

AN APPROXIMATE ASSESSMENT OF EXPLOITABLE GROUND WATER POTENTIAL OF RAJASTHAN

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While formulating the proposals for the Fifth Five-Year Plan of the state for minor irrigation programme, it is felt necessary to assess approximately the available exploitable ground water potential of the state for proper planning. An attempt has been made to assess the annual recharge and estimate the present draft for each district of the state. It has been calculated that the annual recharge of the state is around 8109 million cubic metres against the annual draft of 4746 mcm. The total pumpage for irrigation amounts to 4108 mcm (irrigating 10,82,452 ha. of land) and 637 million cubic metres for drinking and industrial requirements. The surplus potential, therefore, comes to 3363 mcm and a major part of it can be exploited during the Fifth Five-year Plan period. It is, however, proposed that detailed basin-wise water-balance studies may be initiated early for systematic ground water development.

INTRODUCTION

Ground water development programme has been accelerating at an unprecedentedly fast rate with the help of institutional financing in the state. The Rajasthan Ground Water Board has been conducting the hydrogeological investigations for providing technical support to the minor irrigation schemes. So far 115 development blocks have been surveyed and 65 minor irrigation schemes envisaging the future ground water development of assessed surplus exploitable potential have been prepared and submitted to the various financial agencies like the Agricultural Refinance Corporation, Agricultural Finance Corporation and other commercial banks. While formulating the programme of ground water development of the state for the Fifth Five-year Plan, it is felt necessary that an approximate assessment of the potentialities may be attempted based on the results of the previous investigations. This type of an assessment will be more reliable as compared to those attempted earlier which were based on the broad empirical methods.

The authors have attempted to assess the exploitable ground water potential, initially for each block and then for individual district by assessing the annual recharge and estimating the present pumpage. Based on the potential available, the authors have further proposed a tentative ground water development programme for each district during the Fifth Five-year Plan period. It can serve as a guideline for chalking out the requirement of finance, drilling rigs, pump sets, and allied equipments.

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DIFFERENT APPROACHES FOR POTENTIAL ESTIMATION

Various methods are employed for estimating the ground water potential. These vary from very generalised empirical approaches to correct assessment involving complete water balance studies of a basin. The water balance studies of basin or subbasin will be ultimately necessary and are proposed to be completed for all the basins of the state. The ground water development programme of the state, however, cannot be suspended till the results of water balance studies are available and, therefore, ground water development is being supported by semi-detailed surveys, which can be completed in shorter period. Some of the approaches commonly adopted for potential estimation, are described as under.

Infiltration Ratio

This is a very generalised approach where a percentage of rainfall is adopted as a contribution towards the ground water recharge depending on the nature of the rock types. Although, the assumed infiltration rates may be taken on the conservative side, still its actual values may be different for similar rock types located in different hydrometeorologic and hydrogeologic setting.

Increment in Ground Water Reservoirs

A relatively more authentic assessment can be attempted for a particular region if the rise of water level during the pre- and post-monsoon periods is observed in key wells. The net cumulative rise of water levels may be due to different sources of recharge, like precipitation, influent seepage from rivers and streams, seepage from canals and infiltration of irrigation water, etc. The increment in ground water reservoir can be estimated by adopting the value of specific yield, determined either by laboratory studies or by the field pumping tests.

WATER BALANCE STUDIES

For correct assessment of annual recharge, it is necessary that water balance studies are carried out for a delineated basin or subbasin where every individual component of hydrological cycle is calculated.

This generally takes more time and involves, considerable manpower and resources.

We adopted the second method for the recharge estimation for the state of Rajasthan as fairly extensive data were available from the field studies carried out in 115 blocks of 25 districts. The rise of water level was determined for each hydrogeologic unit and fairly proper value of specific yield was adopted. The potentials have been shown for some of the areas, where detailed basin studies were completed under the United Nations assisted projects in Rajasthan.

Table I shows the assessment of annual recharge for different districts. The recharge was determined only for the areas which are actually cultivated and contain fresh water underneath.

