CHAPTER 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 n Figure R 9.1.1. 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.

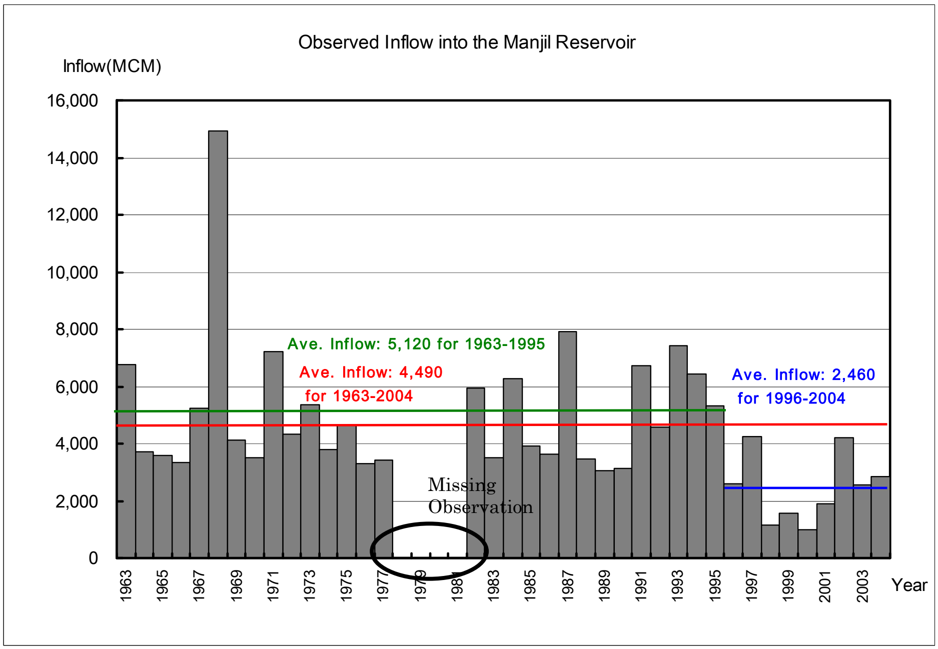


Figure R 9.1.1 Historical Change of inflows into the Manjil Reservoir

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. The following figure 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.

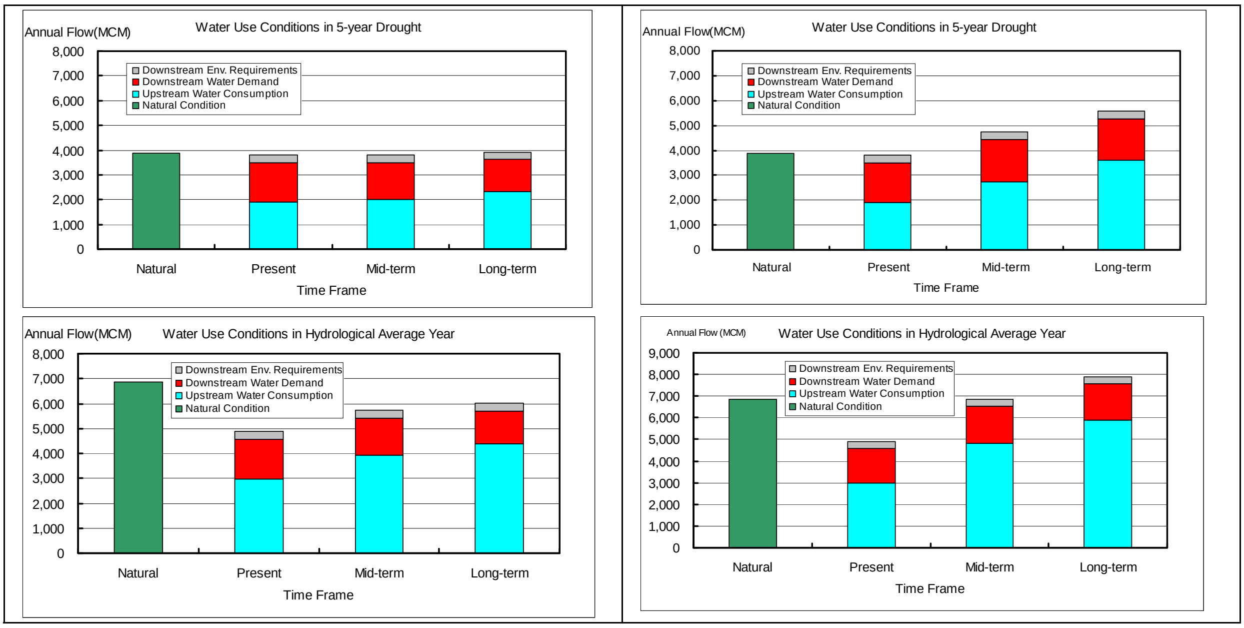


Figure R 9.1.2 Water Resources Potential and Water Consumption/Demand up- and down-stream of the Manjil Reservoir(Left Figure: Improvement of Irrigation Efficiency proposed by WRMC, Right Figure: without Improvement of Irrigation Efficiency)

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.

<u>Three Pillars of the IWRM of the Sefidrud</u>

(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 R 9.1.3.

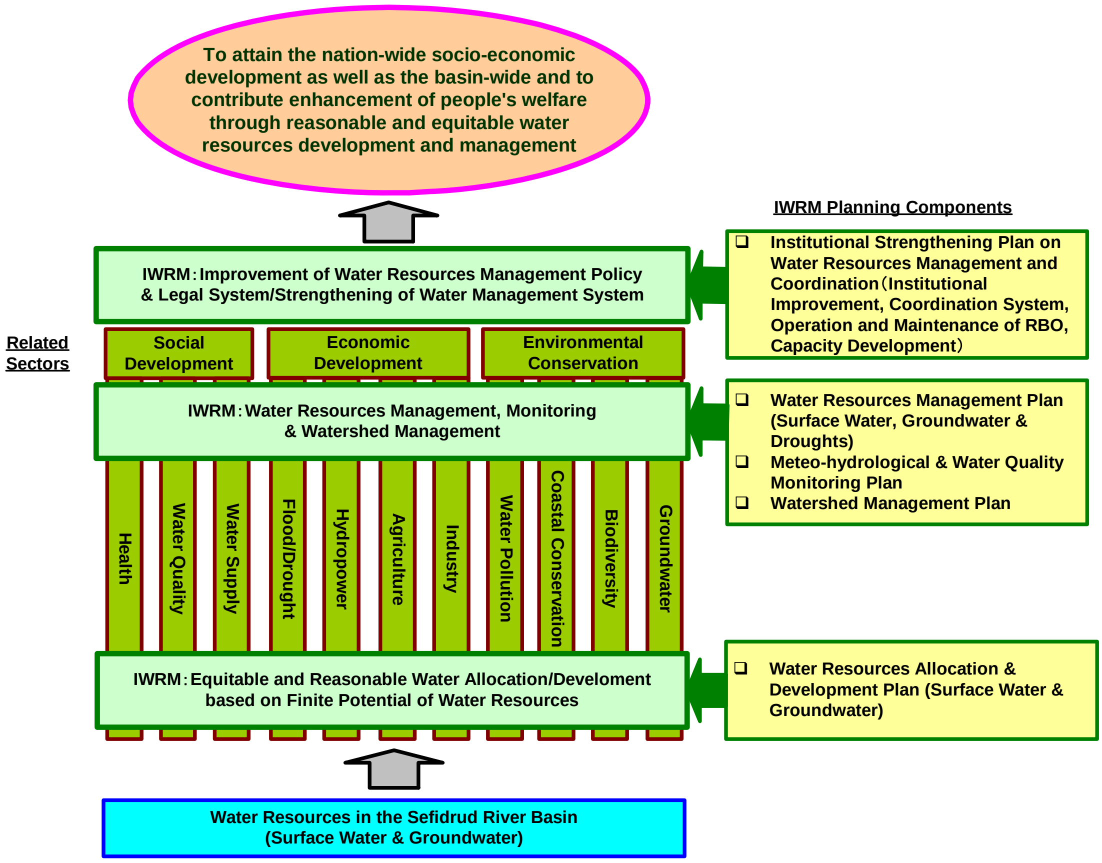


Figure R 9.1.3 Integrated Water Resources Management Concept of the Sefidrud

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 R 9.1.4. Details of the components are described in the section of 9.3.

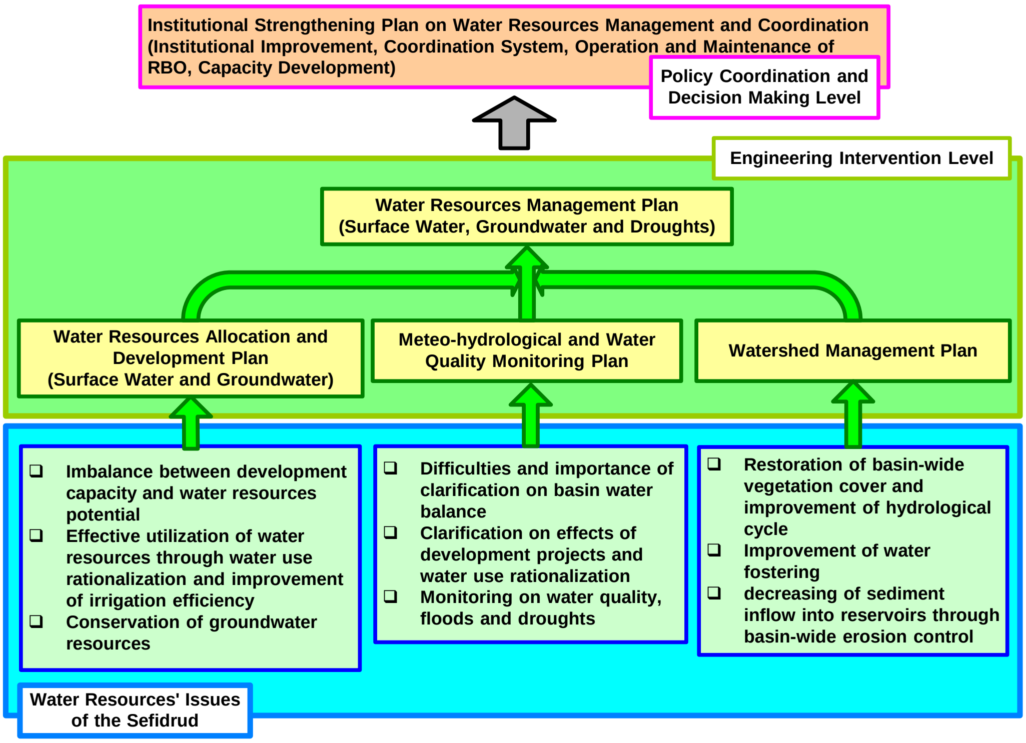


Figure R 9.1.4 Structures of IWRM Components of the Sefidrud

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 R 9.1.5 could illustrate integrated water resources management process in the future.

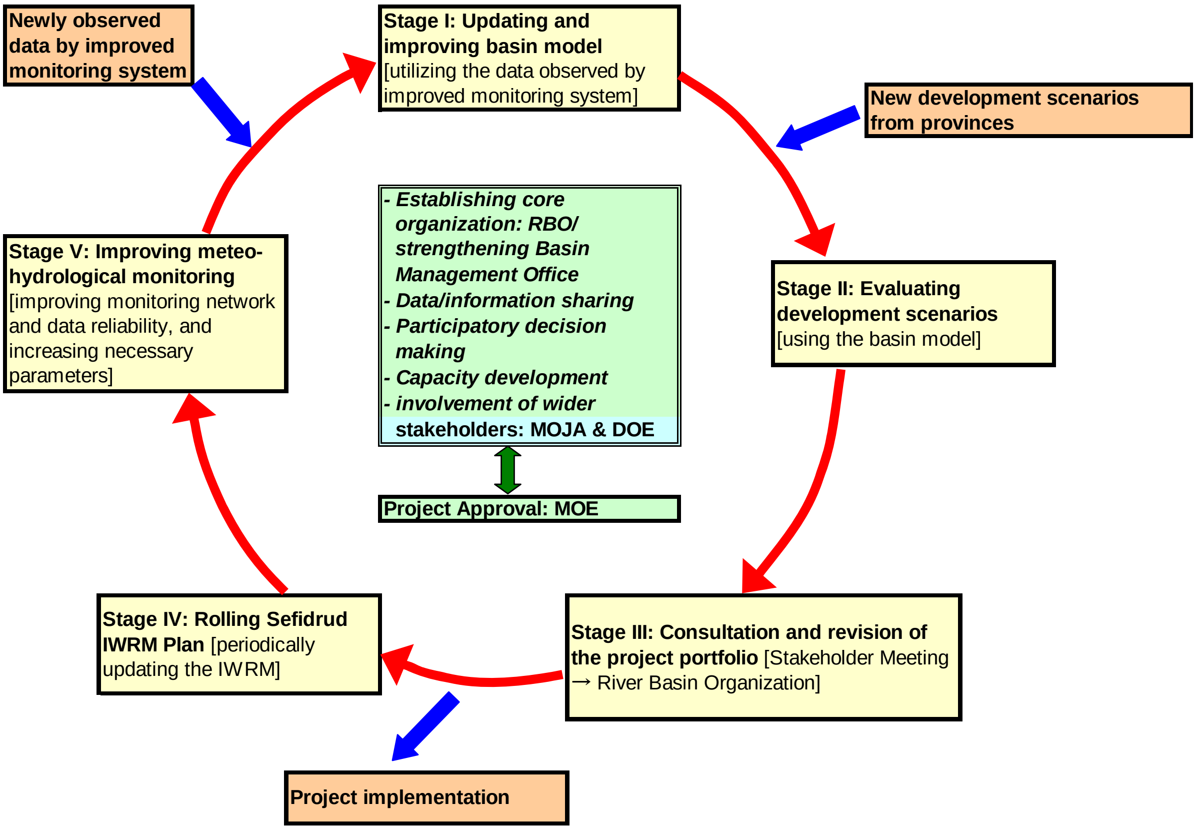


Figure R 9.1.5 Conceptual Management Process in the Sefidrud IWRM

As illustrated in Figure R 9.1.5, 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.

Issues for IWRM Realization

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.

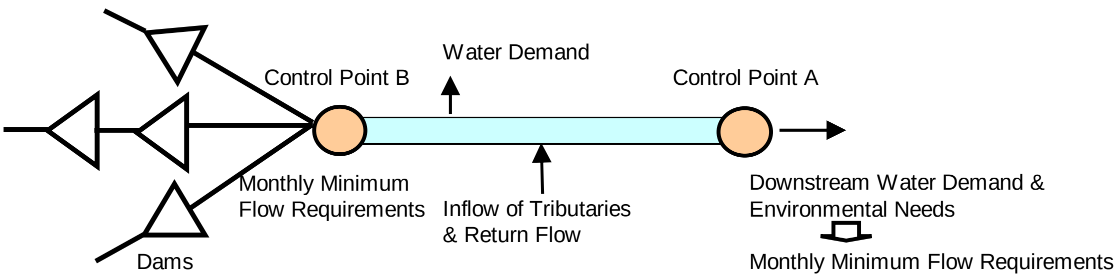


Figure R 9.1.6 Setting-up Concept of Monthly Minimum Flow Requirements

- 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 R 9.1.7.

(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.

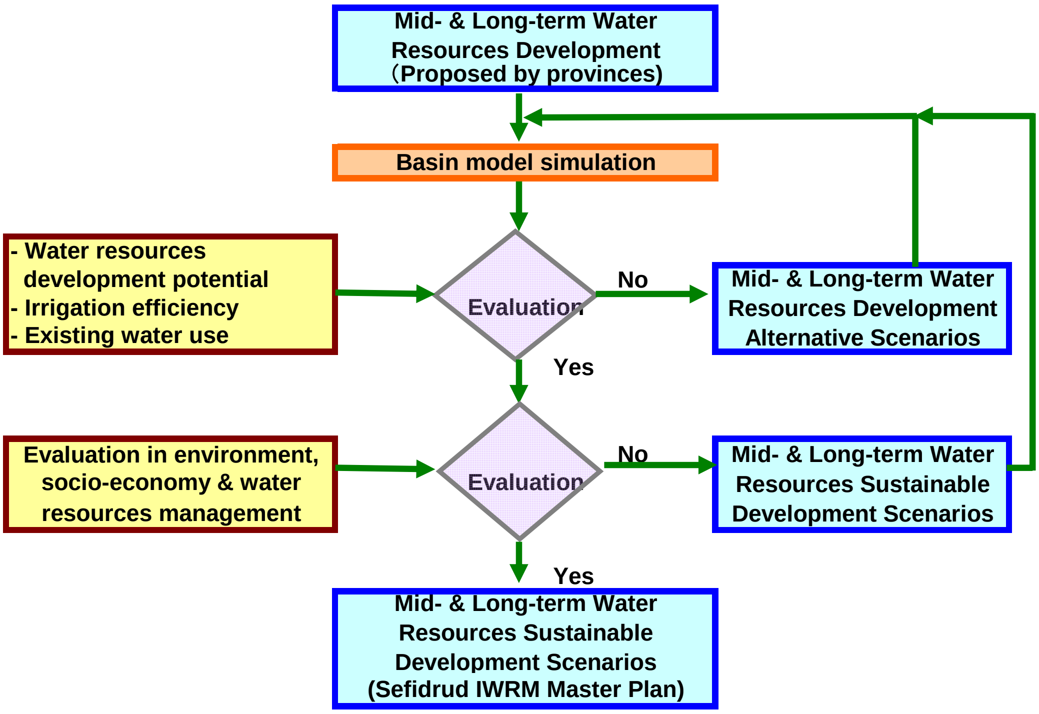


Figure R 9.1.7 Planning Approach for Formulation of the Sustainable Sefidrud IWRM

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 tabulated in Table R 9.2.2, and these are 3 dams at present, 14 dams under construction in the mid-term, and additional 19 dams (later on added 2 dams) planned in the long-term targets. Preliminary evaluation on these dams is made as presented Figure R 9.2.1 and Figure R 9.2.2. Table R 9.2.1 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 basin as illustrated in Figure R 9.2.1.

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 R 9.2.2. 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 R 9.2.1 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

Table R 9.2.2 Existing Dams and Planning Dams proposed by the Provinces Concerned

Time Frame	No.	Dam/Reservoir	Province	Drainage Area (km^2)	Effective Storage (MCM)	Annual Inflow (MCM)	Planning Irrigation Demand (MCM)
Present	1	Manjil	GIL	56,200	1,150.00	2,218.12	1,723.62
	2	Golblagh	KOR	250	6.30	36.09	6.59
	3	Taleghan	THN	828	329.00	531.40	135.00
Mid-term	4	Siazakh	KOR	1,058	245.00	150.50	142.39
	5	Sange siah	KOR	255	32.30	36.49	32.24
	6	Sural	KOR	48	10.50	7.23	8.12
	7	Ostor (Shahriar)	EAZ	42,600	451.00	1,619.44	72.58
	8	Sahand	EAZ	820	135.00	83.79	70.83
	9	Aydughmush	EAZ	1,625	136.60	175.61	138.61
	10	Germichay	EAZ	344	33.80	45.85	37.00
	11	Kalghan	EAZ	203	18.50	18.07	18.12
	12	Golabar	ZAN	1,131	105.00	68.81	57.54
	13	Taham	ZAN	161	82.00	31.37	57.54
	14	Talvar	ZAN	6,441	403.40	307.92	190.47
	15	Givi	ARD	600	48.86	83.00	83.86
	16	Bijar	GIL	242	99.40	73.25	0.00
Long-term	17	Hasankhan	KOR	2,487	17.50	59.93	0.00
	18	Aleh dare	KOR	96	19.00	17.90	20.05
	19	Zardekamar	KOR	2,075	50.00	120.06	48.54
	20	Sir	KOR	444	90.00	28.94	62.70
	21	Chasb	ZAN	135	8.10	15.05	10.35
	22	Mendagh	ZAN	33	38.00	4.12	0.44
	23	Alan	HAM	67	5.85	4.80	3.29
	24	Sheikh Besharat	KOR	451	18.00	85.71	12.35
	25	Babakhan	KOR	924	38.20	175.90	49.39
	26	Songhor	ZAN	102	9.05	7.71	8.45
	27	Ghezel Tapeh	ZAN	75	3.80	7.14	4.43
	28	Mehtar	ZAN	128	13.60	8.98	7.68
	29	Ramin	ZAN	67	9.40	1.30	2.01
	30	Mushampa	ZAN	24,860	328.00	1,029.38	323.19
	31	Sangabad	ARD	61	27.96	13.25	24.18
	32	Tabrizak	ARD	66	7.90	4.16	6.52
	33	Niakhoram	ARD	76	10.33	5.94	9.78
	34	Befrajerd	ARD	39	6.30	1.88	0.00
	35	Khoresh Rostam	ARD	88	42.00	3.86	55.42
	36	Burmanak	QAZ	282	18.31	20.33	29.53

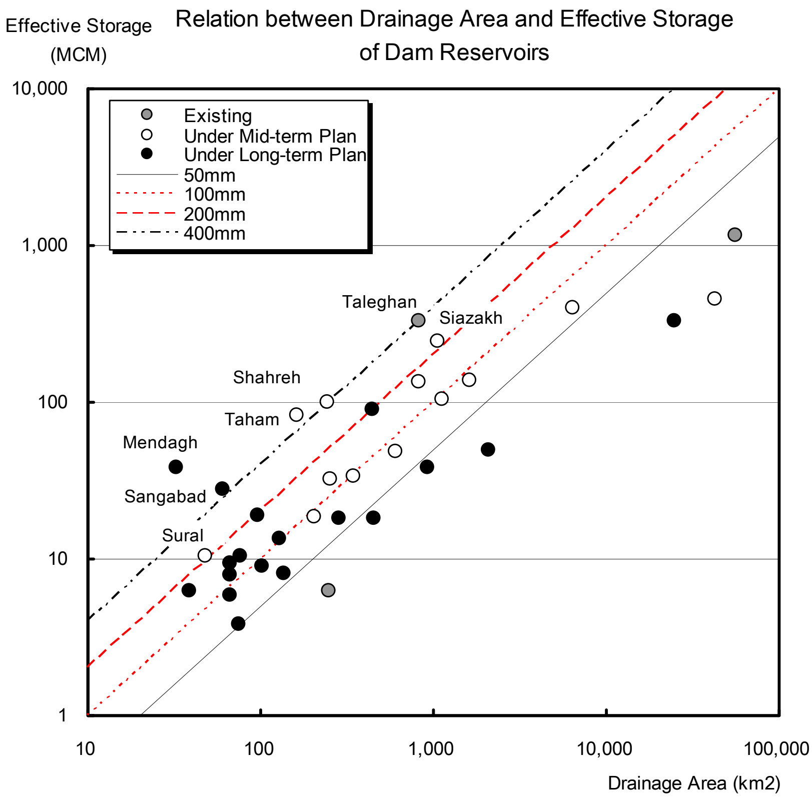


Figure R 9.2.1 Relationship between Drainage Area and Effective Storage of the Target Dams

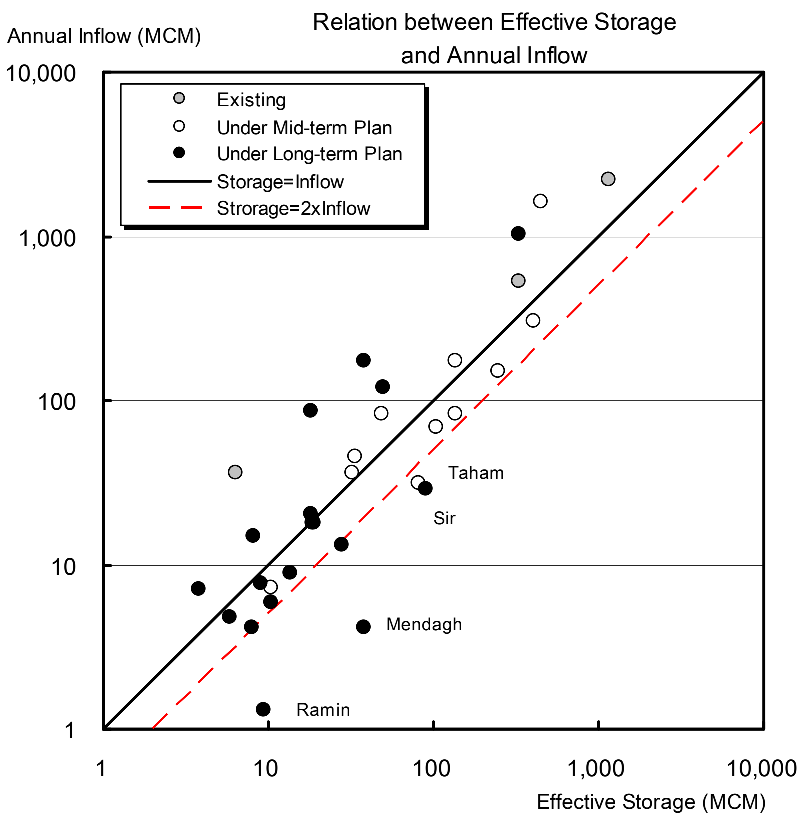


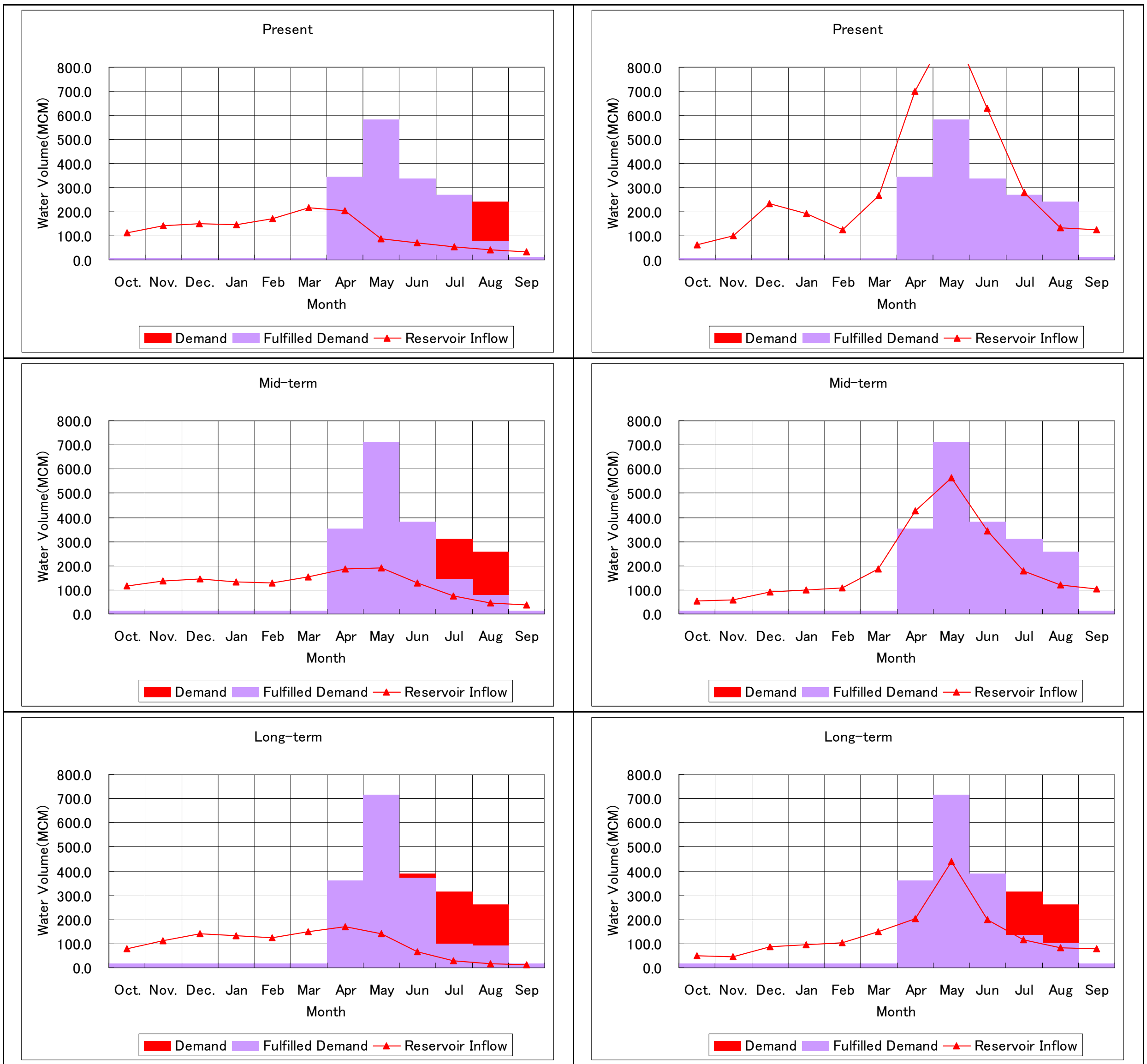
Figure R 9.2.2 Relationship between Effective Storage and Annual Inflow of the Target Dams

9.2.2 Study on Mid- and Long-term Integrated Water Resources Management Scenarios

The study approach shall be taken following the procedure as shown in Figure R 9.1.7. The simulation conditions are described in 9.2.1. Evaluation parameter is set how the Manjil Dam release fulfill the downstream demand, which are composed of domestic and agriculture needs and environmental requirements for Sturgeons' spawning.

1) 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.

The first step is to clarify: if planning dams proposed by the provinces are operated to supply water to their command areas as planned without improvement in the traditional irrigation areas, how the water release of the Manjil will be affected by the upstream developments. Figure R 9.2.3 shows the simulation results.



5-year Drought (1998/99) | Average Year (1991/92)

Figure R 9.2.3 Evaluation of Development Scenario without Improvement of Irrigation Efficiency (at Manjil Dam)

Based on the simulation, Table R 9.2.3 shows how this scenario fulfills the downstream water demands of the Manjil dam.

Table R 9.2.3 Sufficiency Rate to the Downstream Demand of the Manjil

Time Frame	5-year Drought	Average Year
Present	90.9 %	100.0 %
Mid-term	83.0 %	100.0 %
Long-term	80.3 %	83.3 %

As tabulated above, even the case without improvement of irrigation efficiency shows high sufficiency rate to the downstream demand of Manjil dam. Meanwhile, Figure R 9.2.4 indicates future changes of sufficiency of water demand by zone and sub-zone in the upstream traditional irrigation areas.

n addition, Table R 9.2.4 enumerates sufficiency rates for the traditional irrigation areas located in the upstream areas of the Manjil dam.

Table R 9.2.4 Sufficiency Rate for the Traditional Irrigation Areas Upstream of the Manjil

Zone	Sub-zone	5-year Drought			Average Year		
		Present	Mid-term	Long-term	Present	Mid-term	Long-term
A	A-1	57.1	72.4	72.4	74.4	79.3	79.3
	A-2	31.7	76.6	85.3	92.6	93.9	94.2
	A-3	80.7	80.7	80.7	92.2	92.2	92.2
	Sub-total	57.8	76.4	79.0	85.8	88.0	88.0
B	B-1	91.9	91.9	91.9	100.0	100.0	100.0
	B-2	28.4	60.6	64.2	80.9	94.5	94.6
	B-3	37.0	35.1	37.1	67.9	66.5	66.2
	B-4	59.2	47.3	64.8	99.0	100.0	99.2
	B-5	73.7	89.6	95.5	100.0	100.0	100.0
	B-6	73.0	87.5	87.1	100.0	100.0	100.0
	B-7	47.1	47.1	47.1	61.5	61.5	61.5
	Sub-total	56.1	59.1	65.3	87.5	89.0	88.7
C	C-1	52.6	74.7	77.4	93.7	90.9	91.1
	C-2	49.4	59.8	60.5	97.3	97.3	97.7
	C-3	56.5	75.5	74.6	94.1	94.1	94.1
	C-4	69.9	90.3	75.2	100.0	100.0	79.8
	Sub-total	58.0	76.4	72.9	96.0	95.6	90.7
D	D-1	100.0	100.0	100.0	100.0	100.0	100.0
	D-2	100.0	100.0	100.0	100.0	100.0	100.0
	Sub-total	100.0	100.0	100.0	100.0	100.0	100.0
Average		60.8	71.5	74.1	89.7	90.9	89.9

Table R 9.2.4 indicates that the sufficiency rates for the traditional irrigation areas upstream of the Manjil dam will be far lower than those downstream of the Manjil unless the irrigation efficiency will be improved. Thus improvement of irrigation efficiency as well as dam development shall be evaluated in the next scenarios.

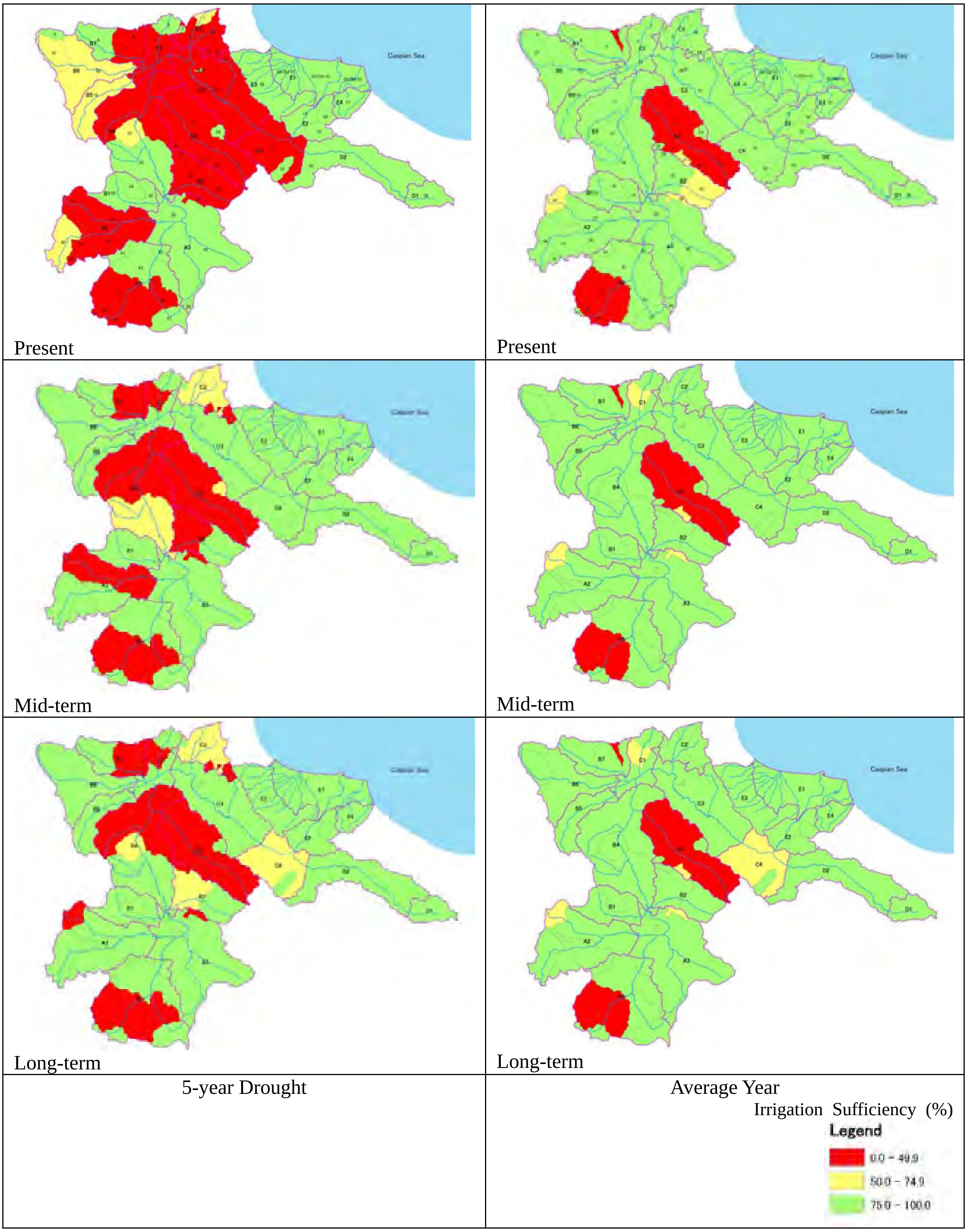


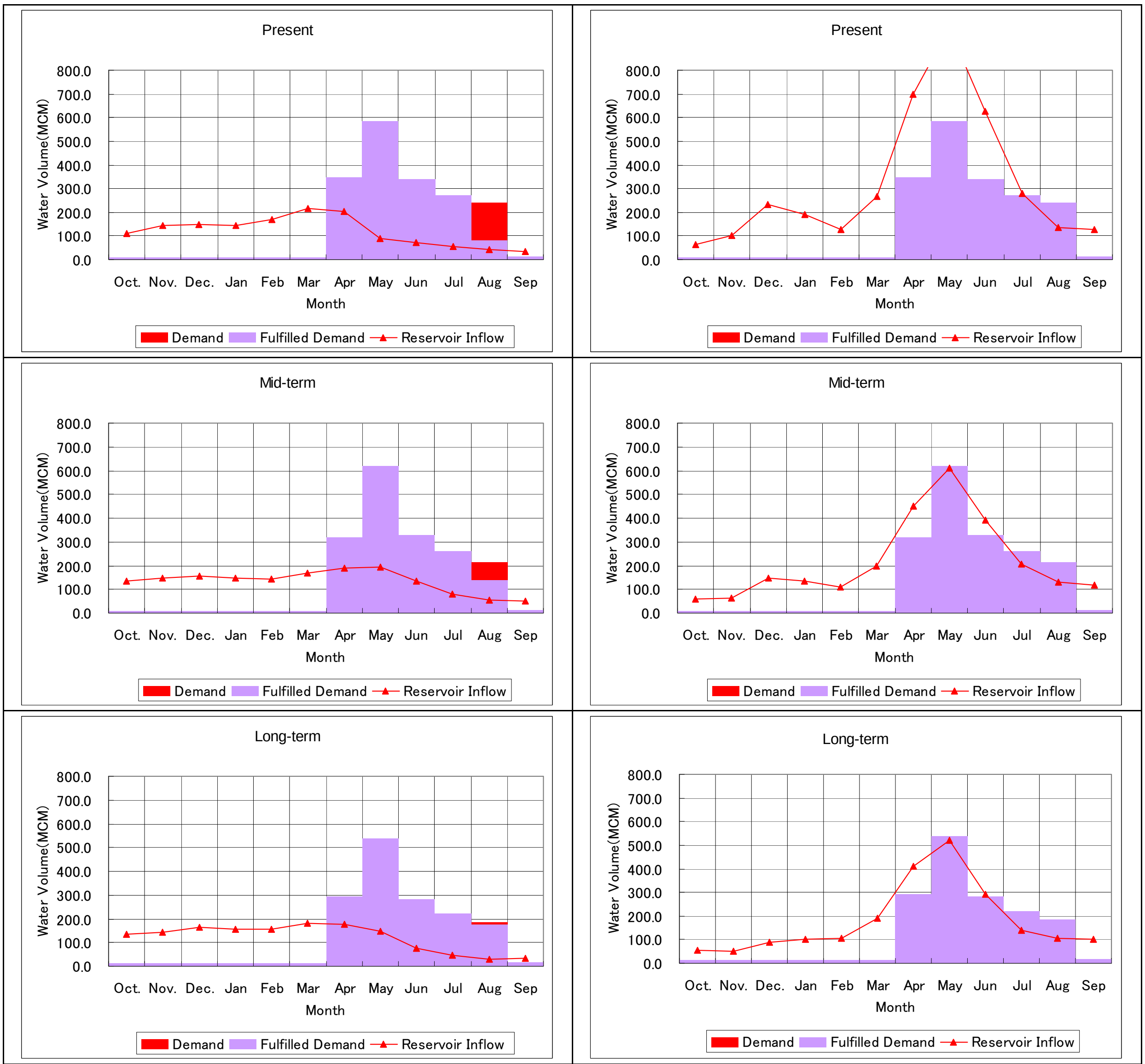
Figure R 9.2.4 Future Changes of Water Demand Sufficiency in the Traditional Irrigation Area
(without improvement of irrigation efficiency)

2) Scenario 2: 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.

Scenario 2 follows the improvement of irrigation efficiency proposed by the WRMC. The efficiencies are summarized in Table R 9.2.5 and the simulation results are presented in Figure R 9.2.5.

