Local Terms and Expressions Used

- **Bund**: literally in the Urdu language this means a dike, usually made of earth, to check a water stream. Contrary to a dam, a bund is a small structure made to divert a stream on to agricultural fields for irrigation purposes; to save river bank areas from flooding; or to store water for multiple uses, such as domestic, livestock, and irrigation.
- **Farm Size**: By farm size, we mean the area of holding irrespective of its location contiguously or fragmentally.
- **Karez**: An underground water conveyance system from one or several mother wells dug at the foothills to lowlands over a distance of several hundred meters. Karezes are the typical means of irrigation in the dry mountainous zones of Balochistan province of Pakistan. Being underground, the karezes help reduce water loss through evaporation.
- **Kharif Season**: Summer to autumn season – May to October in Pakistan.
- **Kharif Crops**: Crops grown in kharif season – such as maize, rice, melons.
- **Khushkaba Farming**: Dry farming, i.e. farming under direct precipitation only.
- **Load-shedding**: Breakdown of electric supply.
- **Lora**: A rainwater stream flowing downslope from highlands. The word is derived from a Pashto language word 'Lwarha', which means 'height'.
- **Nala**: A small rainwater stream; a sewerage drain; or any other small water channel.
- **Patwar Circle (PC)**: The total land revenue area, comprising several villages, under one patwari, who is a revenue official at field level in charge of maintaining land records, conducting property transactions, surveying crops, and collecting revenue.
- **Rabi Crops**: Crops grown during rabi season – such as wheat, barley, cumin.
- **Rabi Season**: Winter to spring season – November to April in Pakistan.
- **Sailaba Farming**: Urdu translation for the word 'flood' is 'sailab'. Sailaba farming is similar to spate farming (or spate irrigation) with a minor difference, and that is, in the latter, flood water is diverted to crops by large dikes across hill torrents;

A.S. Khattak, *Mutual Sustainability of Tubewell Farming and Aquifers: Perspectives from Balochistan, Pakistan*, Advances in Asian Human-Environmental Research,
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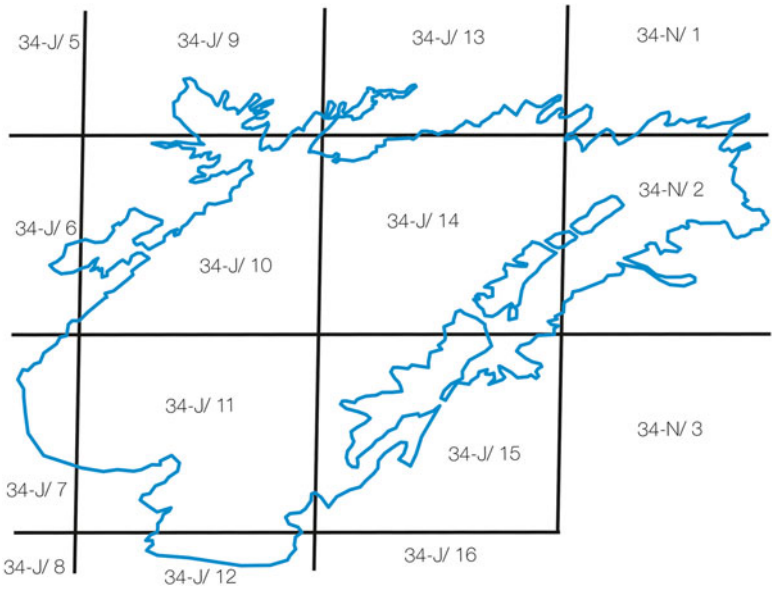
in the former, small guide structures are constructed on hill slopes to divert rainwater from other fallow areas to cropped fields.

- **Shamilat**: Common lands of a village or tribe.
- **Tehsil**: The second-order administrative subdivision of a district.
- **Union Council (UC)**: The lowest political unit comprising a few (four to five) villages. In the Devolution of Power Plan, 2001, a UC was supposed to be politically represented by an elected body of several members headed by a UC nazim (nazim means 'administrator' in local language).
- **Village**: A demarcated rural landscape of a population less than 5,000 for which separate revenue records, including a cadastral map, is maintained.

