Chapter 11

Water Resources: Management and Development

11.1 Introduction

This chapter reviews the status of availability, demand and development possibilities with regard to the water resources in Uttar Pradesh. It also discusses the main issues faced, and likely to be faced by this state, in the water sector. The analysis carried out takes into account work done for the Indian Water Sector, in recent years, and more notably the reports of the "National Commission for Integrated Water Resources Development" (1999).

The chapter is organised as follows: Section 11.2 discusses the status of land use, irrigation and population for the area as a whole and for different regions. It also presents the population and food demand projections up to 2050 as well as the land use planning. The water required for irrigation, domestic use and for electric power is presented in Section 11.3. Section 11.4 discusses the water resources, their availability and usability. The development possibilities, project-wise, as studied by the state are brought out, and compared with the requirements in land use projections in Section 11.5. Section 11.6 brings out the limitations of the land and water-use plan. The environmental issues regarding water quality, water logging and salinity, land drainage are discussed in Section 11.7. Section 11.8 is on floods. Section 11.10 discusses issues in water management. Water conflict related issues are presented in Section 11.11. Section 11.12 deals with water pricing and Section 11.13 deals with issues in sustainability and participatory management. The institutional issues are discussed in Section 11.14. The last Section 11.15 brings out the short and medium-term strategies and the action plan.

11.2 Land Use, Irrigation, Population and Food

11.2.1 Status

Undivided Uttar Pradesh (UUP) had the largest irrigated area amongst all states. Large tracts of canal irrigation cover much of the plains, and groundwater structures dot the landscape. The irrigation map of UUP is shown in Figure 11.1.

UUP had varied land use amongst its regions. While only a small percentage of the area was sown in the hills; in west UUP, almost 70 per cent of the area was sown. Out of the total sown area, only about one-third in the hills was irrigated; while in West UUP, more than 80 per cent of the sown area was irrigated. Rainfed agriculture is not an important activity in West UUP and even in Central UUP. The inter-regional comparison is depicted in Figure 11.2.

The present land use of Uttar Pradesh (new) is given in the table below:

TABLE 11.1

Land Use of Uttar Pradesh (1997–98) (in Million Ha)

Description	*Uttar Pradesh*
Reporting Area	24.20
Forests	1.780
Barren and Unculturable Land	0.641
Land under Non Agricultural Use	2.376
Culturable Waste	0.586
Permanent Pastures and Land under Miscellaneous Trees and Groves not Included in Sown Area	0.365
Current and other Fallow	1.723
Net Sown Area	16.732
Area Sown More than Once	8.075
Net Irrigated Area	11.662

Source: GoI, 1999.

TABLE 11.2

Important Features of Different Regions of Uttar Pradesh (Including Uttaranchal)

Particulars	*Region*					
	Hill	*Bundel-khand*	*Eastern*	*Central*	*Western*	*Total Average*
Total Population Million (1991 Census)	5.927	6.726	52.722	24.187	49.547	139.112
Percentage of State's Population	4.26	4.85	37.90	17.38	35.61	100
Density of Population Person Per Square Km.	116	229	614	528	603	473
Urban Population as Percentage of Total	21.5	2.34	11.58	23.99	25.36	19.88
Geographical Area m.ha	5.112	2.942	8.585	4.583	8.219	29.441
Culturable Area m-ha.	1.054	2.367	6.447	3.647	6.739	20.284
Net Sown Area m.ha	0.657	2.015	5.677	2.967	6.197	17.513
Area Sown More than Once-m.ha	0.405	0.365	2.854	1.523	3.385	8.532
Gross Sown Area–m.ha	1.062	2.380	8.531	4.490	9.582	26.045
Intensity of copping 9/7x100	163.0	118.0	150.2	151.3	154.5	148.7
Net irrigated Area m.ha	0.237	0.816	3.705	2.109	5.145	12.012
Percentage of Net Irrigated Area to Net Sown Area 11/7x100	36.2	40.5	65.26	71.1	83.0	68.6
Gross Irrigated Area	0.391	0.818	5.000	3.042	8.071	17.322
Percentage of Gross Irrigated Area to Gross Sown Area 13/7x100	36.5	34.36	58.6	67.75	84.3	66.5

Source: GoI, 1999.

The comparison, amongst regions, is given in Table 11.2.

11.2.2 Population Projections

In the past, from 1921 to 1961-1971, growth rate of UUP population was less than all-India, but it equalled and exceeded the all-India rates thereafter. Between 1981-1991 and 1991-2001, the all-India decadal growth declined from 23.84 per cent to 21.35 per cent, whereas for UUP, it increased from 25.42 per cent to 25.45 per cent.

These growth rates are given below:

The decadal population growth rate for Uttar Pradesh seems to be following the same trend as All India, but with a time lag. Considering the fact that currently the population growth rate of Uttar Pradesh is considerably higher than the all-India rate (1991-2001), the decadal growth for Uttar Pradesh up to 2050 is projected. For all-India projection, the NCIWRD (1999) projections, based on Visaria and Visaria (standard) as also UN (low) were used, as high and low variants, respectively. These have been used as a basis for projections for Uttar Pradesh.

The decadal growth rates, as projected for all-india (NCIWRD-High growth variant) and as projected by WAPCOS for Uttar Pradesh are given in Table 11.4.

TABLE 11.3

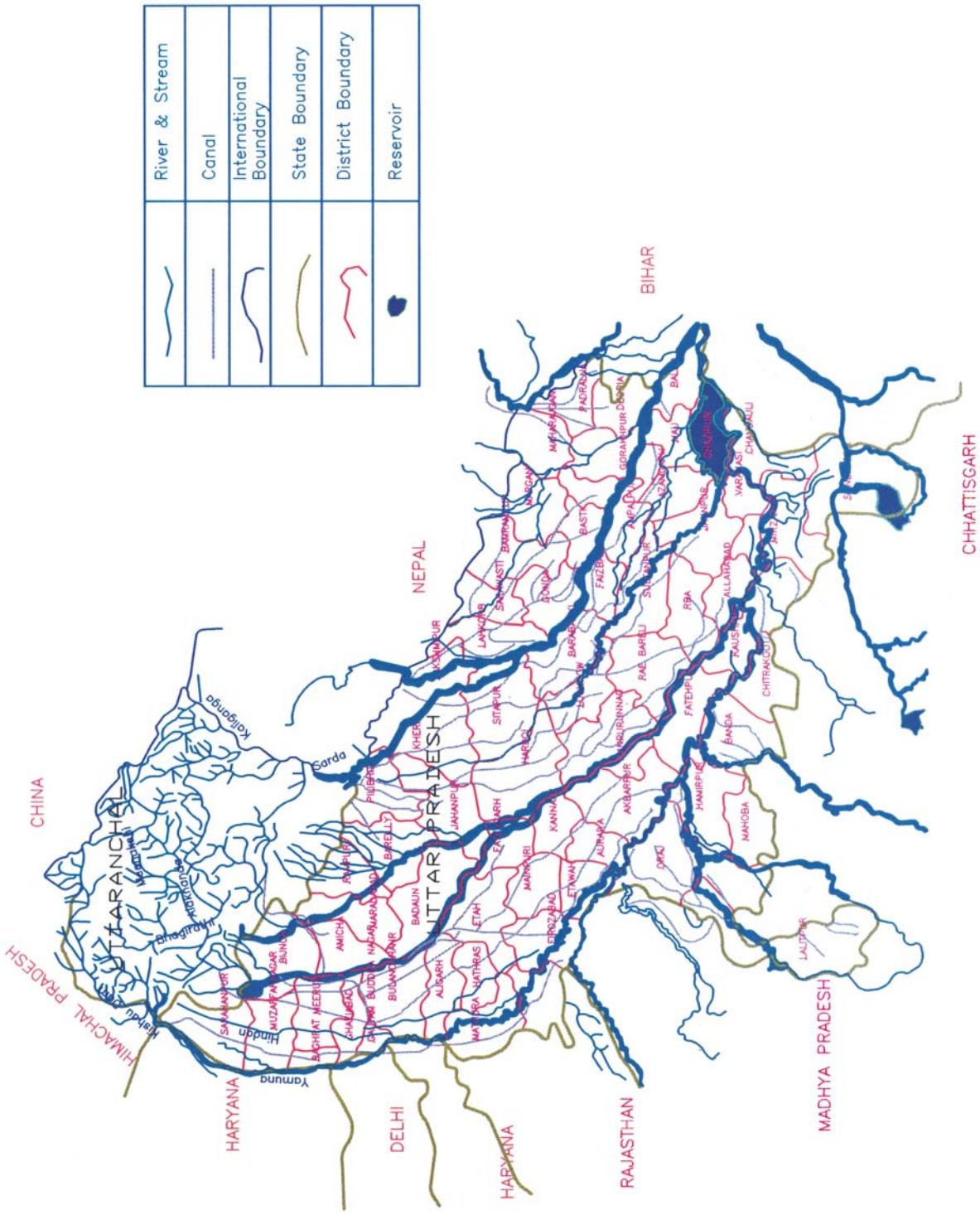
Population and Growth: Undivided Uttar Pradesh and India

Year	*Population (in Million)*			*Decadal Growth (Per Cent)*	
	Uttar Pradesh	*All-India*	*Uttar Pradesh as % of All-India*	*Uttar Pradesh*	*All-India*
1921	46.7	251.3	18.46	-	-
1931	49.8	279.0	17.84	6.638	11.02
1941	56.5	318.7	17.72	13.45	19.22
1951	63.2	361.1	17.5	11.85	13.30
1961	73.8	439.2	16.8	16.77	21.62
1971	88.3	548.2	16.10	19.69	25.23
1981	110.9	683.3	16.23	25.59	26.64
1991	131.0* +8.1# 139.1	846.3	16.43	N.A. 24.23 25.42	23.85
2001 (Provisional)	166.0* +8.50# 174.5	**1027.0**	16.17* **16.99**	25.80 19.20 **25.45**	**21.35**

Source: National Census (Various).

Notes: * Reorganised Uttar Pradesh; # Uttaranchal.

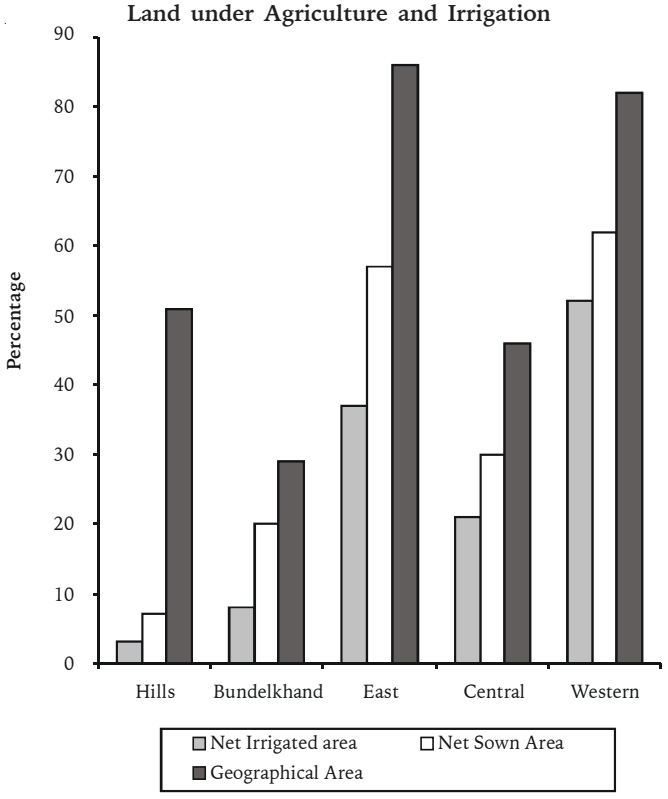
FIGURE 11.1
Irrigation Map of Undivided Uttar Pradesh



Source: UP Statistical Handbooks.

FIGURE 11.2

Land under Agriculture and Irrigation



Source: UP Statistical Handbooks.

TABLE 11.4

Population Growth Projection (High Growth Variant) for Uttar Pradesh

(in Million)

Year	*All India*			*Uttar Pradesh (New)*
	All India (Projection NCIWRD High)	*Actual Population*	*Decadal Growth Rate*	*Decadal Growth Rate (Assumed) for Uttar Pradesh (New)*
1990	-	846	23.86	-
2000	995	1027	21.55	25.8(Actual)
2010	1146	-	15.2	19.4
2020	1283	-	12	16
2030	1390	-	8.3	12
2040	1488	-	7	10
2050	1581	-	6.2	8

Source: WAPCoS.

11.2.3 Projecting Food Demands

The NCIWRD projected the food demand on the basis of the work of C. Ravi, pertinent to an economic growth rate of 4.5 per cent. After considering the change in consumption patterns, the growing food requirements, loss during transportation and storage, seed requirements and carry over for failures, the consumption rates (in kg per person per year) of 218.4, 245.2 and 319.5 for years 2010, 2025, 2050 have been used by NCIWRD. The same rates have been used for population projections. The resulting food demands are given in Table 11.5.

For comparison, this information is shown graphically in Figure 11.3.

FIGURE 11.3

Decadal Growth Rates, Actual and Projected

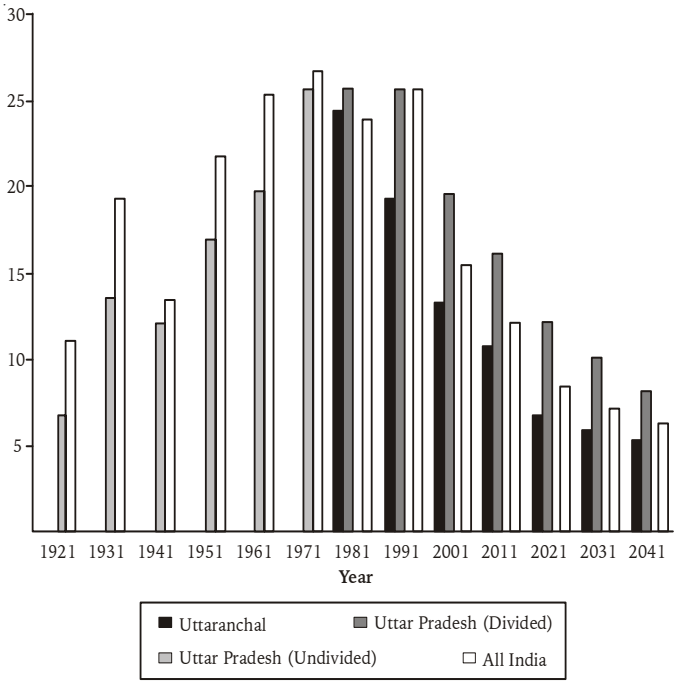


TABLE 11.5

Food Demand: Uttar Pradesh (New)

Year	*Population (Million)*			*Food demand (Million Tonnes/Yr)*		
	High Variant	*Low Variant*	*Average*	*High Variant*	*Low Variant*	*Average*
2010	198.1	194.2	196.2	43.3	42.2	42.8
2025	245.0	236.4	240.7	60.1	58.0	59.0
2050	305.9	260.1	282.9	97.7	83.1	90.4
Uttar Pradesh plus Uttaranchal						
2010	207.7	203.6	205.7	45.4	44.5	44.9
2025	255.7	246.7	251.2	62.7	60.5	61.5
2050	318.5	270.8	294.6	101.7	86.7	94.1

11.2.4 Land Use Planning

The Approach: The possibility of meeting the food requirement of Uttar Pradesh plus Uttaranchal through agricultural and irrigation growth was examined. (Self-sufficiency in foodgrains for the two states is a desirable objective, or a benchmark for comparison.) The general sequence is described in Table 11.6.

Crop Yields: These were projected using the NCIWRD projections as the basis. However, considering that the Uttar Pradesh yields are slightly better than the all India averages, following yields were assumed (Table 11.6).

TABLE 11.6

Projections for Food Crop Yields

(Tonnes/Ha)

Year	*All India Projection by NCIWRD*		*Projection for Uttar Pradesh and Uttaranchal in Present Study*	
	Rainfed	*Irrigated*	*Rainfed*	*Irrigated*
2010	1.1	3.0	1.1	3.0
2025	1.25	3.4	1.25	3.5
2050	1.5	4.0	1.5	4.5

Land use projections were made on regional basis. These are given below:

TABLE 11.7

Possible Land Use Plan

(All Areas in Mha)

Sl. No	*Particulars*	*Hills*	*Bundel-khand*	*Eastern*	*Central*	*Western*	*Total*
1.	Culturable Area	1.054	2.367	6.447	3.647	6.739	20.284
2.	Net Sown 0.66 Area - 2050	2.04	5.8	3.2	6.3	18.0	
3.	Net Irrigated Area (Current)	0.237	0.816	3.703	2.109	5.145	12.011
4.	Gross Irrigated Area (Current)	0.391	0.818	5.000	3.042	8.071	17.322
5.	Assumed Net 'Ultimate' Irrigated Area–2050	0.350	1.200	4.800	2.700	5.800	14.850
6.	Resultant Sown Area without Irrigation (2050)	0.31	0.84	1.00	0.50	0.50	3.15
7.	Gross Irrigated Area Assumed Ultimate	0.6	2.2	8.9	5.1	10.6	27.4
8.	Gross Cropped Area (Current)	1.062	2.380	8.531	4.440	9.582	26.045
9.	Gross Cropped Area Ultimate-2050	1.00	3.34	10.40	5.76	11.31	31.81
10.	Gross Cropped Area under Rainfed Condition (Ultimate)	0.40	1.14	1.50	0.66	0.71	4.41

The predominant logic in these projections is:

a) Net sown area, in all regions will be more or less stationary but a small increase of about 3 per cent in 50 years is projected (row 2).

b) In Central and Western Uttar Pradesh, almost the whole agriculture could be brought under some form of irrigation.

Comparatively larger net rainfed areas exist in the hills (mostly Uttaranchal and Bundelkhand) because of the sheer impracticability of irrigating higher lands, much above the valley floor, either on hill slopes or on plateaus. Even in the Eastern region, the south of the Ganga area in Sone and Tons sub-basins is somewhat similar in topography to Bundelkhand, and hence a larger net rainfed area is projected. With these considerations, row 6 of the above table was derived. Similarly, row 5 was calculated from rows 2 and 6.

c) The net irrigated area getting limited, the gross irrigated area is pegged as about 185 per cent of this (row 7). Significant area will remain under the long duration sugarcane crop, hot weather crops between *rabi* and *kharif* are unlikely to grow in a large way, both due to social factors and non availability of water in this lean season. (Both non-availability of storage of water and downstream commitment need to be kept in view.) These will make larger GIAs (gross irrigated area) impracticable.

d) Gross cropped area (rainfed, ultimate) row 10 was derived from row 6 by assuming practicable rainfed cropping intensity. Row 9 was worked out from row 7 and row 10.

