ANNEX - B

GEOLOGY AND HYDROGEOROLOGY

ANNEX - B

GEOLOGY AND HYDROGEOLOGY

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ANNEX - B

GEOLOGY AND HYDROGEOLOGY

1 General

The details of the hydrogeological investigation in the Kzyl-Orda Left Bank Area are reported herein. Existing data on hydrogeology were collected from the Kzyl-Orda Hydrogeology and the Kzyl-Orda Hydrogeology and Land Reclamation Expedition in Kzyl-Orda. There are about 1,100 existing observation wells on the both bank of the Syr-Darya river, about 650 wells in the Left Bank Area. According to the result of evaluation on the existing data, the data on groundwater of 372 observation wells can be used for the study.

The core borings at 30 points in a depth of 10 m with permeability test and rehabilitation of 20 existing observation wells were performed in the area by local contractor under sub-let contract. Locations of new core boring is planned in parallel and in a cross arrangement to Syr-Darya river. These new wells are supplemented by rehabilitated wells.(Refer to Table B.1 and B.2)

2 Geology

The new core borings at 30 points have confirmed that top soils are composed of clay, loam and sand at or near the surface, which are unconsolidated deposits. The sedimentary faces and thickness of these deposits change irregularly, both laterally and vertically. Figure B.1 shows the location of new core borings, rehabilitated wells and existing observation wells. Geological feature of each deposits is as follows :

(a) Top Soil

Top soil is found at all the core boring spots, which has a thickness of about 0.5 m and contain humus occasionally.

(b) Sand

Sand is predominated in the underlying unconsolidated deposits of top soil. The thickness attains a maximum of more than 7.5 m. Sandy layer is composed of fine to medium-grained sand. Generally, sandy layer is covered by clayey or loamy ayers. Sandy layer appears directly under top soil only in southern part of Terenozek Raion.

(c) Loam

Loamy layers occur at several stratigraphic horizons and appear all over the area. The layers have a maximum thickness of 5.5 m. Loamy layers are mixed with the same sand irregularly.

(d) Clay

Clayey layers occur at several stratigraphic horizons and appear all over the area. Clayey layers may be composed of clay and heavy clay. The heavy clay is very tough and contain organic substances. The clay has a maximum thickness of 5 m. The heavy clay has a maximum thickness of 7 m.

3 Hydrogeology

(1) Distribution of Groundwater

Groundwater level varies between EL.98 m to EL.123 m. Groundwater level becomes low in the western part of the area. The feature described above shows that groundwater in the area flows approximately east to west (Refer to Figure B.2).

Generally, groundwater table is generally formed according to the landform of the area in case of the unconsolidated deposits of the alluvium age. The landform of this area is flat and inclines westward simply. However, the groundwater table is complicated: it is forming the ridge, the valley and a small basin in a few parts of the Kzyl-Orda Left Bank Area. Groundwater level is high alongside the canals, whereas it becomes low alongside the collectors. From this fact, it may be inferred that the distribution of groundwater of the area is affected by the layouts of irrigation canals and collectors.

(2) Relationship between Groundwater and River

Groundwater level is lower than the riverbed at the river side for the reaches from the Syrdarya Raion to the Zhalagash Raion in March and October. On the other hand, it is nearly same or a little higher than the riverbed in Karmakshy Raion. This condition shows that the Syr-Drya river is influential to the groundwater table in the reaches from the Syrdarya Raion to the Zhalagash Raion in March and October.

(3) Seasonal Fluctuation of Groundwater Level

Groundwater level in March and October is nearly same, but it ascends about 2 m in June in the whole area.

(4) Groundwater Quality

(a) Composition of Salinity

According to the result of water quality test over the existing observation wells, groundwater is not variable in composition of salinity through the year. The composition of salinity is of SO4- - followed in the order of abundance by Na++, Cl-, Mg++, Ca++ and HCO3-.(Tables B.3 through B.5 and Figure B.3)

Composition of salinity has a general tendency of decrease in percentage of Ca++ and HCO3-, and increase in percentage of Na++ and Cl-, when salinity concentration becomes high.(Refer to Figure B.4)

(b) Salinity Concentration

Salinity concentrations range from approximately 700 to 36,000 mg/lit throughout the year. The area shows salinity concentration equal to or less than 2,000 mg/lit in some parts of Syr Darya Raion, Terenozek Raion and the southwestern part of Karmakshy Raion. As for the area other than these, the salinity concentration is equal to or more than 2,000 mg/lit. About 60% of the Kzyl-Orda Left Bank Area shows salinity concentration of more than 2,000 mg/lit.

The salinity concentration becomes high in the areas around the valley or small basins where groundwater is accumulated.

(c) Relationship between Salinity Concentration and Groundwater Level

Salinity concentration has no relation to groundwater level. The distribution of salinity concentration is complex; variable relating to groundwater level (Figure B.5).

Tables

Table B.1 List of Core Boring and Result of Permeability Test

No	Core drillings				Groundwater		Permeability Test			Remark
	Name	Raion	Farm	GL (m)	Depth (m)	GWL (EL. m)	Depth (m)	Geology	Permeability coefficien k (cm/sec)	A Above GWL B Below GWL
1	B1	Syrdarya	KZ-MIS	124.20	2.00	122.20	2.00	Loamy soil	1.83×10^{-3}	A
							3.00	Clay	1.51×10^{-5}	B
2	B2			124.30	2.75	121.55	2.00	Fine sand	1.46×10^{-3}	A , Observation well
							4.00	Fine sand	5.97×10^{-3}	B
3	B3		Zhambul	124.40	1.10	123.30	1.00	Clay	7.11×10^{-5}	A
							-	-	-	B
4	B4	Terenozek	Ilyasov	121.60	2.50	119.10	2.00	Clay	4.71×10^{-4}	A
							4.00	Clay	1.73×10^{-5}	B
5	B5			120.50	2.50	118.00	2.00	Heavy Clay	1.79×10^{-2}	A
							4.00	Heavy Clay	7.40×10^{-3}	B
6	B6			118.38	3.30	115.08	3.00	Clay	2.74×10^{-4}	A
							5.00	Clay	1.83×10^{-4}	B
7	B7		Shikkeli	121.25	2.50	118.75	2.00	Loam	3.54×10^{-3}	A , Observation well
							4.00	Sandy loam	1.12×10^{-3}	B
8	B8		Shagan	117.30	2.60	114.70	2.00	Sandy loam	2.47×10^{-3}	A , Observation well
							4.00	Clay	4.46×10^{-5}	B
9	B9			117.50	3.00	114.50	2.00	Loamy soil	1.47×10^{-4}	A , Observation well
							4.00	Sand	1.50×10^{-3}	B
10	B10			118.50	2.60	115.90	2.00	Loamy soil	4.49×10^{-4}	A , Observation well
							4.00	Clay	1.26×10^{-4}	B
11	B11		Akzharma	117.11	2.00	115.11	2.00	Sand	1.18×10^{-2}	A
							4.00	Sand	6.47×10^{-5}	B
12	B12			116.57	2.70	113.87	2.00	Loam	5.26×10^{-3}	A
							4.00	Loam	2.31×10^{-3}	B
13	B13			114.93	2.80	112.13	2.00	Loam	3.57×10^{-3}	A
							4.00	Loam	3.85×10^{-3}	B
14	B14			115.40	3.00	112.40	2.00	Sand	7.60×10^{-3}	A , Observation well
							4.00	Heavy Clay	3.42×10^{-3}	B
15	B15	Zhalagash	Akkumski	114.00	3.00	111.00	2.00	Heavy Clay	6.25×10^{-4}	A
							4.00	Heavy Clay	5.65×10^{-3}	B
16	B16			112.90	2.60	110.30	2.00	Clay	7.34×10^{-4}	A , Observation well
							4.00	Loamy soil	2.27×10^{-4}	B
17	B17		Kazakstan	113.60	2.60	111.00	2.00	Heavy Clay	2.02×10^{-3}	A
							4.00	Heavy Clay	9.52×10^{-6}	B
18	B18			112.80	2.70	110.10	2.00	Loam	4.48×10^{-3}	A
							4.00	Clay	1.00×10^{-5}	B
19	B19		Bukarbaibatir	110.80	3.30	107.50	2.00	Heavy Clay	1.29×10^{-3}	A
							4.00	Heavy Clay	1.02×10^{-5}	B
20	B20			112.10	2.60	109.50	2.00	Heavy Clay	9.21×10^{-5}	A
							4.00	Loam	6.18×10^{-6}	B
21	B21		Madeniet	108.40	2.40	106.00	2.00	Clay	2.23×10^{-3}	A
							4.00	Clay	1.06×10^{-5}	B
22	B22			108.40	2.50	105.90	2.00	Clay	3.19×10^{-4}	A
							4.00	Loam	1.23×10^{-5}	B
23	B23			109.80	2.20	107.60	2.00	Sand	2.19×10^{-3}	A
							3.00	Sand	1.63×10^{-5}	B
24	B24		Tan	110.50	2.50	108.00	2.00	Loamy soil	1.45×10^{-3}	A , Observation well
							4.00	Loamy soil	5.10×10^{-6}	B
25	B25			108.90	1.50	107.40	1.00	Clay	8.85×10^{-3}	A
							4.00	Loamy soil	1.05×10^{-5}	B
26	B26	Karmakshy	Thapaev	105.20	2.60	102.60	2.00	Clay	7.74×10^{-4}	A , Observation well
							4.00	Loamy soil	4.78×10^{-3}	B
27	B27		III-International	104.50	2.60	101.90	2.00	Clay	3.05×10^{-3}	A
							4.00	Loam	8.05×10^{-6}	B
28	B28		Zhanahol	103.20	3.00	100.20	3.00	Loam	2.19×10^{-3}	B
							5.00	Loam	1.25×10^{-3}	B
29	B29		Thapaev	102.00	2.70	99.30	2.00	Sand	5.58×10^{-4}	A , Observation well
							4.00	Sand	8.55×10^{-6}	B
30	B30		Zhanazhol	103.90	3.00	100.90	2.00	Heavy Clay	6.69×10^{-3}	A
							4.00	Heavy Clay	8.05×10^{-6}	B

Table B.2 List of Rehabilitation Well

No.	Name	Location		G.L.	Groundwater		Oliginal
		Raion	Farm	(m)	Depth (m)	E.L. (m)	well name
1	R1	Zhalagash	Akkumski	113.60	2.90	110.70	-
2	R2	Terenozek	Akzharma	113.84	3.60	110.24	1
3	R3	Zhalagash	Bukarbaibatir	114.00	2.41	111.59	-
4	R4		Akkumski	113.00	2.60	110.40	1
5	R5		Kazakhstan	112.80	3.45	109.35	14
6	R6		Bukarbaibatir	110.00	2.38	107.62	6
7	R7		Kazakhstan	111.10	3.60	107.50	3
8	R8		Bukarbaibatir	112.10	2.23	109.87	26
9	R9		Zhanatalan	111.10	2.50	108.60	21
10	R10		Zhanatalan	109.10	2.65	106.45	12
11	R11		Zhanatalan	109.15	2.80	106.35	5
12	R12		Tan	110.20	2.10	108.10	-
13	R13	Karmakshy	Akzharskii	108.70	3.05	105.65	-
14	R14		Akzharskii	108.70	2.87	105.83	-
15	R15		Akzharskii	108.70	2.75	105.95	34
16	R16		Akzharskii	104.20	3.23	100.97	4
17	R17		III-International	104.60	2.90	101.70	38
18	R18		Thapaevo	105.70	2.40	103.30	13
19	R19		III-International	104.50	3.12	101.38	-
20	R20		Zhanazhol	104.60	3.15	101.45	-

Table B.3 Chemical Analyses of Groundwater in the Existing Well (March, 1995)

(Unit : × 1000 ppm)

Total Saline (ppm)	Ca2+	Mg2+	Na+	HCO3-	Cl-	SO42-	Total
700≦TS<1200	3.8	1.5	1.8	6.9	2.6	9.8	26.4
	14%	6%	7%	26%	10%	37%	100%
1200≦TS<2000	12	7.8	14.1	16.8	18.8	48.3	117.8
	10%	7%	12%	14%	16%	41%	100%
2000≦TS<3500	22.6	23.4	54.2	31	57.1	156	344.3
	7%	7%	16%	9%	17%	45%	100%
3500≦TS<6500	28.1	37.4	98.7	42.3	108.2	246.4	561.1
	5%	7%	18%	8%	19%	44%	100%
6500≦TS<8000	5.2	10.5	26	10.6	26.5	60.9	139.7
	4%	8%	19%	8%	19%	44%	100%
8000≦TS	11.2	21.6	80	73	76.7	146.5	409
	3%	5%	20%	18%	19%	36%	100%
Total	82.9	102.2	274.8	180.6	289.9	667.9	1598.3
	5%	6%	17%	11%	18%	42%	100%

(Unit : meq/l)

Total Saline (ppm)	Ca2+	Mg2+	Na+	HCO3-	Cl-	SO42-	Total
700≦TS<1200	188.7	123.5	78.3	113.9	73.4	203.8	781.6
	24%	16%	10%	15%	9%	26%	100%
1200≦TS<2000	597.6	637.2	614.7	275.2	530.2	1005	3659.9
	16%	17%	17%	8%	14%	27%	100%
2000≦TS<3500	1129.5	1920.3	2358	509	1610.4	3244.2	10771.4
	10%	18%	22%	5%	15%	30%	100%
3500≦TS<6500	1399.7	3077.4	4292.1	694.3	3050.3	5124.9	17638.7
	8%	17%	24%	4%	17%	29%	100%
6500≦TS<8000	261.7	863.1	1129.1	173.8	747.5	1267.5	4442.7
	6%	19%	25%	4%	17%	29%	100%
8000≦TS	559.8	1777	3478	1196.4	2164.2	3047.9	12223.3
	5%	15%	28%	10%	18%	25%	100%
Total	4137	8398.5	11950.2	2962.6	8176	13893.3	49517.6
	9%	17%	24%	6%	16%	28%	100%

Table B.4 Chemical Analyses of Groundwater in the Existing Well (June, 1995)

(Unit : × 1000 ppm)

Total Saline (ppm)	Ca^{2+}	Mg^{2+}	Na^{+}	HCO_3^-	Cl^-	SO_4^{2-}	Total
700≦TS<1200	1.1 10%	1.1 10%	0.8 7%	3.1 29%	2.1 20%	2.6 24%	10.7 100%
1200≦TS<2000	7.7 9%	9.2 10%	7.5 8%	13.2 15%	20.8 23%	30.6 34%	89.1 100%
2000≦TS<3500	14.7 7%	22.4 10%	26.5 12%	14.9 7%	45.0 20%	99.8 45%	223.4 100%
3500≦TS<6500	17.7 5%	25.2 7%	63.2 18%	9.8 3%	74.9 21%	164.4 46%	355.3 100%
6500≦TS<8000	2.7 4%	7.1 9%	15.0 20%	2.3 3%	24.2 32%	24.5 32%	75.8 100%
8000≦TS	10.7 2%	38.7 6%	162.0 26%	5.4 1%	181.2 29%	226.7 36%	622.7 100%
Total	54.9 4%	102.3 7%	275.6 20%	49.3 4%	349.4 25%	550.5 40%	1382.0 100%

(Unit : meq/l)

Total Saline (ppm)	Ca^{2+}	Mg^{2+}	Na^{+}	HCO_3^-	Cl^-	SO_4^{2-}	Total
700≦TS<1200	55.4 16%	86.3 25%	33.0 10%	51.0 15%	59.2 17%	54.1 16%	339.0 100%
1200≦TS<2000	384.3 13%	759.1 26%	326.6 11%	216.9 7%	587.3 20%	636.6 22%	2910.8 100%
2000≦TS<3500	735.7 10%	1843.3 25%	1153.1 16%	244.2 3%	1267.7 17%	2076.7 28%	7320.7 100%
3500≦TS<6500	881.5 8%	2075.0 18%	2749.8 24%	161.0 1%	2113.5 19%	3420.3 30%	11401.0 100%
6500≦TS<8000	132.5 5%	584.4 22%	654.2 25%	37.3 1%	682.5 26%	510.4 20%	2601.3 100%
8000≦TS	532.8 3%	3020.0 15%	7045.2 34%	89.4 0%	5109.4 25%	4715.4 23%	20512.1 100%
Total	2722.8 6%	8369.4 18%	11983.1 26%	800.0 2%	9820.8 22%	11414.9 26%	45090.9 100%

Table B.5 Chemical Analyses of Groundwater in the Existing Well (October, 1995)

(Unit : × 1000 ppm)

Total Saline (ppm)	Ca2+	Mg2+	Na+	HCO3-	Cl-	SO42-	Total
700≦TS<1200	2.1	1.3	1.5	4	3.6	5.1	17.6
	12%	7%	9%	23%	20%	29%	100%
1200≦TS<2000	5.4	6.7	8.0	5.8	118.7	30.6	175.8
	3%	4%	5%	3%	68%	17%	100%
2000≦TS<3500	24.1	19.8	48.3	22.9	41.8	157.8	314.7
	8%	6%	15%	7%	13%	50%	100%
3500≦TS<6500	17.7	24.2	70.7	14.6	69.4	171	367.6
	5%	7%	19%	4%	19%	47%	100%
6500≦TS<8000	3.7	9.6	32.3	4.4	29.7	63.7	143.4
	3%	7%	23%	3%	21%	44%	100%
8000≦TS	11.5	41.5	96.4	9.5	143.8	188	490.7
	2%	8%	20%	2%	29%	38%	100%
Total	64.5	103.1	257.8	61.2	407	616.2	1509.8
	4%	7%	17%	4%	27%	41%	100%

(Unit : meq/l)

Total Saline (ppm)	Ca2+	Mg2+	Na+	HCO3-	Cl-	SO42-	Total
700≦TS<1200	104.9	106.6	63.9	65.7	101.9	106.8	549.8
	19%	19%	12%	12%	19%	19%	100%
1200≦TS<2000	270.4	550.3	374.9	94.8	334.6	637.2	2262.2
	12%	24%	17%	4%	15%	28%	100%
2000≦TS<3500	120.5	1624.8	2102.2	375.5	1178.7	3283.1	8684.8
	1%	19%	24%	4%	14%	38%	100%
3500≦TS<6500	884.7	1987.3	3075.2	239.1	1957.4	3556.5	11700
	8%	17%	26%	2%	17%	30%	100%
6500≦TS<8000	185.8	787.6	1404.5	72.3	838.9	1323.9	4613
	4%	17%	30%	2%	18%	29%	100%
8000≦TS	575.7	3411.3	4192.5	155.7	4100	3910.4	16346
	4%	21%	26%	1%	25%	24%	100%
Total	2142	8467.9	11213	1003.1	8511.5	12818	44156
	5%	19%	26%	2%	19%	29%	100%

