

IWMI-TATA WATER POLICY RESEARCH PROGRAM

ANNUAL PARTNERS' MEET 2002

Groundwater Issues in Eastern and
Western Alluvium of Ganga Basin



Niranjan Pant

**International Water
Management Institute**

This is a pre-publication discussion paper prepared for the IWMI-Tata Program Annual Partners' Meet 2002. Most papers included represent work carried out under or supported by the IWMI-Tata Water Policy Research Program funded by Sir Ratan Tata Trust, Mumbai and the International Water Management Institute, Colombo. This is not a peer-reviewed paper; views contained in it are those of the author(s) and not of the International Water Management Institute or Sir Ratan Tata Trust.

**GROUNDWATER ISSUES IN EASTERN AND WESTERN
ALLUVIUM OF GANGA BASIN**

NIRANJAN PANT



**IWMI-TATA WATER POLICY RESEARCH PROGRAM
ANNUAL PARTNERS' MEET 2002**

Contents

<i>Abstract</i>	1
<i>Introduction</i>	1
<i>Ground Water Resources of U.P</i>	3
<i>Regional disparity</i>	3
<i>Ground water development</i>	6
<i>Agricultural productivity</i>	7
<i>Flooding and Water logging</i>	9
<i>Evolution of public policy</i>	11
<i>Main Features of Shallow Tube-wells</i>	13
<i>Power Scenario in U.P</i>	16
<i>Access of Ground Water to the Poor</i>	17
<i>Community/ Group-Tube-wells.</i>	19
Transfer of Management of Public Tube-wells to Co-operatives and Panchayats	20
<i>Ground Water markets</i>	21
<i>Treadle Pumps</i>	23
<i>Conclusions</i>	24
<i>References</i>	25

Ground Water Issues in Eastern and Western Alluvium of Ganga Basin

Niranjan Pant

Abstract

The eastern and western regions Uttar Pradesh are marked by two contrasting features. In terms of ground water resources, the eastern region is richer than the western region. While ground water development diminishes as we move from west to east. The agricultural backwardness of the eastern region arises on account of a variety of factors covered in the paper. While it is desirable that the eastern region emulates its western counterpart in all positive agricultural practices, care needs to be taken to avoid unplanned over exploitation of ground water, which has become a menace in several areas of the western region of Uttar Pradesh.

Introduction

The Ganga basin forms the major portion of the north Indian plains and occupies an area of over 0.557 million square km. It has flat surface, fertile alluvial soil and favourable climate. Apart from millions of ground water extraction works, there is an extensive system of irrigation canals fed by perennial rivers in the basin. The lower portion of the basin in particular, receives sufficient rainfall for wet crops. The plain forming part of the basin supports one of the most dense population in the world. The total population of just three states of U.P, Bihar and West Bengal which lie in the basin, stood over 293 million in 1991. The basin contains one of the best reservoirs of ground water in the world. The area has been formed out of thick alluvial deposits, which at places extend up to a depth of 3000 meters below the ground level. A considerable portion of this alluvial thickness consists of porous and granular materials, such as sand, gravel and boulders, which are good water suppliers. The enormity of ground water availability from the Ganga Basin and its utilizations can be fully appreciated by an examination of Table 1. However, before it is done, it should be understood that while the title of the paper refers to the eastern and western alluvium of Ganga Basin, the examination is confined to the eastern and western plains of Uttar Pradesh. While the basin deals with hydraulic boundaries, the regions like eastern and western parts of U.P subsume districts, which have administrative boundaries. Keeping this in mind table 1 consists of two parts. The first part of the table provides basin wise data, while the second part provides Uttar Pradesh data, including that of the two regions of the state. The data in the table clearly shows that the Ganga basin is the largest basin in India. It contains 17.17mhm/yr replenishable ground water resource, which is about 38% of such resource in India. The rest of the 17 other basins together contain 62% of replenishable ground water resource. The other important point, which emerges from table is that only about 31% of ground water resources in the Ganga basin have been developed. This gives an idea of the enormity of the ground water resources and the vast potential available for its development in the basin.

However, what is important from the point of view of this paper is that whole of Uttar Pradesh constitutes a part of Ganga basin and the state contains about 47% of the basin's replenishable ground water resources. Further, the Eastern and Western regions of U.P, which are intended to be examined in this paper, contain about 72% of

TABLE 1: Ground Water Potential, Basin wise and Regionwise (UP)							
Sl.	Basin	Total replenishable G.W resource (m.h.m/yr)	Provision for drinking industrial & other uses (mhm/yr)	Utilisable G.W Resources for irrigation (mhm/yr)	Net Draft (mhm/yr)	Balance G.W. Potential available for exploitation (mhm/yr)	Level of GW Dev. (%)
1	2	3	4	5	6	7	8
1	Indus	2.5543	0.3870	2.1673	1.7186	0.4487	79.2968
2	Ganga	17.1725	2.5824	14.59	4.4931	10.097	30.7955
3	Kutch Composite & Saurashtra composite	1.3948	0.2514	1.1434	0.4545	0.6889	39.7499
4	Cambai Composite	0.7908	0.1201	0.6707	0.2026	0.4681	30.2072
5	Narmada	1.189	0.1793	1.0097	0.1552	0.0545	15.3709
6	Tapi	0.8173	0.1439	0.6734	0.1764	0.4970	26.1954
7	Subarnrekha	0.2185	0.0328	0.1857	0.0165	0.1692	8.8853
8	Brahmani with Baitarni	0.5879	0.0882	0.4997	0.0258	0.4739	5.1631
9	Mahanadi	2.1293	0.3194	1.0099	0.0782	1.7317	4.3207
10	North East Composite	2.2788	0.3418	1.9370	0.2621	1.6749	13.5312
11	Godavari	4.6762	0.7342	3.9420	0.5907	3.3513	14.9848
12	krishna	2.6646	0.4342	2.2304	0.6493	1.5811	29.1114
13	Pennar	0.5047	0.0757	0.4290	0.1355	0.2935	31.5851
14	Madras Composite & Tamilnadu composite	2.0907	0.3137	1.7770	0.8165	0.9605	45.9482
15	Cauvery	1.3598	0.2041	1.1557	0.5168	0.6389	44.7175
16	Western Ghat composite	1.8289	0.2858	1.5431	0.3027	1.2404	19.6164
17	Brahmaputra	2.7857	0.4179	2.3678	0.0503	2.3175	2.1243
18	Meghna	0.1795	0.0269	0.1526	0.0049	0.1477	3.211
	Total	45.2233	6.9388	38.2845	10.6497	27.6348	27.8173
	UP	8.045	1.207	6.838	2.494	4.344	36.48
	Eastern UP	2.976	0.446	2.529	0.857	1.672	36.66
	Western UP	2.779	0.417	2.363	1.074	1.288	48.06
	Total	5.755	0.863	4.892	1.931	2.96	NA

Source: BHU-JAL January- March 1991 (Special Issue on Ground Water Statistics), p- 94& 98-99

the state's replenishable ground water resources and about 34% of that the Ganga basin. This means that although our examination does not deal with the whole of the eastern and western alluvium of Ganga basin, it does cover a considerable portion of two parts (upper /western and eastern / lower) of the basin. Although the level of ground water development in Uttar Pradesh and more particularly in its western part is higher compared to the basin as a whole, there is tremendous scope for its development in its eastern part. The data also affirms that the level of ground water development is most impressive in Uttar Pradesh and more particularly in its western part.

Ground Water Resources of U.P

The state of U.P has a total geographical area of 29.4 million ha comprising of seven hydrological regimes. Bhabar, Tarai, Himalaya, Central and East Gangetic alluvial plains, Bundelkhand and Vindhyan regions. The alluvial plain areas cover about 21.24 million ha. having fertile soils and voluminous ground water resource. The net sown area of the state is 17.48 million ha with cropping intensity of 148.7 %. An area of about 367 thousand ha is estimated as wetlands. The critical and semi critical waterlogged areas stood at 5.39 and 4.06 millions ha respectively in October 1996 in 49 districts of the state.

