Economic Impact Assessment of Water in the Zayandeh Rud Basin, Iran

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Comprehensive Assessment of Water Management in Agriculture

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The main goal of this research is flush pointing major economic issues related to the economic impact assessment of water availability in the Zayandeh Rud basin in Iran. It goes without saying that economic assessments would start with considering water as a scarce commodity or a resource and then magnifying the intensity of scarcity along with variables or factors affecting the level of scarcity occurred or predicted to occur, for some determined span of time in the future. Having magnified the intensity of water scarcity the economics tools to deal with water scarcity is analyzed, such that goals defined i.e. food security and environmental concern along with growth are met.

To show the intensity of water scarcity there are three main indices being used in the natural resource economics field namely: unit cost of providing water, market price or its shadow price, and rental value of water rights which include value paid to have access to the use of one cubic meter of water for duration of a year. However, in this research due to the lack of appropriate information on the rental value of water rights the other two indices are being used to evaluate the intensity of water scarcity in Zayandeh Rud.

Before getting into the ways that can be used to measure economic scarcity of water we need to clarify the right economic meanings of the terms quantity of water demanded, water demand, quantity of water supplied, and water supplied.

Quantity of water demanded refers to the quantity of water being planned for use or used at a particular price, with the assumption that other factors are being constant. Whereas, demand for water refers to water planned to be used with regards to the change in price as well as the other relevant factors ; in the agriculture sector, price of agricultural products, price of land for uses other than farming, the differences between per capita income in agriculture and non agricultural sectors and so forth (Khoshakhlagh, Brown, Dumars, 1977). So, both the quantity of water demanded and water demand include locus of appropriate points, the first one being caused by changes of the price and the second one caused by a variety of other factors being identified by the relevant theories. The quantity of water supplied refers to the quantity of water planned to be provided or provided at a particular price, with the assumption that some other relevant factors are constant. Whereas supply of water refers to water planned to be provided or provided with regards to the change in price of water as well as other relevant factors such as technological changes in providing and developing water resources and price on inputs being used for such developments. So, again the quantity of water supplied and supply of water include locus of appropriate points, the first one varies due to the price change and second one changes due to a combination of relevant factors.

Whereas, water usage is the amount of water being put into usage in actuality based upon prevailing prices and status of the other prevailing factors and is a fixed point rather than being locus of points. So water usage is invariable with respect to the economic variables causing change in quantity demanded or change in demand for water. Water availability is also the amount of water available for use, based upon prevailing price for water and prevailing current status of other factors changing supply of water.

So, again water availability is a point and is not changing due to the change in price of water or any other factor causing the change in supply of water.
Hence water usage is not demand for water and only is a point of demand for water. Also, water resource availability is not the same as supply of water and only is a point of supply of water. In other words these terms are not helpful for economic analysis and can only help to approximately find the level of the scarcity of water, under existing scenarios or conditions.
Zayandeh Rud is a closed basin and as the name of the river in Persian implies the river, along its course of flow, obtains new water from return flow of withdrawal uses occurring upstream or tributaries along the river basin.
That means in order to tackle water scarcity in the river basin of Zayandeh Rud one needs to take basin as a whole rather than separating surface water from underground water. Though in some of the researches which have quantified water usage (called demand in the original research); and water resource availability (called supply in the original research) have dealt with surface water separately. One of these researches is presented to show occurrence of water scarcity in the basin.
Salemi and Murray-Rust (2002) in a report after categorizing sources of surface water into: a) Natural inflow in the Chadegan Reservoir b) Transbasin diversions c) Other Water sources;
Have categorized water uses into the following groups: a) Greater Esfahan b) Other Urban c) Industrial d) Agricultural e) Environmental f) Transbasin Diversion and g) Unaccounted Losses.
Then they have set up three scenarios to measure present and future surface water balances. The three scenarios being used are:

Scenario 1: All sectors grow at 2% per annum

Scenario 2: All sectors grow at 1% per annum

Scenario 3: High urban growth, moderate growth in other sectors. In this scenario urban use is estimated to grow 25% each decade, while industrial and agricultural uses grow only 10 % each decade.
The following table is the outcome of their research:

Table1. Present and Forecasted Water Surplus/Deficit from 2000 to 2020

Year / Scenario	2000			2010			2020		
	Supply	Demand	Surplus /Deficit	Supply	Demand	Surplus /Deficit	Supply	Demand	Surplus /Deficit
1	1487	1513	-26	1917	1984	-67	1917	2323	-406
2	1487	1513	-26	1917	1844	73	1917	1999	-82
3	1487	1513	-26	1917	1865	52	1917	2051	-134

Source: Salemi and Murray-Rust, 2002

The above table though erroneously uses the terms demand and supply for water uses and water resources but the following conclusions can be drawn from it:

1. Water is a scarce commodity, since with the assumption that average natural flow of water over the last 30 years is indicated to be 900 million cubic meters; water use for the year 2000 is 1513 million cubic meters. So need to the use of underground sources which is costly is evident and it shows that water is a scarce resource in the basin.

2. At the prevailing prices, though high but often non quantified, water use is much higher than water resources provided and so water shortage is evident and relative scarcity for water is confirmed.

3. Around 50% of surface water is from transbasin water and this is another indication for showing severe scarcity of water in this basin.

Since water is shown to be a scarce resource then appropriate evaluation is needed for wise decision making for its allocation. Generally two approaches are being used to allocate water namely: centralized versus market approach. There is a lot of debate about pros and cons of each approach in the literature which is avoided at this stage of this research. In Iran a combination of market and centralized approach is being used to allocate water resources. While for underground water sources market approach is being applied, for surface water sources centralize approach is being practiced.

Water in the basin of Zayandeh Rud is being used in different sectors of the economy of the area. There are four major uses for the water in the basin: Agriculture, Municipalities, Industrial and Environmental or recreational uses. The first three uses lead to water with drawl, whereas the last use occurs on the stream and do not involve water with drawl. All of the water with drawls for agriculture, municipal, and industrial uses is not consumed and a high proportion of it comes as return flows. The difference between with drawls and return flows is water consumed. Water consumed is the one which ultimately is scarce and should be the focus of quantitative economic analysis. Return flows and on the stream and environmental uses have values and in decision making in resource allocation should be taken care of. This latter uses make water running in the lakes, streams, rivers etc a unique commodity leading to externalities and make water distinct from a pure private good.

