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CONJUNCTIVE WATER USE STUDIES IN SAI GOMATI INTERFLUVE A PART OF THE SARDA SAHAYAK CANAL COMMAND, U.P.

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ABSTRACT

The problems of water logging & Usar spread, periodic shrinkage of arable land, ground water contamination and ecological changes taken place over the years in the Sarda Sahayak Canal Command Area (SSCCA) is a matter of serious concern. The study area of Sai-Gomti doab of the SSCCA has been carefully chosen so that the methodology adopted in devising the conjunctive water use strategy could find its applicability not only in the command but else whereas well. Firstly the water resource potential, water demand and water use pattern (ground water & surface water components) was deciphered; secondly a ground water model simulating flow, recharge, canal bed seepage, ground water draft was devised to test the efficacy of various planning options. Based on the simulation studies it is expected that improved performance and the most desirable changes in the area could only be brought about by resorting to regulated ground water draft and restoring of canals in different crop seasons. Another significant finding of the simulation studies is that lining of entire canal network does not improve the performance significantly rather the cropping pattern and the water use pattern holds the key in the command. In order to make the irrigation system efficient and responsive to the crop calender, it is recommended that the Government Managed Irrigation System (GMIS) be transferred to Farmer Managed Irrigation System (FMIS).

BACKGROUND

With the commissioning of Sarda Sahayak Irrigation System (1978), general rise of ground water levels has been observed within two years (Singh et.al., 1984). Over the years the rising ground water trends has resulted in the spread of salt infested land (Usar) owing to capillary rise.

Keeping in view the hazards posed by this rising trend, the Government of India constituted a task force (Dec. 1983) to identify critically water logged/areas prone to water logging and suggest remedial measures. It has been observed that excessive availability/use of surface water in upper and middle reaches of the canal command has given rise to significant seepage resulting in general rise of ground water levels, thus, the agriculture productivity is affected almost in whole of the canal command area for want of well defined strategy for optimal utilisation of water resources.

The Government of India (March, 1990) asked the Central Ground Water Board to take up studies in Sharda Sahayak Canal Command Area (Sai-Gomti Doab; 8270 sq.km) for devising conjunctive water use strategy for optimal use of complementary aspect of the two resources of water. The area has been selected in such a way so as to be representative for the command and the methodology adopted for achieving the objective would find applicability elsewhere in the command area.

SAI-GOMTI DOAB, THE STUDY AREA

The area has well defined physical features, intense network of canals (branches, distributaries, minors) and vast tracts of water logged and salt infested areas (Fig.1). The