The available water resources of the state are enormous with irrigation prospects. The available surface water for irrigation is estimated at about 9.86 mhm with an ultimate irrigation potential of 15.95 mhm. The annual replenishable ground water is presently estimated to be 7.16 mhm with an ultimate irrigation potential of 15.03 mhm. In addition to this utilizable static ground water, there is further scope to utilize an additional ground water of about 7.45 mhm between water levels of 5-10 meters with an additional ultimate ground water potential of 15.69 mhm. This means in U. P the available water for irrigation is about 24.27 mhm (consisting of 14.61 mhm ground water and 9.86 mhm surface water). As regards ultimate irrigation potential, it is estimated to be 46.67mhm with 30.72 mhm in respect of ground water and 15.95mhm in respect of surface water (Rai et al 2000). This clearly means that there is tremendous scope for the utilization of ground water resources in the state.

Regional disparity

The state of Uttar Pradesh¹ like most of the large states of India presents a picture of disparities in term of agro climatic features and resource endowments. It is divided into 3 broad regions containing 83 districts. The hilly region of the north comprises of 12 districts. High mountains formed of sedimentary rocks broken by valleys and deep gorges characterize the terrain. The hill areas are sparsely populated and communication is difficult. Further, many are in accessible. The Gangetic plain consist of 64 districts. The plain stretches across the entire length of the state from west to east, flanked by Terai and Bhabar² areas in the north and Vindhya plateau in the south.

¹ In this paper U.P. includes Uttaranchal, which is a separate state now. This has been done because most of the data used in the paper for U.P. includes Uttaranchal.

² Bhabar denotes a gravel talus with somewhat steep slope fringing the outer margins of the hills everywhere.

Table-2: Indicators of Development in the Eastern and Western Alluviums of Uttar Pradesh

Sl.	Particulars	Western	Eastern	U.P
1	General			
1.1	Population in Million (1991)	49.5	52.7	139.1
1.2	Geographical area in sq.km.(1991)	82192	85844	2944111
1.3	Density of population- per km (1991)	603	614	473
1.4	Percent of urban population to total population (1991)	26.3	11.6	19.8
1.5	Percent of literacy (1991)	42	38.5	41.6
1.6	Percent of Schedule castes (1991)	31.5	37.3	100
1.7	Average Monsoon rain fall (in mm)	765.7	891.3	N.A.
2	Infrastructure			
2.1	Percapita electricity consumption (kwh-1997-98)	206.2	109.3	163.1
2.2	Percent of electrified villages (kwh-1998-99)	87	76.4	78.5
2.3	Post Officer per lakh population (1994-95)	11.1	13	13.5
2.4	Telegraph officer per lakh population (1995-96)	3.3	2.3	3.3
2.5	Telephone per lakh population (1995-96)	705	282	538
2.6	Length of metalled road under PWD per 1000 sq km (1994-95)	326.2	308.7	288.0
3	Credit Facilities			
3.1	Credit deposit ratio (June 1996)	38.6	28.2	32.9
3.2	Scheduled Commercial Banks per lakh population (95-96)	5.7	5.00	5.8
3.3	Co-operative agri. marketing centres per lakh Population(94-95)	4	1.4	2.6
3.4	Co-operative marketing societies per lakh pop. (94-95)	0.19	0.13	0.18
3.5	Joint agricultural Co-operative societies (1994-95)	1.1	0.6	0.9
4	Agriculture Related			
4.1	Percent of marginal holdings (> 1 ha., 1990-91)	66.1	82.3	73.8
4.2	Average size of marginal holding (.1ha. 1990-91)	0.41	0.35	0.38
4.3	Percent of farmers against main workers (1990-91)	47.9	54.8	53.3
4.4	Percent of agricultural labours against main workers (90-91)	18.5	22.5	18.9
4.5	Consumption of electricity in Ag. As % of total con, 1997-98)	51.0	46.3	41.5
4.6	Cultivable area as% of reported area (1994-95)	82.7	77.0	70.9
4.7	Net cultivated area as% of cultivable area (1997-98)	90.6	86.0	83.3
4.8	Net irrigated area as% of net cropped area (94-95)	85.1	61.8	67.4
4.9	% of area irrigated by State tubewells (94-95)	4.2	11.2	6.6
4.10	% of area irrigated by Pvt. tubewells (94-95)	67.4	56.2	57.7
4.11	% of balance GW to total safe yield (96-97)	54.0	64.0	60.0
4.12	Cropping intensity (1997-98)	156.2	150.3	148.7
4.13	Commercial crop area as % of gross cropped area (94-95)	32.7	10.8	20.6
4.14	% of kharif area affected by floods (1997-98)	3.4	11.6	7.6
4.15	Availability of tractor per gross cropped area (in ha. 97-98)	34.4	77.4	49.7
4.16	Distribution of fertilizer per ha gross cropped area (in ha.97-98)	145.2	117.3	117.4
4.17	Value of Agr. Produce per ha on current prices (93-94)	14164	11029	11941
4.18	Productivity of food grains (q/ha 97-98)	25.2	19.4	20.3
4.19	Productivity of wheat (q/ha 97-98)	29.8	22.8	24.9
4.2	Productivity of Rice (q/ha 97-98)	25.1	20.3	21.4
4.21	Productivity of potatoes (q/ha. 97-98)	168.3	126.7	146.7
4.22	Productivity of oil seeds (q/ha 97-98)	6.7	5.2	6.1
4.23	Productivity of sugar cane (q/ha 97-98)	654.3	516.8	610.8
4.24	Gross value of Agr. Produce per rural person on current prices (93-94)	3568	1883	2614
4.25	Income from primary sector as % of net domestic out put (96-97)	74.8	74.3	15.8
Note:	UP includes Uttranchal			
Source:	GO UP, 2002 and Districtwise Indicators of Development, Economics and Statistic Division,			
	State Planning Institue, UP. 1966			

The entire alluvial plain is divided into three-sub regions- western (27districts), central (10districts) and eastern (27districts). The Gangetic plain is watered by rivers Yamuna, Ganga, and its major tributaries Ramganga, Gomti, Ghagra, and Gandale. The whole plain is alluvial and very fertile. The southern region is demarked by Vindhya hills and the plateau. It is called Bundelkhand and comprises of 7 districts. The tract is marked by scanty and erratic rainfall and scarce water resources.

It has been mentioned by us that the eastern and western parts of the Gangetic plain are most important in terms of ground water resource endowments not only in U.P but also in the whole of the Ganga basin. However, in terms of ground water development, there is lot of variations in the two regions (see table 1)

Although eastern and western region form part of the same Gangetic plain, the two regions present a picture of contrast. The eastern tract is flood prone with periodic occurrences of droughts and is least developed. The western tract although receives much less rainfall is assisted by old canal networks and high development of ground water resource. According to some, this kind of disparity is on account of historical antecedents. During the British period, nearly all the agricultural developments in the state took place in the western U. P. A major development was the construction of a network of canal system which reduced the element of risk in agriculture and gave farmers incentives to experiment with the new techniques and crops with new farm related industries. Farmers of the eastern U.P on the other hand with their high density of population resulting in high pressure on land and complete dependence on natural forces for agriculture, were not in a position to take risk and experiment in ways that if they failed, could threaten their very existence (Singh 1976)

In an effort to find out the extent of disparity between the two regions, we have put all the indicators of development in table 2, containing data in respect of two regions and the state as a whole. All the indicators have been clubbed under, four headings dealing with general features, infrastructure facilities, credit facilities and agriculture related development.

