

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Assessment of Hill Torrent (Rod-kohi) Cultivation in Pakistan

Dr. Arshad Ashraf
& Team Members

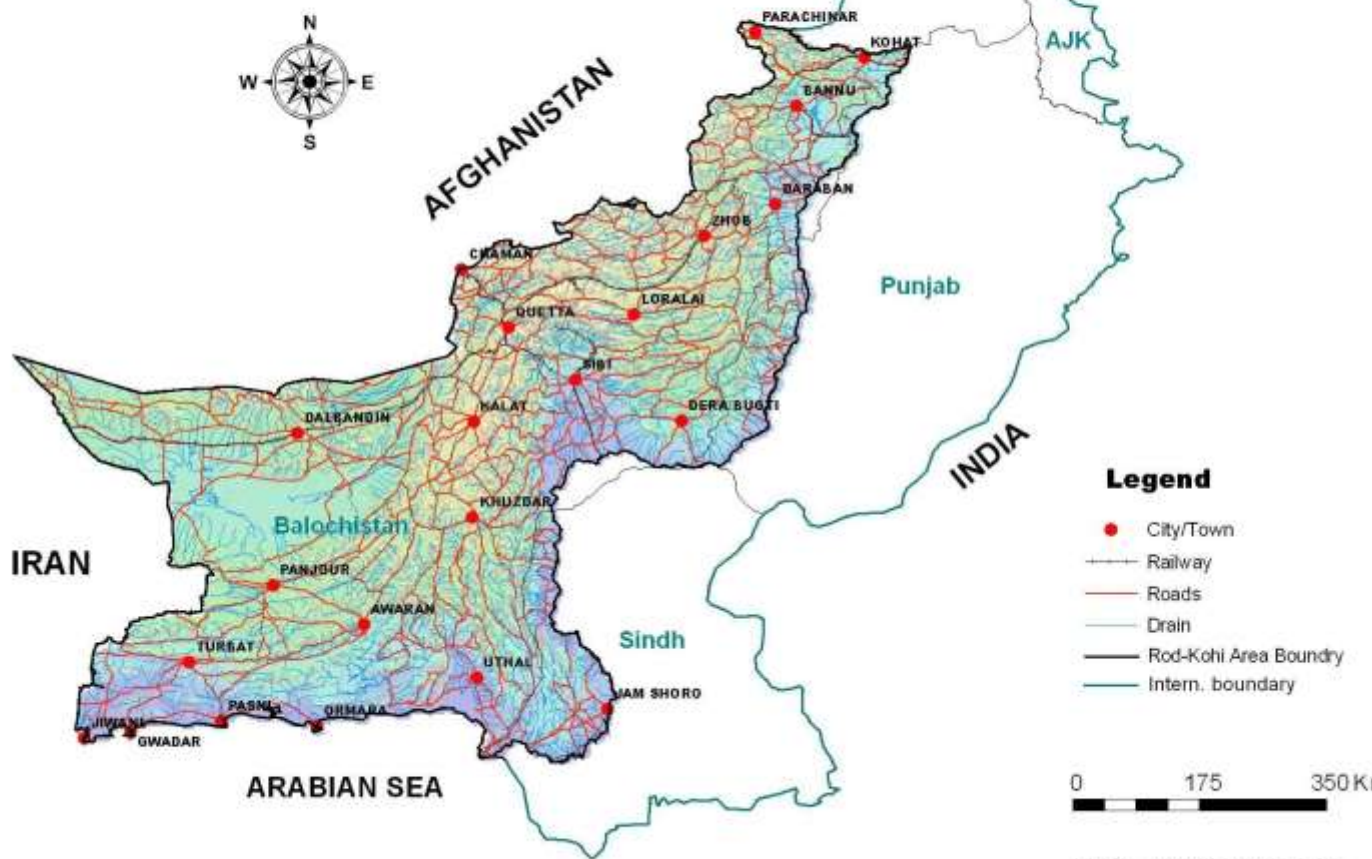
Water Resources Research Institute, National Agricultural Research Centre
Islamabad - 2010

Spate Irrigation Region

- The spate irrigation region (*Locally 'Rod-kohi region'*) of Pakistan stretches over an area of about 41.6 million ha within longitudes $60^{\circ} 50'$ - 72° E and latitudes $24^{\circ} 42'$ - $34^{\circ} 3'$ N in Pakistan. It lies partly in southern Khyberpakhtoonkhwa, southwestern Punjab, western Sindh and in most of the Balochistan province.
- The region is drained by rivers and hill-torrents originating from mountain ranges some of which lie out side international borders. The major rivers are *Gomal, Kurram, Porali, Hingol, Dasht, Nari and Gaj etc.*
- The region mostly falls in arid to hyper-arid climatic zone.

ROD-KOHI REGION OF PAKISTAN

Total Area: 42 Million Ha

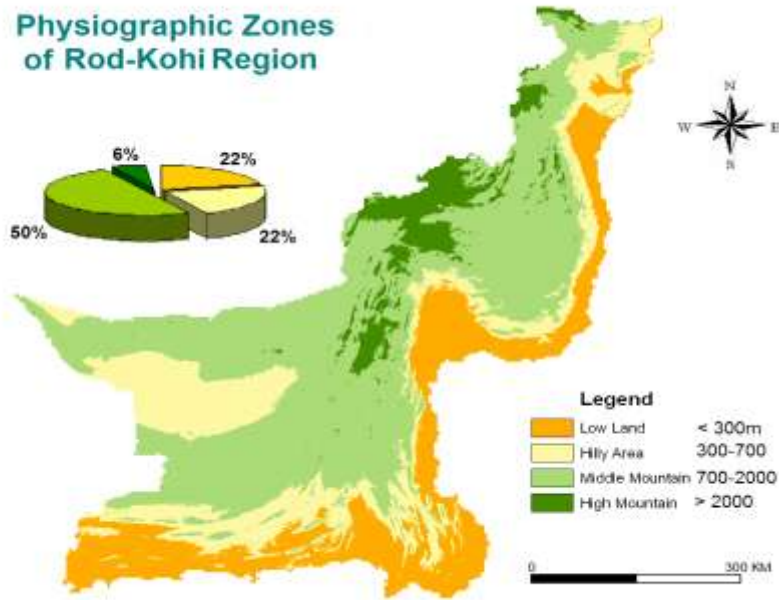
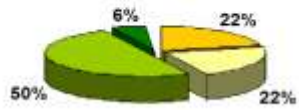


WRRl, NARC, Islamabad

Agriculture & Landuse

- The principal crops grown are wheat, maize, jawar (millet), bajra (sorghum), gram and pulses. Wheat is sown in major part of the region. The irrigated area is of a minor extent only, mostly occurring along streams or where the sub soil water is available at shallow depths.
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- The landuse is subsistence rod-kohi or 'Sailaba' cropping and live stock grazing. On higher altitudes, there are forests of juniper and wild olive, which merge with barren lands with scanty bushes and grasses in low-lying areas. The natural vegetation provides an ample source for livestock grazing.