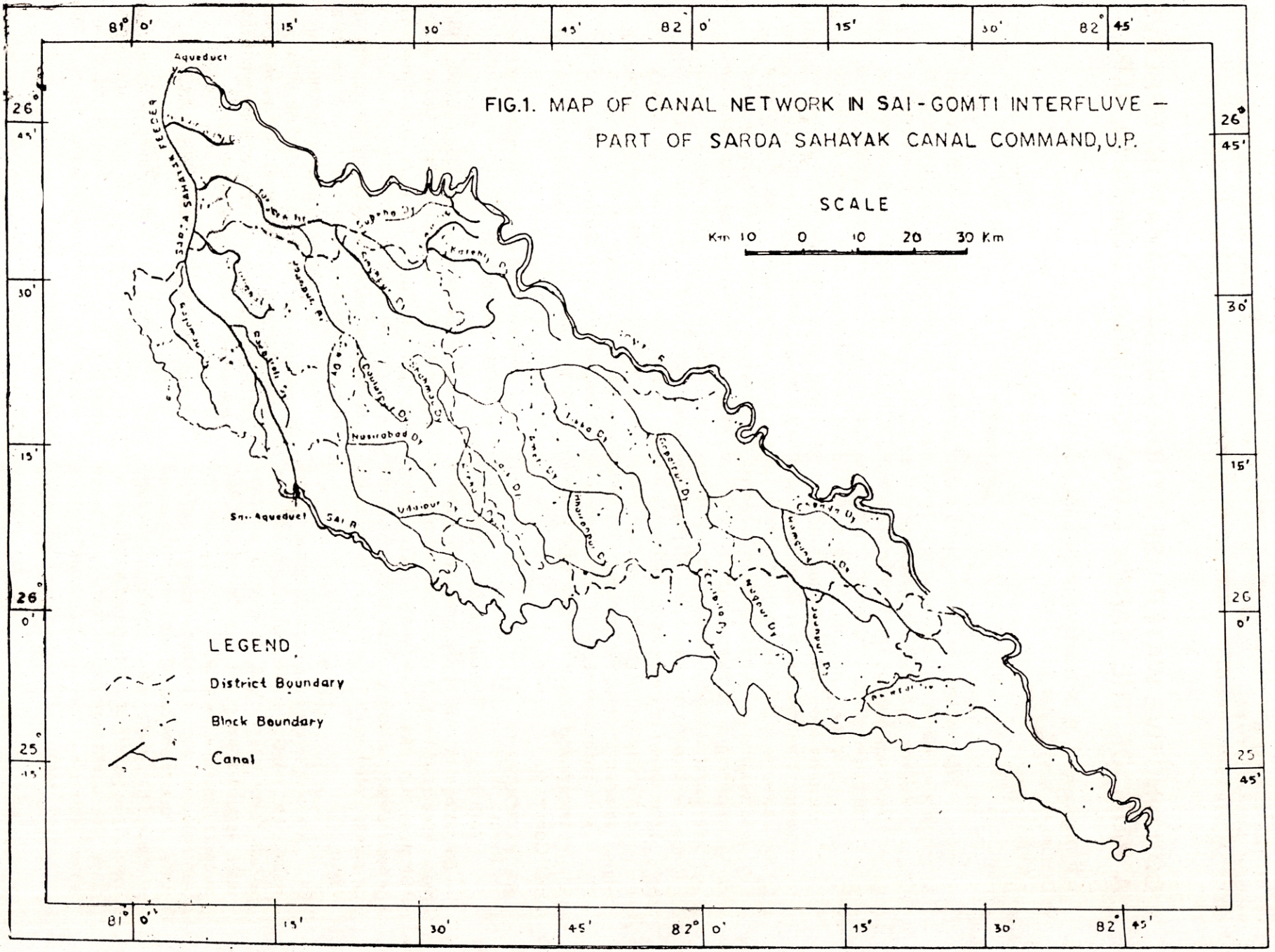
FIG.1. MAP OF CANAL NETWORK IN SAI-GOMTI INTERFLUVE — PART OF SARDA SAHAYAK CANAL COMMAND, U.P.
SCALE
Km 10 0 10 20 30 Km
LEGEND
District Boundary
Block Boundary
Canal
Aqueduct
Sai R.
81° 0' 15' 30' 45' 82° 0' 15' 30' 45'
26° 45' 30' 15' 0' 25° 45'

study area is bounded in the north by river Gomti and by river Sai in the south, the confluence of the two rivers near Jalalpur in Jaunpur district forms the eastern extremity of the area. The feeder channel section between Gomti - Sai aqueducts lying between 153.4 - 184.16 Km. forms the western boundary of the area.

HYDROGEOLOGY

The area forms a part of the central Ganga plain ; is underlain by alluvium of Quaternary era comprising alternations of sand, silt and clay with occasional Kankar/kankar pan. The sediments rest over Bundelkhand Granite/ Vindhyan Sandstone & Shales and the thickness of the soft sediments is quite variable (i.e. 399 - 745 m.bgl.).

Ground water occurs under unconfined, semiconfined/confined conditions in the multiaquifer system. The phreatic aquifer ranges between 0-35 m.bg.l followed by first semiconfined/confined aquifer down to a maximum depth of 160 m.bgl.. Occurrence of brackish/saline aquifer below the first confined aquifer is well established; which may occur between 50-280 m.bgl.. Below this, occur the fresh water in the semiconfined/ confined aquifers.

Problems Associated with Sarda - Sahayak Canal Command Area:

i. Rising Water Level Trend

Monitoring of water levels over 290 observation network stations have precisely demarcated the waterlogged (0-2 m.bgl.) area post monsoon (Fig.2), which is 26 percent of the entire area under study.

The long term ground water level trends (1973-1993) of national hydrograph stations (NHS) present in the area show by and large rising trend (Table I).

ii. Increase of Salt Infested Areas

Salt infested areas, picked up on the Satellite imagery, when superposed on the depth to water table map clearly indicate that spread of Usar is restricted to shallow water level areas where water levels rest between 0 -5 m.bgl. (Fig.3).