Agriculture sector is the main water user of the basin as can be seen in the following tables for both surface water and underground sources. The allocation of water among different sectors for surface, underground and combined sources are shown in the following tables:

Table 2 Consumptive Use of Surface Water for Different Sectors Along with Percentages

Water Uses / Year	Agriculture	Municipalities	Industrial	Environment Govkhoni Swamp	Evaporation from the dam	Total Uses
1380-81	**755.6** (63%)	**306.9** (25.6%)	**96** (8%)	**1.667** (.1%)	**39.2** (3.3%)	**1199.367 (100%)**
1381-82	**1177.37** (74.3%)	**271.5** (17.1%)	**98.6** (6.2%)	**5.1** (.3%)	**33** (2.1%)	**1585.57 (100%)**
1382-83	**1194.98** (74.2%)	**275** (17.1%)	**100** (6.2%)	**10** (.6%)	**30.8** (1.9%)	**1610.78 (100%)**
1383-84	**1259** (72.7%)	**321** (18.5%)	**100** (5.8%)	**16.59** (1%)	**35** (2%)	**1731.59 (100%)**

Table 3 Consumptive Use of Ground Water for Different Sectors Along with Percentages

Water Uses / year	Agriculture	Municipalities	Industrial	Total Uses
1380-81	**2786.4** (93.3%)	**164.64** (5.5%)	**36** (1.2%)	**2987.04 (100%)**
1381-82	2920.8 (93.3%)	173.7 (5.5%)	36.1 (1.2%)	**3130.6 (100%)**
1382-83	3401.9 (94.1%)	177.8 (4.9%)	36.5 (1%)	**3616.2 (100%)**
1383-84	3519.4 (93.9%)	193.33 (5.2%)	37 (1%)	**3749.73 (100%)**

Table 4 Consumptive Use of Surface plus Ground Water for Different Sectors Along with Percentages

Water Uses / Year	Agriculture	Municipalities	Industrial	Environment Govkhoni Swamp	Evaporation from the dam	Total Uses
1380-81	3542 (84.6%)	471.54 (11.3%)	132 (3.2%)	1.667 (0.0%)	39.2 (0.9%)	4186.407 100%)
1381-82	4098.17 (86.9%)	445.2 (9.4%)	134.7 (2.9%)	5.1 (0.1%)	33 (0.7%)	4716.17 (100%)
1382-83	4596.88 (87.9%)	452.8 (8.7%)	136.5 (2.6%)	10 (0.2%)	30.8 (0.6%)	5226.98 (100%)
1383-84	4778.4 (87.2%)	514.33 (9.4%)	137 (2.5%)	16.59 (0.3%)	35 (0.6%)	5481.32 (100%)

Above three tables show that:

Agriculture sector is the main water user of water for surface sources, underground sources and combined sources; the share of this sector is much higher for underground than for surface water resources. In other words as needs grow and surface water is insufficient, in average agriculture goes through more costs than municipalities and industrial to obtain additional water needed.

In the following, first the attempt is made to quantify water cost calculated from the data presented by government agencies and then estimate economic value of water using the approach of the value of marginal product for water or residual approach as is named by some new articles (Young,1996; Mac Gregor et.al, 2000)

CALCULATING UNIT COST AND SHADOW PRICES FOR MARKET VALUE OF WATER

Unit cost is a straight forward concept but we need to clarify shadow price for water. In the new classical theories price of an input such as water is equal to the value of marginal product rendered by one additional unit of water as such one cubic meter of more water used to grow crops. Since factors such as labor, land, capital, and fertilizer along with water are being used to grow crops we need to subtract the cost of all other factors out of total value of crop on a unit of land such as a hectare to obtain the residual value rendered by the amount of water being applied to one hectare of given crop. Then by dividing total residual value rendered by water to the units of cubic meters of water being used we obtain marginal value for one unit of water or shadow price. So, following steps are being taken to calculate unit cost and shadow prices for each cubic meter of water.

In the first column of the following tables major irrigated crops in the province of Isfahan for the years 1378-1381 are presented. In the second column value of one hectare of each crop is shown using the data provided in the site of ministry of Jahad and agriculture (www.agri-Jahad.org) for the years 1378,79, 80 and 81 all being in current values. All monetary values are in toomans. In the third column total costs of each crop is provided.
In the fourth column water costs for cultivation of each crop is presented using previous sources. In the fifth column accordingly the water costs for the growth of each hectare of each crop are given. In the sixth column costs of the water for two previous columns are added to come up with total water costs. This total water costs is used to evaluate the unit cost of each cubic meter of water as the first indices but recorded in the last column of each table. We should take further steps to come up with the marginal value of water. In the seventh column these costs are netted out to come up with all the costs excluding costs for water or as is called in the table adjusted water costs. In the eights column value added obtained on each crop for a hectare of land due to availability of water is calculated. In the ninth column the average amount of water being used per hectare of land is given, these values were obtained from department of jahad in agriculture, province of Isfahan. Though, unclear but it is used as with drawl rather than consumptive use per hectare.
And in the tenth column price of water for each cubic meter of water for different crops using value added mechanism is presented. In the final column unit cost of each cubic meter of water by dividing column sixth into column nine is provided.
Comparison between last two columns shows how much inconsistency exists between these two indices to value one cubic meter of water being used.

Table 5 Calculating Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1377-78

Crop Type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
been	699686	522297	3372	152682	156054	366243	333443	4500	77	35
Pea	421160	232751	1079	39159	40238	192513	228647	4000	57	10
Lentil	325996	179802	366	27582	27948	151854	174142	4000	44	7
Cotton	731734	560264	3681	116222	119903	440361	291373	7000	42	17
Sunflower	404230	227655	578	49880	50458	177197	227033	7500	30	7
cucumber	1286429	921493	865	84853	85718	835775	450654	16000	28	5
Corn	501383	180057	289	20596	20885	159172	342211	14000	24	1
Potato	1122786	1049746	1742	174164	175906	873840	248946	16000	16	11
Tomato	1270576	1200822	725	136125	136850	1063972	206604	16000	13	9
irrigated wheat	298866	253258	1362	34693	36055	217203	81663	8000	10	5
irrigated barley	266893	230885	822	27002	27824	203061	63832	7000	9	10
Sugar beat	338042	303504	74	39334	39408	264096	73946	18000	4	2
Rice	1685638	1172737	82808	119312	202120	970617	715021	18500	39	….
Onion	1016311	2428284	52	178144	178196	2250088	-1233777	18000	-69	10

Table 6.Calculating Value of Marginal Product and
Cost of Each Cubic Meter of Water for Different Crops for the year 1378-79

Crop Type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
been	684134	579221	386	177080	177466	401756	282379	4500	85	39
Onion	2826358	1532041	0	205377	205377	1326664	1499694	18000	83	11
Cucumber	2037480	1271947	1273	94889	96162	1175785	861695	16000	54	6
Cotton	844066	607511	1355	126515	127870	479641	364425	7000	52	18
Sunflower	596622	363750	579	106531	107110	256640	339982	7500	45	14
Lentil	247273	145896	0	21826	21826	124070	123203	4000	31	5
Pea	358514	262699	79	22685	22764	239935	118579	4000	30	6
Potato	1167449	989494	320	153157	153477	836017	331432	16000	21	10
Corn	506887	392710	751	66948	67699	325011	181876	14000	13	5
irrigated barley	285312	248795	1259	40362	41621	207174	78138	7000	11	6
irrigated wheat	328003	287144	2964	43760	46724	240420	87583	8000	11	6
Sugar beat	601170	523113	151	102968	103119	419994	181176	18000	10	6
Tomato	954138	1012671	181	126337	126518	886153	67985	6000	4	21
Rice			0	0	0	0	0	0	0	

Table 7.Calculating Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1379-80

Crop Type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
Onion	2103598	1126338	97	110069	110166	1016172	1087426	18000	60	6
Cotton	714070	482970	6339	114721	121060	361910	352160	7000	50	17
Sunflower	612492	374827	105	41433	41538	333289	279203	7500	37	6
Pea	331089	228834	1719	21713	23432	205402	125687	4000	31	6
Sugar eat	785606	426973	210	88127	88337	338636	446970	18000	25	5
Corn	472941	254872	772	127971	128743	126129	346812	14000	25	9
Tomato	1172999	935381	1160	93420	94580	840801	332198	16000	21	6
Lentil	251803	218000	1245	32508	33753	184247	67556	4000	17	8
wheat	365565	324672	1642	48982	50624	274048	91517	8000	11	6
Barley	309079	309079	1140	39902	41042	268037	41042	7000	6	6
Potato	876822	1002968	3048	144548	147596	855372	21450	16000	1	9
cucumber	899949	964631	997	76882	77879	886752	13197	16000	1	5
Rice	1834512	1475308	223008	127971	350979	1124329	710183	18500	38	
Been	468230	596465	5513	116126	121640	474825	-6596	4500	-2	27