The first striking point, which emerges from the data, is that two regions together constitute the most important segment of the state. The two regions together contain 73% of the population, 57% of the state's geographical area and 72% (table1) of state's replenishable ground water resource. Although the two regions contain the same number of 27 districts each, the eastern region is larger in terms of population as well as in area than its western part. Eastern region has greater density of population, greater percentage of scheduled castes and higher monsoon rainfall. Western part on the other hand has higher rate of literacy and urbanization, greater per capita consumption of electricity, higher proportion of electrified villages, higher proportion of telegraph offices, telephones and higher length of metalled roads. It is obvious from this examination that eastern region lags behind the western region in respect of all the indicators of development but is ahead in respect of indicators, which lead to backwardness. In respect of credit facilities, it is found that western region is more favorably disposed in comparison to the eastern tract. Western region forges ahead in all respects, such as credit deposit ratio, number of banks cooperative agricultural marketing centers and cooperative societies etc.

The fourth and the largest section of the table deals with agriculture related indicators. Here also the same trend continues which was found to be in respect of first three sections. Eastern U.P lags behind western U.P in respect of all such indicators which are positively related to modern / advance agriculture. On the other hand, the region is ahead of the western region in respect of indicators which hinder modern / advance agriculture. An important point, which emerges on the basis of the table, is that the eastern region not only lags behind western region but is also behind the state as a whole. In all, 43 indicators have been used in the table and only in respect of one indicator, i.e. number of post offices (2.3) eastern U.P scores higher than western U.P. Here also, it is possible that the post offices are established keeping in mind population norms. In all other respects, the eastern region lags behind the western region. In comparison to the state as a whole in respect of first 18 indicators, only in case of length of metalled roads, eastern region's position is better than U.P as a whole. However, in agriculture related indicators, eastern region's position is better than the state as a whole and in respect of 9 indicators out of 25 indicators. On the basis of table 2, the picture that emerges presents the eastern region in very poor light. It is a region, which abounds with small and poor farmers with a preponderance of marginal holdings and socially and economically backward area. A large part of the area is affected by floods. In the absence of adequate credit facilities, the resource base of farmers remains poor and small area is covered with commercial crops. This is further aggravated by lower cropping intensity and low yields of crops, which ultimately leads to reduction of gross value of agriculture produce.

Ground water development

As early as in late 1970's, Dhawan had highlighted the wide differences in the agricultural development of eastern and western U.P on account of extent of ground water irrigation in two regions. On further examination, he found that tube well irrigation in the alluvial Gangetic plains diminishes in force as one moves from west to east (including Bihar and Bengal). This downward trend according to him coincides with a like pattern in the matter of agricultural growth. The downward trend as we move from west to east in the Gangetic plain is on account of several factors such as progress in land consolidation, spread of rural electrification, institutional support and finance (Dhawan 1982). Under exploitation of available ground water in Eastern U.P is regarded as the main cause of this region's agricultural backwardness. Even today it utilizes only 36% of its available ground water resource. It is pointed out that excepting parts of the erstwhile Mirzapur district, the rest of the region, have large groundwater resources. It is felt that if the same are exploited intensively in a planned manner, they can help improve crop intensity, promote crop diversification and increase productivity of crops. Therefore, exploitation of ground water is given highest priority (RBI 1984).

A general impression that still prevails among the policy makers and researchers is that the development of ground water is quite slow in Eastern U.P. Table 3 discounts this kind of thinking. No doubt Eastern U.P lags behind Western U.P in the development of ground water as it utilizes only 36% of ground water resource compared to western region's 46% utilization. However, the pace of development has been more rapid in the east compared to the west. Data in table 3 reveals that in 1964-65 in Eastern U.P only about 11% area was irrigated by tube wells which went up to about 62% in 1983-84 and about 73% in 1999-2000. As against this in case of

Western U.P, the tube well irrigated area in 1964-65 was about 20% and went up to 62% in 1983-84 and about 79% in 1999-2000. This means the pace of ground water development was heavily in favor of Western U.P in the mid 1960's but Eastern U.P matched Western U.P by mid 1980's. This means that growth of ground water in Eastern U.P is faster until mid 1980's. No doubt presently the pace of development is marginally in favor of Western U.P.

Agricultural productivity

It is interesting to note that the pace of ground water development has affected the productivity of main crops of rice and wheat to a great extent during this period in the eastern region. In 1964-65, the productivity of rice was 7.97 ql / ha in the west and 7.16 ql / ha in the east. In 1983-84, the same was 14.61 ql / ha in the west. In 1997-98, the productivity of rice went up to 25.1 ql / ha for west and 20.3 ql / ha for the east. In respect of wheat, the productivity in 1964-65 was 9.26 ql / ha for west and 7.31 ql / ha for the east. It went up to 21.55 ql / ha for the west and 15.94 ql / ha for the east. In 1983-84, again it went up to 29.8 ql / ha for the west and 22.8 ql / ha for the east. An interesting trend emerges on the basis of this data. In 1964-65, the productivity of Western U.P was marginally higher compared to Eastern U.P. A dramatic change, however, is noticed in 1983-84. In 1983-84, western region registers a tremendous growth in the two crops, more particularly, in case of wheat. While in case of Eastern region, although there are marginal gains in the productivity of rice, even wheat productivity has doubled here. But what is important is that large variations in productivity of two crops occurred in the two regions in 1983-84. This is in spite of the fact that during this period ground water utilization in eastern region had reached at par with the western region.

Table-3: Source wise Irrigated area (in thousand ha)

Sl.	Source	Eastern			Western			State		
		64-65	83-84	99-2000	64-65	83-84	99-2000	64-65	83-84	99-2000
1	Canals	303	856	1025	1149	1267	721	2225	3330	2988
	%	14.56	27.79	24.95	49.51	27.57	14.74	40.53	33.71	23.97
2	Tubewells	225	1899	2980	467	2839	3885	715	5467	8700
	%	10.81	61.66	72.52	20.12	61.77	79.42	13.06	55.34	69.77
3	Others	1553	325	104	705	490	286	2548	1082	781
	%	74.63	10.55	2.53	30.37	10.66	5.84	46.41	10.95	6.26
4	Net Irrigated area	2081	3080	4109	2321	4596	4892	5490	9879	12469
	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Adapted from : A study of agricultural development in Eastern UP Director Agricultural Statistics and

Crop Insurance UP Lucknow, Publication No.112 Sept. 1986, page 8 and Directorate of agriculture, UP Lucknow, December-2000

Another interesting feature is noticeable in 1997-98. During this period, the productivity of rice in the eastern region has doubled in comparison to rice productivity in 1983-84. In respect of wheat, productivity is doubled in 1983-84 and trebled in 1997-98. This means that productivity gains are maximum in respect of both the crops in eastern region in 1997- 98

In fact the field level data collected by us during our reconnaissance visits in Jaunpur and Moradabad districts during October- November 2001 indicates a much higher productivity. However, it should be noted that the village in Jaunpur and the village in Moradabad represent agriculturally most advanced villages. In case of Jaunpur (Eastern U.P), the village was Chakra in Dhobi block. It was a high caste (Thakur) dominated village. Irrigation in the village was done mainly by private shallow tube wells, which were 40 in number and all were electrical. Most of them were of 5 hp. The availability of power in the village was reported to be 12-18 hours per day, which is quite exceptional in the eastern region. Water charges on sale of water were around Rs. 10 per hour. The ground water level in the village was around 10 ft (post monsoon).

The village from Moradabad was Singhpur Saini, forming part of the Sambhal block, which remains to be a dark block of the district. It was a Jat dominated village. The enormity of ground water utilization can be gauged by the fact that there are 500 electric and 200 diesel pump sets in the village. Although electricity was available for 10-15 hours per day, farmers kept pump sets as an insurance against electricity failure. The water level in the village was reported to be 40-45 feet (post monsoon). Sale of ground water by tube well was Rs. 40-45 per hour, while it was Rs. 20 per hour for electric tube well. The productivity of important crops in the two villages was reported to be as follows.

