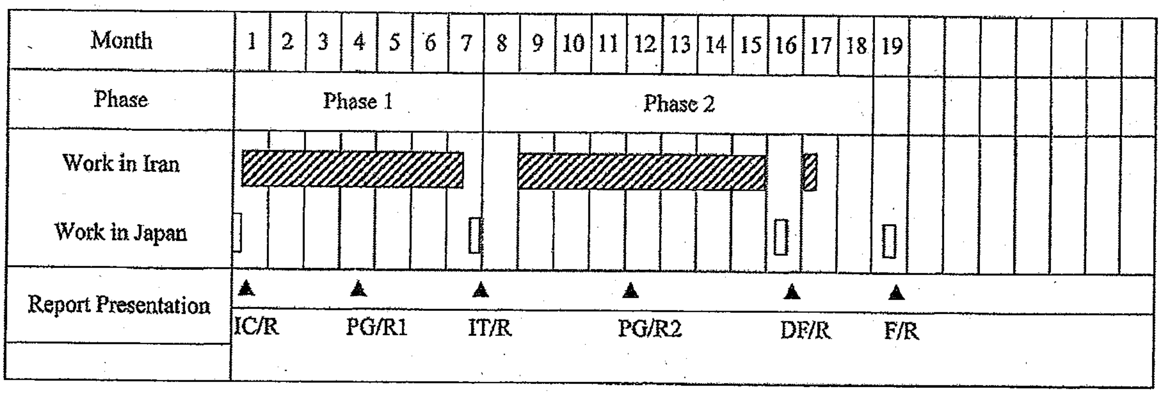
Makoto ASHINO
Resident Representative
JICA Iran Office

Majid SAYYARI
Director General
Planning and Project Office

1. Background

Scope of Work for "the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran" (hereinafter referred to as the S/W) was agreed upon between Water Resources Management Company (hereinafter referred to as WRMC) and Japan International Cooperation Agency (hereinafter referred to as JICA) on February 10, 2007. During the discussion on the S/W, the original study period of 19 months was designed, as illustrated in the following figure.

Tentative Schedule of the Study



IC/R: Inception Report
PG/R1: Progress Report I
IT/R: Interim Report
PG/R2: Progress Report II
DF/R: Draft Final Report
F/R: Final Report

In July 2007, the study team was dispatched to Iran and discussed on the study schedule with the WRMC. The study team proposed the study schedule for the period of July 2007 to December 2008.

2. Pending Issues

In the course of the study, the WRMC raised the following issues.

(1) The dominant water use in the Sefidrud River basin is for agricultural purpose.

(2) The parameters to estimate water demands for irrigation, such as agricultural land use, cropping patterns and irrigation water requirements by crops, have little persuasiveness and objectivity.

(3) In order to increase of transparency on estimation process of irrigation demand and to foster the mutual trust among the related provinces, the WRMC strongly proposed the additional works on agricultural land use survey using satellite imagery with high resolution and water requirement survey by crops.

These matters were agreed as pending issues in the meeting on the Interim Report in July 2008.

3. Discussion Results

After rising the above- mentioned issues, the WRMC and the study team continuously discussed in order to find a suitable solution for them. In March 2009, both parties of the WRMC and the study team finally reached to the agreement on the solution of the pending issues. The agreement is composed of cooperative works by the WRMC including Mahab Ghods consulting company and the JICA study team, and the work schedule agreed is summarized below.

No	Work Items	Time Frame	Responsible Parties
1	Clarification of the area covered by satellite imagery and Spot imagery shooting plan will be made, and the imagery shooting should be ordered for two times.	April and July 2009	Mahab Ghods and JICA
2	After receiving the imagery, pre-analysis activities, topologic and radiometric corrections and maps with a 1:25,000 scale shall be made.	Beginning of May 2009	Mahab Ghods and JICA
3	Field trip, sampling with GPS (±3m) and spectral study for each crop at least 30 points with even distribution in each frame.	Beginning of May 2009	Mahab Ghods
4	Through data analysis, providing classification algorithm and other necessary activities for the spectral analysis, the initial version of maps shall be prepared.	June 2009	Mahab Ghods
5	After calculation of error coefficient, final version of land use maps divided by crops for two seasons of Summer and Autumn shall be submitted.	July 2009 and October to December 2009	Mahab Ghods
6	Water requirements by crops shall be studied, and ETC and ETO shall be estimated by comparing them with national document	July 2009	Mahab Ghods
7	Agricultural field trips shall be made and questionnaires shall be distributed simultaneously.	May and September 2009	Mahab Ghods
8	Accuracy of all information for estimation of water requirements shall be checked and confirmed.	May and September 2009	Mahab Ghods
9	Water requirements estimated shall be submitted.	July and October 2009	Mahab Ghods