Table 8.Calculating Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1380-81

Crop type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
been	793008	739922	4554	250601	255155	484768	308240	4500	77	57
Potato	2306980	1325198	1505	220562	222067	1103131	1203849	16000	75	14
Onion	2407128	1574591	0	140619	140619	1433972	973156	18000	54	8
Cotton	687151	616518	4782	164623	169405	447113	240038	7000	34	24
Wheat	565093	428811	1386	83760	85146	343665	221428	8000	28	11
Corn	711757	451676	1952	78565	80517	371159	340598	14000	24	6
cucumber	1875074	1703586	725	172954	173679	1529907	345167	16000	22	11
Sunflower	547873	552782	4351	162247	166598	386184	161689	7500	22	22
Sugar beat	880437	664105	196	108715	108911	555194	325243	18000	18	6
Barley	456681	427664	2526	79984	82510	345154	111527	7000	16	12
Tomato	1390116	1287932	213	100521	100734	1187198	202918	16000	13	6
Pea	313570	365481	0	92611	92611	272870	40700	4000	10	23
Rice	5507048	1754200	59714	175896	235610	1518590	3988458	18500	216	
Lentil	216565	306612	128	82020	82148	224464	-7899	4000	-2	21

The above tables show that:

1. The explicit cost of each cubic meter of water is much lower than marginal value of water.

2. Marginal value of water for different crops is different.

3. Taking total water being used for each crop along with marginal value of water we can construct water demand schedule for the water being used in the agriculture sector. Such demand schedules are much more meaningful for economic analysis and first are being constructed for different years and then for an average year. After providing the tables for current values then using price indices real values are obtained.

Table 9 Demand Schedule for Water in Agricultural Sector of Province of Isfahan for the year 1377-78

Crop type	**Value of each cubic meter of water**	Estimated Quantity of Water Used
Been	77	10408500
Pea	57	2712000
Lentil	44	4220000
Cotton	42	36750000
Sunflower	30	17745000
Cucumber	28	109952000
Corn	24	95452000
Potato	16	356608000
Tomato	13	45008000
irrigated wheat	10	877304000
irrigated barley	9	372120000
Sugar beat	4	35136000
Rice	39	0
Onion	-69	96912000

Table 10 Demand Schedule for Water in Agricultural Sector of Province of Isfahan for the year 1378-79

Crop type	**Value of each cubic meter of water**	Estimated Quantity of Water Used
been	85	6669000
Onion	83	71370000
Cucumber	54	29648000
Cotton	52	31451000
Sunflower	45	25920000
Tlentil	31	1284000
Pea	30	1416000
Potato	21	2.95E+08
Corn	13	69650000
irrigated barley	11	2.99E+08
irrigated wheat	11	7.55E+08
Sugar beat	10	4140000
Tomato	4	23664000
Rice	-	-

Table 11 Demand Schedule for Water in Agricultural Sector of Province of Isfahan for the year 1379-80

Crop type	**Value of each cubic meter of water**	Estimated Quantity of Water Used
Cucumber	1	20976000
Rice	38	0
Been	-2	3168000
Onion	60	61866000
Cotton	50	22911000
Sunflower	37	39180000
Pea	31	1296000
Sugar eat	25	138474000
Corn	25	23268000
Tomato	21	23008000
Lentil	17	2172000
Wheat	11	510032000
Barley	6	229446000
Potato	1	242928000

Table 12 Demand Schedule for Water in Agricultural Sector of Province of Isfahan for the year 1380-81

Crop type	Value of each cubic meter of water	Estimated Quantity of Water Used
Rice	216	0
been	77	21033000
Potato	75	320448000
Onion	54	72774000
Cotton	34	26523000
Wheat	28	664864000
Corn	24	46606000
cucumber	22	25600000
Sunflower	22	45360000
Sugar beat	18	182160000
Barley	16	294273000
Tomato	13	22400000
Pea	10	5316000
Lentil	-2	4256000

Average of previous four tables

Crop type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
Rice	2515842	1291024	108906	124414	233319	1057705	1458137	18500	79	13
Bean	802811	731800	3858	208414	212272	519528	283282	4500	63	47
Cotton	905893	691710	4788	156960	161748	529961	375932	7000	54	23
Pea	439315	325998	912	51007	51919	274078	165237	4000	41	13
Sunflower	643147	444612	1515	104672	106187	338425	304722	7500	41	14
cucumber	1833380	1445306	1189	126635	127824	1317482	515898	16000	32	8
Potato	1603118	1319057	1988	209302	211290	1107767	495351	16000	31	13
Onion	2442091	2098246	47	197607	197654	1900592	541499	18000	30	11
Lentil	322881	251466	521	46880	47401	204065	118816	4000	30	12
Corn	654230	376876	1053	84938	85992	290884	363346	14000	26	6
Wheat	456290	384430	2260	61606	63866	320564	135726	8000	17	8
Sugar beat	750588	566006	184	99534	99719	466287	284301	18000	16	6
Tomato	1444803	1353693	708	142172	142880	1210812	233991	16000	15	9
Barley	388331	359241	1660	54159	55819	303422	84909	7000	12	8

Since in the above tables current values are being used, though yearly calculations are correct, but finding the average based upon current values is not right and so we need to adjust monetary values for inflation.

How deflation is being implemented?

First the current values of the second columns are deflated for the base year of 1376. PPI deflating was used for this part. The indices being used are:

year	Index
1377	1.226
1378	1.527
1379	1.8
1380	1.95
1381	2.187

But since we are using agricultural year which is from beginning of Mehr month through the end of Shahrivar the average of two consecutive years were used to find appropriate price indices for available data. So, implemented indices are:

Year	Index
1377-78	1.376
1378-79	1.663
1379-80	1.874
1380-81	2.068

For deflating current values in columns 3, 4, and 5 CPI indices were used. The indices were:

Year	Index
1377	1.181
1378	1.418
1379	1.597
1380	1.779
1381	2.06

Again since our data is for agricultural year with the process explained above the following indices were applied:

Year	Index
1377-78	1.299
1378-79	1.507
1379-80	1.688
1380-81	1.92

Calculating deflated Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1377-78

Crop type	**Value of the product**	**Total costs**	**Water costs for cultivation**	**Water costs for growth**	**Total water costs**	**Total costs minus water costs**	**Value of product minus adjusted water cost**	**Average water used per ha (m3)**	**Value of each m^3 of water**	**Cost per m3 of water**
Been	508308	401922	2595	117493	120088	281834	226474	4500	50	27
Pea	305964	179108	830	30134	30964	148144	157821	4000	39	8
Lentil	236830	138362	282	21225	21507	116856	119974	4000	30	5
Cotton	531590	431138	2833	92269	95101	336037	195553	7000	28	14
Rice	1224583	902452	63723	91814	155537	746916	477667	18500	26	8
Sunflower	293665	175187	445	38384	38829	136358	157307	7500	21	5
Cucumber	934565	709114	666	65297	65962	643151	291414	16000	18	4
Corn	364245	138559	222	15849	16072	122487	241758	14000	17	1
Potato	815682	807808	1341	134024	135364	672443	143239	16000	9	8
Tomato	923048	924065	558	104752	105310	818755	104293	16000	7	7
Irrigated wheat	217120	194889	1048	26697	27745	167144	49977	8000	6	3
Irrigated barley	193892	177672	633	20779	21411	156261	37632	7000	5	3
Sugar beat	245581	233554	57	30269	30326	203229	42352	18000	2	2
Onion	738330	1868629	40	137087	137127	1731503	-993173	18000	-55	8