Appendices

Appendix A: Mosaic of the Toposheets (R.F. 1:150,000,000) Covering Pishin Valley



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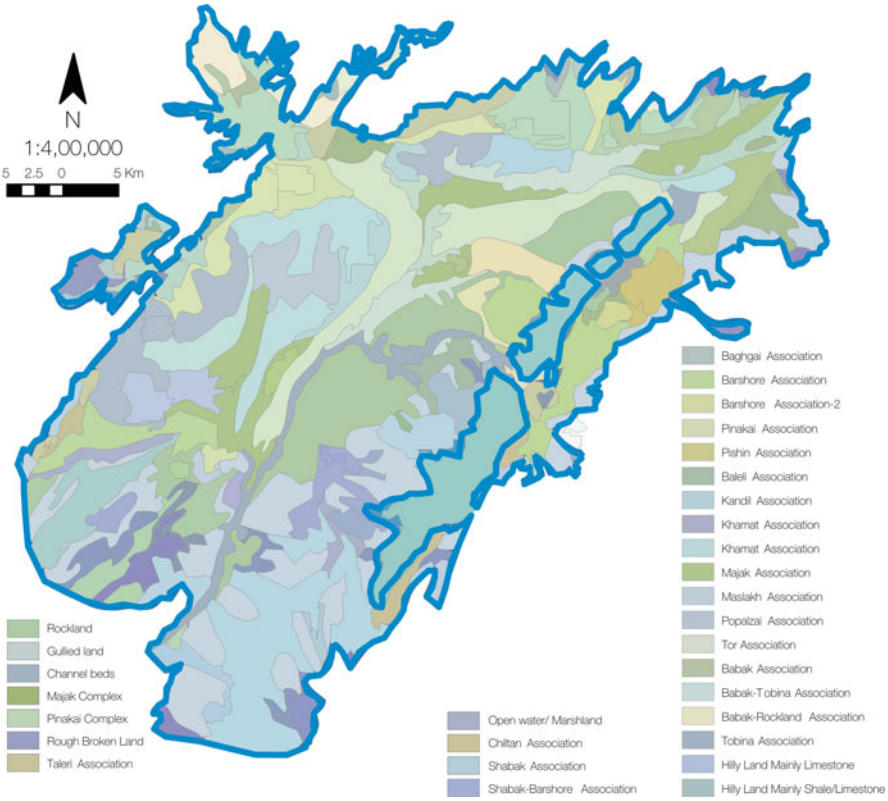
Appendix B: Lithology of Pishin Valley



