COMPARISON OF WATER CHARGE WITH OPERATION AND MAINTENANCE COSTS OF IRRIGATION AND DRAINAGE NETWORKS OF 11 REGIONAL WATER AUTHORITIES IN IRAN

COMPARAISON DU TAUX POUR L'EAU D'IRRIGATION AVEC LES COUTS D'EXPLOITATION ET DE MAINTENANCE DES RESEAUX D'IRRIGATION ET DE DRAINAGE DE 11 AUTORITES REGIONALES DE L'EAU EN IRAN

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ABSTRACT

Irrigation water charge, operation and maintenance costs of irrigation and drainage networks in 11 provinces of Iran including: Khozestan, Khorasan, Fars, Mazandaran, Gilan, Tehran, Isfahan, West Azarbaijan, East Azarbaijan, Hormozgan and Gharb during 2000, 2001, and 2002 were studied and the following information were collected:

1. *Total Costs*
2. *irrigation and drainage network area*
3. *Quantity of delivered water*
4. *Total irrigation water charge*

Based on the study of the data, different indices were defined. For example:

- *(Net and gross farm area) / (Maintenance costs, operation costs, total costs and total water charge)*
- *(Operation and maintenance costs) / (Total costs)*
- *(Operation and maintenance costs) / (Total water charge)*
- *(Total water charge) / (Total costs)*

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The study of indices under different climate, farm area and current cropping pattern of each province, demonstrated that climate, type of soil and irrigation and drainage network area have important effect on the operation and maintenance costs. On the other hand the irrigation water charge are affected by the method and type of water consumption the operation and maintenance costs, farm area and current cropping pattern.

Key words: *Water charges, Irrigation cost, Cropping pattern, Marketing.*

RESUME

Le rapport étudie le taux pour l'eau d'irrigation, les coûts d'exploitation et de maintenance des réseaux d'irrigation et de drainage dans 11 provinces en Iran des années 2000, 2001 et 2002, y compris: Khozestan, Khorasan, Fars, Mazandaran, Gilan, Téhéran, Ispahan, Azerbaïdjan occidental, Azerbaïdjan oriental, Hormozgan et Gharb. Les informations suivantes ont été recueillies:

1. *Coûts totaux*
2. *Zone du réseau d'irrigation et de drainage*
3. *Quantité d'eau fournie*
4. *Taux total pour l'eau d'irrigation*

Compte tenu de l'étude des données, différents indices ont été définis. Par exemple:

- *(superficie agricole net et brut) / (coûts de maintenance, d'exploitation, coûts totaux et taux total pour l'eau d'irrigation)*
- *(coûts d'exploitation et de maintenance) / (coût total)*
- *(coûts d'exploitation et de maintenance) / (taux total pour l'eau d'irrigation)*
- *(taux total pour l'eau d'irrigation) / (coût total)*

L'étude des indices sur différents climats, la superficie agricole et l'assolement actuel de chaque province ont démontré que le climat, le type de sol et la zone du réseau d'irrigation et de drainage exerce un impact important sur les coûts d'exploitation et de maintenance. D'autre part, le taux pour l'eau d'irrigation est affecté par la méthode et le type de consommation d'eau, les coûts d'exploitation et de maintenance, la superficie agricole et l'assolement actuel.

Mots clés: *Taux pour l'eau d'irrigation, coût d'irrigation, assolement, marketing.*

1. INTRODUCTION

The target of this study is evaluation of maintenance and operation costs and water charge of the irrigation and drainage networks in Iran where funds are spent on the network, which has special importance in developing agriculture and hence the country. Unfortunately, many of the networks do not perform as expected.

In this study, information and data about maintenance & operation costs, total costs, allocated & delivery water volume, gross and net farm area, total water charge and etc of the irrigation

and drainage networks of 11 regional water authorities including, Khuzestan Water and Power Authority (KWPA), Eastern Azerbaijan(EARWA) & Ardebil (ARWA), Isfahan (IRWA), Tehran (TRWA), Khorasan (KRWA), Qarb (QRWA), Fars (FRWA), Gillan (GRWA), Mazandaran (MRWA) & Golestan (GRWA) and Hormozgan Regional Water Authorities (HRWA), during 2000, 2001 and 2002 were extracted from the annual reports available at the office in management of water resources company.

The extracted information and data of each regional water authorities were compared and most of them were selected for further analyses.

2. METHODOLOGY

The information, as mentioned above were used to derive the following:

1. Consulting service cost.

2. Dredging costs of canal drain.

3. Service road cost.

4. Maintenance cost.

5. Operation cost.

6. Total cost.

7. Gross and net farm area.

8. Allocated and delivered water volume.

Tables 1 shows the derived data, they are shown in charts and with comparing and analyzing them the maximum of each item are demonstrated.

The following indices were defined for comparison:

1. *Consulting service costs/maintenance costs*
2. *Dredging canal drain costs/ maintenance costs*
3. *Service road costs/ maintenance costs*
4. *Operation costs/Gross farm area*
5. *Maintenance costs/Gross farm area*
6. *Operation costs/net farm area*
7. *Maintenance costs/net farm area*
8. *Total costs/Gross farm area*
9. *Total costs/net farm area*
10. *Total water charge/Gross farm area*
11. *Total water charge/net farm area*
12. *Maintenance costs/Total costs*
13. *Operation costs/Total costs*

14. Maintenance costs/Total water charge

15. Operation costs/Total water charge

16. Total costs/Total water charge

The results of the above proportions are tabulated in Tables 2 and 3.