Thus, non-availability of land would be an important constraint operating in Uttar Pradesh and Uttaranchal's agriculture and irrigation sectors.

A few points to note about this land use plan are:

a) In this calculation, the GIA for Uttar Pradesh plus Uttaranchal comes to around 27.4 m ha which is much smaller than the figure of about 30.499 m ha assumed in some earlier documents. It is felt that land (net sown area) and the sustainability consideration may not allow GIA to increase beyond 27.4 million ha.

b) The NCIWRD has given an outline state-wise figures of water use. In this, they have used the ultimate GIA for combined Uttar Pradesh at 30.5

m ha, made up of 13.7 m ha from surface and 16.8 m ha from ground sources. Our estimates fall somewhat short of these.

As regards the ultimate cropping intensities, the proposals made above are based on the considerations that though reclamation of degraded lands could be possible, but due to rapid urbanisation and round the year occupancy of sugarcane both the cropping intensity and the irrigation intensity cannot be increased beyond the proposed limits (any proposal for such an increase needs to be tested by drawing a land occupancy diagram depicting all the unirrigated and irrigated crops).

intensities and average figures of 'Delta' as presented in our report are based on the national perspective of food grain requirement and the assumed consumptive use. Diversified agricultural practices as suggested in the agriculture sector report are not likely to significantly change the overall irrigation water requirements.

11.3 Water Requirements

11.3.1 Water Requirement for Irrigation

The NCIWRD national figures about water depths requirement for irrigation are used. These are depicted in Table 11.9.

TABLE 11.8

Assumed 'Ultimate' Development Scenarios (Agricultural Production Capacities)

All Figures as Areas in Mha

Particulars	*Hills*	*Bundelkhand*	*Eastern*	*Central*	*Western*	*Total*
Gross Cropped (Total 2050)	1.00	3.34	10.40	5.76	11.31	31.81
Gross Crop Irrigated Area	0.60	2.2	8.9	5.1	10.6	27.40
Gross Cropped Rainfed	0.40	1.14	1.50	0.66	0.71	4.41
Gross Food Crop (Irrigated)(about 75% of GIA)	0.45	1.65	6.47	3.82	7.95	20.34
Gross Food Crop under Rainfed Area (about 70%)	0.30	0.80	1.05	0.46	0.50	3.11
All Figures in Million Tonnes/Year						
Ultimate Yield Irrigated Area Yield 4.5 t/ha (2050)	2.03	7.43	29.11	17.19	35.77	91.53
Ultimate Rainfed Area Yield 1.5 t/ha (2050)	0.45	1.20	1.58	0.69	0.75	4.67
Total Yield 2050	2.48	8.63	30.69	17.88	36.52	96.20

11.2.5 Land Use Plan vis-à-vis Food Requirement

Using the yields and land use as projected, and making assumptions about land for non food crops, the agricultural production possible is computed as follows (Table 11. 8).

A comparison of these capacities with demand shows that in general, regional self-sufficiency may be possible, but some shortages under the high population variant may occur. However, this is a conclusion based on the land availability constraints, but without considering the usable water availability constraints and constraints of engineering possibilities. (These aspects are studied later, and the conclusion is found to stand.)

The report on Revitalising Agriculture in Uttar Pradesh and Uttaranchal has made certain general observations regarding diversification of agricultural practices to improve the financial returns from agriculture. No specifics regarding the changes in cropping pattern have been suggested. The quantum of water earmarked for irrigation based on irrigation

TABLE 11.9

Irrigation Water Requirements (Depth/Season) (Ultimate, 2050)

	Gross Irrigation Requirements at Head (Metres)	*Net Irrigation Requirements (Consumption) (Metres)*
Surface Water Irrigation	0.61	0.36
Groundwater Irrigation	0.49	0.36

Using these on the land use plan, and by assuming that the ultimate irrigation of 27.4 m ha is composed of 12.4 m ha of surface water irrigation and 15.0 million ha of groundwater irrigation, the irrigation water requirements are computed in Table 11.10.

11.3.2 Water Requirements for Domestic (Municipal) Use

Norms: Different supply norms are being used by Central Public Health Engineering Organisation and the

Uttar Pradesh Jal Nigam. Norms again vary between rural and urban areas, with population, by type of supply (stand posts, home connection, etc), between hills and plains etc; and range from 40 lpcd (litres per capita per day) to 200 lpcd. NCIWRD norms, as given in Table 11.1, have been used.

TABLE 11.10

Irrigation Water Requirements

(All Figures in Billion M³/Yr i.e. BCM/Yr.)

	Gross (Withdrawals)	*Net (Consumption)*
Surface Water Irrigation of 12.4 m ha	75.6	44.6
Groundwater Irrigational 15.0 m ha	72.0	54.0
Total	**147.6**	**98.6**

TABLE 11.11

Domestic Water: Projection of Norms for Drinking Water (in LPCD)

Population Type	*Year 2010*	*Year 2025*	*Year 2050*
Class I Cities	220	220	220
Other than Class I	150	165	220
Rural	55	70	150

Population: To use these norms, the projected population was to be divided between urban and rural areas, as also between Class I cities and other cities. The NCIWRD has already projected urban and rural population on an All India basis, and guidance was taken from these. The urban population was assumed to be 32 per cent, 37 per cent, 44 per cent and 55 per cent of the total, for 2001, 2010, 2025 and 2050 respectively. It was assumed that this is equally divided between Class I cities and the other cities. On the basis of these, the water requirements were worked out (Table 11.12).

TABLE 11.12

Domestic Water Demand (Withdrawals)

	Year 2010 Uttar Pradesh	*Year 2025 Uttar Pradesh*	*Year 2050 Uttar Pradesh*
Population (in Million)	198.2	245	305.9
Water Demands (in BCM/Yr.)			
Urban	4.95	7.77	13.5
Rural	2.5	3.52	7.53
Total	**7.45**	**11.29**	**21.03**

11.3.3 Water Demand for Electric Power

These are computed as follows (Table 11.13), based on UPSEB projections:

TABLE 11.13

Consumptive Use of Power

Item	*Rate*	*Consumptive Use (BCM/Yr.)*	
		2025	*2050*
Hydropower (Ultimate Storage 28.36 (BCM)	10% of storage	1.50	2.83
Thermal Power 50000 MW by 2025 125000 MW by 2050	3.92 million m^3 per 100 MW per year	1.96	4.9

Industrial Requirements: NCIWRD has made All India projections for water requirements for different types of industries. Considering that the present status of low industrial development of Uttar Pradesh and Uttaranchal may improve in the future, the following assumptions have been made (Table 11.14).

TABLE 11.14

Industrial Water Requirement (Withdrawals)

(All Figures in BCM/Yr.)

	2010	*2025*	*2050*
All India (NCIWRD)	37	67	81
Share of Uttar Pradesh + Uttaranchal	5%	7.5%	10%
Uttar Pradesh + Uttaranchal	1.85	5.02	8.1

As per NCIWRD, 50 per cent of this is assumed as return flow.

Environmental Requirements: No estimates or norms for low flow requirements for maintenance of river ecology exist. However, separate provisions of large quantities for meeting downstream obligations have been made, and hence no special release for this purpose would be required.

The non-irrigation demands for Uttar Pradesh are as follows (Table 11.15).

11.4 Water Resources-Their Availability and Usability

11.4.1 The Approach

Water resources of a basin, which is a self-contained hydrologic unit, can be defined in a conceptually satisfying way. Deciding the availability and usability of

a non-basin entity becomes problematic since administrative and legal complexities add to the hydrologic complexities.

TABLE 11.15

Non-Irrigation Demands: Uttar Pradesh (BCM/Yr.)

Use	*2010*	*2025*	*2050*
Domestic	7.45	11.29	21.03
Hydro and Thermal	0.47*	1.96*	4.90*
Industrial	1.75	4.82	7.80
Environmental (Addition)	(Nil since considered in D/S Obligations)		
Total	**9.67**	**18.07**	**33.73**
Returns at 50% for domestic and industrial	4.45	8.05	14.41
Net in Consumptive Terms	5.22	10.02	19.32

Note: *Consumptive use.

The states of Uttar Pradesh and Uttaranchal are entirely within the Ganga sub-basin of the Ganga-Brahmaputra-Meghna (GBM) basin, which is shared by India with China, Nepal, Bhutan, Myanmar, and Bangladesh.

We proceed to decide the water availability for Uttar Pradesh and Uttaranchal in the following way:

a) Decide the average natural availability of all major streams upto their last sites, beyond which Uttar Pradesh cannot effectively use the water.

b) Decide the likely and reasonable upstream uses that may take place in other states/nations upstream of these sites. These uses may be the result of agreements or even mere assumption of a somewhat reasonable upstream requirement.

c) Consider the downstream obligations which Uttar Pradesh plus Uttaranchal may have to fulfill. Again, these may be either arising out of treaties and agreements or estimated on the basis of reasonability.

d) Of the remaining waters, it would be both impracticable and undesirable to plan for the use of all (average condition) floodwaters. A very considerable unusable flood flow would have to be catered for.

e) The remaining water can be used by Uttar Pradesh and Uttaranchal for various purposes. While doing so:

   i) The unity of the water resources has to be maintained. The water resource is total, but utilisation can be either through surface source or groundwater source.

   ii) Large return flows would be available and these also need to be accounted for, since these will either lend themselves for re-use in the same command (conjunctive use) or at other places on the downstream and can take care of downstream obligations.

11.4.2 Natural Availability

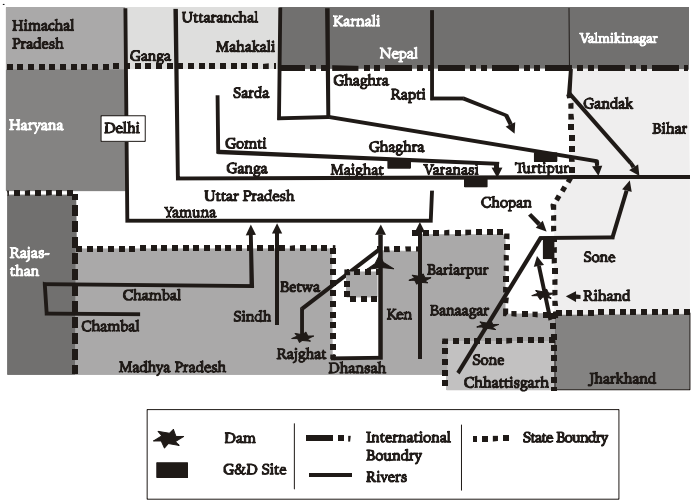
The schematic, showing the rivers of the region as also the last discharge measuring sites of interest for utilisation in Uttar Pradesh and Uttaranchal, is shown in Figure 11.4.

These five terminal sites are:

- Ganga at Varanasi,
- Ghaghra at Turtipar,
- Gandak at Valmikinagar,
- Sone at Chopan, and
- Gomti at Maighat.

FIGURE 11.4

Schematic Diagram Showing Rivers and States around Uttar Pradesh and Uttaranchal



"The Uttar Pradesh Perspective Plan 2025 (of year 2000) forms the initial basis for our work, although we have modified many assumptions."

The Uttar Pradesh Perspective Plan mentions that the observed dependable flow of these five sites was 178.4 BCM. If one corrects these for upstream uses, as also from dependable to average, the natural flow at the

five sites, (which will already include the groundwater base flow component) would be about 250 BCM.

11.4.3 Water Rights of Uttar Pradesh and Uttaranchal

In the absence of an accepted and enforceable law on water, the water rights of nations/states sharing an international basin are often nebulous unless these have been mutually agreed upon through treaties, agreements, accepted arbitration awards or adjudications. In this background, the positions of UUP and the successor states of Uttar Pradesh and Uttaranchal have been examined.

A. International Matters

The rights of UUP would thus be regulated by the rights of India on the Ganga. These are unquantified but partially regulated through the following agreements/treaties, etc.

(i) The Ganga water treaty dated 12-12-96 between India and Bangladesh for sharing Ganga waters at Farakka Barrage; Article VIII regarding cooperation in finding solutions to the long term problem of augmenting the flow of Ganga and clause (ii) of Article II regarding efforts being made by the upper riparians to protect the flows at Farakka are of comparative importance.

(ii) The Mahakali Treaty dated the 12-2-1996 between HMG of Nepal and India about the integrated development of Mahakali river.

B. Interstate Matters

There are a number of existing interstate agreements on the Ganga. The CWC compilation *Legal instruments on Rivers in India,* volume III, "Agreements on Interstate Rivers" (March 1995), lists and reproduces 21 such agreements and between 1892 to 1994. The more important agreements in regard to regulation of the UUP rights are given in Table 11.16.

Summarising, the Uttar Pradesh water development would have to take into consideration:

(a) Upstream Uses

(i) Upstream uses, as flowing out of Yamuna, Sone, Rajghat and other agreement, and Indo-Nepal agreements.

(ii) Upstream established uses in rivers like Chambal.

(iii) Likely future upstream uses, which can take place in the absence of any agreement.

(b) Downstream Obligations

(i) Rights of Bihar in regard to use of Gandak water, which is a boundary river.

(ii) The need to not cause appreciable or significant harm to Bihar, West Bengal or also to Bangladesh, in regard to the Ganga. Mostly, maintaining the low flows from January to May would be the main concern.

(iii) In regard to the southern tributaries of Ganga, UUP is the upper or middle riparian and Bihar is the lower riparian. The obligation would be in allowing the agreed share to Bihar on Sone or its tributaries (and not low flows alone since, for Sone sub-basin, there is a considerable possibility of storage development).

11.4.4 Upstream and Downstream Reservations as Made

After considering the position in 11.4.3, upstream and downstream reservations/obligations are considered as follows:

TABLE 11.16

Important Interstate Agreements

Date	*Parties*	*Subject*
12-05-1994	UP, Haryana, Rajasthan, Himachal Pradesh and Delhi	Yamuna water sharing
20-02-1952	UP, Madhya Pradesh and Bihar	Sharing of Kanhar waters
13-01-1977	UP and Madhya Pradesh	Rajghat, Paisuni, Ken canals, Kanhar, Urmil Ban saga and Bhander canal
9-12-1973	UP and Madhya Pradesh	Rajghat Project
16-09-1973	UP, Madhya Pradesh and Bihar	Bansagar Project
16-09-1973	Bihar and UP	Rihand
01-08-1972	UP and Madhya Pradesh.	Irrigation projects in Bundelkhand
18-10-1985	UP and Madhya Pradesh	Bhander canals Rangawa and Jamni Dam

The Uttar Pradesh Perspective Plan makes a total reservation of 56.6 BCM for upper and lower states. We accept these but add another 10 BCM reservation for Ghagra up to Turtipar, taking the figure to 66.6 BCM.

On the downstream, an average flow of about 2000 m^3/sec for 150 days of low flow period represents a low flow volume of about 28 BCM. The five terminal sites may have to together contribute about 15 BCM towards this.

11.4.5 Unusable Spills

The five terminal sites may have to contribute to an unusable spill of say 4000 m^3/sec average in the three monsoon months, thus discharging about 30 BCM.

11.4.6 Net Water Available to Uttar Pradesh Would Then Approximately Be

Natural Flow	250 BCM
Upstream Reserves	(-) 66
Downstream Obligations	(-) 15
Unusable Spill	(-) 30
Net	139 BCM

11.4.7 Balancing Demands and Supplies-Year 2050

Demands in Withdrawal Terms are as follows:

- Domestic Water Supply 21.91 BCM/Yr.
- Industrial Demand 8.10 BCM/Yr.
- Power Demand 7.70 BCM/Yr.
- Agricultural Demand 147.60 BCM/Yr.

Total 185.31 BCM/Yr.

Net Demand (in Consumption Terms)

- Domestic Water Supply at 50 per cent of Withdrawals 10.95 BCM/Yr.
- Industrial Demand at 50 per cent of Withdrawals 4.05 BCM/Yr.
- Power Demand 7.70 BCM/Yr.
- Agricultural demand 98.60 BCM/Yr.

Total 121.30 BCM/Yr.

Return Flows

- From Irrigation at 70 per cent of Imbalance 0.7 x (147.6 – 98.6) 34.30 BCM/Yr.
- Water Supply 10.95 BCM/Yr.
- Industries 4.05 BCM/Yr.

Total Return 49.30 BCM/Yr.

- Approximate Natural Availability to Uttar Pradesh 139.00 BCM/Yr.

Total Availability Including Returns 188.30 BCM/Yr.

Hence, overall precarious balance exists, with a total availability of 188.30 BCM/Yr, slightly exceeding the total withdrawal demand of 185.31 BCM/Yr.

11.5 Engineering Possibilities *vis-à-vis* the Land Use–Water Use Plan

11.5.1 Major and Medium (M&M) Sector

Status of Water Development: Agriculture and related activities formed a dominant sector of the economy of the UUP contributing about 40 per cent of its GDP. Water is one of the crucial elements of development planning. The planning of this limited resource has therefore, guided the overall development perception of the state.

The irrigation map of Uttar Pradesh and Uttaranchal is already depicted in Figure 11.1.

The action taken in regard to the major and medium irrigation developments in the area during the plan era is shown in Table 11.17.

Major and medium developments relate entirely to public surface water development, which is carried out through the large multipurpose project (MPP), major irrigation projects (GIA as planned exceeding 10000 ha) and medium irrigation projects (GIA between 2000 ha and 10000 ha). The smaller surface projects, public or private, as also groundwater irrigation is classified under minor irrigation.

The large number of projects taken up during each plan, number of completed projects and spillovers are depicted in Table 11.18.

The decreasing relative importance of the major and medium irrigation sector in the state plans is reflected in Table 11.19.

The achievements of the M&M irrigation sectors in regard to utilisation of water, sub-basin wise, is depicted in Table 11.20; and that in creating storages is given in Table 11.21.

TABLE 11.17

Expenditure and Potential Creation by Major and Medium Projects

(Expenditure : Rs. Million; Potential : Million Ha)

Plan Period	*Expenditure*		*Irrigation Potential Created*	
	During	*Cumulative*	*During*	*Cumulative*
Pre-plan Period	N.A	N.A	-	2.553
First Five Year Plan (1951-56)	308.10	308.10	0.333	2.883
Second Five Year Plan (1956-61)	254.30	562.40	0.271	3.154
Third Five Year Plan (1961-66)	549.00	1111.40	0.357	3.511
Annual Plans (1966-69)	489.30	1600.70	0.096	3.607
Fourth Five Year Plan (1969-74)	1724.80	3325.50	0.473	4.080
Fifth Five Year Plan (1974-78)	3718.90	7041.40	1.117	5.197
Annual Plan (1978-80)	2960.80	10002.20	0.397	5.594
Sixth Five Year Plan (1980- 85)	9242.60	19244.80	0.621	6.215
Seventh Five Year Plan (1985-90)	12450.10	31694.90	0.443	6.658
Annual Plan (1990-91)	3004.40	34699.30	0.083	6.741
Annual Plan (1991-92)	2155.20	36854.50	0.048	6.789
Eighth Five Year Plan (1992-97) (State)	15122.20			
(NABARD)	1592.40			
(A.I.B.P.)	665.4			
	17380.00	54234.50	0.254	7.043
Ninth Five Year Plan 1997-2002				
a) 1997-2001 (State)	11187.6			
(NABARD)	4073.9			
(A.I.B.P.)	7957.3			
	23218.8	77453.3	0.779	7.822
b) 2001-2002* (State)	4846.2	++		
(NABARD)	1450			
(A.I.B.P.)	3500			
**Proposed*	*9796.2*	*87229.5*	*.144*	*7.966*

++ Includes 1500 for Externally Aided Projects.