Table R 9.2.5 Proposed Irrigation Efficiency

Time Frame	Traditional Irrigation Area		SIDN in Gilan	
	Present	Plan	Present	Plan
Present(2007)	0.33	0.33	0.42	0.42
Mid-term(2016)		0.40		0.48
Long-term(2031)		0.50		0.55



5-year Drought (1998/99) | Average Year (1991/92)

Figure R 9.2.5 Evaluation of Development Scenario with Improvement of Irrigation Efficiency Proposed by WRMC

Based on the simulation, Table R 9.2.6 shows how this scenario fulfills the downstream water demands of the Manjil dam.

Table R 9.2.6 Sufficiency Rate to the Downstream Demand of the Manjil

Time Frame	5-year Drought	Average Year
Present	90.9 %	100.0 %
Mid-term	95.6 %	100.0 %
Long-term	99.4 %	100.0 %

As tabulated above, if the irrigation efficiency would be improved, high sufficiency rate of approximate 100 % could be attained to the downstream demand of the Manjil dam. Meanwhile, Figure R 9.2.6 indicates future changes of sufficiency of water demand in the traditional irrigation areas.

In addition, Table R 9.2.7 enumerates sufficiency rates for the traditional irrigation areas located in the upstream areas of the Manjil dam.

Table R 9.2.7 Sufficiency Rate in Scenario 2 for the Traditional Irrigation Areas Upstream of the Manjil

Zone	Sub-zone	5-year Drought			Average Year		
		Present	Mid-term	Long-term	Present	Mid-term	Long-term
A	A-1	57.1	78.3	78.9	74.4	81.6	84.4
	A-2	31.7	77.6	85.9	92.6	94.5	95.5
	A-3	80.7	81.4	82.2	92.2	94.2	94.5
	Sub-total	57.8	79.2	82.1	85.8	89.7	91.1
B	B-1	91.9	95.7	99.2	100.0	100.0	100.0
	B-2	28.4	72.5	84.0	80.9	99.1	100.0
	B-3	37.0	50.5	58.6	67.9	91.4	95.2
	B-4	59.2	62.7	89.7	99.0	100.0	100.0
	B-5	73.7	97.2	100.0	100.0	100.0	100.0
	B-6	73.0	96.3	98.8	100.0	100.0	100.0
	B-7	47.1	52.1	57.9	61.5	67.1	73.0
	Sub-total	56.1	70.6	82.7	87.5	95.0	96.5
C	C-1	52.6	97.1	100.0	93.7	100.0	100.0
	C-2	49.4	70.6	77.4	97.3	99.4	100.0
	C-3	56.5	78.1	82.1	94.1	94.8	95.6
	C-4	69.9	100.0	100.0	100.0	100.0	100.0
	Sub-total	58.0	85.2	88.5	96.0	97.6	98.1
D	D-1	100.0	100.0	100.0	100.0	100.0	100.0
	D-2	100.0	100.0	100.0	100.0	100.0	100.0
	Sub-total	100.0	100.0	100.0	100.0	100.0	100.0
Average		60.8	78.7	85.2	89.7	94.3	95.4

unit : %

Table R 9.2.7 indicates that the sufficiency rates for the traditional irrigation areas upstream of the Manjil dam will be far upgraded, in particular in the long-term target, if the irrigation efficiency will be improved at the maximum efforts. In the local consultations, however, officials in charge in related provinces insisted difficulties to attain the target efficiency.

Considering the conditions in which each province did not propose the future improvement plans on irrigation efficiency, setting the future efficiency would be difficult. Thus the intermediate level between scenarios 1 and 2 on improvement of irrigation efficiency shall be evaluated in the next scenarios.

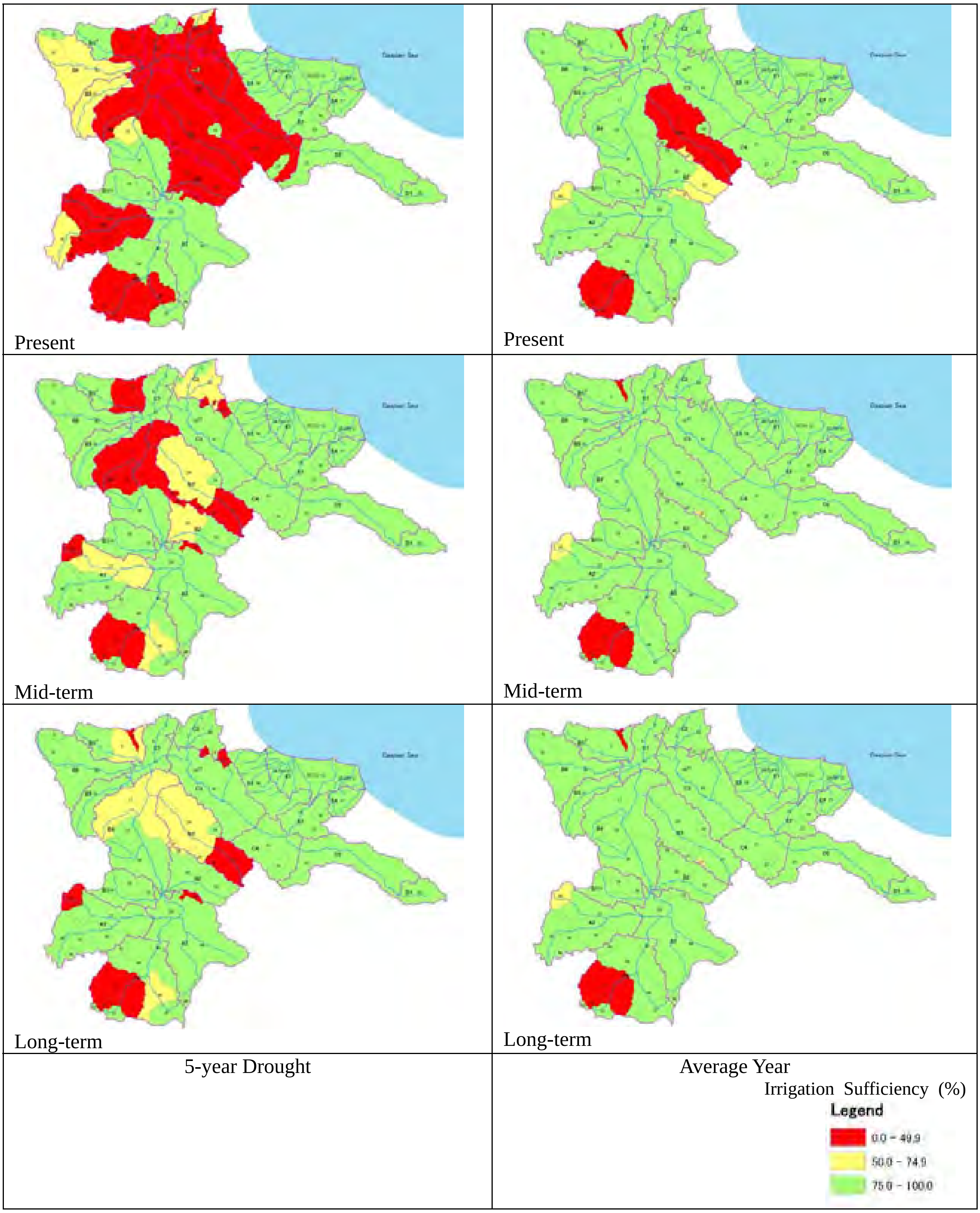


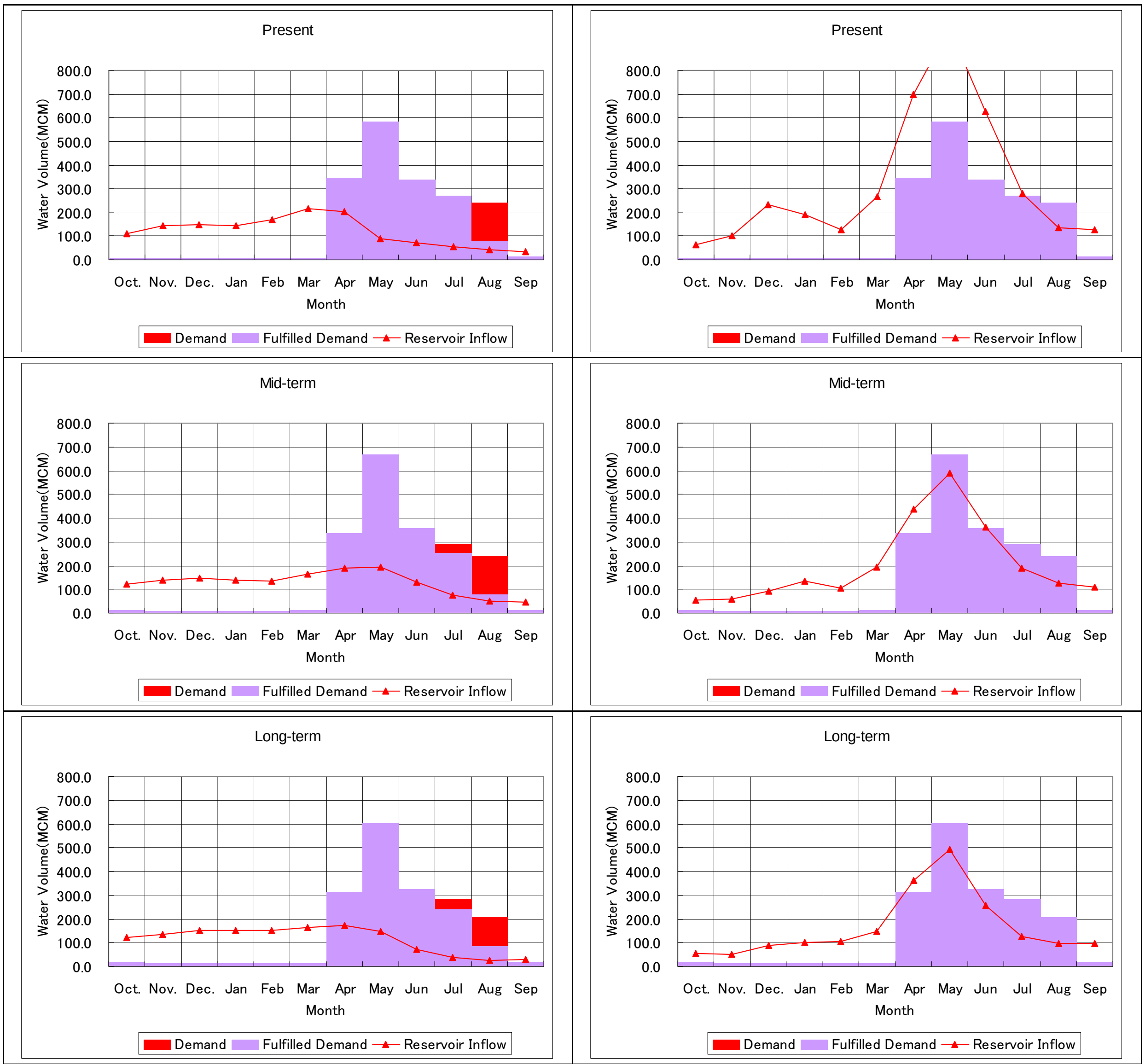
Figure R 9.2.6 Future Changes of Water Demand Sufficiency in the Traditional Irrigation Area (with improvement of irrigation efficiency proposed by WRMC)

3) Scenario 3: Irrigation efficiency in the traditional irrigation areas and SIDN areas will be improved in an intermediate manner between scenarios 1 and 3, and water resources development plan proposed by the provinces will be implemented.

Scenario 3 follows the intermediate level between present and WRMC proposition on improvement of irrigation efficiency. The efficiencies are summarized in Table R 9.2.8 and the simulation results are presented in Figure R 9.2.7.

Table R 9.2.8 Proposed Irrigation Efficiency

Time Frame	Traditional Irrigation Area		SIDN in Gilan	
	WRMC proposed	Intermediate Level	WRMC proposed	Intermediate Level
Present(2007)	0.33	0.33	0.42	0.42
Mid-term(2016)	0.40	0.37	0.48	0.45
Long-term(2031)	0.50	0.44	0.55	0.51



5-year Drought (1998/99) | Average Year (1991/92)

Figure R 9.2.7 Evaluation of Development Scenario with Intermediate Improvement of Irrigation Efficiency

Based on the simulation, Table R 9.2.9 shows how this scenario fulfills the downstream water demands of the Manjil dam.

Table R 9.2.9 Sufficiency Rate to the Downstream Demand of the Manjil

Time Frame	5-year Drought	Average Year
Present	90.9 %	100.0 %
Mid-term	89.4 %	100.0 %
Long-term	90.5 %	100.0 %

As tabulated above, if the irrigation efficiency would be improved, sufficiency rate could be remarkably improved to the downstream demand of the Manjil dam. Meanwhile, Figure R 9.2.8 indicates future changes of sufficiency of water demand in the traditional irrigation areas.

In addition, Table R 9.2.10 enumerates sufficiency rates for the traditional irrigation areas located in the upstream areas of the Manjil dam.

Table R 9.2.10 Sufficiency Rate in Scenario 3 for the Traditional Irrigation Areas Upstream of the Manjil

Zone	Sub-zone	5-year Drought			Average Year		
		Present	Mid-term	Long-term	Present	Mid-term	Long-term
A	A-1	57.1	72.1	73.1	74.4	79.1	81.6
	A-2	31.7	75.2	85.5	92.6	93.6	95.0
	A-3	80.7	81.0	81.6	92.2	93.0	94.2
	Sub-total	57.8	76.0	79.6	85.8	88.0	89.8
B	B-1	91.9	94.1	97.3	100.0	100.0	100.0
	B-2	28.4	64.7	75.0	80.9	97.1	97.2
	B-3	37.0	38.7	43.5	67.9	71.0	74.9
	B-4	59.2	52.9	72.9	99.0	100.0	100.0
	B-5	73.7	96.5	100.0	100.0	100.0	100.0
	B-6	73.0	92.7	97.2	100.0	100.0	100.0
	B-7	47.1	50.0	54.3	61.5	64.4	69.8
	Sub-total	56.1	63.6	73.1	87.5	90.4	91.8
C	C-1	52.6	75.4	88.8	93.7	91.4	97.7
	C-2	49.4	61.9	69.8	97.3	97.4	99.6
	C-3	56.5	75.0	81.2	94.1	94.1	94.9
	C-4	69.9	79.8	79.8	100.0	100.0	100.0
	Sub-total	58.0	74.0	80.1	96.0	95.7	97.4
D	D-1	100.0	100.0	100.0	100.0	100.0	100.0
	D-2	100.0	100.0	100.0	100.0	100.0	100.0
	Sub-total	100.0	100.0	100.0	100.0	100.0	100.0
Average		60.8	72.7	78.9	89.7	91.6	93.0

unit: %

The above two tables show the result of intermediate-range between scenario 1 and scenario 2. The situation in mid-term and long-term time frame is likely to appear near this scenario. Thus the scenario 3 might be the most realistic one.

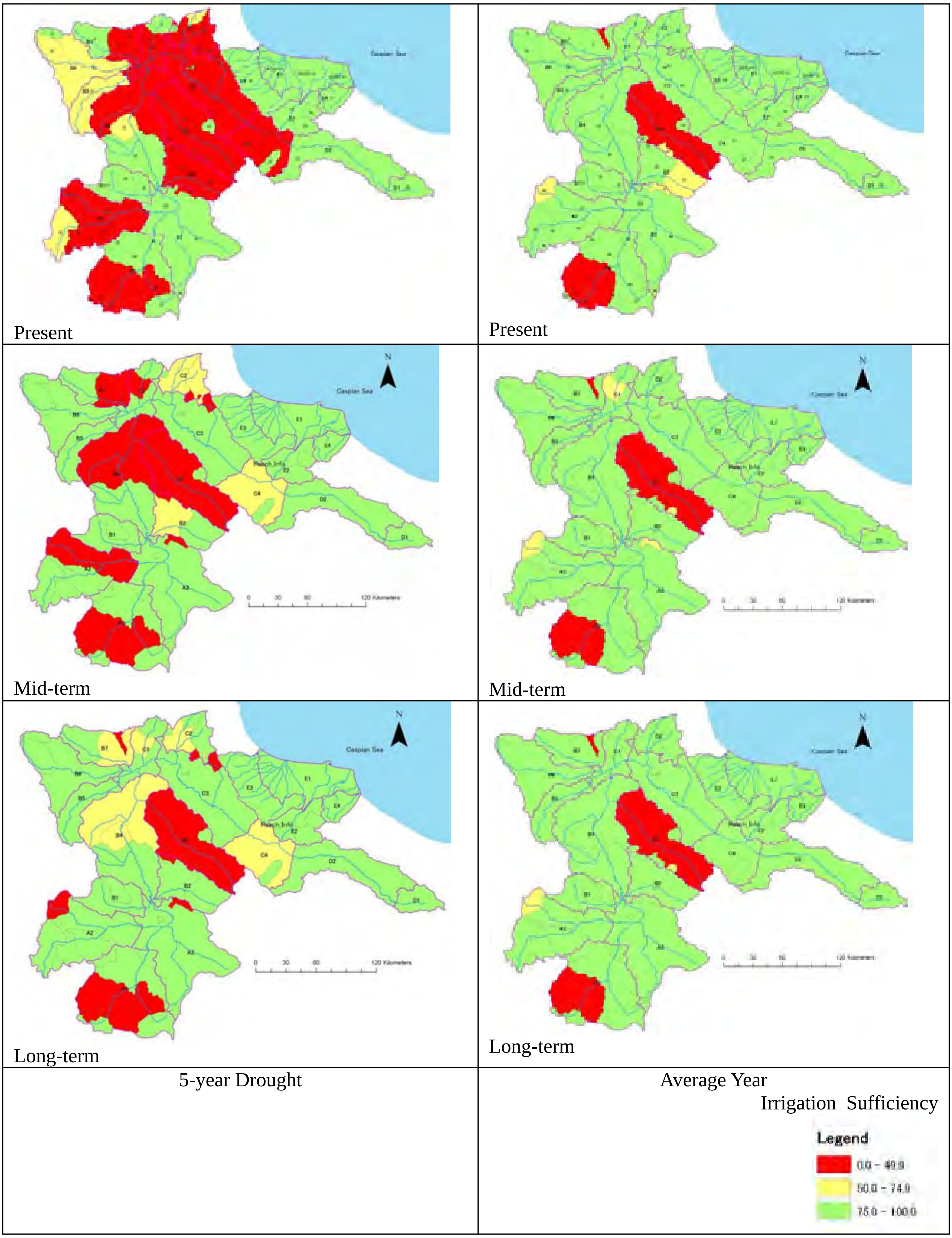


Figure R 9.2.8 Future Changes of Water Demand Sufficiency in the Traditional Irrigation Area (with intermediate improvement of irrigation efficiency)

4) Comparative Study on Irrigation Efficiency Improvement Scenarios

Interactive effects between dam development schemes and improvement of irrigation efficiency could be summarized in Table R 9.2.11 and Figure R 9.2.9. From the figure and table, the following effects could be clarified.

- 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 mid-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 59 % and 41 % in the mid-term and 55 % and 45 % in the long-term targets, respectively, in the case proposed by WRMC.
- 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 mid-term, and 80 % in the long-term targets. Meanwhile, if the irrigation efficiency is improved, the sufficiency could be upgraded to 89 to 96 % in the mid-term, and 91 to 99 % in the long-term targets.

Table R 9.2.11 Agricultural Water Demand Sufficiency by Irrigation Efficiency Improvement

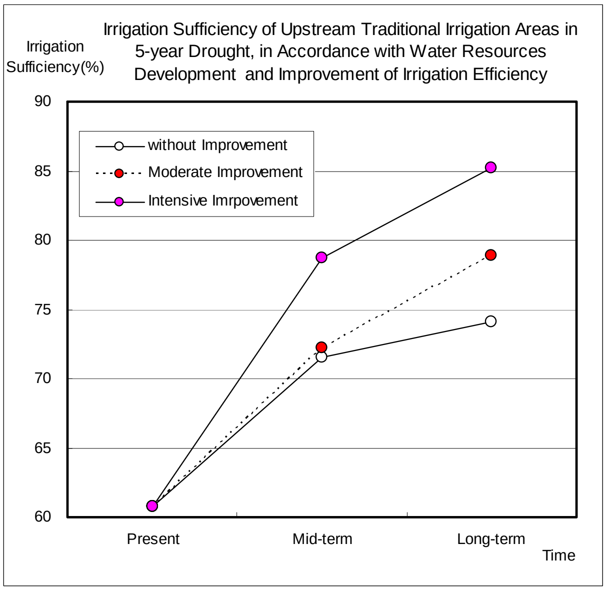
Irrigation Efficiency Improvement Scenario		Without Improvement	Intermediate Improvement	Improvement proposed by WRMC
Irrigation Efficiency	T.I Area	0.33	0.37(Mid) 0.44(Long)	0.37(Mid) 0.44(Long)
	SIDN	0.42	0.37(Mid) 0.44(Long)	0.37(Mid) 0.44(Long)
Hydrologic Conditions	Time/Area	Water Demand Sufficiency 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
	Mid-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
	Mid-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

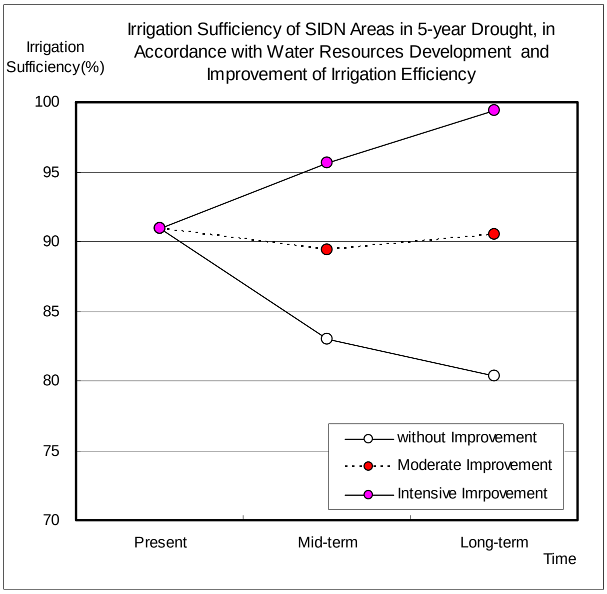
Based on the above observations, obvious are the following principle features of water resources development and irrigation efficiency improvement, and basic future directions.

(i) In the upper reaches of the Manjil dam, water resources development projects by dam construction contribute upgrading water demand sufficiency due to flow regime modification in the drought time. Furthermore the sufficiency could be upgraded much more through irrigation efficiency improvement.

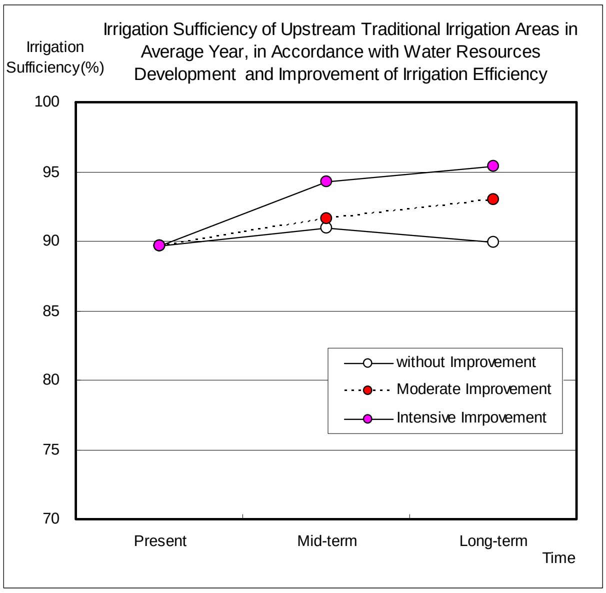
(ii) To sustain the present level of water demand of the SIDN sufficiency continuously in the drought time, at least the intermediate level of irrigation efficiency improvement shall be conducted over the basin.



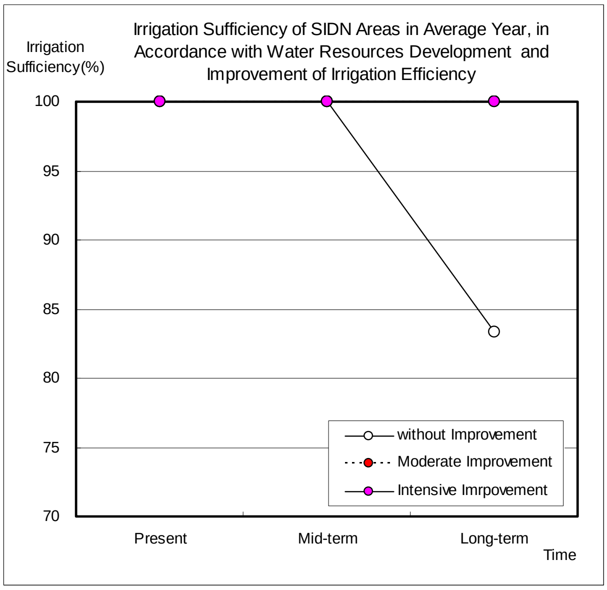
Traditional Irrigation Area：5-year Drought



SIDN：5-year Drought



Traditional Irrigation Area：Average Year



SIDN：Average Year

Figure R 9.2.9 Agricultural Water Demand Sufficiency by Irrigation Efficiency Improvement Scenarios

In conclusion, in order to utilize sufficient water by both sides, downstream and upstream areas of the Manjil dam, without severe conflicts, it is indispensable to implement the water resources development projects as well as irrigation efficiency improvement at least in the intermediate level. In other words, although the water resources development projects could improve the water situations in the upstream area, adverse effects would take place to the water uses in the downstream areas of the Manjil dam due to degradation of flow regime in the lower reaches. In order to remedy this situation, to further upgrade the sufficiency in the upper reaches, and to secure the sufficiency in the lower reaches, improvement of irrigation efficiency is required.

9.2.3 Study on Mid- and Long-term Sustainable Integrated Water Resources Management Scenarios

As described in 9.1.1, the groundwater tables have been lowered by 3.2 m to 9.0 m for recent 5 years in some areas of the Zanjan and Kordestan provinces. These phenomena of groundwater lowering could be caused by overextraction of groundwater beyond their rechargeable potentials. To cope with lowering groundwater tables, some concrete remedial measures such as water source conversion to surface water shall be proposed from sustainable water resources management aspects.

On the other hand, environmental flow is also considered in accordance with people's increasing consciousness on conservation of surface water from environmental aspects. In the Sefidrud River basin, however, there are no specific species of flora and fauna to be conserved, and dam reservoirs have no specific storage volumes for environmental flow. Therefore, changes of flow regime through water resources development projects shall be examined in this clause.

The results studied in the preceding section are summarized below.

- All of the water resources development projects proposed by the provinces concerned are fully incorporated into both mid- and long-term development scenarios.
- In addition, it is indispensable to improve irrigation efficiency, of which 0.37 in the mid-term and 0.44 in the long-term for the traditional irrigation area, and 0.45 in the mid-term and 0.51 in the in the long-term for the SIDN, at least up to 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 adding the following environmental factors/issues. This study shall proceed based on the intensive improvement scenario on the irrigation efficiency proposed by WRMC, since these sustainability issues shall be challenged with the long-term viewpoints.

(iii) Remedial measures against the aquifers in which groundwater tables have been lowering

(iv) Environmental flow in the upper reaches of the Manjil reservoir

1) Remedial Measures against the Aquifers in which Groundwater Tables have been lowering

Table R 9.2.12 summarizes the aquifers in which groundwater tables have lowered, and location of the aquifers are shown in Figure R 9.2.10.

Table R 9.2.12 Groundwater Aquifers Lowering of their Table and their Water Balance

Zone	Sub-zone	Area (km²)	Code of Aquifer	Province	Annual Precipitation*1 (mm/y)	Annual Evapotranspiration (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

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

Figure R 9.2.10 Zone and Sub-zone Divide for Basin and Groundwater Aquifer

Compared with groundwater demands and groundwater recharge potentials, possibility of conversion to the surface water sources is examined focusing on the water demands exceeding the recharge potentials. The necessary conversion volumes are tabulated in Table R 9.2.13 to prevent the lowering of groundwater table.

Table R 9.2.13 Requirements of Conversion of Demands 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 the 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 mid- 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.

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

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

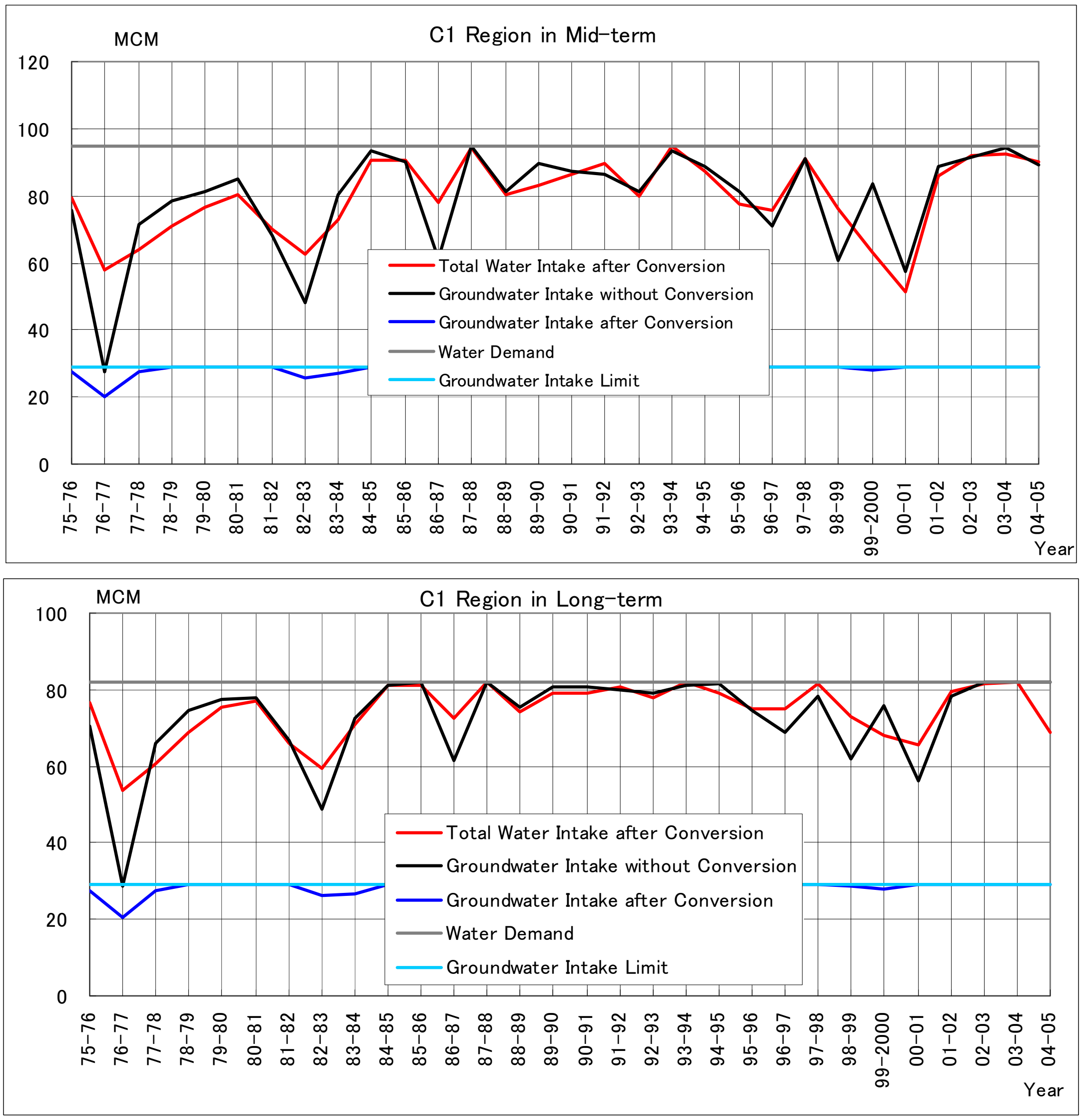
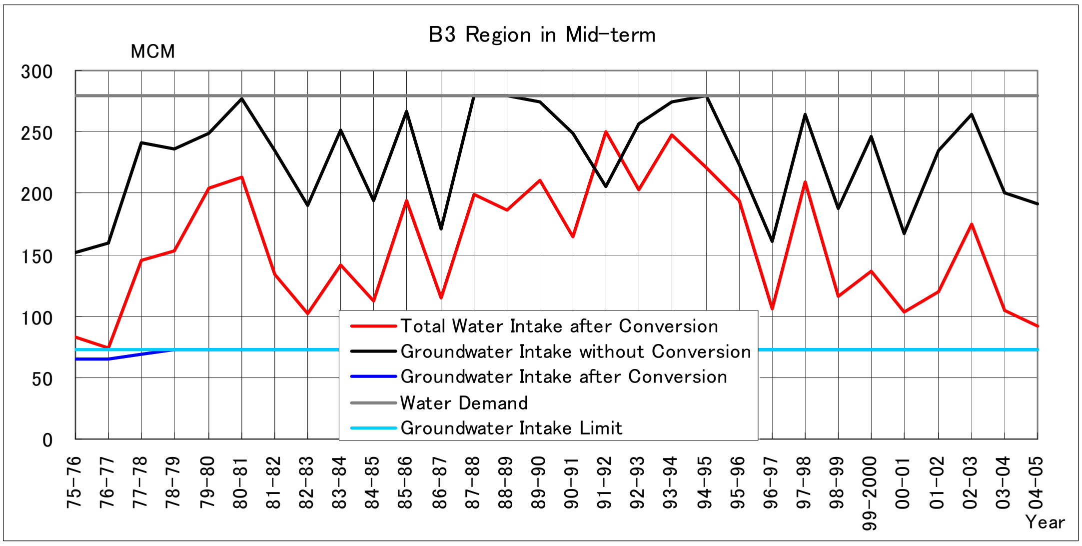


Figure R 9.2.11 Simulation Results of Conversion of Groundwater Intake to Surface Water (C1 Sub-zone, Upper: Mid-term, Lower: Long-term)

<u>Areas with Insufficient Surface Water Potential for the Conversion: A1, B3</u>

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. The following figure shows the simulation results of sub-zone B3 as an example.



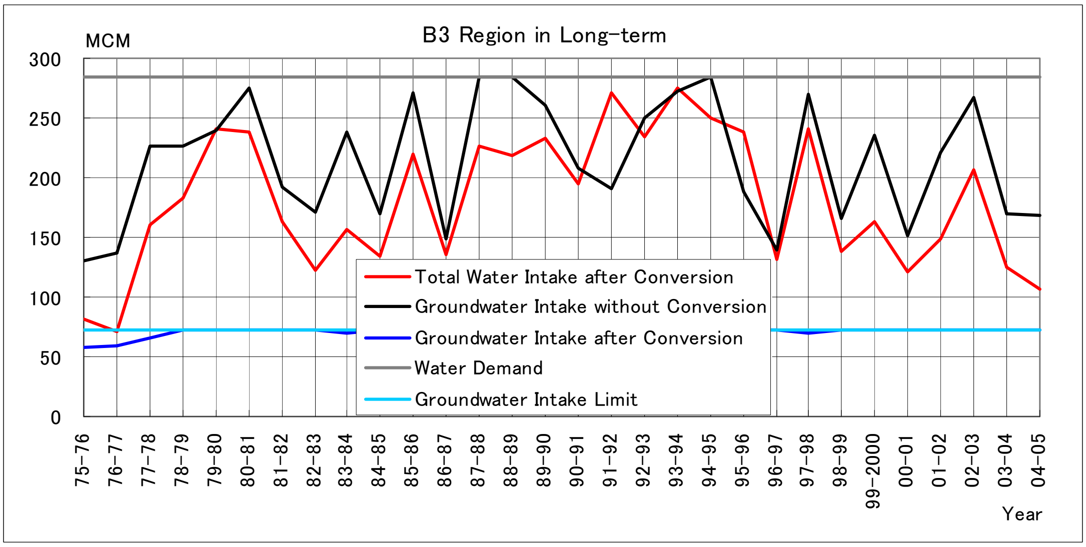


Figure R 9.2.12 Simulation Results of Conversion of Groundwater Intake to Surface Water
(B3Sub-zone, Upper: Mid-term, Lower: Long-term)

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-zone A3, B2, B4, C1, C2, C4, in which conversion of groundwater intake to surface water could be possible due to sufficient water resources potential. Meanwhile, the following measures shall be examined in applicability in the areas of sub-zone A1, upstream of Talvar dam, and B3 of the Zanjan River basin.

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

(vii) Upgrading irrigation efficiency through improvement of irrigation system, and

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

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

Regarding environmental flow in the lower reaches of the Manjil reservoir, environmental flow for Sturgeons' spawning is incorporated in the simulation. In this clause, thus, the environmental flow is examined in the upper reaches of the Manjil 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.

Low flow situations are examined how they will change from present via mid-term until long-term in parallel with development progress, using 90 % probability discharge in the flow duration curves of 5-year drought and average year as a hydrological parameter. The results are tabulated below and illustrated in Table R 9.2.14, Figure R 9.2.13 and Figure R 9.2.14.

Table R 9.2.14 Future Changes of 90 % Flow Discharge at Representative Stations

Hydrological Station (Station Code : Drainage Area)	Q_{90} in 5-year Drought (m^3/s)			Q_{90} in Average Year(m^3/s)		
	Present	Mid-term	Long-term	Present	Mid-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

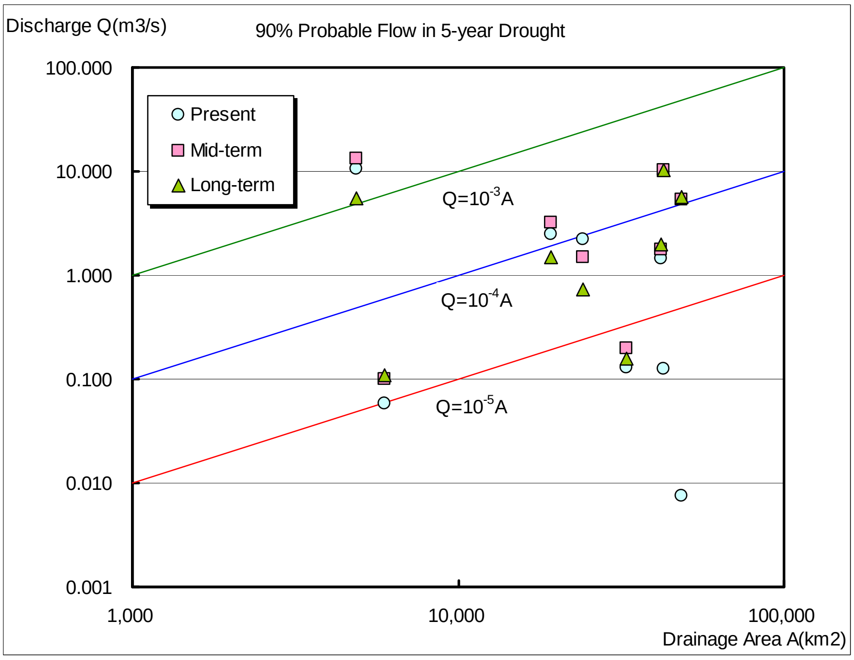


Figure R 9.2.13 Future Changes of 90 % Flow Discharge at Representative Stations in 5-Year Drought

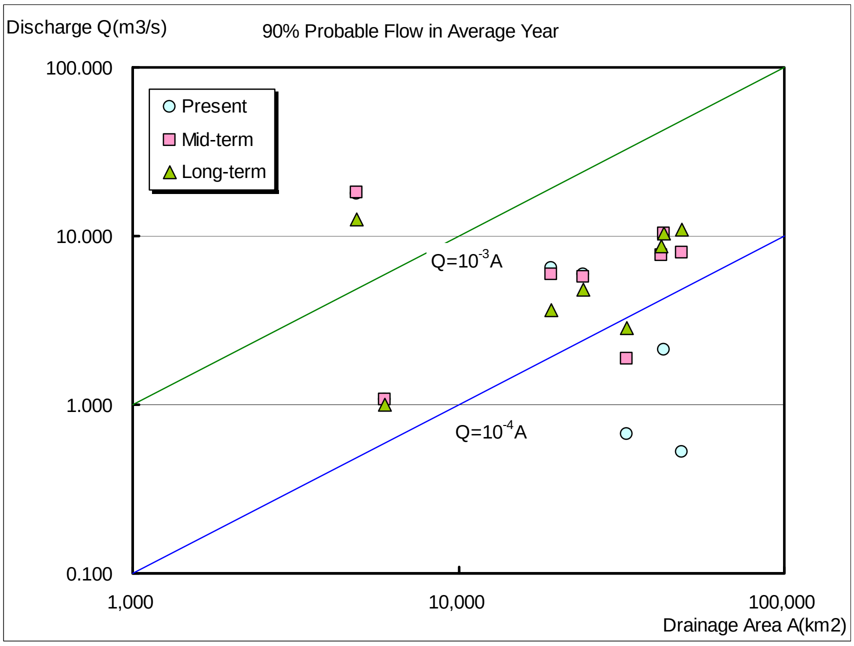


Figure R 9.2.14 Future Changes of 90 % Flow Discharge at Representative Stations in Average Year

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 ones at stations in the upper stretch.
- In the mid-term their low flow conditions at Ostor and Gilvan would be improved after construction of Ostor dam, since they would receive release water of the Ostor for hydropower generation.
- On the other hand, low flow conditions at Pole Dokhtar Mianeh would not be drastically improved in 5-year drought, but would be improved in an average year.