Table 1- Derived data

Name / Derivation Data	Statistical years	Khozestan Water & Power Authority	Eastern Azarbaijan & Ardebil Regional Water Authority	Western Azarbaijan Regional Water Authority	Isfehan Regional Water Authority	Tehran Regional Water Authority	Khorasan Regional Water Authority	West Regional Water Authority	Fars Regional Water Authority	Gilan Regional Water Authority	Mazandaran & Golestan Regional Water Authority	Hormozgan Regional Water Authority
Consulting Service Cost (Billion Rials)	79	2795	-	-	-	39	0	0	0	0	0	50
	80	1298	-	0	222	0	0	0	0	0	0	45
	81	-	-	0	883	0	-	0	8	0	0	0
Dredging Cost (Billion Rials)	79	4701	2647	229	-	842	10	113	759	1051	49	377
	80	4384	-	789	421	810	0	704	457	480	130	381
	81	-	3628	495	361	803	-	-	1482	313	229	420
Service Road Cost (Billion Rials)	79	1917	661	44	-	188	0	124	6	0	21	139
	80	3518	523	75	56	211	0	182	0	0	8	107
	81	-	732	501	112	729	71	0	0	27	25	120
Operation Cost (Billion Rials)	79	32468	7335	0	-	7278	-	-	1791	6772	-	930
	80	47164	9401	2167	507	-	155	-	2744	16701	-	653
	81	-	6851	2591	4089	-	132	-	3630	25840	-	136
Maintenance Cost (Billion Rials)	79	29962	6562	549	-	2441	25	1181	1448	1910	227	930
	80	24540	6172	1499	4086	1930	289	-	774	1066	169	1523
	81	-	8698	1740	6091	7340	376	-	1874	1360	264	1000
Total Cost (Billion Rials)	79	74502	16757	1156	-	9935	397	-	3239	8682	345	1723
	80	71698	15457	3666	4575	12376	421	-	3518	17767	676	2176
	81	-	15694	4331	10180	21163	470	-	5504	27200	-	1136
Total income (Billion Rials)	79	66331	17734	1510	4269	8094	893	419	4908	7958	4371	1661
	80	74850	26189	2893	237	5240	634	-	4837	21350	5636	438
	81	-	30787	6092	5357	15772	0	-	9995	34000	9438	333
Entering Water (MCM)	79	4401	711	72	360	393	28	1929	271	680	105	115
	80	3922	852	335	34	277	857	216	179	1068	349	48
	81	-	1135	568	415	752	-	-	638	1700	195	56
Delivery Water (MCM)	79	3704	612	72	-	303	28	1393	217	605	105	92
	80	3552	776	297	43	219	567	192	141	808	323	48
	81	-	828	512	302	548	-	-	499	1511	165	49
Gross Farm Area (hectar)	79	233320	74326	12977	234700	164000	618	-	50000	90152	11653	151
	80		231200	89414	234700	262000	6884	-	63964	189000	52000	149
	81	-	231200	86200	234700	262000	7330	-	70300	189000	-	78
In Use Farm Area (hectar)	79	145613	74326	12977	105000	164000	-	10500	50000	72121.6	16053	11430
	80	169189	81966	53767	4083	147296	3327	-	24810	152500	16539	5840
	81	-	84126	49017	27840	165603	-	-	50944	185792	-	5946