4. Rescheduling

Following the agreed works for more precise estimation of irrigation water requirements, the study period shall be rescheduled as follows:

(1) Formulation of master plan: April to June 2009

(2) Submission of satellite imagery and discussion of progress on the imagery analysis: May and August 2009

(3) Discussion of progress on the imagery analysis and further necessary study: November to December 2009

(4) Restudy on the proposed master plan based on the results of the imagery analysis: January to March 2010

(5) Submission of draft final report: July 2010

(6) Submission of final report: September to October 2010

The original schedule and updated schedules are attached next page.

5. Effectiveness of S/W

The both sides confirmed that the matters discussed and agreed in S/W dated 10th February 2007 will remain effective unless otherwise agreed herein.

Original Tentative Schedule of the Study singed on February 10, 2007

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19							
Phase	Phase 1							Phase 2																		
Work in Iran																										
Work in Japan																										
Report Presentation	IC/R			PG/R1			IT/R					PG/R2				DF/R			F/R							

New Tentative Schedule of the Study

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Japanese Fiscal Year	JFY2007									JFY2008										
Gregorian Calendar Year	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Phase I Work in Iran																				
Phase I Work in Japan																				
Phase II Work in Iran																				
Phase II Work in Japan																				
Report Presentation	IC/R					PG/R1							IT/R							

Month	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Japanese Fiscal Year		JFY2009												JFY2010						
Gregorian Calendar Year	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Phase I Work in Iran																				
Phase I Work in Japan																				
Phase II Work in Iran																				
Phase II Work in Japan																				
Report Presentation	PG/R2		PG/R3										PG/R4		DF/R					F/R

MINUTES OF MEETINGS

on

the Stakeholder Meetings

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THE STUDY

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Water Resources Management Company

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Tehran, May 31, 2009

Mr. Majid Sayyari
Director General
Office of Project and Planning
Water Resources Management Company

M. Sayyari

Mr. Kanehiro Morishita
Leader of the Study Team
Japan International Cooperation Agency

I. Introduction

The JICA Study Team explained the outline of the draft Maser Plan on Integrated Water Resources Management for Sefidrud River Basin in the Stakeholder Meetings consisting of the representatives of East-Azarbayejan RWC, Ardebil RWC, Kordestan RWC, Zanjan RWC, Gilan RWC, Qazvin RWC, Tehran RWC and WRMC, which were held on 6th and 18th of May 2009 in Tehran. Iranian side and the JICA Study Team had a series of discussions on the Study in such two Stakeholder Meetings.

II. Discussions

Discussions of such two Stakeholder Meetings are described in the following pages.

Minutes of Meeting I

Sefidrud River Basin Stakeholder Meeting, May 6th 2009

Participants: Ardebil RWC, Tehran RWC, Zanjan RWC, WRMC, Mahab Ghods Consultants Co., Kordestan RWC, Guilan RWC, the JICA Study Team

Absence: East-Azerbayejan RWC, Qazvin RWC, Water & Sewage Planning Office

Discussed issues:

First, Mr. Sayyari informed participants that Mahab Ghods Co. has submitted its draft final report before Iranian new year. Also, according to agreement with JICA, satellite imagery shooting has been started in April. Then it was determined that firstly Mahab Ghods and secondly JICA will report the progress of their studies.

Mr. Pakdaman (Mahab Ghods) mentioned that Mahab Ghods report has been sent to the Provinces and asked the Province RWCs to make their comments regarding the report. It was determined that all members of the Stakeholder Meeting make their comments on the report by 20th of May. Then, different scenarios were presented by Mahab Ghods and finally in this section, the Stakeholder Meeting agreed to ask Mahab Ghods to submit the complete information of water resource planning for each reach to all Provinces.