Future water resources development may contribute to some extent to improve the low flow conditions closely related to environmental needs. On the other hand, although low flow conditions at some station would worsen through the development, these areas could be regarded as better flow regime areas from viewpoints of the catchment areas. As described in the beginning of 9.2.3, it could not be recommendable to set up concrete environmental flows and to incorporate some storage for this purpose into the reservoir storage volume because of the following reason:

- The water use demand in the downstream reaches of Manjil dam could be almost fulfilled.
- If some environmental flow would be released from the dam reservoirs, it accelerates the unusable water to flow into Caspian Sea resulting in throwing precious water resources away.

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 mostly improve the flow regime from water environmental aspects, excluding some stretches worsening the flow regime.

In the downstream of Manjil dam, it was 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 withdrawing beyond rechargeable capacity. The possibility to convert water sources from groundwater to surface water was clarified except for aquifer of A1 in Kordestan province and aquifer of B3 in Zanjan province. For these aquifers, the possible conversion of water sources as well as the following measures shall be taken to conserve the aquifers.

- Improvement of the groundwater withdrawing and distribution system to upgrade the irrigation efficiency,
- Formulation of understanding the necessity for the water source conversion from groundwater to surface water, and consensus-building on it among the groundwater users,
- Construction of intake and distribution facilities in surface water utilization system, and
- Establishment of groundwater monitoring and check 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 demand, how the irrigated areas occupy and they will increase is examined from the socio-economy aspects. The following figure shows their occupancy rate to the sub-zone’s area. The highest rate is found in the SIDN area of Gilan province, and it indicates that agricultural development in the area already reaches to the high level.

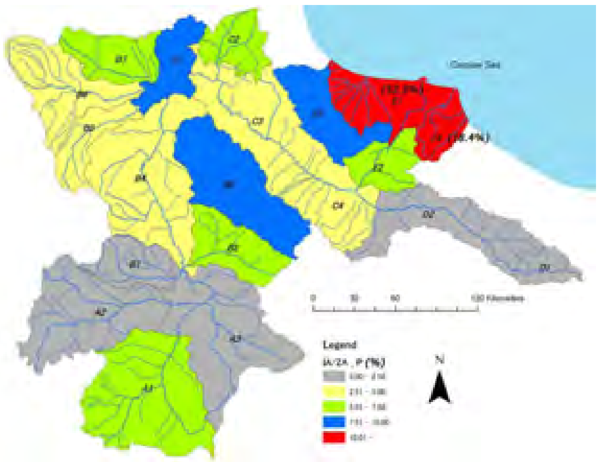


Figure R 9.2.15 Occupancy Rate of Existing Irrigation Area to Sub-zone

To this existing situation, the following figure presents how the irrigation areas will increase in the future. It means the direct effects of water resources development projects. Furthermore, the figure clearly 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 distinguished.

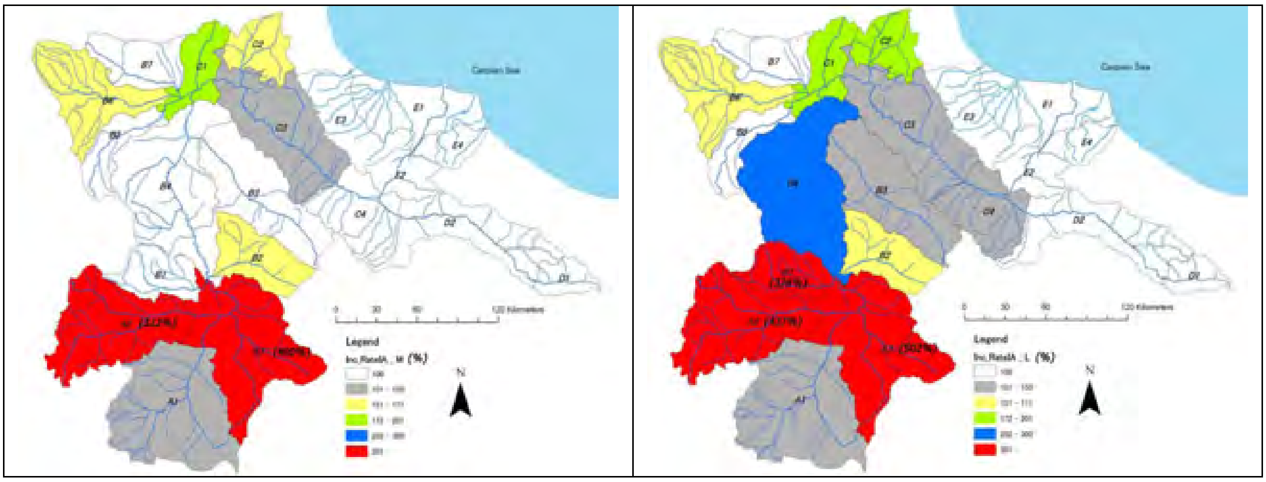


Figure R 9.2.16 Incremental Rate of Future Irrigation Area (left: Mid-term, right: Long-term)

In parallel with increase of irrigation areas, increase of agricultural productivity through increase of irrigation water supply could be considered as another factor of socio-economy. Figure R 9.2.17 indicates an existing agricultural productivity of the irrigation area defined by the agricultural production output in unit irrigation area. Rice has been traditionally cultivated as a national strategic product in Gilan. The agricultural productivity of around 6,000 thousand Rials/ha in Gilan province is relatively lower even though irrigation areas widely extend. On the other hand, alfalfa or fruit trees as high cashability crops have been cultivated in the upper reaches in the recent years, resulting in showing high productivity of around 10 to 15 million Rials/ha.

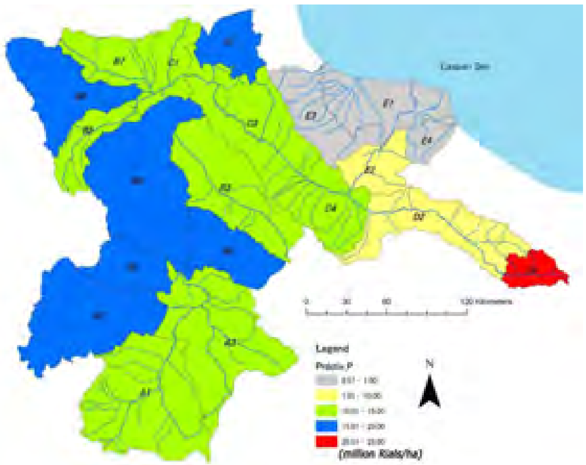


Figure R 9.2.17 Present Agricultural Productivity in Unit Irrigation Area

Using the above unit agricultural productivity, Figure 9.15 illustrates how its rate would be upgraded in the mid-term and long-term targets. As water supply capacity increases, the productivity will increase together. The area of sub-zone A1, however, which is located upstream of Talvar dam, shows difficulty of improvement of the 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 upper-most part of the Sefidrud basin in Kordestan province. The further detailed study in boosting its regional economy would be needed.

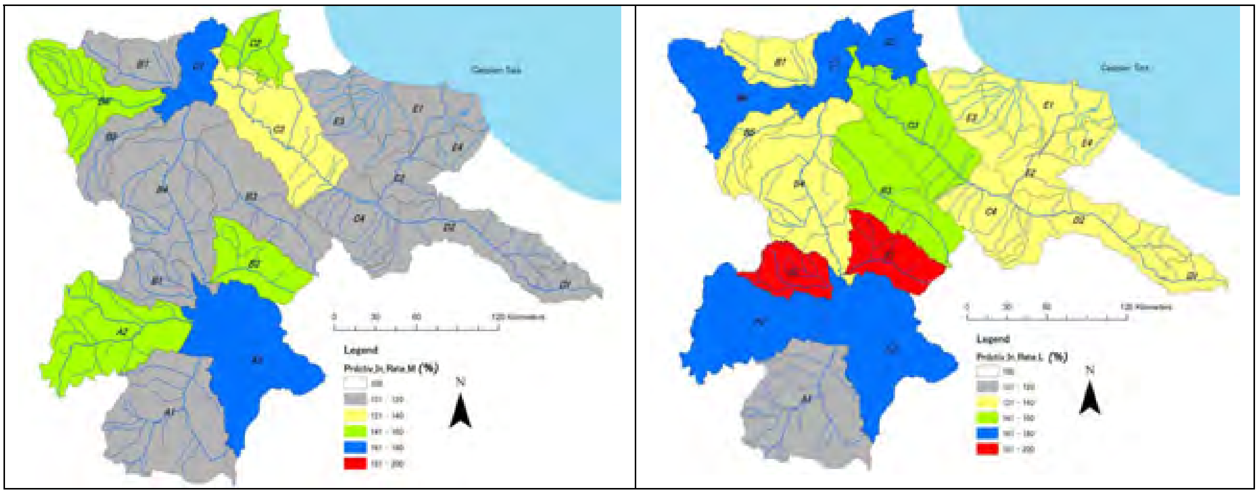


Figure R 9.2.18 Future Increase of Agricultural Productivity in Unit Irrigation Area (left: Mid-term, right: Long-term)

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 of progress of water resources development projects and irrigation system improvement. Figure R 9.2.19 presents its results of irrigation water sufficiency by sub-zone.

Regarding irrigation water sufficiency, it has never been generalized and varies according to crops. In particular, if the crops suffer water stress during the most necessary periods for water, the crop yields drastically drop away. For instance, paddy rice needs enough water in rooting, flowering and booting stages. In another periods, even if growth rate is getting slower, it would not strongly affect the crop yields as far as it runs dry.

Thus, it may be difficult to quantify the criteria on irrigation water sufficiency from a macroscopic view, and seasonal and periodical water sufficiency could affect the crop yields. However, considering that water-saving intermittent irrigation can save the water amount of 20 to 30 % without lowering crop yields, irrigation water sufficiency of 75 % might be an appropriate criterion in the semi-arid areas with insufficient water.

Around more than 75 % of the sufficiency could be secured except for the sub-area upstream of Talvar dam in average year, while some sub-zones would still remain under 75 % of the sufficiency in spite of improvement in 5-year drought.

As a whole, the sufficiency in the traditional irrigation areas would be upgraded in the mid-term and long-term targets, due to increase of water supply by the progress of water resources development projects, and saving the water consumption by the progress of irrigation system improvement.

In addition, examined was the next subject how the planning dams including existing ones could sufficiently supply necessary water to their command areas. Based on the results of hydrological and water use simulation for recent 30 years, Table R 9.2.15 enumerates dams, of which irrigation water only could fulfill less than 75 % of water demand for their command areas, and frequency of occurrence in its situation. As mentioned in 9.2.1, there are several dam plans under unsuitable hydrological conditions which were found through the preliminary examination. The detailed examination shall be carried out, and improvement works shall be taken to them if necessary.

Table R 9.2.15 Irrigation Water Sufficiency to their Command Areas

Target Year	Frequency less than 75 % of Irrigation Water Sufficiency	Number of Dams	Dam Name
Mid-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

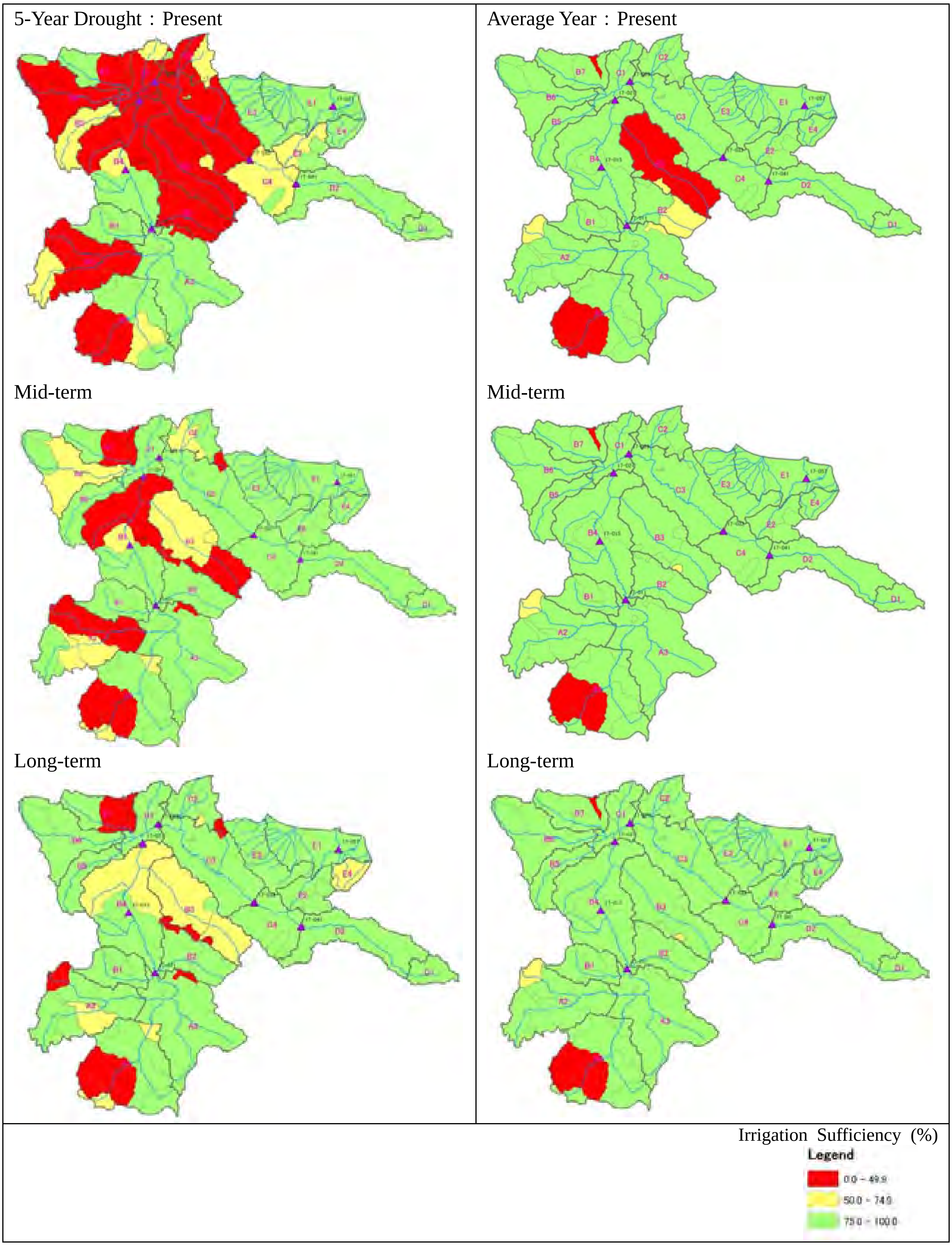


Figure R 9.2.19 Changes of Irrigation Water Sufficiency in the Traditional Irrigation Areas

9.3 SUBCOMPONENTS OF MASTER PLAN

9.3.1 Water Resources Management Plan

1) Management Plan for Surface Water

As 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 tentative flow rate of 10 % of AAF (Average Annual Flow) for the environmental flow. This methodology is one of the hydrological methods, which are most popularly applied 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 major part of Iran is under semi-arid climate conditions and there are 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 R 9.3.1 presents comparison between improved flow regimes of 90 % flow and 10 % of AAF. Although flow of 10 %of AAF could not be secured in 5-year drought, it could be almost secured in an average hydrological year.

Table R 9.3.1 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	Mid-term	Long-term	Present	Mid-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 sown in Table R 9.3.1, the flow of 10 % of AAF could be secured in 2-year drought and until 90 % in its flow duration. Generally safety level of environmental flow is set at lower level than the one of water uses. As a target safety level of water uses is set at 5-year drought, a 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. 90 % flow is much safer than low flow level so that 90 % flow could be considered adequate for environmental flow.

The above consideration is for environmental flow in the mainstream. In the local consultation, several provinces requested environmental flow setting in their tributaries. In order 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 existing two 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 R 9.3.2 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	Mid-term	1,058	I&D	245	Kordestan
Talvar	Mid-term	6,441	I&D	403	Zanjan
Golabar	Mid-term	1,131	I&D	105	Zanjan
Mushampa	Long-term	24,860	I&D&P	328	Zanjan
Sahand	Mid-term	820	I&D	135	E. Azerbayjan
Aydughmush	Mid-term	1,625	I	137	E. Azerbayjan
Ostor	Mid-term	42,600	I&P	451	E. Azerbayjan
Taleghan	Operation	828	I&D&P	329	Tehran
Manjil	Operation	56,200	I&D&P	1,150	Gilan

From now, the efforts to establish a River Basin Organization (RBO) shall be necessary as one of the measures for strengthening water resources management and related coordination system. The drought management shall be included into the major activities/functions of RBO. Since the nine dams will be belonged to five provinces, there might be remarkable difficulties for the integrated management of the large dams in the drought time. Although long time shall be necessary to progress this process, integration system of water management as enumerated below shall be solved/built step by step.

- Establishment of on-line 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 Aldebil City of Aldebil 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 R 9.3.3 tabulates the management framework, in which priority means implementation order.

Table R 9.3.3 Groundwater Management Framework

Management Process	1st Action (Urgent and 1st Priority)	2nd Action (2nd Priority)
1. Urgent measures The area of groundwater lowering area	- Restriction of new development - Control of pumping yield up to recovering water table Basin code: 1304, 1306, 1308 are applicable.	- 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 well
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 well should be constructed in a data shortage area and these wells will be converted to monitoring well in future. - Karst aquifer also should be investigated.
(3) Essential factor (permeability, transmissivity etc)	Examination of the existing results for existing pumping test.	Investigation of pumping test for new test wells
(4) External factor (meteorological-hydrological data)	Almost collected 20 to 40 years periods	Almost collected 20 to 40 years periods
4. Installation of monitoring well	Diverting monitoring wells from existing production wells. Exiting monitoring well: 271 wells Diverting wells: 200	New installation: about 250 wells Arrangement: see Figure R 8.3.1
Parameters to be monitored / Monitoring schedule: Level: every month, other item: 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 Activity 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 collected latest data	- Computation of Groundwater storage capacity - Computation of recharged volume - Renewable every year based on the collected latest data
8. Designation of regulative areas of groundwater pumping yield	Measures in the regulation areas for groundwater lowering area	Strengthening monitoring system in the 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 legal and penalty system	Revision of existing law	Strengthening of penalty system
12. Enhancement of water users' consciousness and 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

a) Urgent Measures

The groundwater tables have lowered from 3 to 9 meters in 1996 to 2002 in the groundwater basins of code 1304 Zanjan, 1306 Sajas in Zanjan Province, and 1308 Ghorveh and 1308 Dehgulan in Kordestan Province. Pumping yield should be regulated as soon as possible until to recover the groundwater table in these areas. But, there are not reliable data for total volume of pumping yield, aquifer data, so pumping yield should be regulated 20% and 40% until to recover the groundwater table in these areas in a one cycle of dry and rainy season in an urgent measure. It is also determined the safety yield in each basin on the basis of the urgent simulation for groundwater recharging volume and pumping test. But, these are only urgent measures and after the accumulation of monitoring data, safety yield of groundwater should be examined formally.

b) Preparation of Well Inventory

As for 271 monitoring wells, following items are described: drilling year, coordinates (UTM), elevation, specification of well (depth, diameter, casing diameter), existence of automatic water level meter, results of pumping test/analysis, aquifer type, water level, geology. But, other wells are not described sufficiently. For example, 67 wells in the basin 1301 (depth: up to 15 meters) and 87 well in the basin 1304 (depth: many of them are 50 to 100 meters) have been monitored the water level. But they have not data without coordinates (UTM), elevation, depth, water level in the well inventory. Accordingly, well inventory should be prepared all wells in the Sefidrud River Basin and it should be cleared the target aquifer (unconfined or confined) and pumping yield for the groundwater management.

c) Investigation of Aquifer

The stretch of aquifer is already investigated by the geological and GIS studies. But, geological survey for the geological structure to the direction of depth is not sufficient. So, electric resistivity survey should be conducted to investigate the large-scale geological structure and after that test well drilling will be conducted to clear the geology, hydologeological factor of permeability, porosity, transmissivity, and the distinction between unconfined and confined aquifer.

d) Installation of Monitoring Well

The monitoring well should be established and the following parameters should be monitored. The existing 271 monitoring wells will be continued to monitor and diverting monitoring wells from 200 existing production wells will be established urgently.

In future, the existing 271 monitoring wells and about 250 new monitoring wells should be established. The monitoring system is detailed in 8.3.3.

- Measuring parameters: water level, water quality, pumping yield
- Measuring aquifer: each unconfined aquifer and confined aquifer
- Measuring schedule: water level; every month, others; every dry and rainy seasons

e) Institutional Strengthening

The strengthening of institute and capacity building of personnel will be started in the unit of province for the water resources management and database management of monitoring wells in a short term target. In a long term target, river basin institute (hereinafter called as River Basin Organization) should be established and these personnel who trained above will play an important role in RBO.

f) Database Construction

Collected database should be compiled in each unconfined and confined aquifers. Database have to include the following items: drilling year, coordinates (UTM), elevation, specification of well (depth, diameter, casing diameter), existence of automatic water level meter, results of pumping test/analysis, aquifer, water level, geology, precipitations, river discharge, land use. Database should be renewed every year.

g) Groundwater Simulation

The storage volume of groundwater and recharging volume to the groundwater will be computed in every year on the bases of every renewal database by MIKE-SHE. The pumping volume of each basin should be determined based on the result of this simulation. For example, the pumping volume will be regulated in the drought year based on the recharged volume.

h) Designation of Regulative Areas of Groundwater Pumping Volume

It is recommended the two regulative areas in an urgent or first priority area and second priority area. The urgent action area is the groundwater lowering area in present where are the basin of 1302, 1304, 1306, and 1308. In the second priority area, it is recommended to strengthen the monitoring system in the areas where much groundwater is used in the basin of 1305, 1307, and 1310.

i) Setup of Water Use Regulation Order in Groundwater Lowering Areas

Pumping of irrigation water should be urgently regulated at the present lowering area of groundwater in a basin of 1302, 1304, 1306, and 1308. Moreover, groundwater table will lower, pumping of irrigation and industry water should be regulated.

j) Measures for Pumping Yield in a Drought Year

Measures for pumping yield in a drought year will be implemented on a basis of the database of precipitation. The precipitation data is one of the important elements of recharging volume of groundwater. In the case of normal precipitation of annual average year, there is not regulation of pumping yield because of normal recharging volume to groundwater. But, in the case of drought year, it is recommended two cases of measures as follows. But it shall be reconsidered based on the further examination of hydrology and Hydrogeology.

- Average annual precipitation year: No pumping yield regulation
- Drought year: 25% for irrigation well from that year to following year
- Severe drought year: 50% for irrigation/industry well and 10% for domestic water well

k) Revision of Legal and Penalty System

The existing laws were almost established and should be revised. Next measures will be recommended to establish the penalty for the smooth and effective application of laws.

l) Enhancement of Water Users' Consciousness and Saving Water

It is recommended to conduct the campaigns of enhancement of users' consciousness for limited water resources. The RWC stuffs who are trained above shall become the trainer and they have to train the residents. After that, saving method of domestic water and irrigation water shall be examined. Furthermore, it shall be examined the recycling use of industrial water and reuse of treated wastewater.

The draft implementation schedule of groundwater management is shown below.

Table R 9.3.4 Implementation Schedule of Groundwater Management (Draft)

	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Urgent measures	—	—	—																	
2	Preparation of well inventory	—	—	—	—	—															
3	Investigation of aquifer				—	—	—	—	—	—	—										
4	Installation of monitoring well				— △△	— △△	— △△	— △△	— △△	— △△	— △△	△△	△△	△△	△△	△△	△△	△△	△△	△△	△△
5	Institutional strengthening	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—					
6	Database construction		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	Groundwater simulation			△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
8	Designation of regulative areas				—	—	—														
9	Setup of water use regulation							—	—	—											
10	Measures for drought year							—	—	—											
11	Revision of law and penalty				—	—	—														
12	Enhancement of water users' consciousness & saving water	- -	- -	- -	- -	- -	- -	- -	- - Intermittent work	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

3) Water Quality Monitoring Plan

Water quality monitoring plan is summarized in Table R 9.3.5 for plan 1 and plan 2. Plan 1 is monitoring for irrigation and plan 2 is those for harmful matters.

Table R 9.3.5 Water Quality Monitoring Plan

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 purpose and water system
Water quality standard	(Already established)	To be determined for purpose and water system
Monitoring	Development of additional monitoring well, continuance of river water monitoring	Twice in a year (dry season and rain season), 10 locations for river, 50 to 100 for groundwater, main dams and drinking-water dams
Capacity building	Improvement of accuracy for instrumental analysis, especially for groundwater	Improvement of accuracy for instrumental analysis, evaluation of analysis result, knowhow for maintenance
Coordination with related organization	Coordination with WRMC, MOJA and agricultural union to sharing the monitoring results and necessary action for irrigation	Coordination with related organization, shearing the reliability
Data base	Development of database to share the monitoring results with MOJA and agricultural union etc., development of alert system for especially high-density brackish water.	Centralization of information, data management in unified format, recording data with its unit
Action	Water-saving irrigation, leaching of salt	Development of sewerage treatment plant, management of land use in urban planning, control by strengthen penalties
Environmental flow	Comprehensive management of environmental flow considering flow regime and natural ecosystem as well as hydrological control	

a) First Priority

Monitoring of water quality for irrigation usage is very important because more than 80% of river water and groundwater will be used for irrigation.

i) Water Quality Index/Water Quality Standard/Monitoring

Water quality index and water quality guideline has already been established and it is important to continue water quality monitoring for irrigation. Number of monitoring station is enough for river, but not enough for ground water. At first, monitoring station in area 1303, 1304, 1305, 1306 and 1307 should be developed where stations are not sufficient. New monitoring well can be dual purpose for level monitoring and quality monitoring. The number of water quality monitoring well is to be determined by condition of pollution and budget.

ii) Capacity Building

Accuracy of monitoring data in area 1302, 1304, 1306, 1307, 1309 and 1310 is not high enough. Capacity building to improve water quality analysis is required together with the maintenance of analytical instrument.

iii) Coordination with Related Organization/Data Base

When semi-brackish water is used for irrigation, special attention is required for maintenance of cultivation field, especially for hot and dry area. Water quality data monitored by WRMC is recommended to share with MOJA, agricultural union, and some other related organization to get necessary information timely. It is also recommended to establish an alert system for agricultural union when high salt density (for example, EC > 1 mS/cm, Cl > 200~300 mg/l) is detected.

iv) Action

Since origin of salt may be natural ground, which may be dissolved into water by soil erosion or precipitation, it is difficult to prevent. Moreover, dissolved ion is hard to be removed. Ion exchange or distillation can be used for drinking water, but these are expensive to use for irrigation water. Therefore, it is recommended to manage properly by establishment of alert system for high salt density, saving-water irrigation by dripping, minimization of evaporation by covering the ground surface, washing out of salt on the ground by leaching.

Red-spotted location is relatively high in salt density. When irrigation water is taken from these areas, special attention is required. Since it is evaluated with existing data, water in upstream of red-spotted location is requested to be monitored or carefully managed.

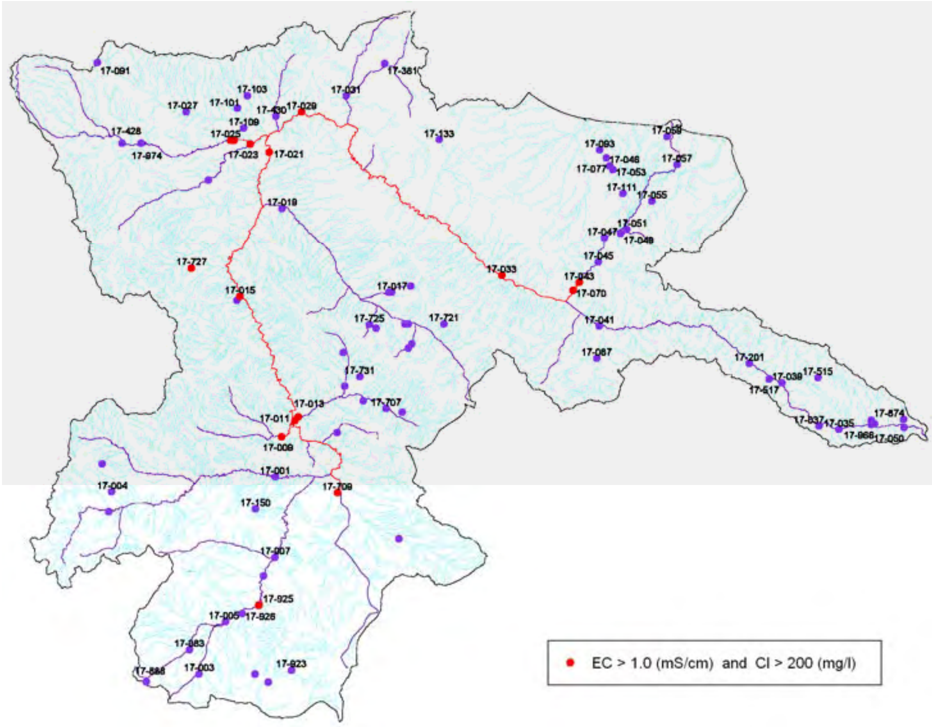


Figure R 9.3.1 Semi-brackish Water Area

b) Second Priority

Harmful materials and health-related materials are not periodically monitored under the status quo. From a long-term viewpoint, monitoring of these materials is summarized below.

i) Water Quality Index

Causality of water pollution and effects are summarized in Table R 9.3.6. In the monitoring of river and groundwater quality in this study area, 4) inorganic materials and soils and 8) others (salinity) are monitored. There is a drinking water standard, but these are not used for periodic monitoring.

Table R 9.3.6 Causality of Water Pollution and Effects

	Materials	Phenomenon	Water Quality Indexes	Method of Control
1	Disease-causing bacterium	Epidemic, catching disease	Coliform bacteria count, number of general bacteria	Disinfection
2	Acute poisonous materials	Death of fishes	Phenol, cyanide	Effluent control, biologicaldegradation
3	Acid and alkali	Corrosion of pipe	pH, alkalinity, acidity	Neutralization
4	Inorganic materials, soils	Turbidity	Suspended solid, turbidity, transparency	Sedimentation, filtration
5	Organic materials, human wastes	Low in dissolved oxygen, death of fish	DO, BOD, COD, TOC, TOD	Biological treatment
6	Inorganic nutrient salt (phosphorous, nitrogen)	Nutrient enrichment, red tide	Total nitrogen, ammonia, nitrous acid, nitric acid, phosphorous	Nitrification and nitrogen removal
7	Persistent chemicals, heavy metals	Chronic toxicity	Alkyl mercury, total mercury, cadmium, chromium, PCB, DDT, etc.	Closed system (closed material circulation)
8	Others	Salt damage, appearance of scale	Water temperature, chlorine, ion, hardness, electronic conductivity	

Since groundwater is a source of drinking water, it is recommended to monitor its quality based on drinking water standard where water is taken for drinking purpose. In other place (not drinking water source), it is recommended to monitor following indexes as well as present ion and EC monitoring for agriculture.

ii) Coliform bacteria count, heavy metals (As, F, Cd etc.), nitrite nitrogen

Some river water is used for drinking water, too. It is recommended to monitor water quality in drinking-water dam reservoir along with drinking water standard. For the dam for other purposes like irrigation and fish farm, it is recommended to monitor following indexes as well as present ion and EC monitoring.

iii) BOD, SS, DO, coliform bacteria count

In dam reservoir, it is recommended to monitor total nitrogen and total phosphorous as well as BOD, SS, DO and bacteria count. In some dam reservoir, there is a case of nutrient enrichment with green water and offensive odor.

iv) Water Quality Standard

Water quality standard is to be established for each water system (river, lake, sea and groundwater) for different purposes (drinking, irrigation, fish farm, industry or domestic effluent control). There are drinking water standard and effluent standard (both industry and domestic) in Iran. It is recommended to establish water quality standard for river, lake and groundwater to monitor by above water quality indexes (e.g. BOD).

v) Monitoring

It is recommended to monitor condition of water quality in river, dam lakes and groundwater based on water quality standard and its indexes. Present monitoring for irrigation is also recommended to continue. Additional monitoring is recommended to do as following frequency and locations.

<u>For Rivers</u>

- Frequency: twice in a year, one for dry season, one for rainy season
- Location of monitoring: around 10 points at main stream and important confluence

<u>For Groundwater</u>

- Frequency: twice in a year, one for dry season, one for rainy season
- Location of monitoring: 5 to 10 for each area (1301~1311), total 50~100, especially for potentially polluted area

<u>For Dams</u>

- All drinking water dams and main dams for other purposes

vi) Capacity Building

For water quality indexes which will be newly monitored, capacity building for instrumental analysis, evaluation of result and maintenance of facility is important. If we look at the collected data of BOD, DO and some other analysis, accuracy of them is not so high, e.g. relation with BOD and DO is not appropriate, DO exceed saturation, range of measured BOD is large etc.

vii) Coordination with Related Organization

At present, WRMC monitor the water quality and MOE takes some action for pollution prevention. However, it may be difficult of take action because harmful materials are not monitored and irrigation-related indexes are monitored. In order to start new monitoring, it is recommended to coordinate with related organization to determine the purpose of monitoring, item and indexes of monitoring and take necessary action.

viii) Data Base

Data measured by different organization are controlled by each organization, not centralized. Therefore, we need to ask WRMC for their data and ask other organization for another data (e.g. data from RWC and MOE). It is recommended to centralize water quality information in one section to share necessary information with related people. And, it is recommended to keep the monitoring data with its unit.

ix) Action

In order to achieve water quality standard, following three actions are taken as usual; effluent control, development of sewage treatment plant and land use management.

Effluent control has already been established in Iran. It is necessary to monitor by on-the-spot inspection to certain industries and other businesses if these standards are well observed. For the location where flow rate in river is relatively smaller than those of effluent, it is recommended to make local effluent standard more stringent than national uniform standard. For the development of sewage treatment plant which require large budget, it is recommended to make a priority for where to be developed (e.g. highly urbanized area). In the land use management, it is recommended to prevent pollution e.g. chemical factory and disposal center are to be located far from spring of drinking water.

x) Environmental Flow

According to Ministry of Energy, methods of environmental flow are all hydrological, e.g. Tenant method (Montana method), flow duration curve analysis, aquatic base flow method and Texas method. Since all of them are very simple method not reflecting the flow regime and natural ecosystem, it is recommended to consider other method (e.g. hydraulic rating methodology or holistic method) to determine environmental flow.

9.3.2 Meteo-hydrological Monitoring Plan

1) Surface Water Monitoring Plan

Meteo-hydrological and water quality monitoring plan aims at providing the basic data/information to support activities of the RBO (River Basin Organization), and providing reliable and prompt data enough to coordinate among the provinces concerned during drought time and emergency such as water pollution accident. The basic concept of the plan is (1) to select the representative monitoring stations located at important locations and (2) to improve their monitoring instruments. Hereinafter present conditions of monitoring system are summarized and the proposed plan will be presented afterwards.

a) Present Condition of Surface Water Monitoring

i) Standard for Hydrological Monitoring

In the Sefidrud basin, the monitoring for surface water is essential to formulate the dam planning, and the integrated water management of dam reservoirs as well as the integrated water resources management planning. Accordingly, the WRMC issued "Directive of Statistical Study of Water Resources Measurement Tools and Method" to establish a standard for hydrological monitoring such as selection of suitable sites, measuring methodology of water level and stream flow, data recording and archiving and so on.

ii) Hydrological Monitoring Network in the Sefidrud River Basin

Ninety stations are located in the Sefidrud basin, but four stations out of them cannot be identified their locations due to lack of the geographical information. The status of the stations and observation periods of stream flow are shown in Tab. 9.3.1 in the Appendix.

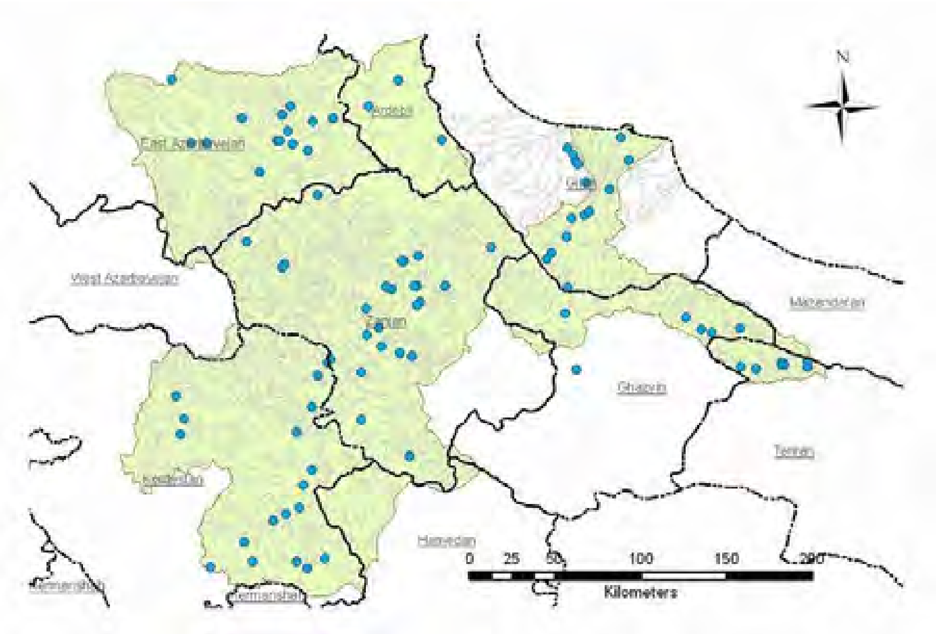


Figure R 9.3.2 Hydrological Monitoring Network in the Sefidrud Basin

iii) Data Collection System and Monitoring Equipment

According to the WRMC, the daily discharge is estimated by using a rating curve to convert the daily water level to the discharge rate. The rating curve is renewed once a year. Normally discharge measurements are made twice a month, while the measurements are made about 10 times every month at the stations located near important dams and geographically important points. All of the observed daily, monthly and annual data collected by the RWC are submitted to WRMC at the end of a hydrological year. WRMC calculates the discharge rate by using the received data.

According to the abovementioned directive, the equipment for the discharge measurement are prepared depending on the importance of monitoring stations as categorized in Table R 9.3.7. WRMC also instructs that the bench mark should be installed in all monitoring sites to check the gauge datum.

Table R 9.3.7 Category of Hydrological Monitoring Stations

Level of Monitoring Station	Monitoring Instruments	Monitoring Task
Level 1	staff gauge, water level recorder and cableway	stations observing year-round stream flow being located along the perennial stream
Level 2	staff gauge and cableway	stations observing flood flow
Level 3	staff gauge and water level recorder	stations observing water current and water level
Level 4	staff gauge	stations observing the water level along the canal

iv) Issues on Discharge Monitoring

Based on the preceding study results, Table R 9.3.8 summarizes the issues on discharge monitoring in the Sefidrud.