Table 2- Studied Proportions

Studied Proportions	Statistical years	Khozestan Water& Power Authority	Eastern Azarbaijan & Ardebil Regional Water Authority	Western Azarbaijan Regional Water Authority	Isfahan Regional Water Authority	Tehran Regional Water Authority	Khorasan Regional Water Authority	West Regional Water Authority	Fars Regional Water Authority	Gilan Regional Water Authority	Mazandaran & Golestan Regional Water Authority	Hormozgan Regional Water Authority
Consulting service cost/maintenance costs (%)	2000	9.33	-	-	-	1.60	0.00	0.00	0.00	0.00	0.00	5.38
	2001	5.29	-	0.00	9.71	0.00	0.00	-	0.00	0.00	0.00	2.95
	2002	-	-	0.00	14.50	0.00	-	-	0.43	0.00	0.00	0.00
Dredging canal drain cost/ maintenance cost (%)	2000	15.69	40.34	41.71	-	34.49	40.00	9.57	52.42	55.03	21.59	40.54
	2001	17.86	-	52.64	18.41	41.97	0.00	-	59.04	45.03	76.92	25.02
	2002	-	41.71	28.45	5.93	10.94	-	-	79.08	23.01	86.74	42.00
Service road costs/ maintenance costs (%)	2000	6.40	10.07	8.01	-	7.70	0.00	10.50	0.41	0.00	9.25	14.95
	2001	14.34	8.47	5.00	2.45	10.93	0.00	-	0.00	0.00	4.73	7.03
	2002	-	8.42	28.79	1.84	9.93	18.88	-	0.00	1.99	9.47	12.00
Operation costs/Gross farm area (Billion Rials/ha)	2000	0.14	0.10	0.00	-	0.04	-	-	0.04	0.08	0.01	6.16
	2001	-	0.04	0.02	0.00	-	0.02	-	0.04	0.09	0.01	4.38
	2002	-	0.03	0.03	0.02	-	0.02	-	0.05	0.14	-	1.74
Maintenance costs/Gross farm area (Billion Rials/ha)	2000	0.13	0.09	0.04	-	0.01	0.04	-	0.03	0.02	0.02	6.16
	2001	-	0.03	0.02	0.02	0.01	0.04	-	0.01	0.01	0.00	10.22
	2002	-	0.04	0.02	0.03	0.03	0.05	-	0.03	0.01	-	12.82
Operation costs/Net farm area (Billion Rials/ha)	2000	0.22	0.10	0.00	-	0.04	-	-	0.04	0.09	0.01	0.08
	2001	0.28	0.11	0.04	0.12	-	0.05	-	0.11	0.11	0.03	0.11
	2002	-	0.08	0.05	0.15	-	-	-	0.07	0.14	-	0.02
Maintenance costs/Net farm area (Billion Rials/ha)	2000	0.21	0.09	0.04	-	0.01	-	0.11	0.03	0.03	0.01	0.08
	2001	0.15	0.08	0.03	1.00	0.01	0.09	-	0.03	0.01	0.01	0.26
	2002	-	0.10	0.04	0.22	0.04	-	-	0.04	0.01	-	0.17
Total costs/Gross farm area (Billion Rials/ha)	2000	0.32	0.23	0.09	-	0.06	0.64	-	0.06	0.10	0.03	11.41
	2001	-	0.07	0.04	0.02	0.05	0.06	-	0.05	0.09	0.01	14.60
	2002	-	0.07	0.05	0.04	0.08	0.06	-	0.08	0.14	-	14.56

Table 3- Studied Proportions

Studied Proportions	Statistical years	Khozestan Water& Power Authority	Eastern Azarbaijan & Ardebil Regional Water Authority	Western Azarbaijan Regional Water Authority	Isfahan Regional Water Authority	Tehran Regional Water Authority	Khorasan Regional Water Authority	West Regional Water Authority	Fars Regional Water Authority	Gilan Regional Water Authority	Mazandaran & Golestan Regional Water Authority	Hormozgan Regional Water Authority
Total costs/Net farm area (Billion Rials/ha)	2000	0.51	0.23	0.09	-	0.06	-	-	0.06	0.12	0.02	0.15
	2001	0.42	0.19	0.07	1.12	0.08	0.13	-	0.14	0.12	0.04	0.37
	2002	-	0.19	0.09	0.37	0.13	-	-	0.11	0.15	-	0.19
Total irrigation water charge/Gross farm area (Billion Rials/ha)	2000	0.28	0.24	0.12	0.02	0.05	1.44	-	0.10	0.09	0.38	11.00
	2001	-	0.11	0.03	-	0.02	0.09	-	0.08	0.11	0.11	2.94
	2002	-	0.13	0.07	0.02	0.06	0.00	-	0.14	0.18	-	4.27
Total irrigation water charge/Net farm area (Billion Rials/ha)	2000	0.46	0.24	0.12	0.04	0.05	-	0.04	0.10	0.11	0.27	0.15
	2001	0.44	0.32	0.05	0.06	0.04	0.19	-	0.19	0.14	0.34	0.08
	2002	-	0.37	0.12	0.19	0.10	-	-	0.20	0.18	-	0.06
Operation costs/Total costs (%)	2000	43.58	43.77	-	-	73.26	-	-	55.29	78.00	34.20	53.98
	2001	65.78	60.82	59.11	11.08	-	36.82	-	78.00	94.00	75.00	30.01
	2002	-	43.65	59.82	40.17	-	28.09	-	65.95	95.00	-	11.97
Maintenance costs/Total costs (%)	2000	40.22	39.16	47.49	-	24.57	6.30	-	44.71	22.00	65.80	53.98
	2001	34.23	39.93	40.89	89.31	15.59	68.65	-	22.00	6.00	25.00	69.99
	2002	-	55.42	40.18	59.83	34.68	80.00	-	34.05	5.00	-	88.03
operation costs/Total irrigation water charge (%)	2000	48.95	41.36	-	-	89.92	-	-	36.49	85.10	2.70	55.99
	2001	63.01	35.90	74.90	213.92	-	24.45	-	56.73	78.22	9.00	149.09
	2002	-	22.25	42.53	76.33	-	-	-	36.32	76.00	-	40.84
Maintenance costs/Total irrigation water charge (%)	2000	45.17	37.00	36.36	-	30.16	0.03	-	29.50	24.00	5.19	55.99
	2001	32.79	23.57	51.81	1724.05	36.83	45.58	-	16.00	4.99	3.00	347.72
	2002	-	28.25	28.56	113.70	46.54	-	-	18.75	4.00	2.80	300.30
Total irrigation water charge/Total costs	2000	0.89	1.06	1.31	-	0.81	2.25	-	1.52	0.92	12.67	0.96
	2001	1.04	1.69	0.79	0.05	0.42	1.51	-	1.37	1.20	8.34	0.20
	2002	-	1.96	1.41	0.53	0.75	-	-	1.82	1.25	-	0.29

3. DISCUSSION

Tables 1 and 2 show that in the year 2000 and 2001 KWPA is the most costly in operation, maintenance and total costs and of course with the maximum allocated and delivery water volume to the irrigation and drainage networks. So KWPA earned the most water charge but in the year 2002 GRWA was the first.