Source: GSP

Appendix C: Landcover Statistics of Pishin Valley Calculated from Landsat Images

UC/PC	Year	Agriculture		Bare soil/ Settlement/Hard rock (acre)	Barren land with salt color (acre)	Wetlands (acre)
		Total acreage	% of total area of the UC/PC			
Ajram Shadezai 186,576 acres (755 km^2)	1989	88.51	0.05	119,841.78	66,788.74	77.1
	1991	93.53	0.05	112,253.82	74,143.3	340.6
	1996	109.1	0.06	100,894.89	85,373.6	303.62
	2000	0.4	0	158,658.71	27,683.85	92.32
	2005	98.6	0.05	123,102.1	63,155.55	219.4
Alizai 8,596 acres (4.8 km^2)	1989	330.35	3.84	4,734.1	3,058.4	511.21
	1991	741.28	8.63	6,677.66	539.3	692.63
	1996	803.59	9.35	4,197.34	3,014.1	555.7
	2000	516.86	6.02	6,588.28	655	796
	2005	789.66	9.19	6,258.23	1,002.56	545.9
D. Khanzai 8,120 acres (32.9 km^2)	1989	1,489.25	18.4	2,003.46	4,146.2	531.67
	1991	3,602.62	44.37	3,791.11	176.9	570.67
	1996	4,712.94	58.05	1,356.78	1,489.6	614.92
	2000	2,542.16	31.11	4,611.18	298.8	662.1
	2005	3,317.44	40.86	3,222.6	1211.8	367.8
Batezai 16,571 acres (67.1 km^2)	1989	1,782.28	10.76	12,150.82	2,403.25	307.7
	1991	2,725.66	16.45	13,223.24	137.8	523.9
	1996	3,383.59	20.42	12,586.9	578.74	24.11
	2000	2,074.4	12.52	14,414.7	26.5	6
	2005	3,636.5	21.95	11,536.36	1,136.14	262.18
Gangalzai 5,210 acres (21.1 km^2)	1989	262.35	5.04	2,166.2	2,645	5.21
	1991	652.73	12.53	4,154.79	407.52	79.4
	1996	809.42	15.54	1,547.54	2,796.73	0
	2000	665.49	12.77	3,843.1	683.21	0.35
	2005	1,006.27	19.32	2,658.89	1,542	3.1
Gulistan 57,654 acres (233.32 km^2)	1989	8,305.25	14.41	1,1649.63	3,0540.8	356.7
	1991	11,979.1	20.78	27,346.26	14,766.65	783.9
	1996	14,800.89	25.67	9,607.32	29,896.63	1,416.5
	2000	11,401.34	19.78	30,255.64	12,751.6	1,227.13
	2005	15,924.92	27.62	22,024	18,541.1	1,164.04
Huramzai 11,056 acres (44.7 km^2)	1989	1,195.8	10.82	3,559.62	6,457.8	28.5
	1991	1,786.78	16.16	7,485.57	1,744.8	88.74
	1996	2,251.62	20.37	2,022	6,729.6	68.4
	2000	1,877.21	16.98	4,125.9	5,398.22	109.64
	2005	2,531.12	22.89	5,605.41	2,877.11	42.43
Karbala 25,953 acres (105 km^2)	1989	161.78	0.63	2,945.18	22,859.13	52.8
	1991	347.45	1.34	4,417.85	2,1193.2	51.74
	1996	305.89	1.18	1,314.18	24,111.5	303.8
	2000	103.81	0.4	3,622.46	22,198.2	15.64
	2005	421.33	1.62	6,735.7	18,761.4	34.2

(continued)