TABLE I : Ranges of Water Level Rising Trend (m) (1973-1993)

District	Min	Max
Barabanki	0.73	3.03
Jaunpur	0.26	2.29
Lucknow	0.23	2.88
Pratapgarh	0.08	7.79
Rae Bareli	0.22	4.48
Sultanpur	0.19	3.68

iii. Shrinkage of Arable Land

The periodic shrinkage of arable land is evident from the progressive increase of water logged area during post monsoon period from 1975-1992;

a. water logged area Nov.'1979 — 100 sq.km. (1.2%)

b. water logged area Nov.'1992 — 2206 sq.km. (26.7%)

iv. Ground Water Contamination and Ecological Changes

Comparative study of ground water quality data from 1979 to 1992 (Table II) clearly indicates the level of ground water contamination and ecological changes that have taken place in the area is a matter of serious concern.

METHODOLOGY ADOPTED

The methodology accepted for tackling the problems associated with the canal command area and devising a suitable-conjunctive water use strategy comprises two steps;

Step I

Detail evaluation of water resource potential and water demand has been carried out and the present water utilisation pattern has been established (Table III).

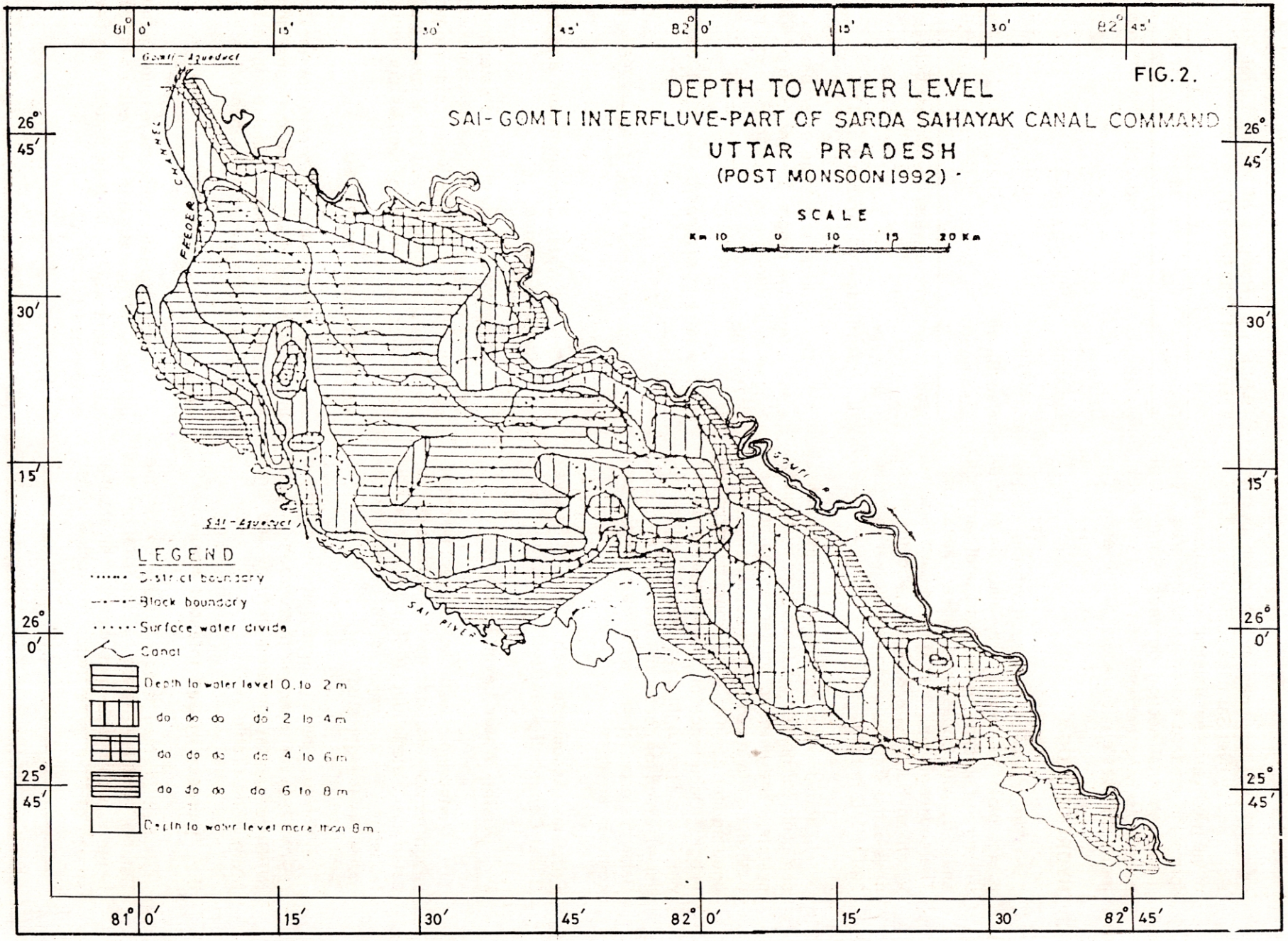
FIG. 2.
DEPTH TO WATER LEVEL
SAI-GOMTI INTERFLUVE-PART OF SARDA SAHAYAK CANAL COMMAND
UTTAR PRADESH
(POST MONSOON 1992)
SCALE
Km 10 0 10 15 20 Km
Gomti-Aqueduct
FEEDER CHANNEL
Sai-Aqueduct
SAI RIVER
SOUTH
LEGEND
District boundary
Block boundary
Surface water divide
Canal
Depth to water level 0 to 2 m
do do do do 2 to 4 m
do do do do 4 to 6 m
do do do do 6 to 8 m
Depth to water level more than 8 m
81° 0′ 15′ 30′ 45′ 82° 0′ 15′ 30′ 82° 45′
26° 45′ 30′ 15′ 26° 0′ 25° 45′