Physiographic Zones of Rod-Kohi Region



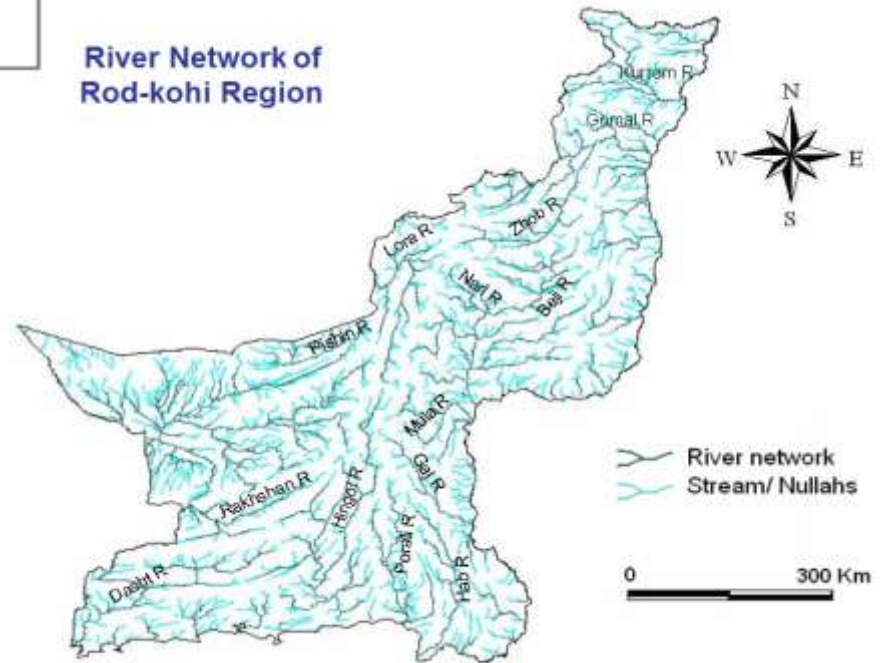
Legend

Low Land	< 300m
Hilly Area	300-700
Middle Mountain	700-2000
High Mountain	> 2000

0 300 KM

WRRRI, NARC

River Network of Rod-kohi Region

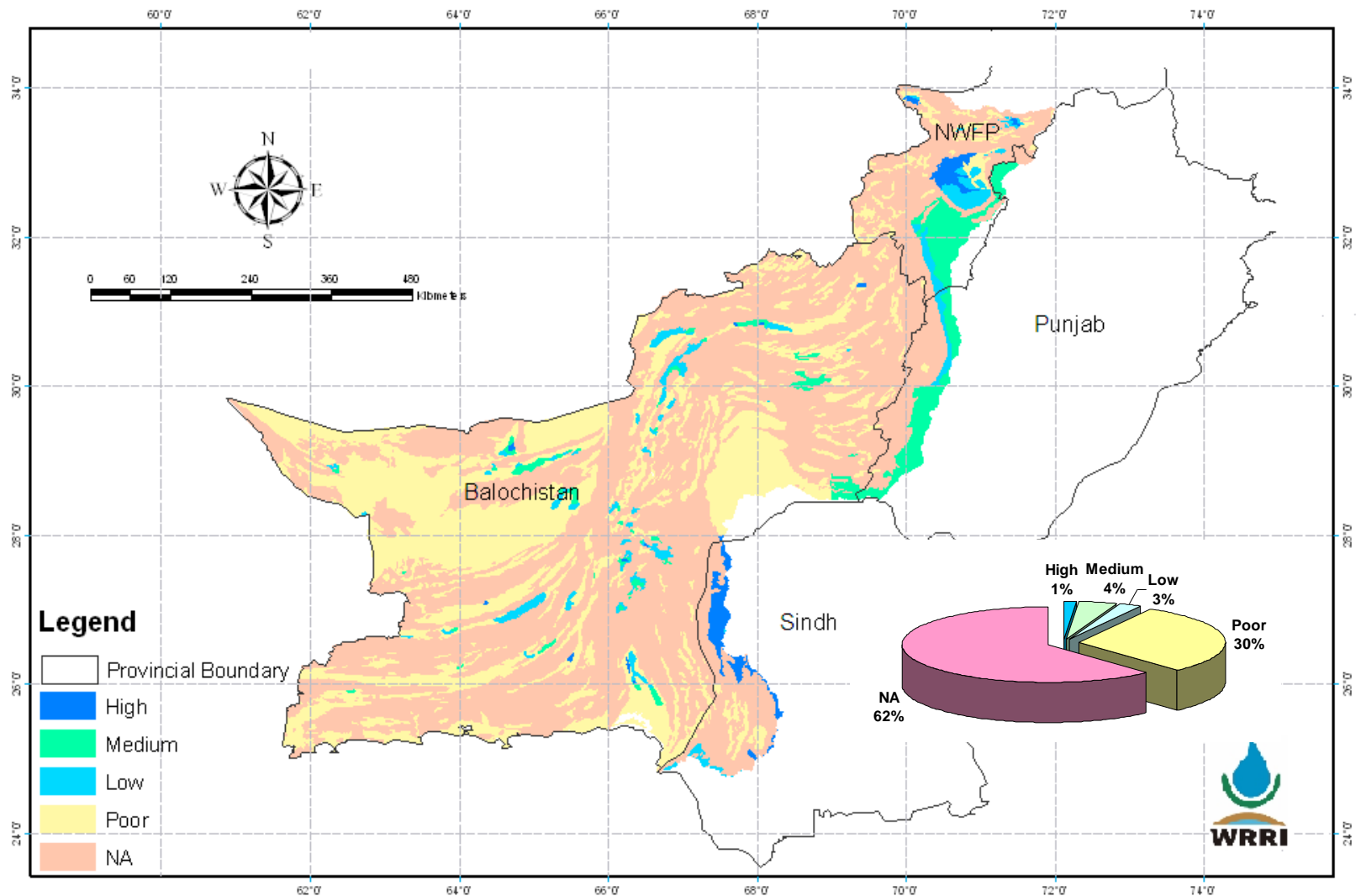


River network
 Stream/ Nullahs

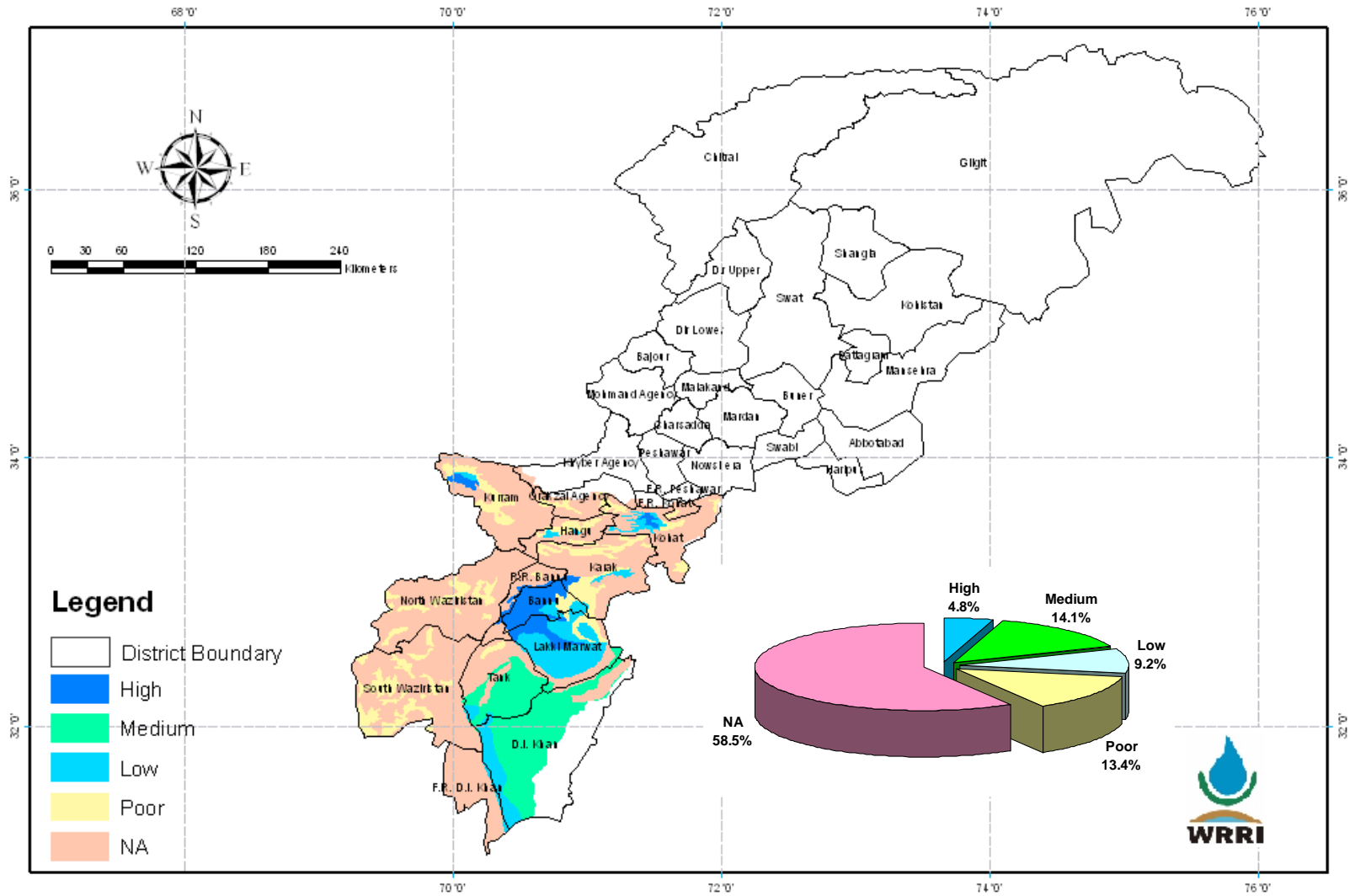
0 300 Km

WRRRI, NARC

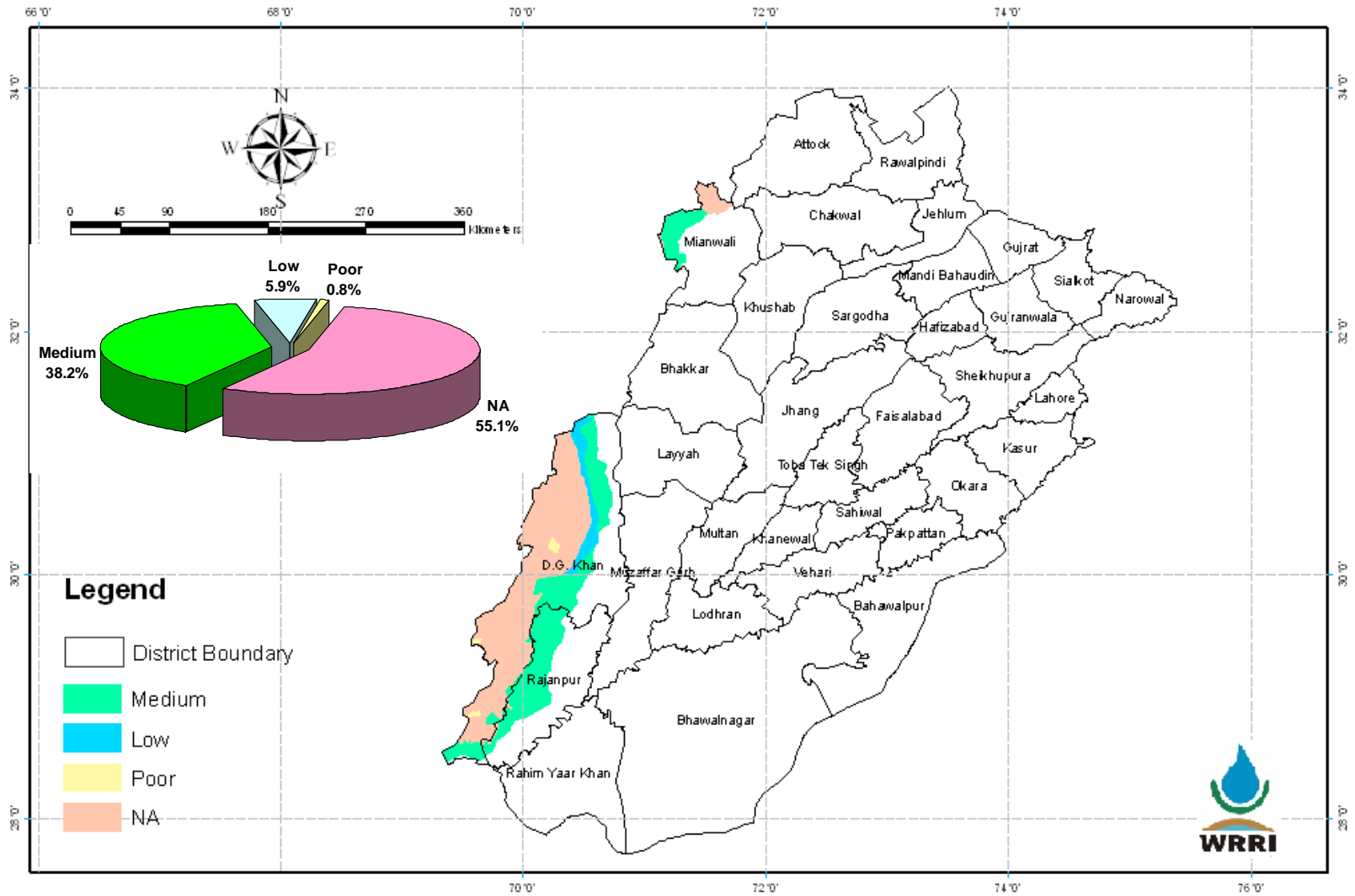
GROUNDWATER POTENTIAL ZONES OF ROD-KOI REGION OF PAKISTAN