Crops	Productivity ql / ha	
	Jaunpur (Chakra)	Moradabad (Singhapur)
Saini)		
1. Rice	35 –40	25 – 30
2. Wheat	40 – 45	30 – 35
3. Sugarcane	750 – 800	700 – 750
4. Potato	250 – 300	N.A
5. Gram / Peas / Pigeon pee	25 – 30	N.A

Although the above data is not indicative of the general productivity levels in Eastern U.P, it does show that there are areas in the Eastern U.P where productivity is as high as anywhere in the western U.P

Flooding and Water logging

Frequent occurrence of floods is a common feature of the eastern region. According to 1997 – 98 estimates, while 11.6% kharif area in the eastern region is affected by floods, only 3.4% of the kharif area is affected by floods in the western region (table 2,item 4.14). The east west differences are most conspicuous if we examine the data for the districts of Jaunpur and Moradabad. While Jaunpur contains 56183 ha of area, which is flood prone, there is no such area in Moradabad (GOUP 1999). Ghagra,

Rapti and Gandak are notoriously flood-creating rivers. Even smaller rivers like Rohni, Burhi, Rapti, Arni, Kuwano, Gurra, Tons, Kunhra, Ghongi, Burhi Gandak deluge in flooding the region. It is estimated that Rapti alone inundates 350,000 ha of area every year in Bahraich, Gonda, Basti, Siddhartha Nagar and Deoria districts (Shah. 2001)

The problem in the eastern region has been further enhanced due to unplanned and haphazard use of water resources in the state. As a result, large areas suffer from miseries of rising water table. It would not be out of context to mention a field visit the author had carried out fifteen years ago with Tushar Shah and Robert Chambers through the commands of Sharda Sahayak and Gandak. We had moved by road from Lucknow to Deoria via Barabanki, Gonda and Gorakhpur. After the visit Robert Chambers had circulated a note, and his comments in respect of water logging remain relevant even today after a lapse of 15 years. He had written, “All canals we saw on Sharda Sahayak and also on Gandak were running full, although it had recently rained and it is doubtful whether anyone was taking water. One wonders whether there is any attempt at all to throttle back on water deliveries. It seems crazy to send more water into these areas when they are already in such trouble. There are difficulties over travel time, but I would have thought long term weather forecasts could enable managers, without any one losing, to reduce flows at times like that of our visit”(Chambers 1987)

The magnitude of water logging can be gauged if the following figures recently worked out by the State Ground Water Investigation Department are taken into consideration. These figures are based on the data collected from 3173 hydrograph monitoring stations, which have been set up by the GOUP. The waterlogged area has been divided in two groups. The one is “critical area” which refers to the areas where ground water level is between 0 to 2 meters. The other is “semi critical” area, which relates to the areas where ground water level is between 2 to 3 meters.

	U.P	west	east
Critical area in thousand ha.	4803	1090	2360
Percentage of such area against the reporting area in thousand ha.	23. 89	13. 50	31. 45
Semi critical area in thousand ha.	3911	1188	1731
Percentage of such area as against reporting area	19. 45	14. 71	23. 07
Critical and semi critical area in thousand ha.	8714	2278	4091
Percentage of such area against reporting area.	43. 34	28. 21	54. 52
Reporting area (in thousand ha)	20107	8077	7502

Although the preceding data sets alarm bells for the Western U.P also, the villages visited by us in the districts of Jaunpur and Moradabad showed a picture in contrast. While in Jaunpur, we witnessed a number of villages with accumulated water, in Moradabad a number of villages had very deep ground water table. In Moradabad 16 out of 19 blocks were critical, semi critical or over exploited. In Jaunpur only 2 out of 20 blocks were having critical water levels. The growing menace of water logging in the eastern region is mainly on account of impeded drainage caused by historical antecedents, high ground water recharge and frequent flooding. One more reason that came to our notice during the recent field visits (October- November 2001) was the construction of rural roads under MPLADS and MLALADS by departments and organizations which do not have the full technical know how³ In the absence of the close scrutiny of the quality of work, lack of resources and absence of technical expertise no attention is being paid to drainage. In some cases even the existing drainage passages are being blocked to meet the district level targets.

Evolution of public policy

Tube well technology got its first shot as a public funded programme in the early 1930s when two public tube wells were installed in Moradabad district. At the beginning of the first five-year plan, the number of state tube wells stood at 2000. By the end of first five-year plan, another 3000 state tube wells were added (GOUP 1971). In the wake of developmental planning, tube well indivisibility witnessed substantial reduction, which induced many farmers to invest in their own tube wells. This inducement was reinforced by the advent HYV seeds and progress in land consolidation, rural electrification, institutional credit etc. However, public policy for a long time continued to encourage state owned tube wells for the rural poor. During the 1980s new design public tube wells were devised with intended beneficiary participation in the operation, water distribution and maintenance of tube well system. However, the performance of such tube wells was found to be far below the expectations. The poor performance of such tube wells had been on both technical and organizational grounds (Pant 1993).

In respect of private tube well, the growth was stupendous and the stock of private tube-well rose in U.P from about 3 thousand in 1951 to 600 thousand in 1977 (Dhawan 1982). By mid 1970s, tube-well irrigation had overtaken canal irrigation, which was the dominant mode of irrigation earlier to that. The rapid growth of private tube-wells had its repercussions on the power point. Historically, as the ground water development was building up in the state, the demand on the power was not significant since there was surplus power available in most areas until the 1970s. However, after that and in early 1980s, the large-scale ground water development in the private sector had led to a situation where the rural demand for electricity always exceeded power availability. It was around this time, power generation and transmission capacity became the constraint to the rate at which electrical connection to tube-well points could be made. In table 4 we are able to put together data from 1980 onwards in respect of various modes of ground water extraction prevalent in the two regions of U.P. Looking at the table, it is found that the traditional modes of

³ Under the schemes members of the Parliament and the State Legislature are allocated Rs. 2 crore and Rs. 50 lakhs respectively for the development of the areas they represent. In U.P most of the money coming from these sources is being spent on the construction of roads under the overall supervision of the district administration.

ground water irrigation, i.e. dug-wells and Persian wheels seemed to be quite popular in both the regions until mid 1980s. In fact, in case of dug-wells the decline had started by mid 1980s. In respect of Persian wheel, the popularity had continued even during 1980s. Between the two regions, dug-well seemed to be more popular in the eastern region compared to the western region. Persian wheel seemed to be equally popular in the two regions although marginally more popular in the western region.

Table –4: No. of Ground Water Works in Eastern & Western Alluvium

At the end of year	Dugwell			Persian Wheel			Diesel Pumping set			Electric Tubewell		
	East	West.	UP	East	West.	UP	East	West.	UP	East	West.	UP
1979-80	271151 (53.60)	258583 (46.64)	679443 (46.14)	15338 (41.06)	179410 (41.65)	239671 (36.36)	128954 (16.30)	317028 (11.73)	581998 (9.38)	183083 (24.94)	217432 (21.17)	465969 (23.08)
1984-85	228655 (45.20)	222371 (40.11)	586119 (39.80)	15500 (41.11)	179786 (41.74)	245022 (37.18)	258727 (12.61)	526343 (19.46)	1030488 (16.61)	285902 (38.95)	290068 (28.24)	674753 (33.43)
1993-94	N.A	N.A	N.A	N.A	N.A	N.A	525389 (25.61)	710862 (26.29)	1624923 (26.20)	81431 (11.09)	194027 (18.89)	306978 (15.21)
1998-99	6110 (11.20)	73430 (13.25)	207042 (14.06)	50147 (17.85)	71540 (16.61)	174371 (26.46)	1138065 (55.48)	1149837 (42.52)	2965357 (47.81)	183623 (25.02)	325743 (31.71)	570748 (28.28)
Total	505916	554384	1472604	280985	430736	659064	2051135	2704070	6202766	734039	1027270	2018448
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

, Source: Updated Minor Irrigation Censuses GOUP

In respect of diesel pump-sets, it is found that there is a progressive increase in their numbers in the two regions. But the growth of diesel pump tube-wells is more pronounced after the mid 1980s in case of the eastern region. In fact, after 1993, the growth of diesel pumping sets is higher in the Eastern U.P in comparison to the Western region. The reverse is noticed, however, in case of electric tube-wells. Here, up to 1984-85, the growth is greater in Eastern U.P while after that period; growth is higher in Western U.P. However, what is noteworthy, there is a decline in the growth of electric tube-wells between mid 1980s and mid 1990s in both the regions and the decline is more severe in case of eastern region. However, there is a growth again after the mid 1990s and the growth is higher for the eastern region.