Figures

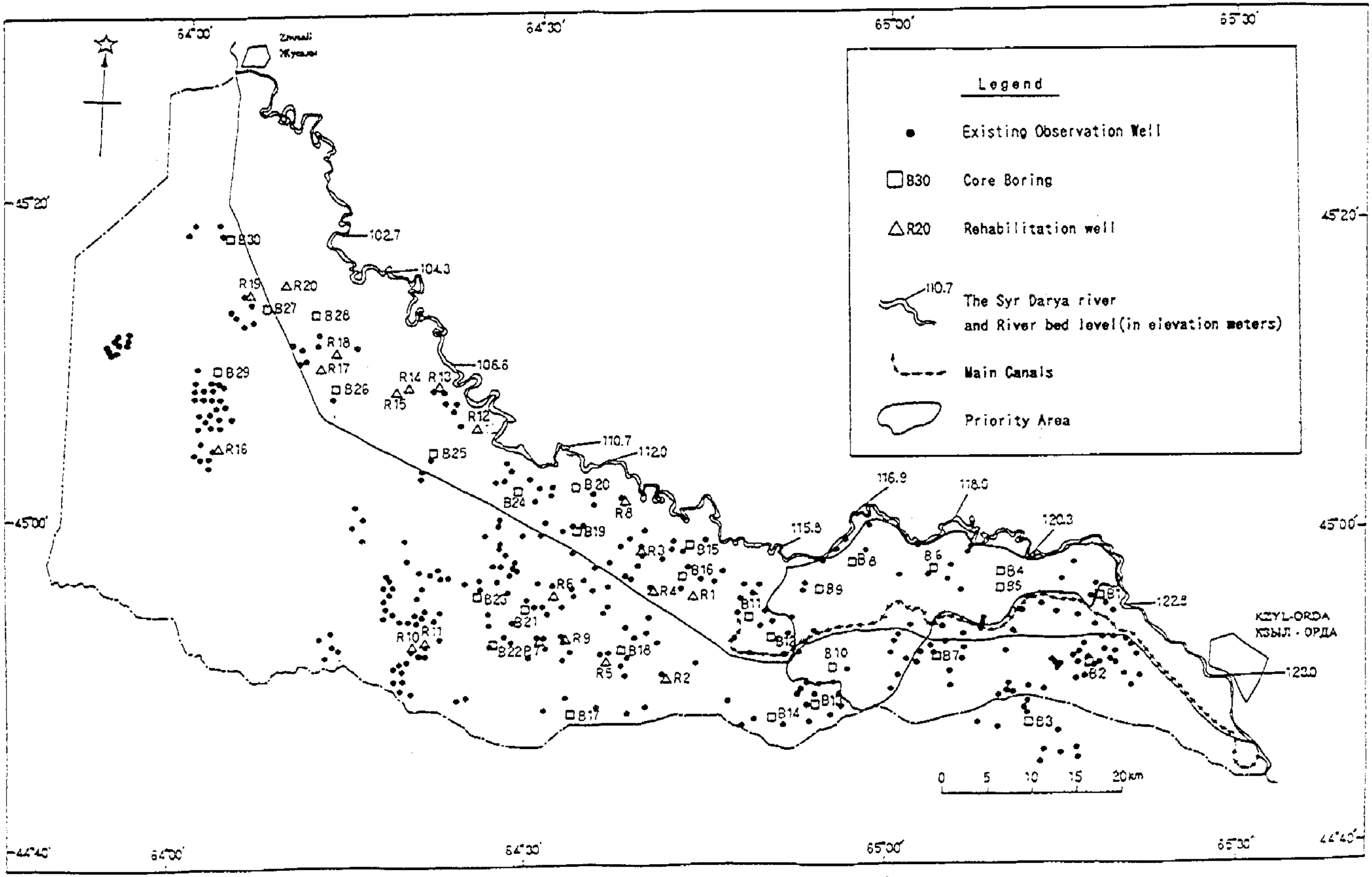


Figure B.1 Location Map of Core Boring and Existing Well

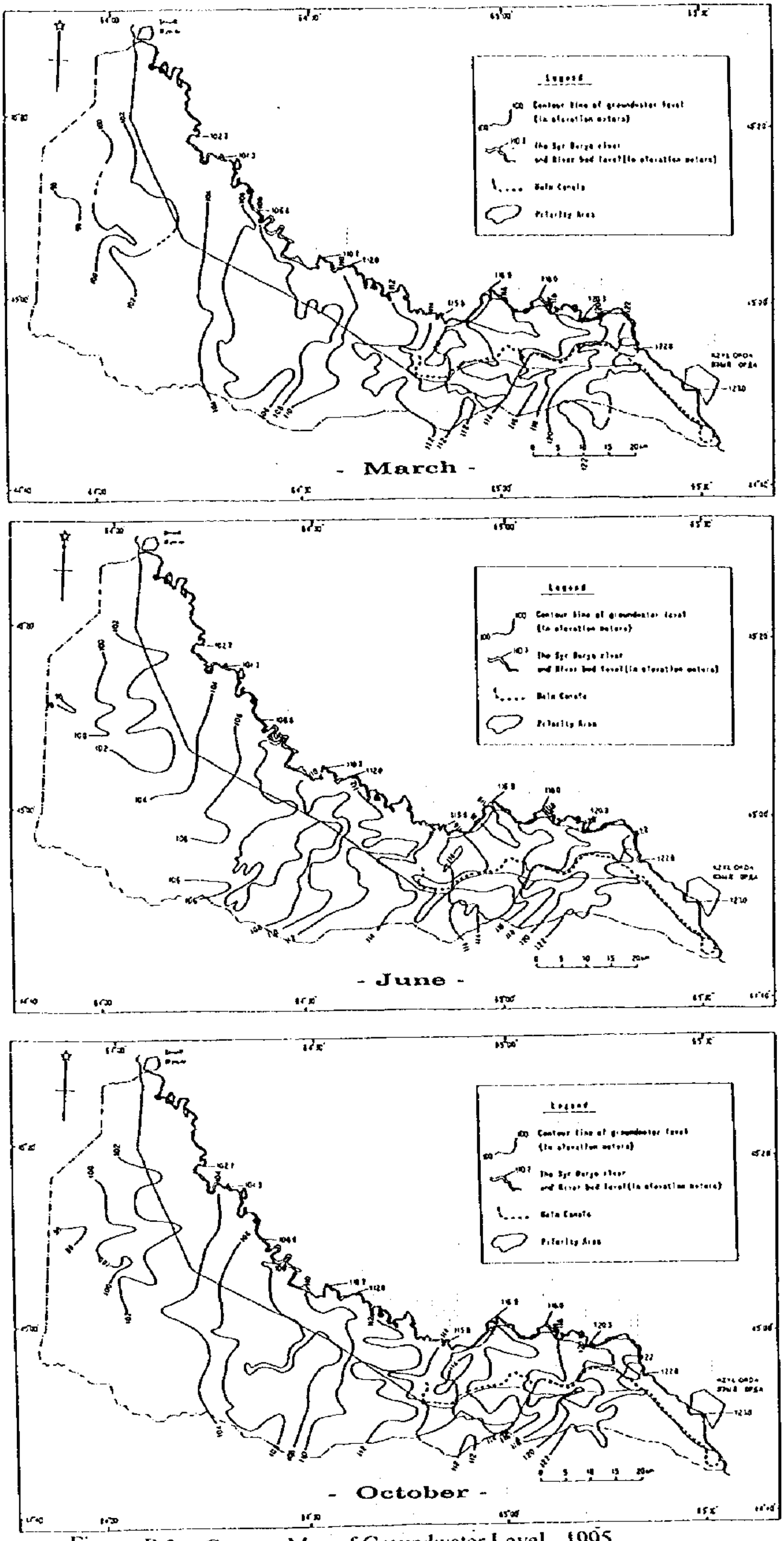


Figure B.2 Contour Map of Groundwater Level - 1995

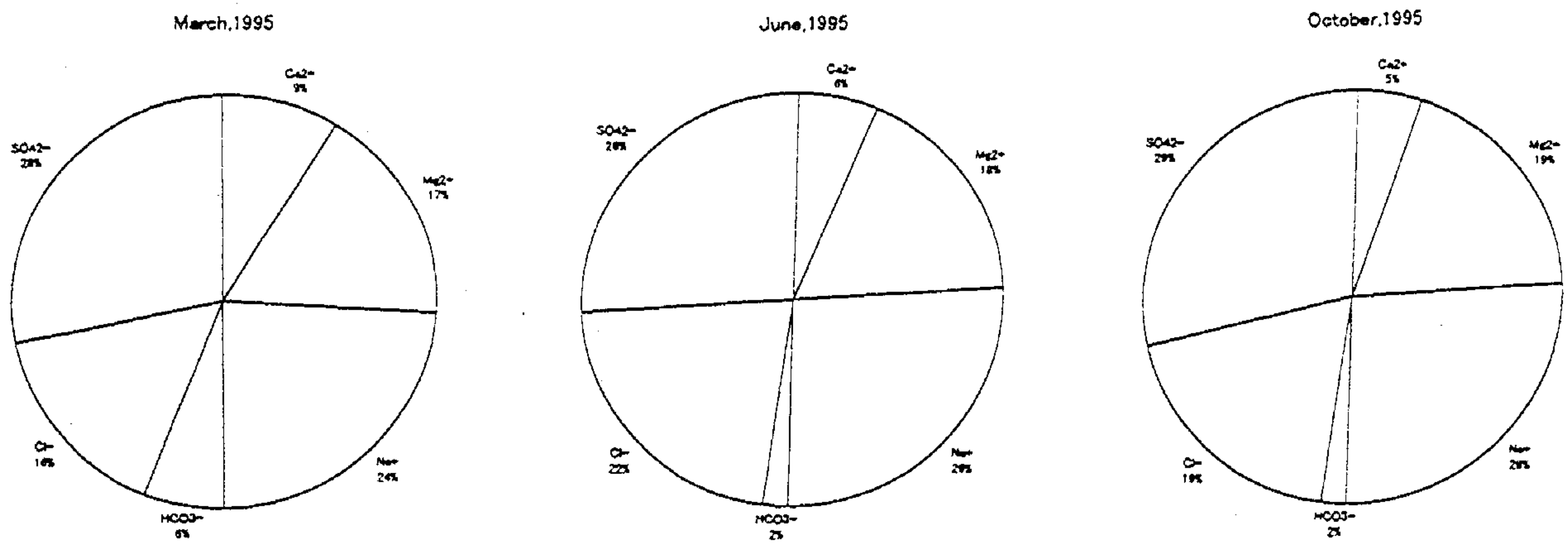


Figure B.3 Circular Diagrams of Groundwater Quality

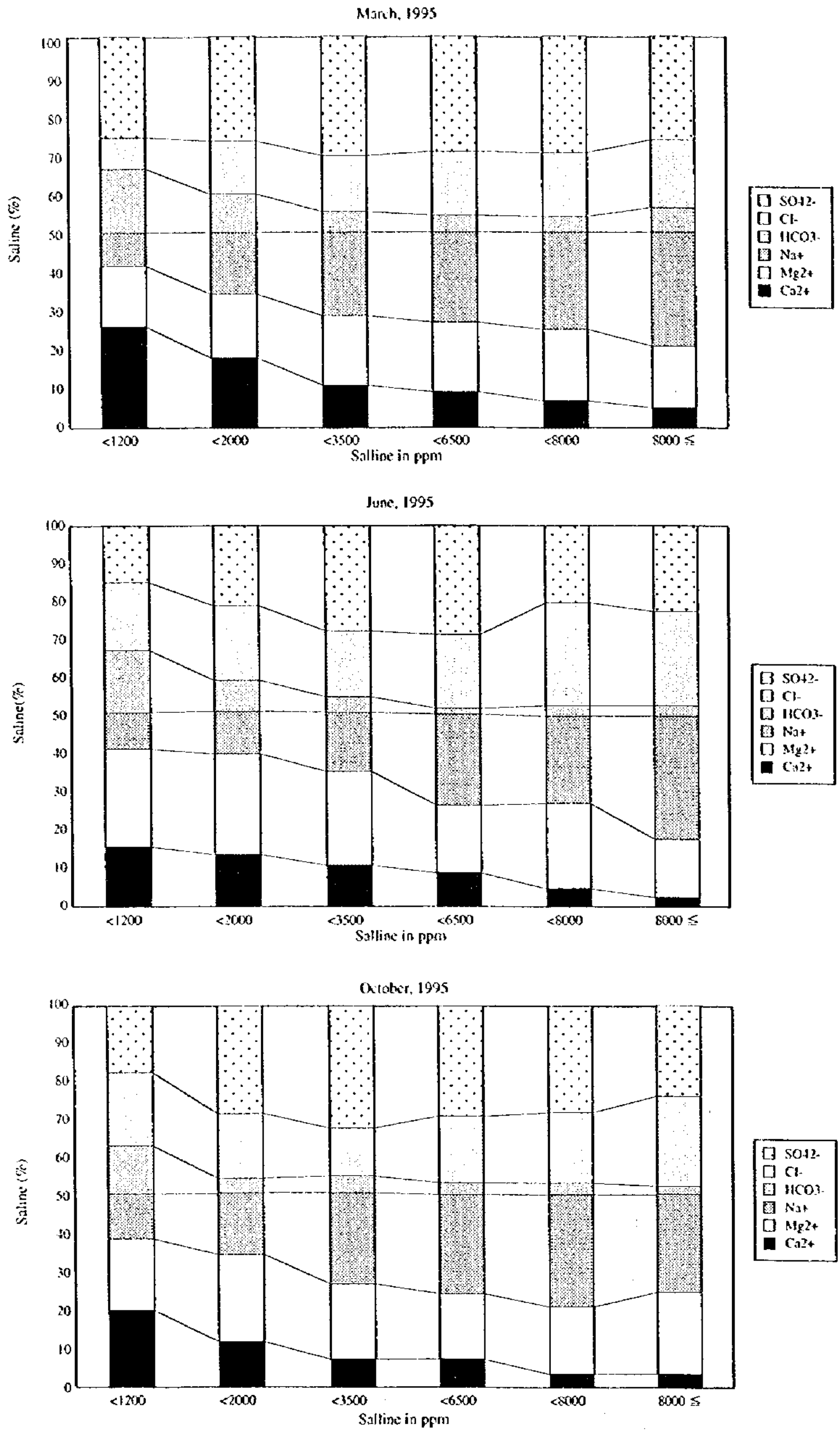
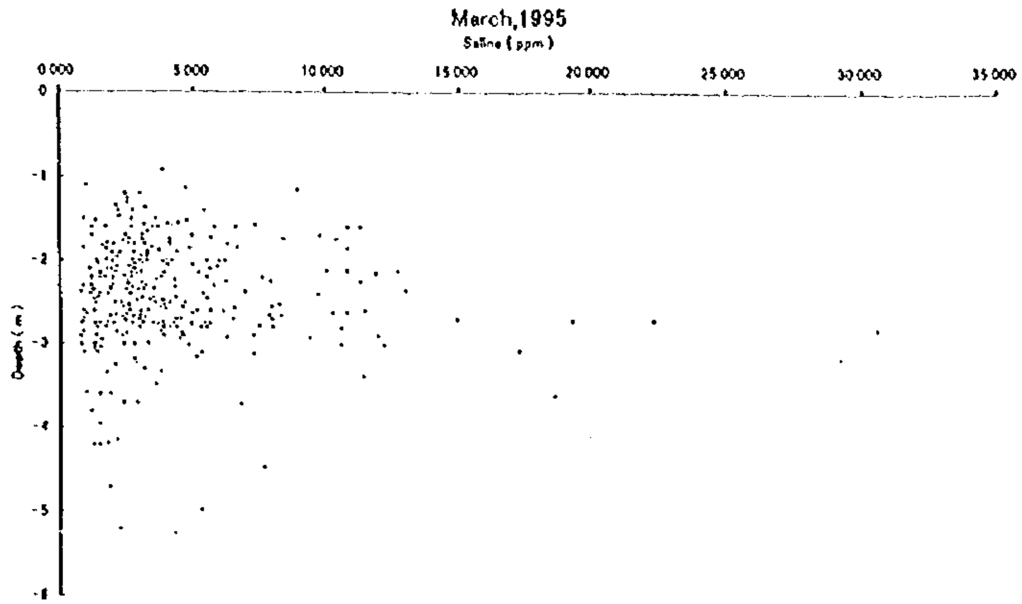
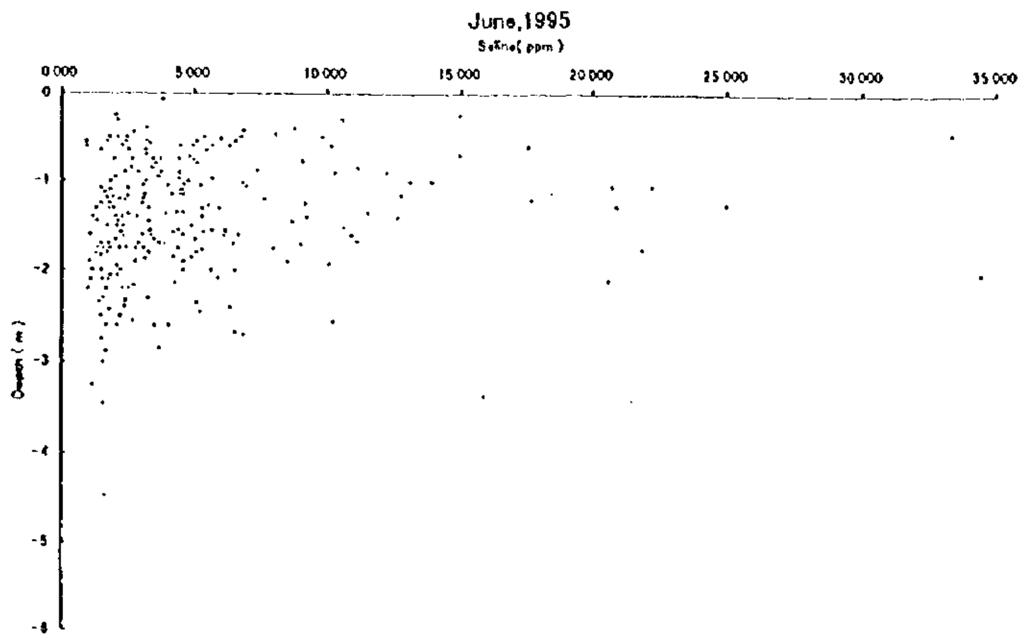


Figure B.4 Change of Groundwater Quality in the Salinity Concentration





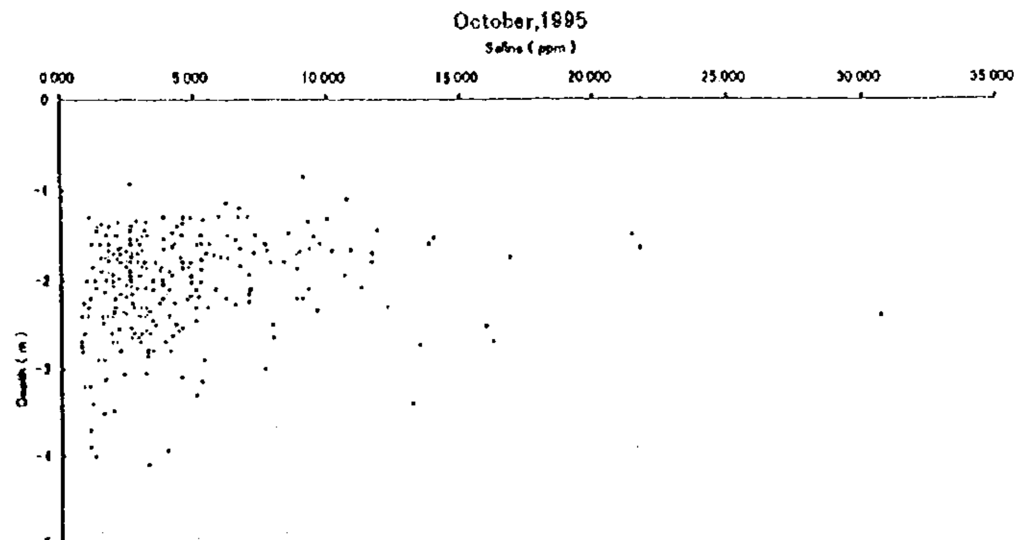


Figure B.5

Relation between Depth to Groundwater Table and Salinity Concentration

ANNEX - C

SOIL AND SALT BALANCE

ANNEX C

SOIL AND SALT BALANCE STUDY

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ANNEX C

SOIL AND SALT BALANCE STUDY

1. Introduction

In order to clarify the irrigation suitability in the Study Area and the Project Area from the view point of land potentials, the soil survey was conducted under sub-let contract basis in the Phase I Study period. Based on the result of the soil survey, the soil classification, irrigation suitability and soil salinity were evaluated and the maps concerned were prepared in both the Study Area and the Project Area . In addition to the soil survey, the salt balance study was carried out in order to clarify the salinization on the agricultural land under the future "with project" Condition.

2. Soil Survey Performed in the Study

The soil survey was condcuted by KAZGIPROVODOHOZ (Collective Enterprise Design Institute) from October 1, 1996 to January 31, 1997 under the supervison of the JICA Study Team on sub-let contract basis. The survey work was divided into two phases; the Phase I covering 430,000 ha and the Phase-II covering the priority project area (Project Area) of around 40,230 ha. The laboratory test was being done for 1,400 samples. The scope of work is summrized as follows:

(a) Phase-I

- 80 test pit sites and 420 auger boring points.
- Total number of soil samples at the pit sites and boring points was 320 and 840, respectively.

(b) Phase-II

- 20 test pit sites and 80 auger boring points.
- Total number of soil samples at the pit sites and boring points was be 80 and 160, respectively.

(c) Laboratory Test

Laboratory Test Items	Test Pits		Boring Points
	Top Layer	Other Layers	
- No. of Soil Samples	100	300	1,000
- Soil texture	o	o	x
- pH (rate of soil to water is 1 : 2.5)	o	o	o
- EC5 (rate of soil to water is 1 : 5)	o	o	o
- ECe (saturation extract)	o	x	x
- Total nitrogen	o	x	x
- Total carbon	o	x	x
- Available phosphorus	o	x	x
- Cation exchange capacity (CEC)	o	x	x
- Exchangeable cations, i.e. Na, K, Ca, Mg	o	o	o
- Anions, i.e. Cl, CO_3, HCO_3, SO_4	o	o	o

o : items analysed, x : items not analysed

3. The Kzyl-Orda Left Bank Area

3.1 Soil Classification

Based on the result of the soil survey in the Phase-I Study period, the soil classification map on a scale of 1:100,000 was prepared for the Kzyl-Orda Left Bank Area of 430,000 hectares as shown in Figure C.1. This soil classification was assessed based on the soil texture, salt composition, soil depth, erosion and influence of surface water or groundwater. The typical soil description and the result of lavoratory analysis of the above soil classes are shown in Table C.1 and C.2. According to the soil classification map, the following seven soil classes are identified in the area.

(a) Alluvial-meadow Soils

These soils were formed by the alluvial deposit of loam brought in by the Syr Darya river. The soils are commonly covered with shrubs, grass and reeds. The surface layer of 0 - 10 cm depth shows spot salinization, while the layers below this are affected by non to strong salinization. The groundwater level is at 2.5-5.0 m below the ground surface.

(b) Old Alluvial-meadow Soils

These soils were also formed by the alluvial deposit of loam brought in by the Syr Darya river. They are still under or after the desertification process. Therefore, they are covered with weeds and tamarisk trees. The soils are affected by spot to strong salinization. The groundwater level stays at 3.0-5.0 m below the ground surface.

(c) Meadow-boggy Soils

These are the major soils in the flood plains of the Kzyl-Orda Left Bank Area. The soils are common in irrigated paddy fields and grazing land. They are black colored weakly structured sandy loam to silty loam soils which are characterized as typical paddy soil.

Some of the soils show salt on the surface. The groundwater level stays at 1.0-10.0 m below the ground surface.

(d) Takyrlike-Solnecheck Soils

These soils are affected by slight to strong saline or alkaline concentrations due to high water evaporation under the desertification process and they become muddy in the upper layer when they get rain. They occur in grazing land or covered with grass and bush. The groundwater level is at 5.0-10.0 m below the ground surface.

(e) Takyrs and Takyrlike-Solnecheck Soils

These soils are characterized by medium to strong saline or alkaline concentrations due to high water evaporation after the desertification process, and they become muddy in the upper layer when they get rain. They are covered with weeds and bush. The groundwater level is at 5.0-15.0 m below the ground surface.

(f) Solnechecks

These soils are characterized by very strong saline or alkaline conditions generated by high content of salt in the groundwater or high evaporation. They show severe salinization in the surface layer. They are not suitable for crop cultivation and, no vegetation is found in these areas. The groundwater level stays 2.0-10.0 m below the ground surface.

(g) Sandy desertified soils

These soils, which are composed of sand to sandy loam influenced by high erosion rate, are developed in the hilly or hilly edge area. The soils are characterized by the low cation exchange capacity and the low content of organic matter. The groundwater level is at 1.0-15.0 m below the ground surface.

Based on the soil classification map mentioned above, the area extent of each soil class is estimated as follows:

(Unit : ha)

Soil Class	Syrdarya	Terenozek	Zhalagash	Karmakshy	Total	(%)
1. Alluvial-meadow Soils	2,240	680	500	2,200	5,620	(1.3)
2. Old Alluvial-meadow Soils	15,420	19,810	22,510	35,980	93,720	(21.8)
3. Meadow-boggy Soils	14,260	46,620	64,720	47,790	167,390	(38.9)
4. Takyrlike-Solnecheck Soils	0	0	0	22,330	22,330	(5.2)
5. Takyrs and Takyrlike-Solnecheck Soils	0	0	0	9,000	9,000	(2.1)
6. Solnechecks	2,450	17,190	26,560	47,110	93,310	(21.7)
7. Sandy Desertified Soils	3,130	0	16,350	19,150	38,630	(9.0)
Total	37,500	78,300	130,640	183,560	430,000	(100.0)

3.2 Irrigation Suitability

Judging from the present landuse in relation with the above soil classification, most of the Solnnechecks are not suitable for agriculture due to high content of salt in the soils, while most of the Meadow-boggy Soils are suitable for irrigated paddy crop due to less permeable soil texture. Most of the Alluvial-meadow Soils are suitable for irrigated upland crops. The other soil classes are marginally suitable for irrigated agriculture, because they require some improvement of drainage condition to solve salinity or alkalinity problem. Thus, the area of each irrigation suitability classification is estimated as follows (Figure C.2):

For Paddy (Unit : ha)

Irrigation Suitability Class	Syrdariya	Terenozek	Zhalagash	Karmakshi	Total
Highly or Moderately Suitable	14,260	40,620	64,720	56,790	176,390
Marginally Suitable	17,660	20,490	23,010	60,510	121,670
Not Suitable	5,580	17,190	42,910	66,260	131,940
Total	37,500	78,300	130,640	183,560	430,000

For Upland (Unit : ha)

Irrigation Suitability Class	Syrdariya	Terenozek	Zhalagash	Karmakshi	Total
Highly or Moderately Suitable	2,240	680	500	2,200	5,620
Marginally Suitable	29,680	60,430	87,230	115,100	292,440
Not Suitable	5,580	17,190	42,910	66,260	131,940
Total	37,500	78,300	130,640	183,560	430,000

3.3 Soil Salinity

Based on the above soil classification and in accordance with the Salinity Classification of Kazakstan, the salinity hazard of soil in the Kzyl-Orda Left Bank Area is evaluated as follows (Figure C.3):

(Unit : ha)

Salinity Hazard	Syrdariya	Terenozek	Zhalagash	Karmakshi	Total (%)
Slight	14,720	40,760	64,820	48,250	168,550 (39.2)
Medium	9,470	6,400	23,400	42,600	81,870 (19.0)
Strong	10,860	13,950	15,860	45,600	86,270 (20.1)
Very Strong	2,450	17,190	26,560	47,110	93,310 (21.7)
Total	37,500	78,300	130,640	183,560	430,000 (100.0)

3.4 Salt Balnce Study

(1) Effect of Crop Rotation on Salt Balance

The preliminary estimate of the salt balance is carried out for 4 crop rotations which are described in Attachment C.1. The calculations of salt balance in the soil profile for four raions are shown in Table C.3. In the calculation, the upland crop after paddy is considered the first year crop for all crop rotation for the purpose of comparing the results of salt balance using different crop rotations. The calculation of the each crop rotation is performed for 32 years.