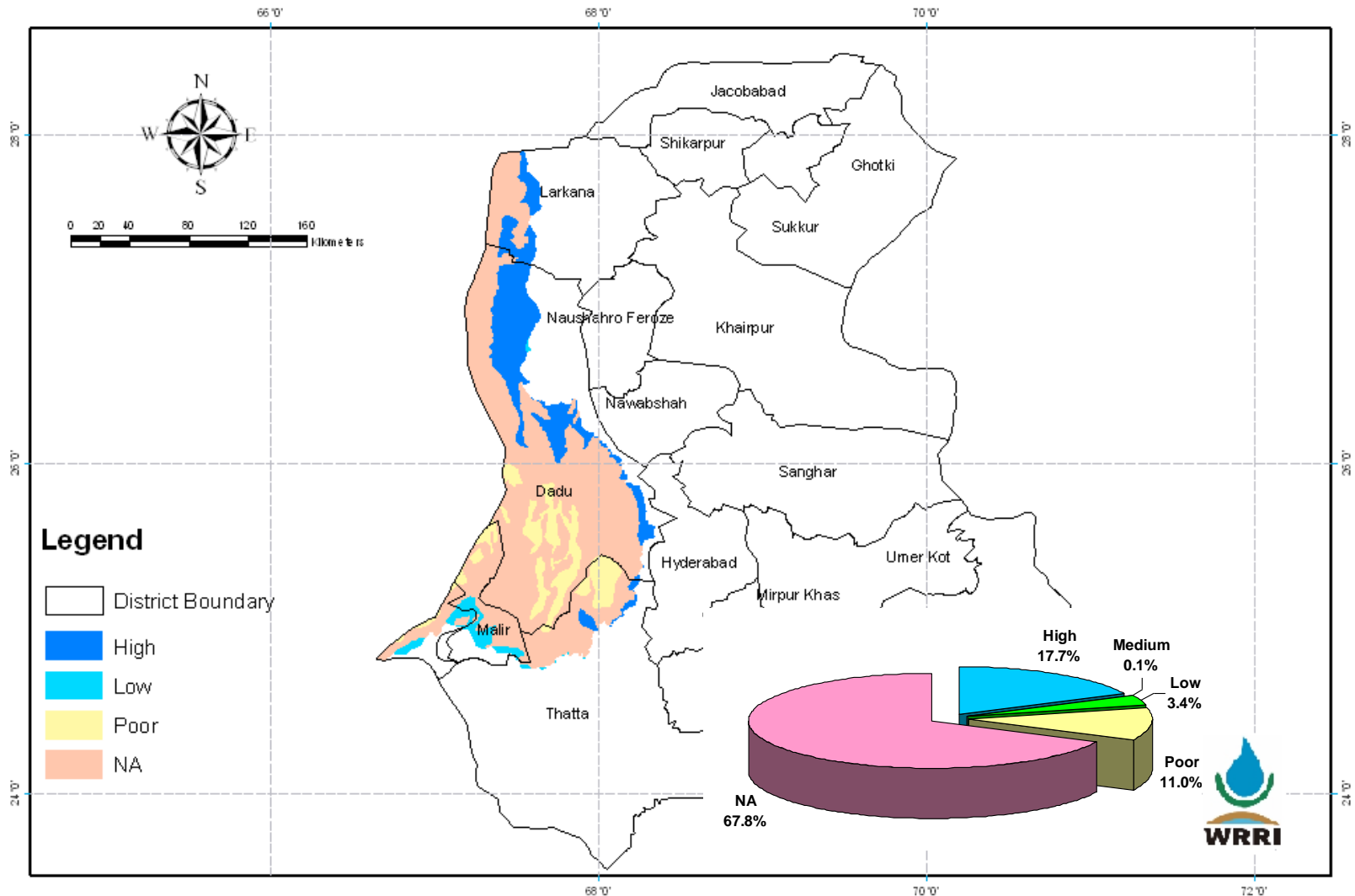
GROUNDWATER POTENTIAL ZONES OF ROD-KOI REGION OF NWFP



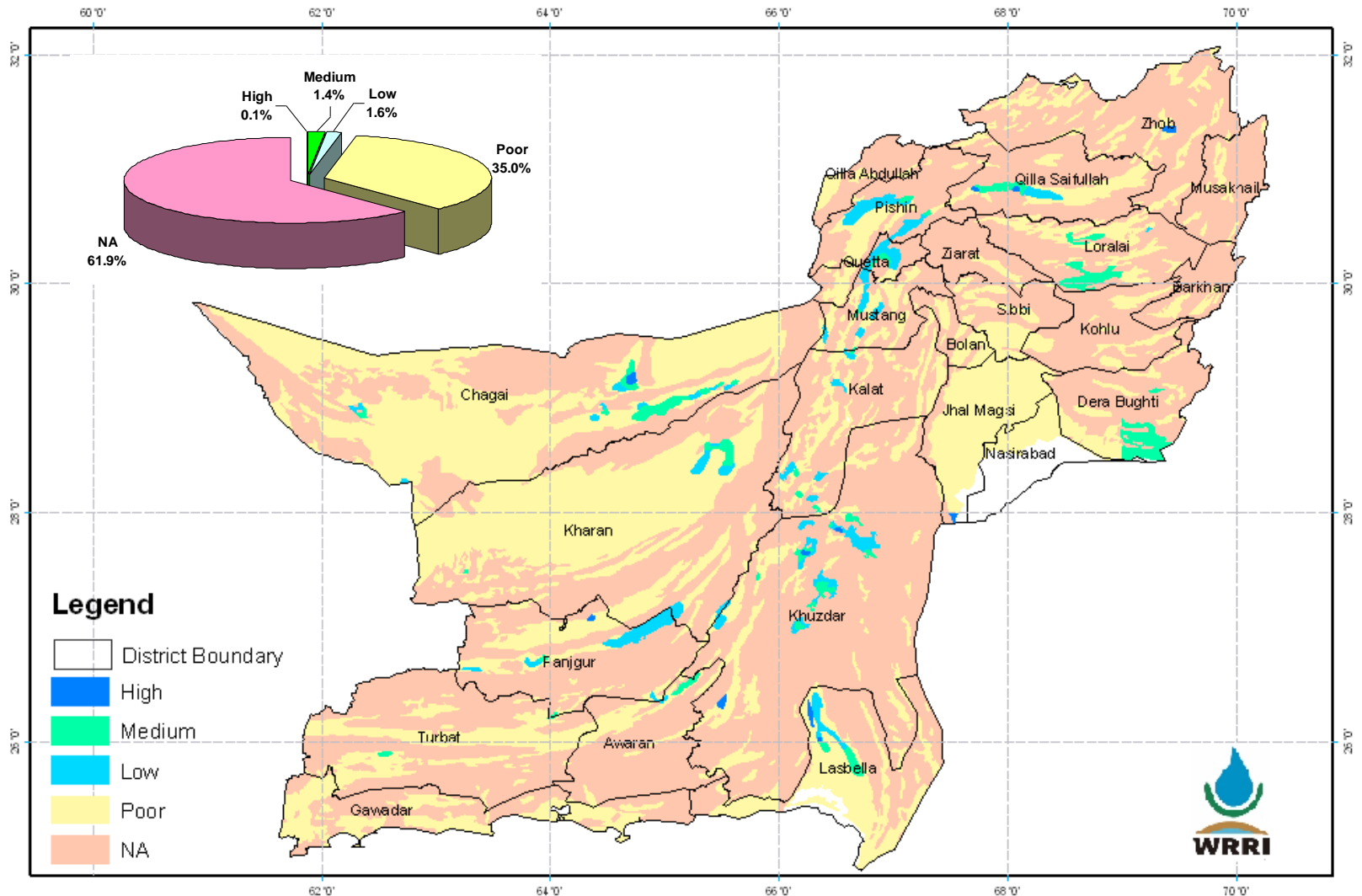
GROUNDWATER POTENTIAL ZONES OF ROD-KOI REGION OF PUNJAB



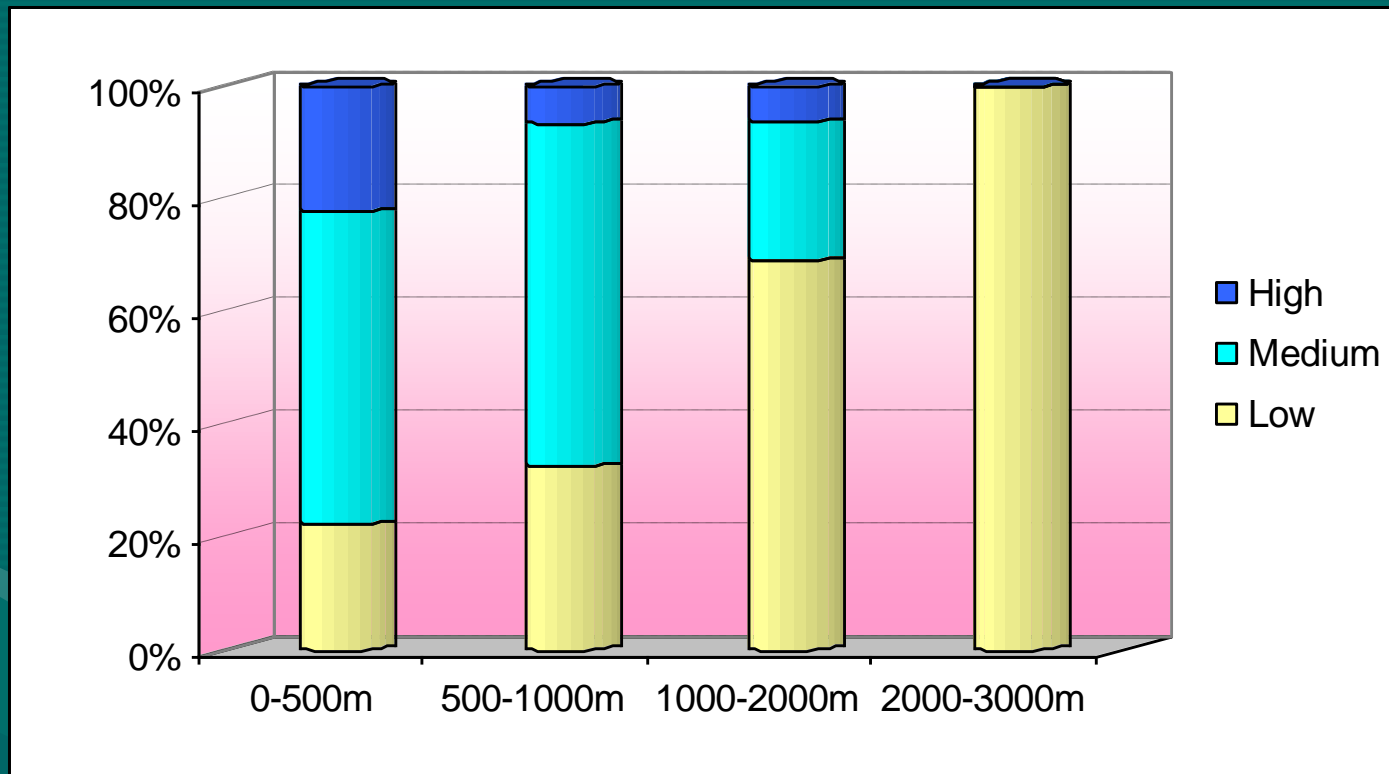
GROUNDWATER POTENTIAL ZONES OF ROD-KOI REGION OF SINDH



GROUNDWATER POTENTIAL ZONES OF ROD-KOI REGION OF BALOCHISTAN

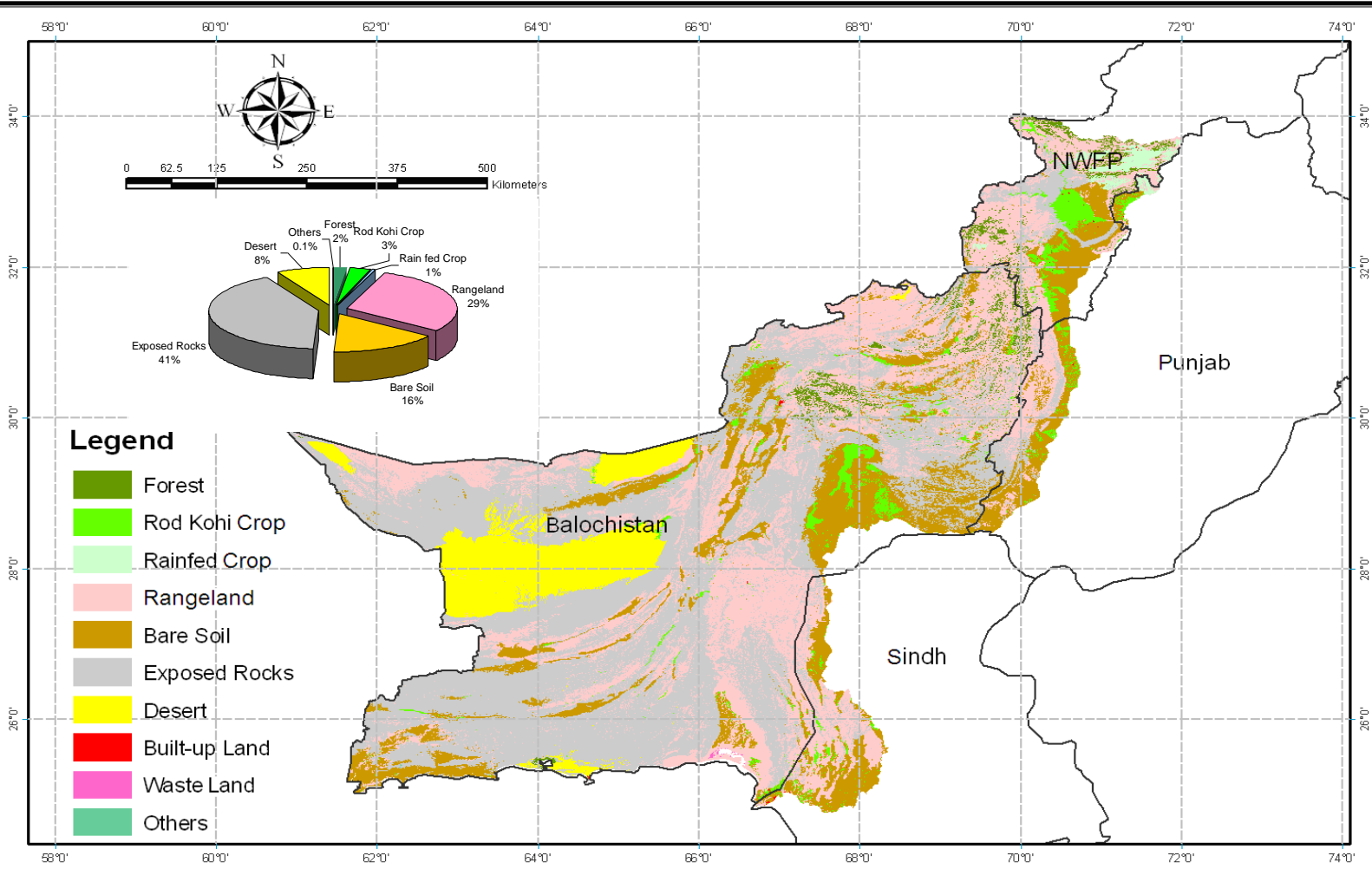


Percentage of Groundwater Potential Zones by Elevation