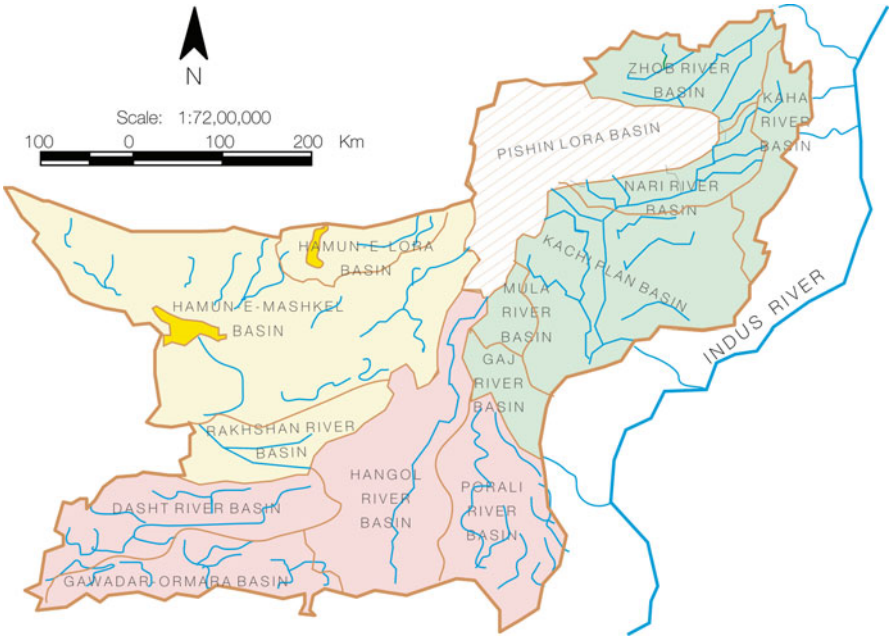
UC/PC	Year	Agriculture		Bare soil/ Settlement/Hard rock (acre)	Barren land with salt color (acre)	Wetlands (acre)
		Total acreage	% of total area of the UC/PC			
Maizai	1989	2,188.91	13.83	1,880.83	11,773.3	38.33
15,831 acres	1991	2,869.67	18.13	869.69	11,975	159.4
(64.1 km^2)	1996	3,087.66	19.51	522.41	11,992.6	29.5
	2000	3,040.47	19.21	1,863.2	10,742.3	174.2
	2005	3,254.38	20.56	3,613.37	8,875.4	88
Malakyar	1989	1,809.98	14.27	5,852.42	3,245.83	1,847.14
12,685 acres	1991	3,457.77	27.26	6,895.6	362.62	2,004.4
(51.3 km^2)	1996	4,277.8	33.73	4,412.24	2,367	1,654
	2000	3,773.86	29.75	5,621.78	1,642.2	1650.15
	2005	4,495.02	53.44	6,050.89	1,048.9	1,089.8
Manzaki	1989	243.86	2.02	9,737.4	17,733.9	570.42
12,098 acres	1991	724.84	6	1,0546.85	261.9	654
(49 km^2)	1996	773.67	6.4	8,212.25	2,465.9	623.87
	2000	605.89	5	9,221.72	1,632.2	577.81
	2005	954.99	7.9	9,395.39	1,300.7	447.26
Manzari	1989	954.97	6.7	5,298.45	7,484.4	602.12
14,262 acres	1991	2,486.86	17.44	9,676.53	1,225.5	928.72
(57.72 km^2)	1996	3,063.13	21.48	5,084.35	5,432.9	706
	2000	1,643.93	11.53	10,265.47	1,318.9	1,009.7
	2005	2,865.12	20.1	8,678.47	2,150.1	568.24
Pishin City	1989	413.45	5.1	6,206.46	1,508.3	1.2
8,109 acres	1991	639.45	7.9	7,212.92	283.5	13.52
(32.82 km^2)	1996	852.03	10.51	5,388.12	1,864.3	7.3
	2000	541.72	6.7	7072.42	467.3	0
	2005	1,406.59	0.17	5,874.78	817.5	10.6
N. Malizai	1989	1,258.63	4.62	1,1487.31	1,4558.9	45.76
27,268 acres	1991	2,805.87	10.3	22,055.49	2,467.5	38.23
(110.35 km^2)	1996	4,042.33	14.82	8,186.26	15,070.1	27.23
	2000	1,270.79	4.66	19022.77	6,901.73	41.74
	2005	4,702.3	17.25	10,819.21	11,731	15.3
Q. Abdullah	1989	3,457.57	10.43	19,867	7,190.2	2,817.4
33,165 acres	1991	5,915.35	17.84	22,347.05	1,209.4	3,883.24
(134.2 km^2)	1996	6,218.74	18.75	16,082.63	6,782.13	3,882.4
	2000	3,962.52	11.95	2,4735.8	487.2	3,714.8
	2005	4,358.2	13.14	20,737.4	5,825.14	2,244.04
Saranan	1989	36.72	0.16	11,607.73	11,822.7	9.64
23,408 acres	1991	80.21	0.34	21,205.92	2178.3	32.62
(94.73 km^2)	1996	192.64	0.82	9,037.48	14,220	0
	2000	18.71	0.08	20,932.12	2,423.4	0
	2005	255.1	1.09	14,337.67	8,811.1	3.9
Segi 90,958 acres	1989	857.24	0.94	46,846.95	24,463.8	163.39
(368.1 km^2)	1991	2,732.1	3	72,216.84	11,615.2	173.32
	1996	3,444.48	3.8	56,662.1	28,851.55	65.68
	2000	2,228.97	2.45	75,488.43	11,459	2.47
	2005	6,529.62	7.18	57,731	26,271.63	425.84

(continued)