Calculating deflated Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1378-79

Crop type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
Been	411262	384226	256	117466	117722	266504	144758	4500	32	26
Onion	1699043	1016279	0	136237	136237	880042	819001	18000	46	8
cucumber	1224815	843746	844	62945	63789	779957	444858	16000	28	4
Cotton	507404	402992	899	83924	84823	318170	189234	7000	27	12
Sunflower	358655	241294	384	70667	71051	170242	188413	7500	25	9
Lentil	148646	96780	0	14478	14478	82302	66344	4000	17	4
Pea	215518	174261	52	15048	15100	159161	56357	4000	14	4
Potato	701803	656381	212	101597	101809	554572	147231	16000	9	6
Corn	304711	260504	498	44410	44908	215596	89115	14000	6	3
irrigated barley	171513	165038	835	26774	27609	137429	34084	7000	5	4
irrigated wheat	197176	190477	1966	29028	30994	159483	37694	8000	5	4
Sugar beat	361389	347007	100	68304	68404	278603	82786	18000	5	4
Tomato	573573	671755	120	83806	83926	587830	-14257	6000	-2	14
Rice		0	0	0	0	0	0	0	0	0

Calculating deflated Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1379-80

Crop type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
Onion	1122218	667262	57.46445	65206.75	65264	601998	520221	18000	29	4
Cotton	380939	286120	3755.332	67962.68	71718	214402	166537	7000	24	10
Sunflower	326750	222054	62.20379	24545.62	24608	197446	129303	7500	17	3
Rice	978667	873998	132113.7	75812.2	207926	666072	312596	18500	17	11
Pea	176628	135565	1018.365	12863.15	13882	121684	54944	4000	14	3
Corn	252302	150991	457.346	75812.2	76270	74721	177582	14000	13	5
Sugar eat	419102	252946	124.4076	52207.94	52332	200614	218488	18000	12	3
Tomato	625766	554136	687.2038	55343.6	56031	498105	127661	16000	8	4
Lentil	134331	129147	737.5592	19258.29	19996	109151	25180	4000	6	5
Wheat	195020	192341	972.7488	29017.77	29991	162351	32669	8000	4	4
Barley	164886	183104	675.3555	23638.63	24314	158790	6096	7000	1	3
Potato	467763	594175	1805.687	85632.7	87438	506737	-38974	16000	-2	5
cucumber	480101	571464	590.6398	45546.21	46137	525327	-45226	16000	-3	3
Been	249789	353356	3265.995	68795.02	72061	281295	-31506	4500	-7	16

Calculating deflated Value of Marginal Product and Cost of Each Cubic Meter of Water for Different Crops for the year 1380-81

Crop type	Value of the product	Total costs	Water costs for cultivation	Water costs for growth	Total water costs	Total costs minus water costs	Value of product minus adjusted water cost	Average water used per ha (m3)	Value of each m^3 of water	Cost per m3 of water
Rice	2662983	913884	31109	91636.36	122746	791138	1871844	18500	101	7
Potato	1115561	690387	784	114906	115690	574697	540864	16000	34	7
Been	383466	385476	2372	130555.4	132928	252549	130918	4500	29	30
Onion	1163988	820313	0	73258.14	73258	747055	416933	18000	23	4
Cotton	332278	321187	2491	85763.48	88255	232932	99346	7000	14	13
Wheat	273256	223397	722	43636.36	44358	179039	94217	8000	12	6
Corn	344176	235309	1017	40929.93	41947	193362	150814	14000	11	3
Sunflower	264929	287982	2267	84525.66	86792	201190	63739	7500	8	12
Sugar beat	425743	345978	102	56637.15	56739	289239	136504	18000	8	3
Cucumber	906709	887515	378	90103.67	90481	797034	109675	16000	7	6
Barley	220832	222800	1316	41669.18	42985	179815	41018	7000	6	6
Tomato	672203	670973	111	52368.33	52479	618493	53710	16000	3	3
Pea	151630	190404	0	48247.46	48247	142157	9473	4000	2	12
Lentil	104722	159735	67	42729.88	42797	116939	-12217	4000	-3	11

In the appendix the tables are presented for the above crops in Persian. In most of the tables the numbers for the crop of rice was missing. So, the price for each unit of water being used for rice was obtained from another research. As regards to the quantity of water being used for rice for some of the years the data were available and for some years not available. So, 0 or – indicates unavailability of data rather than the actual quantity being zero.

The above tables show that high proportion of water in the agriculture is allocated to wheat and barely and the path seems in the direction of food security. But economic indices show such allocation is not in the direction of economic efficiency. Since, the value of each cubic meter of water calulated for weat and barely is much lower than other crops.

Demand for Water in the Industrial Sector:

Demand for water in this sector similar to other sectors has been increasing. Studies, being done on water demand for industrial sector even worldwide are much lower than other sectors. In a study out of 494 researches only 7 were on demand for water in the industrial sector (Fredrick et all, 1997).

Increase in demand for water in the industrial sector for the developing countries could mainly be related to the emphasis that growth in the industrial sector leads to development.

In Iran due to inaccuracies involved we can not find reliable data to evaluate water demand for industrial sector or even its trend. But over the last few recent years water intake or withdrawal has decreased mainly due to drought occurring nationwide. In spite of decrease in the quantity of water being used for this sector its share has grown. Table following table gives the data about water consumption in the industrial sector for Iran and Isfahan.

Water Used for Industrial Sector in Isfahan as Compared to Iran

Year / Geographic unit	1374	1377	1380
Iran	623594	512236	582773
Isfahan	177467	97999	87787
% of Iran for Isfahan	15%	19%	28%

Source: Center of ….Iran

The above table shows that in spite of drought occurring for the years 1377 to 1380 share of water used for industrial sector has increased nationally and of course more so for the industrial province of Isfahan.

Different Uses of Water for Industrial Sector:

Demand for water in this sector could be categorized as factor of production, final good or intermediate use and include a variety of uses. Each industry could have different water factor intensity. Water consumption for each unit of product for several industries is the following:

The amount of water consumed per automobile production 12000 to 16000 gallons

Ton of steel	1400 to 65000
Refining oil	2 to 50
Pound of rubber	15 to 300
Ton of paper	20000
Person working in the Industrial sector	150 litters

As we can see the water intensities of different sectors form a quiet wide margin. So in order to find water demand accurately it's needed to get into differences between different industries. Another point worth explaining is that approximately 90% of water consumed in the industrial sector comes from urban water and with the same quality and only 10% contains lower quality. So, the marginal costs of providing water for industrial use are the same as municipalities.