One cycle of the crop rotation is 8 years, therefore results of the calculation at the end of 8th year, 16th year, 24th year and 32nd year are shown the Table C.3. The salt content in the root zone decreases in all four raions for the proposed crop rotations. The decrease in the salt content is attributed to improvement of drainage system, increasing cropping intensity of paddy and good crop rotation. Crop rotation No. 4 is most effective to decrease soil salinity in the root zone as well as drainage zone. The salt content in the drainage zone decreases in the three raions except Zalagash raion for all the crop rotations. The decrease in the soil salinity of drainage zone is caused by percolating irrigation water. The increase of the salt content in the Zalagash raion is due to lower value of the initial salt content in the drainage zone. In the proposed condition, there is no provision of leaching for upland crops, however additional water for leaching may required if the salt content go higher than desired value. Moreover, the project aims to control the soil salinity with proper drainage system and crop rotation and at the same time saving of water.

(2) Salt Balance in Each Raion

The preliminary estimate of the salt balance is carried out for each raion using the above-mentioned method. The salt balance is calculated for the four raions. The result of calculation is shown in the following table.

(Unit : dS/m)

Soil Depth	ECe in Soil				
	Syr Darya	Terenozek	Zhalagash	Karmakshy	Study Area
Present Condition					
0-100 cm	5.26	4.19	3.85	6.84	5.04
100-200 cm	5.04	3.26	2.14	5.04	3.87
With Project Condition					
0-100 cm	3.83	3.70	3.63	3.91	3.77
100-200 cm	3.25	2.63	2.34	3.69	2.98

The salt concentration in the root zone (0-100 cm) is decreased from the present concentration in all raions. The concentration in 100-200 cm soil layer is also decreased in three raions and increased in one raion. The decrease in salinity is attributed to proper drainage system and increase in the cropping intensity of paddy.

4. The Project Area

4.1 Soil

Based on the result of the soil survey, the soil classification map on a scale of 1: 25,000 was prepared for the Project Area of 40,230 hectares (gross) as shown in Figure C.4. Out of seven soil classes identified in the Kzyl-Orda Left Bank Area in the master plan, four soil classes were identified in the Project Area, namely, Alluvial-meadow Soils, Old Alluvial-meadow Soils, Meadow-boggy Soils and Solonchaks.

Alluvial-meadow Soils were formed on the Syr Darya river banks and are covered with shrubs, grass and reeds. Old Alluvial-meadow Soils are located at flat depressions and covered with weeds and tamarisk trees. Meadow-boggy Soils are the majority in the Project Area and are commonly used for irrigated rice cultivation. Solonchaks are spotted on the elevated areas and covered with scattered saltworts.

Based on the above-mentioned soil classification map, the area extent for each soil class is estimated as follows:

	Ilyasov Area		Shagan Area		Total	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Alluvial-meadow Soils	160	1	0	0	160	1
Old Alluvial-meadow Soils	3,900	24	6,690	28	10,590	26
Meadow-boggy Soils	8,140	52	11,420	46	19,560	49
Solonchaks	2,450	15	4,430	18	6,880	17
Others*	1,280	8	1,760	8	3,040	8
Total	15,930	100	24,300	100	40,230	100

Note: *; including irrigation canals, collectors, roads and built-up areas.

4.2 Irrigation Suitability

Based on the result of laboratory analysis on soils mentioned above, the irrigation suitability classification is assessed taking into account soil salinity, soil texture and soil fertility (Figure C.5). Solonchaks are not suitable for agriculture due to high content of salt in the soils. Most of Meadow-boggy Soils are suitable for irrigated paddy crop and marginally suitable for upland crops due to the less permeable soil texture, while most of Alluvial-meadow Soils are suitable for irrigated upland crops and marginally suitable for paddy crop due to the high permeability caused by coarse texture. Old Alluvial-meadow Soils are marginally suitable for irrigated agriculture both for paddy and upland crops, because they require some improvement of the soil fertility or the drainage condition to solve salinity problem. Thus, the area of each irrigation suitability classification for paddy and upland crops is estimated as follows:

(Unit : ha)

Irrigation Suitability	Ilyasov Area		Shagan Area		Project Area	
	For Paddy	For Upland	For Paddy	For Upland	For Paddy	For Upland
Highly or moderately suitable	8,140	160	11,420	0	19,560	160
Marginally suitable	4,060	12,040	6,690	18,110	10,750	30,150
Not suitable	2,450	2,450	4,430	4,430	6,880	6,880
Others*	1,280	1,280	1,760	1,760	3,040	3,040
Total	15,930	15,930	24,300	24,300	40,230	40,230

Note: *; including irrigation canals, collectors, roads and built-up areas.

4.3 Soil Salinity

Based on the result of laboratory analysis of soil and in accordance with the Salinity Classification of Kazakstan, the salinity hazard of soil in the Project Area is evaluated as follows (Figure C.6):

Salinity Hazard	Ilyasov Area		Shagan Area		Project Area	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Slight	5,010	31	6,850	28	11,860	30
Medium	4,040	25	4,100	17	8,140	20
Strong	3,150	21	7,160	29	10,310	26
Very Strong	2,450	15	4,430	18	6,880	17
Others*	1,280	8	1,760	8	3,040	8
Total	15,930	100	24,300	100	40,230	100

Note: *; including irrigation canals, collectors, roads and built-up areas.

Alluvial-meadow Soils show slight salinity hazard. Meadow-boggy Soils are affected by slight to strong salinization depending on the cultivated crops or present landuse. The salinity hazard is slight in most of Meadow-boggy Soils on paddy field due to the leaching effect of irrigation, while most of the soils in lucerne fields or grass land show medium to strong salinity hazard because of little or no irrigation in the fields. Old Alluvial-meadow Soils and Solonchaks show medium to strong or very strong salinity hazard.

4.4 Salt Balance Study

Salt balance calculation is carried out using the proposed cropping pattern which is described in Attachement C.1. The one cycle of the proposed crop rotation is 10 years for the purpose of the calculation of the salt balance based on the proposed cropping pattern. As the proposed Project considers the partial ground water contribution for the upland crops' water needs to save water and also to reduce the high water table caused by the percolation from paddy field and seepage from canals. Therefore, the upland crops are grown in between two paddy crops, as the partial saline ground water contribution (by capillary action) for the upland crops causes the increase in the salinity of the rootzone. The increased salinity after upland crop plantation would again be lowered by the paddy cultivation. The lucerne is perennial crop and grown for three years in a row. Using above consideration salt balance calculation is carried out for the Shagan and Ilyasov Areas. The present salinity of the root zone is considered as the initial salt concentration. The results are shown in the following table.

		Soil Salinity in Root Zone (ECe in mS/cm)	
Year	Crop	Ilyasov	Shagan
Present		3.88	4.61
1	Paddy	3.28	3.52
2	Wheat	4.49	4.82
3	Paddy	3.48	3.59
4	Lucerne	4.96	5.09
5	Lucerne	6.03	6.18
6	Lucerne	6.89	7.05
7	Paddy	4.26	4.32
8	Paddy	3.40	3.42
9	Wheat	4.73	4.76
10	Paddy	3.56	3.57

The results show a decrease in the root zone salinity after paddy cultivation and increase in salinity after upland crops in both farms. After the completion of one cycle of 10 years, the salinity of root zone in two farms is about 3.60 mS/cm which is lower than the present EC value. The decrease in salinity is attributed to proper drainage system and increase in the cropping intensity of paddy. The salinity temporarily increases during the cultivation of lucerne and other upland crops due to partial ground water contribution of high salinity for the crop water requirements. The paddy cultivation after upland crops causes the decrease in salinity because of leaching effect of percolation in the paddy field. Therefore, the proper crop rotation and drainage system would control salinity increase and at the same time saving of water. In the proposed condition, there is no provision of leaching for upland crops, however additional water may require if the salt content goes higher than the tolerable value.

Tables

Table C.1 Typical Soil Description (1/2)

	Old Alluvial-meadow Soils Depth of genetic horizon, cm					Takylike Soils Depth of genetic horizon, cm				Meadow-boggy Soils Depth of genetic horizon, cm					Meadow-boggy Soils Depth of genetic horizon, cm			
	0-9	9-30	30-55	55-114	114-150	0-16	16-65	65-102	102-150	0-31	31-53	53-79	79-117	117-150	0-20	20-37	37-93	93-150
Transfer of horizon																		
abrupt (fluctuations +-2 cm)	+			+		+				+					+			
winding (+-2-5 cm)		+	+				+	+			+	+	+	+		+	+	+
Humidity																		
dry						+				+					+			
fresh	+	+	+	+	+		+	+	+		+	+	+	+		+	+	
damp																		+
wet																		
Texture																		
clay							+							+				
heavy loam																		
medium loam						+					+							+
light loam								+		+								
sandy loam	+	+	+						+			+	+					
sand				+	+										+	+	+	
Structure																		
clod >5 cm																		
lump 0.5-5 cm																		
nut-shaped 0.05-0.5 cm																		
powdery <0.05 cm	+					+				+					+			
Density																		
mellow										+								
weakly solid	+	+	+	+	+	+					+				+	+	+	+
solid							+	+	+			+	+	+				
very solid																		
Roots of plants																		
continuous (farctate)																		
many roots										+								
few roots	+					+									+			
single roots		+	+	+	+		+	+	+		+	+	+	+		+	+	+
Water dissolved salts																		
thin coating like hoar-frost	+																	
conglomerations						+												
Gypsum soluble in HCl 10%																		
separeted crystals																		
conglomerations																		
continuos layer																		
Carbonate boils and dissolves in 10% of HCl																		
thin coating in the state of mould		+	+	+														
farinaceous bents																		
spots																		
Ferric oxide																		
brown spots			+	+	+			+	+			+	+	+		+	+	+
blue-grey spots				+	+									+				+

Table C.1 Typical Soil Description (2/2)

	Solonechecks Depth of genetic horizon, cm						Alluvial-meadow Soils Depth of genetic horizon, cm					Old Alluvial-meadow Soils Depth of genetic horizon, cm				Sandy Desertified Soils Depth of genetic horizon, cm				
	0-19	19-34	34-75	75-83	83-123	123-150	13-20	20-56	56-88	88-115	115-150	0-22	22-50	50-95	95-150	0-7	7-25	25-66	66-112	112-150
Transfer of horizon																				
abrupt (fluctuations +-2 cm)	+											+				+				
winding (+-2-5 cm)		+	+	+	+		+	+	+	+			+	+			+	+	+	
Humidity																				
dry	+	+										+								
fresh			+	+	+	+	+						+	+	+	+	+	+		
damp								+	+	+	+								+	+
wet																				
Texture																				
clay																				
heavy loam	+	+					+	+							+					
medium loam				+									+	+						+
light loam									+	+		+						+		
sandy loam			+								+					+	+		+	
sand					+	+														
Structure																				
clod >5 cm																				
lump 0.5-5 cm																				
nut-shaped 0.05-0.5 cm																				
powdery <0.05 cm	+											+				+				
Density																				
mellow																				
weakly solid	+						+	+	+	+	+	+	+	+	+	+			+	+
solid		+	+		+	+											+	+		
very solid																				
Roots of plants																				
continuous (farctate)																				
many roots												+								
few roots	+												+							
single roots		+	+		+	+	+	+	+	+	+			+	+	+	+	+	+	+
Water dissolved salts																				
thin coating like hoar-frost	+																			
conglomerations																				
Gypsum soluble in HCl 10%																				
separeted crystals		+	+		+	+														
conglomerations																				
continuos layer																				
Carbonate boils and dissolves in 10% of HCl																				
thin coating in the state of mould																				
farinaceous bents																				
spots																				
Ferric oxide																				
brown spots		+	+		+	+		+	+	+	+		+	+	+			+	+	+
blue-grey spots					+	+				+	+			+	+					+

Table C.2 (1/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils)					Water Extract Cation and Anion (% of 100g dry soil)									Available N (mg/100 g)	Available P2O5 (mg/100 g)	CO3 (mg/100 g)	Organic Mater (% of 100 g soils)
		Ca	Mg	K	Na	Na + K	Anions				Cations								
							HCO3	CO3	Cl	SO4	Ca	Mg	Na	K	pH				
1	0 - 30	5.75	7.0	0.16	2.43	2.59	0.010	0.000	0.304	0.458	0.060	0.066	0.211	0.010	9.180	25.2	10.0	6.61	0.57
	0 - 50	4.0	5.5	0.16	2.62	2.78	0.010	0.000	0.146	0.337	0.034	0.032	0.157	0.006	9.180				
2	0 - 30	22.5	9.0	0.95	3.10	4.05	0.018	0.000	0.497	0.704	0.161	0.075	0.314	0.042	8.600	44.8	17.0	9.32	0.95
	30 - 50	19.25	9.75	0.15	1.64	1.79	0.013	0.000	0.393	0.398	0.143	0.076	0.141	0.002	8.230				
3	0 - 30	11.5	6.5	0.42	2.50	2.92	0.021	0.000	0.269	0.841	0.029	0.034	0.483	0.008	9.150	30.8	23.0	7.28	0.66
	30 - 50	12.5	5.5	0.29	3.55	3.84	0.018	0.000	0.141	0.466	0.037	0.028	0.224	0.003	9.050				
4	0 - 30	5.5	7.0	0.14	5.92	6.06	0.010	0.000	0.794	0.890	0.048	0.050	0.795	0.001	9.200	22.4	4.0	7.45	0.19
	30 - 50	10.0	4.5	0.13	7.01	7.14	0.013	0.000	0.925	1.188	0.057	0.070	0.975	0.002	9.150				
5	0 - 30	13.0	7.5	0.35	1.86	2.21	0.018	0.000	0.166	0.334	0.048	0.039	0.141	0.007	8.840	33.6	29.0	8.74	1.14
	30 - 50	6.0	7.5	0.32	1.08	1.40	0.023	0.000	0.063	0.169	0.020	0.016	0.075	0.003	8.850				
6	0 - 30	11.0	14.0	0.40	2.36	2.76	0.013	0.000	0.828	0.430	0.167	0.149	0.261	0.022	8.440	39.2	21.0	7.79	0.62
	30 - 50	9.5	13.25	0.24	2.94	3.18	0.013	0.000	0.614	0.335	0.104	0.114	0.224	0.007	8.450				
7	0 - 30	16.5	9.5	0.28	1.23	1.51	0.016	0.000	0.130	0.470	0.069	0.057	0.125	0.005	8.650	44.8	42.0	7.66	0.52
	30 - 50	13.5	8.0	0.32	2.41	2.73	0.021	0.000	0.018	0.271	0.057	0.026	0.032	0.004	8.550				
8	0 - 30	17.0	8.0	0.30	4.31	4.62	0.021	0.000	0.058	0.323	0.064	0.032	0.064	0.004	8.400	49.0	36.0	4.78	1.52
	30 - 50	13.5	10.0	0.20	1.18	1.38	0.024	0.000	0.044	0.245	0.036	0.028	0.060	0.001	8.500				
9	0 - 30	12.5	17.5	0.20	2.79	2.99	0.018	0.000	0.435	1.450	0.073	0.300	0.329	0.006	9.200	28.0	7.0	9.32	0.66
	30 - 50	5.0	15.5	0.17	3.10	3.27	0.018	0.000	0.428	0.758	0.035	0.146	0.329	0.003	9.300				
10	0 - 30	18.0	5.5	0.31	1.68	2.19	0.016	0.000	0.104	0.352	0.051	0.031	0.118	0.011	8.900	33.6	34.0	8.79	0.90
	30 - 50	12.5	6.5	0.28	1.64	1.92	0.013	0.000	0.061	0.266	0.043	0.020	0.080	0.008	8.800				
11	0 - 30	10.0	4.0	0.28	1.13	1.41	0.021	0.000	0.023	0.134	0.027	0.010	0.035	0.003	8.450	39.2	42.0	8.23	1.00
	30 - 50	7.0	6.0	0.29	0.51	0.80	0.021	0.000	0.022	0.117	0.021	0.011	0.032	0.002	8.650				
12	0 - 30	7.5	7.5	0.76	0.88	1.64	0.013	0.002	0.186	0.118	0.052	0.025	0.065	0.016	8.400	35.0	23.0	7.99	1.19
	30 - 50	6.5	11.5	0.58	2.51	3.09	0.016	0.000	0.311	0.246	0.032	0.060	0.167	0.015	8.550				
13	0 - 30	6.0	4.5	0.20	1.95	2.15	0.016	0.000	0.033	0.167	0.026	0.014	0.050	0.002	8.650	33.6	41.0	7.91	0.66
	30 - 50	4.5	4.0	0.21	0.43	0.64	0.023	0.000	0.008	0.036	0.009	0.004	0.012	0.001	8.850				
14	0 - 30	19.0	11.0	0.29	2.79	3.08	0.016	0.000	0.166	0.572	0.044	0.032	0.273	0.006	8.950	30.8	42.0	7.21	0.9
	30 - 50	13.5	11.0	0.26	2.55	2.81	0.016	0.000	0.166	0.740	0.082	0.058	0.261	0.005	8.950				
15	0 - 30	2.0	3.0	0.17	0.32	0.49	0.018	0.000	0.010	0.021	0.008	0.002	0.008	0.003	9.350	22.4	13.0	5.03	0.09
	30 - 50	2.5	1.0	0.15	0.36	0.51	0.018	0.000	0.017	0.010	0.010	0.002	0.006	0.002	9.200				
16	0 - 30	33.5	6.0	0.17	0.53	0.70	0.016	0.000	0.040	0.600	0.160	0.034	0.069	0.003	8.350	33.6	37.0	10.13	0.71
	30 - 50	23.0	5.5	0.16	0.88	1.04	0.013	0.000	0.048	0.401	0.097	0.026	0.065	0.003	8.450				
17	0 - 30	10.0	6.0	0.27	0.67	0.94	0.021	0.000	0.052	0.206	0.033	0.021	0.060	0.004	8.550	36.4	46.0	6.47	1.04
	30 - 50	6.5	8.0	0.30	1.80	2.10	0.018	0.000	0.130	0.196	0.015	0.017	0.133	0.004	8.750				
6a	0 - 30	2.0	6.0	0.14	0.30	0.44	0.013	0.000	0.014	0.122	0.007	0.015	0.035	0.001	9.250	25.2	12.0	6.54	0.09
	30 - 50	1.5	6.5	0.14	0.73	0.84	0.013	0.000	0.014	0.163	0.008	0.019	0.046	0.001	9.200				
19	0 - 30	22.0	17.0	0.26	7.30	7.56	0.016	0.000	0.146	0.520	0.057	0.055	0.177	0.005	8.800	30.8	5.0	9.04	1.76
	30 - 50	13.5	14.0	0.23	0.78	1.01	0.023	0.000	0.099	0.406	0.019	0.041	0.166	0.003	8.850				

Table C.2 (2/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils)					Water Extract Cation and Anion (% of 100g dry soil)									Available N	Available P2O5	CO3	Organic Mater
							Anions				Cations								
		Ca	Mg	K	Na	Na + K	HCO3	CO3	Cl	SO4	Ca	Mg	Na	K	pH	(mg/100 g)	(mg/100 g)	(mg/100 g)	(% of 100 g soils)
20	0 - 30	16.0	8.5	0.31	2.31	2.62	0.018	0.000	0.083	0.556	0.044	0.050	0.177	0.008	8.900	36.4	37.0	10.41	1.42
	30 - 50	8.5	11.0	0.34	0.91	1.25	0.021	0.000	0.070	0.292	0.015	0.025	0.125	0.005	8.900				
21	0 - 30	14.0	11.0	0.31	2.19	2.50	0.018	0.000	0.110	0.453	0.039	0.051	0.149	0.008	8.800	36.4	23.0	10.06	1.04
	0 - 50	14.5	9.0	0.12	2.19	2.31	0.018	0.000	0.051	0.316	0.019	0.033	0.104	0.005	8.900				
4a	0 - 30	2.5	3.0	0.14	0.43	0.57	0.010	0.000	0.041	0.085	0.010	0.009	0.042	0.001	9.000	25.2	2.0	7.70	0.33
	30 - 50	17.0	15.0	0.18	7.65	7.83	0.010	0.000	0.255	0.421	0.036	0.062	0.211	0.002	8.000				
23	0 - 30	23.0	4.0	0.18	1.44	1.62	0.010	0.000	0.043	0.570	0.132	0.019	0.111	0.010	8.900	36.4	9.0	6.37	0.71
	30 - 50	170.5	3.6	0.17	0.63	0.80	0.007	0.000	0.057	0.773	0.228	0.028	0.091	0.007	9.000				
24	0 - 30	21.5	6.5	0.11	0.23	0.34	0.016	0.000	0.015	0.359	0.091	0.022	0.039	0.004	8.400	33.6	34.0	9.39	0.95
	30 - 50	7.0	5.0	0.14	0.49	0.63	0.016	0.000	0.014	0.170	0.022	0.018	0.035	0.003	8.750				
25	0 - 30	14.5	9.5	0.25	1.25	1.50	0.018	0.000	0.065	0.295	0.042	0.029	0.085	0.003	8.450	28.0	46.0	9.28	1.37
	30 - 50	6.0	7.0	0.19	0.85	1.04	0.023	0.000	0.019	0.162	0.011	0.013	0.060	0.002	8.750				
26	0 - 30	13.0	9.5	0.30	0.62	0.92	0.023	0.000	0.017	0.138	0.028	0.012	0.028	0.004	8.350	30.8	51.0	7.35	1.52
	30 - 50	6.5	8.5	0.21	0.28	0.49	0.023	0.000	0.018	0.142	0.018	0.016	0.035	0.003	8.760				
5a	0 - 30	11.5	18.0	0.74	4.22	4.96	0.016	0.000	0.145	0.888	0.056	0.116	0.199	0.071	9.160	30.8	17.0	9.88	0.87
	30 - 50	7.0	9.5	0.59	2.34	2.93	0.013	0.000	0.042	0.674	0.036	0.088	0.133	0.023	9.130				
28	0 - 30	16.0	15.0	0.24	1.50	1.74	0.019	0.000	0.055	0.434	0.062	0.048	0.085	0.007	8.650	42.0	9.0	8.55	3.22
	30 - 50	7.3	9.8	0.20	0.97	1.17	0.023	0.000	0.021	0.275	0.026	0.031	0.064	0.003	8.870				
29	0 - 30	64.0	17.5	0.23	8.28	8.51	0.013	0.000	0.834	1.560	0.250	0.180	0.655	0.017	9.160	33.6	23.0	8.48	1.05
	30 - 50	20.0	12.5	0.09	4.90	4.99	0.009	0.000	0.234	0.669	0.118	0.068	0.210	0.003	9.200				
16a	0 - 30	42.5	23.5	0.73	3.72	4.45	0.013	0.000	0.490	1.344	0.236	0.166	0.299	0.138	9.050	30.8	15.0	8.20	0.87
	30 - 50	19.5	11.0	0.12	2.20	2.32	0.009	0.000	0.120	0.357	0.050	0.048	0.091	0.022	9.280				
31	0 - 30	16.0	9.0	0.11	1.03	1.14	0.018	0.000	0.032	0.525	0.090	0.054	0.069	0.007	8.600	33.6	37.0	8.24	1.75
	30 - 50	10.5	8.0	0.25	2.09	2.34	0.023	0.000	0.030	0.232	0.033	0.024	0.054	0.003	8.800				
32	0 - 30	15.5	25.0	0.21	24.71	24.92	0.016	0.000	0.435	1.528	0.133	0.220	0.445	0.010	9.150	39.2	15.0	9.81	1.19
	30 - 50	7.0	19.0	0.16	4.76	4.92	0.016	0.000	0.345	1.033	0.056	0.150	0.375	0.003	9.190				
33	0 - 30	31.0	5.0	0.20	1.25	1.45	0.013	0.000	0.020	0.391	0.069	0.028	0.069	0.007	8.820	33.6	9.0	8.97	1.14
	30 - 50	19.5	7.5	0.14	1.22	1.36	0.013	0.000	0.034	0.258	0.041	0.020	0.064	0.003	8.900				
34	0 - 30	24.0	12.0	0.15	2.34	2.49	0.018	0.000	0.101	0.515	0.083	0.058	0.111	0.004	8.860	39.2	23.0	9.28	0.95
	30 - 50	4.5	7.0	0.14	1.68	1.82	0.018	0.000	0.056	0.043	0.018	0.021	0.080	0.002	9.250				
35	0 - 30	23.5	19.0	0.10	5.33	5.43	0.018	0.000	0.221	0.849	0.150	0.090	0.210	0.005	8.680	44.8	57.0	3.24	2.09
	30 - 50	11.5	12.5	0.17	4.03	4.20	0.018	0.000	0.095	0.522	0.086	0.053	0.118	0.002	8.880				
36	0 - 30	10.0	4.0	0.39	0.61	1.00	0.021	0.000	0.026	0.115	0.022	0.009	0.035	0.004	8.650	34.1	70.0	10.23	1.56
	30 - 50	7.5	7.5	0.25	0.46	0.71	0.023	0.000	0.014	0.111	0.015	0.010	0.034	0.002	8.800				
37	0 - 30	16.0	8.0	0.24	4.96	5.20	0.016	0.000	0.061	0.330	0.069	0.028	0.069	0.003	8.830	39.2	46.0	9.0	1.33
	30 - 50	10.0	5.0	0.13	0.35	0.48	0.018	0.000	0.036	0.140	0.027	0.016	0.035	0.001	8.700				
38	0 - 30	9.5	5.5	0.22	0.69	0.91	0.030	0.000	0.008	0.068	0.021	0.006	0.012	0.002	8.700	42.0	44.0	7.01	1.9
	30 - 50	6.5	5.0	0.22	0.33	0.55	0.025	0.000	0.010	0.036	0.012	0.004	0.010	0.001	8.900				