UC/PC	Year	Agriculture		Bare soil/ Settlement/Hard rock (acre)	Barren land with salt color (acre)	Wetlands (acre)
		Total acreage	% of total area of the UC/PC			
Simzai	1989	769.32	5.8	5,961.2	6,296.8	353.46
13,330 acres	1991	1,502.89	11.3	10,128.7	1,212.2	541.36
(54 km^2)	1996	1,770.97	13.29	5,534.22	5,635.44	406.69
	2000	1,614.75	12.1	9,852.59	1,386.2	457.32
	2005	1,996.96	15	8,599.1	2,381.9	351.78
Tora Shah	1989	2,273	16.2	9,848.89	1,809.6	139.49
14,036 acres	1991	3,721.47	26.5	9,944.39	61.31	389.24
(56.8 km^2)	1996	4,292.55	30.58	9,042.7	688.5	50.9
	2000	2,809.26	20	1,0367.7	578.1	246.22
	2005	3,736.84	26.6	8,882.21	1,024.7	392.13
Yaro 12,194 acres	1989	89.52	0.73	12,148.38	2,294.7	7.41
(49.35 km^2)	1991	157.3	1.3	13,055.31	1,255.8	50.7
	1996	172.48	1.4	10,547.47	3,313.8	342.5
	2000	69.44	0.57	13,247.8	1,008	0.3
	2005	350.34	2.9	8,575.51	3,248.7	19.2
Pishin Valley total area		**5,97,079.16 acres (2,416 km^2)**				

Source: Saeed, 2012 (Derived statistics from Landsat data)

Appendix D: Groundwater Basins of Balochistan Province



Source: Directorate General of Hydrology, WAPDA

Appendix E: Photograph of a Deserted Fruit Orchard in Pishin Valley

Source: Saeed (2012)

Appendix F: Questionnaire A: Farmers

Topic: - Inter-Effects of Tubewell Irrigated Agriculture and the Aquifer Potential in Balochistan: Case Study of Pishin Valley, 1981-2008.

File No. _____Date _____Interviewer _____Respondent (name, age) _____

Village _____UC/PC _____ Tehsil _____District _____

1. Household Information

Family size_____ No. of fulltime farmers_____ Farmers' education _____ Nonfarm Occupations _____

Farm share in income: 2008 _____2004_____2001 _____1991_____1981

2. Land use (acres)

Total holding: 2008_____2004_____2001_____1991_____1981

Under irrigated cultivation: 2008_____ 2004_____2001_____1991_____1981

Under dy cultivation: 2008_____20054_____2001_____1991_____1981

Cultivable-waste land: 2008_____2004_____2001_____1991_____ ____1981

Cultivated land deserted _____Since the year _____Why: 1 _____2_____

Use of the deserted land _____Average year fallow (% of under cultivation): Kharif season_____

Rabi season_____ from when fallowing practiced_____ Why fallowing: 1_____2_____

Avg. year % land intercropped: Kharif ____Rabi ____Crops involved: Kharif _____Rabi _____

3. Water Availability

Tubewells owned: 2008___ _____2004_____2001_____1991_____ 1981

Tubewells dried: 2008 _____2004_____2001_____1991___ _____1981

Bore depth (ft): 2008_____2004_____2001_____1991_____1981

Watertable depth: 2008_____2004_____2001_____1991_____1981

Did the nearest DAD raised watertable: Yes / No; Other uses of DAD _____

4. Water Quality

For humans –good/fair/poor: 2008 _____2004 _____2001 _____1991 _____1981

For laundry –good/fair/poor: 2008 _____2004 _____2001 _____1991 _____ ____1981

For irrigation –good /fair/ poor: 2008 _____2004 _____2001 _____1991___ ___ ___1981

Salt colour on surface: Yes / No; Effects on crops _____

5. Irrigation cost

Bore + casing cost: 2008 _____2004 _____2001 _____1991 _____1981

Motor horsepower: 2008 _____2004 _____2001 _____1991 _____1981

Motor price: 2008 _____2004 _____ ____2001 _____1991 _____1981

Monthly O & M cost: 2008 _____ ___2004 _____2001 _____1991 _____1981

6. Irrigation Technology

No. of alive tubewells _____ subsidized _____ Distance of nearest tubewell ___Does govt check new boring: Yes / No; How many your tubewells are licensed ___ permitted motor power ____ Daily operation (hrs): Kharif ___Rabi ____ Do you sell water to non-owner farmers: Yes / No; Do you use HEIS: Yes / No; If yes, type: Drip / Bubbler; Installation year ____ Who funded_____ HEIS effect on production: increased / decreased / no change; Crops & area served by HEIS_____ If HEIS not used, Why: _____