JICA Study Team made its presentation and gave some explanation about the simulation results for both average year and 5-year drought. The JICA Study Team emphasized necessity of improvement of irrigation efficiency from 33% at present condition to 40% and 50% in mid-term and long-term when 36 dams are considered in the simulation model. Possibility of conversion of water source from groundwater to surface water in some areas was also mentioned. More detailed study on a multi-dimensional management is also necessary regarding this issue. Change or improvement of cultivation pattern in some areas should be considered.

The main purpose of Taleghan dam is another issues remarked. The main purpose of this dam is to supply municipal or drinking water to Teheran.

Agreements:

1- All members of the Stakeholder Meeting should submit their comments and suggestions regarding Mahab Ghods report by 20th May 2009.

2- Mahab Ghods will submit the power point file inncluding result of each scenario which shows irrigation area, water shortage, water demand of new plans, etc. within one week.

3- Mahab Ghods report on water resources planning needs to give a clear conclusion. Mahab Ghods should revise the report according to further comments which will be made later by the members of the Stakeholder Meeting and give the conclusion.

4- Time-consuming process of IWRM and never-ending need of its updating was emphasized again.

5- Revised report of water resources and consumptions (published in Dey 1387), is the base for report on water resources planning, and plans should be considered according to the report of water resources and consumptions.

6- Ardebil RWC made their comments on water resources planning report, and submitted them as a document at the end of meeting. This document will be delivered to Mahab Ghods afterward.

Minutes of Meeting II

Sefidrud River Basin Stakeholder Meeting, May 18th 2009

Participants: East-Azerbayejan RWC, Ardebil RWC, Kordistan RWC, Zanjan RWC, Guilan RWC, Qazvin RWC, Tehran RWC, WRMC, MOE, Mahab Ghods Consultants Co., JICA HQ (Tokyo), JICA Iran Office, the JICA Study Team

Agenda:

1) Opening by Mr. Majid Sayyari, Director General, Office of Project and Planning, WRMC
2) Presentation of Draft M/P and the results of Local Consultation by the JICA Study Team
3) Comments by related Provinces and agencies
4) Report by MG Consulting Company
5) Comments by Mr. Kenji Nagata, Senior Advisor, JICA HQ
6) Comments by Mr. Almas Vandi, Deputy, of Bureau of Development Planning, WRMC

Discussions:

[Comments by related Provinces and agencies and Responses by JICA Study Team]

Gilan Province

- Simulations should be conducted based on the data of past 10 years since when the climate has been changed.
  - ➢ *The simulations were conducted based on the data of past 30 years with using a hydrological model. No one can say that the same trend of drought would continue further. Another examination will be conducted based on the data of 5-year drought in the recent 10 years.*
- The water quality of the lower reaches has been deteriorated and the EC of the river water shows 3,300. Water quality issues should be considered.
  - ➢ *Concerning the water quality, only data analyses were conducted in the Study. As we said in the occasion of the Local Consultation, it is very difficult to solve the salinization problems in this region due to widespread geological origin. However, recommendation will be provided in the report.*
- In Gilan Plain, demands for irrigation water concentrate between April and August, when the flow decreases. Did you consider this effect?
  - ➢ *Our model shows the lowest flow between April and August, which causes the same results. Also, the simulation is based on 12 months, thus the low season will be considered.*
- Technical Office of MOE stipulates that only the projects for which the phase 1 study has been completed can be considered. Is JICA Study contrary to this?