Structure of Industries in the Zayandeh rud basin

As was explained earlier the kind of industry has effect on water used. Another factor changing water use of industries is their location in the area.
Water basin of Zayandeh rud as one of the main industrial regions feeds 8.7% of industries water consumption in Iran. There are 15 plains in the Zayandeh Rud basin and each contains several factories with different number of employees as is shown in the following table:

Number of Factories in Different Plains of Zayandeh Rud basin

Plain Name	Number of Factories	Number of Employees
Damaneh	5	61
Boeen	14	296
Shahabad-Bazdeh	2	87
Bon-Saman	11	208
Lenjanat	44	16670
Maymeh	15	3290
Alavijeh-Dehagh	51	1495
Moorchkhort	164	8024
Najafabad	468	20698
Mahyarshomali	32	1060
Borkhar	749	39464
Koohpayeh-Sagzi	129	6038
Ghomsheh-Dehaghan	74	1888
Aseman	20	1250
Esfandaran-Dastjerd	14	381
Total	1792	100910

The above table shows that plains of Borkhar with 749 industrial units housing 41.8% units of industries and 39% of the employment in the industrial sector and is ranked number one as compared to the other plains of the basin. It is worth noticing that this plain up to recently, that a canal was constructed, directly was not connected to the river and was using underground water of the basin.

Industries located in the Zayandeh rud basin could be classified based upon (ISIC) codes. The following table shows two digits code classification of industries in the basin.

Classifying Industries of Zayandeh rud Basin

Row	Kind of activity	Number of units	Number of Employees
1	Food, Drink and Smoking	194	9148
2	Textile, Clothing and Leather	349	27507
3	Wood and Wood Products	11	366
4	Paper and Print	27	576
5	Chemical	241	12542
6	Nonmetallic Mines	528	18767
7	Producing Basic Metals	90	16521
8	Machines and Equipments	289	14120
9	Power Plants and Miscellaneous	63	1363
Total		1792	100910

Source: Report on Harmony with Climate, Consulting firm of Jama, Ministry of Power, 1384

The above table shows that industries related to the nonmetallic mines, machines and equipments, textile and chemical, as far as the number of units or even employment, have high shares. Though, producing basic metals have smaller share, though providing much higher employment. In the development more priority is given to these types of industries in the basin and consequently 49.8% of with drawl is used for them.

In the next table water with drawl in the industries are classified based upon the source of water.

Distributing Water Used in industries based upon the Source of Water

Row	Kind of activity	Surface Sources	Underground Sources	Total Water used	Percentage of the total industries
1	Food, Drink and Smoking	2697.7	11530.5	14228.2	9.6
2	Textile, Clothing and Leather	2853.8	12412.9	15266.8	10.4
3	Wood and Wood Products	5.9	27	32.9	0.02
4	Paper and Print	46.8	124.7	171.5	0.1
5	Chemical	5668.5	9916.1	15584.5	10.6
6	Nonmetallic Mines	4743	12509.6	19252.6	13.1
7	Producing Basic Metals	70586.8	2808.2	73395	49.8
8	Machines and Equipments	416	2968.2	3384.2	2.3
9	Power Plants and Miscellaneous	2087.6	4046.9	6134.5	4.2
Total		91106	56344	147450	100

Source: Report on Harmony with Climate, Consulting firm of Jama, Ministry of Power, 1384

In the above table producing basic metals uses half of total water used in the industries and the water use mainly is provided by the surface sources.

In the next table return flows for different industries and consumptive use along with corresponding percentages are given.

Return Flow Along with Consumptive use for Different Industries

Total	Kind of activity	The amount of return flow	Percentage of total with drawl	Consumptive use	Percentage of total with drawl
1	Food, Drink and Smoking	8603.2	60.5	5624.9	39.5
2	Textile, Clothing and Leather	9610.6	63	5656.1	37
3	Wood and Wood Products	27.8	84.5	5.1	15.5
4	Paper and Print	48.8	28.4	122.7	71.6
5	Chemical	6390.8	41	9193.8	59
6	Nonmetallic Mines	11196.6	58.2	8056	41.8
7	Power Plants and Miscellaneous	4984.3	6.8	68410	93.2
8	Machines and Equipments	2741.3	81	642.9	19
9	Producing Basic Metals	634.6	10.3	5499.9	89.7
Total		44238	30	103212	70

Source: Report on Harmony with Climate, Consulting firm of Jama, Ministry of Power, 1384

As is shown the highest percentage of water consumed and the lowest percentage of return flow along with the highest amount of water with drawl occurs in the production of basic metals. In contrast Machines and equipments have the highest percentage of flow and the least percentage of consumption as compared to the other sectors.

In a simple comparison between the year 1373 and the year 1380 we can see that water with drawl for industrial sectors has grown from 128.7 million cubic meters to 147.5 cubic meters which shows an increase of 14.5% over this span of time. However, percentage of water with drawl converted to consumptive use has grown from 41% to 70%.The decrease in the return flow shows that due to drought and scarcity of water productivity of water is increasing. The following table compares performance of industrial sector as regards to scarcity of water between 1373 and 1380.

Row		1373	1380	Percentage of change
1	With drawl water m.c.m for total industries	128.7	147.5	14.6
2	Return “	75.6	44.2	-41.5%
3	Consumptive”	53.1	103.3	94.5
4	Water with drawl for basic industries	41.1	73.4	78.6
5	Return ‘	31.1	5	-83.9
6	Consumptive	10	68.4	584

The above table shows that how industries due to scarcity of water could increase productivity of water with drawl. The increase of 14.6 is mainly related to increase in the number of industries established in the area.

Esthetic Value Of water Flows in Zayandehrud

As the water is flowing down in Zayandeh Rud creates on-stream values for the people living or visiting Isfahan. This value is distinct from off stream uses such as agriculture, municipal or industrial uses. This kind of usage is categorized as a public good vis-à-vis private good often obtained by off stream uses.

There are credible economic tools to measure values created in this manner. The most important tool or approach is called “Contingency Valuation Method” here after called C.V.M.

The reason for using this approach is its flexibility to propose the commodity in question with all of its dimensions to the person responding to the questionnaire, its predominance use for similar valuation and its strong link with theoretical concepts in microeconomic theory.

In a research (Kaveh, 1378) a questionnaire was filled out on 265 randomly chosen households out of population of the people living in the vicinity of Zayahdeh Rud in three distinct locations namely above Nazhvan , from Nazzhvan to Pole Shahrestan, and below Pole Shahrestan. The rate of completed questionnaires was 85% .In these questionnaires preferences of the respondents about different quality services of Zayandeh Rud were being asked.

Categories being presented to the respondents were water quality for the services of boating, fishing, swimming, esthetic value for walking or camping in the banks of the river and others which should be indicated by the respondents.

Out of the completed sample 81.88%, 217 households, their first priority was for esthetic value for walking and camping in the banks of the river. The second prior service came to be boating being chosen by 15.47%, 41 households, the rests categories chosen were swimming and fishing.

Also respondents were asked to mention which services of the river had enjoyed in the recent years. 84.9%, 225 said they used the river for its esthetic value.91, 34.33%, respondents also said while they have enjoyed from the esthetic value they have used it for boating.