ESTIMATION OF EXISTING DRAFT

The existing draft for individual district has been estimated on the basis of the data available, e.g. total number of dug wells in use, wells having pump sets, tubewells, number of working hours and the purpose for which these are operated. The annual pumpage as estimated by the number of wells was also checked with the area commanded by wells and types of crops grown and requirement of water for domestic and livestock purposes. The details of the existing draft are shown in Table II. The areas irrigated by different sources are shown in Table IV, and human and cattle population in Table V.

The surplus exploitable potential of ground water worked out for each district is shown in Table III. It is proposed that the provisions for finances required for the ground water development projects during the fifth five-year plan may be provided in relation to the available potential. The future ground water development will mainly be consisting of sinking new wells and tubewells, deepening and revitalisation of existing wells and installation of pump sets and their early electrification.

TABLE I
Assessment of annual recharge

S. No.	District	Total area (sq. km)	Total cultivated area (sq. km)	Total area Considered for recharge estimation (sq. km)	Average rise of water level (metres)	Specific yield (%)	Estimated exploitable potential (mcm)	Hydro-geologic units
1	2	3	4	5	6	7	8	9
1.	Ajmer	8350	4280	500 3780	1.5 3.5	15.00 2.00	112.50 264.60	Alluvium Metamorphics
2.	Alwar	8572	4920	4120 800	0.90 2.50	10.0 2.0	370.80 40.00	Alluvium Crystallines & metamorphics
3.	Banswara	5067	2010	2010	2.00	2.0	80.40	Metamorphics and crystallines
4.	Barmer	29031	4487	864	1.27	8.00	87.78	Alluvium (for Siwana block only)
5.	Bharatpur	8411	5248	4500	1.10	10.00	495.00	Alluvium

TABLE I (Contd.)

1	2	3	4	5	6	7	8	9
6.	Bikaner	27102	4398	3140	1.00	10.00	31.40 ¹	Tertiary sandstones
7.	Bhilwara	10365	3014	650 2364	2.00 3.5	15.00 2.00	195.00 165.48	Alluvium Crystallines & metamorphics
8.	Bundi	5476	2243	2243	3.00	4.00	269.16	Sedimentaries
9.	Chittorgarh	10320	3378	A 1700 B 1178 C 500	5.5 2.9 2.00	1.50 4.00 10.00	140.25 136.64 100.00	Crystallines & metamorphics Sedimentaries Alluvium
10.	Churu	16261	11710	2000	0.40	10.00	80.00	Alluvium (Dungargarh Sardarsahar & Rajgarh)
11.	Dungarpur	3761	1161	1161	2.5	2.00	58.05	Crystallines & metamorphics
12.	Sriganganagar	20674	11800	5379	1.00	10.00	175.00 ²	Alluvium (Canal & well irrigated area of district)
13.	Jaipur	13666	8103	A 1103 B 7000	1.5 1.0	1.5 10.00	49.63 700.00	A) Metamorphics B) Alluvium
14.	Jaisalmer	38475	241	3772 8520	Assessed by U. N. D. P.		58.00 ³ 85.20 ⁴	Lathi area Kishan- garh-Tanot area (Economic mining)
15.	Jodhpur	22213	10298	A 161 B ₁ 140 B ₂ 105 C ₁ 620 C ₂ 630 C ₃ 460 C ₄ 775 D ₁ 548 D ₂ 238 E ₁ 780	Assessed by U.N.D.P.		24.00 9.10 14.80 19.84 13.76 22.08 37.20 34.25 14.87 38.60	Limestone (Bilara block) Sandstone Alluvium Sandstone & Alluvium Shergarh and Balesar blocks Sandstone Osain area Bhopalgarh area

TABLE I (Contd.)