Table C.2 (3/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils)					Water Extract Cation and Anion (% of 100g dry soil)									Available N (mg/100 g)	Available P2O5 (mg/100 g)	CO3 (mg/100 g)	Organic Mater (% of 100 g soils)
		Ca	Mg	K	Na	Na + K	Anions				Cations								
							HCO3	CO3	Cl	SO4	Ca	Mg	Na	K	pH				
39	0 - 30	10.0	5.0	0.19	0.53	0.72	0.027	0.000	0.013	0.137	0.038	0.010	0.021	0.002	8.450	42.0	27.0	8.10	2.18
	30 - 50	6.5	4.5	0.16	0.60	0.76	0.030	0.000	0.030	0.054	0.018	0.004	0.026	0.001	8.900				
40	0 - 30	8.5	12.0	0.24	4.29	4.53	0.020	0.000	0.098	0.710	0.104	0.074	0.148	0.007	8.860	30.8	17.0	3.77	1.52
	30 - 50	9.5	6.0	0.18	1.54	1.72	0.018	0.000	0.029	0.352	0.080	0.008	0.065	0.037	8.440				
41	0 - 30	6.5	6.0	0.28	1.12	1.40	0.027	0.000	0.013	0.074	0.021	0.007	0.016	0.002	8.700	28.0	51.0	7.91	1.16
	30 - 50	6.5	6.5	0.19	0.69	0.98	0.027	0.000	0.012	0.049	0.015	0.004	0.015	0.001	8.850				
42	0 - 30	13.5	7.5	0.32	0.63	0.95	0.020	0.000	0.032	0.507	0.103	0.052	0.050	0.005	8.660	28.0	33.0	9.39	0.9
	30 - 50	5.0	12.5	0.21	0.59	0.80	0.020	0.000	0.052	0.368	0.027	0.058	0.075	0.003	9.040				
43	0 - 30	6.5	6.5	0.32	0.98	1.30	0.025	0.000	0.007	0.066	0.011	0.011	0.011	0.002	8.910	30.8	31.0	8.41	0.84
	30 - 50	2.25	6.25	0.30	1.04	1.34	0.058	0.000	0.005	0.082	0.008	0.002	0.050	0.001	9.320				
44	0 - 30	18.5	19.0	0.26	0.44	0.70	0.025	0.000	0.725	2.363	0.240	0.260	0.834	0.018	9.080	44.8	27.0	4.47	1.4
	0 - 50	45.0	24.0	0.21	0.42	0.63	0.018	0.000	0.531	1.025	0.134	0.164	0.375	0.005	9.150				
45	0 - 30	17.0	7.0	0.21	5.67	5.88	0.025	0.000	0.043	0.246	0.076	0.014	0.039	0.003	8.450	36.4	23.0	6.52	1.5
	30 - 50	14.0	5.5	0.41	12.48	12.89	0.020	0.000	0.012	0.171	0.046	0.014	0.017	0.002	8.800				
46	0 - 30	8.5	4.0	0.34	1.61	1.95	0.015	0.000	0.094	0.331	0.092	0.019	0.075	0.014	8.710	39.2	51.0	5.64	1.34
	30 - 50	7.0	7.0	0.23	2.0	2.23	0.013	0.000	0.110	0.426	0.062	0.044	0.117	0.010	9.340				
47	0 - 30	45.5	33.0	0.24	4.36	4.60	0.015	0.000	1.760	1.262	0.415	0.300	0.693	0.023	8.760	36.4	31.0	6.55	1.55
	30 - 50	8.0	8.5	0.33	1.11	1.44	0.013	0.000	0.297	0.137	0.005	0.046	0.167	0.005	9.120				
48	0 - 30	14.5	7.5	0.78	0.47	1.25	0.020	0.000	0.132	0.201	0.072	0.016	0.075	0.003	8.400	39.2	55.0	5.31	1.66
	30 - 50	13.5	8.0	0.29	0.58	0.87	0.027	0.000	0.085	0.149	0.048	0.014	0.054	0.003	8.520				
49	0 - 30	34.75	21.25	0.14	10.72	10.86	0.015	0.000	1.649	0.607	0.230	0.205	0.712	0.004	9.000	28.0	7.0	8.94	1.05
	30 - 50	9.0	13.0	0.11	3.43	3.54	0.018	0.000	0.711	0.253	0.054	0.072	0.390	0.001	9.240				
50	0 - 30	38.5	20.5	0.20	3.74	3.94	0.020	0.000	0.524	1.608	0.290	0.195	0.407	0.015	9.210	54.6	23.0	11.61	1.81
	30 - 50	10.5	12.0	0.20	6.25	6.45	0.018	0.000	0.863	0.668	0.145	0.100	0.525	0.009	9.100				
51	0 - 30	13.1	19.5	0.39	2.77	3.16	0.021	0.000	0.662	1.875	0.242	0.206	0.630	0.064	8.950	32.48	37.0	6.05	1.55
	30 - 50	48.0	14.5	0.53	1.98	2.51	0.016	0.000	0.317	1.292	0.218	0.128	0.314	0.040	9.000				
52	0 - 30	8.0	4.0	0.30	0.53	0.83	0.023	0.000	0.018	0.123	0.031	0.009	0.024	0.004	9.640	84.0	24.0	8.70	1.40
	30 - 50	5.5	4.0	0.38	0.29	0.57	0.040	0.000	0.039	0.041	0.012	0.007	0.029	0.006	8.750				
53	0 - 30	7.0	3.0	0.28	0.42	0.70	0.023	0.000	0.010	0.124	0.030	0.010	0.019	0.003	8.530	42.0	15.0	7.10	1.40
	30 - 50	9.0	5.0	0.26	0.46	0.72	0.023	0.000	0.014	0.207	0.046	0.020	0.024	0.003	8.530				
54	0 - 30	11.75	1.2	0.16	0.50	0.66	0.018	0.000	0.373	0.627	0.135	0.026	0.329	0.026	8.250	79.8	110.0	4.96	1.50
	30 - 50	17.0	3.0	0.10	0.53	0.63	0.013	0.000	0.248	0.840	0.210	0.034	0.250	0.021	8.700				
55	0 - 30	5.5	3.5	0.17	0.40	0.57	0.021	0.000	0.023	0.089	0.020	0.009	0.023	0.002	9.620	36.4	23.0	7.17	1.71
	30 - 50	7.5	2.5	0.19	0.33	0.52	0.027	0.000	0.008	0.045	0.009	0.005	0.016	0.002	9.700				
56	0 - 30	0.5	0.5	0.13	0.20	0.33	0.018	0.000	0.006	0.014	0.007	0.001	0.006	0.002	9.270	33.6	17.0	1.57	0.21
	30 - 50	-	-	0.11	0.20	0.31	0.018	0.000	0.003	0.011	0.005	0.001	0.003	0.012	9.420				
57	0 - 30	8.5	19.0	0.25	1.63	1.88	0.013	0.000	0.262	1.136	0.094	0.146	0.329	0.010	9.110	39.2	7.0	8.20	1.34
	30 - 50	4.5	17.0	0.19	0.54	0.73	0.013	0.000	0.173	0.725	0.042	0.094	0.236	0.004	9.230				

Table C.2 (4/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils) Ca	Mg	K	Na	Na + K	Water Extract Cation and Anion (% of 100g dry soil) Anions HCO3	CO3	Cl	SO4	Cations Ca	Mg	Na	K	pH	Available N (mg/100 g)	Available P2O5 (mg/100 g)	CO3 (mg/100 g)	Organic Mater (% of 100 g soils)
58	0 - 30	8.5	5.0	0.19	0.62	0.81	0.027	0.000	0.021	0.085	0.015	0.006	0.035	0.002	8.790	34.1	32.0	9.35	2.11
	30 - 50	7.5	5.0	0.26	0.40	0.66	0.027	0.000	0.010	0.041	0.010	0.004	0.016	0.002	8.900				
60	0 - 30	11.5	6.0	0.28	0.47	0.75	0.023	0.000	0.104	0.222	0.046	0.015	0.098	0.005	8.560	40.6	55.0	10.58	1.76
	30 - 50	15.5	8.5	0.26	0.28	0.54	0.021	0.000	0.008	0.300	0.056	0.030	0.042	0.003	8.470				
61	0 - 30	18.5	14.0	0.14	0.46	0.60	0.013	0.000	0.088	0.908	0.146	0.090	0.157	0.003	8.720	30.8	36.0	6.38	1.55
	30 - 50	4.5	8.5	0.13	0.69	0.82	0.021	0.000	0.061	0.285	0.010	0.032	0.111	0.001	9.300				
62	0 - 30	24.0	10.0	0.26	0.74	1.0	0.016	0.000	0.048	0.671	0.125	0.060	0.098	0.006	8.510	36.4	36.0	8.27	2.10
	30 - 50	8.0	10.5	0.26	0.55	0.81	0.021	0.000	0.052	0.346	0.023	0.036	0.111	0.003	8.870				
63	0 - 30	7.0	4.5	0.30	1.25	1.55	0.023	0.000	0.124	0.141	0.021	0.010	0.111	0.004	8.540	44.8	49.0	7.73	1.97
	30 - 50	8.0	5.5	0.33	0.62	0.95	0.023	0.000	0.000	0.116	0.019	0.009	0.023	0.003	8.760				
64	0 - 30	8.0	5.5	0.25	0.44	0.69	0.032	0.000	0.006	0.044	0.010	0.006	0.013	0.002	8.900	35.0	62.0	9.68	2.0
	30 - 50	4.0	6.0	0.20	0.49	0.69	0.027	0.000	0.033	0.046	0.008	0.009	0.026	0.002	9.100				
65	0 - 30	20.5	11.0	0.28	1.46	1.74	0.013	0.000	0.119	0.862	0.146	0.088	0.157	0.006	8.510	39.2	70.0	4.43	2.21
	30 - 50	4.5	9.5	0.19	0.90	1.09	0.021	0.000	0.065	0.280	0.029	0.034	0.085	0.002	8.890				
66	0 - 30	15.0	9.0	0.27	0.50	0.77	0.018	0.000	0.036	0.531	0.100	0.048	0.075	0.006	8.400	42.0	62.0	6.51	1.95
	30 - 50	6.75	6.75	0.29	0.55	0.84	0.023	0.000	0.017	0.199	0.030	0.017	0.046	0.003	8.610				
67	0 - 30	52.0	19.0	0.23	26.56	26.79	0.007	0.000	2.529	2.278	0.294	0.214	1.981	0.019	8.900	25.2	26.0	6.89	0.79
	30 - 50	10.0	16.0	0.07	14.46	14.53	0.010	0.001	1.469	3.658	0.284	0.210	1.981	0.010	9.220				
68	0 - 30	18.5	5.5	0.16	1.06	1.22	0.013	0.000	0.186	0.454	0.086	0.026	0.193	0.003	8.670	36.4	49.0	9.40	1.0
	0 - 50	38.5	1.5	0.10	0.26	0.36	0.010	0.000	0.008	0.461	0.168	0.011	0.014	0.003	8.520				
69	0 - 30	18.0	6.0	0.80	0.37	1.17	0.021	0.000	0.051	0.234	0.048	0.016	0.060	0.016	8.400	47.6	38.0	6.61	3.74
	30 - 50	9.0	5.5	0.30	0.47	0.77	0.021	0.000	0.030	0.127	0.023	0.010	0.039	0.006	8.660				
70	0 - 30	25.0	16.0	0.22	3.86	4.08	0.010	0.000	0.474	1.573	0.164	0.136	0.616	0.006	9.250	39.2	59.0	9.08	1.10
	30 - 50	15.0	10.0	0.16	0.55	0.71	0.016	0.000	0.106	0.616	0.075	0.050	0.187	0.003	8.810				
71	0 - 30	10.0	8.5	0.15	0.52	0.67	0.018	0.000	0.049	0.537	0.081	0.047	0.111	0.004	8.780	44.8	33.0	9.44	0.84
	30 - 50	4.0	3.5	0.12	0.97	1.09	0.021	0.000	0.062	0.138	0.020	0.011	0.069	0.002	8.900				
72	0 - 30	15.5	42.0	0.43	1.14	1.57	0.021	0.000	0.324	3.304	0.195	0.500	0.598	0.057	9.000	53.2	16.0	8.77	0.84
	30 - 50	0.5	12.0	0.19	0.41	0.60	0.013	0.000	0.106	0.563	0.036	0.082	0.141	0.010	9.300				
73	0 - 30	9.0	6.5	0.31	0.50	0.81	0.024	0.000	0.016	0.190	0.037	0.018	0.032	0.003	8.530	49.6	36.0	10.56	2.26
	30 - 50	7.5	12.5	0.22	0.58	0.80	0.030	0.000	0.009	0.117	0.021	0.014	0.020	0.004	8.790				
74	0 - 30	0.5	10.0	0.17	0.35	0.52	0.021	0.000	0.062	0.330	0.010	0.046	0.104	0.006	9.350	25.2	49.0	9.60	0.66
	30 - 50	27.0	26.0	0.67	1.61	2.28	0.021	0.000	0.300	1.818	0.215	0.230	0.360	0.052	9.000				
75	0 - 30	12.0	4.5	0.25	0.53	0.78	0.027	0.000	0.011	0.095	0.025	0.008	0.018	0.002	8.570	36.4	51.0	8.35	2.05
	30 - 50	6.5	6.0	0.20	0.53	0.73	0.027	0.000	0.014	0.062	0.013	0.006	0.020	0.001	8.800				
76	0 - 30	10.5	4.0	0.23	0.44	0.67	0.027	0.000	0.011	0.122	0.032	0.010	0.018	0.002	8.560	53.6	43.0	10.80	1.50
	30 - 50	8.0	4.0	0.19	0.40	0.59	0.030	0.000	0.008	0.070	0.019	0.007	0.013	0.002	8.770				
77	0 - 30	19.5	4.5	0.23	0.18	0.41	0.023	0.000	0.022	0.119	0.040	0.009	0.015	0.002	8.370	42.0	38.0	8.53	2.45
	30 - 50	9.0	5.5	0.18	0.34	0.52	0.025	0.000	0.008	0.120	0.025	0.013	0.017	0.002	8.600				

Table C.2 (5/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils) Ca	Mg	K	Na	Na + K	Water Extract Cation and Anion (% of 100g dry soil) Anions HCO3	CO3	Cl	SO4	Cations Ca	Mg	Na	K	pH	Available N (mg/100 g)	Available P2O5 (mg/100 g)	CO3 (mg/100 g)	Organic Mater (% of 100 g soils)
78	0 - 30	11.5	3.0	0.18	0.49	0.67	0.020	0.000	0.010	0.209	0.049	0.024	0.011	0.002	8.500	33.6	26.0	9.01	1.16
	30 - 50	5.5	3.5	0.15	0.24	0.39	0.023	0.000	0.008	0.171	0.037	0.019	0.015	0.002	8.730				
79	0 - 30	6.0	2.5	0.15	0.40	0.55	0.023	0.000	0.006	0.035	0.012	0.003	0.008	0.001	8.640	30.8	30.0	8.60	1.26
	30 - 50	5.25	4.25	0.18	0.42	0.60	0.025	0.000	0.016	0.062	0.017	0.007	0.062	0.001	8.800				
80	0 - 30	12.5	6.0	0.14	0.12	0.26	0.020	0.000	0.032	0.152	0.040	0.017	0.020	0.002	8.600	35.0	20.0	9.39	1.05
	30 - 50	7.5	2.5	0.14	0.12	0.26	0.045	0.000	0.036	0.168	0.025	0.022	0.050	0.002	8.910				
81	0 - 30	17.0	12.0	0.17	0.34	0.51	0.016	0.000	0.138	0.669	0.094	0.078	0.157	0.006	8.930	36.4	26.0	9.38	1.50
	30 - 50	1.0	3.5	0.11	0.26	0.37	0.016	0.000	0.000	0.074	0.008	0.008	0.016	0.001	9.100				
82	0 - 30	51.0	69.5	0.12	45.77	45.89	0.020	0.000	1.422	2.082	0.225	0.425	0.860	0.009	8.780	36.4	8.0	6.52	1.38
	30 - 50	8.0	19.5	0.12	5.67	5.79	0.025	0.000	0.808	0.437	0.050	0.149	0.390	0.003	9.050				
83	0 - 30	14.0	11.0	0.85	0.48	1.33	0.023	0.000	0.039	0.211	0.051	0.016	0.044	0.003	8.600	30.8	17.0	7.94	1.78
	30 - 50	10.5	9.0	0.30	0.45	0.75	0.025	0.000	0.036	0.176	0.034	0.014	0.050	0.003	8.700				
85	0 - 30	12.0	5.5	0.27	0.11	0.38	0.025	0.000	0.006	0.134	0.035	0.013	0.011	0.003	8.550	30.8	22.0	9.93	1.28
	30 - 50	9.5	7.5	0.19	0.13	0.32	0.032	0.000	0.022	0.183	0.028	0.022	0.040	0.002	8.670				
86	0 - 30	17.0	15.0	0.37	0.17	0.54	0.023	0.000	0.632	0.588	0.081	0.118	0.375	0.015	9.050	36.4	5.0	8.38	1.91
	30 - 50	8.0	6.0	0.14	1.06	1.20	0.020	0.000	0.071	0.284	0.052	0.026	0.080	0.002	8.760				
87	0 - 30	18.0	8.0	0.28	0.21	0.49	0.023	0.000	0.025	0.222	0.041	0.023	0.038	0.005	8.170	42.0	45.0	11.09	2.65
	30 - 50	8.5	7.0	0.38	0.21	0.59	0.035	0.000	0.033	0.131	0.018	0.010	0.055	0.004	8.730				
88	0 - 30	11.5	5.0	0.14	0.24	0.38	0.027	0.000	0.022	0.087	0.021	0.008	0.026	0.001	8.420	50.4	29.0	8.35	2.08
	30 - 50	6.0	5.0	0.19	0.34	0.54	0.035	0.000	0.016	0.020	0.010	0.004	0.012	0.001	8.900				
89	0 - 30	26.5	6.5	0.24	0.80	1.04	0.023	0.000	0.021	0.451	0.120	0.038	0.025	0.005	8.210	33.6	78.0	6.56	2.12
	30 - 50	10.5	10.5	0.24	0.90	1.14	0.025	0.000	0.017	0.287	0.036	0.034	0.050	0.004	8.770				
90	0 - 30	6.5	2.0	0.06	0.56	0.62	0.025	0.000	0.003	0.025	0.010	0.003	0.006	0.001	8.660	42.0	43.0	8.59	1.22
	30 - 50	4.5	3.5	0.11	0.66	0.77	0.025	0.000	0.021	0.022	0.012	0.004	0.012	0.001	8.760				
91	0 - 30	6.5	4.0	0.17	0.80	0.97	0.025	0.000	0.014	0.103	0.022	0.009	0.023	0.002	8.520	30.8	25.0	8.72	0.93
	30 - 50	8.0	3.0	0.17	0.68	0.85	0.025	0.000	0.010	0.069	0.017	0.007	0.015	0.002	8.610				
92	0 - 30	11.0	5.0	0.16	0.17	0.33	0.023	0.000	0.039	0.770	0.280	0.016	0.050	0.002	8.500	36.4	52.0	8.72	1.52
	0 - 50	9.5	5.0	0.15	0.93	1.08	0.016	0.000	0.016	0.091	0.018	0.009	0.022	0.001	8.620				
93	0 - 30	10.0	3.0	0.15	0.31	0.46	0.010	0.000	0.049	0.288	0.080	0.016	0.050	0.002	8.590	33.6	25.0	9.31	0.88
	30 - 50	25.5	3.0	0.18	0.29	0.47	0.010	0.000	0.017	0.695	0.188	0.051	0.033	0.004	8.470				
94	0 - 30	10.5	26.5	0.33	0.29	0.62	0.023	0.000	0.070	0.701	0.085	0.083	0.125	0.017	8.740	40.6	34.0	9.31	1.52
	30 - 50	19.5	0.5	0.23	0.31	0.54	0.023	0.000	0.043	0.331	0.034	0.041	0.075	0.005	8.830				
95	0 - 30	22.5	10.0	0.27	0.28	0.55	0.023	0.000	0.128	0.205	0.060	0.056	0.118	0.005	8.570	49.6	69.0	8.48	1.28
	30 - 50	42.0	6.0	0.24	0.27	0.51	0.009	0.000	0.038	0.420	0.088	0.035	0.060	0.003	8.590				
96	0 - 30	23.5	8.0	0.24	0.26	0.50	0.014	0.000	0.030	0.462	0.101	0.040	0.050	0.005	8.300	33.6	43.0	9.58	1.09
	30 - 50	11.0	6.5	0.19	0.24	0.43	0.014	0.000	0.028	0.288	0.039	0.029	0.060	0.003	8.480				
97	0 - 30	28.0	9.0	0.27	0.27	0.54	0.014	0.000	0.044	0.304	0.049	0.040	0.069	0.005	8.600	33.6	49.0	8.48	0.93
	30 - 50	6.0	12.0	0.34	4.69	5.03	0.025	0.000	0.048	0.321	0.017	0.032	0.110	0.004	8.850				