Chart 1- Operation & maintenance costs

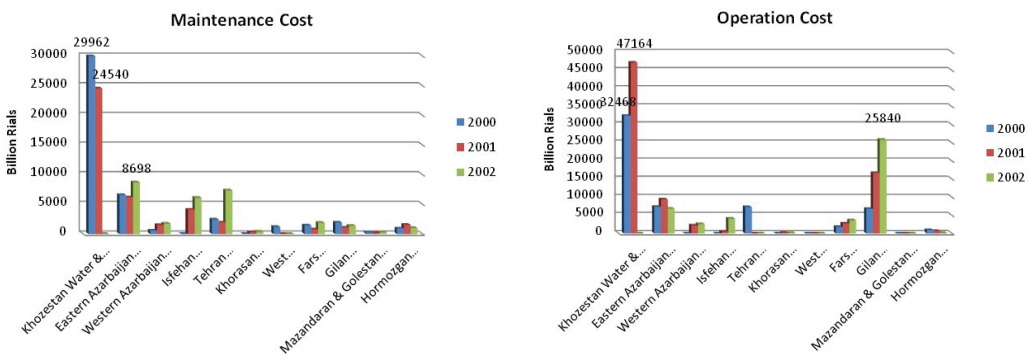
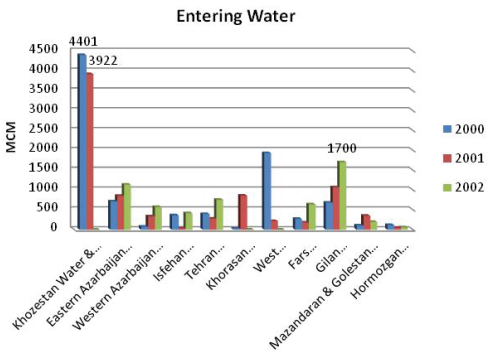


Chart 2- Entering &delivering water volume



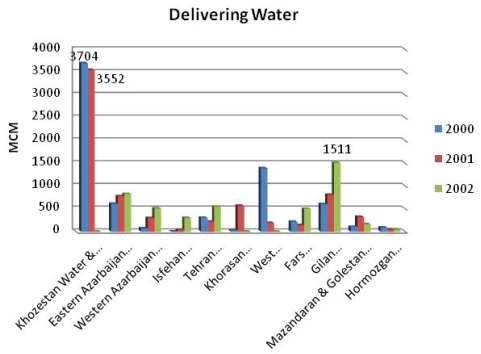
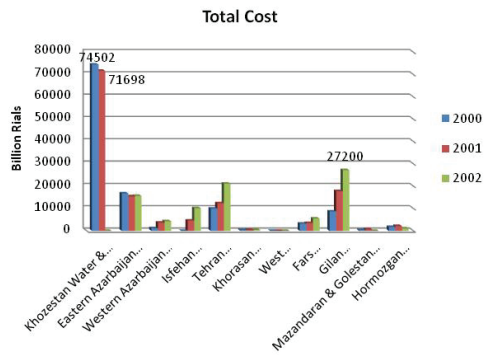


Chart 3- Total cost & water charge



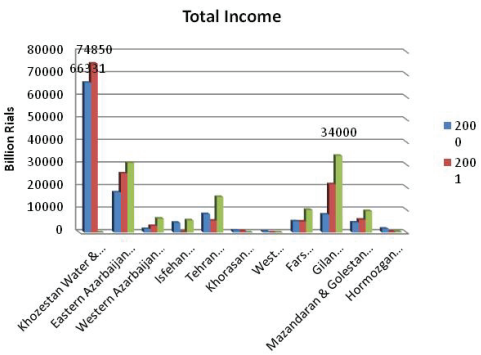


Chart 4- Gross farm area

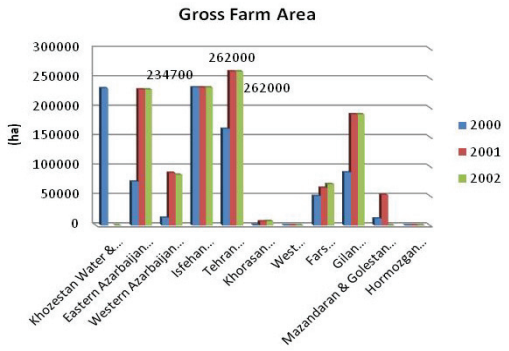
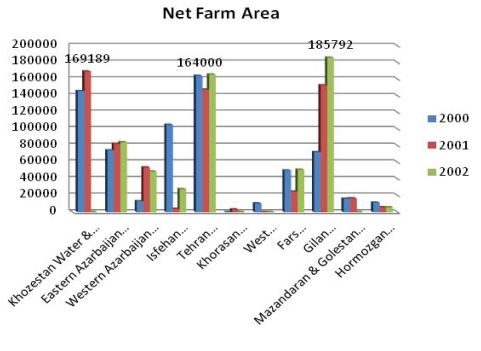