- *We included those projects for which F/S had been completed as stipulated by Technical Office in the main scenario. Also other scenario had been simulated in a wide range.*

- Data of drinking water demands presented by Provinces seem overestimated. Did you check them?
  - *Drinking water demands are very small comparing with those for irrigation. Effects of overestimation on drinking water would be negligible.*
- Only water volumes were examined with the model. Did you examine them from the viewpoints of economy and environment?
  - *We estimated changes in flow conditions with a hydrological model. Based on such data, we made additional examinations from the viewpoints of economy and environment.*
- Water potential in a drought year illustrated in the graph seems too big.
  - *Water potential of the lower reaches of Manjil Dam is the difference of natural flow and water consumed in the upper reaches.*
- The yearly capacity of Manjil Dam is 1,085 MCM. Dam capacities should be examined on monthly or daily basis.
  - *We used the same figure and examined them on monthly basis.*

Tehran Province

- The study conducted by Sanyu consulting company proposed an alternative dam to Manjil Dam because it has a sedimentation problem.
  - *This study is for a master plan. The studies in a small scale such as a sedimentation study shall be done in different projects.*
- Taleghan, Karaj and Lar dams were originally constructed to supply both drinking and irrigation water but presently drinking water supply to Tehran is prioritized. Therefore, integrated operation between Manjil and Taleghan dams is difficult.
  - *Integrated operation between Manjil and Taleghan dams were presented just as an example to show possibility.*
- To set a check point at Manjil Dam is suitable at present. In mid-term and long-term examinations, it should be moved or increased because new dams will be constructed then.
  - *It is important to clarify what should be checked when you consider the check point. We will check flow conditions longitudinally along the river, not at just one point (Manjil Dam).*
- Sensitive analysis is necessary in preparation for the case that the improvement of irrigation efficiency would not be attained.
  - *As the improvement of irrigation efficiency is significant, we will examine some other cases as development scenarios.*

East-Azarbayejan Province

- We would like to know water resources potential, specifications of projects, design volumes and so on, on the basis of Province
  - *Such data will be organized on the basis of Province.*
- The graph in the presentation seems that the demands of the lower reaches area are satisfied by almost 100%, which is deemed unfair.
  - *According to a master plan, we are going to distribute water shortage equally to the whole basin. However, it is impossible to achieve the complete distribution of the shortage of water in each region due to their geographical and hydrological conditions.*

Ardebil Province

- Did you examine criteria for deciding water allocation among related Provinces?
  - *It should be decided by the Provinces what criteria should be applied. JICA Study Team provides a tool for consultation / agreement on the water allocation among the Provinces.*
- We would like to ask you to examine and make comments about water resources facilities whose volume is less than 5 MCM because their number is large.
  - *Comments will be made about those less than 5MCM in the reports.*

Kordestan Province

- According to our examination, the traditional irrigation area whose water sufficiency is less than 50% is much larger than that you presented.
  - *Our study is conducted from a macro viewpoint and we do not have such local information. As it is very useful, we would like to ask you to provide us with more detailed information.*
- We would like to ask you to propose detailed ways for improving irrigation efficiency.
  - *As the scale of a master plan, the target should be defined and the concrete ways for improving irrigation efficiency should be studied in a separate project. However, recommendation will be provided in the report.*

Qazvin Province

- Did you include Burmanak Dam of Shahrud river?
- Did you include Alamut Transfer?
  - *Both of them are included in the model.*
- Did you include water supply of 25 MCM for the slope area in Qazvin Province?
  - *Yes, we considered it in D-1 and D-2.*
- Macro approach which targets the whole river basin provides such results that are not necessarily accurate from a local viewpoint.

- *Accuracy is acceptable by WRMC as a master plan level and all the information is in the report. If there is any inaccuracy in the report, please let us know.*

Water and Sewage Planning Office, WRMC

- I would like to know the details about Master Plan of IWRM. What model is used for the simulation?
  - *The detail information is presented in the report.*

Zanjan Province

- JICA Study Team has produced good results. We are expecting that MG consulting company will also produce good results with being influenced by JICA Study Team.
- Is it recommended to change to water saving crops from water consuming ones in the study?
  - *Since this is a study for a master plan, detail studies should be done in different projects. However, recommendation will be provided.*
- We think that the target of irrigation efficiency should be achieved by making efforts though some Provinces are claiming that the target is too high.
- Water resources should be used firstly to fulfill the demands within its basin. Then, they should be transferred to outside of the basin if they have remaining potential.
  - *It's not the matter to be decided by JICA Study Team. It should be decided by the consultation among Provinces or within the basin.*
- The checkpoint should be placed at the river mouth of the Caspian Sea.
  - *Our checkpoints are distributed from the most upstream location to the most downstream location. The lowest downstream checkpoint is located at Astaneh, which is close to the river mouth at Caspian Sea.*