Table R 9.3.8 Issues on Current Discharge Monitoring

Item	Issues
Location	- Absence of stations at planned sites for dam construction
Basic Information	- Lack of recording about river name at the site of station - Impossible to identify the exact location of the stations along the tributaries due to lack of the information - Impossible to identify the exact location of the stations archiving into the GIS database due to low accuracy of their geographical coordinates - No arrangement and maintenance of the station's inventory
Recording	- Difficulties to distinguish the observed nil data and missing one - Existence of unreliable measurement record

b) Proposed Surface Water Monitoring System

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

i) Sharing of Monitoring Information

The monitoring system could be expected that (1) monitoring stations should be improved for telemetry system step by step, (2) telemetry stations should send the monitored data to the newly proposed RBO in a real-time manner, and (3) the RBO should send the collected and processed data to WRMC in Tehran. It is essential that RBO, WRMC and RWC concern for sharing the related data/information and have similar understandings to the encountering situations for prompt and adequate actions of coordination during the drought and some other emergencies. Thus, the final goal of proposed monitoring system is real-time telemetry system so that the objectives of this system could be enumerated as follows.

- To assist WRMC & RWC concerned in properly making decision for coordination of drought management and emergency actions at some accidents through real-time data/information sharing, and,
- To assist the integrated water management of dam reservoirs' operation for the most efficient water utilization in supplying the timely and reliable data, as its materialization will be much more imminently necessary in parallel with the progress of dams construction.

ii) Selection of Monitoring Stations

Monitoring stations to be satisfied the following conditions are selected as shown in Figure R 9.3.9.

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

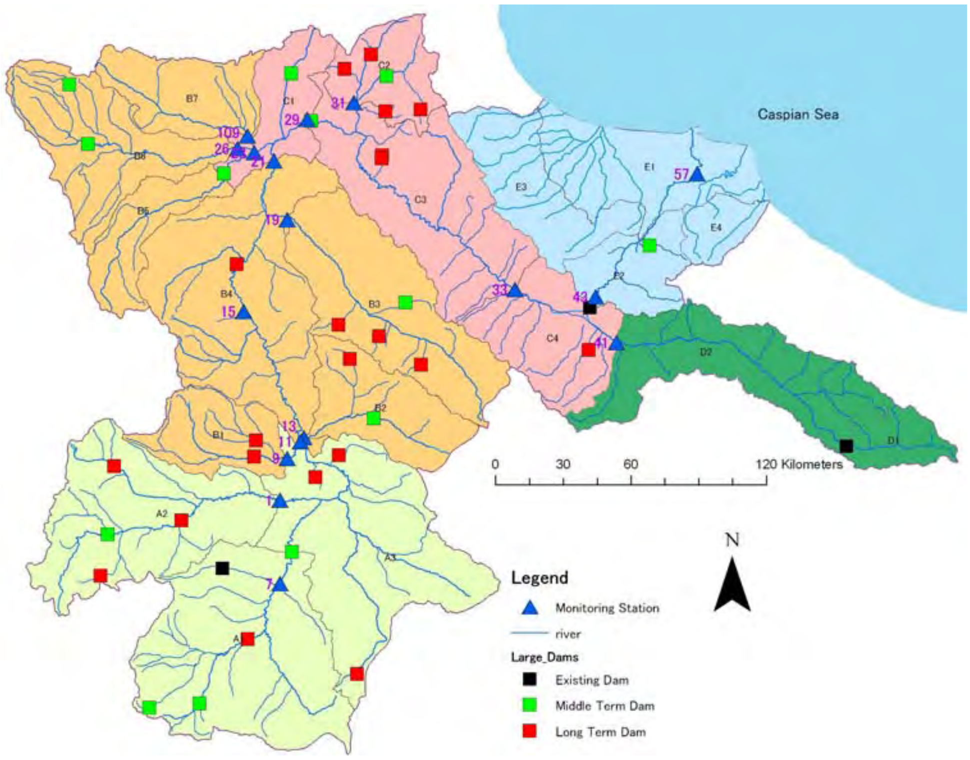


Figure R 9.3.3 Selected Monitoring Station

Table R 9.3.9 Issues on Current Discharge Monitoring

Code	Station	Observation Period	Zone	River
17-057	Astaneh	25	E	Sefidrud River
17-042	Roodbar	38	E	Sefidrud River
17-041	Loshan	35	D	Shahrud River
17-033	Givan	39	C	Ghezelozan River
17-029	Ostor	40	C	Ghezelozan River
17-021	P.D.Mianeh	40	B	Ghezelozan River
17-015	M.N.Lailan	18	B	Ghezelozan River
17-011	G.Goony	30	A	Ghezelozan River
17-109 17-026 17-023	- Mianeh - M.Gharangho - Motorkhaneh	30 29 40	B	Branch Rivers of Mianeh Area
17-019 17-013 17-009	Sarcham Y.Kand H.Joft	32 32 32	B	Zanjan Rivae, Sojas River
17-001 17-007	Binloo S.Abad	28 39	A	Talval River

iii) Monitoring System

On the basis of the development of mobile telephone services and radio communication regulatory 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. Merits and demerits with the introduction of both systems are described next.

In Iran, Meteorological Organization already started to install rain-gauge telemetry system since early 2000s, using GSM because of easy introduction to utilize mobile network. Furthermore, flood management in the IWRM of the Sefidrud River basin is not a key factor, and urgency and reliability to transmit data are not expected to be high and important. Thus telemetry system using GSM might be suitable for low water management in the basin.

<u>Telemetry System by GSM System</u>

Besides its easy installation and maintenance, the GSM system is affordable as compared with the radio communication system although the communication charge shall be paid. Therefore, the GSM system is often introduced for the establishment of telemetry system at the area where the mobile phone service is expanding.

There are several service providers for mobile telephone here in Iran, which are managed by Mobile telephone Company belonging to the Iranian Telephone Company that is one of government enterprise. Then, the penetration of mobile phone is very high under this circumstance. However, the feasibility study before the time of introduction will be necessary to find out a certain coverage area

The schematic diagram of the proposed monitoring system by the introduction of GSM system is shown as Figure R 9.3.4.

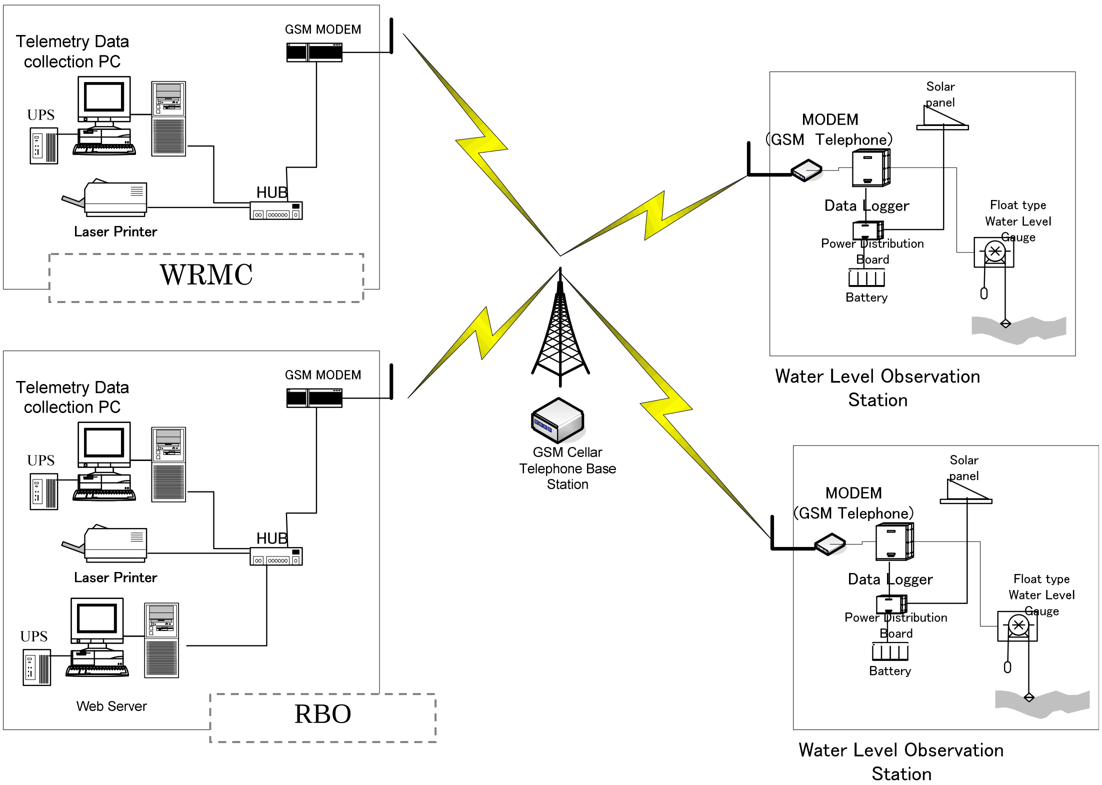


Figure R 9.3.4 GSM Monitoring System

<u>Telemetry System by Radio Communication System</u>

Radio Communication System is a data transmission system through the VHF/UHF radio network. Although the initial installation cost is higher than GSM system and the specialized experience is necessary for the maintenance, there are two merits that this system does not request the communication fee and possess higher reliability in the data transmission.

In the Sefidrud River Basin, about 10 repeater stations will be necessary to connect telemetry gauging stations and regional control center. The service range of VHF /FM radio is as short as about 40 km under the line-of-sight condition. Therefore, the longer the communication distance is, the more relay stations are required, resulting in an increase of the initial cost. Nevertheless, VHF/FM radio communication is generally recognized to be the most suitable for low speed data communication such as a hydrological telemetry system. The conceptual network of option of the system is shown in Figure R 9.3.5.

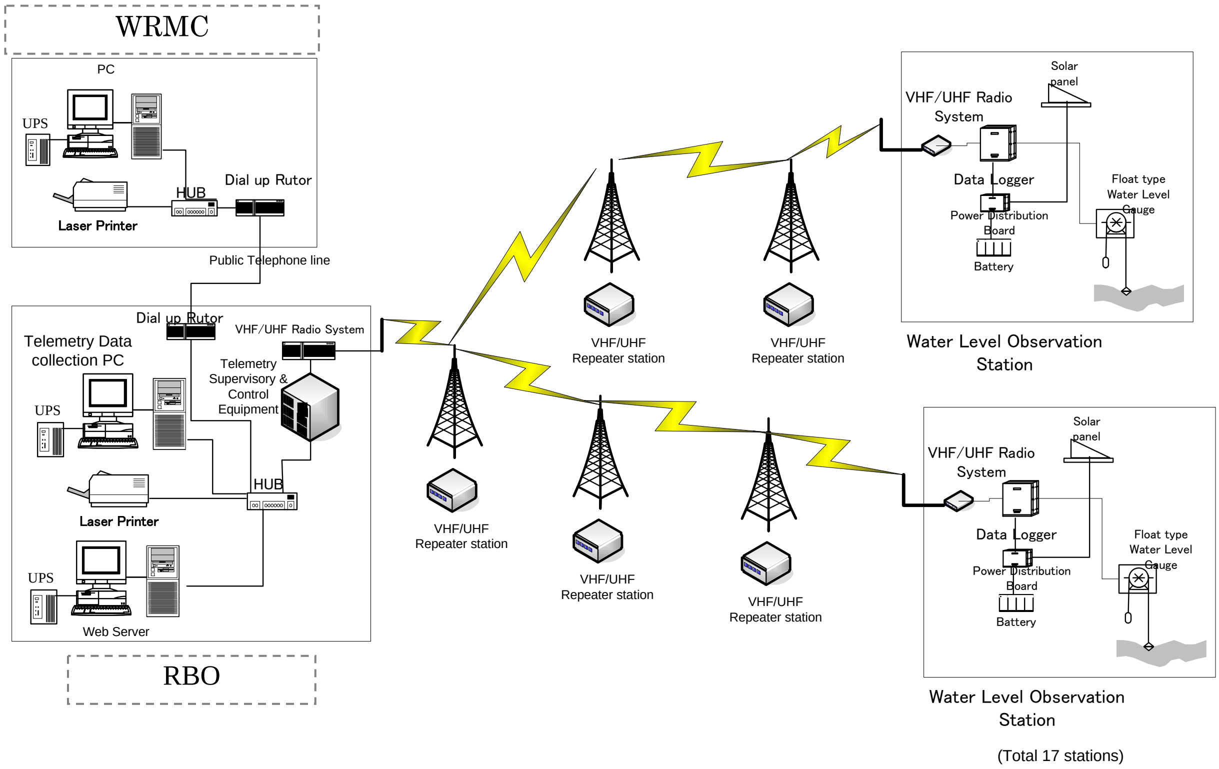


Figure R 9.3.5 Radio Communication System

2) Groundwater Monitoring Plan

a) Present Condition

The fluctuation of groundwater table have not measured enough in the past as explained before chapter, the establishment of monitoring system of groundwater play an important role of the groundwater management. The groundwater monitoring system was established in eight of eleven groundwater basin and groundwater levels have measured continuously, and water quality tests have been conducted periodically.

There are 271 monitoring wells in the groundwater basin of 1301, 1302, 1304, 1306, 1308, 1310, and 1311. WRMC did not investigate in the basin 1303, but, the electric resistivity survey was conducted in the basin 1303 by the other organization. Besides above, there is the WRMC data in GIS but not measuring data in the 1307 basin. Accordingly, it is supposed to be more monitoring wells in the basin including other organization and non-sorting data. No unified data are available in the basin at present.

b) Monitoring Plan

The number of monitoring wells is few considering the area of Sefidrud River Basin with an area of 59,090 km^2. But, if the installation of monitoring was limited in only plain where production wells are distributed, the area of plain is 18,039 km2 that is equivalent to about 31% of total basin area. The installation and number of monitoring wells are sometime encountered difficulty, but here it is recommended to refer to same scale plain and successful example of regulating pumping yield in Kanto Plain in Japan. The Kanto Plain has an area of about 17,000 km2 and has suffered from the land subsidence because of over pumping of groundwater. Total 450 monitoring wells have been installed during about 30 years from 1955 to 1986 and constructed database, conducted groundwater simulation, determined safety yield of groundwater and implemented and finally completed successfully. Referring this example, it is recommended that the number of monitoring will be about 450 in total and they are allocated in proportion to the area of each basin as shown in Table R 9.3.10. It is installed one in each 40 km2, but the existing monitoring wells are too much in basin 1308, so finally total 254 new monitoring wells are recommended as shown in Table R 9.3.10. These new monitoring wells shall be installed in the area shown in Figure R 9.3.6 (Additional monitoring area) and if production wells could be used, it should be diverted as much as possible. However, it is required that there is the geological logs and the results of pumping test of diverted wells. It is also required that electric resistivity survey should be conducted and geological structure should be investigated around the new monitoring wells.

<u>Monitoring Parameters</u>

Monitoring parameters is as follows:

- Measuring parameters: water level, water quality, pumping yield
- Measuring aquifer: each unconfined aquifer and confined aquifer
- Measuring schedule: water level; every month, others; every dry and rainy seasons

Table R 9.3.10 The 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 measuring*	*Water quality test*	Proper well in total in basin	**Additional new 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)
*: Code 1308 There are only one data of the results of pumping test and water quality test

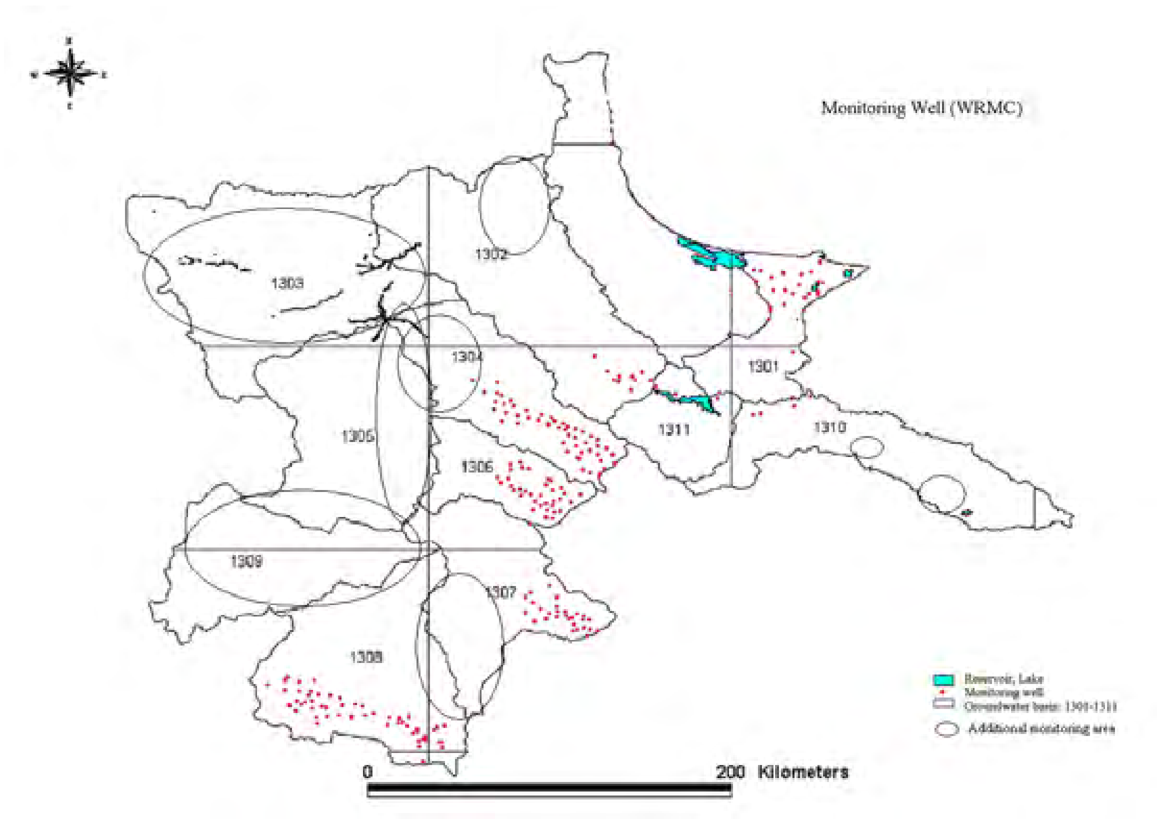


Figure R 9.3.6 The Area of Additional Monitoring Well of Groundwater

3) Present Conditions of Water Quality Monitoring

Water quality monitoring in the pubic water body strongly depends on the water quality standard/guidelines stipulated by the Iranian environmental lows. In general the government designates the water quality standard to the segment of the public water body in accordance with suitable water usage in the segment. One of the objectives of water quality monitoring is to check how water quality in the designated water body complies with the standard.

In the phase II stage, present conditions of water quality monitoring shall be made clear through interview survey to the responsible offices concerned, and issues of the present monitoring system shall be reported.

4) Proposition of Construction of Meteo-hydrological and Water Quality Monitoring System

The basic concept for future construction of meteo-hydrological and water quality monitoring system could be summarized below.

a) Selection of Monitoring Stations

Monitoring stations to be selected should satisfy the following conditions:

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

b) Parameters to Be Monitored

Monitoring stations are divided into three categories from the parameters to be observed, namely surface water, groundwater and water quality. Water quality monitoring stations, however, shall be placed on the same locations of surface water stations, since evaluation of water quality needs water quantities. Parameters to be monitored shall be selected in the phase II stage.

c) Monitored Data Sharing

Final figure of the monitoring system could be expected that (1) monitoring stations should be improved for telemetry system step by step, (2) telemetry stations should send the monitored data to the newly proposed RBO in a real-time manner, and (3) the RBO should send the collected and processed data to RWC. It is essential that RBO and RWC concerned share the related data/information and have similar understandings to the encountering situations for prompt and adequate actions of coordination during the drought and some other emergencies. Thus, the final goal of proposed monitoring system is real-time telemetry system so that the objectives of this system could be enumerated as follows.

(i) To assist RWC concerned in properly making decision for coordination of drought management and emergency actions at some accidents through real-time data/information sharing, and

(ii) To assist the integrated water management of dam reservoirs' operation for the most efficient water utilization in supplying the timely and reliable data, as its materialization will be much more imminently necessary in parallel with the progress of dams construction.

9.3.3 Watershed Management Plan

Watershed management, of which river basin conservation consists of various countermeasures, such as terracing, banquet, and reforestation/afforestation, has been conducted for regional economic development targeting the devastated sub-catchments. After completion of the management sediment yields from the watershed could be reduced so that the sediment inflow to the reservoirs could also be reduced resulting in prolonging the life time of the reservoirs. Ministry of Jihard-e-Agriculture (MOJA) is mandated to conduct the watershed management in Iran.

In particular, sediment of 720 MCM (= 1,900 million tons) was transported and deposited into the Manjil reservoir for 45 years, compared to the gross reservoir volume of 1,750 MCM. So far the accumulated sediment of 450 MCM (= 1,200 million tons) could be discharged out to the downstream channel so that sediment of 270 MCM (= 700 million tons) still remains in the reservoir.

1) Erosion in the Basin

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. The following figure 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.

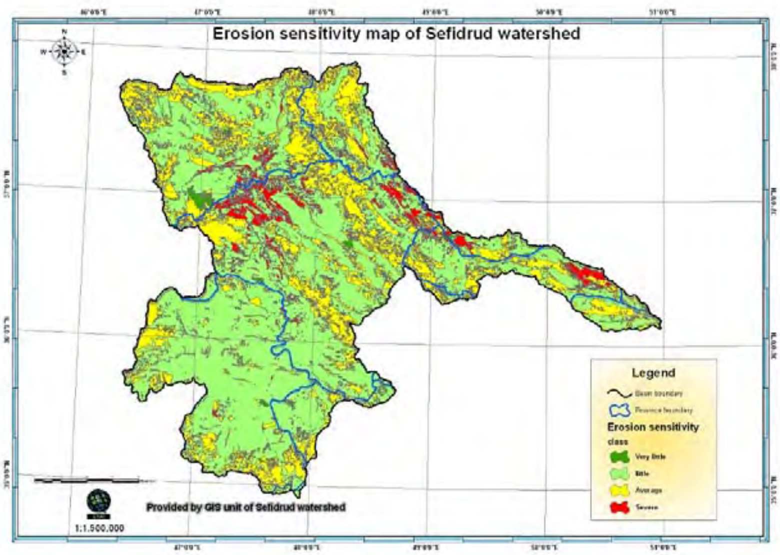


Figure R 9.3.7 Soil Erosion Sensitivity in the Sefidrud Basin

2) Watershed Management Project

The following figure illustrates the sub-catchment where MOJA is conducting or plans to conduct the watershed management project. Referring to the erosion sensitive areas in Figure R 9.3.7, the project sub-catchments concentrate to the sensitive areas around Manjil dam. On the other hand, study and implementation have never been carried out in the Marl areas as mentioned above due to difficulties for applying the remedial measures.

Based on the discussion with MOJA about countermeasures of erosion and water quality control in the middle reaches, watershed management projects could not reportedly be adaptable to such geological vulnerable wide areas. If such watershed management measures could not be applicable, channeling works shall be considered for preventing the salinity dissolution and utilizing the surface water in accordance with importance of this issue.

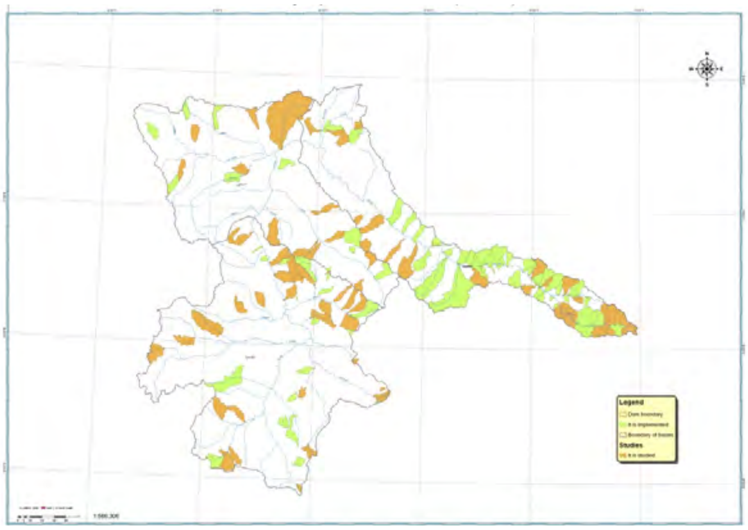


Figure R 9.3.8 Sub-catchments of Watershed Management Projects by MOJA in the Sefidrud Basin

9.3.4 Institutional Strengthening Plan on Water Resources Management and Coordination

1) River Basin Organization (RBO)

a) Basic Concept of River Basin Organization (RBO)

The present system of water related organizations is inappropriate for the integrated water resources management because each RWC devotes itself to the management within its own boundary and at the national level there is no organization which focuses on coordinating the activities of RWCs in the Sefidrud river basin. Establishment of RBO, which is in charge of the water resource management from the viewpoint of the whole river basin, is an effective way for integrated river basin management.

According to a report of the World Bank, "Integrated River Basin Management Briefing Note 1, 2006," RBOs have three typical models, namely 1) river basin coordinating committee/council, 2) river basin commission, and 3) river basin authority. The characteristics of the three models are summarized in Table R 9.3.11.

Table R 9.3.11 Three RBO Models

Model	Assumptions/Preconditions	Organizational Setups
River Basin Coordinating Committee/Council	• The existing agencies within the river basin are operating effectively. • Most of the important data networks are in place and good quality data and information is being generated. • Most of the high priority water projects have been constructed. • Competition for resource use between the states or provinces in the basin and the major uses within each of these has bee resolved.	• It would comprise ministers or senior representatives of the main water-related agencies from each of the states, provinces, prefectures, or other entities operating within the basin. • It would meet, for example, every three months, 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. • As it does not have any executive powers, it cannot override the roles and activities of the member organizations. • It can also be uses as the first step in the development an ongoing form of coordination.
River Basin Commission	• Significant development options are still to be considered in the river basin • Conflicting uses are significant • Information and policies still need further development to ensure equitable sharing of resources and to limit the harmful impacts of resource use. • Water resource planning and management practices are not well detailed - either to facilitate further development or to limit development to restore desired environmental values in the basin. • Simulation models, systems and the underlying data and information are not readily available, or need further development.	• It would normally be a much more formally constituted body than the committee/council model. • It would be comprised of a board of management or group of commissioners who set objectives, goals, policy, and strategic direction. • It would be supported by a technical office of water, natural resources, and socioeconomic planning and management experts. • In some cases, there may be a Ministerial Council that presides over the commission to provide ultimate authority. • Daily operations for water resources management normally would be left to the existing agencies, unless these tasks are not being done effectively. • It would set the bulk water shares that each state/province is entitled to divert and would monitor water uses at the higher state/provincial level.
River Basin Authority	• It was more common about 50 years ago, when there was more large-scale development of water resources systems for urban, industrial, or agricultural expansion. • In some African courtiers, where less than 10 % of the water resources potential has been developed, this model remains relevant and the river basin commission model may not be the optimum choice. • This model would not be the best arrangement for basins which are historically, geographically, and politically very complex.	This model usually takes one of the following two forms: • Multi-disciplinary organization with specific development tasks to under take such as hydropower development or navigation. Examples: Tennessee Valley Authority (USA), Snowy Mountains Authority (Australia) • An organization that absorbs virtually all the water resources functions of other agencies in the basin, rendering it very large and powerful. The authorities resembled large private companies.

Note: Names of the RBOs in actual cases are not necessarily the same with the above Models although they have the same organizational arrangements.
Source: World Bank, 2006. "Integrated River Basin Management Briefing Note 1"

The roles and functions of RBOs varies with the way of their formation and purposes. In addition, they will usually evolve with RBOs' development in a time frame of their activities.

2) Proposal of the RBO for the Sefidrud River Basin

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

Fundamental issues of the present situations of the Sefidrud River Basin are identified based on the Study results as the necessity of 1) basin-wide coordination of water resources management including water resources development, utilization and conservation in accordance with a master plan authorized by all related Provinces, 2) water use coordination reasonably accepted among related Provinces 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 decision making support tools, and evaluation of the newly proposed plan using the model,
- Coordination on water allocation plan and consensus building, and
- Coordination on conflicts including drought and water related accidents and taking prompt action with remedial/countermeasures

b) Caspian Sea & Urumie Lake Basin Office

Caspian Sea & Urumie Lake Basin Office (CUBO) was established in 2008 with the purpose of coordinating water resources issues within the basins. Thus, CUBO has a close relationship with the RBO of Sefidrud and such relationship should be clarified. The jurisdiction of CUBO covers all the river basins in the northern part of Iran, which covers 12 Provinces and includes Sefidrud river basin. CUBO started a coordination work of water allocation of Atrak river with three stakeholder Provinces (Gorestan, North Khorasan and Semnan) in 2009 by establishing a committee, which is similar to Sefidrud's. The General Director of CUBO began to participate in the Stakeholder Meeting of Sefidrud from 2009 and is waiting for the results of the JICA Study.

According to the General Director of CUBO, it should be kept in mind that the coordination of water allocation takes a very long time and it should be conducted on step-by-step basis. In addition, the Iranian Government is being streamlined and it is not a good idea to establish a totally new organization.

c) Organizational Setup of the RBO with the River Basin Coordinating Committee Model

The RBO should employ the river basin commission model with some modification with the following reasons (please refer to the models of RBOs):

- Construction of large dams are still under consideration in the river basin;
- Coordination of water use allocation among related Provinces are significant;
- Improvement of the data and information system is required; and
- The simulation model prepared by the Study Team should be improved after completion of the Study with close cooperation among related Provinces.

As the above-mentioned World Bank report describes, if the existing water-related organizations in the basin are operating well, there is no need for the RBO to take over their operations and management roles and functions directly in this model. The RBO conducts coordination and planning across the whole basin and further develops and operates the tools, systems, and models to be used there.

However, it would be very difficult to start with the basin commission model with considering the present conditions of related organizations and the policy of the streamlining of the Government. Therefore, the RBO for Sefidrud should start with the coordinating committee model by changing the name of the Steering Committee/Stakeholder Meeting, consisting of representatives of RWCs in the related Provinces and being presided by WRMC with the following tasks:

- To make an implementation plan of the Maser Plan of IWRM prepared by the JICA Study Team,
- To make a plan for the operation of the simulation model prepared by the JICA Study Team,
- To share data/information among the Provinces,
- To make basic rules in the IWRM: required minimum (monthly) flow for maintenance including water utilization and environmental needs, water allocation plan, etc.,
- To make water management rules during drought time, and
- To make a plan of employing participatory approach for the water users such as farmers.

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 WRMC.

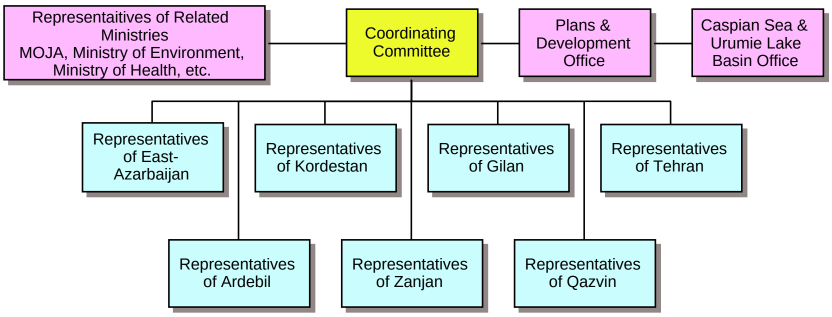


Figure R 9.3.9 Organizational Structure of the RBO with Coordinating Committee Model

d) 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. For such transformation, the Committee is required the following tasks:

- To discuss the details of the RBO (membership, tasks, budget, etc.),
- To explain the necessity and details of the RBO to related Provinces, and
- To draft of an agreement of the RBO among the related Provinces.

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

Table R 9.3.12 Components of the RBO with Basin Commission Model

Component	Functions	Membership
Council	• To make policies and strategies of the RBO and IWRM for Sefidrud River Basin • To authorize significant decisions of the Joint Committee which affect the majority of the related Provinces	Governors of related Provinces and Minister of MOE
Joint Committee	• To decided matters which affects situations of two or more Province(s) • To authorize significant decisions of Working Group • To authorize the budget of RBO	Heads of RWCs, MOJA, Ministry of Environment, Ministry of Health and WRMC
Secretariat	• To support and coordinate of activities of other components • To prepare draft of budget of the RBO • To coordinate capacity development of RWC staff for IWRM • Contact point of the RBO	Staff sent from RWCs and WRMC
Working Group	• To make an implementation plan 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 data and information systems for IWRM	Basically the same members as the Coordinating Committee with expanding the number of members
Technical/ Policy-Making Advisory Group	• To make advice to other components from expert viewpoints	Academic experts from universities or research institutes for water resources management

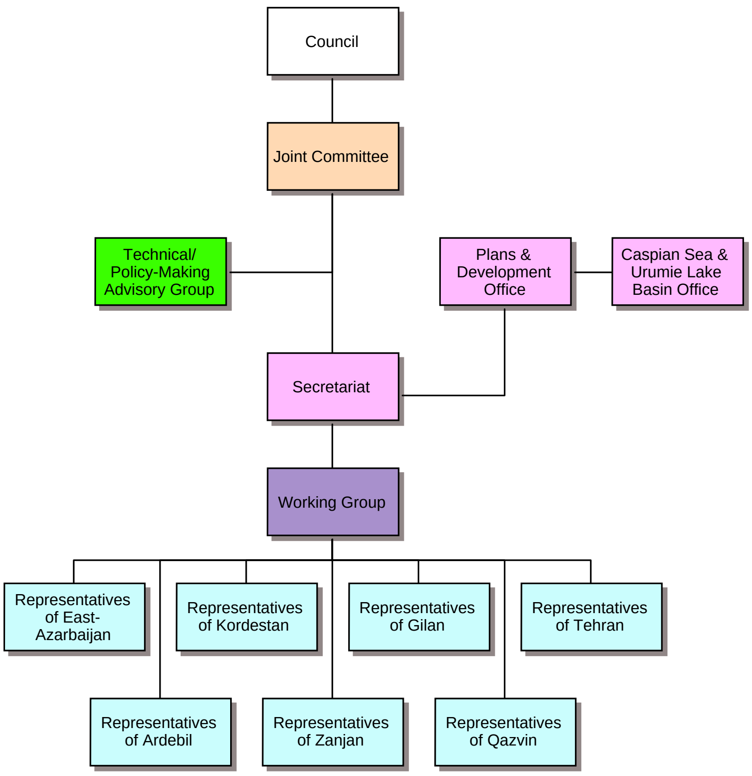


Figure R 9.3.10 Organizational Structure of the RBO with River Basin Commission Model

e) Capacity Development for IWRM under the RBO

Capacities are now considered to be composed of knowledge, skills and motivations in individuals, and supporting systems of organizations where such individuals are working and circumstances where such organizations are located including rules and customs. Thus capacity development is promoted with the following dimensions:

- Human resource development and the strengthening of managerial systems,
- Institutional development, and
- The creations of an enabling environment with appropriate policy and legal frameworks.

In terms of human resource development, the RWC staff is required to carry out the following tasks with enough capacities for IWRM under the guidance of the RBO:

- Operation and maintenance of meteo-hydrological and water quality monitoring system
- Formulation of telemetry upgrading system plan, and operation and maintenance of the system after the completion
- Configuration of database system archiving the monitored data and its data sharing procedures
- Utilization and upgrading of the basin model, and evaluation of the newly proposed plan using the model
- Assistance of rules preparation and coordination among the RWC for consensus building
- Assistance of holding the public hearing workshop to realize the projects through people's agreement

f) Financial Setup for the RBO

The total cost of the activities of the RBO should be borne by the related Provinces in accordance with their shares of water allocation. It is proposed that a fund be established in order to stabilize the financial base of the RBO with raising contributions from the related Provinces, the national treasury and bulk users including large manufacturing companies, utility companies and so on.

Financial planning and accounting are carried out by the Secretariat of the RBO and it reports financial statements to the Joint Committee annually.

3) Legal Framework for the RBO

The roles and powers of the RBO must be clearly stipulated in addition to how it interact with existing agencies. The specific implementing regulation should be developed to establish the proposed RBO in the stage of the River Basin Commission. Since it relies upon the existing regulations for water resources management and agencies, the implementing regulation should include the following stipulations to conduct IWRM by coordinating the activities of RWCs.

Preliminary (objectives, definitions, etc.); Institutional Framework; Investigation, Measurement and Monitoring; Water Resources Planning and Management (quantity and quality); Construction, Operation, and Maintenance Powers and Responsibilities; Water Allocation and Sharing (Water Use Coordination); Flood Management; Catchment Management; Estuary and Coastal Zone Management; Finance and Budgeting; Dispute Resolution; Public Awareness, Education, and Participation; Reporting; Legal Powers and Ability to Prosecute for Violation of Regulation; Schedules

4) 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 Table R 9.3.13.

Table R 9.3.13 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

5) Detailed Activities in the future

Detailed activities required for future IWRM in Sefidrud River Basin are shown in the following table.

Table R 9.3.14 Detailed Activities Required for Future IWRM

Overall Goal: To implement the effective and sustainable water resources management of the Sefidrud River basin and technology transfer on IWRM to the counterparts		
Project Purpose	**Outputs**	**Project Activities**
Improvement of monitoring system for surface water and groundwater resources management in the basin	Improvement of monitoring network of meteorological, hydrological station for surface and ground water resources in the basin	• Review on meteo-hydrological data, monitoring system including surface and groundwater, • Preparation of improved monitoring system including real time telecommunication system and installation of necessary observation equipment, and • Establishment of GIS based data base system.
Improvement of proper conjoined management for both surface and groundwater resources	Improvement of regulatory and conjoined management system for both surface water and groundwater uses in seriously lowering areas of their groundwater tables	• Collection of basic data/information on groundwater aquifers, • Identification of scale of groundwater aquifers and computation of their water balance, safe yield, etc. • Proposition of adequate intake volume from groundwater aquifers and alternative water sources, and • General review of laws and suggestion
Strengthening effective demand control system of water resources	Preparation of suitable guidelines for effective demand control, in particular agricultural water use	• Confirmation of irrigation measures by crops through the field survey, and • Proposition of suitable water saving measures by crops and practical measures to improve the irrigation efficiency by using new skills including satellite image analyzing, • General review of laws and suggestion, and • Preparation of water utilization manuals for IWRM
Improvement and strengthening of cooperative mechanism for data/information sharing, discussion on water related issues and projects' adjustment	Improvement of cooperative mechanism among the related provinces for data/information sharing, discussion on water related issues and projects' adjustment	• Holding the periodical regional meetings in the related provinces to clarify the emerging issues on water resources management and to discuss about their solutions, • Holding the periodical coordination meetings in Tehran to discuss about emerging issues and conflicts among the provinces, and to determine the suitable directions of the Sefidrud IWRM, and • Fundamental consideration of RBO
Establishment of integrated management system on major dams and reservoirs	Improvement of integrated operation system on major dams and reservoirs	• Preparation of integrated operation manual on major dams and reservoirs, and • Preparation of drought and flood management guidelines including the integrated operation system during drought
Improvement of water resources simulation model	Improvement of rain and water resources simulation model to support cooperative mechanism among the related provinces	• Upgrading and transfer of the model by utilizing the newly monitored data, and • Frequent holding of the training workshop for technology transfer
Improvement of social and environmental management issues	Improvement of water quality and water environment.	• Evaluation of effect of pollution sources on water resources, water environment • Consideration of reuse of reclaimed water and • General review of laws and suggestion

CHAPTER 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 addition, the present condition of water demand was estimated based on the result of satellite image analysis by WRMC in cooperating with the Team and the Team carried out the water allocation simulation by MIKE-Basin. The result of the simulation is compared with the previous result in Chapter 9. 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

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. 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 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. It was expected to finish the shooting for the first phase in May; however, at last the first shooting was finished in the beginning of July 2009 due to continuity of unusual cloudy and rainy spring.

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 R 10.1.1 Schedule for Satellite Image Analysis

Where, the description of the processing items is listed as follows.

(i) SPOT Image Ordering: two seasons SPOT satellite image are ordered to cover main body of Sefidrud river basin including agricultural areas and plains. the mentioned area was covered by 20 frames of SPOT Image, so that total number of frames for two seasons are 40 frames. Other area outside of above 20 frames, for example, Gilan Plain and Eastern part of basin use the existing ASTER Archive Information.