After asking about their level of satisfaction for all different uses and what are the main causes of their dissatisfaction they were asked to say if they want reallocation being made about the tax money or budgeted money for competing services . The Reponses received are categorized in the following table:

Title	Yes		No	
	Number	Percent	Number	Percent
Continuing 1200 tomans per capita payment to keep existing level of water quality	210	79.24	55	20.76
Increasing per capita to 2500 tomans to increase water quality	115	43.39	150	56.61
Being aware about water stoppage in flowing in the river in their evaluation	183	69.05	85	30.95
The change in their evaluation due to the experience of water stoppage	166	90.71	17	9.29

Since the table is self explanatory some of its conclusions are:

1. 79.24% of the respondents are valuating on-stream values as much as 1200 tomans per individual to keep existing level of quality. This could be obtained by the water flowing in the river to those applying water below Pole Shahrestan.
2. 43.39% are willing that 2500 tomans per capita of their taxes being used to add to the existing quality and bring it to the level which is satisfactory. Because, according to those being categorized in the first group existing allocation is not acceptable.
3. Water stoppage has made the residents more aware about value of on-stream uses and more willing to allocate their taxes paid for enhancing water quality flowing through the river.
4. In comparing value of water uses between up-streams with down streams the on-stream values should be added to the conventional marginal values obtained through the above calculation.

Supply of Water

As was stated earlier water being provided to the irrigation sector, municipalities and other sectors is not in the form of natural and should be considered a commodity produced by combining natural water with other resources such as labor, capital and entrepreneurship.

So, like any other commodity we need to find out how its supply is formed, modeled and estimated.

Quantity of water supplied is the amount of water (cubic meters etc) which the producer of the water at given prices and ceteris paribus is willing to provide to the market. With the change of price the quantity of water produced changes. Locus of the quantity of water supplied changes due to changes of prices form the supply of commodity water. And as factors other than the price of water change, such as price of input used to produce commodity of water or technology, the supply changes as well.

Then the quantity of water supplied changes due to the change in the price of water and economic supply of water changes due to changes in the price of resources used to produce commodity water such as wage rate, interest rate and also change in technology of providing commodity water.

It is clear that this notion for supply is different from the physical supply which is often assumed to be fixed and is categorized as water resources, surface or ground water resources without real economic meanings for them.

To form economic supply of water three studies needs to be combined namely: hydrological, technical and economic studies.

In the hydrological studies experts determine water resource availability and frequencies for given location whether is surface, underground or combined. It is right to say that through this type of study physical supply which is upper limit for economic supply is being quantified as well.

In the technological studies engineers determine in order to increase, given amount of water availability out of the above upper limit to provide water to different uses or what is called market place, which project or projects are most efficient. It is clear that as the quantity planned changes the optimal projects change as well. In other words with change in quantity of water planned to be provided to the market, optimal project proposed by technological experts change as well.

Then through economic studies appropriate money values are attached to technological information provided by the experts in this field and supply of water is formed (Khoshakhlagh,1378).

What model is suited for supply of water depends upon technological information provided by the second group namely technological studies. This technological information has deterministic impact on the form of the cost function modeled for the supply of water as well.

The cost function is the core of supply of water. In the long run all costs are variable and so we are dealing with long rung supply of water. From the long run supply we calculate long run marginal costs for each additional unit of water being added to the existing water supplied abbreviated by LMC. Assuming water is mainly provided by government agencies which follow maximization of the welfare of societies which are serving, what is called regulated monopoly, or competitive then the marginal cost curves is the same as economic supply of water, though there is a single water provider.

In a research being done on the water basin of Zayandeh Rud (Nouralizadeh, 1378)

The following form of function for the long run cost function is being applied:

$$LMC = a_0 + a_1 q + a_2 q^2 + a_3 t + e$$

In this model q stands for additional quantity of water added to the existing supply and t is used a proxy for the price of inputs used in the production of water.

Statistical water producers' population being considered included all existing or future units involved in supplying or enhancing water being supplied for use in the basin.

All projects used to increase surface water availabilities such as; dams, repairing, improving and covering canals, creating pools to reserve water along with projects to produce water through underground sources such as quanats, wells are part of the long run costs and ultimately being used to find long run marginal costs.

The following quantities are presented in the above research:

Water resources due to rainfall 9800 m.c.m

Transbasin Water:

Koohrang I 320 m.c.m

Koohrang II 250 m.c.m

Total of transbasin water

570 m.c.m

Total volume of current water resources supplied 1370 m.c.m

Though ultimate potential for water supply could be water resource availability, but due to the excessive amount of cost involved the controlled water could only be counted as the limit for economic supply of water .By controlled water we mean water flowing in the streams, rivers or reserved in surface or underground.

So to come up with controlled water following items is subtracted from total water resources:

Evaporation:

In the mountains	1900 m.c.m
In the plains	1000
From reserved water	400
Totals	3300 million cubic meters

Subtracting 3300 million cubic meters out of total recourses of 10370 m.c.u leaves up with 7070 million cubic meters to be counted as ultimate potential for economic water supply.

However, existing water supplied is much lower than this theoretical target as is presented in the following:

Surface flows:

Out of 6600 million cubic meter of water being rained in the mountains only 2500 m.c.m is flowing as surface water. And out of rain in the plains 1500 m.c.m water is flowing as surface water. So the total water flowing as surface water is 4000 million cubic meter for the year of 1378.

Out of this amount 1200 million cubic meters is estimated to go into underground sources. So, the total surface water controllable is only 2800 million cubic meters.

Groundwater sources:

Balance of water provided in the research shows that 5100 million cubic meters of water enters the underground basin but only as much as 3500 million cubic meters are extractable through wells, quanats, and springs which do not lead to water table going down (3900 m.c.m minus 400 deficit due to excessive use). Also, in average each year 800 m.c. m is used from drainage water which could be added to underground water being used to come with potential water could be extracted from underground sources.

So the total water which potentially could be counted as ultimate ground water supply is 4300 million cubic meters.

Adding total amount of surface water to underground sources makes 7100 million cubic meters as a potential for total supply of water or what could we call physical supply.

So a wise and long run scenario for potential supply is 7100 million cubic meters for a year which we call scenario I from now on.

Another scenario would be formed by subtracting water drainage of 800 million cubic in year which leaves us with 6300 million cubic meters per year called scenario II from now on.

Current water supplied from Zayandeh Rud basin in the year 1378 has been:

Surface 900 million cubic meters (1200 – 300 return flow)

Underground sources has been 4700 m.c.m if we go by scenario I. Adding underground and surface water together we come up with total year water being supplied which is also consumed to be 5600 m.c.u.

Since 400 million cubic meters are overdraft water then total long run supply based upon rains occurring in the year 1378 is 5200 million cubic meters.s

Then percentage of water resources being transformable to controllable water for the year 1378 is 7100/10370 * 100 = 68%. And out of 7100 m.c.m of water controllable only 5200/7100 * 100 =

73.24% is economically was to be extracted. Since the quantity of water which is supplied is 5600 m.c.m. The quantity of 5200 m.c.m should be used as quantity related to long run supply. As we can see there is a wide gap between physical supply of 7100 m.c.m and economic supply of only 5200 m.cm.

It should be mentioned that still there is room for increase of water supplied i.e. using runoffs of 1600 million cubic water lost or water drainage of 800 million cubic meters.

How existing economic supply could be estimated?

Existing water supplied has become available through a set of projects carried out up to present and in different parts of the basin.

The projects carried out could be classified into two groups of projects: on the surface projects and underground projects.

Until the year 1378 projects affiliated to increase of surface water sources are:

Constructing dams, tunnels, canals of transferring water, constructing pools for conserving water, covering canals. These projects are listed in the rows of 1 through 19 in the following table.