Chart 5- Net farm area

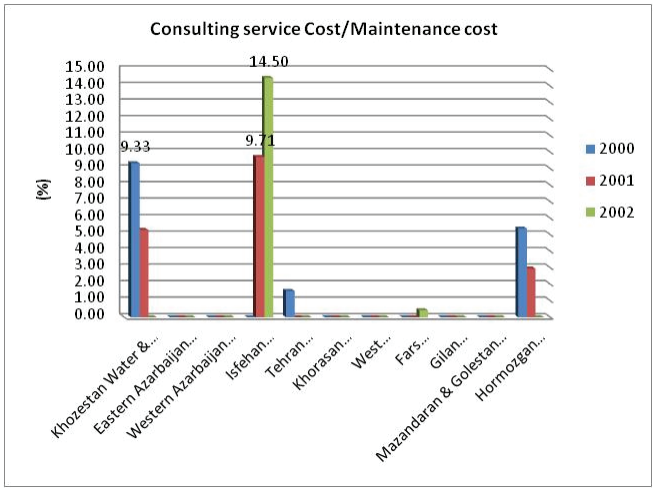


About the gross farm area IRWA in the year 2000 with the 234700 hectares and in the years 2001 and 2002 Tehran regional water authority with the 262000 hectares are the first one. Though IRWA and TRWA have the maximum gross farm area in the different years but with respect to the net farm TRWA with 164000 hectares in 2000, KWPA with 169189 hectares in 2001 and GRWA with 185792 hectares in 2002 are the maximum.

As it is seen in the table number 2 and 3 consulting service, dredging canal and drain and service road costs are the parts of the maintenance costs so they were considered in the maintenance costs for better presentation of the results.

- Consulting service costs in 2000 Khuzestan (9%) and Isfahan in 2001 and 2002 (10%, 15%) are the first.

Chart 6- Consulting service costs/maintenance costs



- Considering the dredging of canal and drain in two Northern regional water authority GRWA in 2000 (55%) and MRWA & Golestan in 2001 and 2002 (77%, 87%) are maximum.

Chart 7- Dredging costs/maintenance costs

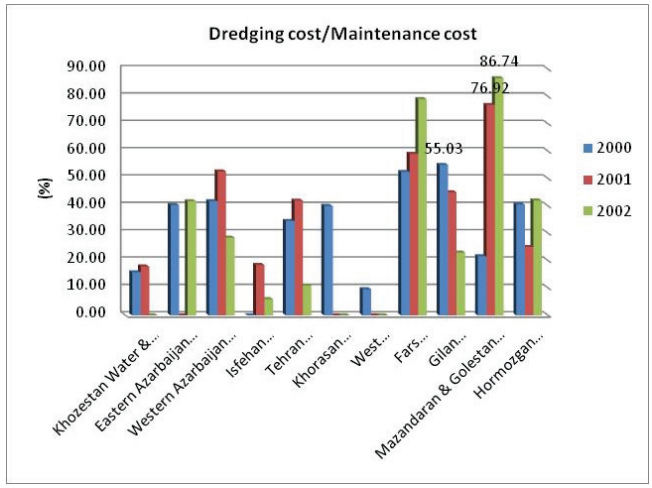
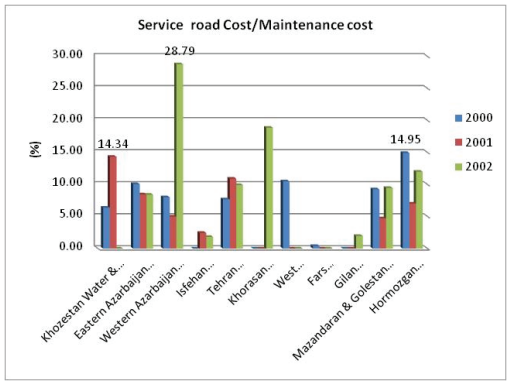


Chart 8- Service road costs/maintenance costs



- HRWA in 2000 (15%), KWPA in 2001 (14%) and Western Azerbaijan in 2002 (29%) have the most service road costs within the maintenance costs.

- With respect to “operation & maintenance costs/gross farm area” HRWA during the 3 years is in the first grade.

Chart 9- Maintenance costs/gross farm area

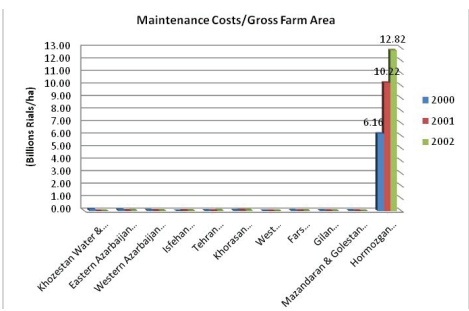
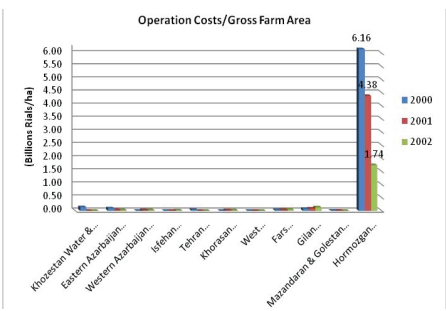


Chart 10- Operation costs/gross farm area



- “Total costs & water charge/gross farm area” HRWA during the 3 years is in the top list.