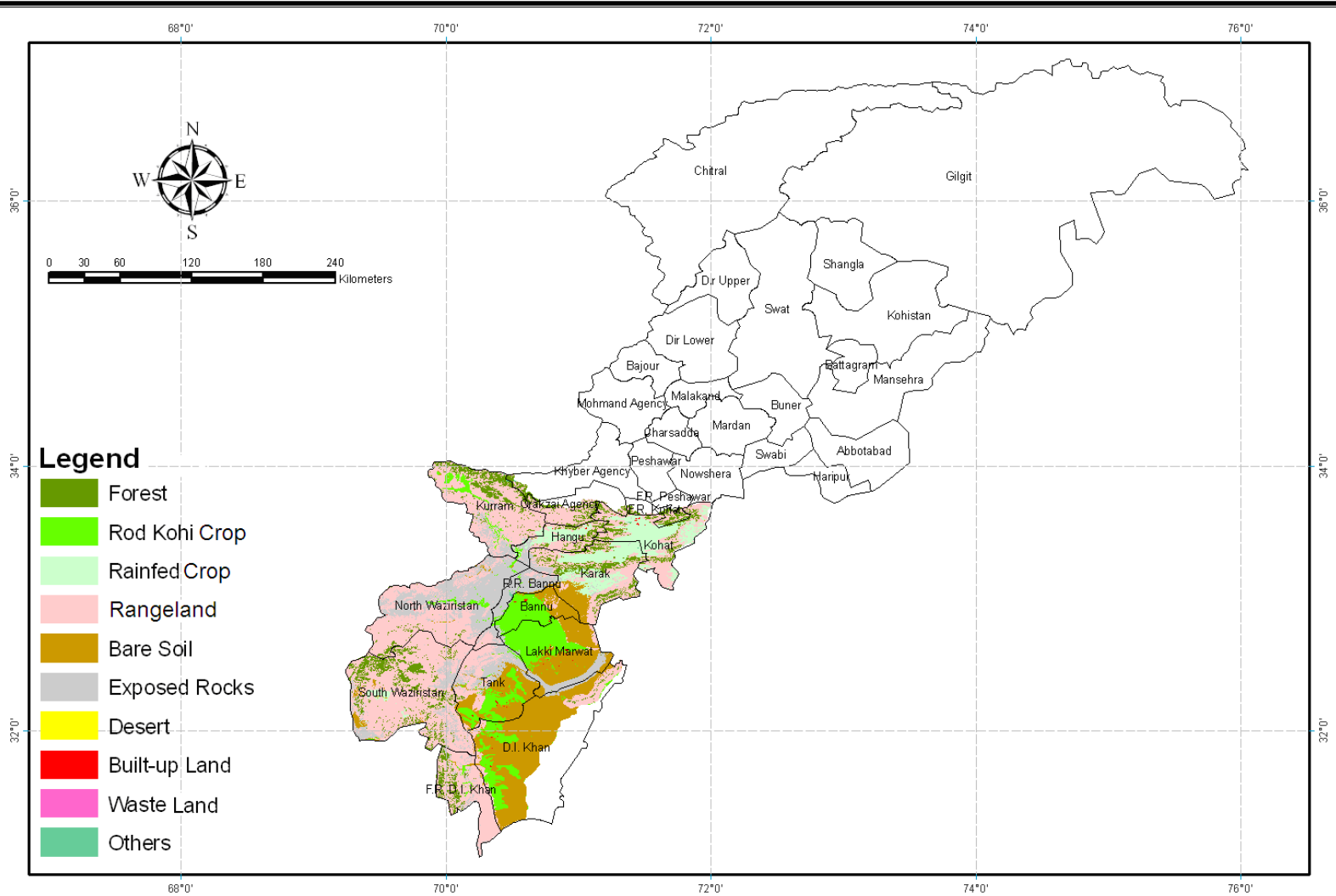
Potential Groundwater zones by Provinces

Zone	KPK	Punjab	Sindh	Balochistan	Total (000' ha)
High	183	-	369	45	597
Medium	543	670	2	488	1,702
Low	353	103	71	543	1,070
Poor	514	15	230	11,868	12,627
N.A	2,245	965	1,414	21,009	25,633
Total	3,838	1,752	2,086	33,954	41,629



LANDUSE MAP OF ROD-KOHI REGION OF PAKISTAN





LANDUSE MAP OF ROD-KOHI REGION OF NWFP



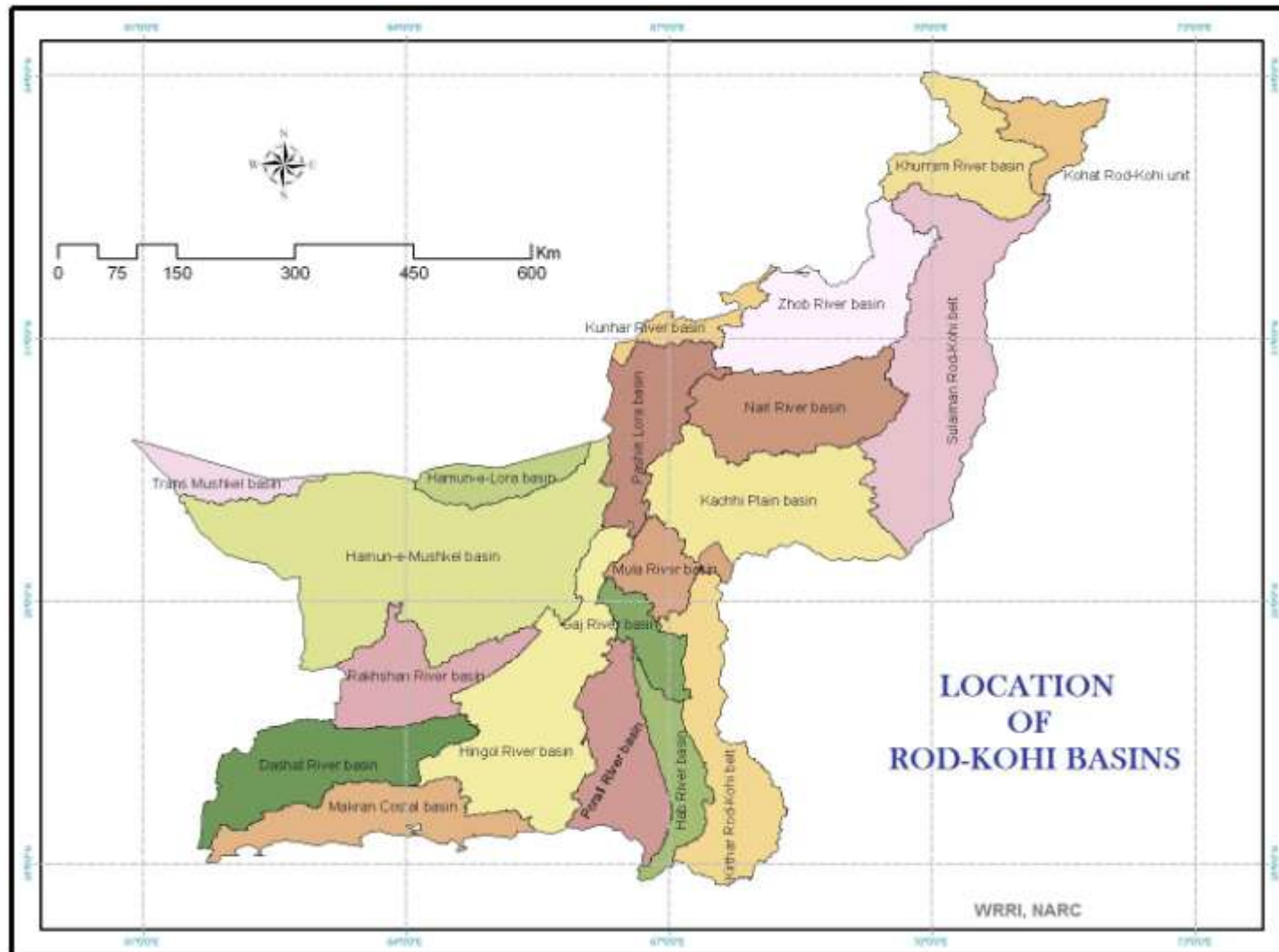
Major Landuse Classes Identified in Rod-kohi region