1	2	3	4	5	6	7	8	9
16.	Jhalawar	6049	2945	2945	4.00	4.00	471.20	Sedimentaries
17.	Jhunjhunu	5648	4509	A 4008 B 501	0.50 3.00	10.00 1.5	200.40 22.54	Alluvium Metamorphics
18.	Jalor	10428	4732	A 2600 B 1000 C 1132	Assessed by U.N.D.P. 1.8 2.00	10.00 1.50	247.00 180.00 33.96	(Jawai basin only) Alluvium Granites
19.	Kota	12218	5818	5818	2.50	4.00	581.80	Sedimentaries
20.	Nagaur	17292	7020	A 69010 B 827 C 5403	2.3 0.55 0.50	4.00 4.00 10.00	63.38 20.39 270.15	Limestone (Cavernous) Sandstone Alluvium and Tertiary sandstone
21.	Pali	11808	3157	A 2482 B 540 C 135	2.5 1.7 1.3	3.5 10.00 7.00	186.16 91.80 12.28	Granites (weathered) Alluvium Limestone Cavernous
22.	Sawai-Madhapur	10432	4948	A 2900 B 2048	1.00 3.5	10.00 4.00	290.00 286.72	Alluvium Sedimentaries
23.	Sikar	7658	5454	A 4650 B 804	0.55 2.50	10.00 1.50	255.75 30.15	Alluvium Metamorphics
24.	Sirohi	5009	1473	A 250 B 1223	0.98 4.00	15.00 3.00	36.75 146.76	Alluvium Crystallines & metamorphics
25.	Tonk	7215	4505	A 400 B 4105	0.90 2.5	15.00 1.5	54.00 153.93	Alluvium Crystallines
26.	Udaipur	17153	3322	A 622 B 2700	3.00 5.00	15.00 2.00	279.90 270.00	Alluvium Metamorphics

¹ Total estimated potential is 314.00 mcm out of this only 10% is proposed to be developed annually.

² Annual groundwater recharge is 537 mcm but 175 mcm can be developed annually by way of tubewells as the thickness of fresh water saturated zone is adequate only in limited area of the district.

³ Total suitable fresh water is 22,912 mcm but 58 mcm is proposed for exploitation annually as recommended by the UNDP.

⁴ Total estimated potential is 852 mcm but of this only 10% is proposed to be developed annually.

TABLE II

Estimation of pumpage of ground Water in Rajasthan

S. No.	District	Total number of wells	Total No. of dug wells in use	Total No. of wells with pump sets	Total No. of tubewells in operation	Total pumpage (mcm)	Area irrigated by wells (sq. km)	Pumpage for irrigation (mcm)	Pumpage for drinking & Live-stock and others	Remarks
1.	Ajmer	59039	48238	1333	17	256.21	524.52	219.71	36.50	
2.	Alwar	97548	71078	3060	18	364.15	820.00	327.75	36.40	
3.	Banswara	6430	5149	227	Nil	36.56	69.97	27.98	8.58	
4.	Barnar	14070	8442	400	42	12.88	58.97	2.35	10.53	
										(for Siwana block only)
5.	Bharatpur	68434	46758	1420	30	237.43	660.07	210.11	27.32	
6.	Bhilwara	87943	70855	1273	Nil	270.35	882.15	260.81	10.14	
7.	Bikaner	*5000	2500	50	90	06	2.48	1.24	7.82	
8.	Bundi	22706	17900	380	7	128.28	220.46	113.07	15.21	
9.	Chittorgarh	64718	48500	1989	Nil	329.33	768.35	305.38	23.95	
10.	Churu	*6000	3485	230	15	26.07	2.52	1.20	24.87	
11.	Dungarpur	10252	7992	138	Nil	30.43	92.47	26.71	3.72	
12.	Ganganagar	*2000	485	885	5	23.50	6.39	2.53	20.97	
13.	Jaipur	208772	156998	10986	134	681.27	2031.94	626.17	55.10	
14.	*Jaisalmer	N.A.	N.A.	—	55	5.50	2.64	2.36	3.24	
										(For Lathi & Kishangarh, Tanot Border area only)
15.	Jodhpur	25967	5910	13603	90	130.26	236.32	94.52	35.74	
16.	Jhalawar	27643	20769	1346	—	170.38	308.24	154.55	15.83	
17.	Jhunjhunu	20537	12087	2249	30	93.11	159.14	67.28	25.83	
18.	Jalore	59458	4500	100	25	292.88	592.46	266.23	26.65	
19.	Kota	24488	20000	1060	Nil	166.98	260.72	130.36	36.62	
20.	Nagaur	19836	12638	1197	50	129.01	200.00	90.00	39.01	
21.	Pali	90602	60000	1360	15	212.36	611.10	188.36	24.00	
22.	Sawai-Madhopur	60849	47650	1016	20	342.92	598.08	308.95	33.97	
23.	Sikar	46865	30806	2014	10	193.12	428.01	163.26	29.86	
24.	Sirohi	33446	25758	241	Nil	96.49	273.20	74.87	21.62	
25.	Tonk	38387	29911	779	20	163.31	400.21	141.91	21.40	
26.	Udaipur	85347	68278	1394	Nil	344.46	624.11	301.50	42.96	
TOTAL		1186337	826687	48730	673	4746.30	10824.52	4108.46	637.84	