Iran Water & Power Development Co., MOE

- We did not receive the report of JICA Study.
- If the submission of the final results is delayed, additional projects will be proposed. We would like to ask you to submit as soon as possible.
  - *Though we would like to submit the final results as soon as possible, they will be submitted in August next year as it takes a long time to analyze the satellite imagery.*
- Concerning the environmental flow, is it really effective with applying a hydrological method?
  - *We considered some methods recommended by the Ministry of Energy and also we have made the environmental review in the report.*
- Does the hydropower dam between Ostor and Manjil dams affect it?
  - *It is difficult to grasp the situation as we do not have the data on hydropower dams. If it is a small-sized run-off dam, it does not affect. We will visit to your office to collect the*

information later on.

WRMC

- If the dam at the upper reaches is a large-sized one, it affects as its annual evapotranspiration is large.
  - ➢ *Evapotranspiration factor was considered in the model.*

[Comments by Mr. Kenji Nagata, Senior Advisor, JICA HQ]

The Master Plan of Sefidrud IWRM has the following issues:

1) Improvement of Irrigation Efficiency

The result is that all the proposed projects could be accepted if the irrigation efficiency was improved to the target level. Efforts and investment are required to achieve the target level. In addition, it is required to examine what would be if the irrigation efficiency remained at the same level in order to propose a realistic master plan. Improvement of the irrigation efficiency should be considered as one of the projects for demand control.

2) Environmental Flow

Though it is a worldwide trend to setup an environmental flow, it should be considered whether it is really necessary at the cost of other demands in the dry areas like Sefidrud river basin. Its objective or what will be conserved should be clarified.

3) RBO

Establishment of an RBO is not enough. It should also be clarified what is necessary to actually functionalize the RBO.

4) IWRM

It requires various data and information. It is important that every Province provides data and information and discusses and confirms them together.

[Comments by Mr. Almas Vandi, Deputy, Bureau of Development Planning, WRMC]

- Since the model used in the Study is a mathematical one, consistent inputs are required to get consistent outputs. Every Province should provide accurate data.
- We would like to ask you to examine the outcomes of the model further from the socio-economic viewpoints.
- It was decided that the satellite imagery be used to improve the accuracy of land use data. It is being shot now.
- Improvement of irrigation efficiency should be achieved. As more than 50% of efficiency was achieved in Latin America, where the water is scarce like Iran, water shortage can not be

attributed to the failure of the achievement.

- Water quality is an important issue. We would like to ask the JICA Study Team to examine it fully.

End

MINUTES OF MEETINGS
ON THE PROGRESS REPORT 4
FOR THE STUDY
ON INTEGRATED WATER RESOURCES MANAGEMENT FOR SEFIDRUD RIVER BASIN
IN THE ISLAMIC REPUBLIC OF IRAN
AGREED UPON BETWEEN
WATER RESOURCES MANAGEMENT COMPANY
MINISTRY OF ENERGY
THE ISLAMIC REPUBLIC OF IRAN
AND
JICA STUDY TEAM

Based on (i) the Scope of Work for the Study on Integrated Water Resources Management for Sefidrud River Basin in the Islamic Republic of Iran (hereinafter referred to as "the Study") and the Minutes of Meeting agreed on 10 February 2007 between the Water Resources Management Company of the Ministry of Energy (hereinafter referred to as "WRMC") and Japan International Cooperation Agency (hereinafter referred to as "JICA"), (ii) the Minutes of Meeting on the Interim Report between the WRMC and JICA concluded on 13 July 2008, and (iii) the Record of Discussion on Work Progress between the WRMC and JICA Study Team (hereinafter referred to as "the Team") on 14 February 2009, the Team has been conducting the Study.

After the close investigation over the study area, the collecting information, the analysis of various matters related to water resources, the Team submitted the Progress Report 4 (hereinafter referred to as "P4/R") describing the activities and the study result in 20 (twenty) copies in English version and presented the summary of P4/R to WRMC. Both sides of WRMC and the Team have discussed and concluded on the contents of P4/R and the Iranian side received P4/R. The result of the discussion was recorded in writing as this Minutes of Meeting and both sides agreed on the attached matters.