Chart 11- Total costs/gross farm area

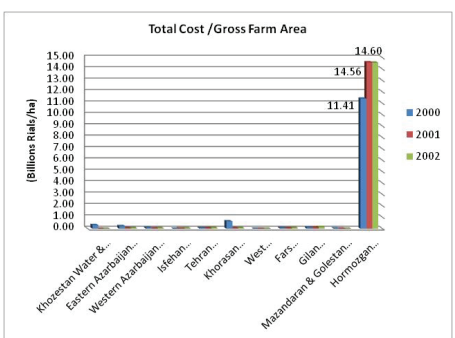
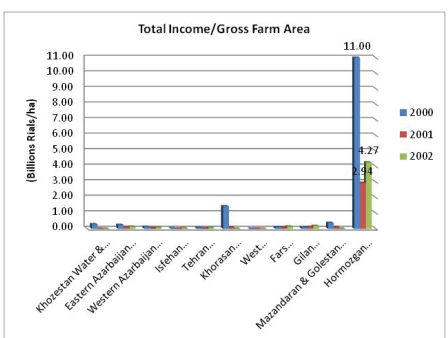
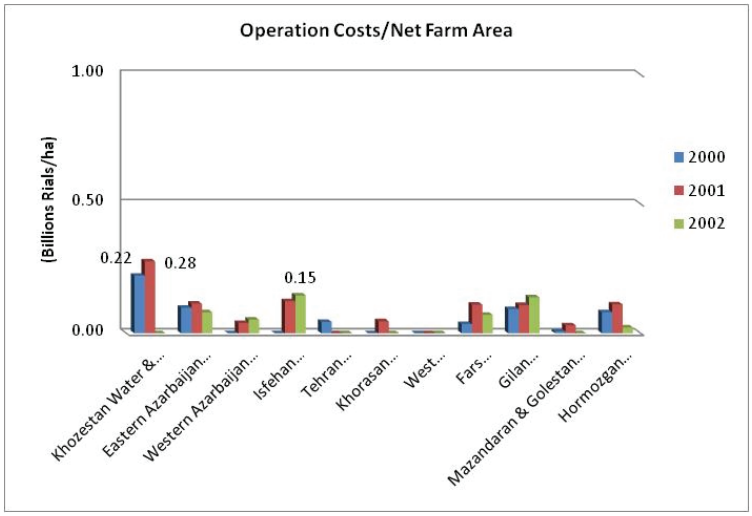


Chart 12- Total water charge/gross farm area



- "Operation costs / net farm area": in 2000, 2001 KWPA (2.2, 2.8 (billion Rials/Ha), in 2002 IRWA (1.5 (billion Rials/Ha) are the maximum.

Chart 13- Operation costs/net farm area



- "Maintenance costs /net farm area" HRWA in the years 2000 and 2002 is maximum and in 2001 IRWA is in the first grade.

Chart 14- Maintenance costs/gross farm area

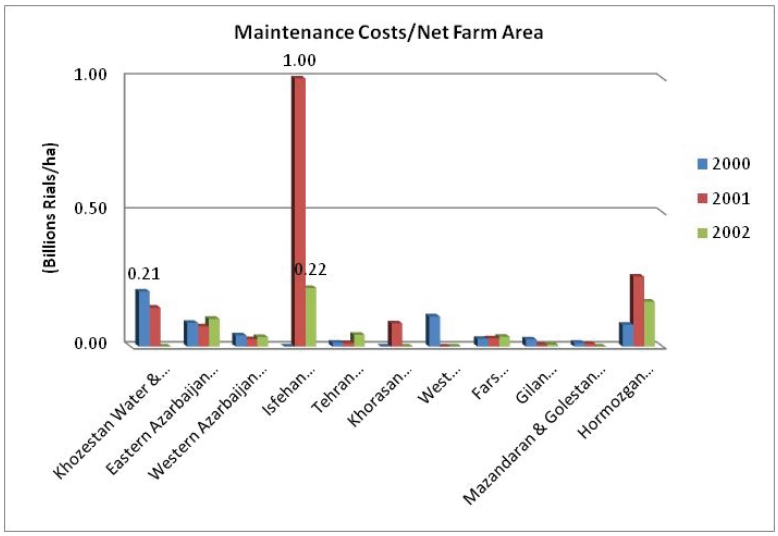
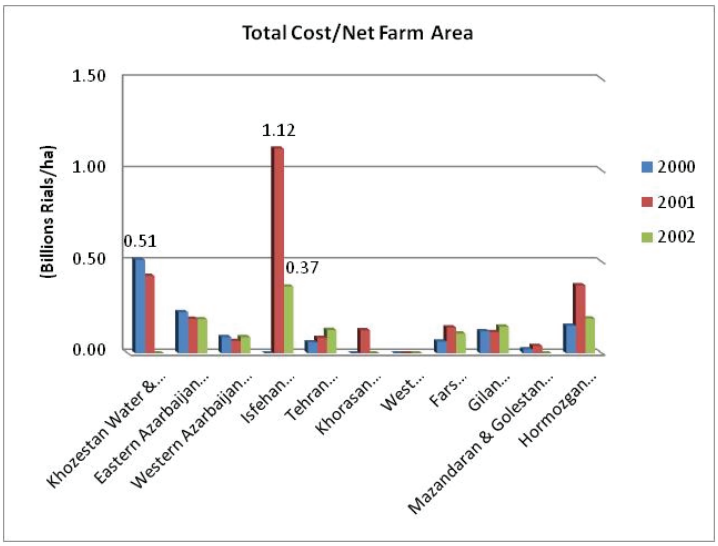
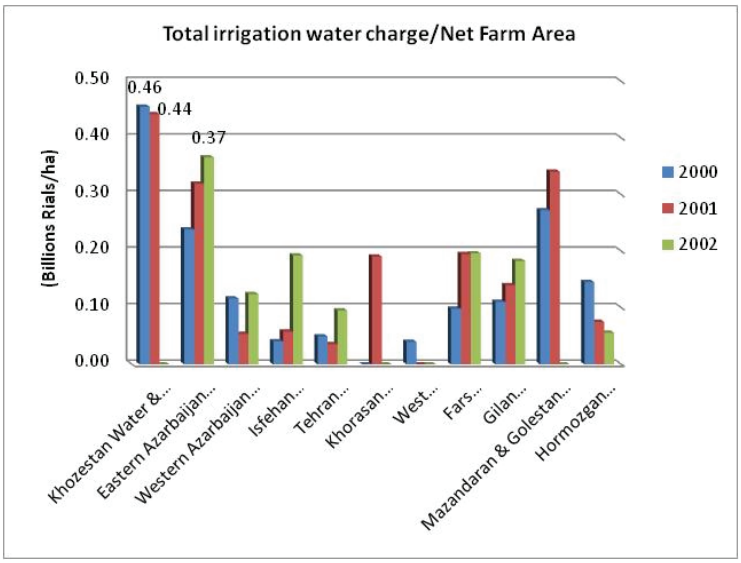