The total number of pump-sets (both E&D) is always higher in the western region compared to the eastern region. However, the proportion of increase goes on declining over the years. While in 1980, the proportion of the total pumps (in the two regions) was 63% for the western region, the same declined by 52% in 1998-99.

The proportion of diesel pumps in relation to electric pumps was always higher in the western region and the proportion went on increasing from 59.3 % in 1980 to 64.5% in 1985 and then 78.6% in 1994 after which it registers a marginal decline of 0.7%. In case of eastern region, the picture is quite different. Here, the proportion of electric pumps was more than diesel in 1980 and 1985 where their proportion was 58.7% and 52.5% respectively. Here a dramatic decline in the number of electric tube-wells occurs between mid 1980s and mid 1990s when the proportion of electric pumps

decline to 13.4%. During the same period, diesel pumps record an overwhelming increase from 41.3% to 86.6%. After the mid 1990s and till 1998-99, like the western region, the eastern region also records a marginal decline of 0.5%.

The inevitable conclusion the data provides is that the power position in Eastern U.P deteriorated very fast between mid 1980s and mid 1990 when many villagers in Eastern U.P discarded their electric tube-wells. The author had witnessed this phenomenon when he conducted two surveys in the Eastern U.P in 1989 and 1990. In fact, during the first survey, the author had found the actual availability of electricity for the World Banks tube-wells to be 8.6 hours per day for Basti and 9.5 hours per day for Deoria. This is despite the fact that these tube-wells were connected with a dedicated power supply which was to provide them an average guaranteed electricity of 18 hours per day (Pant 1989).

Another significant point emerging from the data is that power situation has improved in both the regions between 1994 and 1999 as during this period, the decline of electric tube-well is checked and in fact marginal increase in the growth of electric tube-wells is noticed in both the regions. The validity of this conclusion needs to be checked at the field level. The field level data collected by us from 10 villages (6 from Jaunpur and 4 from Moradabad) during the reconnaissance in October – November 2001 shows that in Moradabad (west) about 65% pump-sets were electrical and the remaining 35% were diesel. One common feature here was that a large proportion of farmers kept diesel pump-sets as an insurance against the failure of electricity. On the contrary, in Jaunpur (east), if we leave Chakra village, over 95% of pump-sets were electrical.

Main Features of Shallow Tube-wells

Table 5 presents the main features of Shallow tube-wells in two regions. The data has been derived from the updated census of 1993-94 carried out by the Minor Irrigation Department of Uttar Pradesh. The first two items dealing with the socio-economic base of the owners are most important from the view -point of access of ground water to the rural poor. In respect of the holding size of owners, it is found that 56% owners in the east and about 36% owners in the west are marginal farmers. If we add small holders also (up to 2 ha), it is found that 85% of such farmers in the east and 69% in west own these Shallow tube-wells. It is understandable that a higher proportion of marginal and small farmers would own such shallow tube-wells as holding size in the east are quite small. However, these findings are different from what we had found during our survey of villages in Bahraich, Faizabad and Basti. In three districts together, we had found 25% of marginal farmers owned shallow tube-wells and together with small farmers, about 57% farmers owned such own such shallow-wells. As per our survey, there were 43% farmers above 2 ha who owned such shallow – wells, against 15% as per Minor Irrigation Department survey (Pant 1992). In terms of caste, it is found that almost similar trends prevail in the two regions.

Table 5 Important features of shallow Tubewells/Pumpsets:

Sl.	Ownership by Land	East	West	East+West	UP
1	Holding size				
1.1	Marginal(0-1 ha)	374670	305165	679835	862395
	(%)	56.3	33.5	43.0	43.53
1.2	Small (1-2 ha)	189301	326508	515809	643856
	(%)	28.4	35.8	32.7	32.50
1.3	Medium (2-10 ha)	95087	268806	363893	440148
	(%)	14.2	29.5	23.1	22.21
1.4	Big (above 2 ha)	7109	11648	18757	34738
	(%)	1.1	1.2	1.2	1.76
1.5	All size owner	666167	912127	1578294	1981137
	(%)	100.0	100.0	100.0	100.0
2	Ownership by caste				
2.1	Schedule caste	69499	100880	170379	261511
	(%)	10.12	11.06	10.66	13.20
2.2	Scheduled Tribe	8718	11408	20186	29840
	(%)	1.27	1.26	1.26	1.51
2.3	Others	608734	799779	1408513	1689786
	(%)	88.61	87.68	88.08	85.29
2.4	All Casts	686951	912117	1599078	1981137
	(%)	100.00	100.00	100.00	100.00
3	Shallow TWs by source of Finance				
3.1	Govt. Fund	21205	49007	70212	95004
	(%)	3.28	0.54	4.5	4.79
3.2	Farmer's saving	219291	567162	786453	988372
	(%)	33.96	62.18	50.48	49.88
3.3	Loan & saving	87974	149822	237796	293120
	(%)	13.62	16.42	15.26	14.79
3.4	Subsidy and Bank loan	309892	137519	447411	580439
	(%)	47.99	15.07	28.72	29.29
3.5	Subsidy only	5239	6680	11919	16968
	(%)	0.81	0.73	0.77	0.86
3.6	Other's	2168	2004	4172	7712
	(%)	0.34	0.22	0.27	0.39
3.7	All Sources	645769	912194	1557963	1981615
	(%)	100.00	100.00	100.00	100.00
	Shallow TWs by horse power of lifting devices				
4.1	(0 to 2 hp)	3053	4367	7420	1105
	(%)	0.47	0.47	0.47	0.56
4.2	(2 to 4 hp)	10400	1468	11868	14289
	(%)	1.61	0.16	0.75	0.72
4.3	(4 to 6 hp)	79869	120623	200492	228265
	(%)	12.36	12.90	12.68	11.51
4.4	(6 to 8 hp)	445757	570200	1015957	1286966
	(%)	69.01	60.99	64.26	64.92
4.5	(8 to 10 hp)	86870	220047	306817	401451
	(%)	13.45	23.54	19.41	20.25
4.6	(Above 10 hp)	19916	16743	36659	38679

	(%)	3.08	1.78	2.32	1.95
4.7	Unspecified	161	1492	1653	1859
	(%)	0.02	0.16	0.11	0.09
4.8	All STW	646026	934940	1580966	1982566
	(%)	100.00	100.00	100.00	100.00
5	Shallow TWs by Ownership				
5.1	Govt. owned	265	230	493	951
	(%)	0.04	0.02	0.03	0.04
5.2	Coop.Societies Owned	46	35	81	102
	(%)	-	-	-	-
5.3	Panchayat owned	25	24	49	310
	(%)	-	-	-	-
5.4	Group owned	1535	5552	7087	7777
	(%)	0.24	0.61	0.45	0.39
5.5	Others	9	26	35	66
	(%)	-	-	-	-
5.6	Individual farmers owned	644142	906513	1550655	1973369
	(%)	99.71	99.36	99.50	99.55
5.7	All types	646022	912380	1558400	1982266
	(%)	100.00	100.00	100.00	100.00

Source: Updated Minor Irrigation census (1993-94), GOUP

Note: Percentage in bold letters

UP excludes the hill districts of Uttaranchal

While in the east, about 11% of SC& ST own shallow-wells, in the west, their proportion goes to 12%. This revelation is particularly significant, if it is kept in mind that the percentage of SCs and STs is higher in the east compared to the west.

Major differences are noticed in the eastern and western region when the source of finance for the Shallow tube-well is examined. In the eastern region, the most important source of finance is subsidy and bank loan, which is availed by about 48% owners. In the western region, the most important source of funding is farmer's savings as about 62% of farmers use their savings to buy the pumping-set. The second most important source of funding in the eastern region is farmer's savings and about 34% of farmers resort to it, while in the west, the second most important source of funding is loans and savings and about 16% of farmers resort to it. The third most important source of funding in the eastern region is loan and saving and about 14% owners resort to this source. As against this, the third most important source of funding in the western region is subsidy and bank loan and about 15% owners resort to this source. The comparative picture that emerges from this data is that, while the majority of farmers in the western region have a sound resource base, their majority counterpart in the eastern region resort to debts and subsidies to own the pump.