TEHRAN, 15 March 2010

Mr. Majid Sayyari
Deputy
Research and Technical Affairs
Water Resources Management Company
Islamic Republic of Iran

M. Sayyari

for Toshihiro Goto

Mr. MORISHITA Kanehiro
Leader, The Study Team
Japan International Cooperation Agency
JAPAN

ATTACHMENT

1. Progress Report 4
   (1) The Team explained the study result in the third field survey, namely, the result of water allocation simulation by using the water demand based on the result of satellite image analysis.
   (2) The Team submitted P4/R in twenty (20) copies in English version.
   (3) WRMC has expressed that the contents shall be amended or added considering the results of the stakeholder meeting on 9 March 2010: namely, (i) the case of 0.39 irrigation efficiency of traditional agricultural area in Gilan province and (ii) the addition of evaluation for improvement projects concerning the water allocation system such as dams, interbasin transfer and irrigation efficiency.
   (4) The Iranian side will provide all of the comments to the Team on the contents of P4/R, if any, by the beginning of May 2007.
   (5) Participants of Stakeholder Meetings are listed in Annex-1.
2. Draft Final Report

   Both sides confirmed that the Team would submit the Draft Final Report (hereinafter referred as to "DF/R") to WRMC at the middle of July 2010. In addition, the Stakeholder Meeting and the Seminar on DF/R would be held at the same time. In addition, the Team will refer to the comment on P3/R and P4/R: especially, the delivered comments late for P3/R; namely, that from Ardebil, Kordestern and Zanjan provinces.

3. Office Space

   Both sides confirmed that the Team continues to use the office space provided by WRMC. The Team appreciates to use the office space until the third week of July 2010.

Annex-1

Participants Of Meeting

No.	Full Name	Affiliation	Position	Contact
1	Mr.A.Ghobadi	Mahab Ghodss	Expert	021-2396-5615
2	Mr.A.Dehmohseni	Mahab Ghodss	GIS Expert	0912-157-9703
3	Mr.Amin Hoseini	Mahab Ghodss	GIS Expert	0912-2689-3287
4	Mr.Zahra Gorjian	Mahab Ghodss	IT Expert	0912-207-9738
5	Mr.Alireza Sanjabi	Mahab Ghodss	Agricultural Expert	0912-304-6785
6	Mr.M.T. Akrami	Zanjan RWC	Expert	0912-390-3917
7	Mr.Shahrokh Amiraslani	Zanjan RWC	Expert	0912-341-2412
8	Mr.Jafar Fahimi	Zanjan RWC	M.D	0912-150-4775
9	Mr.Kazem Azizmoghadam	Ardabil RWC	Expert	0914-152-9414
10	Mr.Ebrahim Mokalaf	Ardabil RWC	Expert	0912- 419-6200
11	Mr.Yadollah Maleki	Qazvin RWC	Expert	0912-282-2623
12	Mr.Ali Ashraf Moradi	Qazvin RWC	Expert	8891-6596
13	Ms.Sedigheh Rasoli	Gilan RWC	Expert	0131-666-7257
14	Mr.Eghbal Shanazari	Kordestan RWC	Head of Project & Development	0871-666-4619
15	Mr.Mojtaba Jalilzadeh	East Azarbayjan	Manager of Planning & Development	0914-116-8592
16	Mr.AbdolrezaFallahrastgar	WRMC	Expert	021-8891-6596
17	Mr.Mojtaba Kord	WRMC	Expert	-
18	Mr.Majid Sayyari	WRMC	Deputy of development & Planning	0912-148-4345
19	Ms.Maryam Movahediniya	WRMC	Expert	021-8893-7223
20	Mr.Taghi Ebadi	WRMC	Expert	021-8889-8698
21	Mr.Fazlali Jafariyan	WRMC	Expert	021-8890-9137
22	Mr.Gholam Reza	IWPCO	Project Manager	021-2782-2132
23	Mr.ENDO Shinichiro	JICA	Expert	021-8893-7310
24	Mr.Amin Karimi	JICA	Translator	021-8893-7310
25	Mr.HIRANO Takahiro	JICA	Project Formulation Advisor	021-8864-8050
26	Mr.GOTO Toshihiro	JICA	JICA Study Team Leader	021-8890-8658
27	Mr. TAKATA Satoshi	JICA	JICA Study Team member	0919-485-3558
28	Mr.Mehran Mahboobi	JICA	Translator	0912-313-5697
29	Ms.Farideh Ghorabi	JICA	Translator	0912-157-5357