S.No	Landuse	KPK	Punjab	Sindh	Balochistan	Total (000' ha)
1	Forest	359.0	1.0	0.9	503.5	864.5
2	Rod Kohi Crop	384.8	104.2	92.0	598.5	1179.5
3	Rainfed Crop	266.4	36.9	-	0.4	303.7
4	Rangeland	1588.0	538.1	1002.1	9135.5	12263.7
5	Bare Soil	695.9	762.7	789.4	4272.4	6520.4
6	Exposed Rocks	537.4	308.2	195.7	16268.2	17309.5
7	Desert	-	-	-	3160.4	3160.4
8	Built-up Land	3.9	0.5	3.8	6.7	14.9
9	Waste Land	-	0.2	-	6.9	7.2
10	Water bodies	2.1	0.1	1.6	1.7	5.5
	Total	3837.6	1751.9	2085.6	33954.1	41629.3

Distribution of Landuse by Physiographic Zones

S.No	Landuse	Lowland	Hilly Area	Middle Mountain	High Mountain	Total (000' ha)
1	Forest	20.4	62.4	488.1	290.2	861.1
2	Rod Kohi Crop	737.9	198.9	264.5	9.7	1210.9
3	Rain fed Crop	9.9	202.6	96.8	0.0	309.3
4	Rangeland	1695.2	1532.3	7490.3	1490.0	12207.9
5	Bare Soil	3865.0	725.0	1974.9	77.1	6642.0
6	Exposed Rocks	2491.6	4169.5	9618.2	952.8	17232.2
7	Desert	108.5	2113.3	914.6	1.3	3137.7
8	Built-up Land	6.7	2.1	6.2	0.0	15.0
9	Waste Land	7.4	0.0	0.0	0.0	7.4
10	Water bodies	3.4	1.0	0.4	0.8	5.6
	Total	8946.0	9007.0	20854.0	2822.0	41629.0

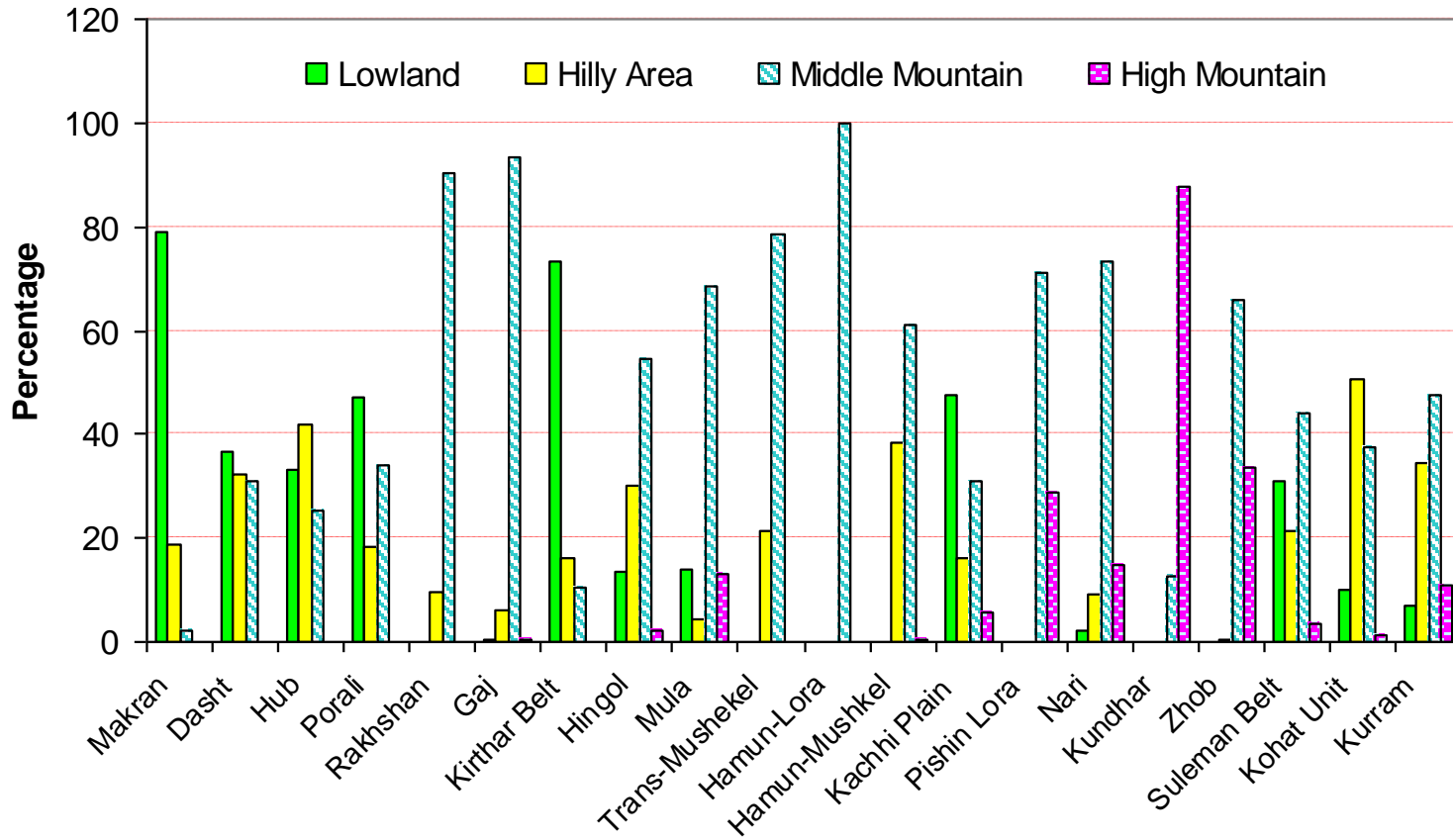
Inventory of Rod-kohi Basins/Units



Physical Characteristics of Rod-kohi Basins/Units of Pakistan

S.No.	Name	Perimeter (km)	Area (sq km)	% Area	Popul. Den (pers/km ²)	Elev. Range (masl)	Annual Rainfall
1	Makran Coastal basin	1,232	18,171	4.4	15	0-1172	71
2	Dasht River basin	1,052	23,318	5.6	17	0-1470	64
3	Hab River basin	827	10,135	2.4	488	0-2169	149
4	Porali River basin	905	18,260	4.4	15	0-2280	150
5	Rakhshan River basin	924	16,929	4.1	9	555-1848	67
6	Gaj River basin	606	6,803	1.6	11	0-2280	141
7	Kirthar Rod-Kohi belt	1,307	23,092	5.5	403	11-2137	127
8	Hingol River basin	1,632	37,375	9.0	11	0-2883	135
9	Mula River basin	664	8,701	2.1	11	41-2819	148
10	Trans Mushkel basin	541	6,389	1.5	4	475-1905	64
11	Hamun-e-Lora basin	499	7,611	1.8	4	845-1936	95
12	Hamun-e-Mushkel basin	1,856	72,057	17.3	4	555-2748	81
13	Kachhi Plain basin	1,224	32,453	7.8	76	48-2819	164
14	Pashin Lora basin	951	16,856	4.1	81	1236-3458	220
15	Nari River basin	876	22,186	5.3	25	118-3458	244
16	Kundar River basin	700	4,950	1.2	98	1232-2829	250
17	Zhob River basin	1,089	25,619	6.2	24	344-2840	257
18	Suleiman Rod-Kohi belt	1,583	42,011	10.1	103	84-3168	294
19	Kohat Rod-Kohi unit	603	7,401	1.8	434	202-2613	471
20	Kurram River basin	874	15,974	3.8	173	207-4660	517
	Total	19,944	416,290	100.0	Avg: 100	0-4660	Avg: 185

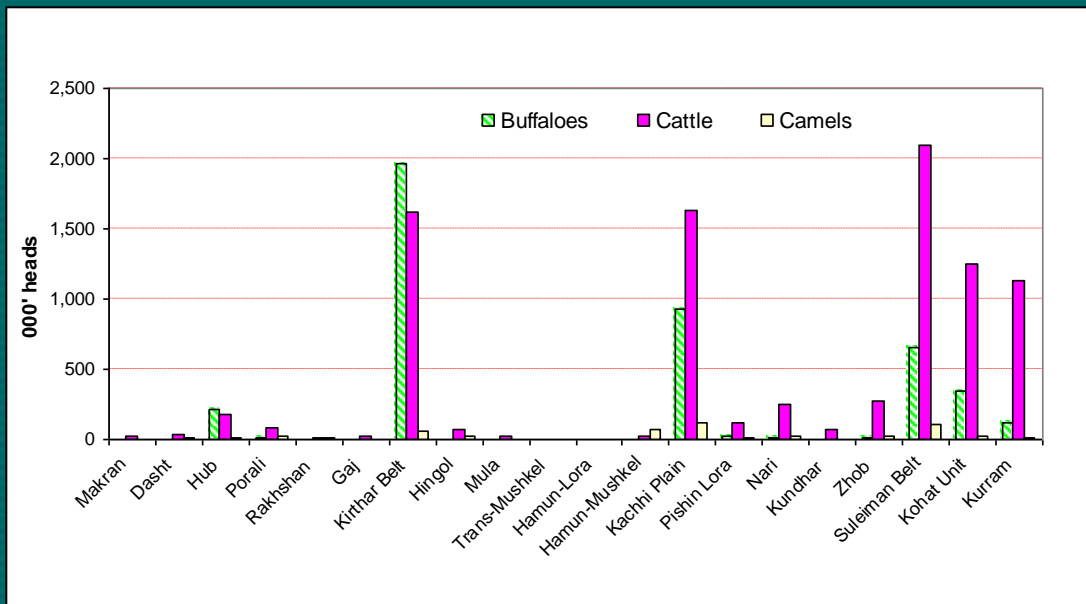
Rod-Kohi Units By Physiographic Zones



Detail of Landuse in different Rod-kohi units (Area in sq km)

S.No	Rod-Kohi B/U	Forest	Crop cover	Rangeland	Bare soil	Expose d Rocks	Desert	Others
1	Makran	149	20	566	3310	12112	1042	13
2	Dasht	0	143	1810	2856	18224	9	2
3	Hub	17	363	3971	860	4563	0	54
4	Porali	1	208	8238	1479	7290	0	71
5	Rakhshan	0	31	4338	2077	9148	1278	0
6	Gaj	1	25	5563	38	1136	0	3
7	Kirthar R. Belt	3	802	11187	7929	2700	0	15
8	Hingol	0	265	9320	2610	24767	10	0
9	Mula	0	155	3225	1545	3791	0	0
10	Trans-Mushkel	5	0	3433	3	2032	952	0
11	Hamun-Lora	0	76	1567	149	1705	4218	0
12	Hamun-Mushkel	1	355	8615	2836	37000	23814	0
13	Kachhi Plain	81	2696	3144	13314	13346	0	3
14	Pishin Lora	196	537	3807	5235	7332	0	40
15	Nari	1785	570	8969	2726	8440	0	1
16	Kundar	0	20	2886	121	1995	0	0
17	Zhob	1931	427	16367	2664	4623	196	4
18	Suleiman R. Belt	2210	2510	16469	12652	8672	0	18
19	Kohat Unit	1394	2633	3123	487	20	0	17
20	Kurram	947	3138	6092	2332	3990	0	36
	Total	8720	14976	122688	65223	172886	31520	276