Table C.2 (6/6) Result of Laboratory Analysis

Pit No.	Depth of samples (sm)	Exchangeable Cation in Soils (meq/100 g dry soils)					Water Extract Cation and Anion (% of 100g dry soil)									Available N (mg/100 g)	Available P2O5 (mg/100 g)	CO3 (mg/100 g)	Organic Mater (% of 100 g soils)
							Anions				Cations								
		Ca	Mg	K	Na	Na + K	HCO3	CO3	Cl	SO4	Ca	Mg	Na	K	pH				
98	0 - 30	8.0	3.5	0.15	0.99	1.14	0.025	0.000	0.017	0.048	0.015	0.005	0.016	0.001	8.500	36.4	29.0	9.42	0.98
	30 - 50	10.0	2.0	0.11	0.45	0.56	0.023	0.000	0.011	0.066	0.024	0.004	0.011	0.001	8.500				
99	0 - 30	31.5	13.5	0.23	0.33	0.56	0.025	0.000	0.120	0.663	0.128	0.076	0.110	0.007	8.480	50.4	35.0	9.0	1.81
	30 - 50	7.5	6.0	0.16	0.12	0.28	0.025	0.000	0.041	0.145	0.018	0.018	0.050	0.002	8.830				
100	0 - 30	15.5	5.5	0.22	0.86	1.08	0.023	0.000	0.010	0.230	0.063	0.018	0.017	0.003	8.210	49.6	59.0	8.41	1.96
	30 - 50	4.5	5.5	0.17	0.99	1.16	0.025	0.000	0.014	0.874	0.023	0.016	0.379	0.003	8.600				
101	0 - 30	6.0	2.0	0.15	0.43	0.58	0.023	0.000	0.008	0.044	0.012	0.003	0.015	0.001	8.790	25.2	71.0	8.43	1.38
	30 - 50	6.0	1.5	0.15	0.34	0.49	0.017	0.000	0.010	0.077	0.030	0.004	0.006	0.002	8.770				
102	0 - 30	9.0	3.5	0.24	0.33	0.57	0.027	0.000	0.014	0.079	0.022	0.009	0.013	0.003	8.600	30.8	49.0	9.42	1.52
	30 - 50	8.5	1.5	0.15	0.41	0.56	0.027	0.000	0.014	0.091	0.034	0.006	0.010	0.002	8.620				

Table C.3 Effect of Cropping Pattern on the Salt Balance

Raion		Year	ECe (mS/cm) Cropping Pattern			
			1	2	3	4
Syr Darya	Root zone	Initial	5.26	5.26	5.26	5.26
		8th	3.84	3.83	3.86	3.83
		16th	3.74	3.73	3.75	3.71
		24th	3.68	3.67	3.69	3.65
		32th	3.65	3.64	3.66	3.61
	Drain Zone	Initial	5.04	5.04	5.04	5.04
		8th	4.32	4.32	4.28	4.16
		16th	3.85	3.85	3.78	3.62
		24th	3.57	3.57	3.50	3.32
		32th	3.41	3.41	3.33	3.15
Ternozek	Root zone	Initial	4.19	4.19	4.19	4.19
		8th	3.63	3.62	3.64	3.62
		16th	3.62	3.61	3.63	3.60
		24th	3.62	3.61	3.62	3.59
		32th	3.62	3.61	3.62	3.58
	Drain Zone	Initial	3.26	3.26	3.26	3.26
		8th	3.27	3.27	3.24	3.18
		16th	3.25	3.25	3.21	3.11
		24th	3.24	3.24	3.19	3.06
		32th	3.23	3.23	3.17	3.03
Karmakshy	Root zone	Initial	6.84	6.84	6.84	6.84
		8th	3.90	3.89	3.91	3.87
		16th	3.81	3.80	3.82	3.78
		24th	3.75	3.74	3.76	3.71
		32th	3.71	3.70	3.71	3.67
	Drain Zone	Initial	5.04	5.04	5.04	5.04
		8th	4.60	4.60	4.57	4.48
		16th	4.18	4.18	4.15	3.99
		24th	3.89	3.89	3.85	3.66
		32th	3.69	3.69	3.64	3.44
Zalagash	Root zone	Initial	3.85	3.85	3.85	3.85
		8th	3.47	3.46	3.47	3.46
		16th	3.51	3.50	3.52	3.50
		24th	3.54	3.53	3.55	3.52
		32th	3.57	3.56	3.57	3.54
	Drain Zone	Initial	2.14	2.14	2.14	2.14
		8th	2.47	2.47	2.45	2.42
		16th	2.69	2.69	2.66	2.59
		24th	2.85	2.85	2.80	2.71
		32th	2.96	2.96	2.91	2.80