(ii) Pre-Image Process Activities: after receiving SPOT Image information, topological and radio metrical corrections work was done before remote sensing analysis.

(iii) GPS Sampling Survey: A field trip and sampling data survey with GPS(+- 3m) and spectral study of crops are exacted. More than 30 points for each crop in each frame are selected.

(iv) Data Analysis for Land use: Data analysis by remote sensing software with classification algorithms is operated. Initial version of land use data is generated.

(v) Improving Quality and Distribution Land use data: after calculation of error and upgrading the data quality by field check, a final version of land use data is submitted.

10.1.2 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 R 10.1.2, 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 R 10.1.2 Shooting Area

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. The specification of the satellite image is shown in Table R 10.1.1.

Table R 10.1.1 Specification of Satellite Image

Items	Specifications
Products	Panchromatic: 5 m Multispectral: 10 m color adjusted
Spectral Bands	P (panchromatic); B1 (green); B2 (red); B3 (near infrared); B4 (SWIR: short-wave infrared)
Footprint	60 km x 60 km
Tasking	April 2009 – June 2009, July 2009 – August 2009
Viewing Angle	Cross-track: +/- 27° Forward/backward stereo-viewing with SPOT 5
Location Accuracy	< 30 m (1 σ) with SPOT 5
Preprocessing Levels	1A, 2A

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.

Then, the final areas would be transferred into a Geo database of the region and the water consumption ratios will be implemented into the areas and total water consumption in the whole study area would be determined. General flow chart is shown bellow.

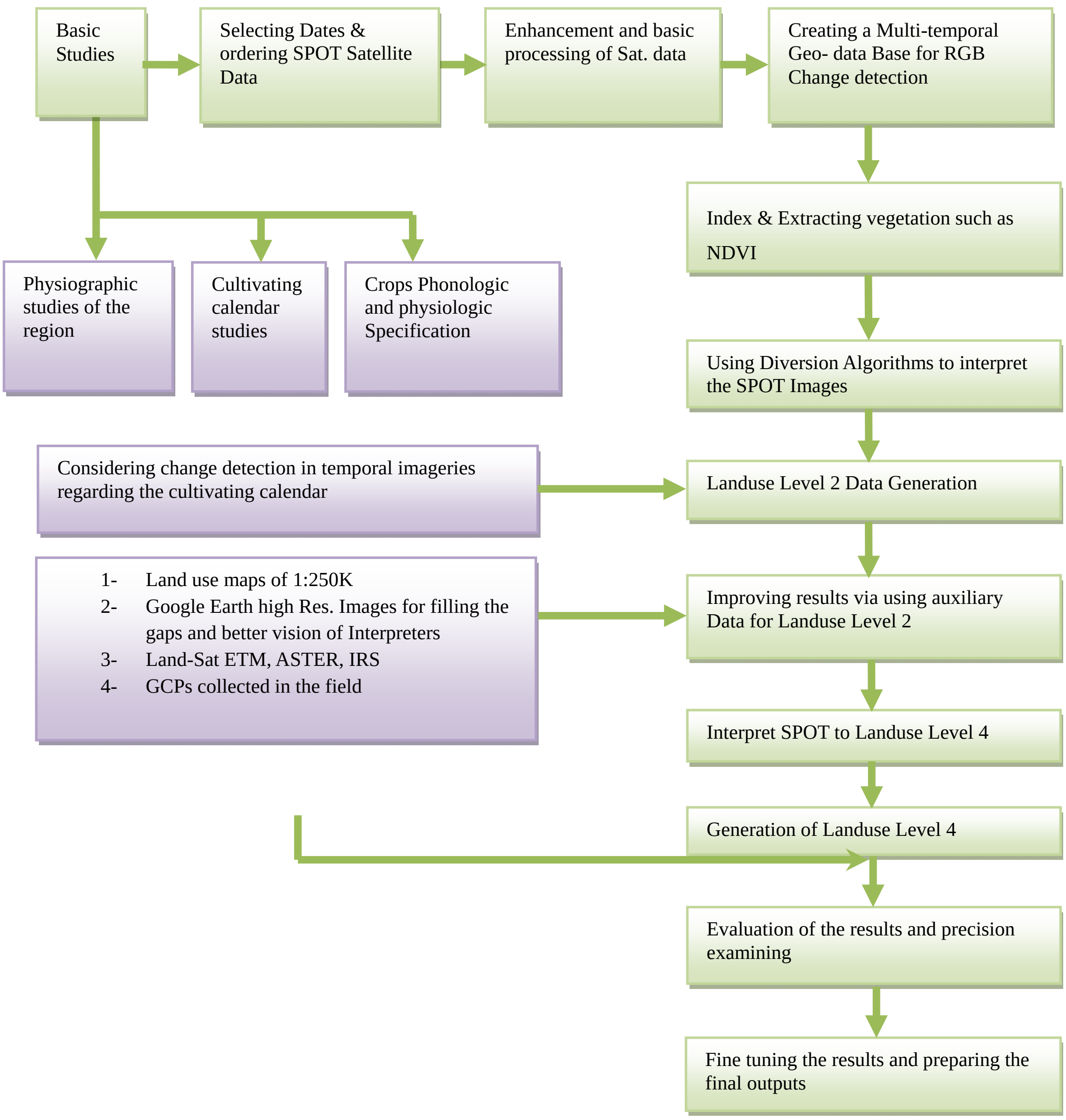


Figure R 10.1.3 Flow of Satellite Image Analysis

4,500 points are selected as the checking points for GPS Sampling survey. Distribution of those points is shown in Figure R 10.1.4.

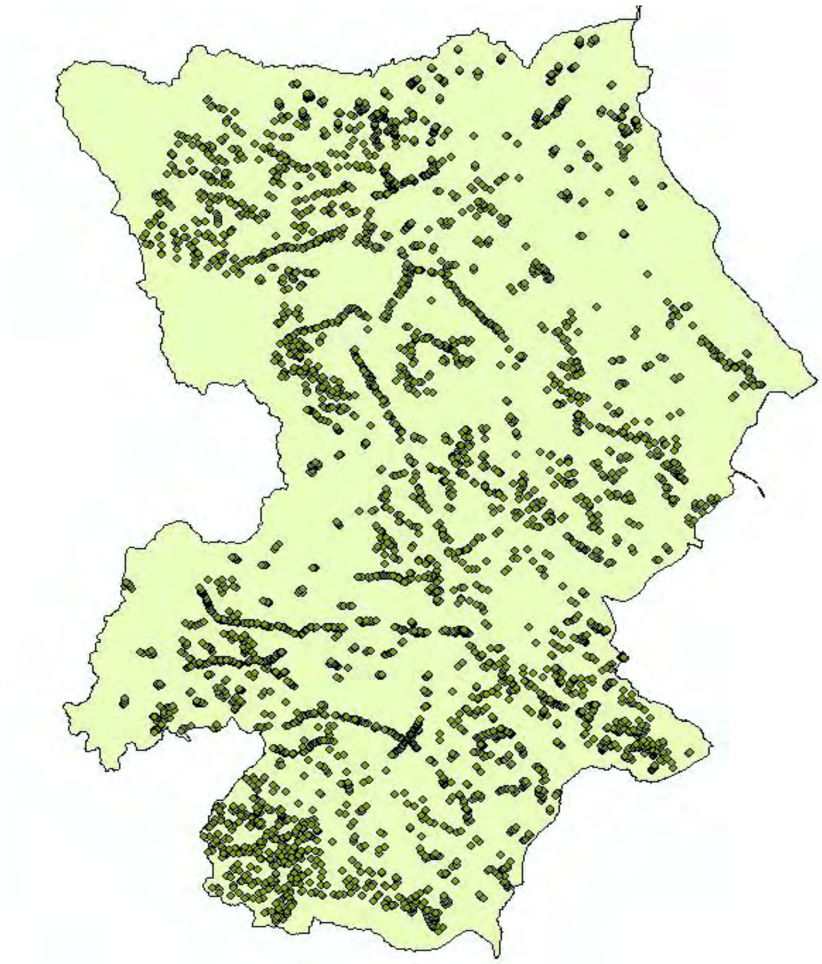


Figure R 10.1.4 Distribution of Checking Points

2) Ingenious Attempt for Interpreting of Landuse

An optimized methodology for achieving the best possible result on the task must be used into interpreting the satellite images. In this way all possible methods were examined and the followings were chosen for covering the methodology requirements.

- Using multi-temporal satellite imageries of SPOT, ASTER, IRS and Land-Sat to be used as main tool of crop identification.
- Collecting check points of different phenomenon in the area, chosen by the interpreters, to help them on better interpretation.
- Identification of microclimates in the region for getting better result in spetral analysis.
- Collecting the Agricultural calendar of each region to identify the crops of different types.
- Using different maps in scales of 1/25,000, 1/250,000 to create slope maps and aspect maps for differentiation rain feed lands from irrigated ones.

3) Outcome of Analysis

The USGS Level 2 map is illustrated in Figure R 10.1.5. The Level 2 map is used for the water balance simulation by MIKE SHE as a vegetation information and the level 4 landuse map, which is divided into the more detailed crop classification compared with the Level 2, is utilize for estimating the water requirement with each Reach.

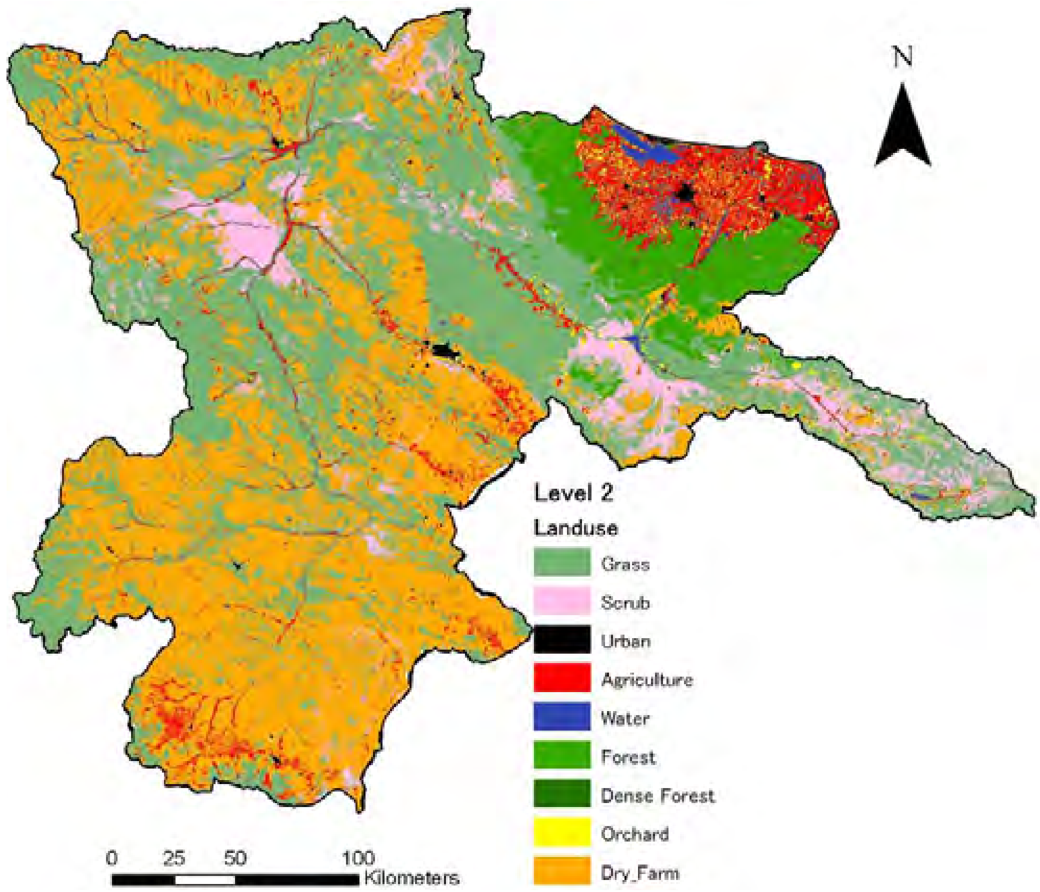


Figure R 10.1.5 Landuse Map (Level 2)

10.2 WATER REQUIREMENT

Based on the new land use map described in Sub-section 10.1, WRMC estimated the water requirement in corporation with the Team. The procedure of the estimation of water requirement is explained as follows:

10.2.1 Water Requirement by Crop

Based on the new land use map and archive images, the irrigation water requirement by crop is estimated according to the following items:

(i) Crop water requirement study: Estimation of ETC and ETO, and comparing them with national document.

(ii) Agricultural Field Trips and Questionnaires: to get a accurate water requirement data, a agricultural field trip team is departure with a questionnaire to the land owner.

(iii) Water requirement estimation: using FAO program, the water requirement will be calculated by inputting ETO, rainfall, crop type and soil type.

10.2.2 Agricultural 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 R 10.2.1 shows the calculation flow of agricultural water requirement and Table R 10.2.1 and Table R 10.2.2 summarize agricultural water requirement categorized by Zone.

Table R 10.2.3 and Table R 10.2.4 show the one for each reach in each month. Incidentially, the agricultural water requirement estimated in this chapter should be considered as the requirement of average year.

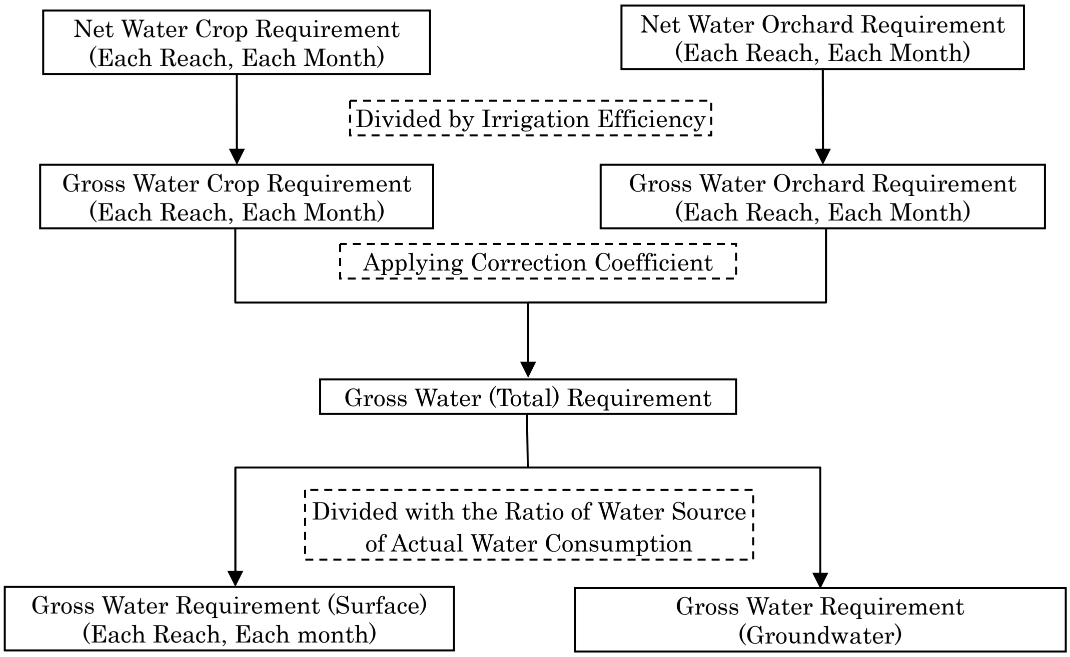


Figure R 10.2.1 Flow of Calculation of Agricultural Water Requirement

Table R 10.2.1 Irrigation Water Demand and Requirement from Surface Wate, Weir and Dam by Zone

Zone	Sub-Zone	Water Demand in Chapter 6 Area (ha)	Water Demand in Chapter 6 Total ('000m³)	Water Requirment Area (ha)	Water Requirment Total ('000m³)	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

Table R 10.2.2 Irrigation Water Demand and Requirement from Groundwater by Zone

Zone	Sub-Zone	Water Demand in Chapter 6 Area (ha)	Water Demand in Chapter 6 Total ('000m³)	Water Requirment Area (ha)	Water Requirment Total ('000m³)	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

Table R 10.2.3 New Irrigation Water Requirement from Surface Water by Reach (2006)

Reach	New Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirment (unit: ‘000m^3)													Unit Requir-ment (m^3/ha)	Rivision
			Meh.	Aba.	Aza.	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Total		
			Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.			
1	303	1.00	237	37	0	16	58	117	279	504	871	806	809	529	4,263	14,063	Yes
2	2,686	0.86	2,423	1,945	262	140	536	1,468	3,081	6,072	7,738	9,428	9,731	6,363	49,187	18,312	Yes
3	1,467	1.00	1,286	177	0	74	274	553	1,321	2,456	4,498	4,413	4,464	2,995	22,511	15,344	Yes
4	3,187	0.80	2,925	2,183	347	148	628	1,866	3,880	7,086	9,425	11,366	11,855	7,707	59,416	18,643	Yes
5	8,092	0.80	6,420	6,568	892	476	1,825	5,003	10,472	20,013	24,324	28,205	28,539	17,941	150,678	18,621	Yes
6	1,594	0.90	1,232	1,261	171	91	350	961	2,011	3,842	4,669	5,412	5,476	3,443	28,919	18,144	Yes
7	198	1.00	160	24	0	10	38	76	180	344	604	574	577	376	2,963	14,962	Yes
8	0	0.88	0	0	0	0	0	0	0	0	0	0	0	0	0	18,201	Yes
9	1,724	0.83	1,521	1,349	182	97	373	1,022	2,143	4,165	5,197	6,200	6,348	4,088	32,685	18,959	Yes
10	4,955	0.67	4,604	3,544	651	223	1,057	3,377	6,983	11,635	15,831	18,516	19,381	12,420	98,222	19,823	Yes
11	3,391	0.85	2,220	2,941	402	215	823	2,256	4,713	8,780	10,223	11,288	11,179	6,718	61,758	18,213	Yes
12	190	0.96	182	36	0	5	33	78	199	351	620	695	720	490	3,409	17,943	Yes
13	423	1.00	381	64	0	10	57	137	351	646	1,265	1,494	1,552	1,073	7,030	16,615	Yes
14	36	0.91	35	7	0	1	6	15	38	67	118	132	136	93	648	17,946	Yes
15	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Yes
16	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	15,250	Yes
17	9,162	0.79	5,750	8,459	1,119	634	2,365	6,348	13,465	24,672	27,887	30,802	31,781	19,041	172,323	18,808	Yes
18	3,051	0.84	3,068	1,550	682	498	1,028	2,622	5,358	8,576	9,645	8,353	8,457	5,953	55,790	18,286	Yes
19	21,079	1.00	1,237	221	0	82	620	1,287	25,805	61,229	37,102	39,644	34,211	4,286	205,724	9,760	Yes
20	6,022	0.94	5,265	1,764	753	524	1,090	2,868	6,094	13,052	18,930	21,108	21,487	14,181	107,116	17,787	Yes
21	8,744	0.89	9,947	4,457	1,384	1,006	1,562	2,798	5,636	13,989	24,498	33,159	34,218	24,422	157,076	17,964	Yes
22	1,307	0.84	2,080	773	465	390	529	1,096	2,370	3,842	4,138	2,833	2,931	2,118	23,565	18,030	Yes
23	431	1.00	208	31	0	9	60	100	522	861	868	1,163	1,140	602	5,564	12,914	Yes
24	640	0.92	769	123	52	36	75	198	422	1,047	1,871	2,421	2,544	1,830	11,388	17,795	Yes
25	1,656	0.98	1,753	827	216	169	285	541	1,179	2,788	4,181	5,757	5,953	4,667	28,316	17,100	Yes
26	1,673	0.90	2,583	903	535	441	596	1,253	2,703	4,531	5,216	4,098	4,274	3,102	30,235	18,072	Yes
27	7,603	0.87	5,533	2,592	1,005	712	1,577	4,121	9,773	19,295	28,043	26,638	26,431	14,317	140,037	18,419	Yes
28	265	0.91	302	56	24	17	35	91	193	460	780	983	1,031	731	4,703	17,747	Yes
29	352	0.87	359	74	27	20	53	132	265	636	1,085	1,324	1,417	980	6,372	18,107	Yes
30	4,741	0.76	5,072	1,822	661	414	1,118	3,055	5,809	10,047	15,034	16,651	17,847	12,754	90,284	19,043	Yes
31	728	0.95	682	170	73	52	108	279	594	1,515	2,267	2,675	2,750	1,916	13,081	17,970	Yes
32	734	0.97	1,003	213	79	54	76	129	342	848	1,940	2,785	2,954	2,385	12,808	17,450	Yes
33	382	0.93	462	77	33	22	47	124	262	634	1,122	1,446	1,516	1,092	6,837	17,900	Yes
34	837	0.74	872	514	240	162	263	651	1,370	2,292	2,896	2,499	2,593	1,823	16,175	19,324	Yes
35	1,196	0.82	1,271	669	280	173	269	709	1,670	3,036	4,077	3,701	3,863	2,758	22,476	18,793	Yes
36	1,727	1.00	1,263	1,995	241	308	677	1,396	2,961	4,274	3,517	4,378	4,618	3,652	29,280	16,955	Yes
37	1,127	0.77	1,282	703	276	147	224	667	1,546	2,682	3,773	3,702	3,883	2,808	21,693	19,248	Yes
38	381	0.83	394	163	58	32	73	219	502	902	1,278	1,260	1,317	938	7,136	18,730	Yes
39	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Yes
40	214	0.74	261	138	52	25	38	122	284	485	721	755	795	584	4,260	19,909	Yes
41	615	0.79	777	445	169	82	123	397	909	1,522	2,188	2,230	2,344	1,702	12,888	18,638	Yes
42	482	0.81	523	306	121	65	99	292	677	1,149	1,570	1,496	1,566	1,122	8,986	18,642	Yes
43	224	0.85	222	143	60	37	58	152	357	606	749	616	639	443	4,082	18,228	Yes
44	2,096	0.98	1,927	903	321	268	465	1,330	3,190	5,418	6,983	5,631	5,807	3,875	36,118	17,232	Yes
45	68	0.92	65	44	18	11	17	46	109	182	222	179	186	128	1,207	17,758	Yes
46	26	0.77	32	17	6	3	5	15	34	58	83	86	91	67	497	19,078	Yes
47	6,873	0.99	3,294	2,121	796	741	1,296	3,419	8,347	16,056	25,496	22,523	22,803	9,862	116,754	16,987	Yes
48	1,946	0.97	1,448	523	194	180	316	832	2,043	4,252	7,187	6,919	7,110	3,694	34,698	17,831	Yes
49	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	13,707	Yes
50	758	1.00	364	231	87	81	141	372	908	1,750	2,783	2,464	2,496	1,085	12,762	16,833	Yes
51	156	1.00	74	47	17	16	28	75	183	353	562	499	506	220	2,580	16,532	Yes
52	216	1.00	98	61	23	21	37	99	241	464	739	656	665	290	3,394	15,713	Yes
53	1,520	1.00	0	0	0	0	0	0	2,581	6,658	3,666	3,666	3,067	0	19,637	12,918	No
54	3,889	1.00	0	0	0	0	0	0	7,863	20,266	11,019	11,179	8,728	0	59,055	15,186	No
55	3,297	1.00	0	0	0	0	0	0	5,355	13,810	7,604	7,604	6,361	0	40,734	12,354	No
56	12,904	1.00	0	0	0	0	0	0	21,660	55,980	30,510	30,860	22,350	0	161,360	11,578	No
57	1,387	1.00	0	0	0	0	0	0	2,340	6,020	3,280	3,320	2,400	0	17,360	12,516	No
59	2,365	0.94	2,328	389	0	60	354	840	2,149	3,959	7,706	9,033	9,381	6,492	42,691	18,051	Yes
60	6,664	0.76	7,227	4,548	741	307	1,320	3,962	8,209	14,499	19,494	24,354	26,177	17,803	128,641	19,304	Yes
61	14,734	0.78	9,042	6,442	1,016	1,480	3,232	6,590	13,185	28,461	48,694	63,590	63,390	33,859	278,981	18,935	Yes
62	180	0.81	2	6	0	4	38	77	523	1,050	561	573	487	23	3,344	18,585	Yes
63	3,348	0.88	2,663	1,267	524	425	1,078	2,589	5,065	8,290	11,276	9,681	10,248	7,127	60,233	17,991	Yes
64	1,352	0.73	1,495	875	362	217	337	908	2,130	3,706	4,820	4,268	4,447	3,138	26,703	19,750	Yes
65	148	0.75	182	84	32	15	23	74	174	310	485	530	561	417	2,887	19,504	Yes
66	335	0.95	275	140	55	39	87	225	527	934	1,188	928	957	622	5,977	17,839	Yes
67	16	0.99	8	5	2	2	3	8	19	37	59	53	53	23	272	17,051	Yes
	167,897		107,088	67,027	15,706	11,487	27,883	70,037	213,554	443,443	485,176	529,602	521,598	283,168	2,775,769	17,032	Yes

Table R 10.2.4 New Irrigation Water Requirement from Groundwater by Reach (2006)

Reach	New Irrigation Area (ha)	Correction Coefficient	Gross Irrigation Water Requirement (unit: '000m^3)													Unit Require -ment (m^3/ha)	Revision
			Meh. Oct.	Aba. Nov.	Aza. Dec.	Dey Jan.	Bah. Feb.	Esf. Mar.	Far. Apr.	Ord. May	Kho. Jun.	Tir July	Mor. Aug.	Sha. Sept.	Total		
1	1,023	1.00	798	126	0	52	195	393	940	1,702	2,941	2,721	2,730	1,787	14,385	14,063	Yes
2	1,599	0.86	1,443	1,158	155	83	319	874	1,834	3,615	4,607	5,613	5,793	3,788	29,282	18,312	Yes
3	2,417	1.00	2,118	292	0	121	451	910	2,177	4,046	7,411	7,270	7,354	4,935	37,085	15,344	Yes
4	1,596	0.80	1,465	1,093	174	74	314	935	1,943	3,549	4,720	5,692	5,936	3,860	29,755	18,643	Yes
5	1,419	0.80	1,126	1,152	157	83	320	877	1,836	3,509	4,265	4,946	5,005	3,146	26,422	18,621	Yes
6	2,175	0.90	1,681	1,721	234	125	479	1,311	2,744	5,243	6,371	7,385	7,473	4,698	39,465	18,144	Yes
7	226	1.00	183	27	0	12	43	86	206	392	690	654	658	430	3,381	14,962	Yes
8	1,682	0.88	1,405	1,122	206	71	335	1,069	2,211	3,662	4,950	5,749	6,008	3,826	30,614	18,201	Yes
9	350	0.83	309	274	37	20	76	207	435	846	1,055	1,258	1,289	830	6,636	18,959	Yes
10	29	0.67	27	21	4	1	6	20	41	68	92	108	114	73	575	19,823	Yes
11	2,529	0.85	1,656	2,193	301	160	614	1,683	3,515	6,548	7,625	8,419	8,338	5,010	46,062	18,213	Yes
12	127	0.96	122	24	0	3	22	52	133	235	414	465	481	328	2,279	17,943	Yes
13	280	1.00	251	43	0	6	38	90	232	427	837	988	1,028	710	4,650	16,615	Yes
14	1	0.91	1	0	0	0	0	0	1	2	3	3	4	2	16	17,946	Yes
15	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Yes
16	28	1.00	24	4	0	1	3	8	21	39	77	90	94	66	427	15,250	Yes
17	3,593	0.79	2,255	3,317	438	249	927	2,489	5,281	9,676	10,936	12,079	12,464	7,467	67,578	18,808	Yes
18	82	0.84	82	41	18	14	28	70	144	231	259	225	227	160	1,499	18,286	Yes
19	1,093	1.00	64	12	0	5	33	66	1,338	3,174	1,924	2,056	1,774	222	10,668	9,760	Yes
20	7,684	0.94	6,718	2,251	960	668	1,391	3,660	7,776	16,654	24,155	26,933	27,418	18,094	136,678	17,787	Yes
21	6,010	0.89	6,837	3,064	952	692	1,074	1,923	3,873	9,616	16,838	22,791	23,519	16,786	107,965	17,964	Yes
22	1,188	0.84	1,891	703	423	354	481	996	2,154	3,492	3,761	2,575	2,664	1,925	21,419	18,030	Yes
23	267	1.00	129	20	0	6	37	63	324	533	538	721	706	373	3,450	12,914	Yes
24	58	0.92	70	11	4	4	7	18	38	95	170	220	230	166	1,033	17,795	Yes
25	19,068	0.98	20,184	9,525	2,493	1,945	3,287	6,226	13,579	32,098	48,139	66,291	68,547	53,742	326,056	17,100	Yes
26	5,266	0.90	8,132	2,843	1,684	1,390	1,877	3,942	8,508	14,261	16,420	12,898	13,452	9,763	95,170	18,072	Yes
27	9,720	0.87	7,074	3,314	1,285	910	2,016	5,268	12,494	24,668	35,852	34,055	33,791	18,304	179,031	18,419	Yes
28	0	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0	17,747	Yes
29	79	0.87	81	16	7	5	12	30	60	142	244	297	318	220	1,432	18,107	Yes
30	1,315	0.76	1,407	505	183	115	310	848	1,611	2,786	4,170	4,618	4,950	3,538	25,041	19,043	Yes
31	71	0.95	67	16	7	5	11	27	58	148	221	261	269	187	1,277	17,970	Yes
32	0	0.97	0	0	0	0	0	0	0	0	0	0	0	0	0	17,450	Yes
33	26	0.93	32	5	2	2	3	9	18	43	76	98	103	75	466	17,900	Yes
34	23	0.74	24	14	7	5	7	18	37	63	80	68	71	50	444	19,324	Yes
35	14	0.82	15	8	3	2	3	8	20	36	48	43	45	32	263	18,793	Yes
36	3,540	1.00	2,588	4,088	495	632	1,388	2,863	6,069	8,760	7,210	8,974	9,467	7,486	60,020	16,955	Yes
37	1,710	0.77	1,946	1,066	419	222	339	1,011	2,345	4,070	5,725	5,617	5,892	4,261	32,913	19,248	Yes
38	290	0.83	300	124	44	24	56	167	382	686	973	959	1,003	714	5,432	18,730	Yes
39	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	-	Yes
40	149	0.74	181	96	37	18	27	85	198	338	502	525	554	406	2,967	19,909	Yes
41	768	0.79	777	445	169	82	123	397	909	1,522	2,188	2,230	2,344	1,702	12,888	18,638	Yes
42	1,044	0.81	1,133	664	261	140	214	633	1,466	2,489	3,400	3,240	3,392	2,430	19,462	18,642	Yes
43	224	0.85	222	143	60	37	57	152	357	606	750	617	640	443	4,084	18,228	Yes
44	1,986	0.98	1,826	856	304	253	441	1,260	3,023	5,134	6,617	5,335	5,502	3,672	34,223	17,232	Yes
45	514	0.92	492	329	138	85	132	349	821	1,375	1,678	1,356	1,405	968	9,128	17,758	Yes
46	38	0.77	46	24	9	4	7	22	49	84	122	126	133	98	724	19,078	Yes
47	20,270	0.99	9,715	6,256	2,347	2,185	3,822	10,083	24,617	47,353	75,194	66,426	67,252	29,085	344,335	16,987	Yes
48	2,687	0.97	1,999	722	267	249	436	1,150	2,821	5,871	9,924	9,553	9,818	5,101	47,911	17,831	Yes
49	601	1.00	186	202	97	97	210	452	1,102	1,910	2,069	829	806	278	8,238	13,707	Yes
50	2,212	1.00	1,061	673	252	235	411	1,085	2,651	5,106	8,120	7,190	7,282	3,166	37,232	16,833	Yes
51	143	1.00	68	42	16	15	26	68	167	323	515	457	464	202	2,363	16,532	Yes
52	2,632	1.00	1,190	746	280	261	456	1,201	2,933	5,658	9,009	7,992	8,099	3,533	41,358	15,713	Yes
53	553	1.00	0	0	0	0	0	0	939	2,421	1,333	1,333	1,115	0	7,141	12,918	No
54	1,632	1.00	0	0	0	0	0	0	3,300	8,507	4,625	4,693	3,664	0	24,788	15,186	No
55	200	1.00	0	0	0	0	0	0	325	837	461	461	386	0	2,469	12,354	No
56	5,890	1.00	0	0	0	0	0	0	7,550	19,512	10,635	10,757	7,790	0	56,244	11,578	No
57	13,130	1.00	0	0	0	0	0	0	22,152	56,988	31,050	31,429	22,720	0	164,338	12,516	No
59	839	0.94	826	138	0	22	125	298	763	1,404	2,734	3,205	3,328	2,303	15,146	18,051	Yes
60	1,090	0.76	1,182	744	122	51	216	648	1,343	2,372	3,188	3,984	4,282	2,912	21,044	19,304	Yes
61	5,653	0.78	3,469	2,472	390	568	1,240	2,528	5,059	10,920	18,683	24,398	24,321	12,991	107,039	18,935	Yes
62	20	0.81	0	1	0	1	5	8	58	117	63	64	54	2	373	18,585	Yes
63	4,768	0.88	3,792	1,804	747	605	1,535	3,686	7,213	11,807	16,059	13,786	14,594	10,150	85,778	17,991	Yes
64	14	0.73	15	9	4	2	4	10	22	38	50	44	46	32	276	19,750	Yes
65	308	0.75	378	175	66	32	47	155	363	645	1,009	1,103	1,167	867	6,007	19,504	Yes
66	15,236	0.95	12,485	6,382	2,486	1,782	3,942	10,228	23,953	42,493	54,032	42,202	43,516	28,294	271,795	17,839	Yes
67	9,128	0.99	4,573	2,788	1,046	975	1,706	4,496	10,985	21,239	33,878	30,087	30,488	13,381	155,642	17,051	Yes
	168,307		118,121	65,904	19,790	15,760	31,684	77,211	209,516	422,184	521,685	526,561	524,376	299,070	2,831,862	17,032	Yes

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. Basically, the simulation is run with the new demand input into the water allocation simulation model (Sefid-WASM) of the present condition which is constructed in Chapter 7. The conditions of the simulation are described as follows:

10.3.1 Water allocation Simulation

1) 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.

2) 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.

3) Irrigation Efficiency

The present condition of the irrigation efficiency is selected to calculate the gross agricultural water demand from net demand for each Reach. The adapted efficiency value is colored in Table R 10.3.1.

Table R 10.3.1 Irrigation Efficiency

Case	SIDN			Traditional Agricultural Area		
	Present Condition	Middle Term	Long Term	Present Condition	Middle Term	Long Term
Present Condition	0.42	0.42	0.42	0.33	0.33	0.33
Intermediate Rate	***0.42***	0.45	0.51	***0.33***	0.37	0.44
WRMC proposed	0.42	0.48	0.55	0.33	0.40	0.50

4) Condition of 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.

a) Water Demand by Reach

The amount of water demand of each Reach for the surface water and the groundwater is summarized in Table R 10.3.2. The demand of each reach in the table is expressed the total demand including the three sectors (agriculture, industry and domestic water).

Table R 10.3.2 Water Demand by Reach

Unit:MCM

Zone	Sub-zone	Area (km2)	Category	Reach										Remarks
A	A-1	6,445.5	Reach	R43	R44	R45	R47	R48	R50	R51	R52	R67	Total	
			Surface	3.7	33.1	1.1	105.4	31.2	11.6	2.4	2.8	0.2	191.5	
			Ground	4.1	34.2	8.8	316.2	54.3	34.0	2.2	34.5	139.7	628.1	
			Total	7.9	67.2	9.9	421.6	85.5	45.6	4.6	37.3	139.9	819.5	
	A-2	5,072.9	Reach	R37	R40	R41	R42	R46	R65				Total	
			Surface	20.1	3.9	11.9	8.3	0.5	2.6				47.3	
			Ground	40.2	4.4	15.4	19.3	0.8	6.2				86.4	
			Total	60.3	8.4	27.3	27.5	1.3	8.9				133.7	
	A-3	6,004.0	Reach	R38	R39	R49	R66						Total	
			Surface	6.5	0.0	0.0	5.4						11.9	
			Ground	5.2	0.1	11.4	264.2						280.9	
			Total	11.7	0.1	11.4	269.6						292.8	SW Total: 250.7
	Sub-total	17,522.4											1,246.0	GW Total: 995.3
B	B-1	1,817.6	Reach	R34	R35	R64							Total	
			Surface	14.4	20.5	23.9							58.7	
			Ground	1.1	1.0	1.7							3.8	
			Total	15.5	21.4	25.6							62.5	
	B-2	2,395.4	Reach	R29	R30	R63							Total	
			Surface	5.7	82.3	53.0							141.0	
			Ground	1.5	25.3	79.9							106.8	
			Total	7.2	107.6	132.9							247.8	
	B-3	4,590.6	Reach	R20	R24	R27	R28	R31	R33				Total	
			Surface	151.7	10.2	123.0	4.2	11.8	6.1				307.0	
			Ground	143.7	1.3	160.5	0.2	1.4	0.5				307.7	
			Total	295.5	11.5	283.5	4.4	13.2	6.6				614.7	
	B-4	6,527.1	Reach	R17	R22	R26							Total	
			Surface	157.5	21.4	26.2							205.2	
			Ground	67.5	20.7	87.8							176.0	
			Total	225.0	42.2	114.0							381.2	
	B-5	1,628.5	Reach	R18									Total	
			Surface	47.0									47.0	
			Ground	4.0									4.0	
			Total	51.0									51.0	
	B-6	3,540.0	Reach	R08	R10	R60							Total	
			Surface	0.0	89.9	116.9							206.8	
			Ground	28.2	1.8	28.5							58.6	
			Total	28.2	91.8	145.4							265.4	
	B-7	2,145.1	Reach	R04	R05	R09							Total	
			Surface	54.7	135.6	29.0							219.2	
			Ground	29.1	26.2	6.1							61.3	
			Total	83.7	161.7	35.0							280.5	SW Total: 1,184.9
	Sub-total	22,644.3											1,903.1	GW Total: 718.2
C	C-1	1,761.2	Reach	R02	R06	R11							Total	
			Surface	43.4	25.7	68.3							137.4	
			Ground	26.5	35.8	48.9							111.3	
			Total	69.9	61.6	117.2							248.7	
	C-2	1,849.7	Reach	R01	R03	R07	R12	R14	R59				Total	
			Surface	3.6	20.1	2.6	2.9	0.6	38.8				68.6	
			Ground	12.3	32.1	3.0	2.0	0.0	18.6				68.1	
			Total	15.9	52.2	5.6	5.0	0.7	57.4				136.7	
	C-3	4,850.4	Reach	R13	R15	R16	R61						Total	
			Surface	5.8	0.0	0.0	226.8						232.6	
			Ground	4.0	0.0	1.0	92.5						97.5	
			Total	9.9	0.0	1.0	319.2						330.1	
	C-4	2,763.3	Reach	R21	R32								Total	
			Surface	143.4	11.5								154.9	
			Ground	108.2	0.2								108.5	
			Total	251.6	11.7								263.3	SW Total: 593.5
	Sub-total	11,224.6											978.9	GW Total: 385.4
D	D-1	942.8	Reach	R36									Total	
			Surface	20.5									20.5	
			Ground	42.8									42.8	
			Total	63.3									63.3	
	D-2	3,909.3	Reach	R25									Total	
			Surface	24.4									24.4	
			Ground	288.0									288.0	
			Total	312.3									312.3	SW Total: 44.9
	Sub-total	4,852.1											375.6	GW Total: 330.7
E	E-1	3,192.6	Reach	R53	R54								Total	
			Surface	42.1	44.3								86.5	
			Ground	39.6	46.9								86.5	
			Total	81.8	91.2								173.0	
	E-2	1,632.3	Reach	R19	R23	R62							Total	
			Surface	163.3	4.7	2.7							170.7	
			Ground	22.4	9.0	3.5							34.9	
			Total	185.7	13.7	6.2							205.7	
	E-3	2,479.9	Reach	R56									Total	
			Surface	124.0									124.0	
			Ground	76.1									76.1	
			Total	200.1									200.1	
	E-4	788.2	Reach	R57									Total	
			Surface	13.3									13.3	
			Ground	144.7									144.7	
			Total	158.0									158.0	SW Total: 394.5
	Sub-total	8,092.9											736.8	GW Total: 342.2
Total		64,336.3	Surface										2,468.4	
			Ground										2,771.9	
			Grand Total										5,240.3	

b) Water Demand of Dam Command Area

The three dams: Manjil, Taleghan and Golbragh Dam, are mounted into the Sefid-WASM on present condition. Of these, the demand of Manjil dam's command area is described in next item c) because the released water from the dam is regulated by the three weir downstream of the dam to distribute the water to SIDN. The demand for the command are of the remaining two dams is summarized in Table R 10.3.3.