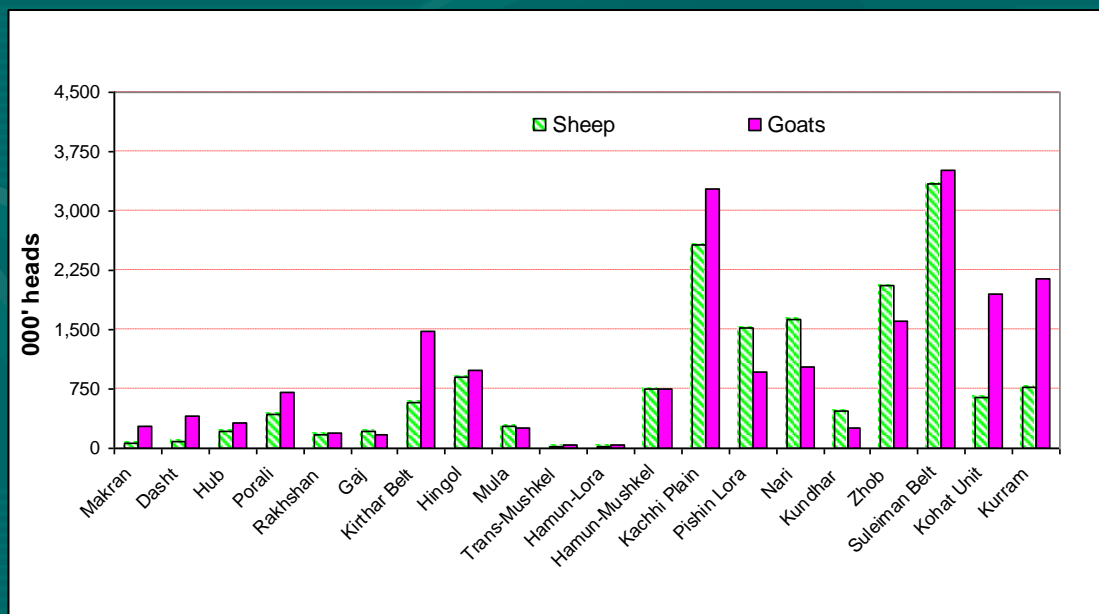
Livestock in Rod-kohi Basins/Units



Large Ruminants



Small Ruminants

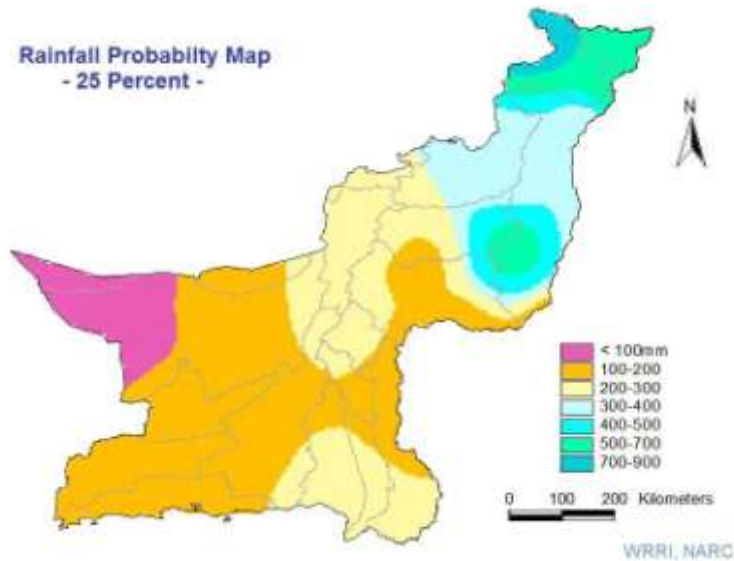


Percentage distribution of Groundwater zones in Rod-kohi Units

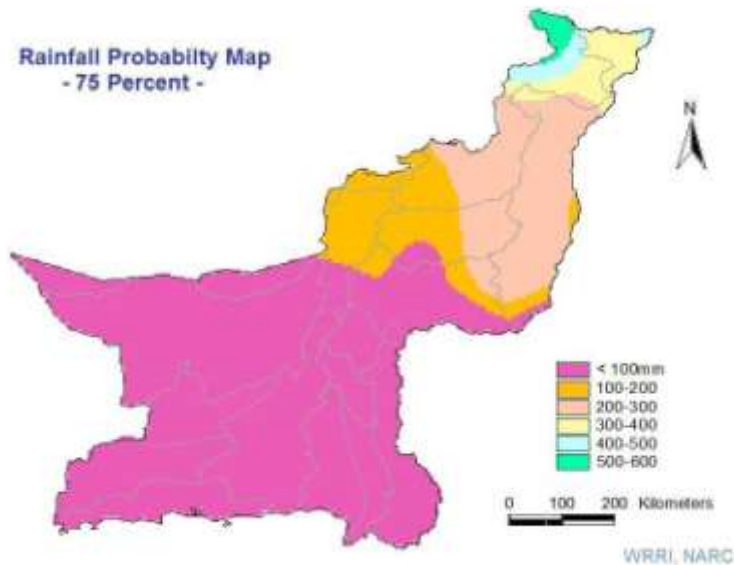
S.No	Rod-Kohi Unit	Area (sq km)	High	Medium	Low	Poor	N.A
1	Makran	18,171	0.0	0.0	0.0	28.5	71.5
2	Dasht	23,318	0.0	0.3	0.0	33.2	66.5
3	Hub	10,135	0.0	0.0	0.8	23.4	75.8
4	Porali	18,260	0.6	3.0	3.9	29.8	62.7
5	Rakhshan	16,929	0.2	0.2	1.3	40.0	58.4
6	Gaj	6,803	0.3	3.2	7.1	11.6	77.9
7	Kirthar Belt	23,092	16.8	0.0	2.0	12.3	68.9
8	Hingol	37,375	0.3	1.0	3.9	22.9	71.9
9	Mula	8,701	0.0	0.0	0.9	21.9	77.2
10	Trans-Mushkel	6,389	0.0	0.0	0.0	68.8	31.2
11	Hamun-Lora	7,611	1.4	1.8	0.3	63.9	32.5
12	Hamun-Mushkel	72,057	0.0	1.3	1.0	58.0	39.8
13	Kachhi Plain	32,453	0.0	4.8	0.0	46.9	48.4
14	Pishin Lora	16,856	0.0	1.4	9.9	31.1	57.7
15	Nari	22,186	0.0	3.6	0.1	22.3	74.0
16	Kundar	4,950	0.0	0.0	0.0	22.7	77.3
17	Zhob	25,619	0.4	1.0	1.0	21.5	76.0
18	Suleiman Belt	42,011	0.0	25.7	4.9	6.0	63.4
19	Kohat Unit	7,401	1.4	9.9	4.2	14.4	70.2
20	Kurram	15,974	10.7	0.5	13.9	15.8	59.2
	Total	416,290					