Chart 15- Total costs/net farm area



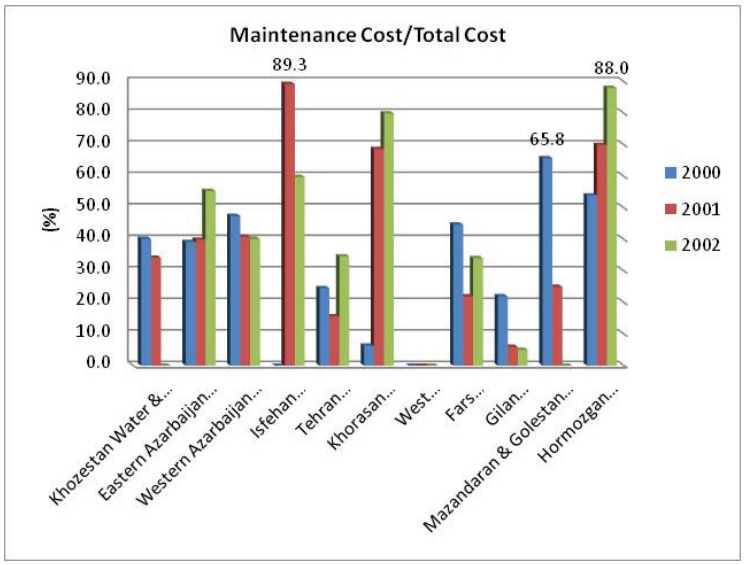
- "Total costs/net farm area": KWPA in 2000 and IRWA in 2001 and 2002 are in the top list.
- "Total water charge/net farm area": in 2000 and 2001 KWPA and in 2002 Eastern ARWA takes the lead.

Chart 16- Total water charge/net farm area



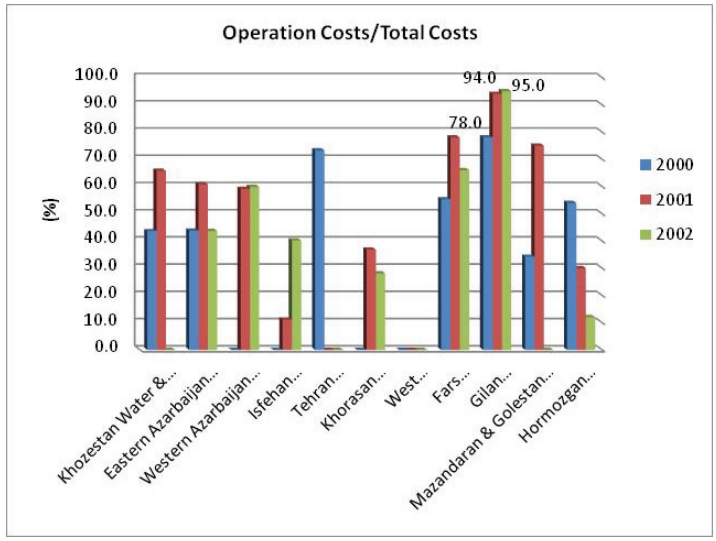
- "Maintenance costs/Total costs": MRWA & Golestan (66%), IRWA (89%) and HRWA (88%) regional water authority in the years 2000, 2001 1nd 2002 are in the top list.