Water tank lined: Yes / No; % of lined watercourses ___ % of piped watercourses ____ Who funded ____

7. Farm-Income (annual average per acre)

Gross income: 2008 _____2004 _____2001 _____1991 _____1981

Net income: 2008 _____2004 _____2001 _____1991 _____1981

8. Cropping Pattern

Principle crops (% of area): Kharif _____ Rabi _____

Water scarcity driven cropping change: Kharif _____ Rabi _____

Does govt. check crop selection: Yes/ No; If yes, which crops restricted_____

Does govt. give incentives for certain crops: Yes/ No, If yes, which crops _____Which incentives_____

Have you been invited to training on crops selection: Yes / No; If yes, how many you attended _____

Name the training agencies _____

9. Views About the 'Flat Rate Policy' in Electricity Tariff

1. Is the Flat Rates Policy causing water overuse: Yes/ No

2. Should Govt. drop the Flat Rate Policy: Yes/ No

3. How would you react if the Policy is dropped: i) Not mind ☐ ii) Protest unconditional ☐

Demand alternatives ☐, like _____

4. What you may do if had to pay full electricity bill: i) Continue with electric motor ☐

ii) Change to diesel machine ☐ iii) Change to rain farming ☐ iv) Abandon farming ☐

5. Is the current Flat Rate of electricity is: High / Fair / Low; Justify answer_____

10. Respondent's Suggestions for Water Conservation: _____

Interviewer's Signature _____**Respondent's Signature** _____

Abbreviations and Local terms

DAD: Delay Action Dam
HEIS: High Efficiency Irrigation Systems
Kharif crops: Summer season crops
Rabi crops: Winter season crops

Appendix G: Questionnaire B: Key Informants

Topic: Inter-Effects of Tubewell Irrigated Agriculture and the Aquifer Potential in Balochistan: Case Study of Pishin Valley, 1981-2008.

File No. ____Date _____Informant's name _____Designation _____

Department_____

Instructions: Please tick one box affront each answer.

- [0] Shows: not agreed / not significant/ or untrue
- [1] Shows: highly agreed / highly significant/ highly true
- [2] Shows: moderate or fair agreement/ significance/ truth
- [3] Shows: slight agreement/ significance/ truth

Note: If applicable, a same level of agreement/ significance may be marked for several answers.

A- Agricultural Development

1. Why are there vast extents of cultivable land barren in Pishin Valley?
   - i. Lack of irrigation water: …… [0] [1] [2] [3]
   - ii. Abundance of land disputes:……. [0] [1] [2] [3]
   - iii. Lack of population/ laborers:……. [0] [1] [2] [3]
   - iv. Lack of interest of owners: …… [0] [1] [2] [3]
   - v. Poverty of owners:…… [0] [1] [2] [3]
   - vi. Abundance of state lands: …… [0] [1] [2] [3]
   - vii. Any other reason: _____

2. What do you suggest for sustainable agriculture (social, economic, ecologic) in the area?

   - i. Control groundwater abstraction by tubewell licensing: [0] [1] [2] [3]
   - ii. Subsidized provision of HEIS: …….. [0] [1] [2] [3]
   - iii. Emphasis on intercropping: …… [0] [1] [2] [3]
   - iv. Adoption of low delta crops:…… [0] [1] [2] [3]
   - v. Protection/development of recharge zones in watershed: [0] [1] [2] [3]
   - vi. Emphasis on traditional Sailaba & Khushkaba farming: [0] [1] [2] [3]
   - vii. Any other suggestion: _____

3. Which changes water shortage has brought in cropping pattern?

   - i. Shift from orchards to field-crops: …….. [0] [1] [2] [3]
   - ii. Shift from low value crops to high value crops:…….. [0] [1] [2] [3]
   - iii. Shift from high delta crops to low delta crops: …..…… [0] [1] [2] [3]
   - iv. Any other change: _____