Source: Various UP Irrigation Department publications.

TABLE 11.18

Number of Irrigation Projects, Starts and Completions

Plan Period	*No. of Schemes Spillover/ Started/Completed*	*Category of Schemes*			
		MPP	*Maj.*	*Med.*	*Mod.*
Schemes Spilled over to IV (19-74)	12	1	4	7	-
New Schemes Taken up during IV Plan	16	1	5	10	-
Total	28	2	9	17	-
Completed during IV Plan	8	-	-	8	-
Balance Spillover to V Plan (1974-78)	20	2	9	9	-
New Schemes Taken up during V Plan (1974-78)	40	1	20	13	6
New Schemes Taken up during Annual Plan (1978-80)	13	1	4	2	6
Total	73	4	33	24	12
Completed during (1974-80)	3	-	1	2	-
Balance Spillover to VI Plan	70	4	32	22	12
New Schemes Taken up during VI Plan	6	-	1	5	-
Total	76	4	33	27	12
Schemes completed during VI Plan	13	1	5	7	-
Balance Spilled over to VII Plan	63	3	28	20	12
New Schemes Taken up VII Plan – 1 – Pathrai Dam (1986-87)	1	-	-	1	-
Total	**64**	**3**	**28**	**21**	**12**

Contd. ...

Contd. ...

Plan Period	*No. of Schemes Spillover/ Started/Completed*	*Category of Schemes*			
		MPP	*Maj.*	*Med.*	*Mod.*
Completed in VII Plan	23	-	4	13	6
Balance Spillover to (1990-91)	41	3	24	8	6
New Schemes Taken up in (1990-91)	2	-	1	1	-
1. Jarauli Pump Canal					
2. Linning of Safal Rajwaha					
Total	43	3	25	9	6
Completed in (1990-91)	4	-	2	1	1
Balance Spillover to (1991-92)	39	3	23	8	5
New Scheme Taken up in (1991-92)	2	-	2	-	-
Total		41	3	25	8 5
1- NWMP (Sarda)					
2- NWMP (Ramganga)					
Completed in (1991-92)	3	-	1	2	-
Balance Spillover to VIII Plan	38	3	24	6	5
Completed in VIII Plan	8	-	5	2	1
Scheme Dropped (NWMP–LGC)	1	-	1	-	-
Scheme Transferred to New Schemes Category (Kishau Dam)	1	1	-	-	-
Balance Spillover to IX Plan	28	2	18	4	4
Completed in (1997-98)	2	-	-	2	-
Balance Spillover to (1998-99)	26	2	18	2	4

Source: Various UP Irrigation Department publications.

TABLE 11.19

Plan Allocation–Trends in Uttar Pradesh

(Figures in Rs. Millions)

Plan Period	*State Outlay*	*M&M Sector Outlay*	*Percentage*
Fourth Five Year Plan (1969-74)	11655.70	1724.80	14.79
Fifth Five Year Plan (1974-78)	30936.40	3718.90	17.74
Annual Plan (1978-80)	10427.80	2960.80	18.02
Sixth Five Year Plan (1980- 85)	64932.90	9242.60	14.23
Seventh Five Year Plan (1985-90)	119487.40	12450.10	10.42
Annual Plan (1990-91)	32082.20	3004.40	9.36
Annual Plan (1991-92)	36955.40	2155.20	5.83
Eighth Five Year Plan (1992-97)	216035.60	15122.20	6.9
(NABARD)		1592.40	
(A.I.B.P.)		665.4	
Total VIII Plan		**17380.00**	**8.01**
Ninth Five Year Plan 1997-2002 Proposed	463400.00	2600.12	5.61

Source: Various UP Irrigation Department publications.

M&M Irrigation Sector: Future Developmental Possibilities

The tasks in the M&M irrigation sector for the future are:

i) completion of ongoing schemes,

ii) modernisation and rehabilitation, and

iii) new schemes to be taken up and completed.

TABLE 11.20

Major and Medium Schemes Completed from VI Plan to IX Plan

Type of Scheme	*Utilisation of Water in BCM/Yr. (Withdrawals)*			*Total*
	Ganga	Ghaghra	Sone	
Lift Irrigation Scheme	3.45	0.62	0.17	4.24
Diversion Scheme	3.44	11.88	-	15.32
Storage Scheme	7.54	0.04	0.55	8.13
Total	**14.43**	**12.54**	**0.72**	**27.69**

Source: Extract from UP Irrigation Dept. publication.

TABLE 11.21

Live Storage Creation in Uttar Pradesh

(All Figures in BCM)

Name of River Valley	*Completed Schemes*	*Projects under Construction*	*Projects under Consideration*	*Total*
Ganga	-	2.61	5.02	7.63
Yamuna	-	0.37	5.78	6.15
Ramganga	3.15	0.20	-	3.35
Ghaghra	-	0.04	2.52	2.56
Betwa	1.91	1.41	0.88	4.20
Sone	10.5	1.36	-	11.86
Total	**15.56**	**5.99**	**14.20**	**35.75**

Source: Extract from UP Irrigation Dept. publication.

The Ninth Plan targets, in regard to items (i) and (ii), as planned by the state, are given in Table 11.22.

TABLE 11.22

Schemes Proposed for Completion during the Ninth Plan Period

Year	*Major Projects*	*Medium and Modernisation Project*
1997-98		1. Revised tonnes pump canal
		2. Chittaurgarh reservoir
1998-99	1. Bewar Feeder	1. Modernisation of Ghaghar Canal
1999-00	-	1. Gunta Nala Dam
2000-01	1. Maudaha Dam (Excluding Charkhari P.C.)	
	2. Sarda Sahayak Phase-I	
2001-02*	1. Maudaha Dam (Including Charkhari P.C.)	1. Pathrai Dam
	2. Upper Ganga Irrigation Modernisation Proejct	
	3. Madhya Ganga Canal	
	4. Rajghat Dam and Canal	
	5. Eastern Ganga Canal	
	6. Gyanpur Pump Canal	
	7. NWMP Sarda Canal	
	8. New Tajewala Barrage	
	9. Providing Paddy Channel in H.K. Doab	
	10. Jarauli Pump Canal	
	11. Chambal Lift Scheme	

Note: * Proposed.

With the completion of these projects, a total additional irrigation potential of 1.0 m ha is expected. The remaining ongoing schemes when completed will create an additional potential of about 2.0 m ha. The balance of 2.5 m ha out of the total 12.5 m ha ultimate potential can be created on completion of the identified schemes which have not been taken up so for.

In regard to new schemes, the Uttar Pradesh Government has identified 33 schemes, which can be abstracted as follows: (Table11.23)

TABLE 11.23

Abstract of New Development Schemes

	Numbers	*Water Utilisation Possible (BCM/Yr.)*	*Irrigation Potential(M Ha)*
Storage Schemes	20	11.085	2.42
Lift/Diversion Schemes	13	1.263	

Note: The 33 listed schemes include both Pancheshwer (Indo Nepal) and its Indian alternative, Chamgadh. Only Chamgadh is considered in this abstract.

The future schemes thus heavily rely on storage development, mostly in Uttaranchal. Some of the notable storages amongst these are Uttayasu, Virat Sagar, Kosi, Kotli Behl in Uttaranchal as well as Panchanad, New Pathri and Rivai in Uttar Pradesh. Some of these new schemes may not be techno-economically or socially feasible.

Summary: M&M Sector

It can be seen that:

1) Large increases in the M&M irrigation potential (2.6 m ha to 8.0 m ha) have been achieved during the plan era of development through large investments.

2) The large spillover of projects (70, from Fifth to Sixth Plan) has been reduced (28, from Eighth to Ninth plan)

3) The relative outlay on the sector has reduced.

4) M&M schemes for further increasing irrigation potential by 2.42 million ha have already been identified. (However, all of them may perhaps not be feasible.)

The abstract of potential M&M schemes is as follows:

BOX 11.1

M&M Sector Irrigation Potential

i)	Irrigation Potential Expected to be Created up to End of Ninth Plan	8.00 m ha
ii)	Additional Irrigation Potential Likely by Completion of Spillover Schemes of Ninth Plan	2.00 m ha
iii)	Potential Likely from Schemes Identified but Not Taken up to Ninth Plan	2.42 m ha
	Total	**12.42 m ha**

11.5.2 Minor Surface Sector

Minor surface irrigation sector consists mainly of small surface tanks and small lifts.

The development statistics for UUP are given in (Table 11.24).

TABLE 11.24

Surface Minor Irrigation (Ultimate Potential 1.2 M Ha)

End of Year	*1984-85*	*1989-90*	*1997-98*
Cumulate Potential Created (m ha)	0.851	0.991	1.063
Cumulate Potential Utilised (m ha)	0.822	0.933	0.997

Thus, this sector has a small potential and little growth potential. Ultimately, the potential will increase from 1.0 m ha to 1.2 m ha.

11.5.3 Minor–Groundwater

Status: Availability of usable groundwater

Water resources of the state have been estimated as the total of the unified (surface and groundwater) resources. However, the utilisation can be assessed source wise.

The groundwater resource in the country was estimated by the Working Group (constituted in 1994-95) based on the large volume of hydrogeological and related data generated by Central Groundwater Board (CGWB) and State Groundwater Organisation as 432.0 BCM.

The estimates made by the state are almost the same as those by the CGWB. The region-wise breakup of the resource is as shown in Table 11.25. The available data has been processed to separate Uttaranchal and Uttar Pradesh.

Status: Groundwater Development

By the end of the Eighth plan, a groundwater potential of 17.80 m ha from private sources and that of about 2.9 m ha through state tube wells have been created. However, these figures, which are based generally on a standard command of 5 ha/shallow (pvt.) tube well and 100 ha for deep (state) tube well may be somewhat overstated. Also, in general, the correction in the number of functional private tube wells, due to tube wells going out of order, (which is called 'depreciation') is likely to be much larger than what is reflected in these estimates. The net potential created though the private sources could be only 12.25 m ha if 5 per cent per annum depreciation is assumed.

Much groundwater development has taken place after 1970, and can perhaps be related to rural electrification and improvement in rural roads. This got a further fillip due to the 'free boring scheme' after 1984.

The number of groundwater structures as of March 2000, without considering the depreciation are as follows:

State Owned	**Approximate Number**
Deep tube wells	29000
Privately Owned	
Dug wells/Bores	382000
Shallow tube well (Electrified)	576000
Shallow tube wells (Diesel)	3052000
Deep tube-wells	4000

TABLE 11.25

Groundwater Recharge from Different Sources

(as on 31.3.95) (BCM/Yr.)

Region	*Rainfall Recharge*	*Recharge from Irrigation Canals etc*	*Potential Recharge*	*Gross Recharge*
Western	15.603	7.682	6.884	30.169
Central	10.183	4.952	1.603	16.738
Eastern	20.085	5.806	4.148	30.039
Bundelkhand	3.234	1.084	0.076	4.394
Total Uttar Pradesh (New)	**49.105**	**19.524**	**12.711**	**81.340**
Uttaranchal	1.333	0.476	1.074	2.883
Grand Total	**50.438**	**20.000**	**13.785**	**84.223**

Groundwater: Future Possibilities

The CGWB (1995) *Groundwater Resources of India* gives the following position for UUP:

Total Replenishable Groundwater	83.21 BCM/Yr.
Reservation for Domestic/Internal	12.57 -
Availability for Irrigation (Net)	71.24 -
Usable for Irrigation (Net)	64.12 -
Utilisation, 1991 (Gross)	38.33 -
Net	26.83 -
Level of Development	37.67%
Resource Available for Future use	44.41 BCM/Yr.

On this basis, they estimate the ultimate groundwater irrigation potential to be 16.79 m ha.

(By 1997-98, the net utilisation had increased to 28.43 BCM as per the state statistics.)

11.5.4 Comparing Engineering Possibilities with Land and Water Use Plan

Summarising, the position is as follows (Table 11.26):

Thus, *prima facie*, the plan as presented here appears feasible from engineering considerations.

TABLE 11.26

Comparing Possibilities with Plans

Sector	*Ultimate Irrigation Possibilities as Per Development Planning M Ha*	*Irrigation Included in Present Land/Water Use Plan M Ha*
Major and Medium Irrigation	12.42	12.4
Minor Surface Irrigation	1.20	
Minor G.W. Irrigation	16.79	15.0

TABLE 11.27

Investments Required for Uttar Pradesh plus Uttaranchal Irrigation (2002–2050)

Item	*Details*	*Capital Cost in Rs. Billion at 2000 Price Level*
Major and Medium Projects	Para 12.2.4.	402
Surface Minor	Additional 0.2 million ha at say Rs.30,000 per ha.	6
Groundwater Development (Pvt.)	Addition 2.8 million ha (15.0 m ha minus 12.2. m ha) at say Rs.20000 per ha.	56
Groundwater Development (Pvt.)	Proportionate capital cost in power sector to install additional power stations to meet groundwater energy needs conversion of half of the existing groundwater area of about 9 m ha to electric supply, at Rs.30000/ha $0.5 \times 9 \times 10^6 \times 30{,}000/10^9$.	135
	For new area of 2.8 m ha $2.8 \times 10^6 \times 30{,}000/10^9$.	84
Total		**683 Billion**

11.5.5 Financing of Water Development

An approximate estimate of investments required for the residual irrigated agricultural developments is given in Table 11.27.

This investment of about Rs.683 billion is only the capital cost for agricultural use. Additional investment would be required for developing sources (as also for treating and disposal) of domestic and industrial water supply, which has not been considered here. Similarly, investments required for the hydropower development (beyond proportionate cost attributable to groundwater irrigation) are not considered.

This investment over 49 years would require a rate of investment of about Rs.14 billion per year (2000 prices). The present rate of investment is about Rs.3300 crores in the Ninth Plan, or about Rs.6.6 billion per year in the M&M sector.

For minor irrigation, the current expenditure levels (2000 prices) include Rs. 1.1 billion per year for government finance and Rs. 1.7 billion per year for institutional finance. To this, possible private investments of farmers owning a well at Rs. 0.6 billion/yr and a component of capital investments in the power sector of Rs. 1.0 billion/yr. is added, to provide for the increased demands of tube wells on power. This totals to Rs. 4.4 billion/yr.

Thus, the present level of investment for irrigated agriculture of around Rs.11 billion/yr. and the future investment of around Rs.14 billion/yr. (at 2000 prices) does not appear impracticable

However, due to shrinking public finances and privatisation, considerable investment may have to be from non-governmental sources. A possible plan can be as shown in Table 11.28.

TABLE 11.28

Irrigation Investment (2002–2050) by Use-Sectors and Sources

(in Rs. Billion)

Item	*Total Investment Required*	*Annual Rate of Investment*		
		Public	*Pvt.*	*Total*
M and M Irrigation	402	7.7	0.50	8.20
Surface Minor	6	0.10	0.02	0.12
Groundwater	56	-	1.14	1.14
Groundwater Electrification	135+84=219	2.0	2.47	4.47
Total		9.8	4.13	13.93
Total for 2002-2050		381	202	683

11.5.6 National Perspective for Water Resources Development

So far, this chapter has talked about the conventional water/irrigation developments as being envisaged by Uttar Pradesh. In addition, unconventional water developments, based on long distance water transfers, are possible and are receiving attention. In particular, the large storage possible in the Himalayas, (India, Bhutan and Nepal) hydropower generation and utilisation of the waters, both in the vicinity of the dams, or by successive westward transfers, in the water short areas of western and peninsular India.

The Himalayan component would provide additional irrigation of about 22 million hectares and generation of about 30 million kw of hydropower, besides providing substantial flood control in the Ganga and Brahmaputra basins. It would also provide the necessary discharge for augmentation of flows of Farakka required *inter alia* to flush the Calcutta port and the inland navigation facilities across the country.

National Water Development Agency (NWDA) was set up in July, 1982 to investigate such a National Perspective Plan.

BOX 11.2

Direct Interest Links to the Ganga Sub-basin

The Links of Direct Interest to the Ganga Sub-basin are:

1. Brahmaputra-Ganga Link (Manas-Sankosh-Tista-Ganga)*
2. Kosi-Ghagra Link
3. Gandak–Ganga Link
4. Ghagra-Yamuna Link*
5. Sarda-Yamuna Link*
6. Yamuna–Rajasthan Link*
7. Rajasthan–Sabarmati Link
8. Chunar-Sone Barrage Link*
9. Sone Dam–Southern Tributaries of Ganga Link*
10. Ganga–Damodar–Subernarekha Link*
11. Subernarekha–Mahanadi Link
12. Kosi–Mechi Link
13. Farakka–Sunderbans Link
14. Brahmaputra-Ganga Link (Jogigopa–Tista-Farakka)
15. Parbali–Kalisinda–Chambal*
16. Ken–Betwa**

Note: * For this link, surveys and feasibility studies are in progress.
**For this link, the feasibility study is complete.

Negotiations and agreements amongst the states involved in inter-basin transfer, preparation of Detailed Project Reports (DPRs), techno-economic appraisal of DPRs and investment clearance of the schemes, funding arrangements and fixing agencies for executions, etc. are essential steps which need to be taken, after the feasibility studies and before implementation.

Summarising

The full details of the National Perspective Plan have not been finalised yet and are not available. However, additional irrigation to the order of 22 m ha through the Himalayan component is being envisaged. Even if a part of the Himalayan component materialises, amongst other regions, the Uttar Pradesh–Uttaranchal area would also get additional usable water.

The present land and water use plan as projected in this study are not based on the national perspective and long distance water transfers. If the 'precarious balance' as projected in the present study is not achieved and water shortages are felt, the National Perspective Plan can meet these shortages. However, as per the present study, the land availability constraints are more serious than those in regard to water availability. Thus, the benefits of the national perspective plan would have to go mainly to other areas where land is comparatively plentiful and water is in short supply.