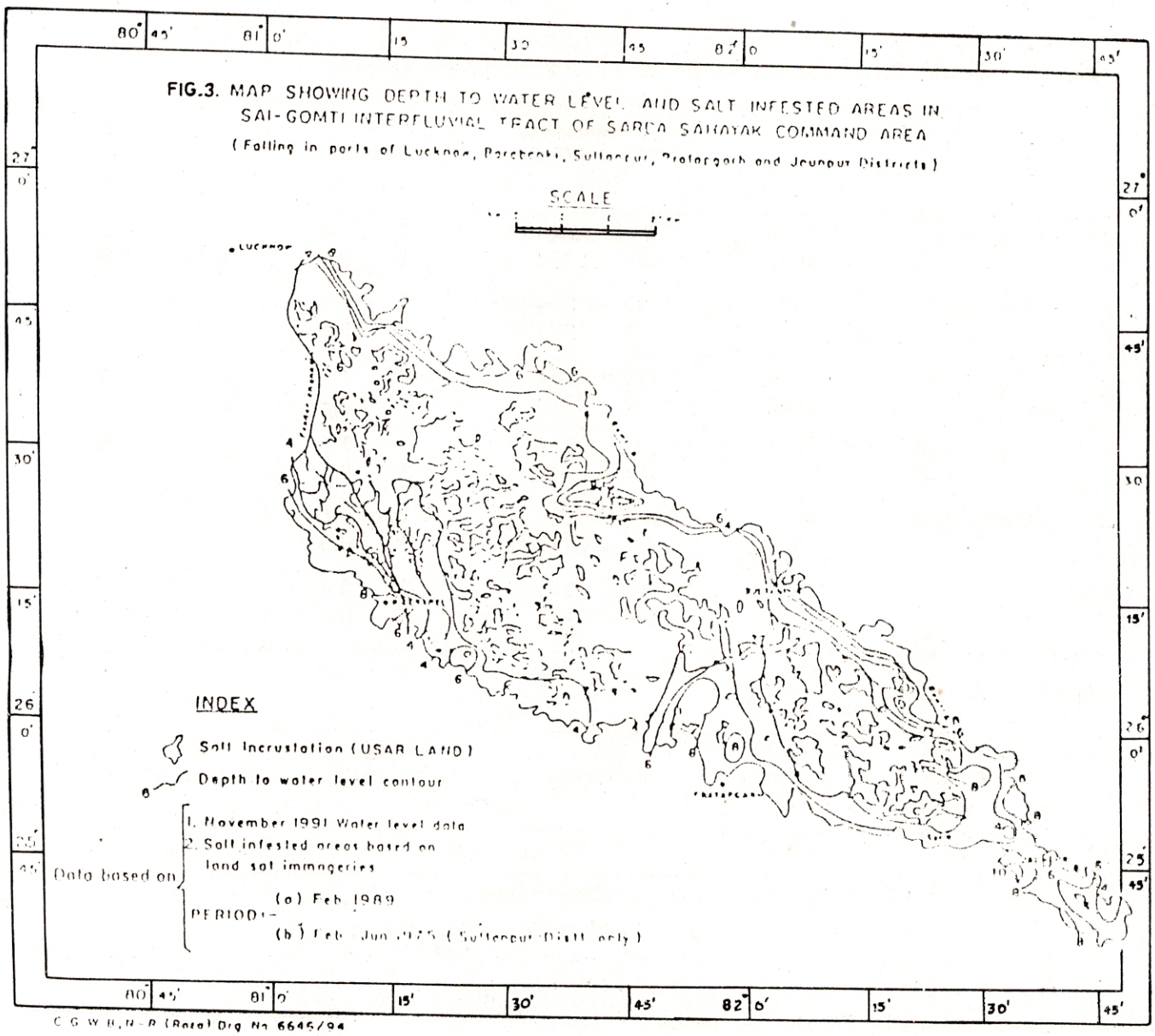

FIG.3. MAP SHOWING DEPTH TO WATER LEVEL AND SALT INFESTED AREAS IN SAI-GOMTI INTERFLUVIAL TRACT OF SARDA SAHAYAK COMMAND AREA

(Falling in parts of Lucknow, Barabanki, Sultanpur, Pratapgarh and Jaunpur Districts)

C.G.W.B./N.R. (Base) Drg. No. 6645/94

Step II

Based on the information available of aquifer characteristics, rainfall, evapotranspiration, canal & river discharge data, a ground water flow model has been devised for simulation studies to test the planning options. The model has been calibrated for the period Jun'91-Nov.'92 and a satisfactory history match has been obtained. The model simulates the ground water flow, transient seepage from the canal bed, total recharge to the aquifer system (i.e. rainfall, return seepage from irrigation etc.) and ground water draft.

Various predictive scenarios depending upon the planning options have been created by the model to analyse the interaction of surface and ground water systems to evolve suitable conjunctive development and management strategy.

SCENE I

When the present water use pattern remains unchanged under the current cropping intensity progressive expansion of water logged area is expected. Table IV is self explanatory.

SCENE II