In terms of pumpage of water, it is found that 6 to 8 hp pumps are most favored in both the regions. In Eastern U.P, their percentage is 69, while in the western part they constitute 61% of total pumps. It is this range of pumps, which can be used for both diesel and electricity and can be utilized for allied agricultural operations. In terms of ownership of shallow tube-wells, it is found that more than 99% of such wells, are owned by individual farmers and only less than 1% are owned by government, panchayats, co-operative societies etc.

Power Scenario in U.P

The installed power capacity in U.P as on March 31, 2001 stood at 5635.3 mw, which were 9.7% of India's installed capacity. About 73% of it was thermal and 27% of it was hydel. The gross generation of electricity in the state stood at 24765 MKWH and it constituted 8.2% of India's gross generated power. The power available to the State from the Central sector was 40.6% against the national average of 33.5%. Despite the heavy Central sector borrowing, the critical shortage of power supply in the State can be gauged by the fact that a large majority of pumps in rural U.P, more particularly in the Eastern U.P have converted to diesel as a source of energy. In table 6, an attempt has been made to highlight the main characteristics of power sector in U.P vis-à-vis country as a whole. In U. P. the share of agriculture in total sales in percentage terms has ranged between 35-37%, which is higher than 31-32% for the India as a whole. Although the share of revenue from agriculture in UP ranges between 10 to 13%, it is better than 4 to 5% share, which is found at the all India level. The per capita consumption of electricity in U.P has ranged between 186-207 kWh compared to the range of 299-348 kWh consumed per capita at the all India level. The unit cost of power supply in the U.P ranges between 222-253 paise / kWh as against 215-240 paise/ kWh at the all India level. The number of employees per thousand consumers as well as average tariff for sale of electricity in U.P is lower than what prevails at all India level.

TABLE – 6: Main Characteristics Of Power Sector In Up And In India

Sl.	Particulars	1993-94	1994-95	1995-96	1996-97	1997-98
1	% Share of Agriculture in total sales-UP	37.5	36.8	36.3	36.24	34.85
2	% share of revenue from agriculture in total sales revenue-UP	12.90	13.25	10.77	10.09	9.56
3	% share Agriculture in total sales for all SEBs (States) (Av.)	31.5	32.6	32.3	31.09	32.12
4	% share of Revenue from Ag. in total sales revenue Av. of all SEBs	4.77	4.37	3.98	3.56	3.56
5	% share of industry in total sale of power UP	25.30	24.34	24.62	23.26	22.32
6	% share of industry in total sale of power all SEBs	34.70	33.57	32.08	32.79	31.63
7	Per capita consumption of Electricity (Kwh)- UP	186.0	204.0	207.0	197.0	199.6
	. -do- all India	299.0	320.0	336.0	334	348.5
8	% Energy surplus (+)/Deficit at the end of 8th plan 1996-97- UP	-	-	-	13.9	-
	. -do- all India				11.5	
9	Unit cost of Power Supply (Paise/kwh), UPSEB	169.4	177.5	192.0	222.3	253.3
	. -do- all India	149	163.4	179.6	215.8	240.2
10	Rate of Purchase of Power (Paise/kwh), UPSEB	102	106.7	99.0	119.7	134.2

	. -do- India	all	87.0	94	109.9	119.1	140.7
11	No of employees per thousand consumers, UPSEB		-	16.60	15.7	14.65	13.82
	. -do- India	all		12.60	11.40	10.75	10.40
12	Average tariff for sale of electricity paise/kwh		111.8	122.4	-	143.0	171.6
	. -do- India	all	116.7	12.8	-	165.0	180.9

Source: Annual Report on the working of State Electricity Boards and electricity Departments. Planning Commission, June, 2001

In table 7, a comparison has been made between U.P.S.E.B and all S.E Bs in respect of average tariff levied on various categories of consumers during 1996-2001. The three things, which clearly emerge from the table, are: First, the overall charges of U.P.S.E.B fall short of charges at the all India level and in respect of three categories of consumers i.e., domestic, commercial (since 1998) and outside the state, the charges of U.P.S.E.B are lower than the all India charges. However, in respect of agriculture / irrigation, industry (since 1999) and railway traction U.P.S.E.B tariff is lower than the all India average tariff. The second, the tariff rates are lower than the unit cost of power supply in respect of domestic agriculture and outside. Here, the biggest gap arises in respect of outside consumers, where tariffs are 13 times lower than the unit cost of power supply. There is every possibility that this power is provided to Nepal. Third, the subsidy in respect of agriculture is 88.2% at the all India level and 80.3% in respect of Uttar Pradesh.

By and large, the power scenario that exists in U.P is far worse in the eastern region in comparison to the western region. As we had seen in table 4, there was a large dieselisation of ground water irrigation between mid 1980s and mid 1990s on account of near disappearance of electricity from rural Eastern U.P. Tushar Shah who has examined the whole question of power scenario in U.P including power sector reforms has offered some solutions to the problem. One of the solutions, which appear pragmatic at face value, is the transferring power distribution to the panchayats. This proposition does need a threadbare discussion if democratic de-centralizations have to succeed. What makes Shah's proposition attractive is the prospect of sharing of meeting collection cost between U.P.S.E.B and the panchayats (Shah, 2001). But is it possible?

Access of Ground Water to the Poor

During the early 1980s, it was found that the main beneficiaries of ground water irrigation in the Gangetic plains were larger farmers (Pant1984a). This was on account of either their resource base or accessibility to credit and thus their ability to use new seed, water, and fertilizer technologies. Benefits to the poor had been co-incidental rather than a matter of deliberate policy and were much less than what they must have been. Around that time, the desirability of well-directed efforts to give benefits of ground water to rural poor of Bangladesh, India and Nepal were discussed in a four-week seminar at IDS. The solutions were suggested on two fronts: first, improvement in traditional lift irrigation devices relying predominantly on human and animal energy source, second, developing and improving new small scale technology especially designed for small farmers such as hand or bicycle powered pumps relying on human or solar energy (IDS 1980)

Table – 7: Average Tariff for various categories of consumers (Paise/kwh)										
Categories of Consumers	1996		1997		1998		1999		2000	
	UPSEB	All SEBs	UPSEB	Other SEBs	UPSEB	OthersSEBs	UPSEB	Other SEBs	UPSEB	Other SEBs
Domestic	99.19	106.24	104.95	137.23	112.81	140.86	129.53	158.66	129.53	174.16
Commercial	264.56	240.3	303.61	295.42	313.25	324.32	313.25	356.60	313.25	341.20
Agriculture/Irrigation	42.48	21.2	49.65	20.22	49.5	20.59	48.95	21.02	49.97	28.42
Industrial	275.95	276.89	383.45	314.63	222.76	322.01	418.42	346.08	423.36	360.23
Rly. Traction	354.59	346.42	414.53	382.17	456.26	405.94	428.7	414.72	421.00	420.76
Outside State	14.5	151.39	15.98	138.53	19.14	164.84	19.14	182.81	19.14	194.79
Overall Av.	142.98	165.74	171.56	180.85	180.61	185.75	182.02	199.13	183.35	212.00

Source: Annual Report on the Working of State Electricity Boards & Departments, Planning Commission, June 2001.

Community/ Group-Tube-wells.

Around that time author's findings were that the group tube-wells installed with the initiative of PADI (predecessor of CAPART) and owned and operated by groups of small and marginal farmers were doing a fine job in the backward regions of eastern U.P (Deoria) and North Bihar (Vaishali) was widely acclaimed. It provided an organizational solution to the problem of indivisibility of tube-well, particularly in Eastern U.P (Pant, 1984b). At that time, community / group-tube-wells were regarded as a viable alternative for the marginal farmers of Eastern U.P whose plots were not only small but were scattered all around. However, by 1988, the group had started dis-integrating on account of World Bank tube-well programme and the free boring scheme⁴.