11.6 Limitations of the Land and Water Use Plan

11.6.1 Water Accounts

Although the water account has been worked out on the basis of a robust conceptual framework consistent with that used by NCIWRD, it suffers from the following limitations;

a) The massive hydrologic data available has not been utilised in firming up the figures. Similarly, the current utilisation is not based on full analysis of either the upstream withdrawals, or of the water balances and evapotranspiration estimates of upper uses. (The classified nature of the hydrologic data, the non-availability of utilisation data and the time constraints did not allow better analysis.)

b) The figures reflect the water account for the whole of UUP. This needs to be done basin-wise or at least for the constituents of the five terminal sites. The matching of demands and availabilities in such a desegregated fashion for smaller areas would bring out both the practicability of the use plan, or the need for considering inter-regional water transfers within Uttar Pradesh. For example, significant transfers from East Uttar Pradesh to Central Uttar Pradesh and on to West Uttar Pradesh may be possible, but transfer to Bundelkhand may be rather difficult, beyond the Ken Betwa link planned by NWDA.

c) The water account as worked out are for an average year. Even here, the year needs to be broken up into, say three seasons, and the balance including waters going to and coming out of surface and ground storages need to be worked out. Such a study would bring out the practicability of the plan with respect to storage availability.

11.6.2 Water Balance

A general water balance of the entire area, bringing out the rainfall of the state, the flows from other states/countries, natural and manmade evapotranspiration and flows downstream also needs to be established, and needs to be constant with (i) the basin water balance, and (ii) the state-wise water account.

11.6.3 Refinements

Refinements in water demands, including explicit consideration of water quality and ecology related demands are necessary. Similarly, the share of each of the five terminal sites in meeting the downstream low flow obligation is to be determined. More importantly, the division in this regard between the five terminal sites listed here and the areas/rivers downstream of these up to Farakka would have to be determined.

11.6.4 Recommendation

A review and reworking of these studies, overcoming these limitations, needs to be taken up, discussed, shared with other states, finalised as a working arrangement and reviewed where necessary.

11.7 Environmental Issues

11.7.1 Water Quality

Central Pollution Control Board (CPCB) classifies river water quality in five classes according to fitness, as following:

Class A: Drinking water source without conventional treatment but after disinfecting

Class B: Outdoor bathing

Class C: Drinking water with conventional treatment and disinfecting.

Class D: Propagation of wildlife and fisheries

Class E: Irrigation, industrial cooling, controlled wastewater disposal

The standards for these classes have been specified on the basis of chemical and biological parameters.

The surface and groundwater quality map of Uttar Pradesh is shown in Figure 11.5 and Figure 11.6. The problem reaches of river water quality are as follows:

1. Ganga

i) From Rishikesh to Kannauj - C

ii) Upstream Kannauj to Kanpur - D

iii) Kanpur downstream to Allahabad - C

iv) Varanasi - D

2. Yamuna

i) Delhi to confluence with Chambal - D

ii) In city areas of Delhi, Agra and Malhara - Partly E

3. Gomti

i) Upstream of Lucknow - C

ii) Lucknow to Junction with Ganga - Partly D and Partly E

4. Hindon

i) Saharanpur to Junction with Yamuna - E

The quality of groundwater in general is good but certain districts have patches of harmful contaminants. Fluoride limits in groundwater are considerably higher than permissible limits in many areas of Uttar Pradesh. Unnao, Rae Bareli and west of Bulandshahr, Aligarh, Agra axis have areas of concentration exceeding 1.5 mg/l. The western part of the state specially Aligarh, Mathura, Agra show a concentration of chlorides in isolated patches whereas in parts of Etah, west Bulandshahr and North Rampur the concentration is marginally higher than the permissible limits. Similarly, north west of Banda and Fatehpur and east of Allahabad have marginally high chloride concentration. Also, in the Orai-Jhansi-Lalitpur sector and Faizabad Sultanpur sector, nitrate concentrations in patches, exceed the permissible limit of 45 mg/l for drinking water, and reach up to 90 mg/1. Non-point sources of pollution from agriculture and other sources combined with point source pollution represent a major challenge for groundwater management.

11.7.2 Waterlogging and Salinity

Reliable data about waterlogging and salinity, in commands of M&M irrigation projects as also outside the commands is not available.

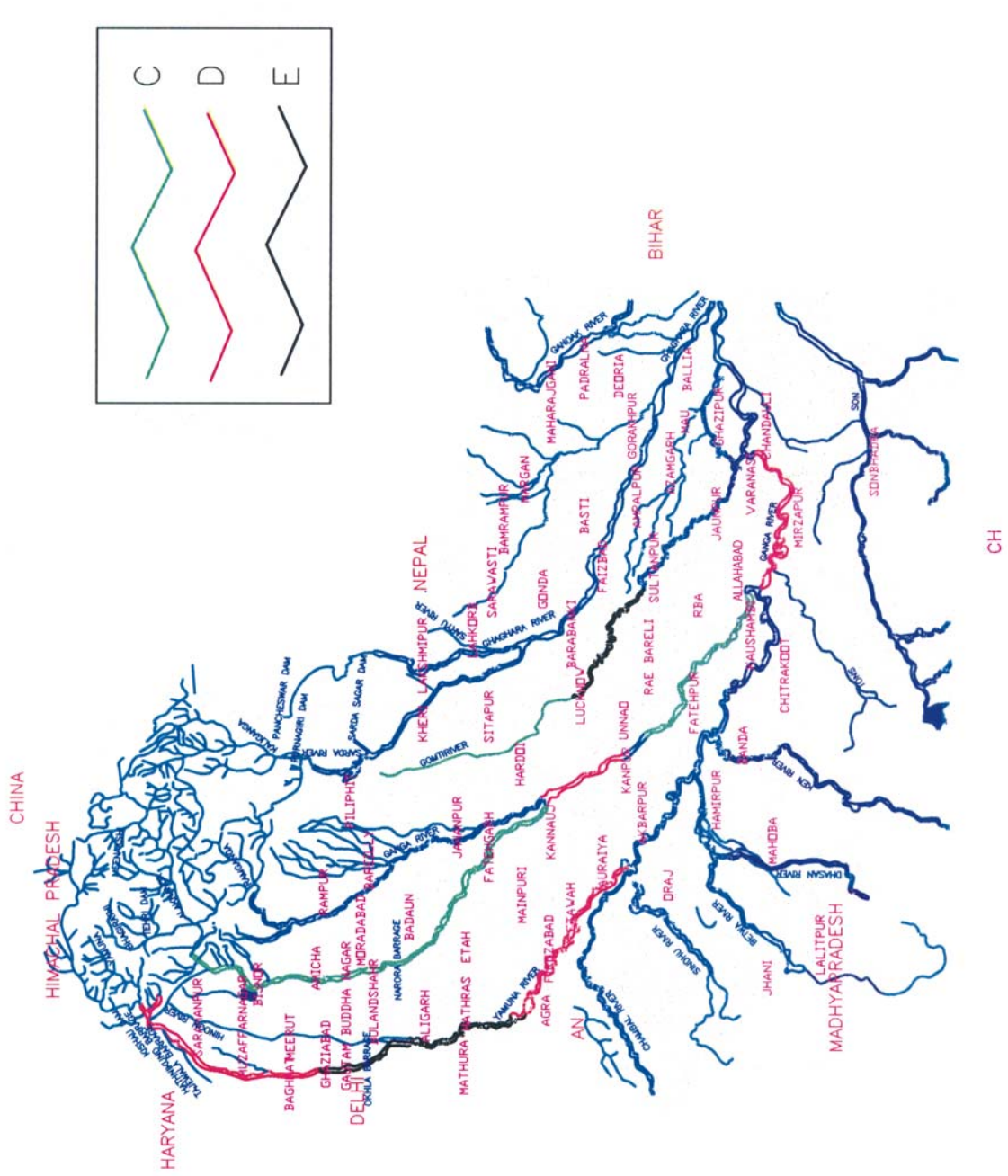
a) The working group of the Ministry of Water Resources (MOWR) mentioned the water logged area in M&M command in Uttar Pradesh as 0.43 m ha in 1991.

b) The earlier figure on the same given by the Irrigation Commission (1972) was 0.81 m ha. Similar figures were given by the National Commission on Agriculture (1976).

c) A National Seminar (Oct. 1992) of the state land use board brought out that three important commands (Gandak, Sarda Sahayak and Ramganga) had a waterlogged area of 0.71 m ha.

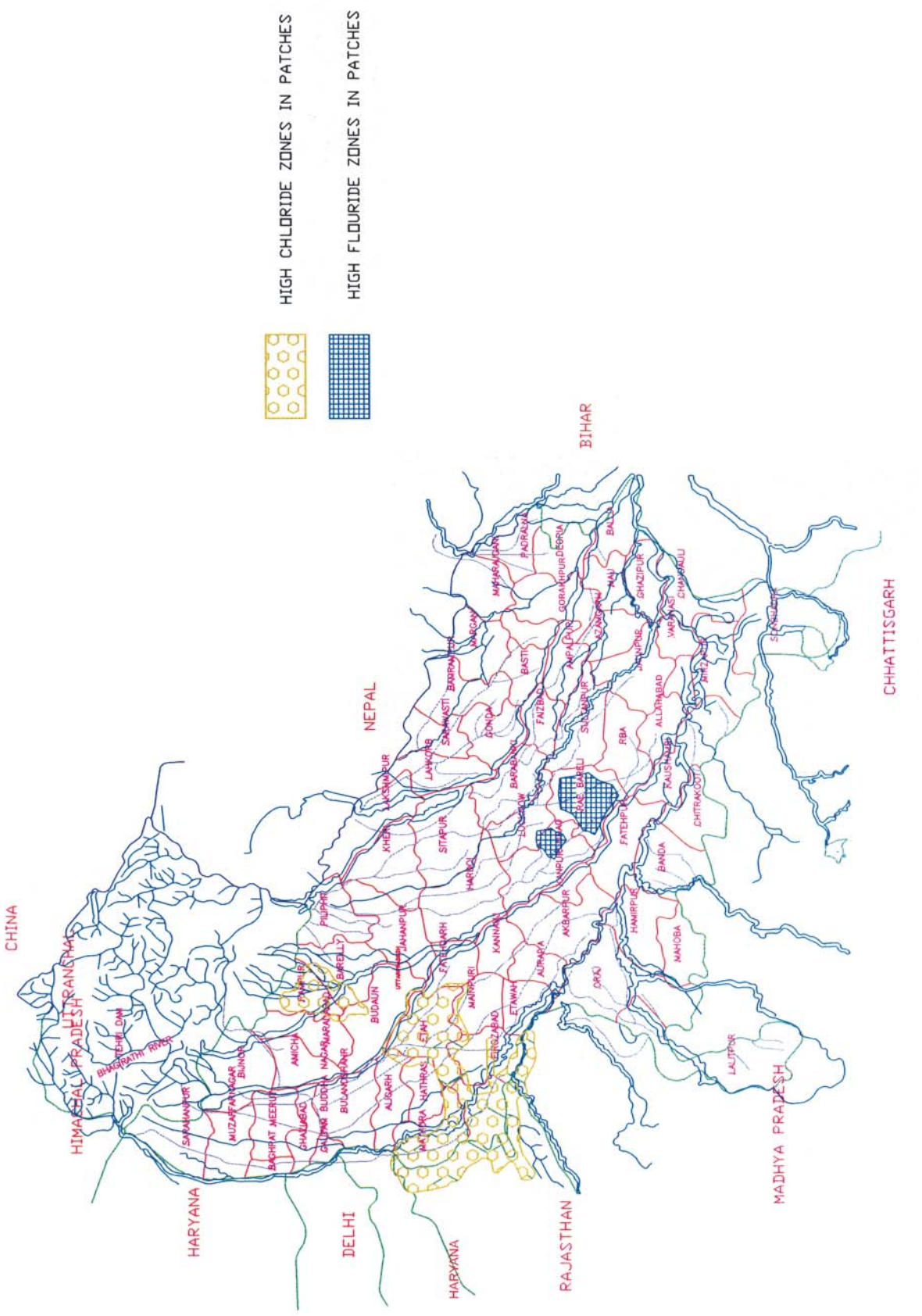
d) A study of waterlogged area (1999) using IRS–IB Liss for remotely sensed data was conducted for

FIGURE 11.5
River Water Quality Map of Uttar Pradesh and Uttaranchal



Source: Various UP Irrigation Department publications.

FIGURE 11.6
Groundwater Quality Map of Uttar Pradesh and Uttaranchal



Source: Various UP Irrigation Department publications.

15 districts of Uttar Pradesh. This brought out the following:

Geographic Area of the 15 Districts : 5.05 m ha

Permanently Waterlogged Area : 53321 ha

Temporarily Waterlogged Area : 56200 ha

The position of the salinised area is also similar. The 1991 MoWR working group put the figure of salinised area in M&M commands as 1.15 m ha. However, as per the Uttar Pradesh Agriculture, Directorate, 1.15 m ha is the total salinised land, including non-command lands. Of this 0.15 m ha has been reclaimed.

Data about groundwater, surface waterlogging and quality of soils and groundwater needs to be collated and firm estimates and maps about waterlogging and salinity need to be prepared every five years.

Where quality problems do not predominate, conjunctive use of groundwater can be very effective in water table control and can increase irrigation. The figures incorporated in our report are based on data made available by the MoWR, Government. of India, Government. of Uttar Pradesh and those adopted by the NCIWRD based on the MoWR working group (The Desai Committee). The area affected by sodicity in Uttar Pradesh is reported as 0.43 m ha while that affected by water logging is reported as 0.81 m ha.

11.7.3 Land Drainage

Surface and sub-surface drainage of agricultural land in general, and irrigated land in particular is essential to ensure productivity and sustainability.

In surface irrigation, major commands of Uttar Pradesh, particularly in the plains, surface drainages have been constructed to assist the carting away of excess rainfall/irrigation. The details of the lengths in this regard are given in Table 11.29.

TABLE 11.29

Surface Drains in Major Irrigation Commands

System	*C.C.A.(Ha)*	*Length of Canals (Km)*	*Length of Drains(Km)*
UGC	923421	6850	5119
LGC	1155069	8278	3780
EYC	221284	1610	937
Agra	327836	1825	929
Madhya Ganga	236635	1753	-
Sarda	1597661	10090	5023
Sarda Sahayak	1692074	15577	16642
Gandak	388590	3366	2637
Total			**35067**

As a separate project, under the sodic land reclamation project, the reclaimed land is being provided with surface drainage. Details in this regard are given in Table 11.30.

Not much is being done about sub-surface drainage. In some projects like Upper Ganga (Modernisation), Gandak and Sarju, vertical drainage through deep tube-wells and its conjunctive use is being provided for. Tile or pipe drains to cart away saline water have not yet been provided. Such interventions may be required in future in the brackish water zones.

11.7.4 Conjunctive Use

Introduction

The concept of conjunctive use of surface and groundwater as quoted in the CWC-INCID *Guidelines for Planning Conjunctive Use of Surface and Groundwater in Irrigation Projects* is as follows:

1. The concept recognises the unified nature of water resources as single natural resources, although the method of exploitation may involve both surface and groundwater structures.
2. The process takes advantage of the interactions between the surface and groundwater phases of the hydrological cycle, as also the natural movement of groundwater, in planning the use of water from the two phases.

   Thus, separate use of surface and groundwater in itself would not always constitute a conjunctive use. Conjunctive use need not necessarily mean mixing of surface and groundwater before its application on land for irrigation.

Integration of the use of water from two sources on land may involve different levels of time and space integration. For example, if one parcel of land is irrigated with surface water and if the excess irrigation results in additional groundwater recharge and if this recharge is allowed to flow to another adjoining parcel of land where it is extracted and used as groundwater, it is one way to meet conjunctive use. Another form would be to use surface water in one season (say, wet season) and to use groundwater in another season (say, in dry season) on the same parcel of land. Yet another form would consist of physical mixing of the water in a common distribution network. In respect of 'run of the river' schemes, watering given from the surface source may be supplemented with use of groundwater in the command.

TABLE 11.30

SLRP Plan for New Drainages

Existing Drains in SLRP Districts		*SLRIP-II Development Plan New Drainage Lengths to be Added (Km)*					*No. of New Drains*
District	*Drainage Lengths (Km.)*	*Yr.-1*	*Yr.-2*	*Yr.-3*	*Yr.-4*	*Total*	*Nos.*
Aligarh	1845	80	106	186	160	532	66
Allahabad	1270	111	148	259	222	741	134
Etah	1146	69	92	160	137	458	67
Elamah	816	62	83	146	125	416	89
Fatehpur	446	20	26	46	39	130	24
Hardoi	1893	65	86	151	129	430	52
Mainpuri	400	31	41	71	61	204	32
Partapgarh	2131	117	156	274	235	782	180
Rae Bareli	2874	198	264	463	397	1322	412
Sultanpur	1210	62	83	145	124	414	90
Total	**14036**	**814**	**1086**	**1900**	**1629**	**5429**	**1146**

The guidelines also give various strategies, which can be adopted in planning conjunctive use. These range from strategy 1, which allocates some land parcels towards surface water use and some towards groundwater use, strategy 2 which uses, for the same parcel, surface water at one time and groundwater at another time, within the year, and some other strategies derived from these. Apart from the strategies, conjunctive use planning also involves division of responsibilities between the Government and the farmers in regard to groundwater exploitation and regulation and decisions about preference amongst shallow and deep groundwater structures, about using a separate or integrated distribution network for surface and groundwater, and about preferred locations of groundwater structures, such as canal side, near *chak*, in individual fields, etc. A host of administrative, pricing and policy issues also need to be considered.

Conjunctive use not only allows optimum use of water through both sources for increasing irrigation, but also combats the twin menace of water logging as also of falling groundwater levels through proper planning and regulation. Thus, under normal circumstances, conjunctive use becomes an important tool for ensuring sustainability of irrigation.

Status

In Uttar Pradesh, a very large use of both surface and groundwaters has developed despite the fact that no integrated planning has been done by the government. Such separate use need not generally qualify as conjunctive use; but in the peculiar situation being obtained in the alluvial plants of Uttar Pradesh, much of this can qualify. The network of surface canals, branches, distributors and minors, covers much of the countryside and affords a very large area extent to the surface irrigation induced seepage. This seepage can flow to land parcels, which are not earmarked for surface irrigation, and can be used in providing groundwater irrigation (as envisaged in strategy 1). Even within irrigation commands, there are a few important *kharif* channel projects such as Madhya Ganga or Eastern Ganga, which are meant for surface irrigation only in the *kharif* season. In effect, the government has encouraged the farmers to use groundwater (stored under the command in *kharif*) during the *rabi* season (as envisaged in strategy 2). Even during a season when the irrigation department is supposed to provide required irrigation to a field, the farmers are known to supplement the surface irrigation through use of groundwater, either to overcome the reliability and timeliness related deficiencies of public systems, or to allow changes in cropping pattern. This is done even though the current laws and policies do not encourage such a proceed.