When the present canal network is fully lined i.e. no seepage from canal bed is simulated, and other conditions remain as in scene I. (Table V) It is seen that the pace of spread of water logging has marginally reduced yet it shows progressive spread over the years.

Table II: Select Chemical Constituents of Ground Water Quality

S.No.	District	Year	EC (micro S/cm at) 25°C	Cl (epm)	Na (epm)
1.	Lucknow	1979	349 - 576	.20 - 5.0	1.1 - 6.3
		1992	441 - 1325	.31 - 7.3	0.5 - 5.9
2.	Barabanki	1979	402 - 1004	.20 - 6.1	1.1 - 6.1
		1992	328 - 1278	.25 - 3.7	0.6 - 15.2
3.	Sultanpur	1979	720 - 2583	.40 - 8.2	1.6 - 7.5
		1992	337 - 3372	.31 - 20.4	0.8 - 65.2
4.	Rae Bareli	1979	480 - 2226	.20 - 7.5	1.1 - 5.8
		1992	454 - 3472	.31 - 8.3	0.8 - 29.1
5.	Pratapgarh	1979	643 - 1587	.20 - 7.8	1.7 - 3.1
		1992	366 - 2141	.19 - 6.3	1.5 - 8.3
6.	Jaunpur	1979	608 - 1859	.20 - 5.6	0.8 - 9.4
		1992	424 - 3478	.39 - 13.7	1.2 - 44.4

Table III : Unit mcm

Year	Water* Demand	GW2# Availability	SW$ Availability	GW@ Component	SW** Component
				Water use for Irrigation	
91-92	2372	2603	2178	906	1466

@ Based on U.P State minor irrigation Department

** Based on water demand minus ground water component

* Based on the findings of the U.G. Irrig. Modernisation Project & Norms of the Agri. Dept. (U.P.)