Water supplied through underground sources includes water obtained from wells and quanats.

Water Supply from Wells:

Since in constructing the supply curve one should use efficient costs rather than inefficient costs then cost information obtained for the year 1378 were adjusted to obtain efficient long run marginal costs. Yearly data showed that in the year 1361-62 there were 12056 wells and in the year 1374 there were 18121 wells. But, the amount of water extracted was approximately the same amount as was extracted in the year 1361-62. The reason for occurance of this situation is externalities involved and over drafting of underground sources by additional wells constructed. So, the costs of the wells in 1378 were multiplied by the factor of total number of wells counted as optimal in the year 1362 divide by total of no optimum to find adjusted cost for the amount of water obtained. Though, there are more than 18000 wells all were combined to find single observation in the table constructed.

In the following table first column indicate the name of the project used as an observation to increase water availability to the users or what is called market place. In the second column of this table the year at which each project was completed is given. In the third column capital cost of each project is provided. In the fourth column capital cost apportioned to each year is given, with 7.5% depreciation.

No	Project name	The year Completed	Capital costs	Annual depreciation(7.5 %)	operation costs	Annual depreciation + operation cost	Additional supply of water Million cubic meters	Price deflator for converting monetary values to the year 1376	
1	Zayandedrud dam	47	257415.4	-	-	-	-	-	
2	Abshar network and dam	55	73877.3	36224.8	2880.4	46317.2	500	66326.230	1.432
3	Neko abad network and dam	56	60284.5	-	-	-	-	-	
4	First Kohrang tunnel and dam	30	26412.7	2462.9	133	2496	320	3574.272	1.432
5	second Kohrang tunnel and dam	57	62770.9	62770.9	6958.3	317.3	250	10418.516	1.432
6	Marbaran and Kolanchin tunnel and dam	60	175010.5	175010.5	19482	20362.5	115	29159.1	1.432
7	Rodashtain irrigated network and deviation dam	72	7042.4059	7042.4059	528.18044	33.59276	220	53.310	1.587
8	Jargoyeh and mahyar deviation dam	76	8731.85001	654.8887	41.6509	696.53967	146	696.5396	1
9	Borkhar plain irrigated network and deviation dam	76	11524.6503	864.34877	54.97258	919.32135	200	919.32135	1
10	Water transfer from Zayandehrud dam to Tiran-kron plain	71	5246.74395	393.5057	25.2968	418.5327	21	897.334	2.144

No	Project name	The year Completed	Capital costs	Annual depreciation(7.5 %)	operation costs	Annual depreciation + operation cost	Additional supply of water Million cubic meters	Price deflator for converting monetary values to the year 1376	adjustment Unit cost per cubic meter in rials
11	Pool of reservation water city of Esfahan	1366	-	-	-	202.7286	9.518	-	-
12	Pool of reservation water city of Chadogan	1368	-	-	-	3.11	0.21	-	-
13	Pool of reservation water city of Shahreza	1368	-	-	-	58.4	2.228	-	-
14	Pool of reservation water city of Fereidan	1367	-			12.33	0.539		
15	Pool of reservation water city of Fereydonshahr	1366				16.12	1.412		
16	Pool of reservation water city of Zarrinshahr	1367				18.02	2.109		
17	Pool of reservation water city of Nejafabad	1366				3.4	0.37		
18	Projects for covering water streams by	1364				278.1445	196.585		
19	Jahhadsazandegi Projects forcovering water streams by the office of agricultur province Jahhadsazandegi	1373				24068.1	280		
20 21	Underground wells	1374				113583.2436	3041		

No	Project name	The year Completed	Capital costs	Annual depreciation(7.5 %)	operation costs	Annual depreciation + operation cost	Additional supply of water Million cubic meters	Price deflator for converting monetary values to the year 1376	adjustment Unit cost per cubic meter in rials
11	Pool of reservation water	1366	-	-	-	202.7286	9.518	-	-
12	city of Esfahan Pool of	1368	-	-	-	3.11	0.21	-	-
13	reservation water city of Chadogan	1368	-	-	-	58.4	2.228	-	-
14	Pool of reservation water	1367	-			12.33	0.539		
15	city of Shahreza Pool of	1366				16.12	1.412		
16	reservation water city of Fereidan	1367				18.02	2.109		
17	Pool of reservation water	1366				3.4	0.37		

18	city of Fereydonshahr	1364				278.1445	196.585		
19	Pool of reservation water city of Zarrinshahr Pool of	1373				24068.1	280		
20	reservation water	1374				113583.2436	3041		
21	city of Nejafabad Projects for covering water streams by Jahhadsazandegi Projects forcovering water streams by the office of agricultur province Jahhadsazandegi Underground wells								

The results of estimating LMC in the above research were:

Ls // Dependent Variable is MC
Date: 3-16-1999 / Time: 14:52
SMPLrange: 2-138
Number of observation: 137
Convergence achieved after 4 iterations

VARIABLE	COEFFICIENT	STD.ERROR	T-STAT	2-TAIL SIG
C	184.357	1457.4138	0.126	0.899
QS	0.017	0.020	0.895	0.371
QSS	-4.331	2.869E-06	-1.509	0.133
T	-0.102	1.092	-0.0941	0.925
AR(1)	-0.048	0.086	-0.562	0.574

R-squared	0.060	Mean of dependent vat	34.342
Adjusted R- squared	0.032	S.D. of dependent vat	36.166
S.E. of regression	35.580	Sun of squared resid	167104.0
Log likelihood	-681.182	F- statistic	2.130
Durbin-watson stat	2.015	Prob (F-statistic)	0.080

Ls // Dependent Variable is MC
Date: 3-16-1999 / Time: 14:44
SMPL range: 1-138
Number of observation: 138

VARIABLE	COEFFICIENT	STD.ERROR	T-STAT	2-TAIL SIG
C	-41.391	1475.082	-0.028	0.977
QS	0.026	0.018	1.411	0.160
QSS	-5.520	2.666E-06	-2.070	0.040
T	0.052	1.107	0.047	0.962

R-squared	0.055	Mean of dependent vat	34.174
Adjusted R- squared	0.033	S.D. of dependent vat	36.088
S.E. of regression	35.470	Sun of squared resid	168593.7
Log likelihood	-686.265	F- statistic	2.604
Durbin-watson stat	2.092	Prob (F-statistic)	0.054

Ls // Dependent Variable is MC
Date: 3-16-1999 / Time: 14:32
SMPL range: 1-138
Number of observation: 138

VARIABLE	COEFFICIENT	STD.ERROR	T-STAT	2-TAIL SIG
C	-182.599	355.578	0.513	0.608
QS	0.005	0.007	0.740	0.460
QSS	2.728	1.284	2.125	0.035
T	0.141	0.259	0.545	0.586

R-squared	0.684	Mean of dependent vat	34.174
Adjusted R- squared	0.677	S.D. of dependent vat	36.088
S.E. of regression	20.506	Sun of squared resid	56348.41
Log likelihood	-610.645	F- statistic	96.769
Durbin-watson stat	0.191	Prob (F-statistic)	0.000

QS Stands for the quantity of water being added as the marginal project and QSS square of such quantities.