Table R 10.3.3 Water Demand of Dam Command Area(MCM)

Dam	Agriculture	Domestic	Industry
Manjil	Refer to item C)		
Taleghan	310.0	150.0	0
Golboragh	6.6	0	0

c) Water Demand Regulated by Weir

The water discharged from Manjil outlet is controlled to distribute to SIDN by the three weirs downstream of Manjil: Tarik, Galerud and Sangar weir. The yearly total water demand assigned to weirs is summarized in Table R 10.3.4. Incidentally, the monthly water demand is referred to Table R 6.2.20 in Chapter 6.

Table R 10.3.4 Water Demand of Dam Command Area (MCM)

River	Weir	Agriculture	Domestic	Industry
Sefidrud Main Stream	Tarik	437.5	0	0
	Galerud	36.8	57.3	0
	Sangar	0	0	0
Right Branch	Sahre Bijar	6.6	57.3	0

5) 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. The initial condition and dimension of dams is described in Table R 10.3.5.

Table R 10.3.5 Initial and Physical Condition of Dams

Dam	Reach	Cachement Area (km2)	Bottom Level (m)	Low Water Level (m)	Flood ontrol Level (m)	Initial Water Level (m)	Effective Storage Vollume (MCM)
Manjir	R53	56,019	191	259	272	271.7	1,150
Taleghan	R36	828	1,688	1,740	1,780	1812	329
Golbolagh	R43	250	1,793	1,808	1,814	1768	6

6) Environmental Flow

The environmental flow at the downstream of Sangar weir is considered in the Sefid-WASM for the spawning of sturgeon as follows:

Table R 10.3.6 Environmental Flow for Sturgeon

Month	May	June	July	Total
Discharge (MCM)	133.9	133.9	40.2	308

7) 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

On the condition as described in subsection 10.3.1, 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, in comparison with the previous result in Chapter 9.

1) Sufficiency Level of Traditional Irrigation Area

The sufficiency level estimated by the previous model (using the demand based on the agricultural inventory) and the revised model (using the demand based on the satellite image analysis) are shown by each small zone and large zone in Table R 10.3.7.

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. The reason why the increase of sufficiency level can be seen in some zone despite the increase of the water demand in whole basin are explained in Ssection 10.3.

Table R 10.3.7 Sufficiency Level by Zone

Zone	Sub-Zone	5-year Drought (1998/99)		Average Year (1991/92)	
		Previous Model	New Model	Previous Model	New Model
A	A-1	57.1	59.4	74.4	73.5
	A-2	31.7	42.1	92.6	97.4
	A-3	80.7	81.8	92.2	92.7
	Average	57.8	62.1	85.8	87.0
B	B-1	91.9	93.6	100.0	100.0
	B-2	28.4	37.1	80.9	84.4
	B-3	37.0	39.0	67.9	71.8
	B-4	59.2	55.2	99.0	100.0
	B-5	73.7	100.0	100.0	100.0
	B-6	73.0	79.3	100.0	100.0
	B-7	47.1	46.3	61.5	64.7
	Average	56.1	59.2	87.5	89.3
C	C-1	52.6	59.5	93.7	92.8
	C-2	49.4	57.3	97.3	98.8
	C-3	56.5	60.5	94.1	88.3
	C-4	69.9	39.4	100.0	100.0
	Average	58.0	54.6	96.0	93.6
D	D-1	100.0	100.0	100.0	100.0
	D-2	100.0	100.0	100.0	100.0
	Average	100.0	100.0	100.0	100.0
Average of Upper Basin		60.8	62.7	89.7	90.4

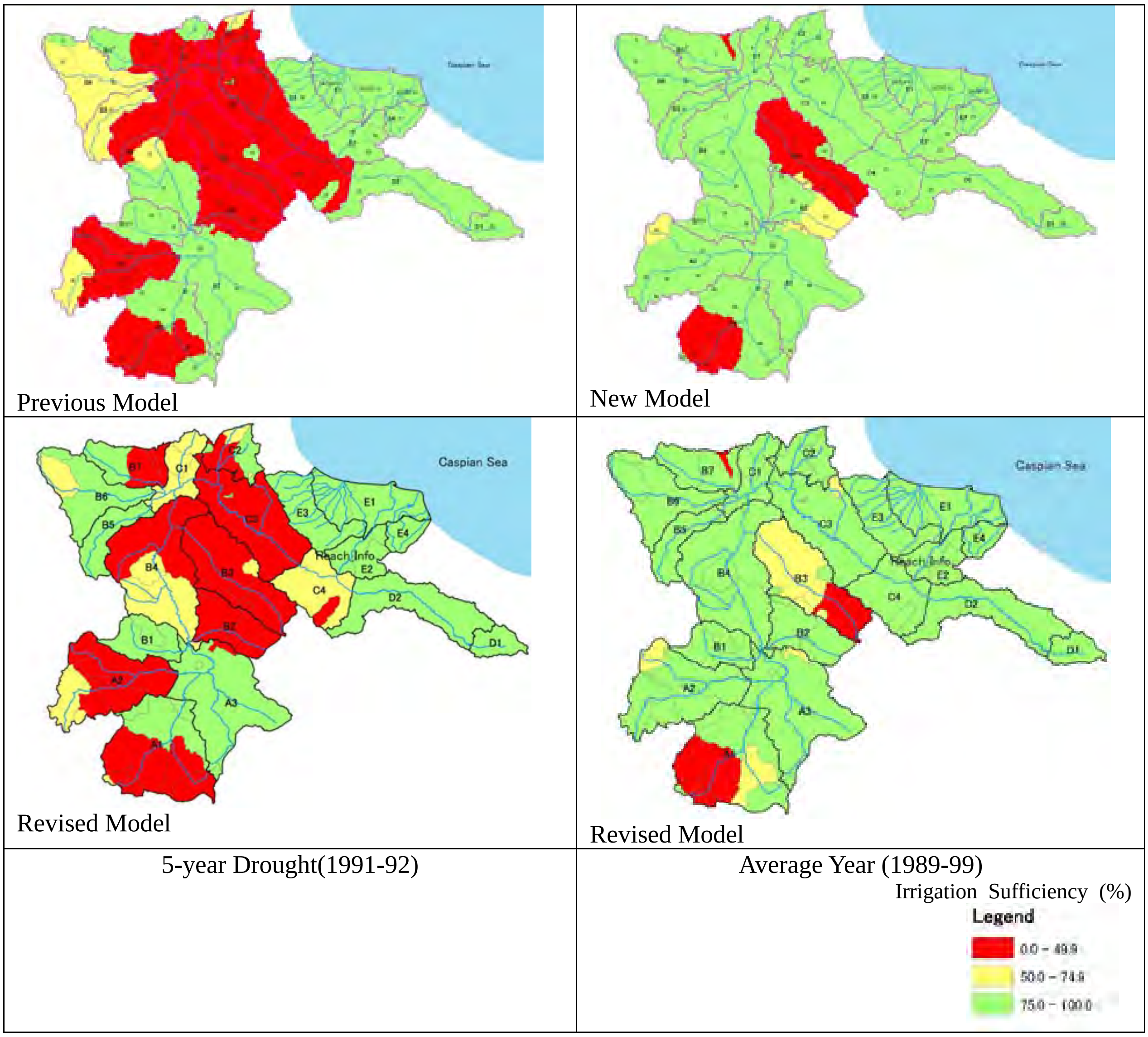


Figure R 10.3.1 Sufficiency Level of Traditional Irrigation Area

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 Figure R 10.3.2. 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 R 10.3.8 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 Gillan surface water)	100%	100%

Figure R 10.3.2 is also illustrated about the result of water demand sufficiency of SIDN by the revised model and the previous model in three cases.

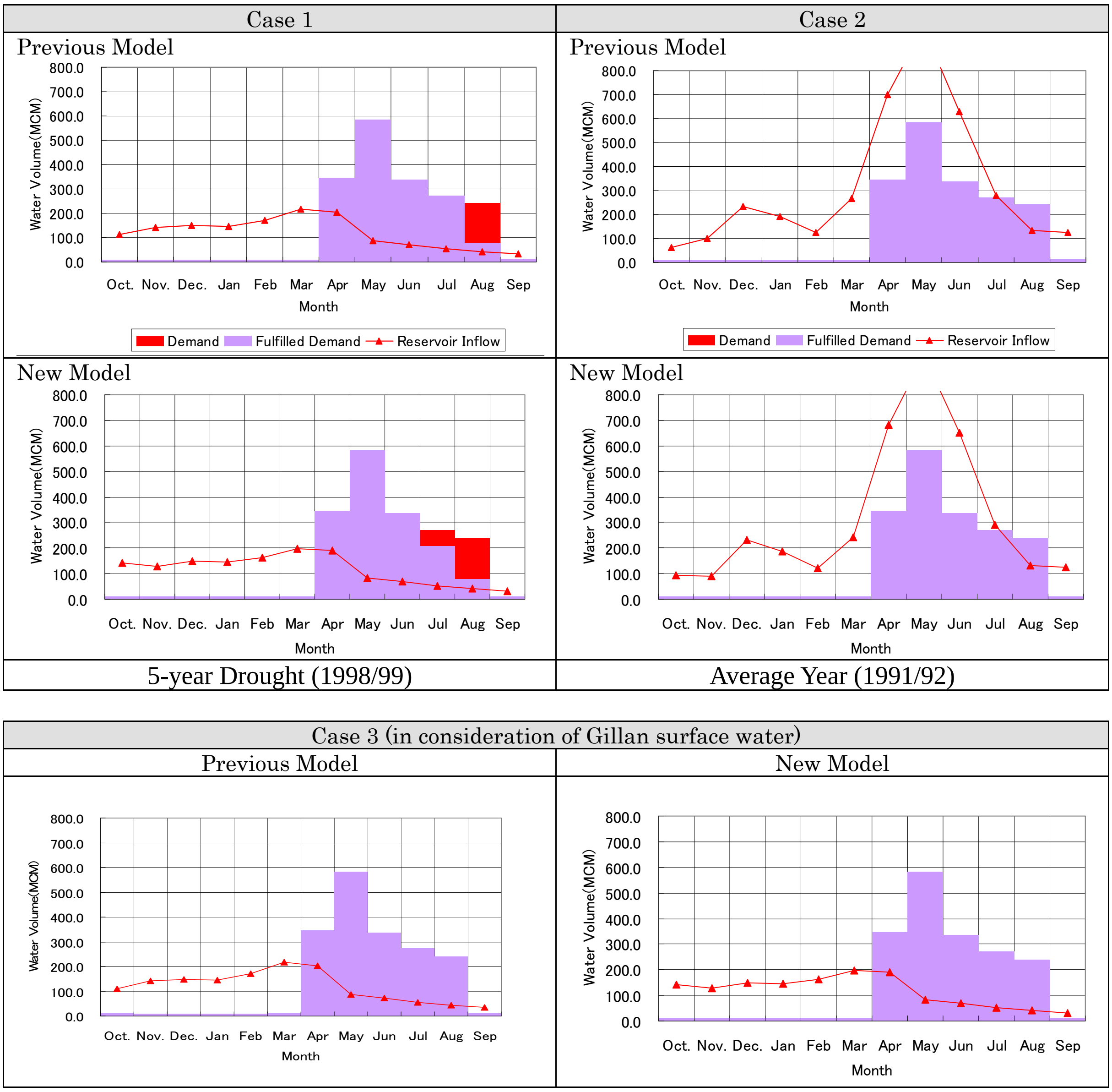


Figure R 10.3.2 Sufficiency Level in SIDN

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 is increased about 2%. 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. Figure R 1.4.1 presents how change the revised demand series in month compared with the old one in a place where such a condition above mentioned occurs. As shown in the figure, 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.

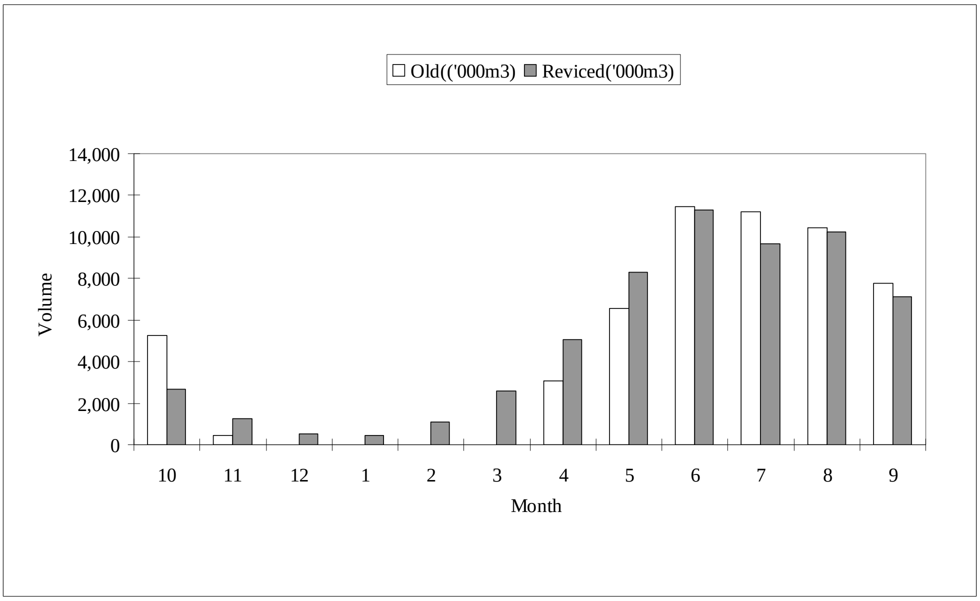


Figure R 10.4.1 Monthly Distribution of Water Demand

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.

Incidentally, there is the way to raise the precision of the satellite image analysis, for example, the increase of the number of shot for the satellite image or the sampling for supervised classification. However, it is recommendable to combine the inventory way and the satellite image analysis because the latter way is very expensive in comparison with the former way. From now on, the issues in case of organizing the agricultural inventory should be made clear and the stakeholders should consensually establish the procedure to confirm the condition of water demand at fixed interval.

CHAPTER 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 'Chapter 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 Chapter 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 Chapter 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', 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 Chapter 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 '3.6 Groundwater in Chapter 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 Chapter 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’.

Annex - Supplemental Study

CHAPTER 1. SUPPLEMENTAL STUDY

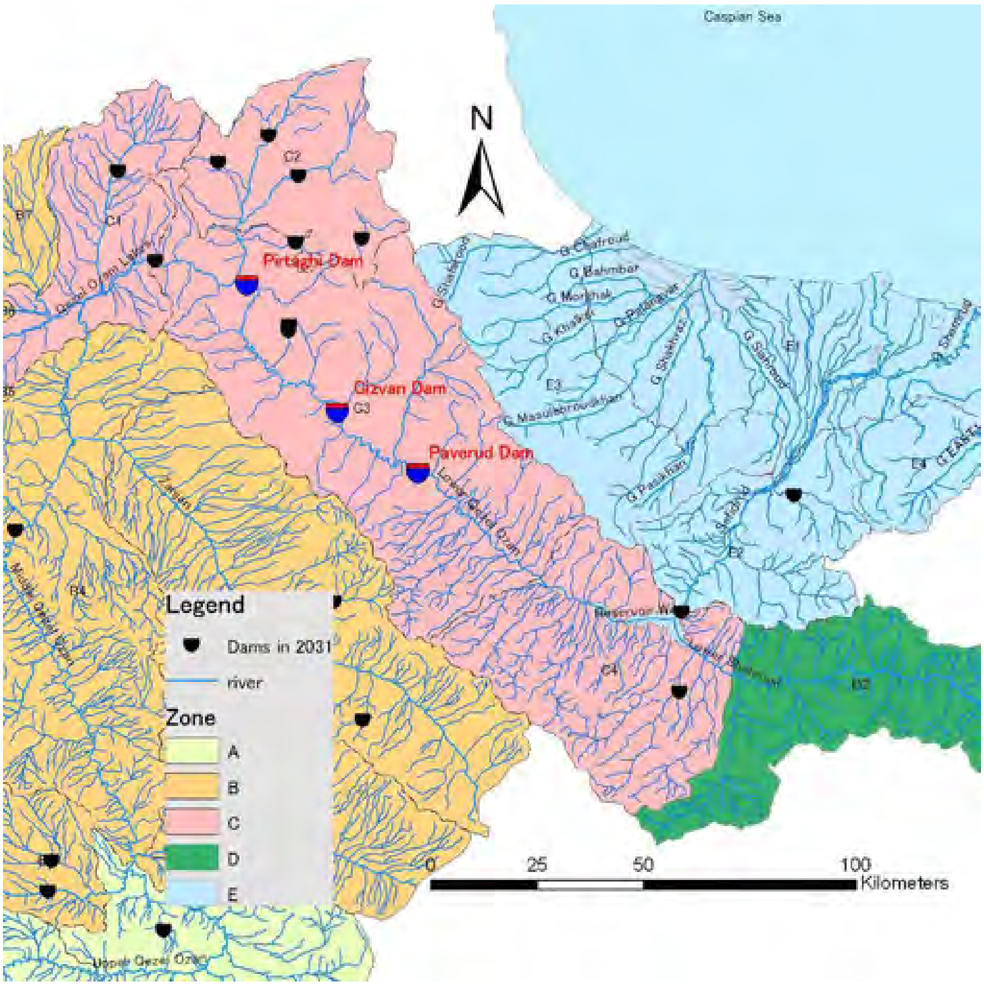
Presently, the effect of three hydroelectric dams, which is planned between Manjil dam and Ostor dam by Water and Power Resources Development Company and Ardebil Interbasin Transfer Project (carrying water outside of the basin from Ostor dam) on Sefidrud River is the issues in terms of water resource management at the stakeholder meeting. These projects are still in the stage of completion of the concepts. The determination of target completion years of construction and detail designs are not yet started so that these projects are not considered in the master plan described in Chapter 9. However, considering that the effects of those two projects are large and the intense request made by the stakeholders, the supplemental study was done under insufficient information. This supplemental study evaluated the effect of those two projects to the water resource management in the Long-Term (2031). This Evaluation was performed revising the water balance simulation made during the Study.

1.1 GENERAL INFORMATION ON PROJECTS

1.1.1 Hydroelectric Dams

1) Location

Paverud dam, Gizvan dam and Pirtaghi dam are presently planned to be located in Qezel Ozan river between Manjil dam and Ostor dam by Water and Power Resources Development Company. The location of those dams is shown in Ann-Figure 1.1.1.



Ann-Figure 1.1.1 Location of Hydroelectric Dams

2) Specification of Dam and Standard Water Levels

The relation between the water level, area of the reservoir and the water volume is shown in Ann-Table 1.1.1. The total storage volume of Gizvan dam and Paverud dam is approximately same with or larger than the one of Manjil dam. Pirtaghi dam also possess the total storage volume comes with the ones of Ostor dam. In Ann-Table 1.1.1, orange-hatched, green-hatched and blue-hatched values show the low water level (the top of inactive storage capacity), the normal water level and the surcharge water level respectively. The normal water level and the surcharge water level for Gizvan dam and Paverud dam is not found out.

Ann-Table 1.1.1 Water Level – Area- Storage Volume Relation

Pirtaghi Dam			Gizvan Dam			Paverud Dam		
Level (MSL)	Area (ha)	Volume (MCM)	Level (MSL)	Area (ha)	Volume (MCM)	Level (MSL)	Area (ha)	Volume (MCM)
856	0.0	0.0	615	0.0	0.0	468	0.0	0.0
860	8.6	0.1	620	16.5	0.3	480	150.0	6.0
880	76.3	7.5	660	369.5	63.2	500	301.7	50.3
890	121.7	19.4	700	1229.1	363.6	520	727.1	150.1
900	167.1	31.2	740	2076.8	1001.6	540	1017.2	323.7
920	301.4	77.4	780	3440.0	2092.0	560	1346.0	559.3
940	498.4	156.6	820	5449.5	3859.6	580	1696.5	862.8
960	873.0	292.0	840	6136.1	5017.5	600	2166.0	1248.1
966	986.2	357.2	871	7196.9	6806.4	600.4	2175.3	1256.9
970	1055.3	397.0	890	7852.6	7912.3	620	2674.0	1731.3
980	1237.5	502.0						

1.1.2 Ardebil Interbasin Transfer

The project of Ardebil Interbasin Transfer is to carry 538 MCM/year to the outside of the Sefidrud river basin, which consists of irrigation water, domestic water and industrial water. This amount is about one third of the average inflow at Ostor dam in Long-Term (2031) and equivalent to the effective storage volume of Ostor dam. The detail information such as the target completion year is not clear in the present situation. According to Ardebil RWC, the amount of transfer water is as shown in Ann-Table 1.1.2.

Ann-Table 1.1.2 Amount of Ardebil Transfer ('000m^3)

Month	Irrigation	Domestic	Industrial	合計
Oct.	20,339	5,247	13,080	38,667
Nov.	26,115	6,736	16,795	49,647
Dec.	26,952	6,952	17,338	51,238
Jan.	27,371	7,060	17,602	52,034
Feb.	27,371	7,060	17,602	52,034
Mar.	26,115	6,736	16,795	49,647
Apr.	27,622	7,125	17,763	52,511
May	24,190	6,240	15,557	45,987
Jun	22,097	5,700	14,211	42,009
July	20,339	5,246	13,080	38,667
Aug.	18,225	4,707	11,734	34,689
Sep.	16,238	4,189	10,443	30,870
合計	283,000	73,000	182,000	538,000

1.2 EXECUTION OF SIMULATION

1.2.1 Conditions

1) Basic Conditions

Since the target completion year is not defined yet, the three hydroelectric dams were modeled in the water balance simulation with MIKE-BASIN as a Long-Term model. This model includes the dams and Almout Transfer whose completion years are set by 2031.

2) Duration of Model Simulation and Natural Flow

Water allocation simulation was executed using natural flow obtained with MIKE SHE model for 20 years from 1985 to 2005 in hydrological year.

3) Water Demand and Irrigation Efficiency

Irrigation efficiency in the traditional irrigation area in each Reach and irrigation area located at the lower stream of Manjil Dam was set as shown in Ann-Table 1.2.1. Irrigation efficiency was used for the calculation of water demand and the intermediate value between present condition and WRMC target values were applied.

Ann-Table 1.2.1 Irrigation Efficiency in the Simulation

Irrigation Efficieny Variations	Irrigation Area at Lower Stream of Manjil dam			Traditional Irrigation Area in Each Reach		
	Present	Middle-Term	Long-Term	Present	Middle-Term	Long-Term
Present	0.42	0.42	0.42	0.33	0.33	0.33
Intermediate	0.42	0.45	***0.51***	0.33	0.37	***0.44***
WRMC Target	0.42	0.48	0.55	0.33	0.40	0.50

4) Initial Condition of Dams

In the model, the initial water level at each dam was set at a certain height with witch the storage volume of a dam can be 70% of its effective storage volume. In case the water level reached at the surcharge water level and above, the amount of discharge was set at the same amount of the inflow. Since the surcharge water levels of Gizvan dam and Paverud dam were not clear, those were set by 5m higher than the normal water level in order to avoid complexity of the modeling. The inactive storage capacity of three dams was estimated by reference of the ratio between the total capacity and the inactive capacity of Manjil dam.

5) Discharge for Electrical Power Generation

Discharge for electrical power generation of new three dams is not clear presently. Hence, it was set at the same discharge of Ostor dam. Discharge for other purposes was not set in the model.

Ann-Table 1.2.2 Discharge for Electrical Power Generation ('1000m^3)

Month	Discharge	Month	Discharge
Oct.	23,872	Apr.	111,314
Nov.	32,841	May	113,966
Dec.	47,226	Jun	83,191
Jan.	59,512	July	41,354
Feb.	70,036	Aug.	26,945
Mar.	94,261	Sep.	26,945
Total			731,463

6) Priority of Intake from Ostor Dam

Ostor dam provides electricity, irrigation water and domestic water in the basin. In the simulation, continuously utilized water until 2031 was prioritized and intake for Ardebil Transfer was set at lower. Simply saying, in the algorithm of the simulation, irrigation water, domestic water and hydroelectric discharge were subtracted from the flow at first, then the residual amount of water flow is applied for Ardebil Transfer.

1.2.2 Simulation Cases

Simulation cases are shown in Ann-Table 1.2.3. Comparing these results, the effect of the hydroelectric dam and Ardebil Transfer was evaluated in terms of water resource management.

Ann-Table 1.2.3 Simulation Cases

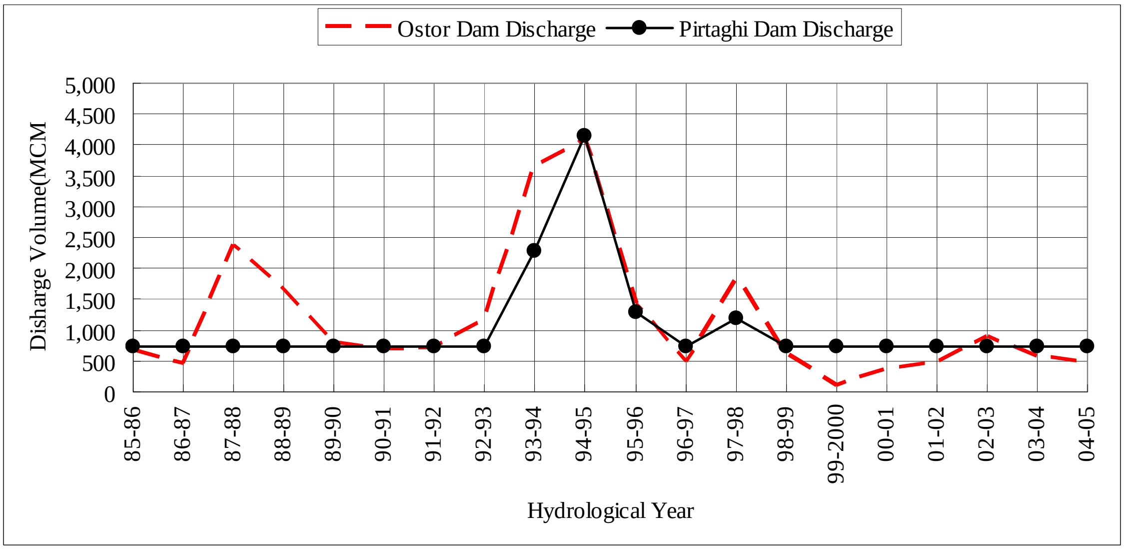
Cases	Conditions
1	Neither Hydroelectric Dam nor Aldebil Transfer
2	Construct Hydroelectric Dams only
3	Construct Both Hydroelectric Dam and Aldebil Transfer

1.2.3 Result of Evaluation

1) Effect of Hydroelectric Dam

a) Effect on Flow

Ann-Figure 1.2.1 shows the relation between the discharge at Ostor dam and the flow at the lower stream point of a group of the hydroelectric dams, or the discharge at Pirtaghi dam. This figure tells that there is a positive effect of the flow recovery at the lower stream with interannual storage of the hydroelectric dams even in the sever drought years from 2000 to 2003. In other words, the discharge for hydroelectric generation contributed to stabilization of maintenance flow. As a conclusion, this result indicates that establishment of a discharge rule of the hydroelectric dams which has a large amount of storage capacity has a high potential of improving maintenance flow.



Ann-Figure 1.2.1 Comparison of Discharge at Ostor Dam and Pirtaghi Dam

Ann-Table 1.2.4 shows the annual inflow and discharge between Ostor dam and Pirtaghi dam. Considering the average of these inflow and discharge, the discharge at Ostor dam was reduced by only 1% in comparison to the outlet flow of the Gizvan dam which has the largest storage capacity among three dams. In addition, no lack of discharge for hydroelectric generation can be seen in any year.

Ann-Table 1.2.4 Annual Inflow and Discharge at Ostor・Pirtaghi・Gizvan・Paverud Dams

No.	Hydraulic Year	Ostor		Pirtaghi		Gizvan		Paverud	
		In	Out	In	Out	In	Out	In	Out
1	85-86	1,024	835	931	905	905	735	740	735
2	86-87	543	787	836	818	818	735	737	735
3	87-88	3,378	2,935	3,027	2,991	2,991	2,630	2,633	2,630
4	88-89	1,907	2,061	2,140	2,119	2,119	2,064	2,066	2,064
5	89-90	1,364	1,149	1,180	1,151	1,152	965	965	965
6	90-91	1,125	1,091	1,123	1,094	1,094	931	931	931
7	91-92	1,396	1,267	1,323	1,296	1,296	1,124	1,125	1,124
8	92-93	1,734	1,734	1,841	1,822	1,822	1,684	1,687	1,684
9	93-94	4,400	4,269	4,484	4,458	4,459	4,238	4,244	4,238
10	94-95	4,625	4,583	4,821	4,800	4,800	4,722	4,729	4,722
11	95-96	1,812	1,895	1,951	1,927	1,927	1,815	1,818	1,815
12	96-97	516	743	767	746	746	737	738	737
13	97-98	2,630	2,110	2,166	2,134	2,134	1,776	1,779	1,776
14	98-99	619	967	1,003	984	984	905	907	905
15	99-2000	131	121	149	610	610	732	732	732
16	00-01	448	435	445	443	443	737	737	737
17	01-02	605	543	571	566	566	735	735	735
18	02-03	1,732	1,229	1,273	772	772	735	736	735
19	03-04	607	886	962	929	930	732	733	732
20	04-05	635	683	739	768	768	737	738	737
Average		1,562	1,516	1,587	1,567	1,567	1,473	1,475	1,473

b) Effect on Water Demand at Lower Stream

The effect in terms of reduction of water demand of SIDN was approximately 3% by the hydroelectric dams. Since these dams don't possess any water demand which consumes water flow, this negative impact can be fully covered by establishing an operation rule of hydroelectric dams. The management rules such as more water flow to Manjil dam before and during an agricultural season will be recommended.

2) Effect of Ardebil Transfer

Assuming the hydroelectric dams would be constructed, the water demand for Ardebil Interbasin Transfer at Ostor dam was taken into account in the water allocation simulation. The effect of the transfer is discussed below.

a) Effect on Stream Regime

Ann-Table 1.2.5 shows the annual inflow and discharge between Ostor dam and Pirtaghi dam. Due to Ardebil Interbasin Transfer, the average of the discharge at Ostor dam and the one at Pirtaghi dam was reduced by approximately 22% and 30% respectively.

Ann-Table 1.2.5 Effect of Ardebil Transfer on Annual Inflow and Discharge at Ostor, Pirtaghi, Gizvan, and Paverud Dams on Flow Regime

No.	Hydraulic Year	Ostor		Pirtaghi		Gizvan		Pirtaghi	
		In	Out	In	Out	In	Out	In	Out
1	85-86	1,024	671	767	735	735	735	740	735
2	86-87	543	449	499	735	735	735	737	735
3	87-88	3,378	2,381	2,474	2,111	2,111	735	737	735
4	88-89	1,907	1,665	1,744	1,722	1,723	735	737	735
5	89-90	1,364	796	828	799	799	735	735	735
6	90-91	1,125	703	735	735	735	735	735	735
7	91-92	1,396	719	775	735	735	735	736	735
8	92-93	1,734	1,167	1,274	1,242	1,242	735	737	735
9	93-94	4,400	3,644	3,859	3,833	3,834	3,406	3,412	2,289
10	94-95	4,625	4,088	4,326	4,305	4,305	4,194	4,201	4,155
11	95-96	1,812	1,437	1,493	1,469	1,470	1,342	1,345	1,295
12	96-97	516	488	512	737	737	737	738	737
13	97-98	2,630	1,840	1,895	1,628	1,628	1,297	1,301	1,191
14	98-99	619	611	647	757	757	735	737	735
15	99-2000	131	100	127	461	461	732	732	732
16	00-01	448	386	396	394	394	737	737	737
17	01-02	605	474	503	498	498	735	735	735
18	02-03	1,732	892	936	732	732	735	736	735
19	03-04	607	568	644	732	732	732	733	732
20	04-05	635	468	524	607	607	737	738	737
Average w/ Transfer		1,562	1,177	1,248	1,248	1,248	1,100	1,102	1,034
Average w/o Transfer		1,587	1,516	1,587	1,567	1,567	1,473	1,475	1,473

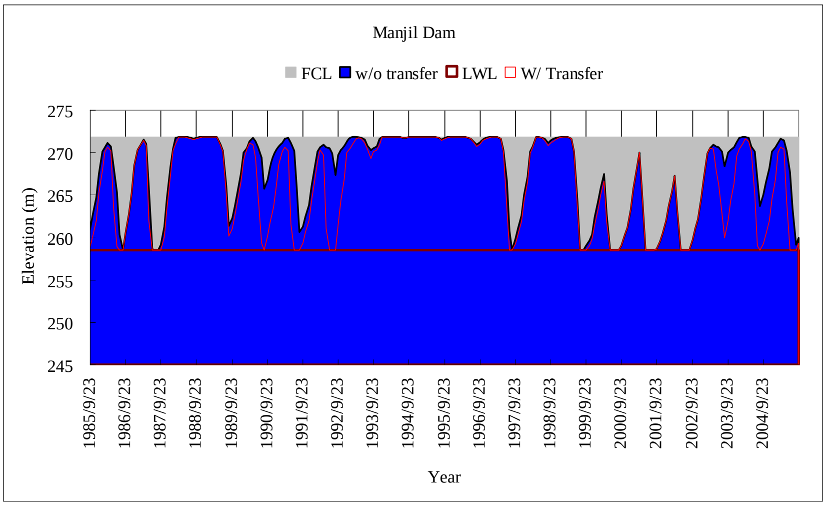
w/: with w/o: without

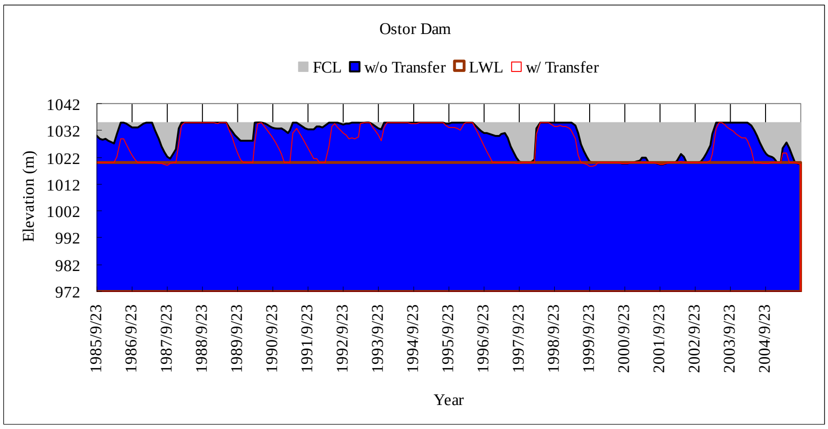
b) Effect on Ostor Dam and Manjil Dam

As shown in Ann-Table 1.2.6, after the completion of Ardebil Interbasin Transfer, the frequency of emptying Ostor dam and Manjil dam are 15 years (times) in 20 years. This means the frequency becomes 2.5 times and 1.7 times as large as the one before completion in Ostor dam and Manjil dam, respectively. In the actual dam management, it is hardly possible to predict the inflow in the following year. Hence, this result is undesirable.

Ann-Table 1.2.6 Frequency of Emptying Dams

Condition	Ostor Dam	Manjil Dam
Without Transfer	6 years (6 times)	7 years (7 times)
With Transfer	15 years (15 times)	15 years (15 times)

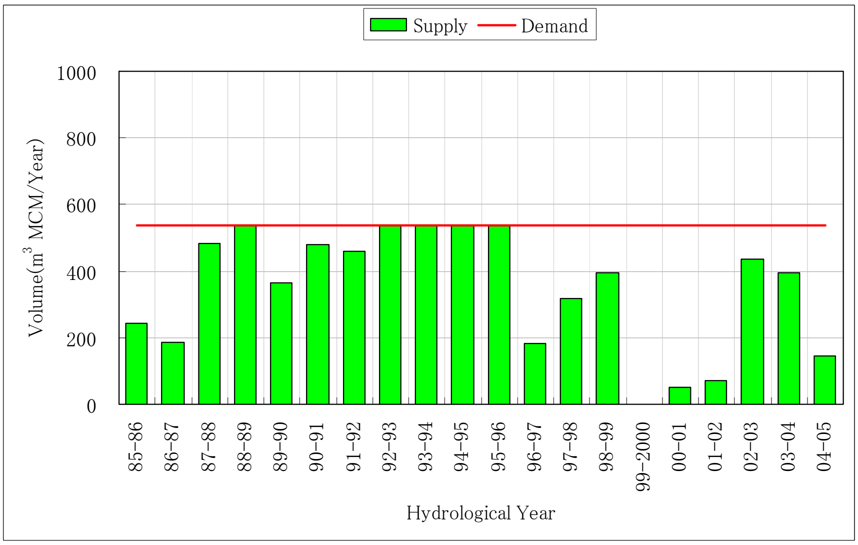




Ann-Figure 1.2.2 Interannual Change of Water Level at Manjil Dam and Ostor Dam

c) Sufficiency of Ardebil Transfer

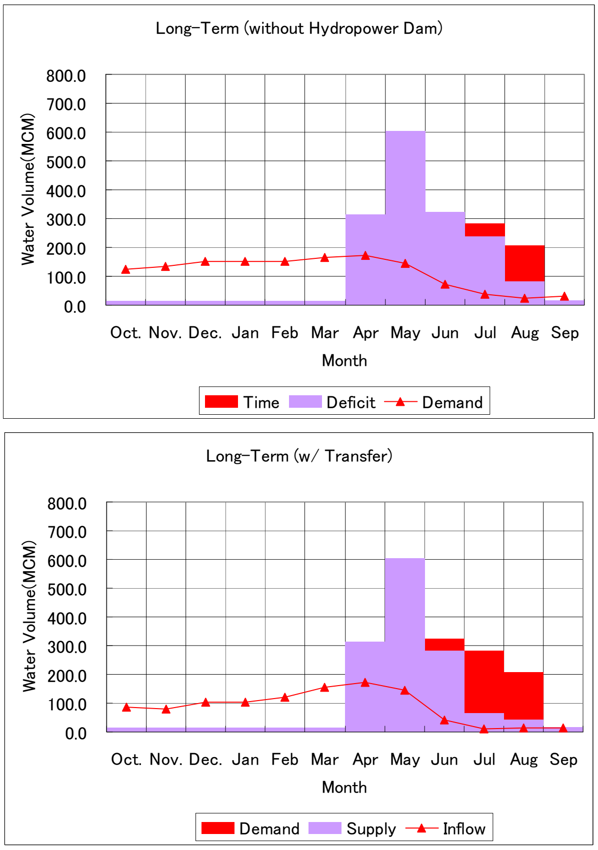
The sufficiency of Ardebil Interbasin Transfer is at 64.2% and it is not considered as high. In 20 years, the year when the transfer can carry 100% of design discharge is only 4 years. It is required for the stakeholders to discuss and study how to solve this problem, and then find an adequate water demand allocation.



Ann-Figure 1.2.3 Water Supply and Demand Set at Ardebil Transfer

d) Sufficiency at lower Stream

The sufficiency of water demands in Long-Term at the lower stream of Manjil dam in the drought year is reduced from 90.5% to 75.7% by Ardebil Transfer. Comparing to the case without any improvement in the traditional irrigation area, in which the sufficient was 80.3%, it is clear that Ardebil Transfer is carrying water more than the improvement can save.



Ann-Figure 1.2.4 Monthly Sufficient at Lower Stream of Manjil Dam

1.3 CONCLUSION

Conclusion of the simulation above is summarized in Ann-Table 1.3.1. The hydroelectric dams can provide positive effect to beneficiaries with appropriate discharge control at the dams. However, since Ardebil Interbasin Transfer Project carries away water outside the basin, the negative effect to the beneficiaries is considerably large. Regarding this issue, WRMC should discuss with the stakeholders and set the adequate timing and amount of water discharge.