Properly planned conjunctive use ingrained in the planning of public projects is a rarity. The Sarju project and some other recent projects are supposed to implement conjunctive use plans.

The Analysis

Thus, in our opinion, the Uttar Pradesh farmers, through their own initiative have acted in such a way

that a replicable 'good practice' model of conjunctive use has developed on its own. To test this, the following analysis was undertaken:

(i) Fourteen districts in Uttar Pradesh alluvial plains fairly covered by canal network were chosen.

(ii) The agricultural statistics like reporting area, NSA, GCA, NIA, GIA, etc. for the above 14 districts were noted from the Uttar Pradesh statistical publication.

(iii) The expected natural groundwater recharge, recharge from canals and groundwater draft related information was collected from *Groundwater Resources of India*, CGWB (1995).

(iv) Using the CGWB data, the net draft as a percentage of natural recharge (ND/NR) was computed. Similarly, the canal recharge as a percentage of natural recharge (CR/NR) was computed.

(v) A regression of ND/NR on CR/NR was carried out and is shown in Figure 11.7.

The coefficient of correlation is very high at 0.8875. The graph also shows a family of curves, which depict the percentage of the net groundwater draft to the total recharge available from nature and from the canal. Of the total available recharge, only a part of it can be used for irrigation.

Results

From this analysis, it can be seen that:

(a) The quantum of groundwater use, which has developed in the Uttar Pradesh plains, is directly related to the quantum or recharge available from canals. Where no such recharge is available, only about 32 per cent of the natural recharge is used for groundwater irrigation. Districts, say, having a canal recharge equalling the natural recharge tend to use almost double the quantity (at 60%) and a few districts where the canal recharge is twice the natural recharge, triple the quantity of groundwater is used, compared to what they would have used in the absence of canals.

(b) The scatter of this graph indicates that there are no strong regional trends in this pattern of development of use. For example, districts using more groundwater than that indicated by the trend line include Basti in the east Uttar Pradesh, and Bulandshahr and Mathura in West Uttar Pradesh. Similarly, districts with less groundwater use, compared to the trend include districts from western Uttar Pradesh (Mainpuri), central Uttar Pradesh (Lucknow) and eastern Uttar Pradesh (Gonda, Baharaich).

(c) In general, in terms of net groundwater draft for irrigation, only 30 to 40 per cent of the total recharge is being used. With increasing per cent of canal recharge, this level tends to increase a little.

Discussions

The analysis supports the hypothesis about the model of 'good practice' in regard to conjunctive use having developed in Uttar Pradesh plains. However, a few districts like Bulandshahr, Mathura need to be careful in using the groundwater so that it does not become unsustainable.

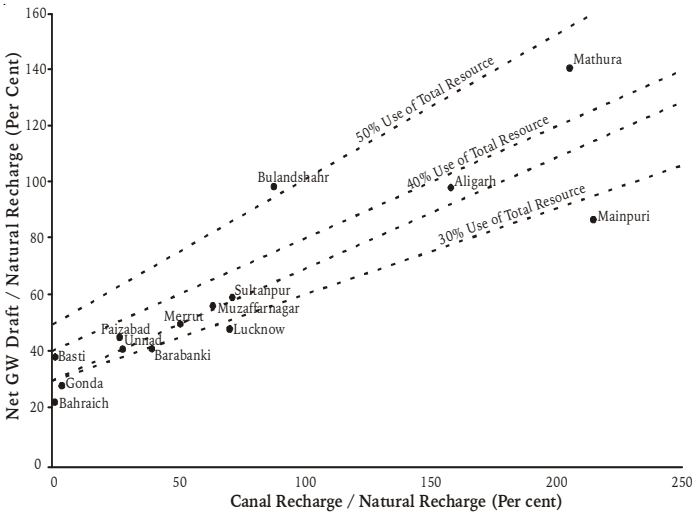
In general, the conjunctive use has succeeded in both avoiding large-scale water logging and also in avoiding overexploitation of resources. As discussed under 'analysis' the total use of resources through groundwater irrigation seems to range from little below 30 per cent (Mainpuri) to little above 40 per cent (Bulandshahr). The CGWB (1995) publication defines the level of groundwater development in a slightly different way. The districts listed by them as having levels exceeding 50 per cent include Badaun, Bulandshahr, Brjnor, Farrukhabad, Firozabad, Jaunpur, Mathura and Moradabad. CGWB (1995) also classifies blocks as overexploited or dark. In Uttar Pradesh, out of 895 blocks, only 19 are overexploited and 22 are dark. Thus, the overall situation is not very serious. (This can be contrasted with Tamil Nadu, where out of 384 blocks, 54 are over exploited and 43 are dark.)

Conjunctive use involves further disturbance of the groundwater balance, and involves larger recycling. In turn, this disturbs the salt balance of the area, both in the soils and in the groundwater. It is therefore necessary to work out the mass balance of the salts taking into account the salts brought in from the surface sources, the salts present in the soil and groundwater, the salts in the water infiltrating to the root zones and the salts percolating to the groundwater. Dilution of saline groundwater with better surface water and use of this mixture for irrigation is a workable conjunctive use strategy, but it could lead to problem in the long run. In long run, carting away the saline water to the sea is a more sustainable strategy.

In this background, the large-scale use of conjunctive use in the brackish water zones in

FIGURE 11.7

Regression of Net Draft on Canal Recharge



Aligarh, Mathura and Agra and in the smaller packets of Etah, Bulandshahr and Rampur requires further consideration.

Recommendations about Conjunctive Use

i) The 'good practice' in regard to conjunctive use, as developed in the plains of Uttar Pradesh requires proper documentation, analysis, publicity and demonstration, so that these could be improved and replicated.

ii) The various policies, pricing and administrative aspects, which hamper the growth of conjunctive use, need to be studied and modified. In particular, irrigation acts need to be modified and need to encourage, rather than discourage conjunctive use.

iii) Water Uses Associations (WUA) need to play an important part in regulating groundwater levels in the command, within tolerable range. The MOU between ID and WUA needs to provide for such a duty, with a provision for reducing surface supplies if groundwater levels show a rise.

iv) Research in modelling of conjunctive use as also in modelling of salt balances in commands is necessary. Such mathematical models, once established, should become operational tools. Necessary groundwater quality data needs to be collected.

v) Although the conjunctive use has worked well so far, continuation of this strategy in the brackish water zones needs to be studied carefully. Plan for subsurface drainage of these areas, to cart away the salts through rivers like Yamuna and Ganga need to be initiated now itself.

11.8 Floods

1) The flood prone areas of Uttar Pradesh are shown in Figure 11.8. In Uttar Pradesh, about 25 per cent of the geographic area is flood prone. The assessment of the flood prone area of 7.336 m ha is based on the extra ordinary large flood of 1978. The average annual area affected by floods is about 2.3 m ha. However, there seems to be no increasing trend in the area affected. The time series in this regard is depicted in Figure 11.9.

2) Uttar Pradesh's performance in giving protection to flood prone areas has been rather poor. So far, only 22.4 per cent of the flood prone area has been protected in Uttar Pradesh whereas the nearby states of Bihar, West Bengal, Punjab and Haryana have protected 60 per cent to 96 per cent of their flood prone areas. The comparison is shown in Figure 11.10.

3) There seems to be no increasing trend in the area affected by floods.

4) On an average, 383 persons and 1791 cattle perish in floods in Uttar Pradesh. The all-India averages are 1595 and 94000 respectively.

5) By the end of the Ninth Plan, 1.61 m ha were protected, 1910 km of embankments and 13072 km of drainage channels were constructed and 4511 villages were raised in Uttar Pradesh. However, the progress, from the Sixth Plan onwards, has been very slow.

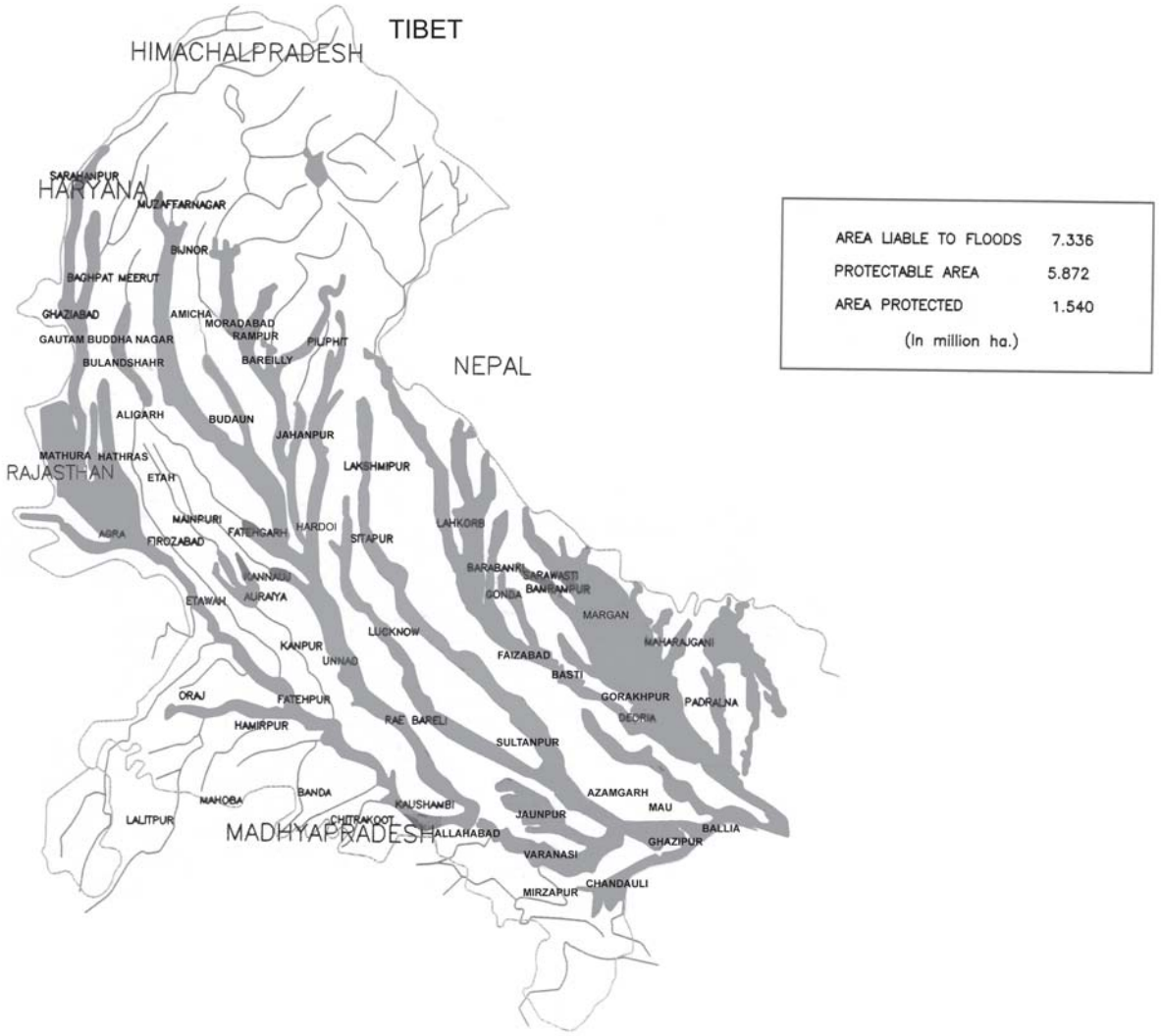
6) The expenditure of flood sector, as compared to the overall state plan has been coming down from 1.33 per cent in the Sixth Plan to a mere 0.17 per cent in Ninth Plan.

7) Perhaps, a frequency based delineation of the flood prone area, which appears more logical, needs to be adopted. If this is done, a single large flood may not increase the flood prone area.

8) Much larger expenditure on flood and erosion protection seems necessary since the flood risks may be acting as a constraint to the developments in some pockets.

FIGURE 11.8

Flood Prone Areas of Uttar Pradesh



Source: Various UP Irrigation Department publications.

FIGURE 11.9

Time Series for Flood Affected Areas

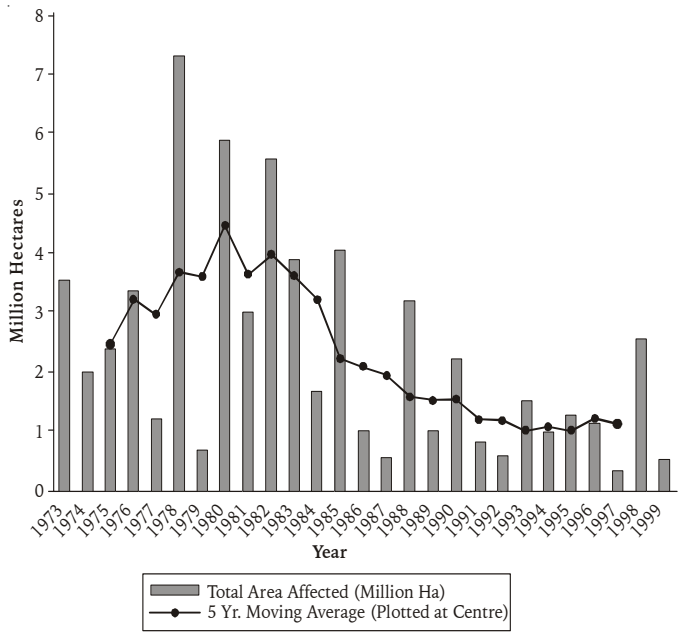
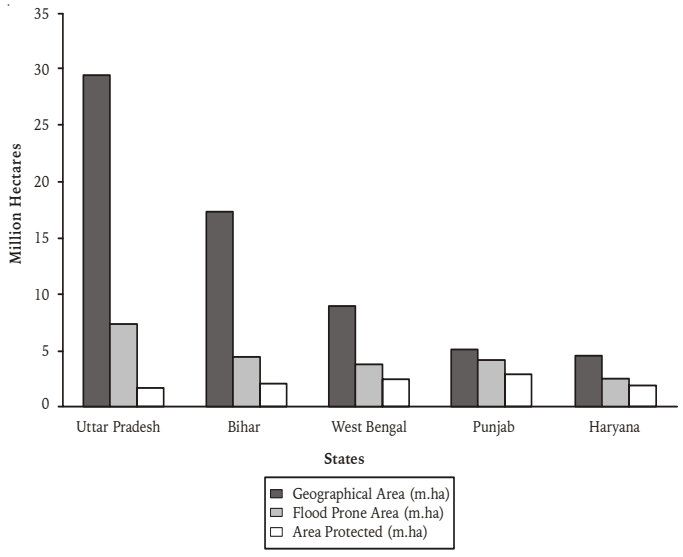


FIGURE 11.10

Comparison of Flood Protected Area



9) Serious consideration needs to be given to the desirability and practicability of flood plain zoning. If necessary, as a first step, all future decisions at least could be subjected to zoning regulations.

In addition, micro hydel potential of 635 MW has also been assessed in the state of which 400 MW is in Uttaranchal and 235 MW in Uttar Pradesh (new).

11.9 Issues in Water Management

11.9.1 Dealing with Old Irrigation Systems

(i) Structural Problems Requiring Replacement

At many places the old structures have either out lived their physical life and are under distress or are not able to meet the present day operational requirement. For example four major drainage crossings on the upper Ganga Canal are being replaced for risk aversion. Nanak Sagar Dam was rebuilt after an initial failure. Lachura head works of the Dhasan canal system need replacement.

(ii) Considering New Information in Regard to Design

Design standards may have to be changed due to unexpected earthquakes and dams may have to be strengthened. Unexpectedly large floods may require additional spillway capacities to be added. A dam safety programme to tackle such problems is under process in the state and rehabilitation of dams under distress has being included as a part of Tenth Plan Programme.

In Ramganga, Matatilla and Rihand, (i.e. all the three mega storages available in the region), the dams have caused safety related concerns, (structural and hydrologic). These need to be addressed on priority.

(iii) Meeting Increasing Demands

The increase in demand for water may be due to additional irrigation areas or changing cropping patterns, particularly due to crop varieties requiring larger amount of water. It may be possible to meet such demands after modification. For example the old capacities of upper Ganga canal, eastern Yamuna and Agra canals have been increased. The upper Ganga canal capacity was increased from about 180 m^3/sec to about 300m^3/sec. The Eastern Yamuna canal capacity has been increased from 70 m^3/sec to about 113 m^3/sec. The Agra canal capacity has been increased from 60 m^3/sec to 113 m^3/sec. Additional storage systems have been added on storage fed canals in the Bundelkhand region and capacities of large pump canals have also been increased in the recent past.

(iv) Catering towards Improved Management

Improvement in irrigation management would *inter-alia* require the following specific actions to conserve the resource and optimise its use efficiently.

(a) Reducing Water Losses

Selective lining in reaches of high seepage is a measure of conservation of water. Sarada Sahayak and parallel upper Ganga canals are some such cases. Recharge of the groundwater should be carefully looked into before deciding on lining proposals. Selective reaches have been lined in the Madhya Ganga and Eastern Ganga canals also.

(b) Providing Control Structures

Provision of suitable and better control structures on the canal distribution systems may ensure better water distribution.

(c) Provision of Field and Trunk Drains

Some of the old canal systems did not provide for adequate field and trunk drainage net works. However when problems cropped up drainage facilities were provided like in the case of Sarda Sahayak, Gandak and Ramganga projects. Adequate provision for drainage has been made in Saryu project also.

(d) Installation of Conjunctive Use Component

As demands grow or as need for vertical drainage is felt, conjunctive use of groundwater in the commands will be required to be adopted. This can be achieved through action of individual farmers installing their private tube-wells as has happened in most of the western Uttar Pradesh. However in projects like Gandak and Saryu, large-scale public efforts are necessary.

(e) Provision of Better Distribution Network

Some of the old systems did not have any field channels beyond the outlet catering for areas up to 40 ha. But now water is provided to 5 to 8 ha blocks beyond which the farmers will have their own field channels. Such extensions have been done mostly through command area development authorities in projects like Sarda Sahayak, Ramganga, Gandak, Sarda and a few others.

(v) Lack of Maintenance

The canal systems in Uttar Pradesh have generally lacked proper maintenance for want of sufficient funds and this requires special programmes.

Performance Review of Existing Projects

It would be necessary to conduct performance review of all stabilised irrigation/water projects and to bring out the performance in terms of some agreed performance indicators. Although a large number/types of indicators are possible, the following appear important:

a) irrigating a desired quantum of area,

b) efficiency of water distribution and utilisation including efficiencies after considering conjunctive use and reuse, and

c) equity in water distribution.