During 1996-98, another variant of group/ community tube-well was tried under a government project. The project was undertaken under one million well scheme of government of India and was implemented by U.P Project and Tube-well Corporation. It was taken up on the initiative of the then Managing Director of the Corporation. Under the scheme, about 100 tube-wells, each with a command of 20 ha was installed in the districts of Lucknow and Kanpur. The management of tube-wells was handed over to committees of beneficiary farmers to be headed by a local representative. The scheme failed on account of delay in getting electric connection, frequent electric failures after connection was obtained and factionalism over who would head the committee.

Free boring scheme

The origin of free boring scheme were laid in the RBI report of 1984 which recommended a heavy dose of subsidy for the development of ground water in the Eastern India. Following this report, the government of U.P launched a poverty targeted free boring scheme. Under the programme, free boring facility to the extent of Rs.3000 was provided to the small and marginal farmers. Additionally, they were also provided subsidies of 33.3% and 50% to small and marginal /SC&ST farmers respectively for the purchase of electric or diesel pumps. U.P Government used its own financial resources to enhance the rate of subsidy provided by the GOI from 25% to 33.3% and from 33.3% to 50 % (Pant 1991).

The liberal dose of subsidy together with achievement targets to be obtained, there was mushrooming of shallow tube-wells in both the regions. In table 8, year wise attainment of free borings in Moradabad district has been provided. If we look at the level, it is found that the largest numbers of borings were done during late 1980 and mid 1990s. It was the period when greatest number of diesel / electric pumps were installed at the state and at the regional levels also. The dramatic drop of borings in 1997-98 was because of detection of large scale bungling in the purchase of boring pipes during the previous year. This led to the suspension of the then Chief Engineer of Minor Irrigation Department and appointment of a probe committee because of

⁴ During a field visit to Deoria in October 2001, the author visited village Barsat where one of the earliest group tube-wells was installed in 1981. It was found that of the four tube-wells then installed around the village, two were still operative. Another interesting discovery was that one of the persons who was then working as a daily wage fourth grade staff with the PADI project had started a NGO of his own in the village after his services were terminated from the project. During 1999-2000, with the funding from CAPART he had installed 15 group tube-wells in adjoining areas. All the pumps were of diesel, and mostly the pumps were of 10 horse power

which practically no progress was made that year. Since next year, the backlog of previous year was also added; good progress was made in 1998-99. The reason for fewer borings in recent years is that the actual achievements are far below the targets set for the same. This is despite the fact that targets have been reduced by one fourth in recent years. In Jaunpur district, the targets for 2001-2002 were 1569, while the achievement up to October 2001, under general component was 8.5% and under special component, it was 5.5%, giving an overall achievement of 7.5%

Table – 8: Free Borings in District Moradabad				
Year	Under General Plan	Under Special Component	Under 1 million Wells Plan	Total
1984-85	212	-	-	212
1985-86	779	-	-	779
1986-87	888	-	-	888
1987-88	879	-	-	879
1988-89	3476	-	-	3476
1989-90	3155	-	-	3155
1990-91	1952	-	-	1952
1991-92	2262	-	-	2262
1992-93	1231	-	205	1436
1993-94	1009	-	661	1670
1994-95	1190	-	1550	2670
1995-96	1270	-	555	1825
1996-97	191	497	996	1617
1997-98	16	5	-	21
1998-99	492	1513	-	2005
1999-00	384	148	-	532
2000-01	166	345	-	511
Total	19482	2441	3967	25890

Source: Assistance Engineer Minor Irrigation Moradabad

Tushar Shah regards the free boring scheme of U.P a roaring success and considers the mechanism adopted as a role model for rest of eastern India. He also thinks that the scheme is one of the three options (the other two being water markets and treadle-pumps) for access of ground water to the rural poor (Shah 2001). However, our own surveys carried out in Eastern U.P during 1989 and 1990 (Pant 1989 and 1992) bring out a contrary picture in this regard which is substantiated by the 1993-94 Minor Irrigation Census presented in table 5.

Transfer of Management of Public Tube-wells to Co-operatives and Panchayats

One of the mechanisms used by the state governments for better access of tube-well irrigation to the rural poor is to transfer tube-wells to co-operatives / panchayats. In a policy decision in 1992, about 50 state tube-wells were transferred to beneficiary farmers to run it as a co-operative venture. An internal evaluation done by the

department found that only about 10% of the transferred tube-wells had run satisfactorily and only one studied by the author (Pant 1995) sustained the satisfactory working for a longer period of time.

In another policy decision in 1999, the state government transferred the management of all the state tube-wells to panchayats. We have been able to obtain the data for a division and a sub-division in Gorakhpur in respect of working of these tube-wells before and after the transfer to the panchayats. The deterioration is most obviously visible after the transfer (see table 9). As regard the access of poor farmers to the tube-well water, we did not find any difference. However, it was found that greater proportion of local influential shared the water theft.

Ground Water markets

The author had examined the question of access of ground water to the poor right from 1981 and had found in all his studies that ground water markets were the main source of irrigation of marginal and poor farmers. In one of his recent studies, the author had found that the smallest farmers with land holdings up to 0.4 ha were the biggest beneficiaries of ground water markets and that they gained the least from the public tube-wells. The data reveal that among this category of farmers 60% irrigated their wheat crop by purchased water as against 7% who used public tube-well for their wheat irrigation (Pant 1992)

During the October / November 2001 field visit, the author found that water markets still remained the main source of irrigation of marginal farmers' land. In respect of water rates, it was found that in Jaunpur, Gorakhpur and Deoria, sale of water from electric pumps was non prevalent and diesel drawn water was sold at Rs.40-50 per hour. The same rate was prevalent for diesel pump sets in Moradabad. In addition, in Moradabad, water from electric tube-wells sold at Rs.20 per hour or Rs.60 per acre.

Table -9: Working of State Tube Wells

Part-A: Tubewell Division-II, Gorakhpur		(area in ha.)									
Sl. No.	Year	No. of STWs	Net Irrigated area (in 000)	Av. Per TW	Watering area (in 000)	Av. Per TW	Running hrs. (in 000)	Av. per TW	Assessed Water charges (Rs. in 000)	Av. Per TW	
Before Transfer to Panchayats											
	11996-97	302	8.6	28.5	13.1	43.5	309.8	996.1	3657.8	12112.1	
	21997-98	302	7.9	26.4	10.8	35.9	279	923.8	1493.4	4945.3	
	31998-99	302	5.6	18.5	7.5	24.8	154.9	513.2	1768.5	5856.2	
After Transfer to Panchayats											
	499-2000	467	4.1	8.9	5.6	12.1	117.3	251.3	1480	3169.3	
		467	3.7	8.0	4.9	10.7	123.5	264.70	1508	3229.2	
Part-B: Tubewell Sub-Division-I											
Before Transfer to Panchayats											
	11997-98	93	3.1	33.6	5.4	58.6	123.5	1329	588.3	6326.7	
	21998-99	93	1.7	18.3	3.3	35.5	101.4	1090.5	491.1	5281.1	
After Transfer to Panchayats											
	399-2000	150	1.1	7.5	1.4	9.3	85.1	567.4	365.2	2434.8	
	42000-01	150	1.0	6.9	1.3	9.2	63.9	426.2	360.5	2403.4	

Source : Gorakhpur Tubewell Division-II

Treadle Pumps

This is a low cost foot operated pumps to enable small and marginal farmers to increase their income in high water table area of Bangladesh, Nepal and India. It was developed in Bangladesh in 1980 by Norwegian working in a local NGO. International Development Enterprises (IDE) promoted in India in 1995. The brand in India is known as Krishak Bandhu or KB. KB pumps follow the basic lifting principle of the hand pump. It consist of two barrels, plungers and pedals and is operated by one person, including a child who moves his weight on the foot pedal while holding a bamboo frame for support (Bhanot 1999). A report, which has reviewed evidence from a variety of sources, including their own study concludes that the pump raises annual incomes of adopter households by conservative estimate to Rs. 5000 per year. The researchers of the study are highly impressed by the performance of the pumps. According to them, the total sales of the pumps in India and Nepal are around 2 lakhs and they wonder as to why the sales are not picking up enough to tap the potential of 1 lakh pumps per year (Shah et al 2000). Our own field level impressions (October2001) based on the interviews of 7 pump owners substantiate that most of the owners are very small farmers. The average land holding size of the owners was 0. 35 acres and the largest owner were having one acre of land.