Conclusions:

1) Water is, as expected, a scarce commodity in the basin and appropriate allocation or reallocation should take this valid understanding into consideration.
2) In allocating water among the users; agriculture, municipalities, industrial and esthetic values, distinction should be made between off streams and on stream uses.
3) There is a clear distinction between withdrawals uses and consumptive use. While the rights rendered by withdrawal mechanism should be supported ultimately consumptive water is the main core of scarcity.
4) Agriculture sector is the main water user, for both surface as well as underground sources, and appropriate allocation should be focused on this sector. Since providing water efficiency in this sector enhances agriculture products and so leads to obtain the goal of food security.
5) Water cost per unit indice, often being applied to find the value of water for different uses and crops, shows much lower value for scarce water than marginal value of water which is economically supported indice.
6) Marginal value of water for different crops is quite varying and economic allocation or reallocation should be based upon measured marginal values or estimated ones.
7) Water demand constructed based upon marginal values of water should be the focus of evaluating water use.
8) Water intensity among different industries is varying and value per unit of water for different industries should guide water allocation to different industries.
9) In changing the use or place of water use the impact on esthetic values must be taken into consideration. Since, inhabitants of Isfahan province put high value in water running through the city. That means in comparing value of water for different uses instream values in each case should be added to off stream values.

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اطلاعات مربوط به سال زراعی 79-78

نوع محصول	ارزش تولید در یک هکتار	هزینه کل	اب بها مرحله داشت	اب بها مرحله اماده سازی*	اب بها(آبیاری + داشت)	هزینه کل منهای آب	ارزش تولید- هزینه کل منهای آب	متوسط آب برای یک هکتار	ارزش هر واحد آب
گندم آبی	298866	253258	34693	1362.311841	36055.31184	217202.6882	81663.312	8000	10.207914
جو آبی	266893	230885	27002	822.1570649	27824.15706	203060.8429	63832.157	7000	9.11887958
شلتوک	1685638	1172737	119312	82807.67884	202119.6788	970617.3212	715020.68		#DIV/0!
ذرت دانه آبی	501383	180057	20596	289.0027111	20885.00271	159171.9973	342211	14000	24.4436431
نخود آبی	421160	232751	39159	1078.85184	40237.85184	192513.1482	228646.85	4000	57.161713
عدس آبی	325996	179802	27582	366.462359	27948.46236	151853.5376	174142.46	4000	43.5356156
آفتاب گردان	404230	227655	49880	578.3816509	50458.38165	177196.6183	227033.38	7500	30.2711176
پنبه آبی	731734	560264	116222	3680.912515	119902.9125	440361.0875	291372.91	7000	41.6247018
چغندر قند	338042	303504	39334	74.10891081	39408.10891	264095.8911	73946.109	18000	4.10811716
خیار آبی	1286429	921493	84853	864.8066743	85717.80667	835775.1933	450653.81	16000	28.1658629
سیب زمینی آبی	1122786	1049746	174164	1741.596959	175905.597	873840.403	248945.6	16000	15.5590998
پیاز آبی	1016311	2428284	178144	52.33071376	178196.3307	2250087.669	-1233776.7	18000	-68.543148
گوجه فرنگی آبی	1270576	1200822	136125	724.5787476	136849.5787	1063972.421	206603.58	16000	12.9127237
لوبیا سفید آبی	784538	607065	207851	3517.206594	211368.2066	395696.7934	388841.21	4500	86.409157
لوبیا قرمز آبی	549036	433172	115299	1951.46459	117250.4646	315921.5354	233114.46	4500	51.8032144
لوبیا چیتی آبی	765483	526655	134896	4648.796086	139544.7961	387110.2039	378372.8	4500	84.0828436

اطلاعات مربوط به سال زراعی 80-79

نوع محصول	ارزش تولید در یک هکتار	هزینه کل	اب بها مرحله داشت	اب بها مرحله اماده سازی	آب بها(مرحله داشت+آماده سازی)	هزینه کل منهای آب	ارزش تولید- هزینه کل منهای آب	متوسط آب برای یک هکتار بر حسب مت مکعب	ارزش هر واحد آب
گندم آبی	365565	324672	48982	1642	50624	274048	91517	8000	11.439625
جو آبی	309079	309079	39902	1140	41042	268037	41042	7000	5.863142857
شلتوک	1834512	1475308	127971	223008	350979	1124329	710183		0
ذرت دانه آبی	472941	254872	127971	772	128743	126129	346812	14000	24.77228571
نخود آبی	331089	228834	21713	1719	23432	205402	125687	4000	31.42175
عدس آبی	251803	218000	32508	1245	33753	184247	67556	4000	16.889
آفتاب گردان	612492	374827	41433	105	41538	333289	279203	7500	37.22706667
پنبه آبی	714070	482970	114721	6339	121060	361910	352160	7000	50.30857143
چغندر قند	785606	426973	88127	210	88337	338636	446970	18000	24.83166667
خیار آبی	899949	964631	76882	997	77879	886752	13197	16000	0.8248125
سیب زمینی آبی	876822	1002968	144548	3048	147596	855372	21450	16000	1.340625
پیاز آبی	2103598	1126338	110069	97	110166	1016172	1087426	18000	60.41255556
گوجه فرنگی آبی	1172999	935381	93420	1160	94580	840801	332198	16000	20.762375
لوبیا سفید آبی	471072	505485	107548	2280	109828	395657	75415	4500	16.75888889
لوبیا قرمز آبی	591883	800050	132634	5439	138073	661977	-70094	4500	15.57644444
لوبیا چیتی آبی	341734	483860	108197	8821	117018	366842	-25108	4500	5.579555556

اطلاعات مربوط به سال زراعی 81-80

نوع محصول	ارزش تولید در یک هکتار	هزینه کل	اب بها مرحله داشت	آب بها مرحله اماده سازی	آب بها(مرحله داشت+ اماده سازی)	هزینه کل منهای آب	ارزش تولید- هزینه کل منهای آب	متوسط آب برای یک هکتار(متر مکعب)	ارزش هر واحد آب
گندم آبی	565093	428811	83760	1386	85146	343665	221428	8000	27.6785
جو آبی	456681	427664	79984	2526	82510	345154	111527	7000	15.9324287
شلتوک	5507048	1754200	175896	59714	235610	1518590	3988458		0
ذرت دانه آبی	711757	451676	78565	1952	80517	371159	340598	14000	24.3284287
نخود آبی	313570	365481	92611	0	92611	272870	40700	4000	10.175
عدس آبی	216565	306612	82020	128	82148	224464	-7899	400	-1.97475
آفتاب گردان	547873	552782	162247	4351	166598	386184	161689	7500	21.5585333
پنبه آبی	687151	616518	164623	4782	169405	447113	240038	7000	34.29114286
چغندر قند	880437	664105	108715	196	108911	555194	325243	18000	18.06905556
خیار آبی	1875074	1703586	172954	725	173679	1529907	345167	16000	21.5729375
سیب زمینی آبی	2306980	1325198	220562	1505	222067	1103131	1203849	16000	75.2405625
پیاز آبی	2407128	1574591	140619	0	140619	1433972	973156	18000	54.0642222
گوجه فرنگی آبی	1390116	1287932	100521	213	100734	1187198	202918	16000	12.682375
لوبیا سفید آبی	523396	649293	206682	5906	212588	436705	86691	4500	19.2646666
لوبیا قرمز آبی	896309	742527	213284	1132	214416	528111	368198	4500	81.8217777
لوبیا چیتی آبی	959319	827947	331836	6624	338460	489487	469832	4500	104.407111