N.A.—Not available

*Figure Tentative

For Lathi series and Kishangarh Tanot Border area only.

(Data of wells and area irrigated are based on the statistics of Agriculture Department)

TABLE III

Surplus exploitable groundwater potential of Rajasthan

S. District No.	Existing annual pumpage	Estimated annual re-charge/annual economically mining yield	Surplus exploitable potentials	Remarks
1. Ajmer	256·21	377·10	120·89	
2. Alwar	364·15	410·80	46·65	
3. Banswara	36·56	80·40	43·84	
4. Barmer	12·88	87·78	74·90	(for Siwana block only)
5. Bharatpur	237·43	495·00	257·57	
6. Bhilwara	270·35	360·48	90·13	
7. Bikaner	9·06	31·40	22·34	
8. Bundi	128·28	269·89	141·61	
9. Chittorgarh	329·33	376·89	47·56	
10. Churu	26·07	80·00	53·93	
11. Dungarpur	30·43	58·05	27·62	
12. Sriganganagar	23·50	179·50	152·00	
13. Jaipur	681·27	749·63	68·36	
14. Jaisalmer	5·50	143·20	137·70	For Lathi series & Kishangarh Tanot region
15. Jalore	292·88	460·96	168·08	
16. Jhalawar	170·38	471·20	300·82	
17. Jhunjhunu	93·11	222·94	129·83	
18. Jodhpur	130·26	228·50	98·24	
19. Kota	166·98	581·80	414·82	
20. Nagaur	129·01	353·92	224·91	
21. Pali	212·36	290·23	77·87	
22. Sawaimadhopur	342·92	576·72	233·80	
23. Sikar	193·12	285·90	92·78	
24. Sirōhi	96·49	183·51	87·02	
25. Tonk	163·31	207·93	44·62	
26. Udaipur	344·46	549·90	205·44	
Total	4746·30	8109·63	3363·33	

TABLE IV
Area Irrigated by Different Sources in Rajasthan

(in Hectares)

S. No.	District	Canals	Tanks	Wells	Other sources	Total area irrigated
1.	Ajmer	—	20623	52452	235	73310
2.	Alwar	10081	—	82000	—	92081
3.	Banswara	—	4807	6997	1244	13048
4.	Barmer	—	—	5807	—	5807
5.	Bharatpur	34624	34337	66007	9917	144885
6.	Bhilwara	—	31170	87215	129	118514
7.	Bikaner	—	—	248	—	248
8.	Bundi	60957	9169	22046	913	93085
9.	Chittorgarh	—	12003	76835	1030	89868
10.	Churu	—	—	252	—	252
11.	Dungarpur	—	2183	9247	487	11917
12.	Sriganganagar	534994	—	639	2352	537985
13.	Jaipur	—	9470	203194	271	212935
14.	Jaisalmer	—	—	264	—	264
15.	Jalore	—	—	59246	365	59611
16.	Jhalawar	238	701	30824	114	31877
17.	Jhunjhunu	—	335	15914	—	16249
18.	Jodhpur	—	150	23632	—	23782
19.	Kota	92203	2714	26072	1896	122885
20.	Nagaur	—	617	20000	—	20617
21.	Pali	—	583	61110	—	61694
22.	Sawaimadhopur	29936	11006	59808	248	100998
23.	Sikar	28	—	42801	—	42829
24.	Sirohi	—	852	27320	383	28555
25.	Tonk	—	27780	40021	170	67971
26.	Udaipur	—	16430	62411	597	79438
Total		763061	184930	1082452	20352	2050795