Based on the G FC norms (1983)

$ Based on the U.P. State Irrigation Department

SCENE III

Regulated pumping and restoring of canal at block level as simulated in conjunction is suggestive of progressive decrease in water logged area as under: (Table VI)

Kharif season	Rabi season
1248.8 mcm from ground water	226.7 mcm from GW
1205.6 mcm from canals/SW	691.0 mcm from canals

CONCLUSIONS

I) There is a progressive increase of water logged area should the present water use is allowed to continue.

II) Lining of canals is not radically changing the water logging situation in the coming years as is evident from the simulation studies.

III) Regulated pumping and rostering of canals i.e. ground water irrigation to the tune of 1248.8 mcm with simultaneous reduction of canal irrigation limited to 205.6 mcm. during kharif and ground water irri

TABLE IV : UNDER NORMAL STRESS CONDITIONS (DEPTH TO WATER LEVELS ZONES IN SQ.KM.)

YEAR	0-2m.	2-5m.	5-10 m.	10-15 m.	(Percent AREA) 0-2m.	0-4.	2-5m.
1993	2750.00	3156.25	1281.25	787.50	33.18%	61.99%	38.08%
94	3087.50	2831.25	1256.25	800.00	37.25%	63.50%	34.16%
95	3337.50	2587.50	1243.75	806.25	40.27%	63.73%	31.22%
96	3531.25	2418.75	1212.50	812.50	42.61%	64.18%	29.19%
97	3625.00	2356.25	1181.25	812.50	43.74%	64.86%	28.43%
98	3737.50	2262.50	1156.25	818.75	45.10%	65.31%	27.30%
99	3850.00	2150.00	1162.50	812.50	46.46%	65.76%	25.94%
2000	3975.00	2043.75	1156.25	800.00	47 96%	66.21%	24.66%
01	4031.25	2012.50	1137.50	793.75	48.64%	66.67%	24.28%
02	4125.00	1931.25	1137.50	781.25	49.77%	66.97%	23.30%
03	4175.00	1900.00	1118.75	781.25	50.38%	67.35%	22.93%
04	4225.00	1862.50	1112.50	775.00	50.98%	67.65%	22.47%
05	4256.25	1862.50	1081.25	775.00	51.36%	68.02%	22.47%
06	4293.75	1837.50	1068.75	775.00	51.81%	68.33%	22.17%
07	4325.00	1818.75	1056.25	775.00	52.19%	68.40%	21.95%
08	4368.75	1787.50	1043.75	775.00	52.71%	68.55%	21.57%
09	4437.50	1731.25	1031.25	775.00	53.54%	68.70%	20.89%
10	4462.50	1712.50	1025.00	775.00	53.85%	68.85%	20.66%
11	4512.50	1668.75	1018.75	775.00	54.45%	69.00%	20.14%
2012	4556.25	1631.25	1018.75	768.75	54.98%	69.16%	19.68%

gation to the tune of 226.7 mcm with simultaneous canal irrigation to the tune of 691.0 mcm during rabi brings about the desirable changes in the area.

IV) There is an imperative need for enhancing the cropping intensity to 200 percent so as to fully utilise the water resources potential of the area.

RECOMMENDATIONS

I) Piezometric network should be installed in the underlying brackish/saline aquifer to monitor the interaction of everlying fresh water aquifer.

II) Additional hydrological tests in the phreatic aquifer should be conducted for updating the model.

III) Additional pumpage as recommended under scene III, the concern state government agencies have to ensure the limits of quantum of pumping recommended during each crop season to avoid any deleterious effect on the ground water regime.

IV) In order to make the irrigation system efficient and responsive to the crop calender, it is recommended that the Government Managed Irrigation System (GMIS) be transferred to Farmer Managed Irrigation System (FMIS). Under this turn over system, the farmers themselves would ensure the finer aspects of 'Crop- Field' care like timeliness and duration of each watering. This will go a long way in boosting the agriculture production and also effective management of water levels within safe zone.