Figures

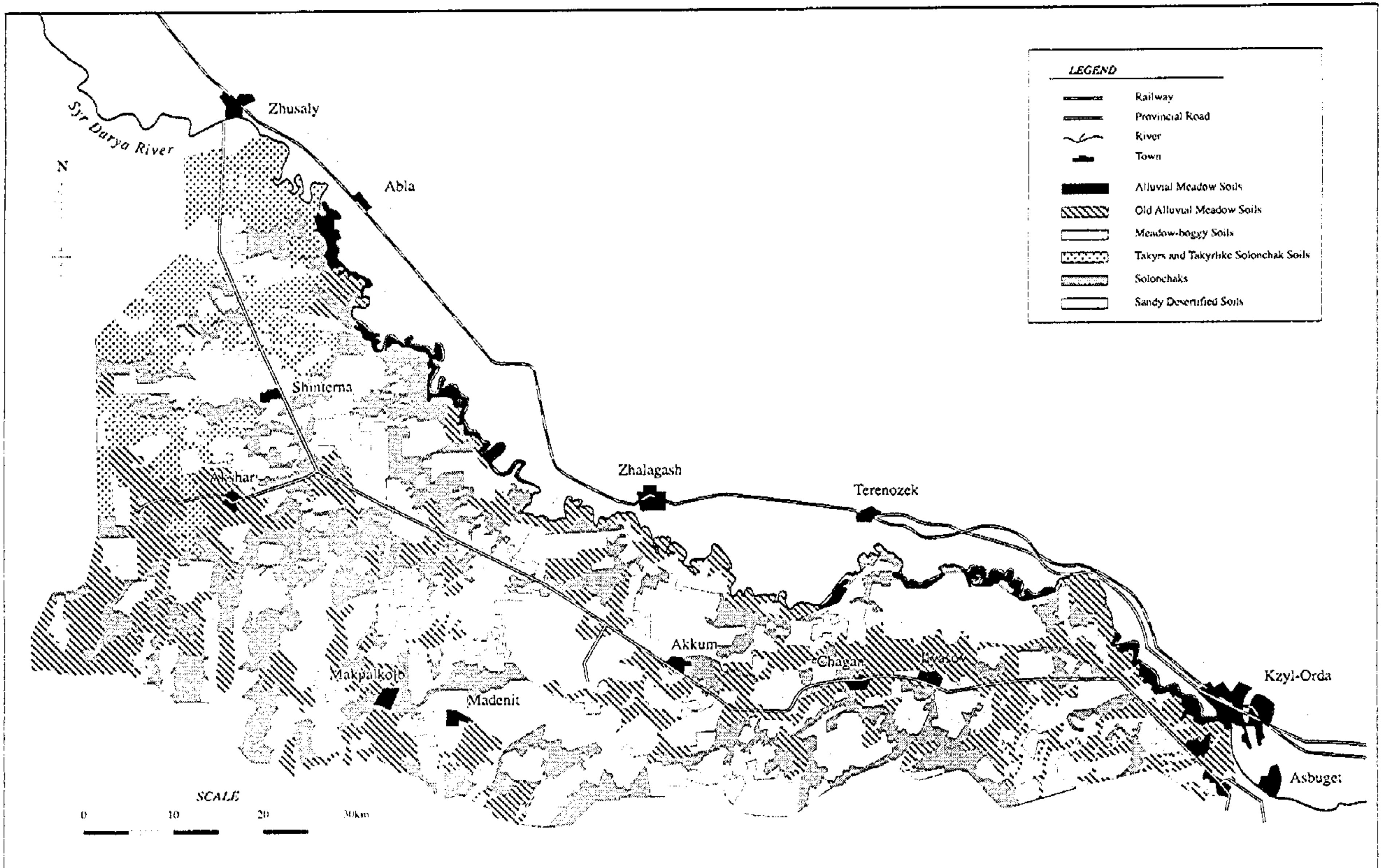


Figure C.1 Soil Classification Map in the Study Area

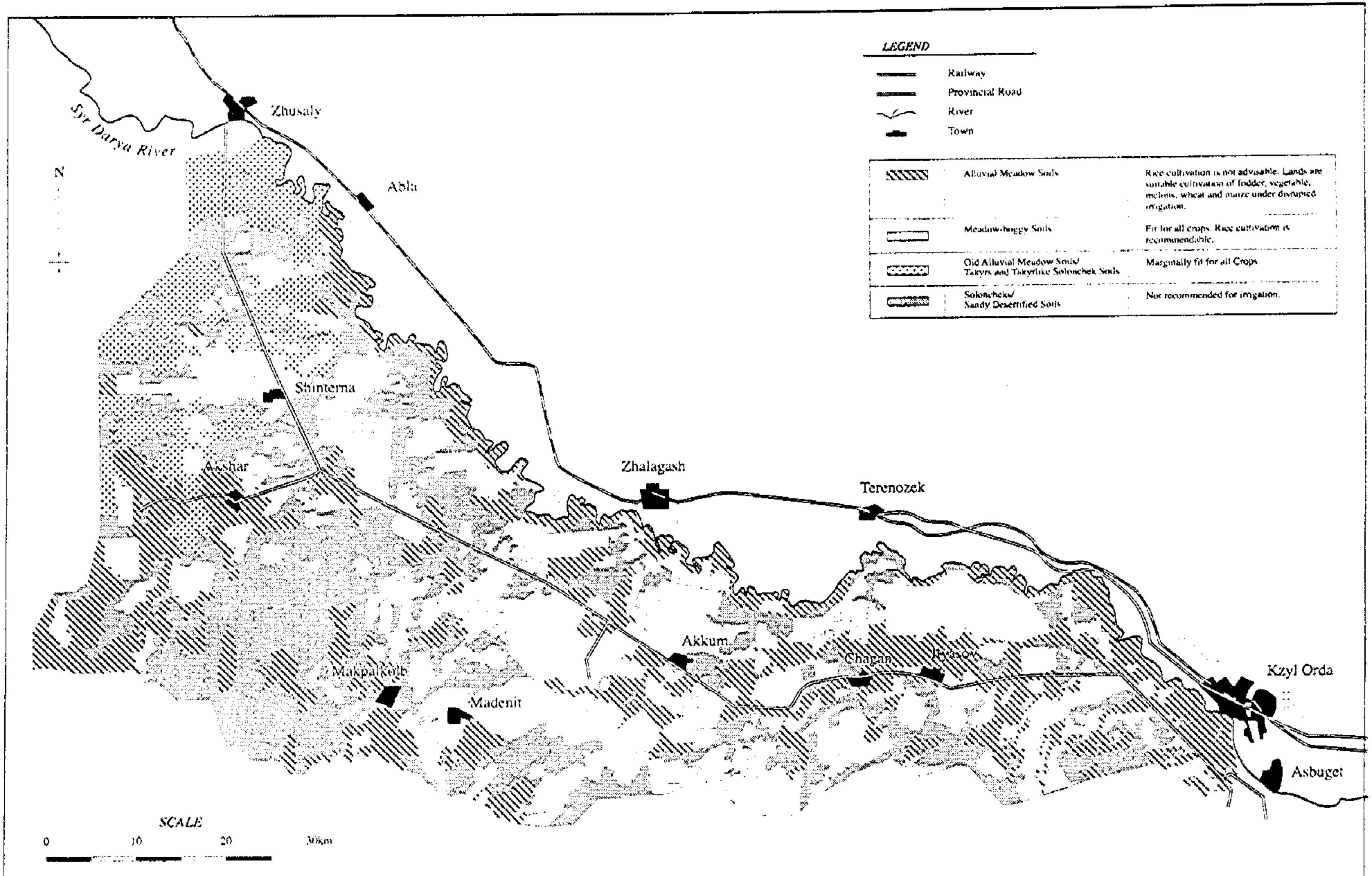


Figure C.2 Irrigation Suitability Map in the Study Area

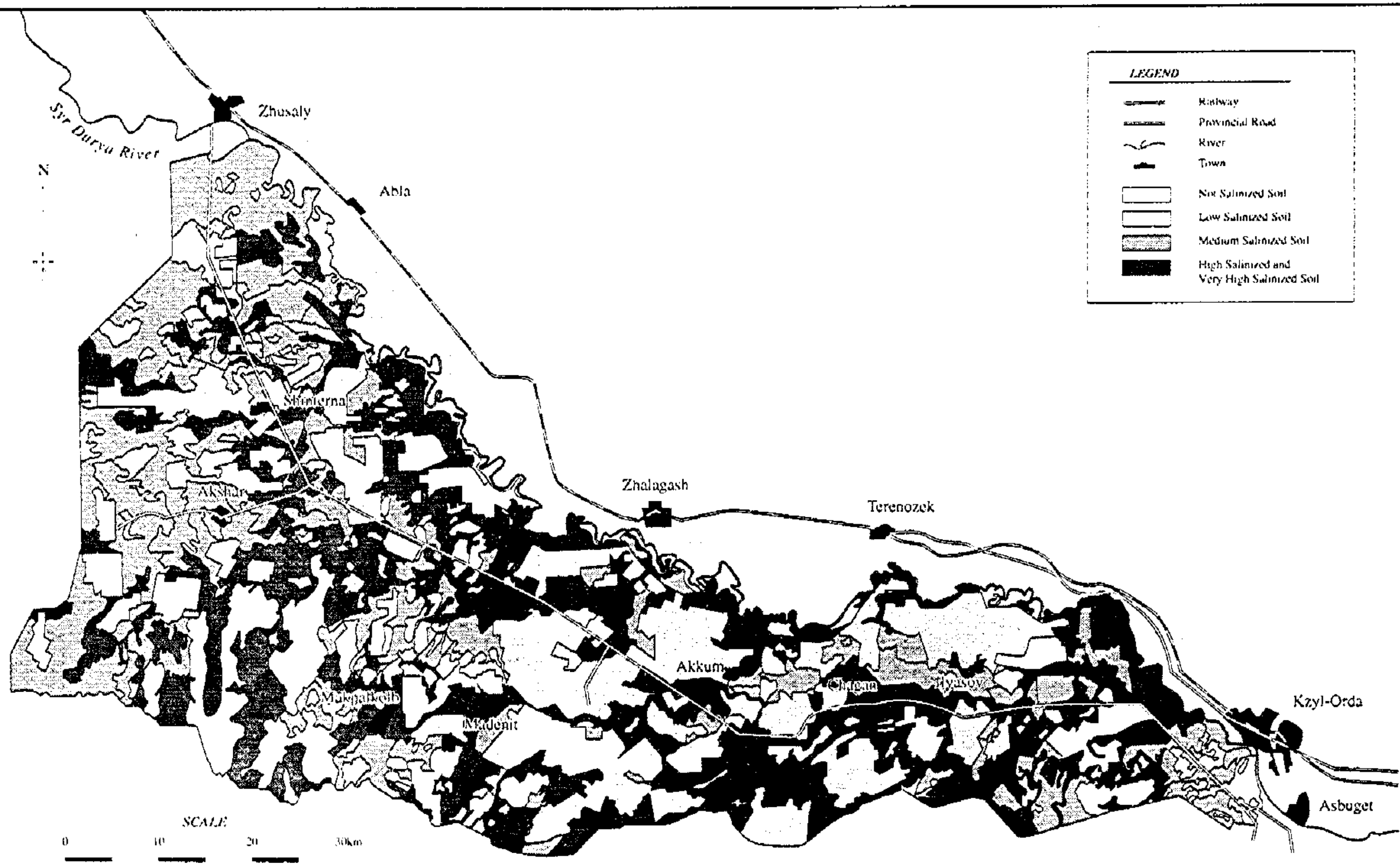


Figure C.3 Soil Salinity Map in the Study Area

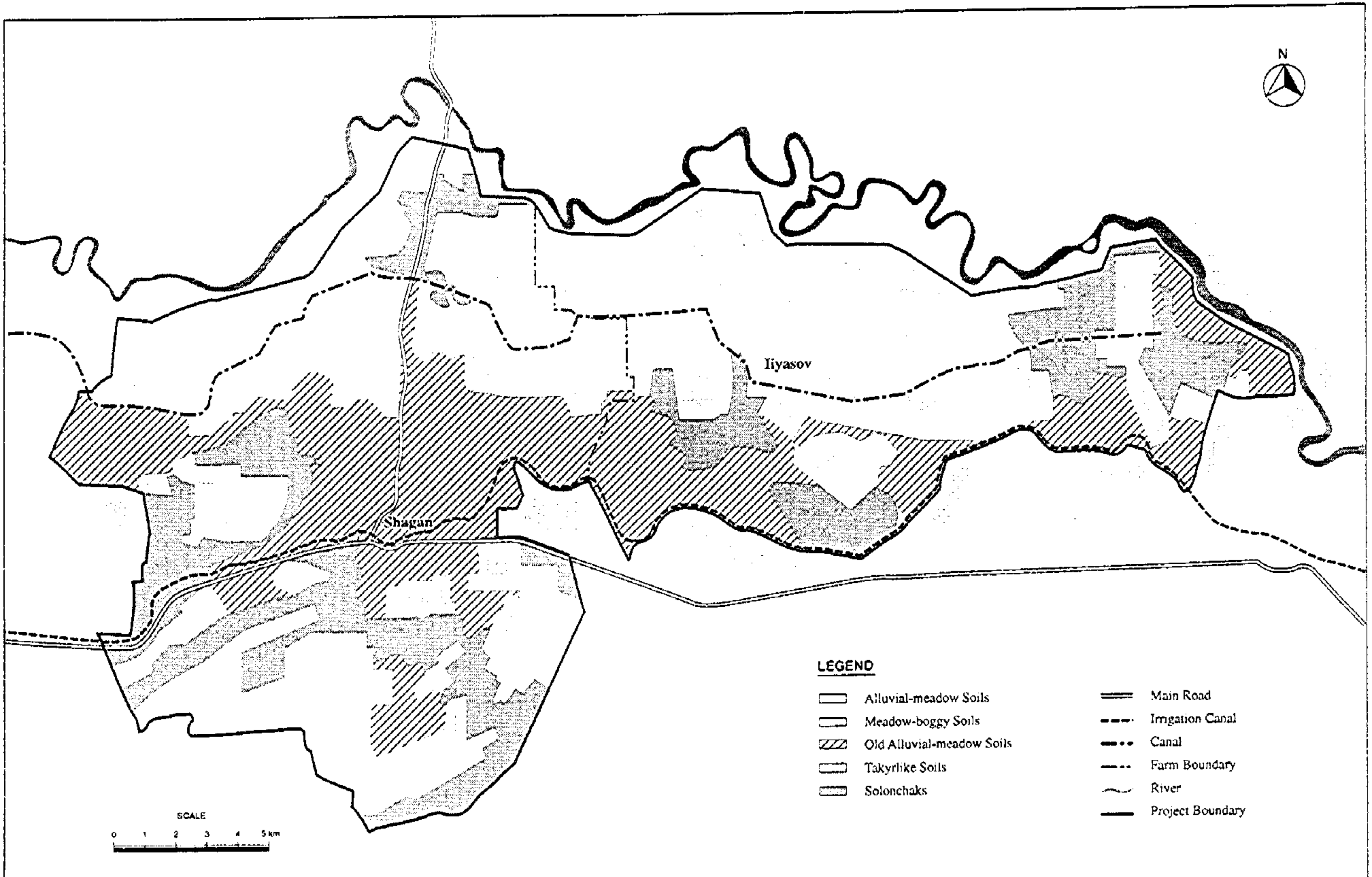


Figure C.4 Soil Classification Map in the Project Area

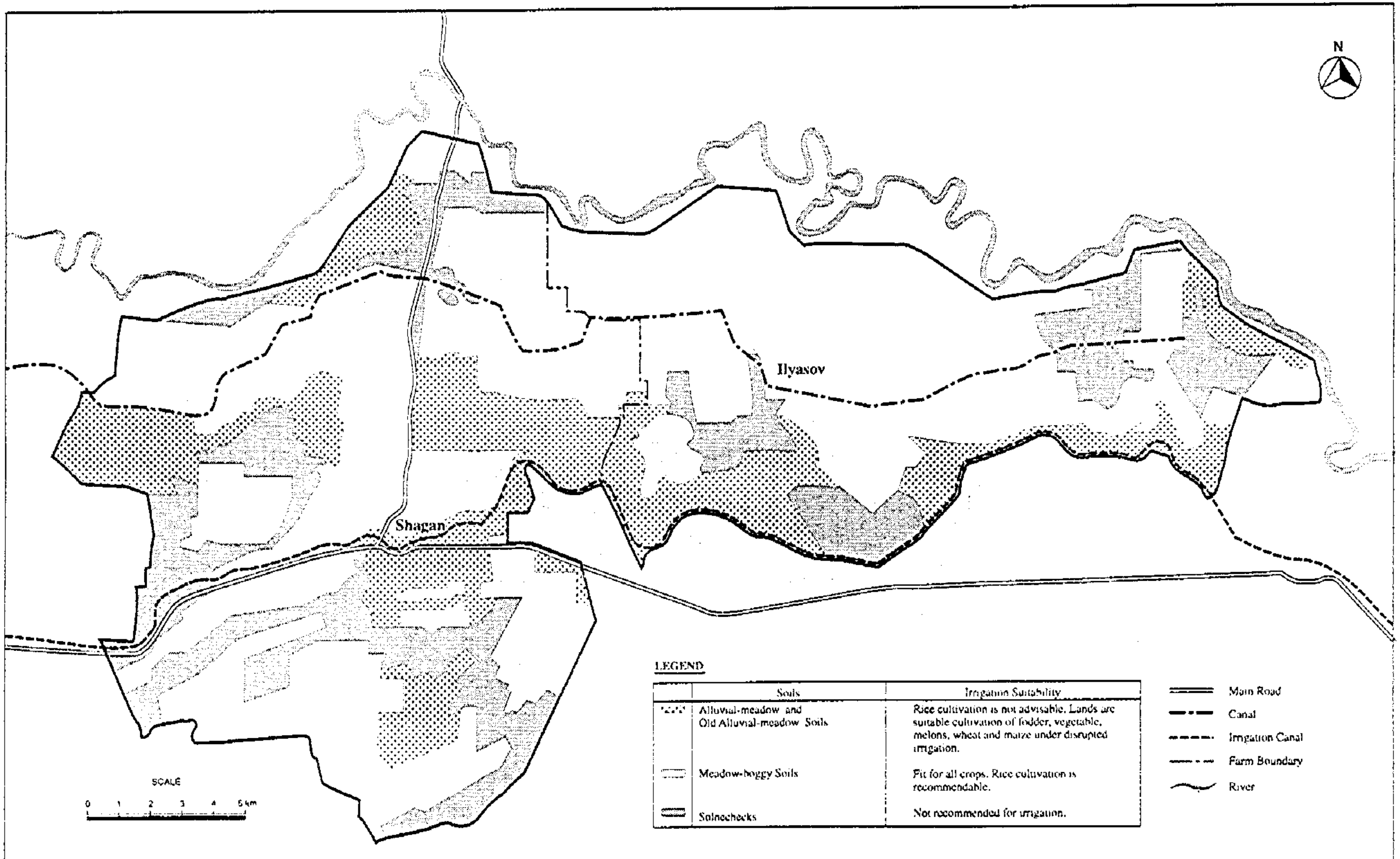


Figure C.5 Irrigation Suitability Map in the Project Area

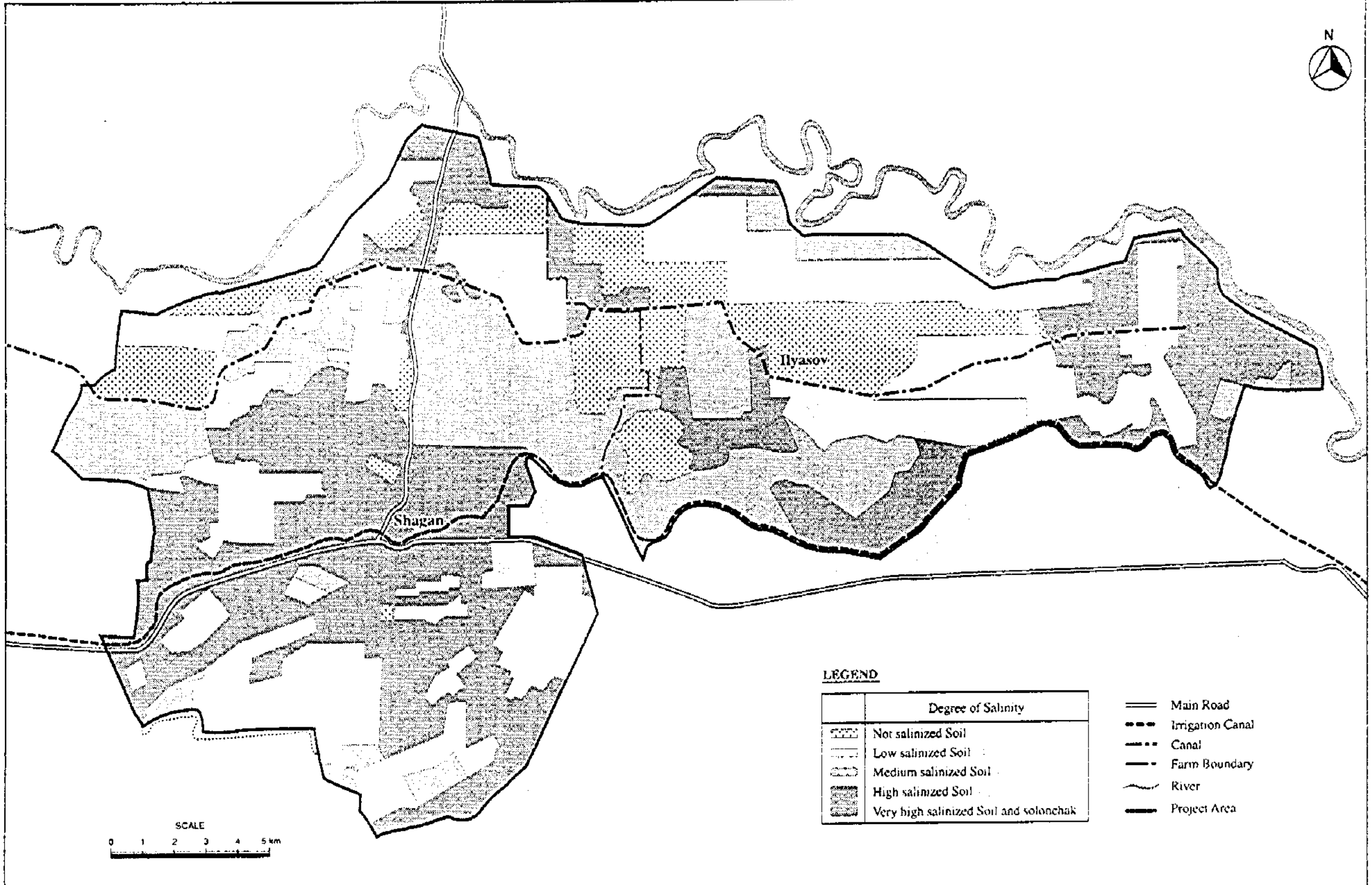


Figure C.6 Soil Salinity Map in the Project Area

Attachments

Attchment C.1

Procedure of Salt Balance Calculation

A.1 General

The irrigation water supplied from the Syr Darya river has a certain amount of soluble salts and the soils in the Study Area contain considerable amount of soluble salts. The surface irrigation method is used in the Study Area, which is inevitably accompanied with deep percolation as an irrigation loss. The irrigation losses to the subsoils consist of canal seepage and infiltration losses in the irrigated field. These percolation waters may be useful and are necessary for leaching and controlling the salts in the soils. The percolation water seeps vertically downwards to the ground water and has to be drained. The horizontal movement of ground water is considered negligible as compared with all percolation water. All the percolation water is considered to be drained through drainage canals.

Water and salt balance describes the gains or losses of water or salt in a given area or soil layer over a certain period of time period. They can be written as follows:

Incoming quantity - Outgoing quantity = Change of storage in the soil

A.2 Procedure of Calculation

The salt balance is examined by using the following method, which was developed by Boumans   and later on extended by Van Der Molen.

A.2.1 Water balance

In general water balance for any given land is expressed by the following equation:

$$I(t) - D(t) = DS/dt$$

where, I(t) is incoming water to the land, D(t) is outgoing water and dS/dt is the change of water stored in soils. Precipitation and irrigation water are in this case the only means of supply of water to the root zone. Capillary rise of ground water is possible in high ground water table area during non-irrigation period.

Water balance of the root zone of an irrigated field may be written as:

$$Ir + N = ET + P + Sr + \Delta V$$

where,

Ir	=	Field irrigation supply (dm) (1 dm= 10 cm)
Sr	=	Surface water losses from the applied irrigation water (dm)
N	=	Precipitation less interception and surface run-off (dm)
ET	=	Evapotranspiration (dm)
P	=	Deep percolation below root zone or capillary water supply from below (P negative) (dm)
ΔV	=	Change in quantity of water stored (V) in root zone (dm)

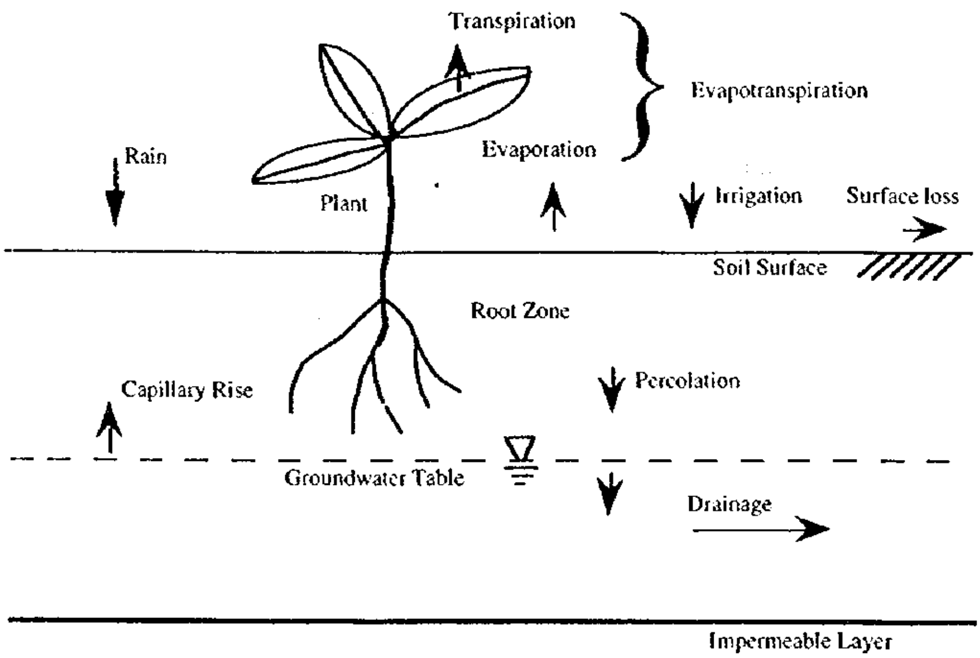
Water balance below the root zone can be described by following equation:

$$P + S_p = D_n + D_r + \Delta W = D_t + \Delta W$$

where,

S_p	=	Underground water supply
D_n	=	Natural drainage
D_r	=	Artificial drainage
D_t	=	Total drainage
ΔW	=	Change in water storage below root zone

In this study underground water supply (S_p) is considered negligible.



Components of Water Balance, Each of Which Has Own Salt Content

A.2.2 Salt balance

Salt supplied by precipitation or assimilated by crops can be neglected. The salt balance of the root zone is as follows.

$$Ir \cdot C_{ir} = P \cdot C_p + S_r C_r + \Delta Z$$

where, C_{ir} = Salt concentration of irrigation water (g/l)
C_p = Salt concentration of percolation water (g/l)
C_r = Salt concentration of surface loss water (g/l)
ΔZ = Change in quantity of dissolved salt (Z) in root zone (g/dm^2)

As already mentioned, P is negative when it represents capillary rise. If, in the period over which the balance is considered, both positive and negative percolation occurs, P is taken as the algebraic sum of both.

Efficiency of Leaching

Percolation water often passes through cracks, relative large pores in soil profile without any leaching effect. If the share of the effective water passage to the total percolation is k and the ineffective part is 1-k, the following relationship is valid:

$$C_p = k. C_{sm} + (1\text{-}k) C_{ir}$$

where, C_{sm} is the salt concentration of the soil water in the root zone at the field capacity (g/l) and k the leaching coefficient.

For salinity control the salt content of the soil moisture (C_{sm}) in the unsaturated zone is decisive. One might take as an approximation C_{sm} at field capacity equal to C_p for light soil. The leaching coefficient is less than 1. It depends on the soil and, to some extent, also on the depth of root zone. Boumans suggested the following values for different soil classes. In this study, leaching coefficient is assumed 0.7 in consideration of soils in the Project Area.

Soil type	Leaching Coefficient (k)
Sand	0.7 - 0.8
Loam, sandy loam	0.5 - 0.7
Clay loam, clay	0.3 - 0.5
Heavy clay	0.2 - 0.3

Better information on the seasonal variation of soil salinity and peak drainage of soil salinity and the peak drainage demands can be obtained by studying the irrigation-salt-drainage relationship over monthly periods.

To obtain the quantity of salt content at the end of each month the following equation is used.

$$Z_2 = Z_1 + \Delta Z$$
$$\overline{Z} = 0.5\,(Z_1 + Z_2)$$

Where,
Z_2 = Dissolved salts in the root zone at the end of the month (g/dm^2)
Z_1 = Dissolved salts in the root zone at the beginning of the month (g/dm^2)
Z = Increase (+) or decrease (-) of salt per month (g/dm^2)
$\overline{Z}$ = Average of dissolved salts in the root zone during the month (g/dm^2)

The average content of dissolved salts in the root zone of thickness, T (dm), saturated up to field capacity is expressed as follows.

$$\overline{Z} = Z_1 + 0.5\,\Delta Z = T.\,FC.\,C_{sm}$$

where, FC = Soil moisture at the field capacity (by volume)

By combining the relationship between the salt balance in root zone, leaching efficiency and the average content of dissolved salts, the following equation is obtained.

$$\Delta Z = \frac{F - B\,.\,Z_1 - Sr\;Cr}{A}$$

where,

$F = (Ir - (1\text{-}k)\,.\,P)\,.\,C_{ir}$
$B = k\,.\,P/(T\,.\,FC)$
$A = 1 + 0.5\,B$

A.2.3 Salt Concentration of Drainage Water

The percolation water used for leaching of root zone and drainage zone is mixed with other irrigation loss and surface run-off of rainfall from non-cropped area and drained to Kuvandariya river through drainage canal. The salt concentration of surface run-off of rainfall, however, is negligibly small. The salt balance of drainage water is as follows.

$$S_r\;C_r + P\,C_p = (S_r + P)\,.\,C_d + \Delta Z$$

where,
S_r = Surface water loss from the irrigation water (dm)
P = Percolation water (dm)
C_r = Salt concentration of surface loss water (g/l)
C_p = Salt concentration of percolation water (g/l)
C_d = Salt concentration of drainage water (g/l)
ΔZ = Variation of quantity of dissolved salt (g)

A.3 Basic Data Applied for Study

Salt balance in the Study Area was examined on the basis of the field test results of soil sample analysis. Although not all required data are available, value of unavailable data is assumed based on soil type.

In order to calculate the salt balance in the field, the irrigated area is divided into the three zones based on raion and depth of drainage zone system. The soil depth is divided into root zone (1-100 cm) and drainage zone (below root zone and up to impermeable layer) for the purpose of the estimation of salt balance. Initial (present) salinity of the root zone and drainage zone in three raions is shown in the following table.

Raion	Irrigated Area (ha)	Root Zone		Drainage zone		Total depth
		Depth (m)	Salinity (ECe) (mmho/cm)	Depth (m)	Salinity (ECe) (mmho/cm)	(m)
Syr Darya	3,330	1.0	5.26	5.5	5.04	6.5
Zalagash	34,400	1.0	3.85	9.0	2.14	10.0
Karmakshi	25,600	1.0	6.84	8.5	5.04	9.5
Terenozek	23,670	1.0	4.19	7.5	3.26	8.5
Total	87,000					

The salt content of soil was measured at several points in two farms of the Priority Project Area during the Phase I Study Period. Salt content is measured at several depths in the top layer. The average EC_e of top 0-100 cm soil and 100-150 cm are shown in the following table. The EC of ground water was also measured at 40 points in the two farms during Phase II Study Period and average value of EC of ground water in two farms is also shown in the following table.

Name of Area	Irrigation Area	Average ECe of Rootzone (0-100 cm) (mS/cm)	Average ECe of 100-150 cm depth (mS/cm)	Average EC of Ground water (mS/cm)
Ilyasov	6,480	3.88	3.12	2.78
Shagan	7,210	4.61	4.23	2.98

Other input parameters for the calculation of salt balance are assumed as follows.

(a) Irrigation water

Irrigation water is the diversion irrigation requirement excluding the evaporation and canal operation losses for calculating salt balance of whole study area. For the calculation of salt balance in each farm, field water requirement is taken as irrigation water. The irrigation water supplied from the Syr Darya river is estimated to have a salt concentration of 1.22 g/l throughout the year.

(b) Rainfall

The mean monthly rainfall of the Kzyl-Orda Meteorological Station is used in water balance study.

(c) Surface water loss

Surface water loss from irrigation is defined as the outgoing surface flow of supplied water, which consists of operational losses of canal water and irrigation surface runoff. In this study surface loss from irrigation was assumed to be 5% of the total canal head supply. The surface runoff from rainfall was assumed 10% of total rainfall.

(d) Percolation loss

Percolation loss in paddy field is taken as 3 mm/day. For upland crop, field efficiency is 70 %, therefore 30% of irrigation water is lost as a deep percolation and surface runoff. The deep percolation loss for upland crops is assumed as 20% of field irrigation requirement.

(e) Evapotranspiration from cropped land

Evapotranspiration from cropped land was calculated for the proposed cropping pattern by modified penman equation.

(f) Evaporation

Evaporation from canal water surface was estimated to be 1% of canal head supplies. Evaporation from non-cropped land is estimated assuming that all the rain falling on the non-cropped land are directly evaporated and that evaporation from ground water corresponds to 10% of evaporation from free water surface.

(g) Salt Concentration of ground water

The average salt concentration of ground water in Ilyasov Area is 2.78 mS/cm and in Shagan fArea 2.98 mS/cm. The capillary rise from the ground water is considered for the upland crops for meeting evapotranspiration needs. In this case, the water extraction from the top layer is reduced due to reduction in evaporation loss from soil surface.

Based on the above data, the salt balance in the root zone and drainage zone is estimated using above mentioned Bouman's quantitative calculation technique.

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SOCIO-ECONOMY AND RURAL SOCIETY

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SOCIO-ECONOMY AND RURAL SOCIETY

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SOCIO-ECONOMY AND RURAL SOCIETY

1 Land and Population in Kazakstan

Kazakstan is a land-locked country in Central Asia bordering Russia to the north and northwest, and Turkmenistan, Uzbekistan, and Kyrgystan to the south. The national territory is 2,725 thousand km^2 and extends 3,200 km east to west and 1,800 km north to south. Kazakstan has a semi-arid continental climate with cold dry winters and hot dry summers. Annual precipitation ranges from less than 150mm in the north to 450mm in the southern foothills. Kazakstan's land ranges from semi-arid steppes in the northern and central regions to desert and mountains along the southern borders with Uzbekistan and Kyrgystan. Most irrigated agriculture occurs in the south along the Syrdarya River. Cropland includes about 34 million ha of which about 32 million ha is rain-fed and about 2.4 million ha irrigated. Soils are moderately fertile.

The World Bank estimates the 1994 population of Kazakstan at 16.8 million in an area of 2,717 thousand km^2. The State Committee of Statistics estimates 1996 population at 16.5 million. Using World Bank figures, the population density is 6.18 per km^2. As is true throughout the former Soviet Union, population growth is well below world averages; the average annual growth rate for 1990-1994 in Kazakstan was only 0.9%. This is due to both higher than average death rates and emigration. The percentage of the population residing in urban areas is 59% with 41% residing in the rural sector. Nationally, the urban sector is growing at 0.9% per year.

The population of Kazakstan is comprised of eight major nationalities or ethnic groups. The largest is Kazakh which presently accounts for 46% of the population. The nation was a multi-ethnic pluralist, secular society during the Soviet Period. With independence in 1991, the population's ethnic structure began to change with the emigration of Russians, Ukrainians, and Germans. Ethnic tension, although modest, is present. Russians, who had been a majority in the 1980's, are now a minority. However, there is no evidence of the religious fundamentalism that has troubled other former Soviet republics.

Ethnic Nationalities in Kazakstan (percent of total)

Nationality	1989	1990	1993	1994	1995
Kazakh	39.7	40.3	43.1	44.3	46.0
Azerbaijani	0.6	0.6	0.6	0.6	0.6
Belorussian	1.1	1.1	1.1	1.1	1.0
German	5.8	5.5	4.1	3.6	3.1
Russian	37.8	37.6	36.5	35.8	34.8
Tatar	2.0	2.0	2.0	2.0	1.9
Uzbek	2.0	2.0	2.1	2.2	2.3
Ukrainian	5.4	5.4	5.2	5.1	4.9
Others	5.6	5.5	5.3	5.3	5.4

Source: State Committee of Statistics

During the three years, 1993 to 1995, 1,123,846 Kazakhstani citizens emigrated abroad in large numbers. The largest groups were Russians, Ukrainians, and Germans:

Selected External Migration by Nationality, 1993-1995

Nationality	1993	1994	1995
Russian	170,129	283,154	160,883
German	88,212	92,586	82,657
Ukrainians	23,278	36,899	22,204

Source: State Committee of Statistics

2 Agricultural Reform and Privatization in Kazakstan

The Institutional, Legal, and Managerial Environment of Agricultural Reform and Privatization in Kazakstan: Implications for the Kzyl-Orda Irrigation & Drainage Project

Agriculture is a major, but declining, component of Kazakstan's economy. The proportion of the Gross Domestic Product generated by agriculture has been declining steadily since independence in 1991 and currently accounts for 14% of GDP. About one-fifth of Kazakstan's labor force is involved in agriculture and this proportion also is declining. The total area of agricultural lands is correspondingly getting smaller as lands are abandoned due to low productivity, lack of profitability, and environmental degradation including salinization, poor drainage, and high water tables. The total area under cultivation has decreased by 20% since 1991. Livestock herds are now at one third their pre-independence level. Accompanying the drop in production has been a rural to urban population migration. Rural social welfare has worsened and the number of people whose income does not provide a basic basket of commodities has increased. Rural unemployment has risen significantly. Yet, despite these changes, agriculture still accounts for a significant portion of the nation's exports and remains vital to the country's future.

The transition to market agriculture has been particularly difficult for Kazakstan. In large part this is because the previous command system was highly subsidized, environmentally unsound, managerially inept, not structured for profitability, and designed with poor economics of scale. Agriculture has also received comparatively less government attention than other economic sectors as the reforms have proceeded. In addition, at the outset of agricultural reform, prices of inputs and machinery were liberalized, but the markets for agricultural products were not. Farms were put into a price/cost squeeze in which they could not recover their costs in the marketplace. The result has been that former state farms are collapsing, output is dropping precipitously, and fully 80% of all farms are unprofitable. In the absence of state subsidies and price supports, large and small farms have little cash for machinery, fuel, electricity, agricultural inputs, spare parts, social infrastructure, and maintenance. Many transactions are by barter. Rural finance is limited as banking institutions also undergo reform. The formerly state-owned agricultural bank, Agroprom, is being privatized, but has limited liquidity and is burdened with bad loans. Access to private finance at reasonable rates is still problematic in the rural sector.

Thus, apart from many smaller peasant (family) farms, most farms today in Kazakstan are in great disrepair; buildings are dilapidated, old machinery is abandoned, roads are deteriorated, herds have been sold off for slaughter, and marginal crops are being produced on degraded soils with few inputs and minimal conservation methods.

Most agriculture takes place on former state farms. These farms, which numbered 2,100 before the privatization process began, were large scale agricultural factories which ranged in size from 10,000 to 80,000 ha. Administered under a Soviet command economy, their leadership was comprised of political appointees who administered the farm in a highly centralized manner under directives of the Ministry of Agriculture. Farms were provided with credits for inputs and machinery and social infrastructure and their production was utilized by state agro-processing firms. Farms met specific production quotas and observed centralized orders for specific crops. Inputs and outputs were not marketized and did not respond to a price structure. Private agricultural land holding for market production was illegal. In addition, the environmental costs of agriculture were not accounted with the result that vast sections of land were abused and water resources were treated as "free." The Aral Sea disaster is the most well known environmental by-product of the system, but other examples abound.

As a result of upstream water diversions for large scale irrigation of rice, cotton, and other water consumptive crops the Aral Sea's volume fell to 1/3rd of its former size between 1960 and the present.

Early in the privatization process begun in 1991, it became apparent that Kazakh agriculture was in decline and that policy measures needed to be taken to address this historically important part of the nation's economy. Such efforts have been necessary in order to maintain food security, reduce food imports, generate foreign markets, address falling rural standards of living, and limit environmental decline. The Government of Kazakstan requested assistance from the World Bank, the Asian Development Bank, and other sponsors in an effort to acquire needed technical assistance and capital. In addition, the nation embarked on an extensive series of legal and policy reforms aimed at easing and accelerating the transition of agriculture into the world market economy.

The focus of agricultural reform is primarily in three areas: 1) Farm privatization and restructuring, 2) Price and trade policy, and 3) Marketing reform. More recently, attention has also been given to rural finance.

At this time, nearly all farms have been privatized, however in most cases this has been a paper exercise in which farm laborers are granted a share of the farm and it has changed its name. In reality, most former state farms retain their former management structure; the specialists and managers are the same ones as before privatization. Indeed, many managers have acquired large portions of the total farm's shares only exacerbating the centralized nature of control and creating a monopoly of power. Nonetheless, the legal option for members to secede from a farm and operationalize their share as a registered peasant family farm has resulted in a significant increase in small scale, private family farming.

By 1997, agricultural prices had been liberalized and the price/cost squeeze which had accelerated farm collapse had eased. However, markets are poorly developed, the transportation and storage infrastructures are deteriorated, and farms are burdened with significant unresolved debts.

To date, many of the structural and policy constraints to agriculture have been removed. In January 1997, the Price Commission was abolished and floor prices and state order systems were eliminated. Trade barriers have also been removed and export quotas were eliminated. Marketing has also experienced rapid recent reform. Mandatory procurement quotas have been abolished. The government network of grain elevators has been privatized. Barriers to international firm investment and procurement have been lifted. As a result, international firms are now purchasing Kazakh cereals and marketing and selling inputs and supplies. However, access to such markets and inputs has been uneven and most farms lack the liquidity for input purchase. Fertilizer application is a small fraction (10%) of its use in 1990.