Rainfall Probability Analysis Using 50y data

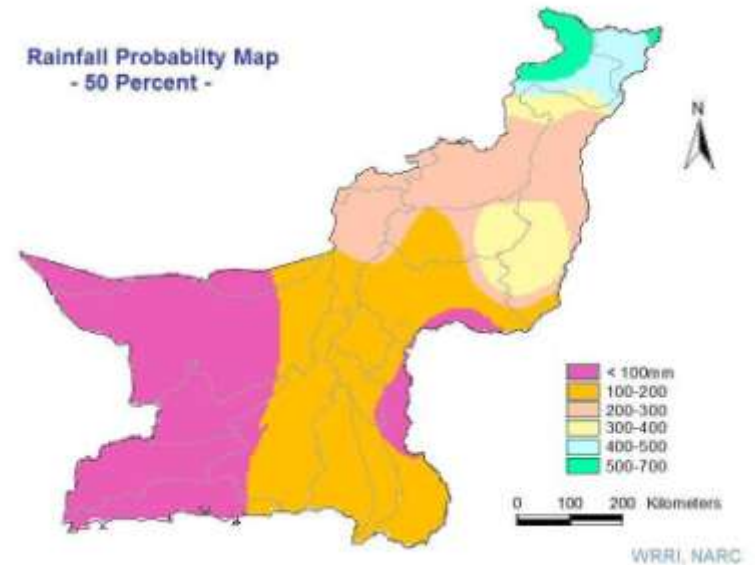
Rainfall Probability Map
- 25 Percent -



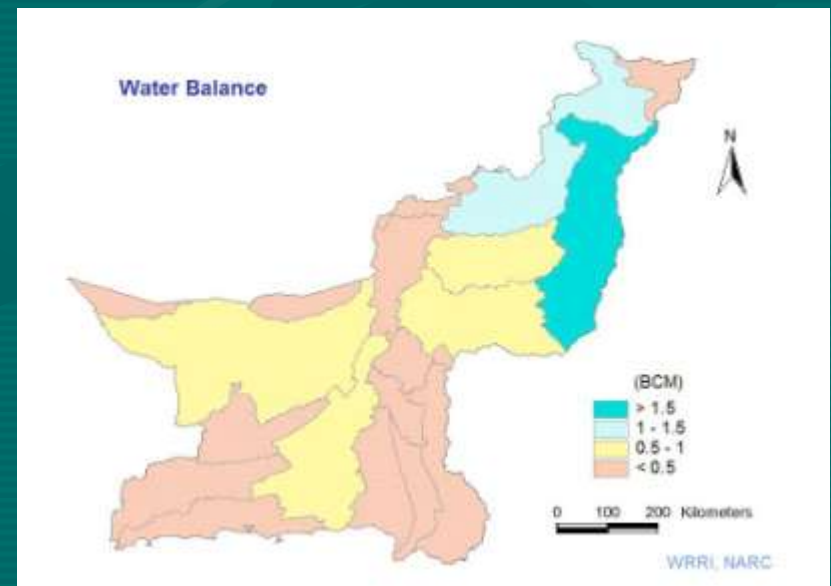
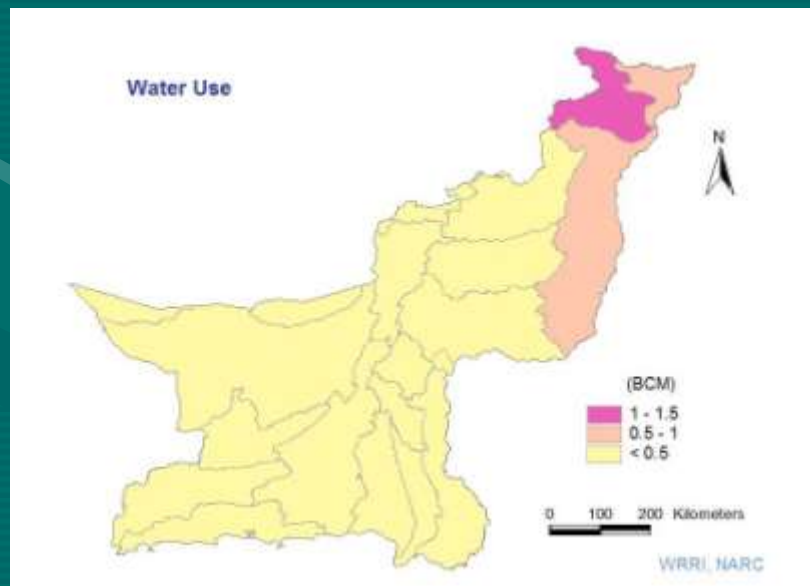
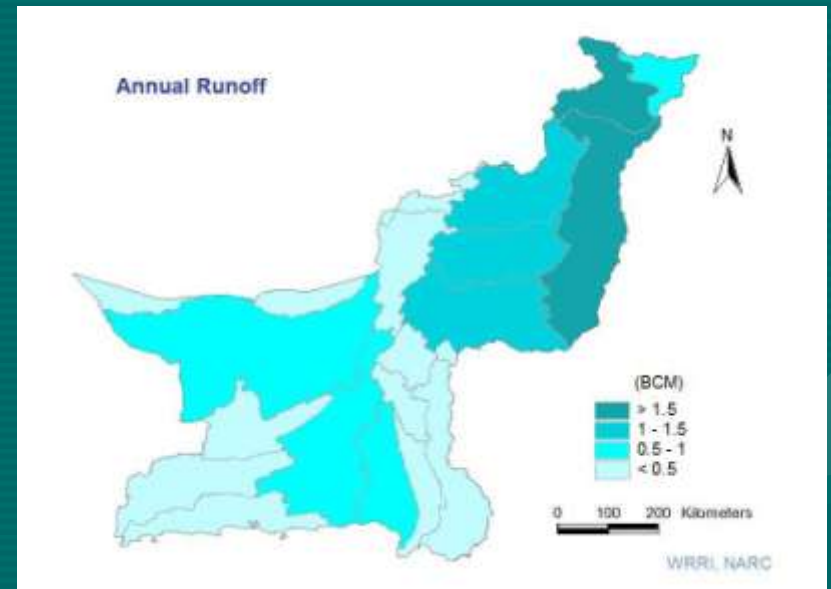
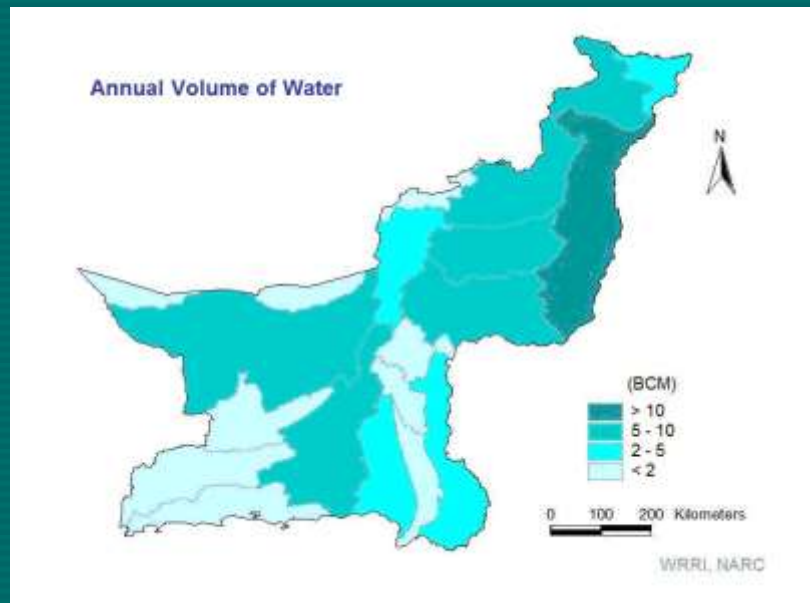
Rainfall Probability Map
- 75 Percent -



Rainfall Probability Map
- 50 Percent -



Assessment of Water Conservation Potential



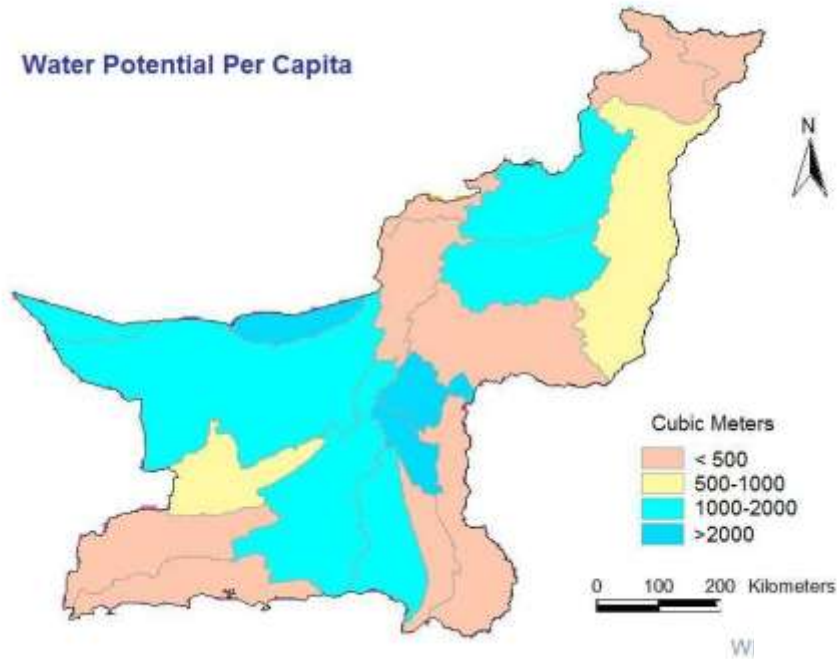
Water Conservation Potential in Spate region

Provinces	Volume (BCM)	Runoff (BCM)	Water use (BCM)	Balance (BCM)
KPK	15.990	4.269	2.103	2.167
Punjab	5.758	1.480	0.462	1.018
Sindh	2.663	0.461	0.102	0.359
Balochistan	47.737	8.487	1.670	6.818
Total	72.148	14.698	4.337	10.361

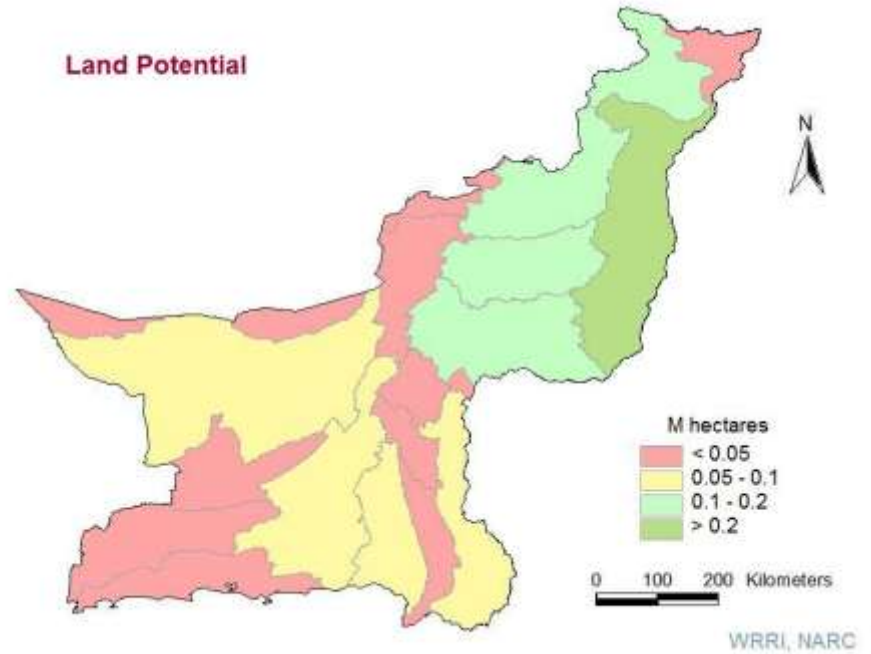
Water Balance Analysis of Rod-kohi Basins/Units

S.No.	Rod-kohi B/U	Annual Rainfall (mm)	Volume (BCM)	Annual Runoff (BCM)	Water Use (BCM)	Balance (BCM)	Runoff coefficient
1	Makran	65	1.179	0.236	0.153	0.083	0.200
2	Dasht	64	1.492	0.298	0.195	0.103	0.200
3	Hub	137	1.387	0.269	0.079	0.190	0.194
4	Porali	150	2.739	0.548	0.155	0.393	0.200
5	Rakhshan	68	1.151	0.115	0.006	0.109	0.100
6	Gaj	138	0.938	0.211	0.033	0.178	0.225
7	Kirthar Rod-kohi Belt	124	2.872	0.491	0.106	0.385	0.171
8	Hingol	129	4.831	0.966	0.311	0.656	0.200
9	Mula	149	1.294	0.281	0.040	0.240	0.217
10	Trans-Mushkel	73	0.467	0.047	0.002	0.045	0.100
11	Hamun-e-Lora	96	0.733	0.073	0.003	0.071	0.100
12	Hamun-e-Mushkel	81	5.837	0.584	0.025	0.558	0.100
13	Kachhi Plain	165	5.341	1.014	0.129	0.886	0.190
14	Pishin Lora	220	3.713	0.371	0.006	0.365	0.100
15	Nari	245	5.443	1.018	0.088	0.930	0.187
16	Kundar	250	1.238	0.175	0.007	0.168	0.142
17	Zhob	258	6.619	1.394	0.212	1.183	0.211
18	Suleiman Rod-kohi Belt	312	13.093	3.378	0.802	2.576	0.258
19	Kohat Unit	468	3.465	0.898	0.818	0.080	0.259
20	Kurram	521	8.315	2.330	1.167	1.164	0.280
	Total		72.148	14.698	4.337	10.361	0.203