(Data of irrigated area based on the statistics of Agriculture Department)

TABLE V
Human and Cattle Population of Rajasthan

Human population (in lakhs)
 Density per sq. km

S. No.	District	Human Population	Density of population	Live stock					Total
				Cows	Buffal- low	Sheep	Goat	Others	
1.	Ajmer	11.45	135	438	157	487	381	14	1477
2.	Alwar	13.82	165	438	287	119	470	42	1347
3.	Barmer	7.76	28	457	121	26	281	16	901
4.	Banswara	6.54	128	637	28	792	1047	117	2621
5.	Bharatpur	14.89	184	472	382	79	231	37	1201
6.	Bhilwara	10.54	100	775	237	736	579	28	2355
7.	Bikaner	5.72	21	356	45	533	133	52	1119
8.	Bundi	4.48	80	315	74	86	281	8	764
9.	Chottorgarh	9.44	87	764	203	215	467	23	1672
10.	Churu	8.72	52	288	131	362	271	90	1142
11.	Dungarpur	5.29	139	351	122	90	247	8	818
12.	Sriganganagar	13.93	68	373	200	334	249	209	1265
13.	Jaipur	24.77	177	862	391	283	668	41	2345
14.	Jaisalmer	1.66	4	344	1	591	204	59	1199
15.	Jalore	6.67	62	404	93	516	356	28	1397
16.	Jhalawar	6.21	100	458	140	29	249	12	888
17.	Jodhpur	11.48	50	177	99	176	387	47	786
18.	Jhunjhunu	9.21	154	607	57	663	375	53	1755
19.	Kota	11.43	91	693	160	62	310	21	1246
20.	Nagaur	12.59	71	610	126	590	445	42	1813
21.	Pali	9.64	78	585	141	660	479	28	1893
22.	Sawaimadhopur	11.92	113	540	272	110	399	30	1342
23.	Sikar	10.39	133	390	133	324	410	44	1220
24.	Sirohi	4.23	81	255	65	164	259	9	744
25.	Tonk	6.25	87	411	156	276	280	8	1121
26.	Udaipur	18.08	105	1204	410	412	983	35	3044

(Data of Human and Cattle population based on the statistics of Agriculture Department.)

TABLE VI

Ground Water Development Programme Proposed for Rajasthan during the Fifth Five Year Plan

S. No.	District	No. of Medium duty T/W	No. of Low duty T/W	Deepening of existing wells by boring	Revitalisation dug wells by blasting & lateral drilling	Installation of pumping sets
1.	Ajmer	—	1000	250	4500	7800
2.	Alwar	50	500	500	1000	3500
3.	Banswara	—	500	—	500	3200
4.	Barmer	25	—	100	—	600
5.	Bharatpur	125	500	750	250	5225
6.	Bhilwara	25	500	100	5000	5800
7.	Bikaner	50	—	100	—	700
8.	Bundi	25	1000	1000	500	5500
9.	Chittorgarh	50	500	250	500	3000
10.	Churu	25	—	50	—	200
11.	Dungarpur	—	500	—	1000	2000
12.	Sriganganagar	400	—	500	—	5000
13.	Jaipur	50	500	500	500	4900
14.	Jaisalmer	125	—	—	—	250
15.	Jodhpur	300	—	600	—	4200
16.	Jhalawar	100	500	500	300	6300
17.	Jhujhunu	50	300	300	300	4000
18.	Jalore	25	150	250	250	3000
19.	Kota	75	500	350	400	2575
20.	Nagaur	150	—	400	100	4500
21.	Pali	50	100	200	500	2000
		(Jaitaran and Sojat blocks)				
22.	Sawaimadhopur	50	1000	200	500	7000
23.	Sikar	100	200	250	200	4200
24.	Sirohi	—	500	250	500	3950
25.	Tonk	—	500	200	500	2200
26.	Udaipur	—	2500	—	5000	7500
Total		1850	11750	7600	22300	105100