In the financial sector, Agroprom Bank has been privatized, but its ability to inject capital into the agricultural sector has been limited by its own difficult transition, including its lack of liquidity. Few commercial banks make agricultural loans and those that do seek greater assurance of collateral than is possible in the current context. In large part, this stems from privatization laws which do not permit agricultural land to be identified as strictly private property with accompanying rights of redistribution, and commitment to alternative use. Agricultural land is, by legal definition, the property of the state. This means that permanent rights of "use" are granted to registered farmers who may transmit the lease through sale or inheritance, but may not redirect the land to other uses. With little or no alternative property as collateral, commercial banks are reluctant to extend credit to those in an already perilous situation.

Finally, it should be noted that apart from the diminishing policy constraints on agriculture, there is an enormous void of expertise on the management of farms in a market context. Even if all remaining policy and legal barriers to market agriculture were immediately removed, there are very few people with the skills, training, and information necessary to respond to the demands of a competitive, entrepreneurial, market-based agriculture system. This is true among government officials who interpret and apply policy as well as among those directly engaged in the agricultural endeavor. This suggests that the managerial and administrative elements of the transition will be slow as individuals acquire the skills and attitudes requisite to competitive enterprise. Moreover, markets require accurate and timely information. Not only is information needed about prices, inputs, technologies, credit, and buyers, but also about the legal and policy environment in which the market functions. Few farm managers and specialists are fully aware of the rapidly changing legislative and policy environment in which Kazakh agriculture is functioning. Fewer still are the peasant farmers and farm laborers who have access to this information.

The implications of this changing institutional and policy environment for the Kzyl-Orda Irrigation and Drainage Improvement Project are several.

First, it must be recognized that the project area is evolving into new administrative arrangements. While there were two state farms in the Priority Project Area a few short years ago, there are multiple farms of different types there today. As restructuring proceeds, the situation will become more complex and not less so. As farms strive to reach viable economies of scale and as farmers respond to new opportunities presented by the reformed environment, the likelihood of continued disaggregation and new farm types increases. Thus, the project must account for organizational complexity. This suggests that the constituents of the project are not the managers and specialists of the former state farms, as attractively simplistic as this may be. The constituents are all of the peasant farmers, cooperative farm laborers, and families in the identified project area. To reach all of them will be best accomplished through organizations, such as the water user association, in which they all have a voice. Note also that the peasant farms in the priority area belong to the Peasant Farm Association located in Terenozek town. Although this new organization has no capital and minimal expertise, it may become a viable organization in the future and additional peasant farms emerging in the area may well elect to use this organization for marketing, credit, and training.

A second implication is that the need for training, which is so evident in the project area, is not only in agronomy and irrigation. Project beneficiaries have much greater skills deficits in management, marketing, accounting, economics, business planning, and democratic decision making. The management techniques and related skills applicable to the command economy have no relevance in the current environment. Beneficiaries also have little knowledge of the policy environment in which they now work. Few are aware of the options available to them, such as the rights of property entitlement holders to sell or lease their entitlements or to establish new enterprises. Many workers are embittered by their current situation and see few alternatives but to continue to work in the near serfdom which characterizes their current situation or flee to an even more uncertain future in the cities. The project's Agricultural Extension Office, outlined in Section 2.2.6, should stress training in the institutional and legal environment which permits beneficiaries to exercise the range of choices open to them.

A third implication relates to information. The command economy stressed unidirectional information flow in which farms, processing units, and other agricultural enterprises provided data to central authorities for use in centralized decision making. Little information was provided in return and agricultural extension was non-existent. Now that agricultural reform is proceeding apace, information must be distributed freely and multi-directionally. Economic and financial decision making in a competitive market rely on timely data of high quality, yet such information is not available in the project area. Regular access to world market prices for a range of commodities is a data deficit; currently only prices for rice, wheat, and wool are broadcast on television. But additional information on a wide range of technical, social, and financial parameters is crucial to informed and intelligent farm decision making. The Agricultural Extension Office must take this into account and work with newspapers and other media to create self-sustaining mechanisms for information distribution. Other major agricultural projects undertaken by foreign donors have begun to take the training and information needs of farmers into account in project design. It is no less important in the Kzyl-Orda oblast where information and training infrastructures are absent or poorly developed.

Another issue revolves around the democratic process. The former state farms have charters and by-laws which pay lip service to democratic decision making and farmer participation, but much of the language used is reflective of the Soviet period in which democratic terminology was used to describe a highly authoritarian regime. In actual fact, the former state farms function somewhat like autocracies. Information is held at the top. Decision making resides with the leadership. Little is explained to farm laborers beyond what they need to know in order to do their immediate jobs at hand. The old system is dying hard and there is every incentive for leadership to maintain monopoly advantage wherever possible and to use its well developed political connections to buttress its position. Leaders run unopposed in too many elections and few fresh faces can be seen at any level of leadership from the farm level up to the ministry. Thus, to foster project sustainability, technical assistance must be decentralized and promote democratic decision making.

Free markets work best in democratic environments where actors can exercise free choice over economic and political matters which affect them. Not only does this require ample information, it is grounded upon democratic institutions which value the rights of the individual over the rights of governments, firms, or collectives. Where individuals choose to align themselves with political and economic organizations, it will be because they perceive it to be in their own best interest. Specifically, this means that the water user association, and any other organizations developed with technical assistance from the project, be administratively independent of the former state farms, the government, and any political organization. It also implies that training stress the rights of farmers and project beneficiaries to voluntarily choose among their options free of any coercion or intimidation by holdovers from the former regime.

The command structure fostered large scale mono-cropping and production for state organizations. The marketplace is much more varied in its choices. Consumers, both internal and foreign, determine what foods they will purchase based on price, quality, and preference. As the market for agricultural products has become free at the consumer end, so too must it be able to respond at the production end. This implies that decisions over crop selection, varieties, and marketing be devolved to the producers themselves. This is already the case with peasant farmers, but not so with production cooperative workers. In fact, many crops are grown *despite* their lack of profitability. Moreover, quality seed is scarce as are seeds for new varieties. Little or no experimentation with alternative crops or varieties is underway in the project region. If the project area is to be competitive and thereby return on the investment, it must provide foodstuffs and products which match consumer preferences. Thus, the decision making for crop selection should be decentralized. And training and demonstrations for new varieties and alternative crops should be provided through the Agricultural Extension Office and Demonstration Farm. Because a crop has been grown in an area for a long time and because farmers are accustomed to growing it are not necessarily good reasons to continue. As farmers see demonstrations and acquire new information, they may elect to diversify their cropping pattern and raise alternative breeds of plants and animals.

Lessons learned world wide in agricultural development indicate that when provided with good information, access to affordable credit, current technology, marketing skills, and the freedom to choose and administer their own affairs, farmers from any culture can provide high quality foodstuffs that match consumer preferences while yielding profits for the farm which increase rural social and economic welfare. These are among the keys to sustainable, long term agricultural reform and development.

3 Socio-Economic Conditions in The Kzyl-Orda Left Bank Area

3.1 Location and Administration

The Kzyl-Orda Left Bank Area consists of four districts in the agricultural area west of the capital city of Kzyl-Orda in the central and eastern region of the Kzyl-Orda Oblast. This oblast is an administrative unit located in south central Kazakstan bordering Uzbekistan to the south, the Aral Sea to the west, South Kazakstan Oblast to the east and the Dzhezkagan and Aktobe Oblasts to the north. The Kzyl-Orda Oblast is comprised of 228,100 km² encompassing 8 raions, 3 towns, 11 town type settlements, and 97 rural settlements. The Kzyl-Orda Left Bank Area includes agricultural and non-agricultural land on the left (south) bank of the Syrdarya River. The Area encompasses 430,000 ha: Syrdarya (37,500 ha, 8.7%), Terenozek (78,300 ha, 18.2%), Zhalagash (130,640 ha, 30.4%), and Karmakshy (183,560 ha, 42.7%).

Kzyl-Orda Left Bank Area

Raion	Agricultural	Non-Agricultural	Irrigated Area
Syrdarya	27,210	10,290	3,330
Terenozek	55,960	22,340	23,670
Zhalagash	115,370	15,270	34,400
Karmakshy	127,180	56,380	25,600
Total	325,720	104,280	87,000

Grand Total Area (Agricultural + Non-Agricultural)=430,000

3.2 Population and Labor Force

The Kazakstan Census Bureau estimates the population of the Kzyl-Orda Oblast at 676,800 for October, 1996. Interestingly, the population of the Kzyl-Orda Oblast is more urban than the national average; 429,900 (63%) reside in urban settings and 246,900 (37%) live in rural communities. The population of Kzyl-Orda City is 160,700.

Total Population, Kzyl-Orda Oblast & Four Raions Concerned (x1000)

Raion	1989	1994	1994/1989 %	1995	1995/1994 %	1996	1996/1995 %
Zhalagash	37.1	38.7	104.3	38.6	99.7	38.6	100
Karmakshy	40.7	42.6	104.7	42.6	100	42	98.6
Syrdarya	46.8	47.2	100.9	47.3	100.2	47.3	100
Terenozek	29.1	29.5	101.4	29.3	99.3	29.7	101.4
Oblast	651.3	606.3	93.1	606.1	99.9	676.8	111.7

Source: Kzyl-Orda Statistics Department

Total Households, Kzyl-Orda, 1989

Raion	Households	Household Density
Syrdarya	5,344	8.7
Terenozek	3,312	8.9
Zhalagash	3,959	9.7
Karmakshy	3,508	11.9

Source: 1989 National Census

Population, Kzyl-Orda Left Bank Area

Raion	Total Resident Population	Total Number of Household	Average Size of Household
Syrdarya	9,426	1,083	8.7
Terenozek	11,149	1,253	8.9
Zhalagash	18,026	1,918	9.4
Karmakshy	14,508	1,219	11.9
Total/Average	53,109	5,473	9.8

Source: Farm Survey

The population of Kzyl-Orda Oblast is remaining steady, however there is an out-migration process underway which is attributed to limited employment opportunities. During each of the years 1993 to 1996, net outflows exceeded net inflows.

Population Migration, Kzyl-Orda Oblast, 1993-1996

Year	1993	1994	1995
In-migration	10,613	7,326	12,113
Out-migration	17,006	20,980	21,034
Net Change	-6,393	-13,654	-8,921

Source: Kzyl-Orda Statistics Department

The Kzyl-Orda Oblast is located within the Kazakh region of the country and the ethnic structure reflects a profile quite different from that of the nation. Fully 93% of the population of Kzyl-Orda Oblast is Kazakh, only 4.3% is Russian, and no other ethnic nationality comprises more than one percent of the total.

Kazakhstan's 1994 labor force (ages 15-64) is 8 million. The labor force is growing at 0.9% per annum. Of the labor force, 47% are women. Of the total labor force, agricultural labor accounts for 32%, industry 32%, and the reminder (36%) is employed in the service economy. The Gross National Product per capita is $1,160 with an annual growth rate (1985-1994) of -6.5%. The national labor force is growing at an annual rate of 0.9%, the same rate as the national population growth rate of the population (0.9%). Income is comparatively evenly distributed:

Income Distribution, 1993

Quintile	Percent of Total Income
Lowest 20%	7.50%
Second Quintile	12.30%
Middle Quintile	16.90%
Fourth Quintile	22.90%
Highest 20%	40.40%
Gini Coefficient*	32.70%

*Measure of income equality in which 1=All persons earn same income and 100=One person earns all of the income. Thus, 32.7=Moderate income equality

Source: World Bank

Official data on employment has tended to significantly underestimate unemployment. As recently as three years ago, national unemployment was estimated at below one percent. This is because estimates have only included those registered for unemployment benefits and payment levels are so low that many unemployed do not opt to apply. Also excluded from calculations are "discouraged workers" which includes the chronically unemployed who have given up on finding work. These figures would drastically underestimate the number of adults who are not working. Figures on *under*employment are not collected. For these reasons, we compute unemployment as a percent of the able-bodied ages 16-59 years who are not working. In Kazakstan, this age group is defined as the economically active (able-bodied of working age). While these figures are far larger than those who are actively seeking work, they reflect the size of the economically active population which is not engaged in employment activities.

Labor Force and Unemployment, Kzyl-Orda, 1996

Raion	Economically Active Population	Total Employed	Total Unemployed	Unemployment Rate
Karmakshy	19,300	15,624	3,676	19.00%
Zhalagash	18,173	10,056	8,117	44.60%
Terenozek	13,497	9,446	4,051	30.00%
Syrdarya	21,400	13,371	8,029	37.50%
Oblast	280,912	201,459	79,453	28.20%

Source: Kzyl-Orda Labor Protection Department

To estimate the size of the economically active population of the of the Kzyl-Orda Left Bank Study Area, we calculated the percentage of able bodied persons aged 16-59 in the raion and applied that proportion to the population of the Kzyl-Orda Left Bank. Following are estimates for the left bank area total and by raion.

Estimated Economically Active Population Kzyl-Orda Left Bank Area, 1996

Raion	Population in Kzyl-Orda Left Bank Area	Percentage of Economically Active Population	Economically Active Population in the Kzyl-Orda Left Bank Area
Syr Darya	9,426	45.2	4,261
Terenozek	11,149	45.4	5,062
Zhalagash	18,026	47.1	8,490
Karmakshy	14,508	46.0	6,674
Total	53,109	46.2	24,487

Although the wage structure is comparatively flat (equitable), wages are low and have not kept pace with inflation. Reportedly, income inequality is rising during the transition period. Workers in government and state-owned enterprises and pensioners have seen their standard of living decline more rapidly than the general population.

The World Bank pegs average annual inflation, 1984-1994 at 150% using the GDP Deflator Method. Using Tenge/Dollar exchange rates as an index of inflation, the value of the Tenge declined by 9.9% during 1995 and by 9.4% in the first ten months of 1996. Adding in the inflation of the dollar yields an estimated inflation figure of 12.9% for 1995 and 12.2% for the first ten months of 1996. The State Committee of Statistics compiles a Consumer Price Index (CPI) as a measure of inflation and purchasing power. They estimate the Aggregate CPI has risen by 60.3% during the first three quarters of 1996, however this is unrealistically high. Following are wages by branch of the economy:

Average Monthly Earnings by Sector Kzyl-Orda Oblast, 1996 (in Tenge)

Sector	January	August
Industry	11,761	19,402
Agriculture	3,065	4,072
Forestry	3,115	4,866
Transportation	12,283	13,870
Trades	2,740	5,011
Information Technology	4,215	8,947
Education	3,495	4,860
Finance, Credit, Insurance	8,622	13,451
State Management	4,855	8,898

Source: Kzyl-Orda Labor Protection Department

3.3 Social Infrastructure

(1) Transportation and Communication

The transportation network in Kzyl-Orda is developed for both railways and roadways. The oblast is intersected by a major rail line that links Moscow with Almaty. The rail link connects Kzyl-Orda to the northwest to the Aktobe Oblast and on to the Russian Federation. To the southeast, the rails connect the Kzyl-Orda to the Chimkent Oblast with continuing routes to Almaty; northern and central Kazakhstan; Bishkek, Kyrgystan; Tashkent, Uzbekistan; Ashkabar, Turkmenistan; Peking, China; and Dushanbe, Tajikistan.

The nearest port served by the railway is Atyrau (formerly Guryev) on the Caspian Sea with regular ship service to Turkey and Iran. Rail conditions are reportedly good and fuel supply for locomotives is adequate. Trains carry both passengers and cargo and travel at an average speeds of 100km/hr. Travel time from Kzyl-Orda are Almaty (23 hours), Bishkek (23 hours), Tashkent (10 hours), Ashkabar (48 hours), and Moscow (72 hours). Agricultural cargo is estimated by the railway department to have declined precipitously although statistics are cargo tonnage were not available.

There are 1,266 km. of roads in the Kzyl-Orda Oblast. Of them, 29 km. are concrete, 141 km. are gravel, and 1096 are improved gravel.

Roads in Study Area Raions (Kilometers), 1996

(Unit : km)

Raion	Concrete	Improved Gravel	Gravel
Syrdarya	18	383.0	111.0
Terenozek	0	129.5	22.3
Zhalagash	0	164.4	29.6
Karmakshy	0	214.3	103.7

Source: Kzyl-Orda Oblast Roads Department

There are presently seven incoming and seven outgoing airline flights per week at the Kzyl-Orda Airport. All flights originate in or are bound to the capital, Almaty. Flights are operated by Kazakhstan Airlines and each flight has a capacity of 40 passengers. Maximum passenger volume per week in one direction is 280.

Communication infrastructure in the oblast is comprised of telephones, televisions, radio stations, and newspapers. Data for households with telephones, radios, and television were supplied by the Kzyl-Orda Department of Telecommunications. The oblast is served by the same broadcasters as the nation as a whole. The number of radio stations is "classified." Communication infrastructure is adequate for agriculture extension.

Communication Infrastructure, Kzyl-Orda, 1996

Raion	Number of Households		
	Telephone	Radio	Television
Terenozek	2,100	3,481	4,976
Syrdarya	1,810	1,581	6,755
Karmakshy	2,529	1,420	6,247
Zhalagash	1,814	2,756	6,768
Oblast	40,847	52,838	119,292

Source: Kzyl-Orda Oblast Department of Telecommunications

There are four weekly newspapers in the Study Area: Terenozek Spirit, Karmakshy Morning, Syrdarya, and Zhalagash Bulletin.

(2) Domestic Water Supply

According to the Oblast Water Department, 82.4% of households in the Kzyl-Orda Oblast have piped potable water. Households supplied by private domestic water wells comprise 17.6%. No households use streams or irrigation canals for domestic water supply.

More detailed data supplied by the Ministry of Public Health Kzyl-Orda Sanitary Epidemiology Station summarize the distribution of domestic water supply by raions in the Study Area.

Source of Domestic Water, Kzyl-Orda, 1996
Percent of Population

Raion	Water Pipe	Delivery Water	Well Water	Open Reservoir
Syrdarya	60	15	20	5
Terenozek	46	29	24	1
Zhalagash	70	15	14	1
Karmakshy	25	60	10	5

Source: Ministry of Public Health, Kzyl-Orda

Tests conducted by the Water Department on piped water quality samples indicate an alkaline supply with trace elements.

	Zhalagash	Karmakshy	Terenozek	Syrdarya
Arsenic	0.22	0	0	0
pH	8.3	8.2	8.4	7.9
Fluorine	0.4	0.3	0.3	0.45
Nitrate	0	0	0.11	0
Chloride	287	277	240	135
Zinc	0.22	0	0	0

Source: Kzyl-Orda Water Department

Excepting Arsenic in Zhalagash, the samples indicate compliance with official norms. Pass rates for tests on micro-organisms are high. Data on water quality in Kzyl-Orda should be interpreted with caution and independent tests are recommended.

(3) Education

Education is mandatory in Kazakhstan up to completion of the eleventh grade. Completion rates for basic education are comparatively high and adult literacy is also high. The State Committee on Statistics reports total adult literacy at 97.5%. Male literacy is 99.1%; female literacy is 96.1%. World Bank figures indicate that the 1993 percentage of age group enrolled in primary education in Kazakhstan is 86% for both males and females. Current enrollment rates of age groups in secondary (high) schools are 91% for females and 89% for males. Enrollment rates for tertiary (higher) education at the university or institute level are 42% which is nearly twice the average of middle income nations. Figures provided by the Ministry of Education - Kzyl-Orda reveal that the percent of the population over age 6 with no formal education is higher in Kzyl-Orda Oblast where 15.7% have no formal schooling.

Schools are divided into two categories, primary and secondary. *Primary schools* provide schooling from the first to the fourth grades. *Secondary schools* provide schooling from the first to the eleventh grades.

Newly privatized state farms in the rural sector provide their own social infrastructure including housing, health clinics, and schools. Schools are located within the farm area and are staffed by certified teachers. Access to schooling from first to the eleventh grade is universal throughout the Study Area.

Higher education in Kazakstan is provided at universities, technical schools, and polytechnic institutes. In Kzyl-Orda Oblast, higher education is located in the capital city.

After completion of the ninth grade, students may transfer to *Technical School* where they study for four years to receive a diploma in trades, occupations, or mechanical fields. Students completing eleven grades may be admitted to technical schools to complete the same programs in two to three years rather than four.

After eleven years of schooling, students also may enroll in either a *University* or *Polytechnic Institute*. There are two such institutions in Kzyl-Orda. The Humanities University offers programs in the arts and sciences including biology, physics, chemistry, etc. The Polytechnic Institute offers programs in the professions including engineering, agronomy, agricultural economics, and other applied areas. Farm specialists such as agronomists and engineers are typically graduates of the Polytechnic Institute.

The following table lists the percentages of the population 6 years old and older who have completed education at a given level. For example, in Karmakshy, 17.9% of the population have no formal schooling, 34.1% have completed primary school, 41.8% have completed primary and secondary school, and 6.2% have completed primary, secondary and post secondary education.

Highest Educational Attainment (Percent)*, Kzyl-Orda, 1996

Raion	None	Primary	Secondary	Higher
Karmakshy	17.9	34.1	41.8	6.2
Zhalagash	19	30.6	44.5	5.9
Terenozek	15.7	34.9	43.2	6.2
Syrdarya	17.6	34.7	41.8	5.9
Oblast	15.7	31.3	42.5	10.5

*Population 6 years old or more
Source: Kzyl-Orda Department of Education

The post-graduate degree is selectively offered in Kzyl-Orda. The Candidate of Science (master's) is offered in agriculture, engineering, and education. The Ph.D. degree is offered only in Almaty. Thus, a full range of education is widely available in Kzyl-Orda from the elementary to the post-graduate levels.

Schools and Pupils in Kzyl-Orda, 1996

Raion	Number of Pupils	Primary Schools	Secondary Schools	Graduates
Syr Darya	10,403	1	18	544
Terenozek	7,117	0	12	445
Zhalagash	9,628	0	2	513
Karmakshy	11,596	0	22	699
Total	38,744	1	54	2,201
Kzyl-Orda City	32,507	2	34	1,432
Oblast	133,271	25	21	7,229

Source: Kzyl-Orda Oblast Department of Education

(4) Medical Facilities

Sanitary conditions in the Study Area are poor. Farms visits revealed that indoor sanitary plumbing was not commonly available and outhouses were often used in homes and farm facilities. Drainage is poor and there is considerable standing water with widespread infestations with mosquitoes and other insects. Garbage collection is erratic and refuse is left out in the open. Streets and pathways are not regularly cleaned. Winds carry airborne salt, dust, and trash. Sanitary and environmental conditions in the area are not conducive to good public health.

Although sanitary and public health conditions in the nation are often quite poor, health care is heavily subsidized by the state and access to physicians is granted at no cost including clinic visits, patient services, and hospitalization. Drug and medicine costs are borne by the patient, but pensioners are granted drug subsidies.

The World Bank Economic Sector Review notes that, nationally, there is a surplus of hospital beds, but a shortage of drugs and supplies. Hospital stays average 12.5 days, well over world averages. Efforts to reduce the bed space surplus and enhance efficiency are underway. Resources are scarce. Public fiscal support for health care has declined by over 40% in real terms since the beginning of the economic transition in 1990. Currently, budgeted support for health care is only 2% of Gross Domestic Product. Annual per capita expenditures on health care are $15. Salaries for health care providers, including physicians, are also declining rapidly in real terms to levels as low as $10/month. Hospitals experience infrastructure decay and supply shortages.

Health status and health care indicators rose rapidly during the 1950's and 1960's, but have remained static or fallen during the past two decades. Among the three most commonly used indicators of population health status are life expectancy, infant mortality, and maternal mortality. In 1994, overall life expectancy at live birth was 68 years. Men have a life expectancy of 64 years and women live an average of 73 years. Infant mortality is 24 per 1,000 live births which is over three times the average in the developed economies. Maternal mortality is 80 per 100,000 births. Contraceptive prevalence is 59% nationally.