11.9.2 Improving Canal System Operation

The essential constituents of a large irrigation distribution system are as follows

1. Primary System–For water conveyance (main and branch canals)
2. Secondary System–For water distribution (distributories and minors).
3. Tertiary System–For water delivery (Field Channels)

Normally the primary system runs continuously, throughout the irrigation season, at full or partial discharges. The secondary system can also be planned to run continuously through out the irrigation season. However, more often (and in all cases in Uttar Pradesh), these are run for only a part of the time. The field channels serve only on time sharing basis. This is necessitated by the minimum discharge which channels can carry which is around 30 lit/sec.

In Uttar Pradesh, 'warabandi' is practised at the irrigated chak, serving 10 to 15 holdings totalling 5 to 8 ha. The field channels run continuously during the week when the secondary system is carrying water and consequently all chaks on that part of the secondary are receiving water. The *chaks* are ungated, and as the chak supplies water, this is shared on time sharing basis by all land holdings.

Though the 'warabandi' method of water allocation is widely practised in the state, the main difficulty in operationalising it is traceable to deliberate malfunctioning of the secondary system during partial discharges, where the head secondary system can still draw 100 per cent by manipulating the cross and head regulators and causing serious equity problems on the downstream.

Three broad methods have been advocated to avoid this situation:

1. Actively involve farmers in management of not only tertiary (which is the present norm) but also the secondary system; have deliberative committees where farmers of different secondary systems discuss problems together. This will curb tendency of manipulation. This method lays stress on PIM.
2. Avoid partial running. All systems should run at 100 per cent discharge and cuts can be imposed on time (say two weeks running in one month). Also have proportionate distributories instead of head and cross regulators on secondary system, so that only a specified percentage flow can be taken in an off taking channel.
3. Have a full scale automated system with computerised controls.

Currently, in Uttar Pradesh the situation can be described as follows:

a) In West Uttar Pradesh, because of water stress and larger awareness, w*arabandi* works fairly well.

b) In other parts of the state, *warabandi* does not work very well and the state government. is stressing the need for formulating active F.O.'s and encouraging PIM to make it work.

11.9.3 Canal Automation

In the conventional design of a canal system, a steady state condition with a steady (time invariable) flow in all the elements is assumed. In actual field conditions, water demand changes from day to day due to weather conditions, rainfall and field operations.

The supplies from the headworks take considerable time to reach the place of demand, thus balancing supply and demand becomes difficult when the demand reduces. Even if supplies are reduced after receiving the reports of rainfall, the reduction may take 3 to 4 days to be effective in the command.

Canal automation upgrades the system and provides better match between the canal deliveries and current demand. Automation works on the principle of 'on demand' deliveries, to the user. Thus anyone who wants water gets it from the storage in the canal. Similarly, in case of any breach, or even a quick reduction in demand, the water flowing in the upstream canals gets stored, and this reduces wastage. In this method the canal system serves both as a conveyance and a storage element.

11.9.4 Summary

(i) Since Uttar Pradesh has many old irrigation systems, improving water management in the old public irrigation systems is an important problem for Uttar Pradesh. It is recommended that all old stabilised irrigation/water projects in Uttar Pradesh be subject to a performance review.

The review needs to bring out important performance indicators, as discussed in 11.10.1

(ii) Based on the performance review, projects with poor performance and scope for improvement need to be chosen for framing and implementing ERM projects, or for special maintenance/repairs.

(iii) When implementation of restoration/ improvement works is time taking, during the transition period, operational plans based on the existing system capabilities need to be framed.

(iv) Uttar Pradesh's canal operation and field water distribution methods are based on *warabandi*, but the performance of *warabandi* is not uniformly good.

There seems to be a significant scope for adopting the ON-OFF system, with proportionate distributories at the secondary level, by giving up control structures on secondaries which cannot be managed well. Such systems may provide better upstream-downstream equity since manipulation may become difficult. Pilot implementation of such systems, particularly in the central Uttar Pradesh areas is recommended.

(v) In different topographic conditions such as in Bundelkhand or in Sone–Tons areas, use of small chalk size and use of gated turnouts (as is common in the Shejpali areas of western India) seem to have some advantages. This system would require rotational supplies at the secondary–tertiary interface, by forming groups of such gated outlets.

Pilot implementation of such operational practices is recommended.

(vi) Canal automation saves considerable water and affords 'on demand' irrigation. Such automated projects may be of much use where:

a) the system is storage based,

b) water scarcity conditions exist and importance of water is realised, and

c) water distribution system is lined and well maintained.

Considering that many states in India are slowly implementing pilot automation schemes, but Uttar Pradesh has still not moved in this direction, it is recommended that Uttar Pradesh also undertake these schemes on a pilot basis. A suitable storage based project, in the Bundelkhand or in the Sone-Tons area can be chosen for this purpose.

11.10 Water Conflict Related Issues

1. Conflicts between uses and users are likely to grow. The main concerns are:
   a) Irrigation *versus* domestic use.
   b) Irrigation *versus* hydro-power, and water use *versus* ecologic flows.
2. Water rights of individuals and group of individuals need better delineation through a legalised process of allocations and review of allocations. This system needs to cover returned waters, water quality, and meeting demand through water of a quality appropriate to the demand.
3. Fluvial groundwater also needs to be brought under the allocation system, and the proprietary rights of landowner over groundwater need to cease.

   Water rights of individuals and groups need to be linked with obligation to return a predetermined quantity of acceptable quality to the system. The 'user pays–polluter pays' principle needs to be adopted.
4. Water management for hydrologic units like basins/sub-basins needs to involve stakeholders. For homogenous areas with only irrigation use, WUA's could be the vehicle for management. For heterogeneous uses, stakeholder committees would have to be formed and empowered to manage the resource, within allocations and financial sustainability.
5. Important interstate issues are being faced:
   a) A large number of storage dams including those under construction and those proposed, would be located in Uttaranchal, with benefits shared by Uttar Pradesh. Joint actions would be required in implementing such projects.
   b) Institutional provisions made in the Uttar Pradesh Reorganisation Act (2000) need to be followed.
   c) A number of issues with Madhya Pradesh, particularly regarding Chambal lift, Urmil, Left Bariarpur, Rangawan Ken Multipurpose and Orchha Multipurpose would have to be settled.
   d) Sone water re-assessment and distribution and the problems regarding Kadwan dam require urgent attention.
   e) Uttar Pradesh needs to get more involved in regard to negotiations and studies connected with Indo-Nepal and within Nepal Water and Power Developments.

11.11 Water Pricing

1. While the norms of the Tenth Finance Commission would require an O&M expenditure for Uttar Pradesh irrigation of about Rs. 2300 million per year, the actual allocations have been only around Rs. 650 million per year, on actual O&M works. However another Rs. 3000 million per year are being spent on irrigation establishment and about Rs. 1200 million on energy charges. Revenue assessments have been very low at about Rs. 1100 million.
2. Currently water prices constitute an expense of a mere 1 to 2 per cent of the farm budget.
3. Farmers seem to be readily paying about 10 times the 'public water' price for purchase of irrigation water in the unorganised grey water market.
4. The present prices and rate structures have been discussed.
5. Recommendations and views of various committees about water pricing have been discussed.
6. A large increase in water prices and a uniform volumetric water price for all crops needs to be effected.

The details regarding water pricing for irrigation are given in Appendix A-11.1. The Appendix suggests recommendations regarding:

a) changing the basic concepts for deciding water prices;

b) having a basic crop-wise price based on a somewhat uniform virtual volumetric rate; and

c) having separate surcharges on the basic price.

The salient features of the proposals in regard to water prices are shown herein below:

(a) Basic Rates

Crop	*Present Rate in Rs/Ha*	*Proposed Rate on Virtual Volumetric Basis Converted to Rs/Ha.*				
		1st Year	*2nd Year*	*3rd Year*	*4th Year*	*Terminal Year of Revision*
Paddy	287.0	400	440	460	480	500
Wheat	287.0	500	550	610	650	700
Barley	287.0	500	550	610	650	700
Arhar	212.0	300	330	360	390	420
Gram	212.0	300	330	360	390	420
Rapeseed/ Mustard	212.0	410	450	470	500	560
Jowar	173.0	180	200	200	210	220
Bajra	173.0	180	200	200	210	220
Maize	173.0	180	200	200	210	220
Potato	356.0	400	450	470	500	650
Sugarcane	474.0	800	950	1100	1250	1400

(b) Storage Surcharge

Present	*Proposed Percentage Increase for Gravity Rate Systems Based on Storage Dams*				
	1st Year	*2nd Year*	*3rd Year*	*4th Year*	*Terminal Year*
NIL	10% of basic rate of the correspon-ding year	15% of basic rate of the correspon-ding year	20% of basic rate of the correspon-ding year	- do -	20% of basic rate

11.12 Issues in Sustainability and Participatory Management

11.12.1 Performance of Canal Irrigation

The canal irrigation sector is underperforming primarily due to following reasons:

1. inadequate maintenance of irrigation system,
2. abysmally low revenue, and
3. galloping establishment costs.

This is illustrated in the Table 11.31

TABLE 11.31

Surface Public Irrigation in Uttar Pradesh Revenue and Expenditure

(in Million Rs.)

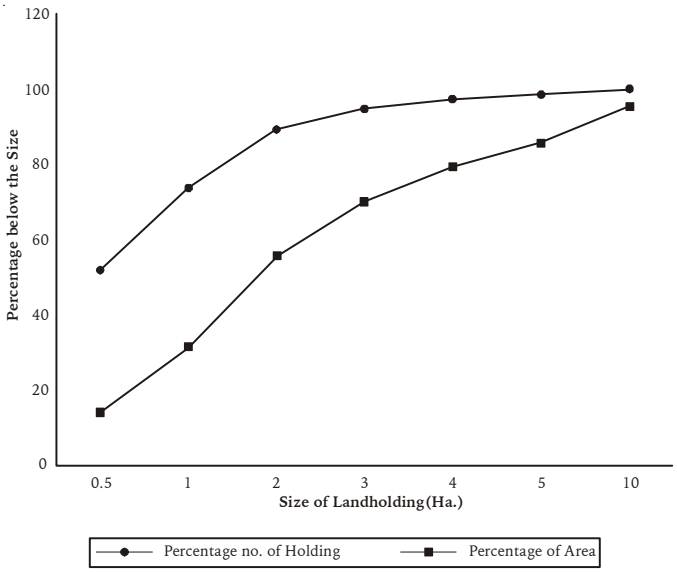
Year	*O&M Expenditure (Works)*	*Establishment Charges*	*Revenue Assessment*
1990-91	614.00	941.70	376.20
1991-92	626.50	1638.0	395.50
1992-93	564.30	1035.80	495.60
1993-94	596.90	1315.00	612.30
1994-95	698.80	1335.00	700.50
1995-96	714.10	2504.50	1065.90
1996-97	923.70	2832.50	1102.40
1997-98	532.50	3150.58	1188.40

The O & M requirements as per norms decided by the Tenth Finance Commission work out the Rs. 2200 million for works only where as the grants over a period of last about 8 years has staggered around 600 million to 700 million.

Another major concern in this sector is increasingly large number of marginal holding and want of land consolidation and settlement in many parts of the State. As per 1991 Census the actual number of holding in Uttar Pradesh was about 20 million, of which 15 million (75%) were marginal (<1ha) and 3 million (15%) were small (1-2ha). This is illustrated in the Figure 11.11.

FIGURE 11.11

Landholding Size in Uttar Pradesh



Source: Census, 1991.

(c) Energy Surcharge

Present Rate Range of Pumping Head	*Present Rate*	*Proposed Percentage Increase for Lift Schemes*				
		1st Year	*2nd Year*	*3rd Yearover*	*4th Year the Basic Rates*	*Terminal Year in % of Basic Rate*
0–20 m	Nil	20	40	50	60	60%
20–50 m	Nil	50	100	120	140	150%
50–100 m above 100 m	Nil	80	120	150	180	200%

With small holdings, agriculture on its own is not economically viable and the task of irrigation delivery, recording of irrigated area, revenue collection, day to day water distribution, conflict management, etc also become extremely cumbersome for government. agencies. Unless the marginal land holders form some organisation for adopting modern package of agriculture practices, irrigation and other input management the productivity of marginal land holding will keep on declining

11.12.2 Participatory Irrigation Management (PIM) and Water Users' Association

For the equitable and optimal utilisation of canal irrigation there is an urgent need to evolve a strategy for community participation. There is a general consensus now that the participation of the users in irrigation management has improved the efficiency of the systems.

Two of the most dramatic management transfer programmes have been under taken in Mexico and Turkey. In many of the developed countries participatory irrigation management has been in practice for a long time, for e.g. in countries like, Australia, USA, Japan and Spain. In India, PIM initiative has started in some of the states. For example, Maharashtra and Gujarat have taken up the programme in a phased manner, whereas, Andhra Pradesh, through an Act of the legislature, has turned over the canal systems to farmer organisation for management. Tamil Nadu and Madhya Pradesh have also enacted similar Acts. The Uttar Pradesh government, having realised the importance and inevitability of PIM, has adopted a policy resolution to introduce it on the minors of canal systems in a phased manner. Salient features of the resolution are as follows:

1. Government invites water users (farmers) association belonging to canal commands on minors and having membership of at least 51 per cent water users (covering at least 51% of area also) to come forward to take responsibility of irrigation management of the command.
2. Water users' association should be registered under Uttar Pradesh Cooperative Act, 1965 or Societies Registration Act. However, in the initial phase the WUA'S may be given recognition as a proposed society by the Uttar Pradesh Irrigation Department (UPID).
3. Before turnover of the minor, the executive engineer of UPID shall sign an MOU with WUA.
4. The ownership of canal systems and appurtenant structures shall be vested in the state government, whereas WUAS will be responsible for water distribution, O&M, irrigation charges recovery, etc. The government will continue to be responsible for providing technical guidance and financial assistance towards essential construction, additions, alterations and modernisation as well as rehabilitation.
5. Water users association would be expected to adopt appropriate water economising measures including installation of water saving devices such as drip and sprinkler irrigation and also crop varieties which are less water intensive.
6. Initially farmer's participation in management shall cover Sarda Sahayak and Saryu canal projects and 'Bundhis' of Mirzapur and Sonebhadra, etc.
7. Uttar Pradesh WALMI shall be designated as the nodal agency for training of representatives of WUA, UPID and other line agencies.

11.13 Institutional Issues

11.13.1 The Status

The present institutional arrangement in Uttar Pradesh, for the water resources sector as a whole can be described as one which is highly desegregated, loosely coordinated and highly governmental and bureaucratic with very little effective participation of other stakeholders. The irrigation department is the main line department for controlling the functions of

providing irrigation through public surface sources and for flood control services. Till the recent past, the department was also engaged in providing irrigation services through deep public tube-wells. (These tube wells have now been transferred to the village *panchayats*. However, the Irrigation Department is still carrying out their maintenance work.) The Irrigation Department is dominated by the civil engineering wing. It currently employs about 84700 regular employees apart from about 7000 skilled and unskilled workers and daily wage employees for inhouse maintenance and supervision, although most of the construction and a major part of the maintenance is done through contracts. The department employs about 3890 professional engineers and 7461 junior engineers. The Organisational Chart of the Irrigation Department of UUP is shown in Figure 11.12.

Domestic water supply is dealt with by Uttar Pradesh Jal Nigam, Jal Sansthan and Local Bodies.

Internal Coordination amongst Departments of Uttar Pradesh

A State Water Board has been constituted under the chairmanship of the Chief Secretary with the Engineer-in-Chief of the Irrigation Department as its member secretary. However the meetings of the board are very infrequent and most of the decisions are being taken by following normal departmental procedures.

11.13.2 Capacity Building Inculcating Excellence and Facilitating Decision Making

The Irrigation Department recruits its professional (engineering) staff from amongst degree holders. While Uttar Pradesh and Uttaranchal have some of the best engineering colleges/universities the government recruitment to line departments does not provide for recruitment to specialised posts from post graduates or doctorates.

In service, professional training is provided by the training institute at Kalagarh and Water and Land Management Institute, Lucknow with a sub centre at Okhla, Delhi. However, WALMI does not have any interdisciplinary faculty or a core faculty, and is not undertaking any serious action on this.

Satisfaction levels in the professional staff are said to be low. Lack of promotion to higher responsibilities, dearth of 'preferred' postings in jobs having large financial budgets on construction and maintenance, lack of participation in decision making process, etc. could be the main cause. A large 'in breeding' of professional thinking with inadequate interaction with academic institutes, research institutes, with professional developments in other states and countries, preoccupation with departmental practices, etc. are the reasons for a general lack of professionalism.

11.13.3 The Need for Institutional Reforms

The need and desirability of institutional reforms based on institutional consolidation and professional growth was viewed and discussed with this background. It was found that there is a large opposition to or apprehensions about large scale reforms.

The main apprehensions against reforms seem to be the following:

1. Whereas inculcating interdisciplinary work and professionalism may be slated as an objective of the reforms, it is feared that a top heavy umbrella department, which favours generalists at decision-making levels by bringing out the multidisciplinary nature of work may finally prevail. In the process, the professional autonomy enjoyed today may come to an end.
2. It is felt by some that by improvements short of structural reforms, the past health and vitality of the Irrigation Department can be regained, and it can take care of all major issues by effective coordination with other departments, without any umbrella type arrangements.