M. Sayyari

Minutes of Meeting

on

Draft Final Report

for

The Study on Integrated Water Resources Management for Sefidrud River Basin

in the Islamic Republic of Iran

Agreed upon between

Water Resource Management Company

Ministry of Energy

and

The Study Team of Japan International Cooperation Agency

Tehran, 17th July 2010

Kanehiro Morishita
Leader of the Study Team
Japan International Cooperation Agency
Japan

Majid Sayyari
Deputy
Planning and Development
Water Resource Management Company
Islamic Republic of Iran

Witnessed by
Kenji Nagata
Leader of the Monitoring Mission
Japan International Cooperation Agency
Japan

In accordance with the Scope of Work for "The Study on Integrated Water Resources Management for Sefidrud River Basin" (hereinafter referred to as "the Study") agreed upon between Water Resources Management Company (hereinafter referred to as "WRMC"), and Japan International Cooperation Agency (hereinafter referred to as "JICA") on 10 February, 2007, JICA Study Team prepared the Draft Final Report (hereinafter referred to as "DF/R"), and submitted DF/R to WRMC; twenty (20) copies of Main Report and forty (40) copies of Summary.

The Stakeholder Meeting on DF/R chaired by Mr. Majid Sayyari, Deputy, Development and Planning was held on 13th July, 2010 in attendance with the members of the Stakeholder Meeting and participants from WRMC (hereinafter referred to as "the Iranian side"), where the Study Team explained the contents of DF/R. The list of the participants to the Meeting is shown in Appendix 1.

The followings are the main points discussed and/or agreed upon the Stakeholder Meeting, and this Minutes of Meeting was prepared and signed by both sides.

I. Draft Final Report

(1) The Iranian Side basically received the basic outcomes of the Study mentioned in the DF/R.
(2) Comments on DF/R will be forwarded from WRMC to JICA Iran Office by the middle of August.
(3) JICA Study Team has submitted an outline of revision to be made to the DF/R. Revised chapters (mainly chapter 4 and 9) shall be sent to the Iranian side by the end of August 2010.
(4) Comments on mainly the chapter 4 and 9, if any, will be forwarded from WRMC to JICA Iran Office by the end of September 2010.
(5) Final Report will be delivered after necessary modification by incorporating the comments from the Iranian side.
(6) Both sides agreed that the Final Report be open to public.

II. Further Requests made by the Iranian Side

JICA Study Team agreed upon the following requests from the Iranian side;

(1) Donation of equipment and software

The Iranian side requested JICA to donate all equipment and software which JICA Study Team has been using for the Study after JICA Study Team finishes all the necessary works in Iran. The list of the equipment and software is shown in Appendix 2. The Iranian side is planning to utilize the equipment for future activities and will ensure that the equipment is properly maintained.

(2) Sensitivity Analysis for Ardebil Interbasin Transfer Project

The Iranian side requested JICA Study Team to conduct the sensitivity analysis by using the water allocation simulation model on the long-term condition. JICA Study Team agreed to assist to clarify the water balance variation caused by the above project.

(3) Evaluation of Environmental Flow and Preparation of Schematic Flow Diagram

The Iranian side requested JICA Study Team to evaluate the environmental flow by Montana Method and to figure the study results on the schematic flow diagram.

III. Further Technical Cooperation

The Iranian side requested further technical cooperation on the Integrated Water Resource Management sector, especially policy formulation, coordination and facilitation of the project implementation for WRMC and authorities concerned. JICA Study Team promised to convey this request to JICA Headquarters.