In Kzyl-Orda Oblast, overall life expectancy is estimated by the Oblast Health Department at 67 years. Male life expectancy is 62.9 years and female expectancy is 71.3 years. 1996 data on infant mortality is 30.3 per 1000 births; maternal mortality is 43 per 100,000 births.

Mortality Figures for Kzyl-Orda Oblast, 1996 (1st Three Quarters)

Raion	Infant Mortality (per 1000)	Maternal Mortality (per 100,000)
Karmakshy	26.4	0
Zhalagash	29.9	0
Terenozek	23.4	0
Syrdarya	30.2	123.3
Oblast	30.3	43

Source: Kzyl-Orda Health Department

During the past fifteen years, the birth rate in the oblast has declined from 31.2/1000 to 26/1000. During the same period the death rate rose from 7.13/1000 to 9.02/1000. Births are declining and deaths are increasing during the period. Physicians partly attribute the changes to economic factors. Note that unemployment is rising, real wages are falling, and the standard of living is being eroded. During the ten year period 1985-1994, the GDP per Capita in Kazakstan fell by -6.5% per year. There are no aggregate national data available on malnutrition or access to potable water.

Raion	1991	1992	1993	1994	1995
Zhalagash	7.85	8.14	8.08	7.15	8.21
Karmakshy	6.73	7.06	7.88	7.98	9.07
Syrdarya	7.74	7.03	7.98	7.73	7.67
Terenozek	6.52	6.72	7.94	8.51	8.46
Oblast	7.13	6.74	8.15	7.98	9.02

Death Rate (per 1000), 1991-1995, Kzyl-Orda

Source: Kzyl-Orda Statistics Department

Mortality data reflect significant differences from both advanced and developing societies. Neo-plastic disease (cancers) comprise significantly less than the norm in the industrial nations. This is partly a result of shorter life spans and higher incidence of pulmonary disease, accidents, murder, and suicides. Cardio-vascular diseases are higher than in developing nations while infectious diseases, particularly of the gastro-intestinal system, are lower. World Bank reports link the high rates of cardio-vascular and pulmonary disease to life style differences in Kazakstan.

Major Causes of Death, Kzyl-Orda Oblast (% of Total)

	1993	1994	1995
1) Cardio-Vascular Disease	51.16	47.35	54.46
2) Pulmonary Disease	15.56	18.29	14.85
3) Neo-Plastic Disease (Cancer)	12.25	13.46	10.86
4) Accidents, Murder, Suicide	10.62	10.38	9.47
5) Gastro-Intestinal Disease	3.15	3.99	2.98
6) Tuberculosis	3.11	3.29	3.96
7) Renal & Venereal Disease	1.32	1.51	1.25
8) Other	2.83	1.73	2.17

Source: Kzyl-Orda Statistics Department

Although sanitary conditions are sometimes poor, particularly in Kzyl-Orda, access to health care is not a problem in Kazakstan or in the Study Area. Within the oblast, there are 44 Hospitals, 39 Rural Medical Out-Patient Departments, and 177 Medical Attendant Obstetric Points. Within the Study Area raions, there are 21 hospitals, 19 Rural Medical Out-Patient Departments, and 55 Medical Attendant Obstetric Points. Supplies of drugs and medical equipment are reportedly inadequate. There are 1,702 physicians in the Oblast, 320 physicians in the four raions of the Study Area. The oblast averages 28.1 physicians per 10,000 inhabitants-an unfavorable ratio.

Medical Facilities, Kzyl-Orda & Study Area, 1996

Raion	Hospital	Rural Medical Out-patient Depts.	Medical Attendant Obstetric Points
Syr Darya	5	3	15
Terenozek	2	7	19
Zhalagash	7	4	17
Karmakshy	7	5	4
Total	21	19	55
Oblast	44	39	177

Source: Kzyl-Orda Health Department

3.4 Land Holding and Land Tenure

Prior to 1991, agriculture in Kazakstan was exclusively a function and responsibility of the state. Excepting private subsistence gardens, all farming activity was overseen by the Ministry of Agriculture and administered by over 2,000 state farms and collectives. Legislative decrees on the process of privatization began in 1991 and culminated in 1996 when prices on farm commodities were fully liberalized. By October 1996, all state farms and collectives had been privatized except for state research farms which remain the responsibility of the government.

Land is still the property of the state, however the government has granted inheritable rights of use to farmers on leases of 99 years or less. Thus, while land remains the property of the state, individuals and collectives may use land leased to them as if it were private property. At this time, land may not be bought or sold in the free market as such. There are two legal ways of transferring use rights to another individual or entity. The first is through renting the land, which is widespread. The second is by selling or transferring the inheritable right of use which has been permitted since a Presidential Decree on Land Reform in April 1994.

If land is not utilized for productive purposes, the inheritable right of use may be revoked and the land reverts to the state. There has been some discussion of fully privatizing agricultural land, thereby permitting agricultural real estate to be owned and exchanged in the open market, however at this time such transfers of ownership title are not possible.

Privatization is a process, rather than an event, and the process is still incomplete in agriculture. On paper, all of the farms are now private, however the management and structure of former state farms is mostly unchanged. The same managers and specialists are usually still in place and labor is performed under a collective model. Moreover, in the absence of the ability to buy and sell permanent land titles, the privatization process is unfinished. In addition, the legal land registration process is slow and bureaucratic and encumbers a genuine land market.

The best example of genuine privatization is to be found in the thousands of independent family farms that have emerged in Kazakstan during the past five years. These units are privately held and administered and provide for subsistence and surplus agricultural commodities.

Within the Kzyl-Orda Left Bank Area there are 21 former state farms and 165 independent family farms. With the exception of one state research farm, the former state farms are now organized as 25 collective enterprises, locally referred to as production cooperatives. All assets, including land, machinery, infrastructure, and buildings are jointly held and operated. Farmers own their private dwellings; other property is held in common. On the private family farms, all assets are held and administered by the family unit.

3.5 Farms and Farmers' Organizations

Prior to the beginning of the privatization process in 1992, there were 2,100 state farms in Kazakstan, most of which were quite large, averaging 80,000 ha. In addition, there were 430 collective farms which were smaller, but functioned under the same form of management as state farms. As a result of government decree, all farms, except state research farms, were required to become private enterprises and by October 1996, all of the non-exempt farms in the nation had been privatized, at least on paper.

With independence and the transition of the economy toward a free market, agriculture entered a period of crisis. In each year since 1992, agricultural production has declined markedly, from -5.3% last year to -13% in 1993. Several factors have led to the crisis, including the loss of guaranteed price supports and inputs from the state, declining trade with Russia, lack of funding for machinery and on-farm improvements, high interest rates on credit for inputs and the subsequent decline in fertilizer use. Moreover, for several years, prices for agricultural commodities were not liberalized, but prices for industrial products and agricultural inputs were liberalized. Thus, farms were confronted with a price/cost squeeze as the cost of inputs rose while the farm gate prices of agricultural commodities remained fixed. With the loss of income, farms are in a state of disrepair, equipment is being cannibalized for parts, irrigation structures are deteriorating, and living standards of workers in agriculture are declining.

Privatization of farms in the nation has proceeded in two stages. During Phase I (1991-1993), state agro-enterprises involved in marketing and processing were privatized on a one-by-one basis. Such enterprises usually became joint ventures between the state and workers, but the prior management typically retained control and worker shareholders had little or no input into enterprise operation. Phase II (1993-1996) entailed the privatization of state farms and collectives. It proceeded with an assessment of farm value by the State Committee on Privatization and the allocation of shares to workers within the farm based on their position, longevity with the farm, and family size. In some cases, a portion of shares was allocated to the state and another portion was made available for public sale. Generally, farm managers were allocated 10% of the shares. Each member's shares were officially registered. Share holders then consulted on farm structure and management, wrote by-laws, and selected a board of directors and manager. In practice, most of the former state farms retained their former managers and specialists (agronomists, economists, engineers) and have continued to function as large collective agricultural enterprises. By mid-1996, many farms had begun to issue formal share certificates to workers. By law, farmers are allowed to convert their shares into discrete land holdings and farm independently if they so wish, but often farmers are unaware of this provision. When farmers have seceded from the collective, they have usually been granted inferior land with limited use of irrigation. Moreover, farm and raion management have rarely facilitated the process of secession. Nonetheless, thousands of independent family farms have emerged in the country and despite the obstacles, many have been moderately successful.

As noted in a number of World Bank and Harza Engineering reports, newly privatized farms are moving through a fluid period. Some have reorganized as Joint Stock Companies (JSC) in which the farm is administered by managers, labor is performed by brigades of workers, and planning is carried out by specialists. JSC members have regular assemblies and vote on matters of policy and the selection of leadership. In production cooperatives, associations, and other *Collective* Enterprises, the share holders also select management, but property and land is held and farmed jointly. The surplus or profit is distributed to the membership collectively based on their share holdings. On both JSC's and collective enterprises, land is cultivated by machinery that is held in common, inputs are purchased collectively, and debts, assets and profits are jointly shared. Finally, *Private Independent Farms* are those operated by family units or other groups who work entirely within the private marketplace and administer their farm independent of any organization. The processes of privatization and organizational change are likely to continue to be fluid for some time as organizations work to achieve economies of scale and market "shake out" proceeds.

Within the Study Area data were collected on the management of 17 former state farms. Of them, all had been privatized except the Kzyl-Orda Research Farm in Syrdarya which is exempt because it is a state-supported research entity.

Farm Types in Study Area, October 1996

Farm Name	Raion	Farm Type
1. Madeniet	Zhalagash	Production Cooperative
2. Akkum	Zhalagash	Production Cooperative
3. Tan	Zhalagash	Production Cooperative
4. Zhurgenov	Zhalagash	Production Cooperative
5. Buharbai-Batir	Zhalagash	Production Cooperative
6. Zhanatalap	Zhalagash	Production Cooperative
7. Zhanazhol	Karmakshy	Production Cooperative
8. Akzharskii	Karmakshy	Production Cooperative
9. III International	Karmakshy	Production Cooperative
10. Turmagambet	Karmakshy	Production Cooperative
11. Aktobe	Karmakshy	Production Cooperative
12. Shagan	Terenozek	Production Cooperative
13. Sherkeily	Terenozek	Production Cooperative
14. Akzharma	Terenozek	Production Cooperative
15. Iiyasov	Terenozek	Production Cooperative
16. Kogalykol	Syr Darya	Association
17. Kzyl-Orda MIS	Syr Darya	State Research Farm

At the end of 1995, there were also 165 independent family farms in the Study Area; 32 in Karmakshy, 19 in Terenozek, 59 in Syrdarya, and 55 in Zhalagash. These farms are not organized into any farmer association or water users group.

In practice, there is no functional difference between a Production Cooperative (also called a Comrade Association) and an Association. Both maintain a management structure which includes a director, professional staff (specialists), and workers. The leadership (generally a board of directors) is elected by general assembly and the board selects and supervises farm management. Work is carried out collectively under the supervision of section or brigade leaders. Profits and surplus are shared by all after providing for the subsistence needs of the membership. Housing has been privatized. Workers maintain private gardens and may raise private livestock. They may sell their production on the open market and generally do so to commodity buyers and in the local market. A portion of their production, estimated at 41% in the Study Area, goes as barter to state corporations or Joint Stock Companies (such as Yuzneftigas) to pay back loans of fuel and fertilizer.

Farmer organizations such as water user associations do not exist in the Study Area. The production cooperative *is* the farmer group and provides the means of organization for production, marketing, water management, and worker welfare. As farms continue to evolve and more independent family farms emerge in the area, it will be necessary to organize water user associations to administer irrigation water among different users. Where private family farms may have not emerged, the cooperative may continue to function as an irrigation organization. But, because on-farm and inter-farm irrigation structures are in such a serious state of disrepair, and because water volumes are often insufficient for maximum yields and efficiencies, water user associations can be a vital element in carrying out the O&M plan, assuring equitable distribution, and the collection of water fees.

3.6 Women in Development

The republics of the Former Soviet Union, including Kazakstan, inherited a legacy in which women were accorded full equality under law. In practice, this meant that women were encouraged to complete schooling, pursue higher education, engage in the professions, and participate fully in political life. Women throughout Kazakstan are involved in careers as medical doctors, engineers, economists, professors, and elected officials. Women in rural settings vote in elections, participate in the financial decisions of the family, work as farm specialists, and serve in leadership positions in their communities. 47% of the nation's labor force is female.

Unlike the situation of gender inequality in many developing societies, women in Kazakstan are not relegated to second class citizenship or excluded from careers and advanced education. Women have lower rates of literacy than men, but literacy rates in Kazakstan for both women and men are above 95% which is comparable to the advanced economies. While differences in wages have been reported and women are underrepresented in farm leadership positions, the differences are not unlike those found in the advanced economies

World Bank statistics indicate that female literacy in Kazakstan is 96.2% and male literacy is 99.1%. The percent of women age group enrolled in secondary education is 91%, higher than the 89% rate of the male age group in secondary education.

Female Labor Force by Selected Sector, Kzyl-Orda, 1996

Economic Sector	Workers	Employees	Managers	Specialists
Industry	5,726	1,201	161	947
Agriculture	5,926	1,088	23	1,027
Timber	26	35	4	14
Transport	3,061	2,787	155	2,095
Communication	1,260	527	55	453
Construction	902	500	86	317
Trades	2,949	1,123	150	659
Information Technology	70	180	0	176
Public Health, Social Services	4,626	9,268	79	8,973
Education	4,074	12,580	968	8,724
Finance and Insurance	123	471	14	401
State Management	206	1,692	93	1,049

Source: Kzyl-Orda Statistics Department

3.7 Socio-Economic Constraints for Agricultural Development

The major socio-economic constraints to higher farm productivity are:

(a) Lack of funds for production inputs, especially fuel and fertilizers. This year, fertilizer was applied at only 45% of the recommended rate.

(b) Lack of training or experience in the following:

   (i) Marketing and competing in a private enterprise system.

   (ii) Self-financing or arranging credit sufficient to cover operating costs for the next year's crop.

   (iii) On-farm water management.

   (iv) Irrigation maintenance.

   (v) Structure and governance of autonomous water user associations.

(c) Farmer's use of the state resource system to obtain credits for spring sowing, at the cost of losing access to free market prices for much of their marketable surplus

In 1994, it appeared that the biggest constraint to agricultural development was state regulated prices on agricultural commodities, which were far too low in relation to the unregulated prices for production inputs. There was hope that this constraint would be removed with the government's promise to the World Bank to end all state interference in prices by 1995. Now, 1996 is the first year that commodity prices have not been regulated. However, there is little opportunity for farmers to benefit from free market prices because much of their marketable surplus is already committed at fixed low prices (plus interest) to repay barter credits for inputs from Astyk, Yuzneftigas, and others.

(d) Deteriorated and worn out physical infrastructure and equipment. Moreover, there is little cultural tradition emphasizing regular maintenance and local control of farm structures. Tradition has emphasized a major role for the state in farm operation, production, and maintenance. Reliance on state provided inputs and equipment has diminished self-reliance and market orientation. With the withdrawal of the state, an organizational vacuum has been created which has not been filled by local farm organizations. This is particularly evident in irrigation infrastructure which is still viewed as the government's responsibility.

(e) High cost of credit from Agroprombank.

The annual rate of interest for short term operating loans from Agroprombank is 45-50%. Adjusting for inflation which was 10% the past year, results in real interest rates of 35-40%. By comparison, the interest rate on short term farm loans in developed economies is less than 10%.

4 Improvement Plan of Farms and Farmers' Organizations

The Improvement Plan for Farms and Farmers' Organizations entails the development of water user associations within the Project Area.

Research by the social science consultant conducted this year for the World Bank revealed that:

(a) Newly privatized state farms are in crisis: Production is down; profits are elusive; yields are declining; inputs are too expensive and are underutilized; infrastructure and machinery are in disrepair; soils are waterlogged and saline; lands are being taken out of production; and, living standards are falling.

(b) Welfare standards on independent family farms are generally higher than for workers in joint stock companies and production cooperatives, despite the obstacles these farms face.

(c) Irrigation water is irregular and inadequate in supply due to poorly maintained irrigation infrastructure at the on-farm and inter-farm levels.

(d) Water fee payments to the Committee on Water Resources (CWR) are often in default due to low farm production and under-supply of water by CWR.

(e) Farm workers still have little influence in the management of the Joint Stock Company (JSC) or production cooperative despite privatization.

(f) Farm workers and independent family farmers are willing to pay more for irrigation water, if it improves the volume and predictability of supply.

(g) Independent family farmers have no voice in the supply and management of developed irrigation water except insofar as they purchase water from JSC's or collective enterprises.

It is apparent that water user associations could do much to remediate the situation in Kzyl-Orda Study Area. Water user associations (WUA's) provide the organizational structure for equitably distributing water, collecting fees, controlling water theft, and implementing the O&M plan.

The WUA is a corporate form of organization that entails an elected board of directors, a manager, irrigation employees, and a definition of water users as stockholders. It is an organization that can be fitted to any type of farming system found in Kazakhstan. Political support for the formation of WUA's is evident at high levels of national government, including the Ministry of Agriculture and the Committee on Water Resources. The nation has embarked on an effort to implement WUA's with support and technical assistance from World Bank and USAID contractors.

In an inter-farm system serving multiple plots regardless of their size or type, the WUA administers water distribution, fee payment , and O&M while assuring equity. In an on-farm system such as multiple users of one type within a farm jurisdiction, the water user association may be assumed under the by-laws which govern the farm, but which performs the same functions as on an inter-farm system. Because the situation in Kzyl-Orda is evolving and there are 165 independent family farms within the study area, and action plan for developing water users associations is needed to assure equitable distribution among users throughout the hydraulic region, collect fees from multiple types of users, and assure compliance with the O&M plan. The WUA 's formed would be consulted at each stage of the project, including feasibility, design, construction, testing and acceptance.

The steps in developing WUA's in the project area include:

(a) Census and Site Selection - identifying farms for initial trials. Criteria include evidence of poor water management, irrigation infrastructure decay, fee non-payment, and poor compliance with O&M plans. All farm types, including family farms, will be included in the project.

(b) Initial Field Work - Conducting focus group discussions with farmers to assess he feasibility of forming a WUA in the pilot area.

(c) Consultation with Stakeholders - At a special session of the general assembly, the membership consents to establish a water user association. Benefits and costs are explained. Independent family farms within the project area would be included in the discussions and have the option to join the association.

(d) Corporatization - The general assembly elects a board of directors which appoints a manager. In production cooperatives, the group may chose to utilize its existing board of directors. Representation from family farmers will be assured.

(e) Development of by-laws. With technical assistance from the project, the WUA leadership develops by-laws appropriate to their circumstances. These by-laws are ratified by the general assembly.

(f) Design Review - WUA and farm leadership are involved in designing the system's rehabilitation and construction. Project design is explained to the general membership and accepted in writing.

(g) Construction - Members of the WUA participate in construction supervision.

(h) Testing and Acceptance - Members of the WUA participate in final testing and formally accept the system and terms of loan.

(i) Training - The O&M Plan is explained and workers and hydro-technicians are trained in its implementation. An agricultural extension plan is developed at this time.

The Priority Area is scheduled for a census of farms in July 1997. At this time, all private independent farms will be inventoried as well as the two production cooperatives within the Priority Area. The census will include specific identification of households within the area and include information on their exact location, irrigation access, production, problems, income, and willingness to join a water user association. Upon completion of the census, the sociologist will work with a counterpart in the Ministry of Agriculture Project Implementation Unit (PIU) to form a water user association which incorporates all of the family farms as well as the members of the production cooperative so that all households in the Priority Area have equitable input into and access to project benefits. Upon approval by the General Assembly, a board of directors for the WUA will be elected and by-laws will be prepared with the assistance of the technical team. An agricultural extension plan will also be developed which will identify training needs and content on irrigation management, operation and maintenance of irrigation systems, effective use of inputs, agricultural marketing, and skills related to successful farming in a market economy.

5 Surveys Performed by Rural Society Expert

5.1 Social Infrastructures

(a) Collection of demographic information on population of oblast, raions, households, farms, women, and areas from the Census and the Oblast Statistics Department.

(b) Collection of information on labor force including number of employed, nature and sector of employment, unemployment, wages by sector, women in labor force by sector, and wages by sector from the Oblast Department of Labor Protection and the Statistics Department.

(c) Collection of information on health and access to health care including infant and maternal mortality, death rates, birth rates, causes of death, life expectancy, number and types of hospitals, physicians per 1000 population, and drinking water quality from the Oblast Health Department, Oblast Epidemiology Station and Oblast Water Department.

(d) Collection of data on education including school age population, number of pupils and level of schooling, average educational attainment, number of primary and secondary schools, higher education, and adult literacy rates from Oblast Department of Education, Oblast Statistics Department and State Committee on Statistics.

(e) Collection of data on transportation and communication including roadways, railways, airline flights, number of households with telephones, radios, televisions, number of radio stations, television stations and regional newspapers.

(f) Collection of data on farmer organizations in Study Area.

(g) Collection of information on farm types and agricultural institutions in Study Area.

(h) Farm visits to interview farm workers, managers, specialists and family farmers.

(i) Supervision of Socio-Economic Team Survey of Study Area with data on production, farm income, population and organizational type.

(j) Development and supervision of Participatory Process with General Assembly meetings in all affected farm areas.

5.2 Public Consultation Process

This project proposes to involve constituent beneficiaries (farmers) in three major aspects of project decision making, including feasibility, construction, and acceptance. This approach emulates the participatory strategy adopted by the World Bank, USAID, and other donor agencies in orchestrating irrigation and drainage improvement projects.

For example, World Bank projects in Kazakstan use a five step consultative process involving the following stages:

(a) Initiation - This entails a consultation with project staff, managers, specialists and relevant government officials regarding project parameters, cost recovery mechanisms, data collection, and outline of basic engineering issues.

(b) Fixing the Package - In this stage, project design staff discuss and present preliminary alternative scenarios of interventions with estimated costs and benefits as well as maintenance and operation issues. Agricultural plans and cropping are discussed.

(c) Final Design and Pre-Tendering - The final design is presented to the general membership and potential beneficiaries along with cots, cost recovery, operation and maintenance requirements, and timing of events.

(d) Tendering - The final construction costs are detailed specifying all relevant engineering and agricultural parameters.

(e) Performance Testing - Upon completion of the construction and before works are handed over to farmers, farmers participate in testing the system.

The Kzyl-Orda Irrigation and Drainage Project has involved farmer, manager, specialist, and government official participation throughout the study process. On July 29, 1997 this process was formalized in two public consultations with project beneficiaries in the Shagan and Ilyasov Project areas. These consultations detailed the proposed engineering, economic, and social aspects of the project with presentations from government officials, farm managers, JICA Study Team experts, and JICA Study Team counterparts (See following agenda and minutes). An open question and discussion period ensued with full participation of farm laborers and others. At the conclusion of the discussion, a call for votes by farmers in favor or opposed to the project was made and in both public consultations, participants voted unanimously in favor of the project.

Thus, the Public Participation Process involves three formal stages:

(a) Feasibility - This stage, completed July 29, 1997, entails a detailed preliminary explanation of proposed engineering interventions, anticipated costs, projected benefits, timetables, and social aspects including the formation of water user associations.

(b) Construction - Upon project approval and loan tendering, and as the project construction period begins, constituents will participate in a public consultation which details the final design, the construction timetable, costs and benefits, and water user associations.

(c) Acceptance - Upon construction completion and testing, the project will be formally turned over to the farmers in a final public consultation.