Ann-Table 1.3.1 Evaluation of Projects

Evaluation Item	Hydroelectric Dam Project	Ardebil Interbasin Transfer Project
Change of Flow	No significant change in the lower stream Group of dams can cover the change during the draught years.	Discharge to the lower stream is reduced to approximately 1/3.
Effect on Surrounding Dams	As long as the hydroelectric dams release the same amount of discharge at Ostor dam, the effect is negligible.	The possibilities of emptying Ostor dan and Manjil dam become about twice as large as the case without the project.
Sufficiency in Project	No restriction on releasing hydroelectric discharge as much as the one at Ostor dam. Discussion with water user in the lower stream will be required for additional discharge.	In average, approximately 64% of the design discharge can be transferred.
Effect on the Lower Stream	It is possible to have flexible action for the water demand in the lower stream with integrated management of lower dams.	Reducing the sufficiency in the lower stream by approximately 15% More than saved water with improvement of traditional irrigation area in Long-Term (2031) are carried away.

1.4 SENSITIVITY ANALYSIS FOR ARDEBIL INTERBASIN TRANSFER

To execute further examination for the effect on water use of the Sefidrud River basin by the Ardebil Transfer Project, sensitivity analysis by using the simulation model was carried out in case of 5 water demand to be transferred outside the basin. The result of this sensitivity study would be used to designe amount of water transfer for the project and is summerised as follows:

a) Condition of Water Demand

The water allocation simulation was carried out for 5 cases of total water demand per year, namely, 100, 200, 300, 400, 538MCM. The other conditions are the same as explaied in Subsection 1.2.1.

b) Effect on Ostor Dam and Manjil Dam

As shown in Ann-Table 1.4.1, after the completion of Ardebil Interbasin Transfer, the frequency of emptying Ostor dam and Manjil dam are 15 years (times) and 12 times in 20 years. This means the frequency becomes 2.5 times and 1.7 times as large as the one before completion in Ostor dam and Manjil dam, respectively. In the actual dam management, it is hardly possible to predict the inflow in the following year. Hence, this result is undesirable.

Ann-Table 1.4.1 Frequency of Emptying Dams

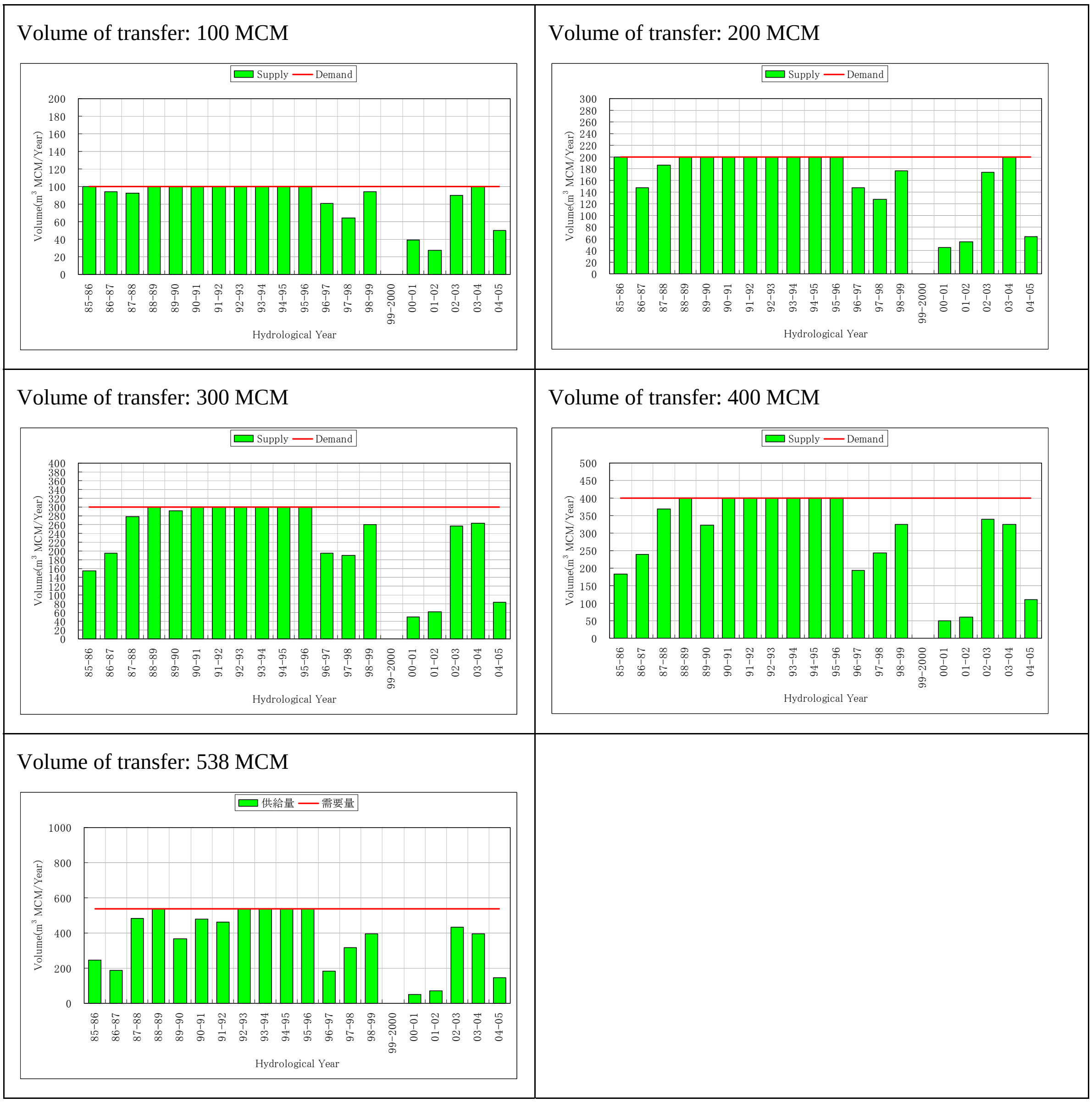
Condition	Yearly Transfer Volume (Demand) (MCM)	Ostor Dam	Manjil Dam
Without Transfer	0	6 years (6 times)	7 years (7 times)
With Transfer	100	8 years (8 times)	13 years (13 times)
	200	10 years	13 years
	300	13 years	13 years
	400	13 years	15 years
	538	15 years	15 years

c) Sufficiency of Ardebil Water Transfer

Based on the simulation result, annual average sufficiency rate and frequency of 100 % sufficiency during 20 years for water supply to the project is summarised in Ann-Table 1.4.2. The monthly water supply and water demand for Ardebil Transfer Project is illustlated in Ann-Figure 1.4.1.

Ann-Table 1.4.2 Sufficiency for Water Supply

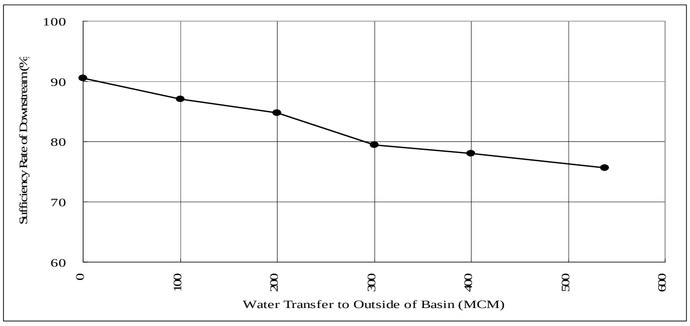
Condition	Yearly Transfer Volume (Demand) (MCM)	Annual Avegrage Sufficiency for Water Supply	Frequency of 100 % Sufficiency during 20 year
With Transfer	100	81.7 %	14
	200	78.0 %	11
	300	73.0 %	9
	400	69.4 %	8
	538	64.2 %	5



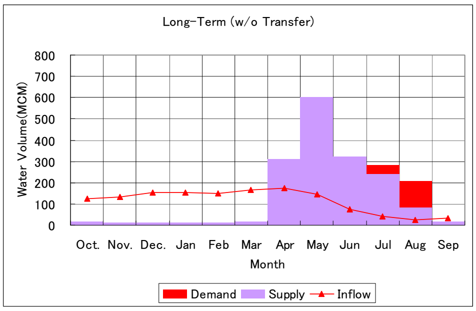
Ann-Figure 1.4.1 Monthly Water Supply and Demand et at Ardebil Transfer

d) Influence on Water Supply to Lower Stream

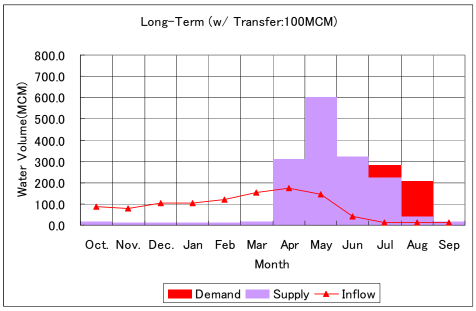
The alternation of annual average water demand sufficiency of lower area from Manjil Dam is shown in Ann-Figure 1.4.2. According to the table, the sufficiency rate is decreased by 3% to 5 % whenever the transfer volume is increased by 100MCM. The Ann-Figure 1.4.3 shows monthly sufficient and deficit water volume for 6 cases (namely, no transfer, 100, 200, 300, 400 and 538 MCM).



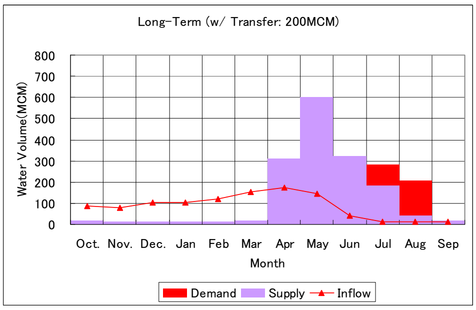
Ann-Figure 1.4.2 Sufficiency at Lower Basin corresponding to Water Transfer Volume



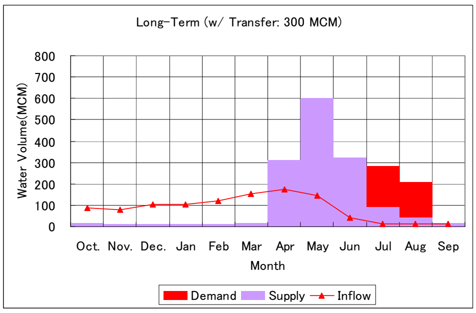
Water Supply Sufficient Rate: 90.5 % (Without Project)



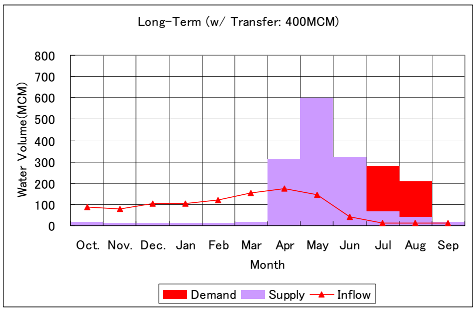
Water Supply Sufficient Rate: 87.1 % (100 MCM Transfer)



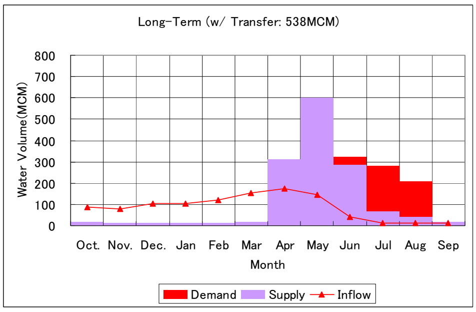
Water Supply Sufficient Rate: 84.8 % (200 MCM Transfer)



Water Supply Sufficient Rate: 79.5 % (300 MCM Transfer)



Water Supply Sufficient Rate: 78.0 % (400 MCM Transfer)



Water Supply Sufficient Rate: 75.7 % (538 MCM Transfer)

Ann-Figure 1.4.3 Monthly Sufficient at Lower Stream of Manjil Dam

Initial Environmental Examination for the Study on Integrated Water Resources Management for Sefidrud River Basin

1. TITLE OF THE PROJECT AND RELEVANT REPORT

Title of the project: The Study on Integrated Water Resources Management for Sefiedrud River Basin in the Islamic Republic of Iran

Relevant Reportt: The Study on Integrated Water Resources Management for Sefiedrud River Basin in the Islamic Republic of Iran / Draft Final Report

2. TYPE OF THE STUDY

Master Plan

3. ENVIRONMENTAL CATEGORY AND REASON FOR CATEGORIZATION

Category B

Reason

This project is to study socioeconomy, topology, meteoroly, environment etc. and formulate masterplan for integrated water resources management for Sefidrud River basen based on the results of water balance simulation. In this study, management of dam operation and water storage efficiency are also evaluated and optimized.

Effects on social environment and natural environment have been studied for future enforcement planning after implementation of the master plan. Expected programs in this enforcement planning are 1) Improvement of Irrigation Channel; 2) Construction of Intake Channel; and 3) Management of Dam Operation. Main environmental aspects of this study are conflict on water rights, misdistribution of benefits, hydrological change, effects on aquatic ecosysytems, and pollution caused by construction. Conflicts and misdistribution of benefits are serious problem now under the limitation of available water resources, and future impact under enforcement planning is expected to be smaller and not large as Category A. Hydrological change and effects on aquatic ecosystems can be improved by the good implementation of the projects. Pollution caused by construction is expected to be limited and temporal because of small-scaled construction. Therefore, environmental category of this project is B because some impact is expected but not large as category A.

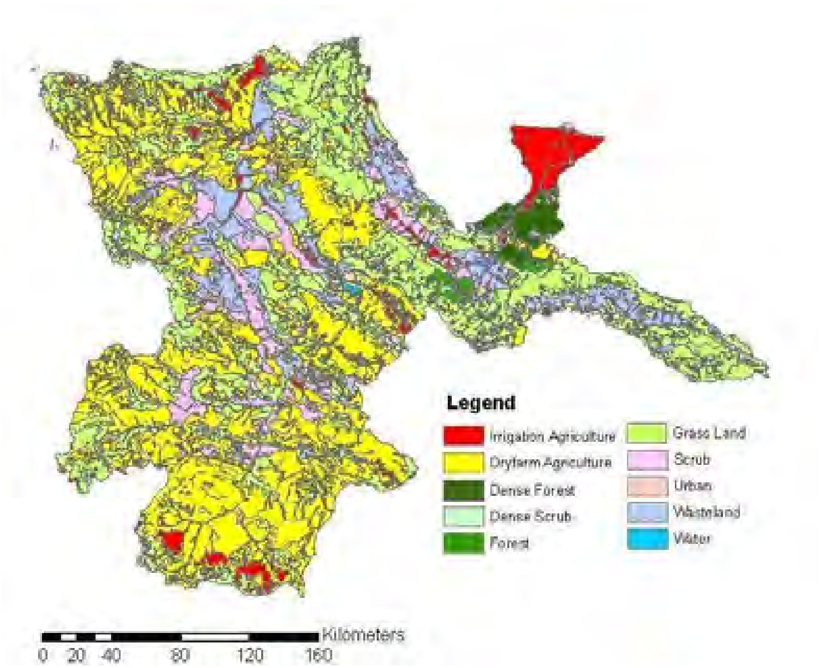
4. AGENCY RESPONSIBLE FOR IMPLEMENTATION OF THE PROJECT

Water Resources Management Company: WRMC

5. OUTLINE OF THE PROJECT

The Sefidrud River, one of the largest rivers in Iran, is located in the northwest part of the country and its basin runs through 8 provinces with the total area of 59,090 km^2 and a population of about 4.7 million. The annual average precipitation in the areas between the Caspian Sea and Albultz range (the north part of the Sefidrud River Basin) is estimated to be more than 1,000 mm while it is from 200 mm to 400 mm in its south. Area marked read in Fig. 2 is big rice-producing region, and water demand for irrigation is very high.

Ann-Figure 1 Location of the Study Area



Ann-Figure 2 Land Use Map

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

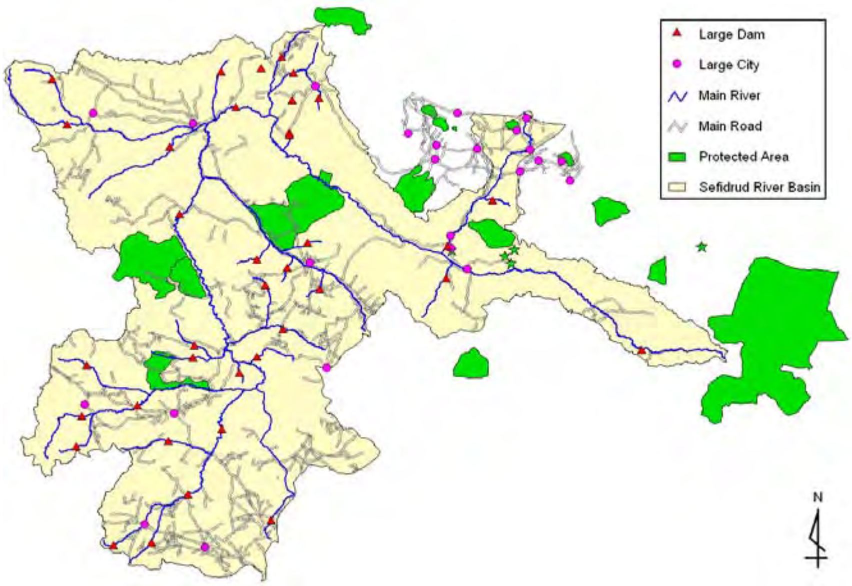
From the viewpoint of contribution of the economic activities, “mining and quarrying” makes up 21 % to GDP as of 2005. The second and the third highest ones are “manufacturing”, and “transport, storage and communications” with 15 % and 12% respectively. The economic activity of “agriculture” shares only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

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

Ann-Figure 3 Ethnic and Religious Groups and their Geographcal Distribution

Some protected areas are located within the Sefidrud River basin. Some protected animals listed below are reported to live in protected areas. Categories in IUCN red list are shown as “EN” for endangered species and “VU” for vulnerable species. There are no large dams within the protected areas.

- Red-breasted goose (EN)
- Saker falcon (EN)
- Meadow viper (EN)
- Lesser white-fronted goose (VU)
- Wild goat (VU)
- Houbara bustard (VU)
- Lesser kestrel (VU)
- Goitered gazelle (VU)
- Spur-thighed toutoise (VU)



Ann-Figure 4 Location of Protected Areas and Large Dams

6. LEGAL FRAMEWORK OF ENVIRONMENTAL AND SOCIAL

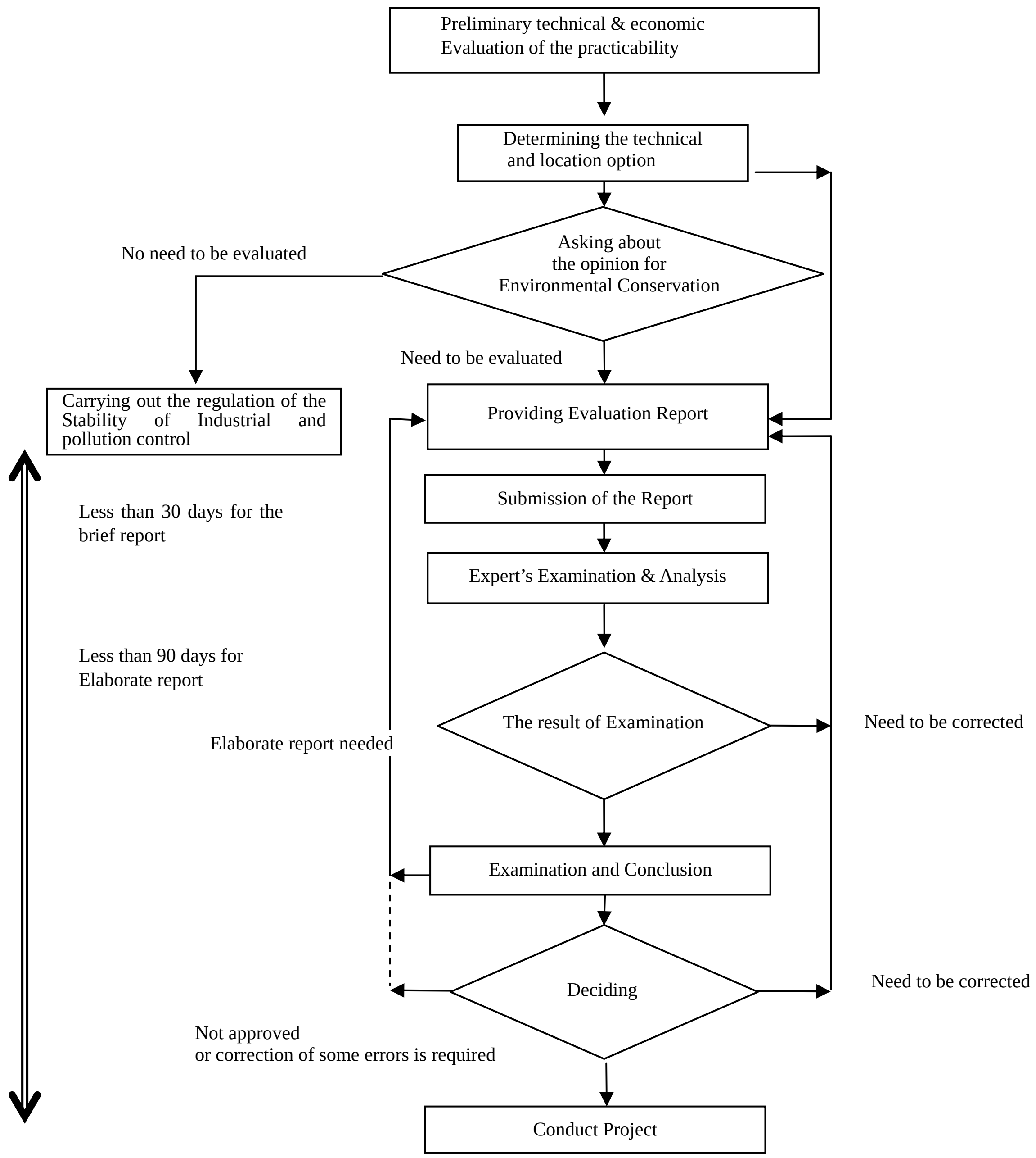
CONSIDERATIONS

(1) Environmental Laws and Institution Frameworks

The Department of Environment (DOE) is the competent authority for approving EIA reports as defined in Note 2 of Decree 138 under the authority of Environmental High Council (EHC). The DOE processes the EIA reports and gives its recommendations to the government directorate responsible for a project. According to the EHC (1997), guidelines proponents of the following national projects and programs are obliged to prepare and submit environmental evaluation and feasibility studies as well as an EIA.

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

The EIA procedure from the implementation manual of the DOE is shown in the following chart



Ann-Figure 5 Flowchart of EIA in Iran

This study is to formulate integrated river basin management system by evaluating efficiency of existing or planned dam and its operation method. This study will not induce construction of new dam. According to EHC (1997) of the Islamic Republic of Iran listed above, this study does not fall into the item to evaluate EIA.

Therefore, this IEE study has been carried out based on JICA guide line.

(2) Related Organization

According to Decree138（12/04/1994）, agency to approve EIA is Department of Environment, EIA division. When governmental body conducts a project, EIA report shall be submitted to Environment Agency. When province conducts a project, EIA report shall be submitted to Department of

Environment in each province.

7. BRIEF SUMMARY OF MASTER PLAN

In due consideration of the emerging issues surrounding the IWRM of the Sefidrud River basin, the master plan shall be formulated following the basic concepts below.

Goals of the IWRM of the Sefidrud

To attain the socio-economic development in the nation as well as in the basin and to contribute enhancement of people's welfare through reasonable and equitable water resource development and management.

To achieve the above goals, the following three pillars are setup as main supportive actions. The various active measures derived from these could mutually boost up to realize the goals.

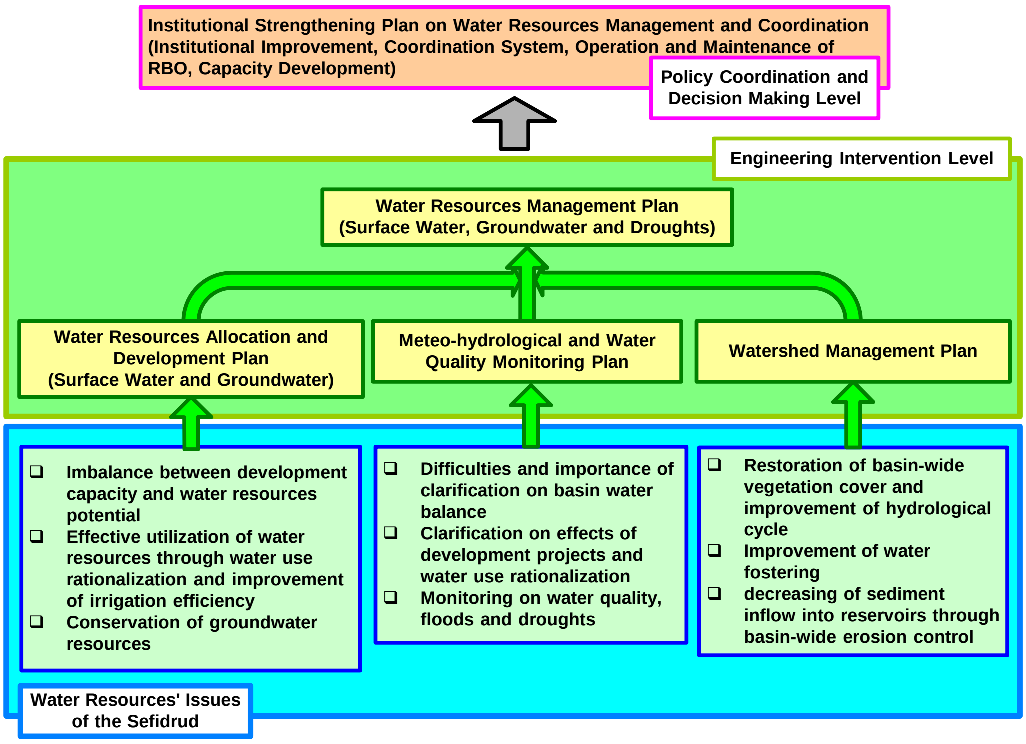
Three Pillars of the IWRM of the Sefidrud

(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.

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



Ann-Figure 6 Structure of IWRM Components of the Sefidrud

8. STAKEHOLDER MEETING

8.1 Workshop for Conflict Analysis

Conflict analysis workshop has been held in each province in Phase 1 study. Applicants list are shown in Ann-Table 1.

Ann-Table 1 Breakdown of Participants of Conflict Workshop

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

Main opinion in these workshops is, “to distribute water resources efficiently and fairly considering effect on natural environment and ecosystem”, which were discussed in all provinces. Problem discussed in these workshops are categorized in various aspects like water shortage, degradation in water quality, conflict toward water rights among upstream and downstream, lacking in management system, and another social problems.

The main tops in the workshops are;

1. Water shortage of drinking water and irrigation water;
2. Water quality degradation in the rivers and groundwater;
3. Drawdown of groundwater level, and;
4. Lacking in management system and regulation for water resources management.

Water shortage is the main problem especially at the upstream area, and water quality degradation by upstream water usage is the main problem at the downstream. Conflict among upstream and downstream is clearly shown. In addition, irrigation water shortage, abandonment of farming and migration to the city, urbanization of city to cause water shortage and pollution are discussed, too. In environmental aspect, water quality degradation was discussed, mainly caused by industrial wastewater, domestic wastewater, irrigation, and saline water.

Ann-Table 2 Opinions in Conflict Workshop

Opinions	E.Azar.	Ardebil	Kordstan	Zanjan	Gilan	Qazvin	Tehran
Severe Shortage of Water Resources							
Shortage of irrigation water and low productivity	○	○		○	○	○	
Shortage of drinking water	○	○		○		○	○
Shortage of industrial water				○		○	
Escalation of draught by population growth and decreasing precipitation		○		○	○	○	○
Drawdown of groundwater by excess water intake		○	○	○		○	
Water Pollution and Environmental Problem							
Pollution of groundwater, pollution of drinking water by spring water			○	○	○	○	○
Pollution of river water by industrial wastewater	○	○	○	○	○	○	○
Salt damage, high salinity in river water			○	○	○		
Malfunction of environmental impact assessment	○	○	○	○		○	
Soil erosion, sedimentation in dam reservoir	○	○	○	○			○
Conflicts on Water Rights							
Water interception by other province	○	○		○	○	○	
Inefficient water usage; complain from upstream to downstream and vise versa	○	○	○	○	○	○	
Water pollution by upstream; complain from downstream		○			○		○
Problems in Governing Structure							
Miscommunication between political organization, provinces	○	○	○				○
Lacking in laws, regulations and control system	○	○	○	○	○	○	○
Lacking in education and enlightening program	○			○			
Public opinions are not reflected to the governmental policy	○		○	○	○	○	○
Lacking in funds	○		○	○			○
Lacking in reliable information	○		○	○	○		
Social Problems							
Abandon of farming and immigration to the city	○	○	○	○	○	○	
Culture of ethnic minority are not protected			○				
Low income of farmer, poverty			○	○	○		

Conflicts in the opinion are shown in Ann-Table 3. Downstream residents are oppose to the interception of water by upstream residents as a result of water resources management. On the other hand, upstream residents are suffering from serious water shortage.

Ann-Table 3 Conflicts in Opinion Among Upstream and Downstream

Conflict	Opinion of Upstream Residents	Opinion of Downstream Residents
Water Rights	Residents near water source have water right	We have water right, over 40 years water usage.
Economic Efficiency	Soil condition of upstream is good with development potential. Water usage in downstream area is ineffective	We produce national strategic crop, or rice, and Gilan is suitable place for rice.
Fairness and Social Justice	To reduce income gap by development of farming and industry in upstream area is fair.	Farmer income has already been fallen, and it will cause social disorder if income decreases more.
Reliability of Information	No reliability of data prepared by downstream government or organization.	No reliability of data prepared by upstream government or organization.

8.2 Stakeholder Meeting for IEE

Stakeholder meeting has been held on July 12, 2008 in order to report IEE and discuss about it. Stakeholder to invite was discussed with WRMC and decided as RWC. RWC is regional organizations of WRMC, working at central city in each province. Scope of work of RWC is water resource development for surface water and ground water, maintenance of water usage facility, planning of water resource distribution, approval of water rights, approval of wellbore, development and maintenance of river. RWC also coordinate conflicts between upstream and downstream to improve regional and national benefit. RWC is the direct stakeholder of water resources management and delegates of residents. Attendant list of stakeholder meeting is shown in Ann-Table 4.

Ann-Table 4 Attendant List of Stake Holder Meeting

Full Name	Affiliation
Ms. Sadighe Rasouli	Gilan RWC
Ms. Merila Mafakheri	Kordestan RWC
Mr. Ali Heidari	Iran Water Power Company
Mr. Mohammad Taghi Talebpour	Zanjan RWC
Mr. Ali Mozaffarian	Tehran RWC
Mr. Kazem Aziz Moghaddam	Ardebil RWC
Mr. Jafar Fahimi	Zanjan RWC
Mr. Ahmad Rajaee	Ministry of Environment
Mr. Vahid Karami	Mahab Ghodss
Mr. Amirhossein Pakdaman	Mahab Ghodss
Mr. Abdolali Ghobadi	Mahab Ghodss
Mr. Majid Sayyari	WRMC
Mr. Mojtaba Jalilzade	East Azarbaijan RWC
Mr. Yadollah Maleki	Qazvin RWC

Stakeholder meeting was held on WRMC building in Tehran City. Summary of Phase 1 study and IEE are reported, and explained about further study. In this stakeholder meeting, following opinions are stated;

1. Natural environment should be considered as stakeholder;
2. Water quality should be considered for mainstream and tributaries and;
3. Query on simulation: whether outlet of wastewater are considered in simulation.

In addition, opinions of stakeholders were submitted on September 2008. In this report, study on salinity and evaluation of environment are requested by several people. In our study in January to March, 2009, effects of saline water were evaluated, too.

9. SCOPING FOR ENVIRONMENTAL AND SOCIAL IMPACT STUDY

Environmental impacts have been evaluated for the condition when master plan is developed to enforcement plan. This master plan is to develop hydrological modeling considering existing dam and future plan, and to formulate framework of water resources management plan with the simulation result. This master plan will not invite new dam construction. Future enforcement plan may include following three projects listed in Ann-Table 5, which is 1) Improvement of Irrigation Channel; 2) Construction of Intake Channel, and; 3) Management of Dam Operation.

In addition to listed below, capacity building of operation manager are considered but not included into scoping item because it will not invite construction. Also, introduction of cash crop are considered but not included into scoping item because environmental impact is very small. Further constructions of water gates are excluded because there are many existing plan and further development are not valid.

Ann-Table 5 Expected Project in Enforcement Plan

Expected Project	Notes
(1) Improvement of Irrigation Channel	Development of unlined irrigation channel to concrete lined channel, introduction of drip irrigation and its facility. Note: these were already planned by Iranian Government.
(2) Construction of Intake Channel	Construction of irrigation channel to convert irrigation water from ground water to river water. Small channel are assumed.
(3) Management of Dam Operation	Improvement of water resources management by appropriate dam operation. As a result, some area may reduce their vested water right, and conflicts are expected.

Base line of evaluation is set as the condition that all existing dam plan are assumed to be constructed. And, on the condition of baseline, environmental impacts are assessed for implementation of expected project in Ann-Table 5. Results of scoping are shown in Ann-Table 6. Supplemental notes for aquatic ecosystem are shown below.

● Effect on the protected area and protected animals

This study will not cause impact on protected area because the master plan does not include construction within the protected area. And, protected animals are also considered not to be affected because these are migratory birds along with Caspian Sea and inland animals on the hills, which will not be affected by hydraulic change of river water. When river water drastically decreases, it might be affected. The hydraulic circulation, however, will be properly managed by the results of this hydraulic simulation.

● Effect on aquatic ecosystem

Normally on the construction of river facility, interruption of fish migration is the main problem. In this study area, due to the Manjil dam and weirs near the river mouth, migration of fish has already been interrupted. Moreover, our master plan (1) and (2) will not interrupt migration of fishes. As a effect of this study, interruption of local migration of fish might be a problem. Fishes living in the rivers, however, are family of carps, which are not the protected animals.

Sturgeon in Caspian sea, or protected animals, migrates the river for breeding. Since migration is difficult due to the existing river facility, there is a spawning station for sturgeon at the river mouth. This protection activity is highly evaluated, and Iran is only country which is allowed to catch sturgeon under protection.

Ann-Table 6 Scoping of Expected Project

	Item	(1) Irrigation Channel	(2) Intake Channel	(3) Dam Operation	Reasons
● **Social Environment**					
1	Involuntary Resettlement	D	C	D	Item (2) might invite small-scale resettlement because of construction. (1) and (3) might not cause resettlement because of improvement of existing facility and capacity building.
2	Local Economy such as Employment and Livelihood, etc	C	B	B	Item (2) and (3) might change water resource distribution and local economy. (1) might not cause impact because improvement of existing channel might not reduce water resources, rather increase.
3	Land Use and Utilization of Local Resources	D	C	D	(2) construction might affect land use. (1) and (3) might not affect land use because of improvement of existing facility and capacity building.
4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	D	D	C	Item (3) might affect existing social institution and their scope of work. (1) and (2) might not affect social institution.
5	Existing Social Infrastructures and Services	D	D	D	All of them might not interrupt access to social service because (1) and (2) are small-sized construction, and (3) does not invite construction.
6	The Poor, Indigenous and Ethnic people	D	D	D	Although nomads are living in Iran, their life might not be interrupted because (1) and (2) are small-sized construction, and (3) is capacity building.
7	Misdistribution of Benefit and Damage	C	C	B	(1)(2)(3) might reduce regional gap of water resources, but still remain because of large gap in water potential.
8	Cultural heritage	D	C	D	Although (1)(2)(3) are not large improvement plan, construction plan of item (2) must pay attention to cultural heritage.
9	Local Conflicts of Interest	C	C	B	Item (1)(2)(3) might cause regional conflict by distribution of water resources in the region with large gap of water potential.
10	Water Usage or Water Rights and Communal Rights	C	C	B	Item (1)(2)(3) might cause regional conflict by distribution of water resources in the region with large gap of water potential.
11	Sanitation	D	D	D	Sanitation might not be worsened because of (1)(2)(3) small construction and flux of migrant workers are small.
12	Hazards (risk) Infectious Diseases such as HIV/AIDS	D	D	D	(1)(2)(3) Because of small flux of migrant workers, risk of infectious disease might not be the problem.
● **Natural Environment**					
13	Topography and Geographical Features	D	D	D	Item (1)(2)(3) might not invite large-sized construction to change topography.
14	Soil Erosion	D	D	C	If item (3) increase flow of river water partially, it might cause soil erosion. (1) and (2) might not increase flow of river water and no risk of soil erosion.
15	Groundwater	D	D	D	Item (1)(2)(3) are intended to protect groundwater, and they might not erode ground water.
16	Hydrological Situation	C	B	B	Although (1)(2)(3) will improve distribution of water, river flow might decrease at some location.
17	Coastal zone	D	D	D	Most of the plan are located at the upstream of Mansil dam, which might not cause effect of Caspian Sea.
18	Flora, Fauna and Biodiversity	C	C	C	(1)(2)(3) River flow at some location might decrease, to cause some impact on aquatic ecosystem.
19	Meteorology	D	D	D	Item (1)(2)(3) are not building large impoundment vessel, and not affect meteorology.
20	Landscape	D	D	D	Item (1)(2)(3) are not large-sized construction to change landscape.
21	Global Warming	D	D	D	(1)(2)(3) No effect on global worming because of small construction works.

● **Pollution**					
22	Air Pollution	C	C	D	Item (1)(2) might affect air by construction machinery. Item (3) might not affect air because of no construction works.
23	Water Pollution	C	C	D	(1)(2) Construction works might cause water pollution with sandy water. (3) Dam operation might not cause water pollution.
24	Soil Contamination	C	B	C	(2) By changing irrigation water from ground water to river water, salt might be accumulated on the farmland. Maintenance of farmland is recommended. Although effect of (1) and (3) might small, it is recommended to take care.
25	Waste	C	C	D	(1)(2) Solid waste by construction must be treated carefully. Item (3) might not cause waste because of no construction.
26	Noise and Vibration	C	C	D	Item (1)(2) might cause noise by construction machinery. Item (3) might not cause noise because of no construction.
27	Ground Subsidence	D	D	D	Item (1)(2)(3) are intended to protect ground water and might not invite drawdown of groundwater.
28	Offensive Odor	D	D	D	(1)(2)(3) No offensive odor by channel construction or improvement.
29	Bottom Sediment	D	D	D	(1)(2)(3) No sedimentation to cause.
30	Accidents	C	C	D	(1)(2) Accident must be prevented in the construction works.
Overall rating		B			

Rating;
A: Serious impact is expected, *B: Some impact is expected,*
C: Extent of impact is unknown, *D or blank: No impact is expected. IEE/EIA is not necessary.*

10. MEASURE TO MITIGATE ENVIRONMENTAL IMPACT

When expected projects are implemented, some environmental impacts are expected as described above. In order to mitigate impact, environmental protection plan should be examined beforehand and necessary action should be taken in timely manner.

(1) Improvement of Irrigation Channel

By development of unlined irrigation channel to concrete lined channel, it is expected to cause following impact;

- Conflict on water rights and misdistribution of benefit in terms of social environment;
- Impact on hydraulic circulation and aquatic ecosystem in terms of natural environment, and;
- Impact on air pollution, water pollution and waste by construction works.

In order to mitigate impact, following action shall be taken.

1） Social Environment

・To discuss with local residents before construction, in order to minimize unfairness between upstream and downstream

・To compensate damage of the residents when available water resources decreases

2） Natural Environment

・To manage balance of water resources among upstream and downstream in order to avoid over extraction of water

・To study environmental impact where river water decreases and confirm the impact is small or manageable. When huge impact is expected, construction should be stopped and re-examined.

3） Pollution

・To select good construction machinery to minimize impact on air pollution and noise.

・To manage waste, water quality and accident caused by construction and minimize them.

・To educate management system to avoid damage on farm land from salt water.

(2) Construction of Intake Channel

By construction of intake channel to change irrigation water source from ground water to surface water, it is expected to cause following impact;

- Impact on resettlement, conflict on water rights, effect on local economy and cultural heritage in terms of social environment;
- Impact on hydraulic circulation and aquatic ecosystem in terms of natural environment, and;
- Impact on air pollution, water pollution and waste by construction works and salt damage on farmland.