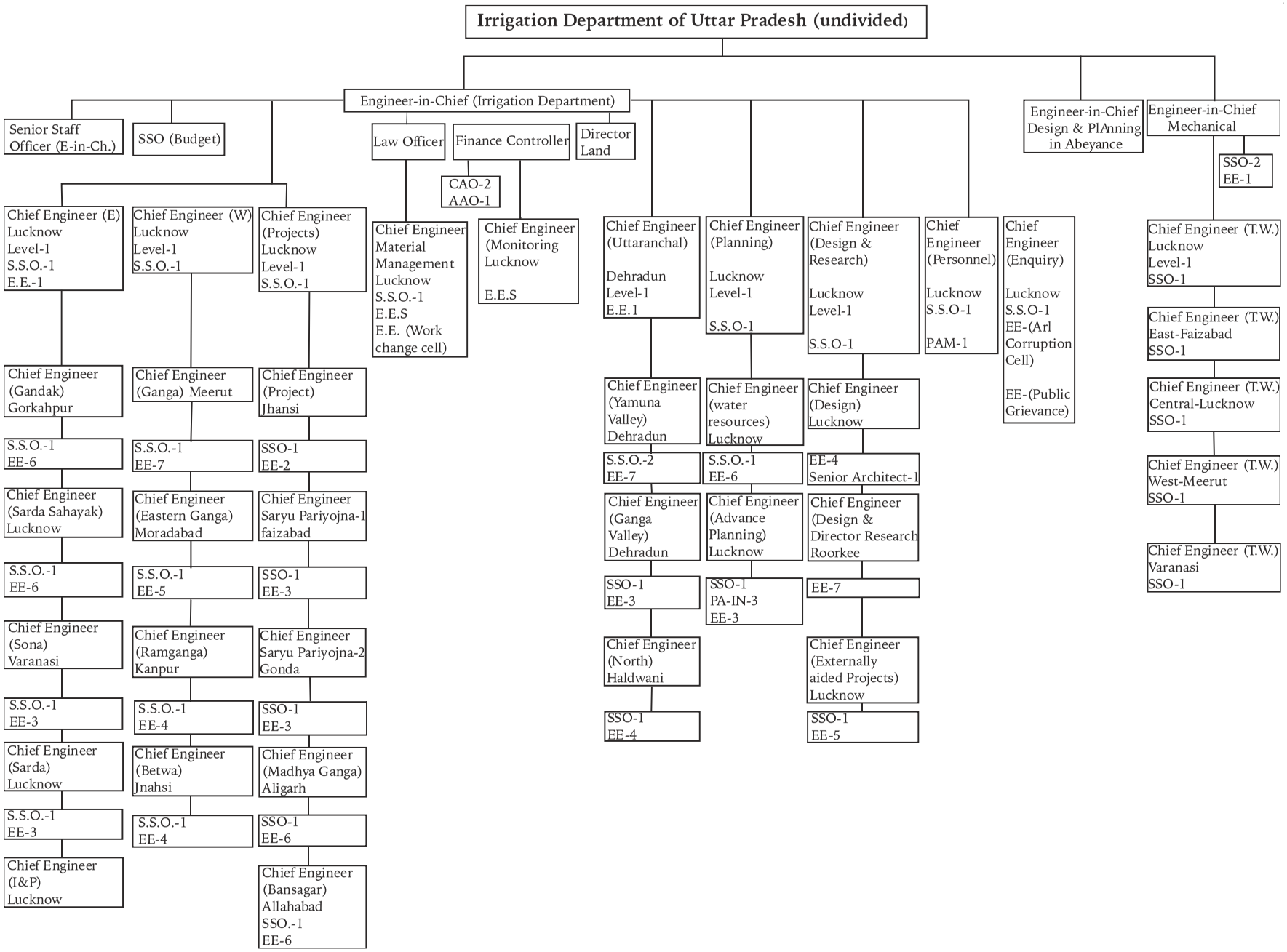
The Alternate Proposals

While it is agreed that this is a weighty argument, it needs to be considered carefully. (In particular, if water resources is going to become a general administrative setup in the state, reforms better not be done.)

However, based on our analysis of the strengths and weaknesses of the Uttar Pradesh water sector and its institutions, as also on the basis of the opinions expressed in the report of the National Commission for Integrated Water Resources Development (Govt. of India, 1999) and the earlier reports of approach to operational and procedural changes (C.W.C.), we are giving an indicative report on the possible lines these institutional changes need to take. This proposal is given in Appendix A-11.2. However, this is only one possible model and a detailed study is necessary. It is understood that the World Bank aided 'Uttar Pradesh Water Sector Restructuring Project' already envisages such studies.

FIGURE 11.12

Organisation Chart (Current) Irrigation Department of UUP



Source: UP Irrigation Department, Annual Administrative Report.

11.14 Fifteen Short-and Medium-term Strategies and Action Plan

11.14.1 Introduction

So far, we have discussed the integrated and optimum water development and management necessary for the Uttar Pradesh and Uttaranchal regions, in the long-term context, i.e. up to 2050.

Water developments are slow in implementation and acceptance by users. They also are, more or less, irreversible. Management practices also evolve and change slowly. Therefore, the long time horizon is relevant. However, we also need to look at a shorter time period scenario as also the present state and pace of activities to develop short or medium term strategies and indicate the mid course corrections necessary to be implemented now itself. These are being discussed in the present section.

In developing this, we have taken into account some additional sources of information. These are:

1. Report of the Working Group on Major and Medium Irrigation Programmes for the Tenth Five Year Plan, Ministry of Water Resources, Central Water Commission (October, 2001).
2. Draft Report of the Working Group on Major and Medium Irrigation for the Tenth Five Year Plan, Irrigation Department (Uttar Pradesh) (December, 2001).
3. Tenth Five Year Plan 2002–2007, Sectoral Programmes–Government of Uttaranchal, April 2002.

The development strategy in regard to the Major and Medium Irrigation, as documented in the Planning Commission Working Group Report for Tenth Five Year Plan is as follows:

1. Continuing old projects which have already achieved 90 per cent or more of the ultimate potential should be considered as completed projects and projects with 70 per cent to 80 per cent achievement of the potential should be reviewed for the achievable potential, so as to decide on the completion status of these projects.
2. According to status of completion of various components of all the ongoing projects of pre-Fifth and Fifth Plan period, the projects should be split into Phase-I, Phase-II, etc. and phase-wise completion indicated.
3. Earmarking of funds should be made for the projects with incurred expenditure of more than 85 per cent of the estimated cost.
4. *Inter se* priority among the ongoing projects for completion need to be carried out taking into account various aspects such as externally aided projects, inter-state projects, benefit to drought prone or tribal areas, drinking water supply, regional imbalance, etc. using the guidelines prepared by the National Commission for Integrated Water Resources Development Plan (NICWRDP).
5. High priority may be accorded to the Pre-Fifth and Fifth Plan Projects for funding under AIBP with emphasis to complete these projects during the Tenth Plan. Fund allocation under AIBP should be enhanced for this purpose, if necessary.
6. Earmarking of funding should be done for inter-state projects to ensure desired progress of works in all the associated states for early completion of such projects.
7. It is necessary to ensure that only those projects are posed for external assistance where all infrastructural works, layouts and detailed designs are ready or could be provided within the time schedule. The concerned state governments should also take simultaneous action for clearances of such projects from the Advisory Committee and subsequently investment clearance from Planning Commission.
8. Given the situation of the resource crunch, foremost priority should be given to completion of ongoing projects. New projects should be taken up very selectively keeping in view the necessity for removal of regional imbalances and development of drought prone and tribal areas.
9. Since the fund requirements for medium projects are less, maximum possible fund may be made available for completion of the medium projects, without jeopardising the programmes for important major projects.
10. A separate budget head as Irrigation Maintenance Fund (IMF) may be provided for maintenance works of the irrigation projects which will comprise of up to 15 per cent of the plan fund and full amount of irrigation revenue as collected should be credited to IMF.

11. The IMF will be spent on works only without inclusion of any component of establishment cost or salaries. Expenditure on staff component should not exceed 20 to 30 per cent of overall O & M fund.
12. In addition to liabilities of completed projects and provisions for on-going and new projects, the state Plan proposals should incorporate provisions for (i) special repairs of existing irrigation systems (ii) dam safety measures (iii) improved water management and (iv) water development aspects encompassing survey and investigation, research & development training and newly proposed National Hydrology Projects.
13. It is necessary to provide substantially higher outlays in order to bring out the effective role in plan activities of the Central Institutions by way of suitably strengthening them and providing adequate funds for taking new initiatives in R&D programmes.
14. Reassessment of the ultimate irrigation potential in major and medium irrigation sector is necessary.
15. The existing regional/state level institutions such as WALMIS should be strengthened and brought into the mainstream activities for irrigation management improvement.
16. Dam safety measures should be taken up all over the country which are very essential in the context of disaster prevention and management.

Basing, its recommendation on this strategy, the Uttar Pradesh Working Group report has classified and fixed *inter se* priority amongst the new and ongoing projects as follows:

1. Projects externally aided in the past (up to 9/94).
2. Interstate projects, to ensure desired progress of works for early completion of each project.
3. Other ongoing projects where substantial expenditure has been incurred.
4. Medium and modernisation schemes that can be completed during the Tenth Plan.
5. Selected new schemes, mostly with a view to reduce the regional imbalances.
6. Projects for restoration of existing capacity which includes modernisation and rehabilitation of old gravity canals as well as major lift canals and strengthening of dams under distress, to reduce the gap between potential created and utilised.
7. Provision has been made for Special Repairs of Existing Irrigation System and Water Development Programme comprising survey investigation, research and training, etc.

11.14.2 Short-and Medium-term Strategies

Although, we generally agree with the above, after some modification, we would indicate the following short and medium term strategies grouped as below:

i) improving information, knowledge and capacities,

ii) improved management of existing developments and system,

iii) completion of major and medium scheme, and

iv) improved planning of new development.

We now discuss each strategy group by listing possible strategies also actions necessary to achieve there.

Strategy-1: Improving Information Knowledge and Capacities

Actions for achieving this strategy objective

1.1 Creation of a water data centre.

1.1.a. Preparing a plan of water data centre through consultants, including equipment specification.

1.1.b. Procurement of hardware and software.

1.1.c. Manning and training of personnel .

1.2 Prepare a plan for institutional restructuring

1.2.a. Consultancy.

1.2.b. Discussions and decision making.

1.2.c. Setting up a performance, evaluation and policy wing.

1.2.d. Commissioning an independent review of performance and policy analysis.

1.3 Developing a personnel & HRD policy for water sector.

1.4 Develop WALMI as an interdisciplinary institute for action research and training.

1.4.a. Commission an independent study on the performance of WALMI and its consolidation.

1.4.b. Investigating the possibility of financial viability and self sustainability of WALMI.

1.4.c. Change personnel policies in line with departments making training as a pre-requisite for advancement.

1.5 Give a legal basis to PIM through modification and simplification of laws and procedures

1.5.a. Commission inter-disciplinary (Irrigation, Administration and Law) study for changes in acts, procedures and rules.

1.5.b. Set up a high level committee for implementing changes.

1.6 Establishing and empowering local sub-basin wise users committees for inter-sectoral water use related issues, including water quality maintenance.

1.6.a Set up area water partnerships (AWPs) and stakeholder committees.

1.6.b. Evaluate working of stakeholder committees elsewhere (other countries and states of India) and plan changes in Uttar Pradesh.

1.6.c. Amend laws and procedures for empowering the stakeholder committee.

1.7 Prepare a state water plan, through the department and with the help of consultants, which *inter alia* estimates the basin-wise availability and usability of water and develops an integrated plan of use.

1.8 Coordinate amongst the basin states for the solution of unresolved interstate problems.

1.9 Draft and enact legislation for groundwater regulation.

1.10 Draft and enact legislation or lay down executive procedures to regulate developments in the flood plains.

Strategy–2: Improved Management of Existing Development and Systems

Actions for achieving this strategy objective:

2.1 Stress on CAD Programme

2.1.a. Study performance evaluation reports and suggest changes in CAD programmes.

2.1.b. Reassess commandable areas of major systems, considering *inter alia*, planned, desirable and actual cropping patterns, topographic and other difficulties in commanding the area.

2.1.c. Plan conjunctive use of surface and groundwater as a part of the CAD activity, on a pilot basis for one large command.

2.1.d. Plan drips, sprinklers and associated on farm/off line storage creation as a part of the CAD activities, on a pilot basis, for one large command.

2.1.e. Plan and implement proportionate distribution by removing lower level gated structures on a pilot, for one command.

2.2 Prepare performance evaluation studies leading to ERM schemes for all old projects and for a few other projects with known unsatisfactory performance:

The objective need not be one of restoring the earlier planned hydraulic capacities, but one of making the best use of available supplies and systems, through minimum necessary improvements to achieve the optimum production. Aspects like water saving, conjunctive use, proportionate distribution automation, setting up of an MIS for the system, etc. need to be included.

2.3 Strengthen dam safety organisation

2.3.a Conduct external dam safety evaluations periodically.

2.3.b Study desirability of additional dam safety cess on storage based irrigation system.

2.3.c. Draft dam safety legislation and decide desirability of enactment. In particular, consider the future situation in which dams may be owned by non-governmental entities in large numbers.

2.4 A precedence needs to be built up in which the full maintenance grants, as per the norms adopted by the finance commission are made available towards irrigation O&M. While the state has the inherent authority in changing these amounts in its budget exercise, the deviations, the reasons and their likely implications need to be brought out in the budget.

2.5 Decide on the desirability of setting up an autonomous irrigation management corporation for a large system, which would be empowered to collect and spend revenues from irrigation. If

possible, set up one such corporation and plan for its financial viability in phases. Initially, subsidies and capital would have to be arranged by the government, since at present the water rates are low. The revenues may not be sufficient for the O&M activities.

2.6 Expedite downsizing of maintenance staff through redeployment and VRS.

2.7 Consider privatisation of irrigation distribution and O&M on a small pilot, as an alternative to WUAs thus using small private entrepreneurs.

2.8 Transfer maintenance of the tertiary system entirely to the stakeholders through the PIM.

2.9 Encourage watershed management and rainwater harvesting. Prepare a strategy paper of desired package for different slopes, different soils and for rainfed areas as also for command areas.

2.10 Start pilot studies on rainwater harvesting in one of the large command areas, as a part of CAD.

2.11 Decide on legal, procedural and policy changes necessary for encouraging conjunctive use in command areas. The aim can be to:

2.11.a. Allocate downstream lands, where reliability of surface supplies may be low to groundwater use.

2.11.b. Ensure that the farmers using groundwater conjunctively do not have to pay a disproportionately higher price than the farmers obtaining surface water.

2.11.c. Develop a model MOU with WUA, which has provisions relating to WUAs responsibility in regulating groundwater in their area and a possibility of reduction of surface supplies if groundwater is rising.

2.12 Increase water prices, to reflect the scarcity value of water and to give incentives to the users to save water.

2.12.a. Decide on increasing and rationalising water prices on virtual volumetric basis, with additional charges for *rabi or zaid* and energy surcharge for lifts, etc.

2.12.b. For a suitable pilot area with sufficient land slope (perhaps in Bundelkhand on forth hills), try volumetric deliveries and document pre and post situation scenarios, responses of users, etc.

2.12.c. Decide on a policy for WUAs, covering issues like: i) percentage of revenue which they may keep, and (ii) if they have liberty to charge more for the water, etc.

2.13 Management of Water Quality

2.13.a Enhancing information through collection and collation of data.

2.13.b. Analysing data to locate problem reaches and aquifers.

2.13.c. Preparing water quality models for problem areas.

2.13.d. Drafting guide lines for minimum flows required.

2.13.e. Improving mechanism for achieving acceptable quality norms through laws and policies.

2.13.f. Improving mechanism for achieving acceptable quality norms through new technologies and development.

2.13.g. Improving mechanism for achieving acceptable low flows through reduction in other uses.

2.14 Adjusting inter-sectoral uses to changing situations

2.14.a. Developing strategy for changing allocation from low priority to high priority uses.

2.14.b Establishing a reviewable regime of water rights amongst users within the state.

2.15 Improve availability of electric energy and encourage electrification of tube wells running on diesel.

Strategy–3: Completion of Major and Medium Projects

Actions for achieving this strategy objective:

3.1 Action to be taken by the state to get the cost estimates of ongoing new schemes approved at appropriate levels and subsequent investment clearance from the Planning Commission for correct assessment of spillover and new project costs.

3.2 Completion of projects which have achieved 90 per cent or more of the ultimate potential be notified and fresh DPR be made if there is a requirement for any essential balance work.

3.3 The projects need to be prioritised for implementation as per the detailed guidelines incorporated in the report of the NCIWD, which have been endorsed by the Planning Commission Working Group on Major and Medium projects. Having prioritised the schemes competing for the funds, higher priority schemes need to be fully financed before funding of schemes with lower priority ranking is considered. In this way, even with limited funds, some high priority (and highly beneficial) schemes would get completed. This exercise needs to be taken up. The Uttar Pradesh Working Group on Major and Medium schemes does seem to be based on such an exercise.

3.4 Government/Planning Department of the state should take suitable action to enhance the overall plan allocation under this sector to about 10 per cent of the total Plan outlay as against 5 to 7 per cent being provided at present.

3.5 Allocation under RIDF (NABARD) and AIBP should be substantially enhanced to ensure resource mobilisation for the plan implementation as decided by the Working Group. However, (a) the performance of water sector depends not only on the availability of finances but also on the other reform measures. Preference for higher funding through AIBP may be linked to sectoral reforms, and (b) a more efficient process of ensuring a quick or automatic transmission of the RIDF/AIBP to the project authorities as also a stronger monitoring system which links funding to proper execution, need to be put into place.

3.6 Schemes which have been under construction for a long period (say Fifth Plan and earlier schemes) need to be reviewed afresh. If the schemes have developed somewhat insurmountable constraints, or if they have become unattractive, these could be downsized and reshaped to give some early benefits with reduced cost. In any case, attempts could be made for their break-up in phases so that the benefits can start flowing in early and in phases.

Strategy–4: Improved Planning of New Development

Actions for achieving this strategy objective

4.1 Groundwater Development strategy

In general, exploration of deep seated groundwater through deep tube wells (which were publicly owned) has received a setback since the government is withdrawing from this function.

At a few places, water quality or geo-hydrology may be such as to make the use of deeper groundwater for irrigation more attractive than the exploration of upper layers through private shallow tube-wells.

Studies need to be done to (4.1.a) locate such areas and (4.1.b) to develop a strategy for exploiting and developing the deeper waters, in regard to ownership, financing, etc.

4.2.a The preparation of the state water plan, and its subsequent detailing needs to be done in order to allocate sources and schemes (of all sizes) to various proposed water uses like domestic and industrial waters, irrigation, etc. Larger projects would have to be multipurpose, but with well documented use-wise allocations.

4.2.b Preparation of detailed sub basin master plans for all uses is a prerequisite for development. Reuse of effluents needs to be a part of the plan. Such developed plans need to be taken up.

4.3 New development projects need to integrate the use of local rainwater, surface water and groundwaters. Guidelines for conjunctive surface and groundwater are available but these in regard to integration of rainwater harvesting with other developments need to be drafted. These need to consider aspects like land slope, soils and crops.

4.4 New irrigation development needs to provide for a balance between lifts from head pond/ reservoir, lifts from canals, etc. and long distance gravity conveyance. Both the economics of lifting versus. gravity conveyance and the social desirability of giving benefits to marginally higher lands near the water source need to be considered. Guidelines and procedures need to be developed.