Out of seven pumps only one was found to be in the working condition. The person from Gorakhpur recently bought this particular one for Rs. 1500. The other six were provided largely free to the farmers by a NGO who had received a grant for this purpose from OXFAM etc. During the field examinations and discussions, the main points that emerged regarding the pump were: 1 It was used for the cultivation of vegetables only. 2. Most of the owners found the job of taking water from the pump tiring and monotonous and they preferred buying water even @ Rs. 50 per hour. They argued that it was more advantageous to work as a laborer and earn more money than the advantage derived from drawing the water from the pump. Some of them said that they preferred Dhekuli (the traditional method), while their children preferred drawing water from this pump. 3. The pump is capable of irrigation very small patch of land, which was invariably homestead land. 4. It was reported that after two years it was difficult to maintain the treadle pump as lots of wear and tear occur and replacements of parts was not feasible. 5. The presence of the pump even in high water table areas of Terai of eastern U.P. is not that widespread as reported by the IDE. 6. The month of October is not a proper time to see the working of treadle pumps. The better time to see it's working is after November.

Although the pump has been appreciated by one and all, the questions regarding its wide range acceptance and sustainability in high water table poverty ridden areas with preponderance of marginal holdings remain unanswered.

In addition to the issues discussed in the preceding, there are other issues like consolidation of holdings, regulation of ground water and conjunctive use of ground and surface water. These issues are equally relevant to the topic of the paper. However, on account of non-availability of the data on these aspects at this stage, we have not been able to take up these issues in this paper.

Conclusions

The Gangetic alluvium in the state of Uttar Pradesh presents a picture in contrast between the eastern and western parts. The eastern part characterizes: over population, existence of very small and fragmented holdings, poor infrastructure, poor credit facilities, meager electrification, flood proneness, impeded drainage and water-logging. Consequently, low consumption of fertilizers and HYV seeds etc leading to low cropping intensity and low crop yields. In contrast, the western part is favorably oriented in terms of all the shortcomings. The strategy invariably suggested for the improvement in agricultural front in the eastern part lays emphasis on greater development of abundantly available ground water in this part of the alluvium. Although, eastern part still lags behind the western part, it has made tremendous stride particularly after the mid 1980s and in recent years has tried to catch up with the western part. An important feature of development in the two regions is that every trend, which occurs in the west, is followed in the east after some time lag.

It is desirable that such steps need to be taken in the east, which have proved beneficial for the agricultural development of west, for example land reforms. At the same time, lessons need to be taken in respect of negative aspects of ground water development. One such issue is over exploitation of ground water. The enormity of excessive use of ground water in the western region can be understood by the fact that of the total 22 over exploited / critical blocks in the two regions, 21 are in the western region, Again about 76% of semi critical blocks fall in the western region as against 24% in the western region.

One of the strategies generally suggested to eliminate unplanned use of ground water is through integrated planning and management of ground and surface water resources. In actual practice, it could never be done in the absence of a coordinating agency, which planned and implemented water resources projects, basin or sub basin wise. In order to counter this lacuna in 1999, the government of U.P constituted a State Water Resources Agency (SWARA) under the chairmanship of the chief secretary. Recently (June 2001), as part of the World Bank funded the state water restructuring project, efforts are being made to give practical shape to this organization. It is envisaged to establish a Water Resources Data and Analysis Center under the agency to provide logistic support to it. The success of integrated water resources development in general and balanced ground water development of the state in particular will depend mainly on the effectiveness of these institutional measures.

References

- Bhanot, Arun. 1999(October) SPAN, USIS, New Delhi pp 7-9.
- Chambers, Robert. 1987. Notes on a visit to Eastern U.P. 26-28 February.
- Dhawan, B. D.1982. Development of Tube-well Irrigation in India. Agricole Publishing Academy. New Delhi, pp. 39-59.
- GOUP 1971. Working of State Tube-wells in Uttar Pradesh- An Evaluation Study, State Planning Institute, U.P, Lucknow, pp 1-2.
- GOUP. 1999, (March). Block wise Ground Water Status Report, District Moradabad
- GOUP. 1999, (August). Block-wise Ground Water Status Report, District Jaunpur.
- IDS. 1982. Who Gets a Last Resource? The Potential and Challenge of Lift Irrigation for the Rural Poor, University of Sussex, Study Seminar, pp 3-4.
- Pant, N. 1984 a. Organization, Technology and Performance of Irrigation Systems in Uttar Pradesh, Giri Institute of Development Studies, Lucknow (mimeo).
- Pant, N. 1984 b. Community Tub-wells: An Organizational Alternative to Small Farmers' Irrigation. Economic and Political Weekly. Vol. XIX, No. 26(Review of Agriculture).
- Pant, N. 1989. Water Distribution and Management in New Design Public Tube-wells in Eastern Uttar Pradesh, Centre for Development Studies, Lucknow. Pp 65-66.
- Pant, N. 1991. Ground Water Issues in Eastern India in Future Directions for Indian Irrigation- Research and Policy Issues, ed, Ruth Meinzen-Dick and Mark Svendsen, International Food Policy Research Institute, Washington DC. Pp. 258-260.
- Pant. N. 1992. New Trends IN Indian Irrigation- Commercialization of Ground Water, Ashish Publishing House, New Delhi. P 58.
- Pant. N. 1993. Performance of the World Bank Tube-well in Ground Water Irrigation and the Rural Poor: Options for Development in the Gangetic Basin ed. by F. Kahnert and G Levine, The World Bank, Washington DC.
- Pant. N. 1995. Turning of Public Tube-wells in Uttar Pradesh: Case Study of a Successful Cooperative Society, IIMI and FAO, Rome pp. 177- 190
- Rai. D; A, N.Singh, A. Hussain; N. Hasan and R.K Khanna. 2000. Ground water development strategies for optimization of sustainable agricultural production in U.P. plains, Remote Sensing Applications Center, Lucknow.
- RBI: 1984. Report on Agricultural Productivity in Eastern India, vol. II, Pp. 391-393.
- Shah. T, M. Alam, M. D. Kumar, R. K. Nagar and M. Singh. 2000. IWMI, Sri Lanka.
- Shah. T.2001. Wells and Welfare in Ganga Basin: Public Policy and Private Initiative in Eastern Uttar Pradesh, Research Report No. 54, IWMI, Sri Lanka.
- Singh. Srinath. 1976. Modernization of Agriculture, Heritage Publishers. New Delhi.

International Water Management Institute

127, Sunil Mawatha, Pelawatta,
Battaramulla, Sri Lanka.

Tel: 94-1-867404, 869080, 872178, 872181

Fax: 94-1-866854 **Email:** iwmi@cgiar.org

Website: <http://www.iwmi.org>

IWMI-Tata Water Policy Research Program Office

Elecon, Anand-Sojitra Road, Vallabh Vidyanagar,
Gujarat – 388 120, India.

Tel: 91-2692-29311-13

Fax: 91-2692-29311-13 **Email:** iwmi-tata@cgiar.org

Website: <http://www.iwmi.org/iwmi-tata>

International Water Management Institute

India Regional Office, ICRISAT Patancheru,
Andhra Pradesh – 502 324, India

Tel: 91-40-3296161

Fax: 91-40-3241239 **Email:** iwmi-india@cgiar.org

Website: <http://www.iwmi.org>