Chart 17- Maintenance costs/total costs



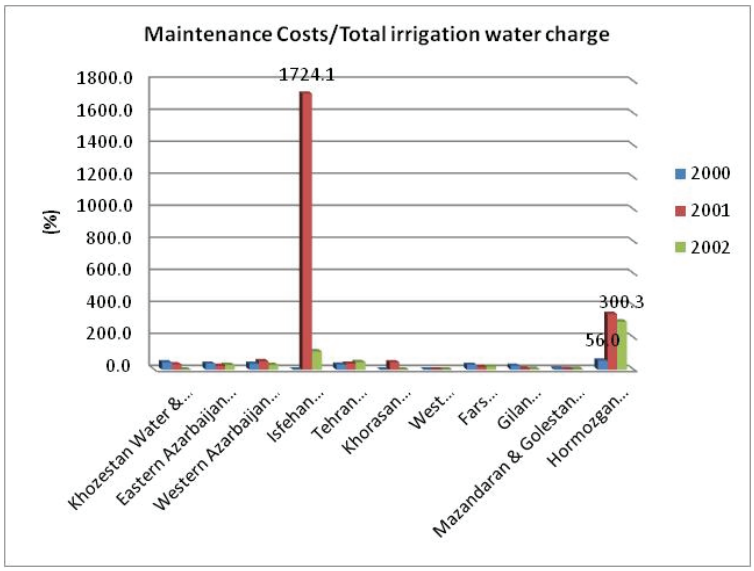
- "Operation costs/total costs": GRWA is above all during 3 years. (78%, 94% and 95%)

Chart 18- Operation costs/total costs



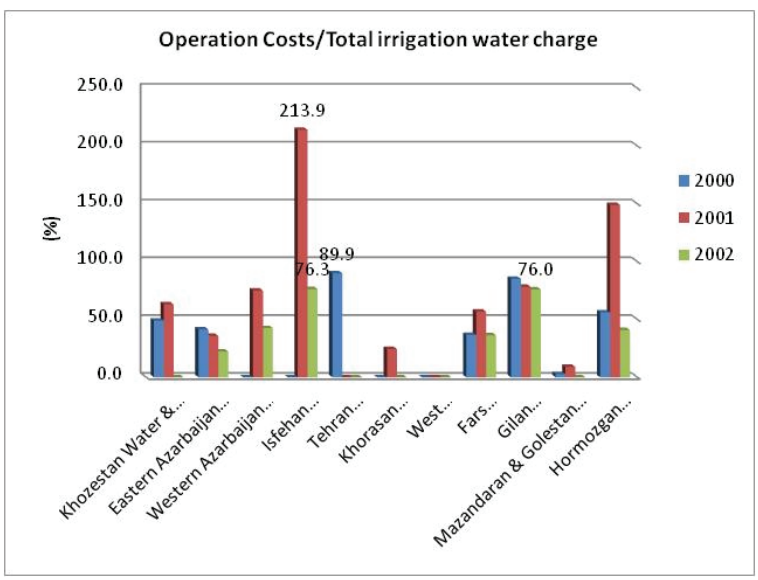
- "Maintenance costs/total water charge": in 2000 KWPA (45%), in 2001 IRWA (1724%) and in 2002 HRWA (300%) are above all.

Chart 19- Maintenance costs/total water charge



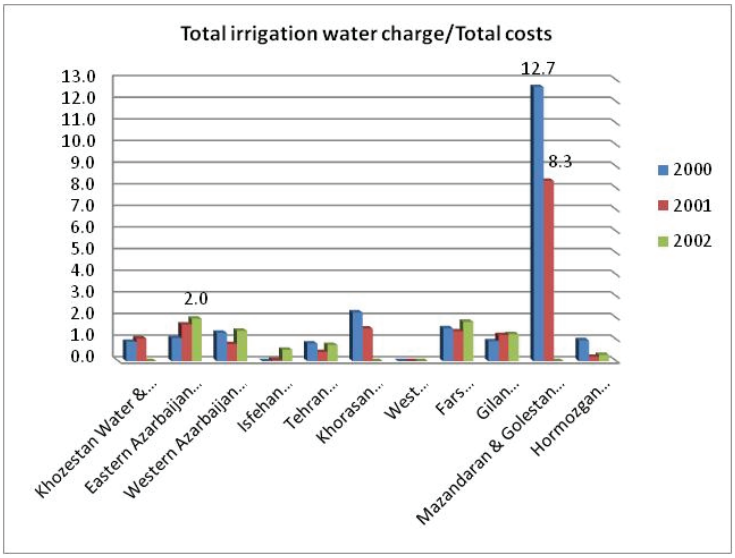
- "Operation costs/total water charge": TRWA in 2000 (89%), IRWA in 2001 and 2002 (213%, 76%) are maximum.

Chart 20- Operation costs/total water charge



- "Total water charge/ total costs": MRWA & Golestan regional water authority in 2 years 2000 and 2001 and EARWA in 2002 are above of others.

Chart 21- total water charge/total costs



3. CONCLUSIONS

The results of comparing the indices show that in most regional water authorities the changes of irrigation water exceed the all operation and maintenance costs of networks. Hence having regular and attentive maintenance and operation systems in irrigation and drainage network provides more beneficial outcomes and return of invested capital.

Another important finding was that the suitable cropping pattern relative to climate, soil type and society culture of each region and of course the crop yield marketing would improve the project outcomes considerably.

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