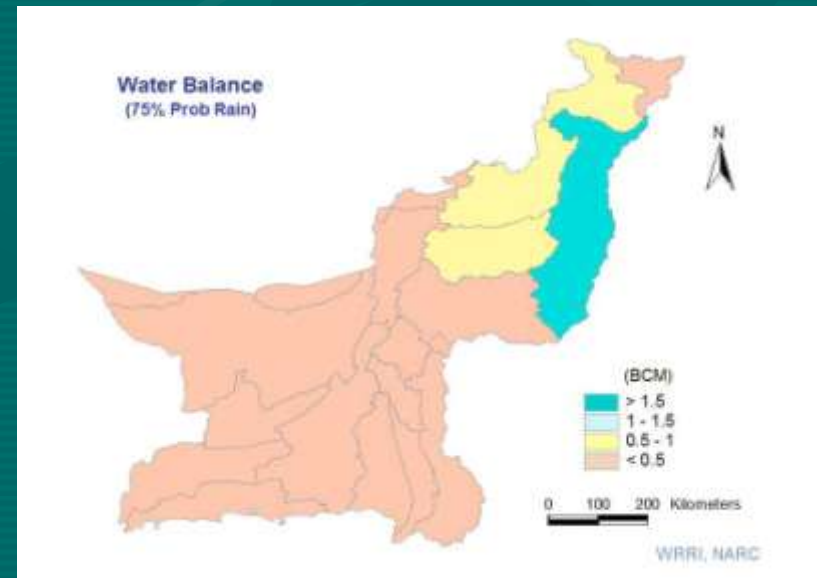
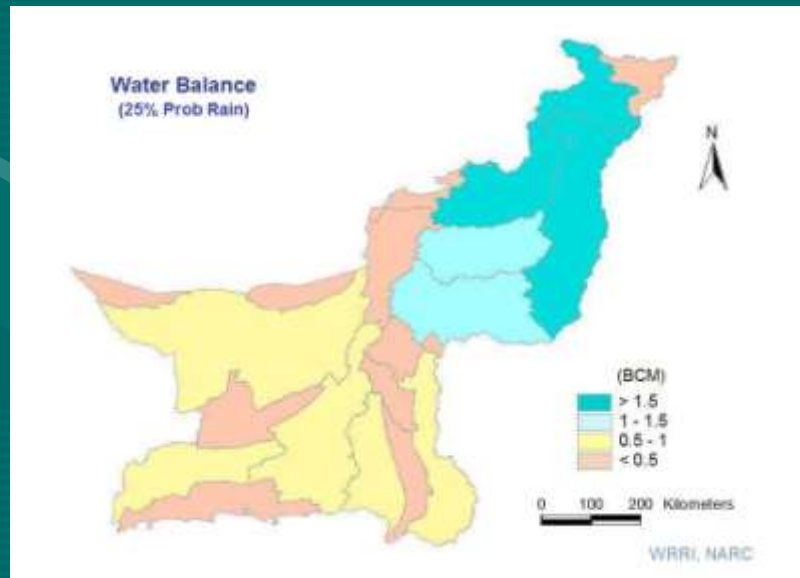
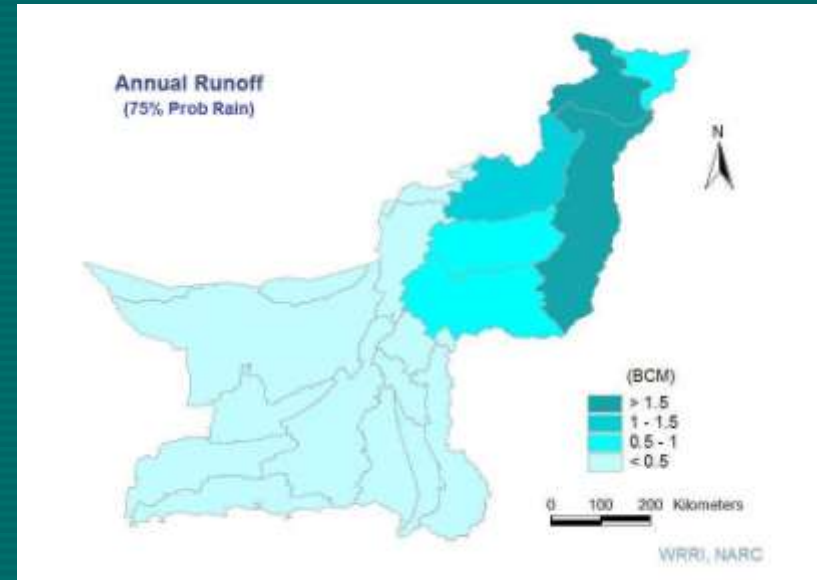
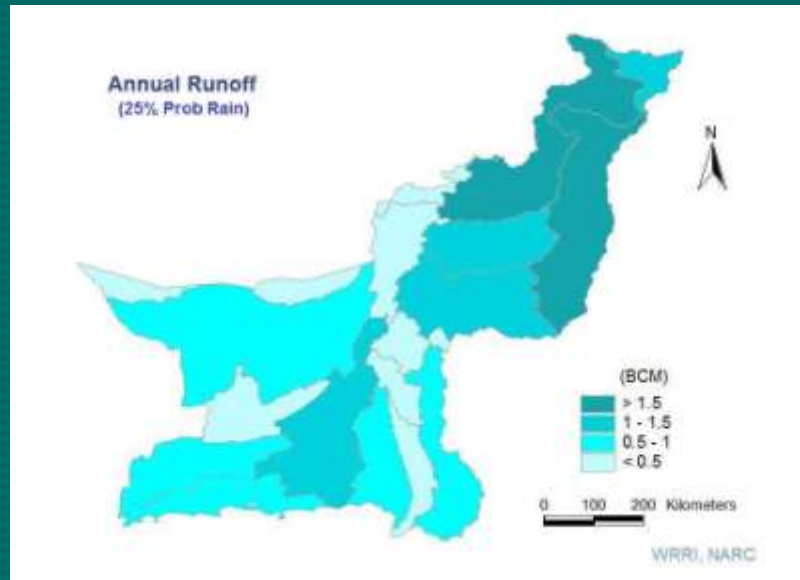
Water Potential Per Capita



Land Potential



Water Potential at Various Rainfall Probabilities



Water Potential at Various Rainfall Probabilities

NAME	25% (BCM)	50% (BCM)	75% (BCM)
Makran RB	0.394	0.105	0.047
Dasht RB	0.504	0.103	0.061
Hub RB	0.361	0.213	0.029
Porali RB	0.670	0.393	0.046
Rakhshan RB	0.248	0.107	0.087
Gaj RB	0.251	0.183	0.051
Kirthar RB	0.682	0.396	0.111
Hingol RB	0.990	0.698	0.101
Mula RB	0.395	0.239	0.064
Trans-Mushkel B	0.044	0.039	0.033
Hamun-e-Lora RB	0.122	0.069	0.039
Hamun-e-Mushkel	0.932	0.557	0.372
Kachhi Plain B	1.232	0.884	0.432
Pishin Lora RB	0.415	0.365	0.205
Nari RB	1.245	0.923	0.653
Kundar RB	0.176	0.168	0.099
Zhob RB	1.602	1.175	0.977
Suleiman RB	3.620	2.387	1.800
Kohat RU	0.345	0.085	-0.120
Kurram RB	1.839	1.149	0.703
Total	16.066	10.238	5.790

Land Potential at Various Rainfall Probabilities

NAME	25% (M ha)	50% (M ha)	75% (M ha)
Makran RB	0.039	0.011	0.005
Dasht RB	0.050	0.010	0.006
Hub RB	0.036	0.021	0.003
Porali RB	0.067	0.039	0.005
Rakhshan RB	0.025	0.011	0.009
Gaj RB	0.025	0.018	0.005
Kirthar RB	0.068	0.040	0.011
Hingol RB	0.099	0.070	0.010
Mula RB	0.040	0.024	0.006
Trans-Mushkel B	0.004	0.004	0.003
Hamun-e-Lora RB	0.012	0.007	0.004
Hamun-e-Mushkel	0.093	0.056	0.037
Kachhi Plain B	0.123	0.088	0.043
Pishin Lora RB	0.042	0.037	0.021
Nari RB	0.125	0.092	0.065
Kundar RB	0.018	0.017	0.010
Zhob RB	0.160	0.118	0.098
Suleiman RB	0.362	0.239	0.180
Kohat RU	0.035	0.009	-0.012
Kurram RB	0.184	0.115	0.070
Total	1.607	1.024	0.579

Glimpses of Spate Irrigation Systems in Rod-kohi Areas



D.I.Khan



D.I.Khan

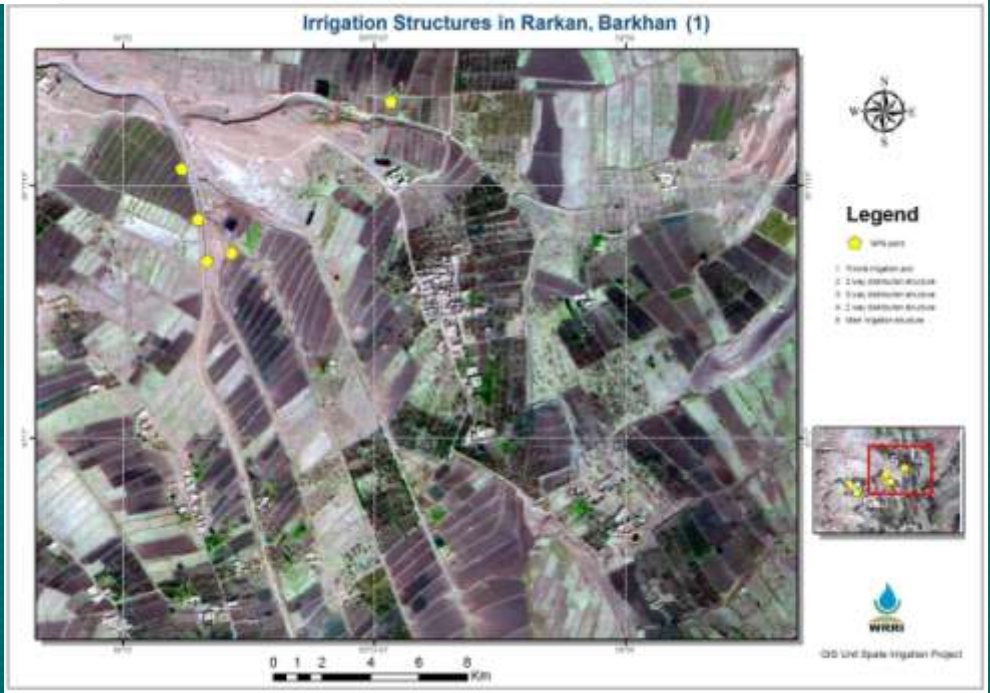


Barkhan



D.I.Khan (KPK)

Spate Irrigation in Rod-kohi Areas



Barkhan
(Balochistan)

Conclusion cont...

- Overall spate irrigation region ('*Rod-kohi region*') stretches over an area of about 41.6 million ha partly in each province of Pakistan.
- There exists water conservation potential of about 10.2 BCM (8.3 MAF) which if properly utilized for irrigation purpose would be able to bring about 1.0 million ha of land under rod-kohi cultivation.
- The landuse analysis indicated rod-kohi crop over 1.2 M.ha and together with the land potential it may form over 2.2 M.ha of potential rod-kohi area in the country. About 0.3 M.ha area was found under rainfed crop.

Conclusion

- The bare soil or culturable waste was found over 6.5 M.ha which can be developed for rod-kohi agriculture through adopting proper flood management techniques.
- High potential of groundwater was found over 0.6 M.ha area while medium potential in about 1.7 M.ha area.
- More than 1.0 BCM of water potential exists each in Suleiman Rod-kohi belt, Zhob and Kurram River basins.

Way Forward

- There is need to investigate surface and sub-surface water resources of the rod-kohi region in detail for sustainable development of these areas.
- The water conservation potential should be utilized through construction of small dams and farm ponds for agriculture and economic productivity enhancement.
- Effective use of groundwater commodity through adopting high efficiency irrigation techniques like drip-irrigation system can help in enhancing water as well as agriculture productivity.
- The efforts going on at various levels on developing rod-kohi areas in the country must be integrated through a common platform or a focal point for effective resource sharing, coordination and unified planning of these vital areas.

Thanks