Appendix 1: List of Participants

1. Iranian Side

Mr. Majid Sayyari	Deputy	Planning and Development, WRMC
Mr. ENDO Shinichiro	JICA Expert	WRMC

No.	Name	Position	Organization
1	Mr. Ibrahim Mokalef Sarband	Expert of Technical Office	Ardabil RWC
2	Mr. Kazem Azizmoghadam	Manager of Technical Office	Ardabil RWC
3	Mr. Mohamad Reaza Rahimi	Expert	Deputy of Protection
4	Mr. Ghasem Soltanzadeh	Deputy of development & plan	East Azarbayjan
5	Mr. Mojtaba Jalilzadeh	Manager of Planning office	East Azarbayjan
6	Ms. Sedighe Rasoli	Manager of water resources development plans	Gilan RWC
7	Mr. Eghbal Shanazari	Deputy of development & plan	Kordestan RWC
8	Mr. Abdolah Ghobadi	Senior Expert	Mahab Ghods
9	Mr. Abdolrahim Safaritabar	Water resources Expert	Mahab Ghods
10	Mr. Amir Hossein Pakdaman	Senior Expert	Mahab Ghods
11	Ms. Behiye Jafari	Expert	MOE , Ab Abfa Planning office
12	Mr. Mohamad Ghasem Safieei	Manager of Studies	Qazvin RWC
13	Mr. Yadolah Malaki	Deputy of protection & Operation	Qazvin RWC
14	Mr. Ali Mozafariyan	Expert of Planning	Tehran RWC
15	Mr. A.Fallah Rastgar	Director of Drainage & Irrigation Networks development Office	WRMC
16	Mr. Abdolamir Kakahaji	Khazar basin	WRMC
17	Mr. Fazlali Jafariyan	Head of the group integration	WRMC
18	Mr. Isa Aghajani	Head of the group of planning	WRMC
19	Mr. Mansour Jamshidnezhad	Expert	WRMC
20	Mr. Masoud Najafi	Expert	WRMC
21	Mr. Mohamad Taghi Tavakoli	Director	WRMC
22	Mr. Mosa Aminnezhad	Director	WRMC
23	Mr. Seyyed Ahmad Alavi	Manager of Basin	WRMC
24	Mr. Seyyed Morteza Mousavi	Manager of Casin Area	WRMC
25	Mr. Taghi Ebadi	Manager of Technical Office	WRMC
26	Ms. Ghazal Jafari	Head of the Group	WRMC
27	Mr. Hossein Mehdinezhad	Deputy of planning & Improvement Managment	Zanjan RWC
28	Ms. Solmaz Mohamadi	Expert of Water allocation	Zanjan RWC

2. Japanese Side

JICA Monitoring Mission

1) Kenji Nagata	Team Leader
2) Miki Inaoka	Project Manager

JICA Iran Office

1) Takahiro Hirano	Project Formulation Advisor

JICA Study Team

1) Kanehiro Morishita	Team Leader/IWRM Planning Specialist
2) Toshihiro Goto	Deputy Team Leader/Water Balance Modeling Specialist
3) Makoto Yajima	Conflict Management Specialist

Appendix 2: List of Equipment and Software

Equipment and Software:

No.	Items	Lot	Description
1	DEM data	-	ASTER DEM in the Study Area
2	Satellite Images	-	ALOS (ERSDAC) 5 images (one season in the Study Area)
3	Facsimile	1	SHARP FO-P610
4	Color Laser Printer (A3)	1	HP Color LaserJet 5550
5	Color Laser Printer (A4)	1	HP Color LaserJet 4005
6	Plotter machine	1	HP Designjet 800 ps
7	Laptop PC	1	Lenovo 0768-4BG (without Microsoft Software*)
8	Multi copy machine	1	HP Laserjet M5025
9	Desktop PC	3	Original (without Microsoft Software*)
10	UPS	3	FARATEL SM1250
11	Mobile GPS	3	Garmin eTrex Legend Cx
12	MIKE BASIN, MIKE SHE and MIKE 11 (2 DVDs, 2 keys)	1 set	- First key is for Mike-Basin Extended licenses, Mike-SHE Enterprise licenses and Mike 11 Enterprise licenses. (Key No. MZ-17615) - Second key is for Mike-Basin Extended licenses and Mike-SHE Enterprise licenses. (Key No. MZ-18318) - Without ESRI software license*

* Unfortunately, these official softwares are not allowed to be granted in Iran.