In order to mitigate impact, following action shall be taken.

1） Social Environment

・To select location carefully to avoid resettlement.

・To discuss with local residents in order to minimize unfairness among upstream and downstream.

・To compensate damage of the residents when available water resources decrease.

・To select location carefully to avoid destruction of important cultural heritage.

・

2） Natural Environment

・To manage balance of water resources among upstream and downstream in order to avoid over extraction of water

・To study environmental impact where river water decreases and confirm the impact is small or manageable. When huge impact is expected, construction should be stopped and re-examined.

3）Pollution

・To select good construction machinery to minimize impact on air pollution and noise.

・To manage waste, water quality and accident caused by construction and minimize them.

・To educate management system to avoid damage on farm land from salt water.

(3) Management of Dam Operation

By management of dam operation, it is expected to cause following impact;

- Conflict on water rights, misdistribution of benefit, effect on local economy in terms of social environment;
- Soil erosion where water flow increase, impact on hydraulic circulation and aquatic ecosystem in terms of natural environment, and;
- Salt damage on farmland.

In order to mitigate impact, following action shall be taken.

1）Social Environment

・To discuss policy of operation with local residents in order to minimize unfairness among upstream and downstream.

・To compensate damage of the residents when available water resources decrease.

・To clearly define the role of dam organization, communication flow, in order to maintain good relation with related organization.

2）Natural Environment

・To study environmental impact where river water decreases and confirm the impact is small or manageable. When huge impact is expected, dam operation manual should be re-examined.

3）Pollution

・To educate management system to avoid damage on farm land from salt water.

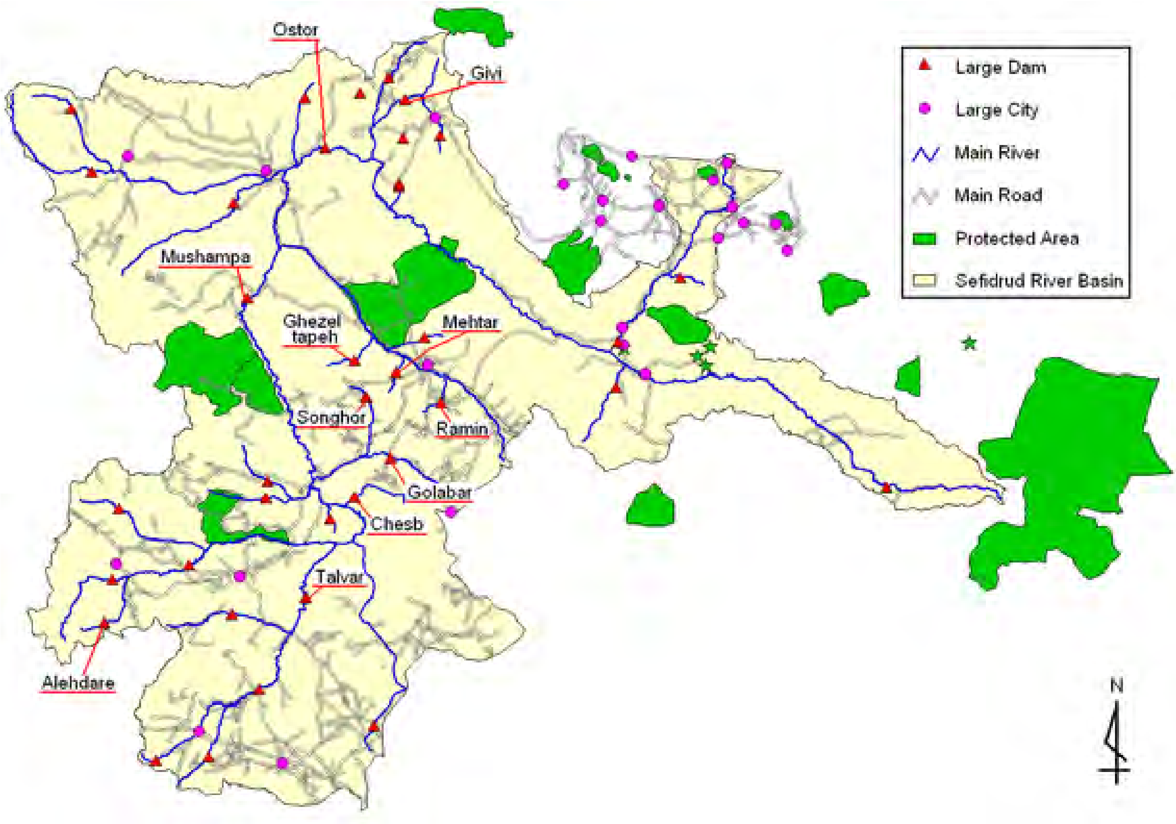
11. RELATED INOFRMATION

As a part of dam operation study, existing EIA report on dams are collected and re-evaluated. This study is also aimed at collection of information of natural and social environment, which is considered for evaluation of scoping. Studies on existing EIA study are summarized below.

In Ann-Table 7, overview of 11 dams, with existing EIA study, are shown. The locations of 11 dams are shown in Ann-Figure 7 together with protected area. Environmental impacts under the construction phase are summarized in Ann-Table 8, and environmental impacts under operation phase are summarized in Ann-Table 9. Degree of effect is shown by the number, where plus shows positive impact and the minus shows negative impact. Reasons of the evaluation are described in right column. Comments on existing EIA report are shown below.

Ann-Table 7 Details of Dams

Dam	Province	Purpose	Phase	Catchment area (km^2)	Height (m)	Capacity (MCM)	Resettlement (ppl)
Golabar	Zanjan	Irrigation	Phase 3	1,131	82.0	116.0	736
Ostor	E.Azarbaijan	Multi	Phase 3	42,600	135.0	700.0	17,000
Talvar	Zanjan	Irrigation	Phase 3	6,441	85.0	500.0	578
Givi	Ardebil	Irrigation	Phase 3	600	79.0	53.1	50
Mushampa	Zanjan	Multi	Phase 3	24,860	124.0	700.0	-
Ramin	Zanjan	Drinking	Phase 2	67	63.0	9.8	1,083
Alehdare	Kordestan	Irrigation	Phase 1	96	44.5	19.7	-
Mehtar	Zanjan	Irrigation	Phase 1	128	40.0	14.0	350
Songhor	Zanjan	Irrigation	Phase 1	102	42.0	10.4	-
Chesb	Zanjan	Irrigation	Phase 1	135	45.5	9.9	-
Ghezel Tapeh	Zanjan	Irrigation	Phase 1	75	57.0	6.0	-



Ann-Figure 7 Location of Dams

Ann-Table 8 Environmental Impact in Construction Phase

	Dam	Talvar	Golabar	Ramin	Givi	Ostor	Mushampa	Alehdare	Mehtar	Ghezel Tapeh	Songhor & Chesb	Main Causality
Social Environment	Involuntary resettlement		-3		+3		-2	-2			-	Involuntary resettlement, immigration of construction staff[1]
	Local economy		+3	+3		+1	+3	+3	+1	+2	+	Increase in income by new job
	Poor people & ethnic minority					+2				+1	+	Increase in income by new job
	Regional conflicts						-1	-3				
	Water rights									-2		
	Public hygiene		0			+2	-1		-1	-2		Water pollution by construction, purchasing hygienic facility by increased income[2]
	Land use			-1	-1		-2	-1	+1	-2		Change in land use by construction
	Land value							-3	+1	+1		Change in land value by road construction
	Social acceptance			-1						+1		Agree with compensation
Natural Environment	Animal & plant				-3	-1	-3	-2	-2	0		Cut & fill construction will decrease habitat of wild life.
	Protected animal				-1		-1	-3		0		Decrease in habitat of protected animals, small impact due to no protected animal
	Downstream flora & fauna				-1	-2	0	0	-2	0		Migration of fish will be obstacled[3]
	Aquatics &benthoses				-1	-2		-3		-2	-	Heavy machinary will compact river bed to affect benthoses
	Micro-climate		0				0		-1		0	
Pollution	Hydrology			-2	-1		-2	-2	-2	-1		Decrease in flow rate
	Water pollution		-1	-1	0	-3	-3	-2	-1	-2	+	Water pollution by soil excavation and effluent of construction staff
	Air pollution		-1	-1		-1	-3	-1	-1	-2	-	Air pollution by heavy machinary
	Noise		-2	-2		-1	-2	-1	-4	-1	-	Noise by heavy machinary
	Solidwaste	-1				+1	-3	-1		-2		Solid waste by construction staff

Note: (-) Negative impact, (+) Positive impact, (Number) Degree of impact, (blank) No Evaluation

[1] Temporal immigration of construction staff is different from involuntary resettlement due to submerging land. Even though total population increase, effect on involuntary resettlement should be evaluated to minimize their impact.

[2] Linkage between cause and effect is not clear. Worsen in hygien by acute population growth in rural area is not argued.

[3] Migration of fish is possible in construction phase because upstream flow will be diverted by tunnel or half closure construction. Migration will be much difficult in operation phase.

Ann-Table 9 Environmental Impact in Operation Phase

Dam		Talvar	Golabar	Ramin	Givi	Ostor	Mushampa	Alehdare	Mehtar	Ghezel Tapeh	Songhor & Chesb	Main Causality
Social Environment	Involuntary resettlement	-5		-3	-3	-5	+3	+3	-1	+3	-	Involuntary resettlement by submerging land, settlement of worker, population growth by improvement of irrigation[4]
	Local economy	+2		+3	+3	+5	+3	+3	+4	+3	+	Increase in income by new job[5]
	Poor people & ethnic minority	+3								+2	+	Increase in job opportunigy, stable income by new job[6]
	Regional conflicts						+2					
	Water rights	+2							-1	+2		Effective control of water resources by tax system, reduction in flow rate
	Public hygiene	+2		+2		+3	-1		+2	+1	-	purchasing hygienic facility by increased income[7]
	Land use				-1		-2		+2	+2	-	Change in land use by construction
	Land value			＋2			+3	+1	+4	+3	+	Change in land value by dam and road construction
	Social acceptance	+2								+3	-	Level of living will increase by compensation [8], local people will agree with project which increase irrigation water
Natural Environment	Biological diversity	+3			+3	+1	-3	+3	-1	-1	+	Good habitat by stabilization of flow rate by dam[9], few impact because of no protected animals
	Protected animal				-1		-2	+3		0	+	Migratory birds will come to dam lake
	Downstream flora & fauna	+3			+1		+2	+4			+	Good habitat by stabilization of flow rate by dam[10]
	Aquatics &benthoses		+1		+2		-2	+2	-2	+1	+	Good haitat by stabilization of flow rate by dam, goode habitat in dam lake, effect by decreasing flow rate
	Micro-climate	+1	+2		+2		+3	+2	+1	+3	+	Wetness will increase by dam lake which will affect micro-climate[11]
Pollution	Hydrology	+3			+1	+4	+3	-1	+1	+3		Flood prevention
	Water pollution	+2		+1		+1	-2	-3	-1	+1	+	Improvement of water quality by catchment of suspended materials by dam lake[12], eutrophication
	Air pollution			0		0	+1	-1	+1	+1	+	Purification of air by increased vegitation[13]
	Noise			0			-2	-1		-1		Noise by dam facility
	Solidwaste			0		0	-2	-1	+1	-1		Solid waste of staff

Note: (-) Negative impact, (+) Positive impact, (Number) Degree of impact, (blank) No Evaluation

4 Impact on involuntary resettlement should be evaluated, not the population growth or decrease
5 Thousands of construction staff will decrease to tens of staff in operation phase. Since many worker will lose their jobs, local economy will not improve. Activation of economy by improvement of agriculture is practical.
6 Same as above. Most of the construction worker will lose their job. If ethnic minority are hired for construction, there is a risk that they won't be back to previous work and life.
7 Linkage between cause and effect is not clear.
8 It depends on the content of compensation, but the details of compensation is not clear.
9 In this study area where water shortage is serious problem, flow rate in downstream river may rather decrease.
10 Same as above. Flow rate may rather decrease which will worsen the acquatic ecosystem.
11 Huge dam lake may affect climate. Dam lake in this study area is not so large as to change climate. Even though amount of evaporation increase, they may not be precipitated within study area.。
12 Settlement of soil in the dam lake should be minimized to maintain capacity. Eutrophication and cold water discharge etc. are not mentioned.
13 No reason to increase vegetation. If intentionally forested for soil erosion, vegetation will increase.

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
Deputy of Planning and Economies Affairs
Water Resources Management Company
Ministry of Energy
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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;

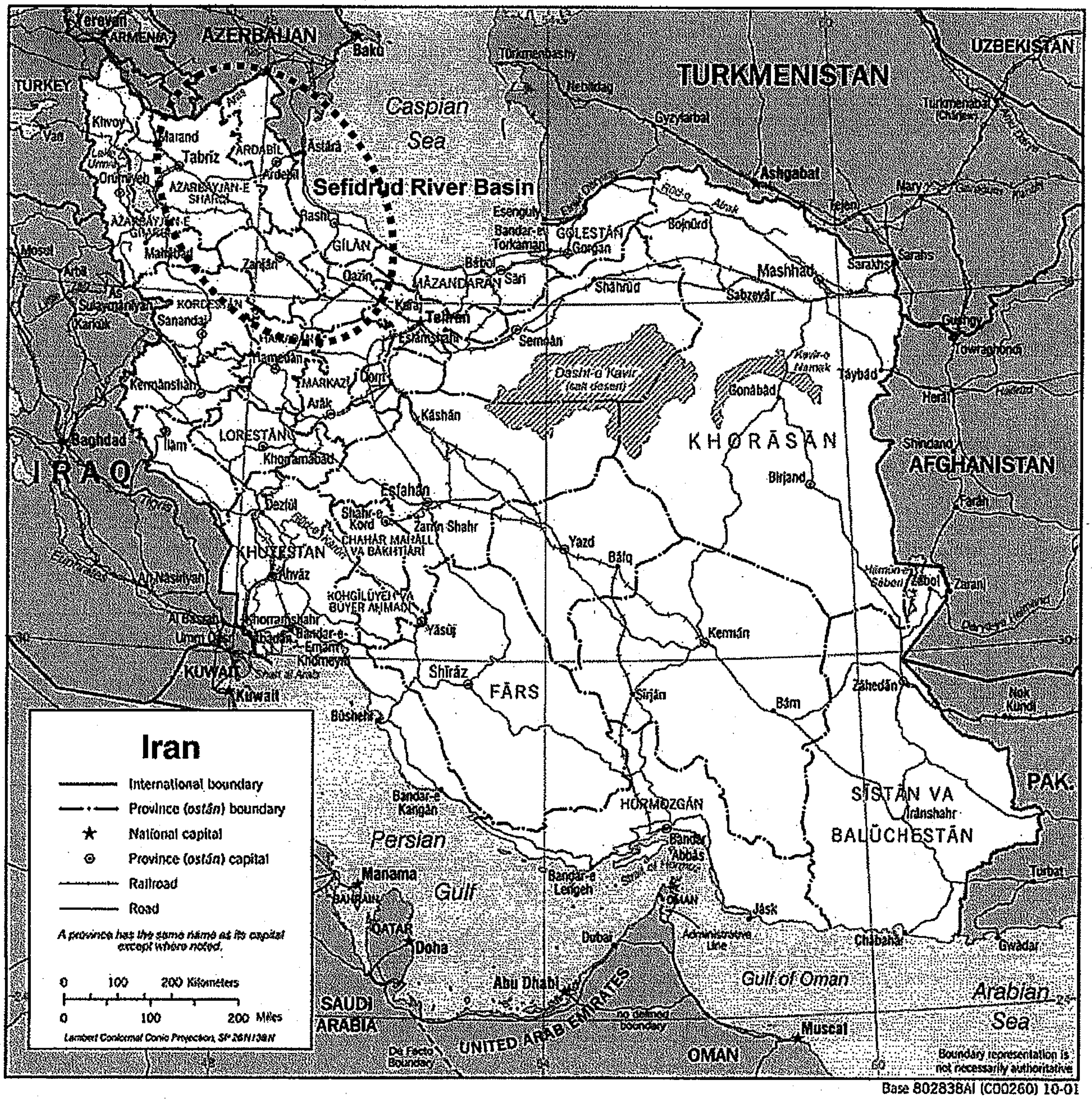
(5) Suitable office space with necessary equipment; and

(6) Credentials or identification cards.

VIII. CONSULTATION

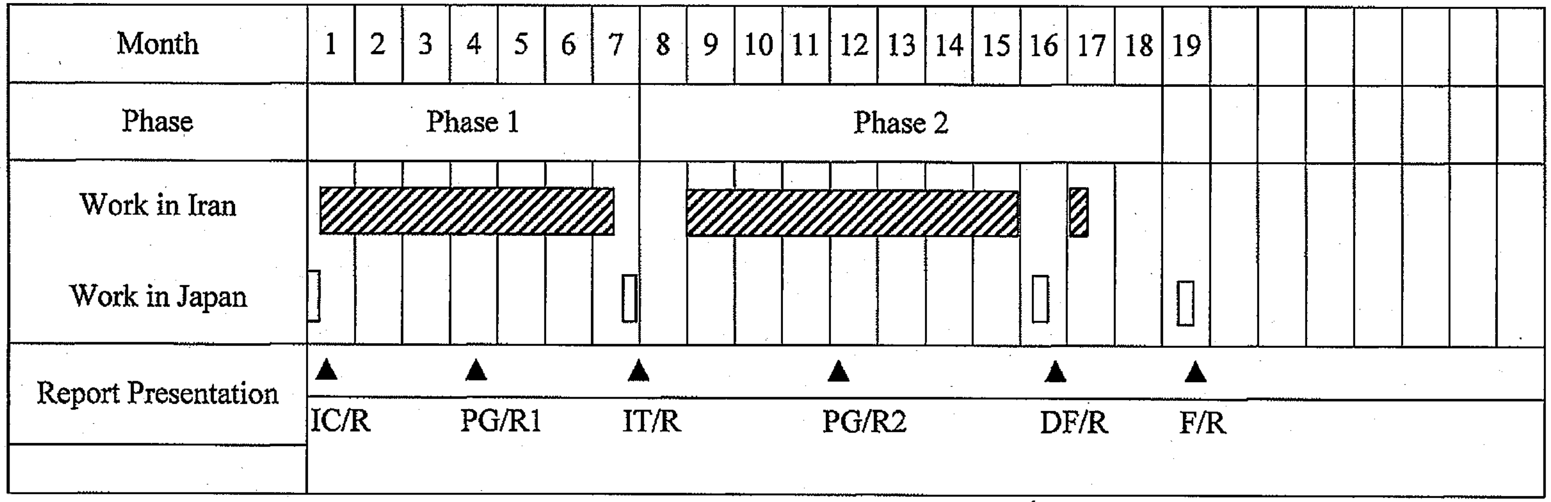
JICA and the Ministry of Energy shall consult with each other in respect of any matter that may arise from or in connection with the Study.

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

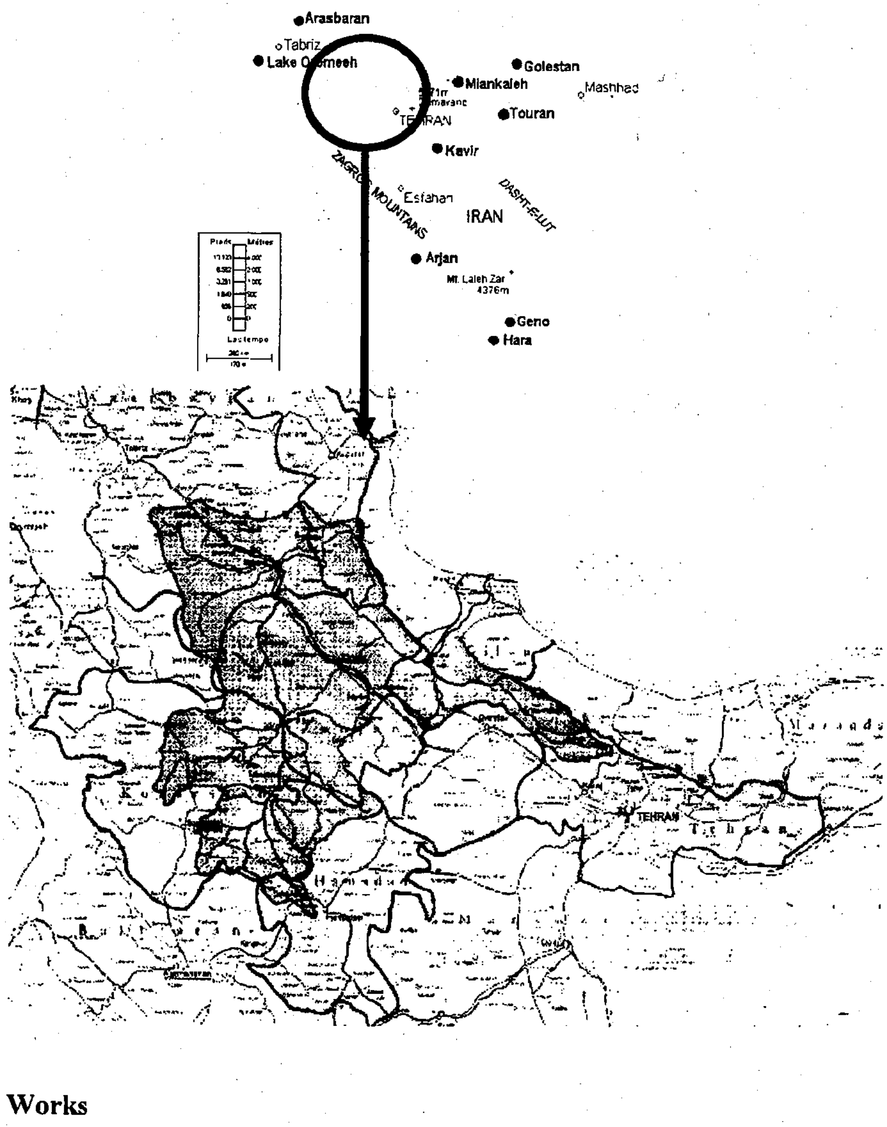
The IEE will be conducted for generic master plan. The study process is shown below.

- 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 invcstigate 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

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

<u>ATTACHMENT 2</u>

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

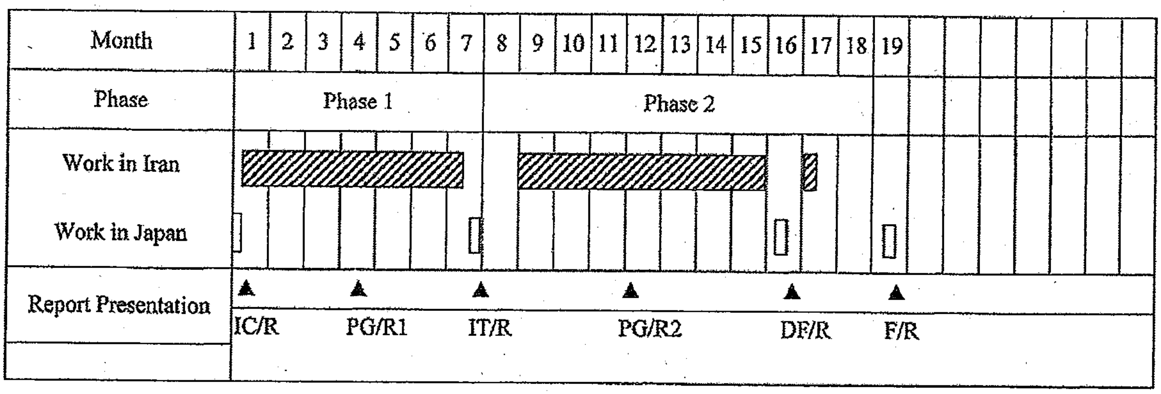
Tehran, April 15, 2009

芦野 誠	M. Sayyari
Makoto ASHINO	**Majid SAYYARI**
Resident Representative	**Director General**
JICA Iran Office	**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

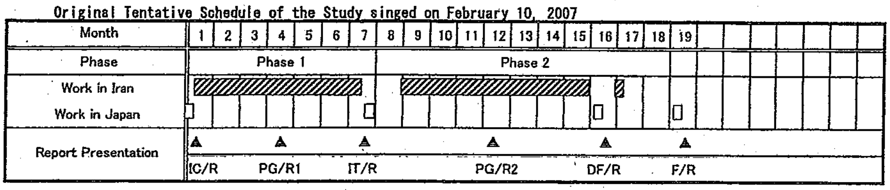
(6) Submission of final report: September to October 2010

The original schedule and updated schedules are attached next page.

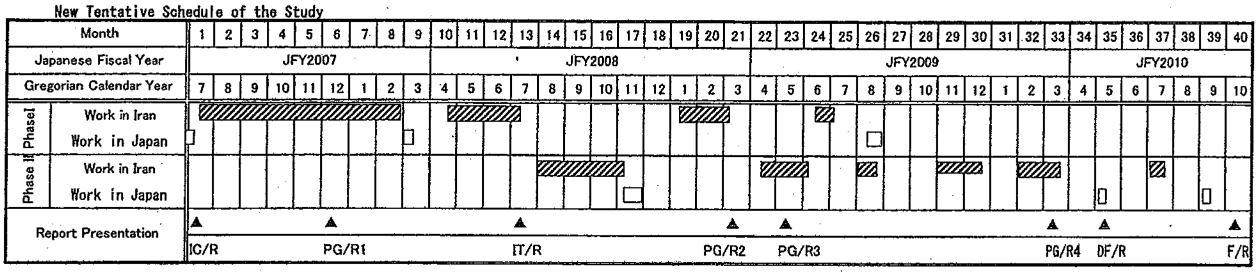
5. Effectiveness of S/W

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



New Tentative Schedule of the Study



MINUTES OF MEETINGS

on

the Stakeholder Meetings

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, May 31, 2009

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

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

Toshihiro Goto

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

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

M. Sayyari

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.

M. Sugiyama

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

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

M. Sayyari

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

Kenji

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.

Appendix

Tables

Tab.3.7.1 Drinking Water Quality Standard (ISIRI)

1.General

	Parameter	Maximum Permissible Level	Desirable
1	Turbidity	5NTU (Nephelometric Turbidity Unit)	1=>
2	Color	20 T.C.U (True Color Unit)	1=>
3	Odor	2 at 12 and 3 at 25 degree Celsius	0
4	pH	6.5-9	7-8.5
5	Taste	Acceptable to public, no objection of public	-
6	Oil	Not visible	-

2.Toxic/Heavy Matals

	Parameter	Maximum Permissible mg/l
1	As	0.05
2	Pb	0.05
3	Cr	0.05
4	Se	0.01
5	Cd	0.005
6	Sb	0.005
7	Hg	0.001
8	Mo	0.07
9	CN	0.07
10	V	0.1

3. Organic Materials

	Parameter	Maximum Permissible microgram/l		Parameter	Maximum Permissible microgram/l
1	Aldrin-dialdrin	0.03	20	THM'S: Chloroform	200
2	Chlordane	0.2		THM'S: Bromoform	100
3	2-4 Dichlorophonexy acetic acid	30		THM'S: Bromodichloromethane	60
4	DDT (Dichloro Diphenyl Trichloro ethan)	2		THM'S: Dibromochloromethane	100
5	1,2-dichloroethane	30	21	Isoproturon	9
6	1,2-dichiloroethene	50	22	2methyl 4 chloro phenoxy Acetic Acid MCPA	2
7	Heptachlor and heptachlor epoxide	0.03	23	Metolachlor	10
8	Hexachloro benzene	1	24	Molinate	6
9	Lindane	2	25	Pendimethalin	20
10	Methoxychlor	20	26	Pentachloro phenol	9
11	P.A.H (Poly Nuclear Aromatic Hydrocarbons)	0.2	27	Permethrin	20
12	Alachlor	20	28	Propanil	20
13	Aldicrab	10	29	Pyrodate	100
14	Atrazine	2	30	Simazine	2
15	Bentazone	30	31	Trifluralin	20
16	Carbfuran	5	32	Dichloroprop	100
17	Chlorotoluron	30	33	Fenoprop	9
18	1,2-dibromo 3-chloropropane	1	34	2-4-5 Trichlorophenoxipropenic Acid	9
19	1,2-dichloropropane	20	35	Surfactant	200
			36	Phenol Index	0.5
			37	Residural pesticides (Used in the region)	WHO standards

4. Inorganic Materials

	Parameter	Maximum Permissible mg/l
1	(TDS)	1500
2	CaCO3	500
3	Cl	400
4	So4	400
5	H2S	0.05
6	Fe	0.3
7	Mn	0.5
8	Al	0.2
9	Zn	3
10	Cu	1
11	NO3	50
12	NO2	3
13	Ca	250
14	Mg	50
15	NH3	1.5
16	Na	200

Tab. 3.7.2 Water Emission Standard (DOE)

	Contaminants	Discharges into surface water (mg/l)	Absorbing Wells (mg/l)	Agriculture and Irrigation use (mg/l)
1	Ag	1	0.1	0.1
2	Al	5	5	5
3	As	0.1	0.1	0.01
4	B	2	1	1
5	Br	5	1	1
6	Be	0.1	1	0.5
7	Ca	75	-	-
8	Cd	0.1	0.1	0.05
9	Cl	1	1	0.2
10	Cl-	600	600	600
11	CH2O	1	1	1
12	C6H5OH	1	Very low	1
13	CN	0.5	0.1	0.1
14	Co	1	1	0.5
15	Cr+6	0.5	1	1
16	Cr+3	2	2	2
17	Cu	1	1	0.2
18	F	2.5	2	2
19	Fe	3	3	3
20	Hg	Very low	Very low	Very low
21	Li	2.5	2.5	2.5
22	Mg	100	100	100
23	Mn	1	1	1
24	Mo	0.01	0.01	0.1
25	Ni	2	2	2
26	NH4	2.5	1	-
27	NO2	10	10	-
28	NO3	50	10	-
29	P-PO4	6	6	-
30	Pb	1	1	1
31	Se	1	0.1	0.1
32	SH2	3	3	3
33	SO3	1	1	1
34	SO4	400	400	500
35	V	0	0.1	0.1
36	Zn	2	2	2
37	Oil (liquid)	10	10	10
38	ABS-Detergents	1.5	0.5	0.5
39	BOD	30	30	100
40	COD	60	60	200
41	DO	2	-	2
42	TDS			-
43	TSS	40	-	100
44	SS	0	-	-
45	pH	6.5-8.5	5-9	6-8.5
46	Radioactive substances	0	0	0
47	Turbidity	50	-	50
48	Color	75	75	75
49	Temperature-C			
50	Fecal Coliform (NO/100ml)	400	400	400
51	Total Coloform (NO/100ml:MPN)	1000	1000	1000
52	Nematode egg	-	-	<1 per 1000ml

Tab. 3.7.3 Industrial Emission Standard (Ministry of Energy)

	Parameter		**Value**
1	Temperature	*C*	43
2	pH		6.5-9
3	Total oil & grease	*mg/l*	50
4	Sulphates	$mg/l\text{-}SO^{4}$	400
5	Suspended solids (SS)	*mg/l*	350
6	BOD	$mg/l\text{-}O^{2}$	280
7	Phenol and creosol	*mg/l*	5
8	Copper	*mg/l-Cu*	1
9	Zinc	*mg/l-Zn*	1
10	Nickel	*mg/l-Ni*	2
11	Silver	*mg/l-Ag*	0.1
12	Mercury	*mg/l-Hg*	0.1
13	Lead	*mg/l-pb*	1
14	Cadmium	*mg/l-cd*	1
15	Cromium	$mg/l\text{-}cr^{6+}$	2
16	Cromium	$mg/l\text{-}cr^{3+}$	6
17	Iron	$mg/l\text{-}Fe^{2+}$	10
18	Beryllium	*mg/l-Be*	1
19	Cyanide	*mg/l-CN*	0.5
20	Arsenic	*mg/l-AS*	4
21	Radioactivity	$mg/l\text{-}cm^{3}$	

Tab.3.10.1 Yield of Production in Provinces

Crop Year	Province (Crop in detail)	Crop Area (ha) Irrigated	Crop Area (ha) Rainfed	Crop Area (ha) Total	Production (ton) Irrigated	Production (ton) Rainfed	Production (ton) Total	Yield (kg/ha) Irrigated	Yield (kg/ha) Rainfed
Paddy	**Gilan**								
1383/84	Long grain (sadri)	194,810	0	194,810	743,154	0	743,154	3,815	0
	Long Grain Productic	3,387	0	3,387	16,597	0	16,597	4,900	0
	Middel Quality grain	332	0	332	1,367	0	1,367	4,117	0
	Short Grain	528	0	528	1,796	0	1,796	3,402	0
	Total	199,057	0	199,057	762,914	0	762,914	**3,833**	0
1382/83	**Paddy, Gilan**	198,327	0	198,327	721,714	0	721,714	**3,639**	0
	Average							**3,736**	**0**
Wheat									
1382/83	E-Azalbayejan	101,090	351,951	453,041	332,278	408,351	740,629	3,287	1,160
1382/83	Zanjan	22,481	292,327	314,808	78,831	304,491	383,322	3,507	1,042
1382/83	Kordestan	32,607	435,325	467,932	127,744	567,011	694,756	3,918	1,303
1383/84	E-Azalbayejan							3,580	1,111
1383/84	Zanjan							3,580	984
1383/84	Kordestan							4,060	980
	Average							**3,655**	**1,097**
Barley									
1382/83	E-Azalbayejan	20,516	56,086	76,602	53,152	53,088	106,240	2,591	947
1382/83	Zanjan	10,676	46,632	57,308	26,651	35,774	62,426	2,496	767
1382/83	Kordestan	4,701	32,364	37,065	14,720	38,772	53,491	3,131	1,198
1383/84	E-Azalbayejan							2,899	933
1383/84	Zanjan							2,775	723
1383/84	Kordestan							3,013	1,019
	Average							**2,818**	**931**
Beans									
1382/83	E-Azalbayejan	4,314	0	4,314	5,161	0	5,161	1,196	
1382/83	Zanjan	8,656	0	8,656	16,561	0	16,561	1,913	
1382/83	Kordestan	671	0	671	647	0	647	965	
	E-Azalbayejan	5,378	68,281	73,659	9,482	37,776	47,258	1,763	553
	Zanjan	8977	25,520	34,497	19,535	9,163	28,698	2,176	359
	Kordestan	1,406	85,324	86,730	1,203	30,563	31,766	856	358
	Average							**1,478**	**423**
Potato									
1382/83	E-Azalbayejan	10,253	0	10,253	306,857	0	306,857	29,929	0
1382/83	Zanjan	6,895	0	6,895	192,473	0	192,473	27,915	0
1382/83	Kordestan	10,462	0	10,462	282,697	0	282,697	27,021	0
1382/83	E-Azalbayejan	10,003			300,720			30,063	0
1382/83	Zanjan	6,917			152,216			22,006	0
1382/83	Kordestan	10,351			271,947			26,273	0
	Average							**27,201**	0
Alfalfa									
1382/83	E-Azalbayejan	70,005	19,729	89,734	460,406	39,069	499,475	6,577	1,980
1382/83	Zanjan	38,907	4,402	43,309	171,436	9,669	181,105	4,406	2,197
1382/83	Kordestan	26,480	60	26,540	155,912	96	156,008	5,888	1,600
1383/84	E-Azalbayejan							8,284	2,156
1383/84	Zanjan							4,628	2,062
1383/84	Kordestan							6,967	2,544
	Total/Asverage							**6,125**	**2,090**
Apple									
1381/82	E-Azalbayejan	23,054	0	23,054	382,041	0	382,041	**16,572**	0
	Young tree	3,315	0	3,315		0			
1381/82	Zanjan	3513	0	3,513	56,533	0		**16,093**	0
	Total/Asverage							**16,332**	0
Olive									
1381/82	Zanjan	4,650			18,832			**4,050**	0
	Young tree	3,727							

Olive in the Basin distribute Zanjan (4564ha), Qazvin (6283ha) and Gilan (320ha irrigated) and 642ha rainfed) only.

Tab. 3.10.2 Efficiency of Irrigation by Reach

Reach No.	Present Irrigation Area (ha)			Future Irrigation Area (ha)				Efficiency (%)		
								Present		Future
	Crop	Orchard	Total	Improve	Develop	Total	Future	Crop	Orchard	Plan
1	1,232	107	1,339	600	0	600	2964	33	36	65
										57
										57
2	1,197	1,728	2,925	1200	2300	3500	5225	33	36	
3	3,523	600	4,123	0	0	0	4123	33	36	57
4	1,562	962	2,524	0	0	0	2524	33	35	
5	7,249	1,649	8,898	0	0	0	8898	33	35	
6	3,827	1,336	5,163	0	0	0	5163	33	36	
7	120	67	187	150	450	600	637	33	36	57
8	1,581	26	1,607	1090	1500	2590	3007	33	35	
9	2,254	225	2,479	0	0	0	2479	33	35	
10	3,272	754	4,026	600	10300	10900	14326	33	35	
11	5,926	259	6,185	0	6500	6500	12685	33	36	
								33	35	
12	383	141	524	225	675	900	1199	33	36	57
13	272	40	312	0	0	0	312	33	36	
14	81	7	88	0	0	0	88	33	36	
15										57
16	12	5	17	150	600	750	617	33	36	57
17	12,099	740	12,839	0	7000	7000	19839	30	33	
								33	35	
								33	35	
18	3,989	457	4,446	1240	12630	13870	17076	33	36	
19										
20	12,868	3,830	16,698	0	0	0	16698	30	32	
21	2,585	5,115	7,700	**192407**	0	192407	200106	33	36	
								33	35	
22	2,906	321	3,227	4000	26000	30000	29227	33	35	62
23								33	35	
24	561	211	772	0	0	0	722	33	36	
25	3,890	1,323	5,213	0	0	0	5213	31	34	
26	5,365	1,021	6,386	0	0	0	6386	32	35	
27	15,199	1,890	17,089	0	0	0	17089	30	33	
28	171	77	248	108	450	558	698	30	32	64
29	508	89	597	0	0	0	597	30	33	
30	4,234	880	5,114	0	0	0	5114	30	32	
31	659	170	829	100	900	1000	1729	30	33	64
32	73	3	76	1079	1201	2280	1277	32	35	52
33	365	187	552	0	0	0	552	30	33	
34	733	97	830	1500	0	1500	830	32	35	62
35	551	99	650	0	0	0	650	32	35	
36	821	1,321	2,142	34000	24000	58000	26142	31	34	
37	2,283	314	2,597	0	0	0	2597	37	43	
38	422	84	506	0	1182	1182	1688	31	37	
39	7	2	9	0	9000	9000	9009	31	37	
40	1,368	165	1,533	754	21246	22000	22779	37	43	76
41	2,566	174	2,740	0	0	0	2740	37	43	70
42	1,691	200	1,891	2500	5000	7500	6891	37	43	76
43	372	34	406	0	800	800	1206	37	45	62
44	1,871	365	2,236	0	0	0	2236	37	45	
45	252	37	289	0	0	0	289	37	45	
46	139	10	149	2100	0	2100	149	37	43	
47	16,004	387	16,391	0	0	0	16391	37	45	
48	2,539	571	3,110	0	0	0	3110	37	45	
49	318	55	373	310	90	400	463	37	45	61
50	2,492	60	2,552	0	0	0	2552	37	45	73
51	339	17	356	192	1008	1200	1364	37	45	
52	3,059	213	3,272	0	3400	3400	6672	37	45	
53										
54										
55										
56										
57										
58										
59	3,182	625	3,807	927	6300	7227	10107	32	36	57
										66
60	8,013	1,358	9,371	0	0	0	9371	32	35	
61	10,210	5,500	15,710	0	0	0	15710			65
										57
62										
63	5,833	936	6,769	0	7900	7900	14669	30	33	67
64	691	111	802	50	5950	6000	6752	32	35	62
65	1,142	77	1,219	0	0	0	1219	37	43	
66	7,323	2,038	9,361	362	39412	39774	48773	37	45	62
								32	35	65
								31	37	67
								37	43	71
67	7,060	274	7,334	0	0	0	7334	37	45	
Total	179,244	39,344	218,588	245,644	195,794	441,438	608,263			

Source: Appendix I of Vol.5 by WRMC & Mahab Godss