4. Which steps govt. taking to popularize low delta crops?

i. Restricts cultivation of high delta crops:…… 0 1 2 3
ii. Subsidizes seeds, etc. of low delta crops:…….. 0 1 2 3
iii. Trains and educate farmers for low delta crops:….. 0 1 2 3
iv. Increases support price for low delta crops:…… 0 1 2 3
v. Provides special marketing for low delta crops:…. 0 1 2 3
vi. Any other step: _____

B- Aquifer Issues

5. What are reasons for the quicker watertable decline in Pishin Valley?

i. Precipitation reduction due to climate change: ……. 0 1 2 3
ii. Elimination of recharge zones by settlements expansion: 0 1 2 3
iii. Enormous development of tubewell farming: ……. 0 1 2 3
iv. Misuse of water in irrigation system: …….. 0 1 2 3
v. Any other reason: _____

6. What do you suggest to avert quick fall of watertable?

i. Change from agriculture to industry or else less water intensive landuse: 0 1 2 3
ii. Construction of more DADs & other recharge structures: ……..…. 0 1 2 3
iii. Use of HEIS and better irrigation scheduling: …..…… 0 1 2 3
iv. Complete ban on further boring for irrigation use……..……. 0 1 2 3
v. Any other suggestion: _____

C- Water Management Strategies

7. What impedes enforcement of groundwater regulations?

i. Lack of political will . ……. 0 1 2 3
ii. Poor accessibility of the area…… 0 1 2 3
iii. Weakness of enforcing agencies…… 0 1 2 3
iv. Corruption on the part of enforcing agencies…… 0 1 2 3
v. Inadequacy of the regulations:…… 0 1 2 3
vi. Any other reason: _____

8. Have Delay Action Dames proved useful as deemed? Yes ☐ No ☐ . ----If yes, how?

i. Much effective in long duration aquifer recharge: 0 1 2 3 5
ii. Much effective in short term aquifer recharge:… 0 1 2 3 5
iii. Marginally effective in aquifer recharge: …… 0 1 2 3 5
iv. Effective in flood control:…… 0 1 2 3 5
v. Useful as non irrigational water uses: …… 0 1 2 3 5
vi. Any other benefits: _____

9. It was how where the DADs failed to come up to expectations?

i. Quick sedimentation: ……. 0 1 2
ii. Choking of subsurface pores quickly: 0 1 2
iii. Any other shortfall: _____

10. What constrains adoption of High Efficiency Irrigation Systems?
    i. High operation & maintenance cost: …… 0 1 2 3
    ii. Lower production than flood irrigation:……. 0 1 2 3
    iii. Availability issues of the system & spare parts: ……. 0 1 2 3
    iv. Lack of consciousness for water conservation: …… 0 1 2 3
    v. Lack of skill in using HEIS: ……. 0 1 2 3
    vi. Cheap availability of water for flood irrigation due to FRP: 0 1 2 3
    vii. Any other constraint: _____
11. What do you suggest to make High Efficiency Irrigation Systems popular?
    i. Subsidized supply of HEIS: …… 0 1 2 3
    ii. Withdrawal of the Flat Rates Policy: …… 0 1 2 3
    iii. Making use of HEIS a condition for power subsidy: 0 1 2 3
    iv. Any other suggestion: _____
12. Do you think the F R P. is the cause of water misuse? Yes ☐ No ☐
13. Do you support dropping FRP? Yes ☐ No ☐ . If no, why_____
14. Which motives drive the Flat Rates Policy?
    i. Vested interests of decision makers:……..…… 0 1 2 3
    ii. Fear of public resentment against dropping FRP:…… 0 1 2 3
    iii. WAPDA's inabilities in thefts checking & bill collection: 0 1 2 3
    iv. Farmers' welfare; to reduce their irrigation cost: …… 0 1 2 3
    v. Any other motive: _____
15. Do you think dropping FRP may cause public resentment? Yes ☐ No ☐ - --If yes, how?_____
16. Suggest socially / politically acceptable alternatives/ modifications in the FRP: _____
17. Informant's open note on the subject issues: _____

Interviewer's signature: _____ **Informant's signature**:_____

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