It is expected, once the scheme is followed in its strict term of reference, the results as expected would follow viz. elimination of adverse effects like water logging. and soil salinity/alkalinity and better management of water resources. In the area (<10%) where it is not possible to overcome water logging by conjunc

TABLE V: UNDER NORMAL STRESS WITH LINED CANAL DEPTH TO WATER LEVELS ZONES IN SQ.KM

YEAR	0-2m.	2-5m.	5-10 m.	10-15 m.	(Percent AREA) 0-2m.	0-4.	2-5m.
1993	2587.50	3268.75	1331.25	787.50	31.22%	61.54%	39.44%
94	2806.25	3062.50	1306.25	800.00	33.86%	61.84%	36.95%
95	2931.25	2887.50	1350.00	806.25	35.37%	62.07%	34.84%
96	3018.75	2781.25	1350.00	825.00	36.43%	61.92%	33.56%
97	3187.50	2587.50	1381.25	818.75	38.46%	62.14%	31.22%
98	3300.00	2468.75	1381.25	825.00	39.82%	61.92%	29.79%
99	3381.25	2368.75	1393.75	831.25	40.80%	61.92%	28.58%
2000	3468.75	2300.00	1375.00	831.25	41.86%	62.67%	27.75%
01	3531.25	2262.50	1362.50	818.75	42.61%	62.52%	27.30%
02	3575.00	2231.25	1350.00	818.75	43.14%	62.82%	26.92%
03	3625.00	2187.50	1356.25	806.25	43.74%	62.75%	26.40%
04	3668.75	2143.75	1356.25	806.25	44.27%	63.05%	25.87%
05	3706.25	2131.25	1337.50	800.00	44 72%	63.42%	25.72%
06	3756.25	2081.25	1337.50	800.00	45.32%	63.80%	25.11%
07	3793.75	2056.25	1325.00	800.00	45.78%	64.03%	24.81%
08	3856.25	1993.75	1325.00	800.00	46.53%	64.03%	24.06%
09	3875.00	1981.25	1318.75	800.00	46.76%	64.18%	23.91%
10	3906.25	1950.00	1318.75	800.00	47.13%	64.48%	23.53%
11	3937.50	1918.75	1318.75	800.00	47.51%	64.63%	23.15%
2012	3987.50	1875.00	1312.50	800.00	48.11%	64.78%	22.62%

TABLE VI: REGULATED PUMPING & RESTORING OF CANALS DEPTH TO WATER LEVELS ZONES IN SQ.KM.

YEAR	0-2m.	2-5m.	5-10 m.	10-15 m.	>15m	(Percent AREA) 0-2m	2-5m.
1993	793.75	3525.00	2568.75	1037.50	362.50	9.58%	42.53%
94	918.75	3118.75	2762.50	1087.50	400.00	11.09%	37.63%
95	937.50	2750.00	2993.75	1193.75	412.50	11.31%	33.18%
96	925.00	2518.75	3150.00	1231.25	462.50	11.16%	30.39%
97	881.25	2368.75	3256.25	1306.25	475.00	10.63%	28.58%
98	868.75	2150.00	3381.25	1387.50	500.00	10.48%	25.94%
99	831.25	1987.50	3512.50	1443.75	512.50	10.03%	23.98%
2000	800.00	1862.50	3612.50	1493.75	518.75	9.65%	22.47%
01	781.25	1768.75	3643.75	1550.00	543.75	9.43%	21.34%
02	725.00	1706.25	3668.75	1606.25	581.25	8.75%	20.59%
03	712.50	1625.00	3675.00	1668.75	606.25	8.60%	19.61%
04	681.25	1556.25	3662.50	1756.25	631.25	8.22%	18.78%
05	631.25	1493.75	3675.00	1843.75	643.75	7.62%	18.02%
06	625.00	1443.75	3631.25	1931.25	656.25	7.54%	17.42%
07	631.25	1331.25	3643.75	2000.00	681.25	7.62%	16.06%
08	612.50	1231.25	3675.00	2050.00	718.75	7.39%	14.86%
09	593.75	1175.00	3650.00	2112.50	756.25	7.16%	14.18%
10	587.50	1137.50	3556.25	2225.00	781.25	7.09%	13.73%
11	575.00	1087.50	3487.50	2300.00	837.50	6.94%	13.12%
2012	556.25	1050.00	3458.75	2356.25	856.25	6.71%	12.57%

tive water use strategy, horizontal pipe drainage programme or even inter aquifer transfer of water using connector wells/siphon may be attempted.

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