BOX 11.3

Matrix of Action Points

Short Description	*Strategy in which this is Referred*	*Other Directly Relevant Strategies*	*Other Connected Strategy*	*Priority*	*Remarks*
Planning of Water Data Centre (WDC)	1.1.a	4.7d 2.13.a	4.7d	I	
Procuring Hardware & Software for WDC	1.1.b			I	
Manning WDC and Training	1.1.c			I	
Planning Institutional Restructuring	1.2.a	2.5	2.6, 2.7 2.13.e, 4.1.b	I	
Decision Making about Institutional Restructuring	1.2.b		2.6	I	
Setting up of a Performance & Policy Wing	1.2.c		2.13.b	II	
Independant Review of Performance	1.2.d	1.4.a	2.1.a, 2.1.b	I	
Developing a Personnel and HRD Policy	1.3			II	
Independent Performance Review of WALM	1.4.a	1.2.d		II	
Training Obligatary for Advancement	1.4.c	1.3		II	
Inter-disciplinary of Study about Changes Necessary in Laws and Procedure	1.5.a	1.6.c 1.1	1.9, 2.3.c, 2.11, 2.13.e., 2.14.b, 4.1.b	I	
Inplementing Legal and Procedural Change	1.5.b	2.13.e		II	
Setting of AWPs and Stakeholders Committee	1.6.a	2.8	2.12.c	I	
Study of Stakeholder Committee	1.6.b			II	
Preparing a State Water Plan	1.7	1.8	4.2.a, 4.2.b	I	
Resolving Interstate Problem	1.8	1.7		II	
Performance Evaluation of CAD	2.1.a	2.2		III	
Reassesment & Irrigation Potential of System	2.1.b			II	
Conjunctive use of Rainwater SW&GW as a CAD Activity	2.1.c	2.9, 2.10, 2.11	2.4.a, 4.3	I	
Drips, Sprinkler & Off Line Storage as CAD Activity	2.1.d			II	
Proportionate Distribution as CAD Activity	2.1.e			III	
External Evaluation of Dam Safety	2.3.a			I	
Dam Safety Cess in Water Prices	2.3.b			III	
Dam Safety of Legislation	2.3.c			II	
Ensuring Full O&M Grants	2.4			I	
Autonomous Irrigation Management Corporation	2.5	2.7		II	
Downsizing of Maintenance	2.6			I	
Pilot for Staff Privatisation of Irrigation Distribution	2.7			III	
Developing Technology for Integration of Rainwater Harvesting with water development	2.92.10	2.1.c		II	
Water Pricing Deciding on	2.12.a	2.1.c		I	
Pilot Studies on Volumetric Delivery	2.12.b			II	
WUA Related Pricing	2.12.c			I	
Preparing Water Quality Models for Problem Areas	2.13.c			I	
Guideline for Reallocation of Water Use	2.13.g	2.14.g	2.14.b	II	
Revising Cost Estimates of Ongoing Scheme	3.1			I	
Early Notification about Completion of Project	3.2			I	
Priortising of Projects as Per NCIWRD Guideline	3.3			I	
Enhance Allocation for Ongoing Project	3.4	3.5		I	
Enhance AIBP/RIDFL/NABARD) Found Availability with Conditionalities on Reforms	3.5	3.4		I	
Reviewing Pending Schemes for Downsizing and Phasing	3.6			II	
Locate Areas where Deeper GW need to be used	4.1.a			II	
Develop Strategy about Ownership & Planning Deep GW Exploration	4.1.b			III	
Subbasin wise Detailing of Water Plan	4.2.b	4.2.a, 4.3, 4.6	4.5	I	
Integrating Micro & Minor Irrigation with Large Command	4.5			I	
Integrating Ecologic Concerns with Development Guideline about Low Flow	4.7.a	4.7.b, 2.13.d, 2.13.f			I
Information about Nature Fishes in River Reaches	4.7.b			II	
Developing Technology to Facilitate Fish Movement	4.7.c			II	
Developing Procedures for Storage Use for Quality Management	4.7d			II	

4.5 Similarly, new water developments for irrigation need to integrate the existing micro, minor and medium projects in the command for optimal use. Minor tanks, etc. could be fed from canals to enhance their utility. Some minor tanks, open wells, etc. can be used as off line storage, which allow the use of sprinklers and drips even when the major canal distribution system is in the off mode during a rotation. Guidelines and procedures need to be drafted for this.

4.6 Integration of various types of water uses in an area such as a sub-basin requires preparation of a detailed master plan, based on projected demands of domestic and industrial water as also of irrigation.

The plan needs to indicate how each demand would be met, and how the priority for water supply gets reflected by allocating the more reliable and better quality water for this purpose. It will also treat groundwater utilisation possibility and consider the additional withdrawals and enhanced recharge to groundwater. Maintenance of groundwater levels and maintenance of low flows need to be provided for. Preparation of such outline plans for 3 or 4 pilot areas in different agroclimatic/ topographical regions need to be taken up for getting more experience.

4.7 Integrating the concept of water for nature in new developments

4.7.a. Prepare a guideline for deciding the minimum low flows which need to be maintained in rivers from ecological considerations (maintenance of natural fish and aquatic life, etc).

4.7.b. Prepare information about the types of fishes native to various river reaches and the special considerations required for the sustenance of each type.

4.7.c. Evolve, test and standardise fish ladders, fish locks, etc. suitable for each type of fish.

4.7.d. Evolve a procedure for reserving a part of the storage in a reservoir for water quality management during periods of distress.

11.14.3 Developing a Short-term Plan of Action

Having decided on four strategy groups for obtaining a marked improvement in the water sector and having listed the possible actions to achieve the stated strategy (section 11.14.2), we now proceed to develop a preliminary plan of short-term actions.

This is done by preparing a matrix of action points and its direct or indirect correspondence with other action points (Box 11.3).

Some actions would be relevant to many strategies and sub-strategies and may be of indirect relevance to other sub-strategies. These automatically come out as priority actions, since these will have larger multiplier effects elsewhere. Some strategies would be of basic importance due to the intrinsic nature of the studies involved. Considering both these aspects the somewhat subjective priority groups are indicated in the matrix for the action points.

For all Priority I action points, implementation may start immediately and the aim could be to complete these actions (such as studies, pilot implementation areas) within the Tenth Plan. Priority II action also could start within the Tenth Plan period, whereas Priority III actions can perhaps be started in the Eleventh Plan.

The mode of implementing these actions (such as entrusting the work to an office, setting up a committee, setting up an internal review group or assigning this as a job to a consultant, etc.) and the exact terms of references (ToRs) would have to be done judiciously to cover the basic issues involved in that action as also those in other actions, directly or indirectly related to that action. Again the matrix would give an initial guidance in this regard. Although the matrix gives only a short description of the action, discussions in this section as also in the report would help in understanding the type of issues involved.

References

Government of India (GoI)

————. Reports of National Commission for Integrated Water Resources Development, 1999.

————. *Report of the Working Group on Major & Medium Irrigation Programmes for the Tenth Five Year Plan*, Ministry of Water resources, Central Water Commission, October 2001.

————. *Draft Report of the Working Group on Major & Medium Irrigation for the Tenth Five Year Plan*, Irrigation Department (Uttar Pradesh), December 2001.

————. *Tenth Five Year Plan 2002-2007*, "Sectoral Programmes", Government of Uttaranchal, April 2002.

Census, Planning Commission.

Report of Central Pollution Control Board (CPCB).

Groundwater Resources of India, CGWB, 1995.

Planning Commission, *Tenth Plan Document*.

APPENDIX A-11.1

Water Pricing

1. Introduction

The status and history of water management firmly established water as both a social and an economic good. The pricing of water will therefore be decided on the basis of its:

i) social characteristics, and

ii) considering it as an economic good.

Water development has mostly been a monopoly of the public sector. A free, competitive water market generally cannot exist, both due to the area specific nature of the resource and consequent monopolistic development, and because of the deep involvement of the public sector. Therefore, water prices are administered prices, which get decided without the help of the market forces. An unorganised grey market in water exists, and in this, market forces do play a part in deciding the prices at a much higher level, which gives some indication about the true price of water; but in general, administered prices is the norm at present as also for the future.

The principal of ensuring a positive rate of return i.e. recovery of full O&M costs with some return in capital was done away with during the development phase in the 1960s and 1970s to ensure a large area coverage under irrigation. With the realisation of the goal of food self-sufficiency in the state as well as in the country the irrigation projects can now be again considered more as commercial rather than a social obligation. Although in the past and at present, water prices are purely administered prices and although even for immediate future, we are recommending administered prices based on fiats and dictats, we need to cater to the situation where regulated water markets based on private investments and returns will come into force. Although subsidies may exist, market forces will generally decide the price. In view of his, we base the prices on the volume of water used and not on either the crops grown or on the affordability. These would adjust themselves to the prices charged.

2. Water Charge Norms

The question of norms for fixing water rates and the principles for its revision has been engaging the attention of all state governments and the Government of India for a long time now. Various committees and commissions both at the central and state level have from time to time, examined the issue in detail and have given their recommendations which are tabulated below. However no uniform policy/mechanism could be evolved in this regard so far and the socio-political considerations have invariably dominated the judgement making process except in the case of a few states.

3. Present Financial Status of the Irrigation Sector

The present pricing structure of irrigation water in most of the states as also in Uttar Pradesh is such that now even the O&M costs are not being met. In fact the O&M grants are far too little as compared to the normative requirements and the revenues are abysmally low. The state is accordingly running into huge losses in

BOX A-11.1.1

Recommendations of Various Commissions/Committees

Name of Commission/ Committee	*Recommendation*
Irrigation Commission, 1972	Evaluation of contribution of water input is net income of the farmer is difficult. The irrigation rates should be fixed in reference to gross income of the farmer and it should be 5 to 12 per cent.
National Water Policy, 1987	Water rates should convey the scarcity value of the resource and foster motivation for economy in its use. The rates should be adequate to cover the O&M costs and a part of the fixed cost. The ideal should be reached in a phased manner.
Vaidyanathan Committee-1992	Two part tariff : 1. Fixed charge of Rs.50 applicable on entire command area as membership charge. 2. Variable per ha charge of irrigation to recover O&M cost and 1 per cent interest on capital cost. The objective was to more towards full cost recovery in phased manner leading to rates on volumetric basis.
Group of Officers to Review Committee Recommendation	Fixed charge not acceptable to States. Ultimate full recovery of O&M cost in phased manner. The Vaidynathan following empirical formula was recommended for phased increase in water rates to ultimately recover the fill O&M costs in a five year period. $X_y = X_o + \frac{(0 - X_o)(1 + \frac{1y}{100})}{p - y}$ Where X_y = Water rate to be adopted/revised in particular year. X_o = Water rates in previous year O = O & M charges at the beginning of total revision intended. Y = Particular year considered for revision. P = Total period of time in years in which full revision in water rates is to be achieved plus one I_y = Inflation rate (as per cent) considered for the particular year for revision
Economic Survey 1992–93	Water rates should be such as to achieve certain return on capital in addition to full recovery of expenditure on O & M.
Majumdar Committee U.P	40 to 50 per cent of the net income due to irrigation.
U.P. Taxation Committee	5 to 7 per cent of gross value of produce.
Budget 1999–2000	To encourage better management and maintenance of costly irrigation assets the Centre will provide large financial assistance to states that rationalise their water rate to cover at least O&M costs.
National Commission on Integrated Water Resources Development (September 1999)	i) Adopt a uniform set of guide lines to water tarrif fixation. ii) Water rates need to be revised to cover the full O&M costs +1 per cent of gross value of produce. iii) Set up water pricing authorities on analogy to the energy pricing authority.

this sector. The details regarding expenditure on the surface public irrigation in Uttar Pradesh and revenue, as given in Table A-11.1.1 below would illustrate the deteriorating fiscal condition of this sector.

The logic followed for the recommendations about water rates by the various committees and commissions is as follows:

1) Irrigation system should systematically move towards supplying irrigation water on volumetric basis in the ultimate stage. This will help in conservation and would avoid wastage.
2) Introduction of participatory management.
3) The recovery should cover the full O&M expenditure in the first phase. One per cent of the capital may further be recovered.

TABLE A-11.1.1

Surface Public Irrigation in Uttar Pradesh–Revenue and Expenditure

(Expenditure : Rs. Million
Area: Million Ha)

Year	*Irrigation*	*O & M Grants/ Expenditure*	*Establish -ment Charges*	*Energy Charges*	*Interest on Capital*	*Total*	*Revenue Assessment*
1990-91	4.882	614	941.7	310	1927.4	3793.1	376.2
1991-92	5.098	626.5	1603.8	630.1	2109.4	4969.8	395.5
1992-93	5.067	564.3	1035.8	771.0	2217.6	4588.7	459.6
1993-94	5.144	596.9	1315.0	771.0	2318.9	4999.3	612.3
1994-95	5.381	698.8	1335.0	864.1	2792.4	5690.3	700.5
1995-96	5.152	714.1	2504.5	875.8	2538.6	6633.0	1065.9
1996-97	5.295	923.7	2832.5	870.6	2712.0	7338.6	1102.4
1997-98	5.36	532.5	3250.8	1454.3	2915.6	8053.0	1188.6

Source: Extracted from UP Irrigation Dept. publications.

The main reasons for continuance of this anomalous position are:

i) Farmers would not like to pay more to cover O&M costs which in their perception includes costs of overstaffing and inefficiency in the public system.
ii) Since all revenues go to and since all expenditures come from a common financial part of the state, there is no structural link relating revenues and expenditure.
iii) Acute reluctance of the government in taking measures which may not be liked by the very large number of farmers in the short run.
iv) A general thinking framework seems to perpetuate the poverty of small farmers by declaring that they have a low capacity to pay, and hence water prices need to be subsidised, and consequently the farm output prices need to be kept low, so as to match the urban development capacity to purchase.

Even while farmers and the government is reluctant to increase water prices, there are two main indicators, which bring out the fact that a large increase is possible:

a) Present prices are so low that water is a very minor part of the farm budget, although it is the single most important input.
b) In the unorganised grey water market, the farmers are paying a price which is about 10 times more than that charged by the government. Similarly farmers have been spending much more on water obtained through their own shallow tube wells run on diesel. Undoubtedly, this water purchased in the grey market has better reliability and is more amenable to the farmer's management, but this alone cannot explain the large difference in the price, and suggests that the true economic price of water is far higher than that charged by the government.

4. O&M Norms

Recommendations of the Eleventh Finance Commission

In computing the admissible expenditure on maintenance of irrigation projects, the Tenth Finance Commission had adopted a norm of Rs.300 per ha for the utilised potential and Rs.100 per ha for the unutilised part. The commission had also followed the past practice of enhancing the norms by 30 per cent for the hill states. It had proposed sustainable increases in the norms in each year of the forecast period to insulate the expenditure against inflation.

Based on the MoWR recommendation, the Eleventh Finance Commission (EFC) has adopted the norm of Rs.450 per hectare for maintenance of the utilised potential and Rs.150 per ha for the unutilised potential in case of major and medium irrigation projects.

Considering the cost differential for maintenance in the hill states an additional provision of 30 per cent has been made in their case. An increase of 5 per cent per annum has been provided to take care of the possible price escalation.

5. Present Water Rates

The present water rates are based on the area and crop. Assuming somewhat reasonable deltas, that is water depths for different crops, the rates can be changed to virtual volumetric basis. The details in regard to Schedule I of water rates as applicable in Uttar Pradesh are as follows:

TABLE A-11.1.2

Schedule I of Water Rates as Applicable in Uttar Pradesh

Crop	*Rate/Ha in Rs.*	*Assumed at Head*	*Virtual Volumetric Rate*
Paddy	287	1.0 m	Rs.0.0287/m^3
Wheat	287	0.5 m	Rs.0.574/m^3
Sugarcane	474	1.0 m *Kharif* + 1.0 m *Rabi*	Rs.0.0237 m^3'
Barley	287	0.5 m	Rs.0.0574/m^3
Jowar/Bajra/Maize	173	0.4 m	Rs.0.043/m^3
Arhar	212	0.3 m	Rs.0.07/m^3
Rapeseed + Mustard	212	0.4 m	Rs.0.053/m^3
Potato	356	0.3 m(average for *Rabi* and *Kharif*)'	Rs.0.14/m^3

6. Proposed Rate Structure

(A) Basic Rates

The recommendations made by the EFC are being adopted in rationalising the water rate structures for irrigation with the following assumptions:

i) The rate of Rs.450/ha is for a combined mix of the diversion as also storage based gravity canals.

ii) Incidence of energy charges for pump canals has not been included in these rates. There is a tendency to go in for high lift pump canals, without charging any increase in water price to meet the cost of energy. This needs to be corrected.

iii) The rates shall be increased in a phased manner to achieve the objective of full O&M recovery at the end of five years from now.

The O&M charges for the run of the river i.e. diversion based gravity canals are assumed to be Rs. 400/ha on the basis of recommendations of the EFC. The surcharge for storage dam maintenance and energy charges for pump canals are being shown separately. A separate surcharge for storages would be more effective since this money could be made available for O&M of the dam. As present, since project by project grants are normally given on area basis, this gets neglected. The non maintenance of a storage dam not only erodes efficiency but also becomes a potential threat to the downstream areas through the hazards of a dam failure. Thus, an additional surcharge can improve the dam safety programme.

Allowing for five per cent escalation over the five year period and absorbing the O&M charges for the unirrigated potential the O & M charges/ha at the end of the terminal year for the gravity canal systems work out to Rs.565/ha. The virtual volumetric rates for *kharif* and *rabi* crops based on their present area coverage ratio would work out to Rs.500/ha and Rs.700/ha respectively. At the assumed delta for the present rates the virtual volumetric rates for *kharif* paddy and *rabi* wheat would work out to Rs. 0.05/m^3 and Rs.0.14/m^3. For the hot weather crops the value can be assumed as Rs. 0.2/m^3.

Based on the above analysis the Schedule-I basic rates for diversion gravity canals at the end of the terminal year would work out as follows:

TABLE A-11.1.3

Basic Crop-wise Rates for the Terminal Year

(in Rs./Ha.)

Kharif	*Rate*	*Rabi*	*Rate*	*Hot Weather*	*Rate*
Paddy	500	Wheat	700		
		Barley	700		
		Arhar, Gram	420		
Jowar		Rapeseed	560		
Bajra	*220*	Mustard			
Maize		Potato & Vegetable	420	Potato & vegetable	550
Sugarcane		Rs.1400			

B. Storage Dam Surcharge

Canal supplies supported on storage dams have an additional incidence of O&M charges with regard to head works to ensure dam safety.

Assuming that an average (medium) storage dam irrigated about 5000 ha, the current cost of such projects is about Rs. 100000 /ha, and of this 40 per cent could be for the headwork. Hence, in terms of the replacement cost of the dam the cost would work to about Rs. 2000 lakhs.

Assuming an O&M (special) requirement at half per cent per year, the additional O & M charges would be Rs. 10 lakhs/ per yr. O&M charges for the storage dam would thus be Rs.200/ha.

Assuming an average delta of 0.5 m, the virtual volumetric rates would work out to Rs. 0.04/m^3. This indicates a 30 per cent storage surcharge for *rabi* crops. In the initial stages this surcharge can be put at 20 per cent for storage based *rabi* & hot weather crops.

C. Surcharge for Energy for Pump Canals

The lift systems in Uttar Pradesh vary from 20 m head to about 160 m head of pumping. For the purposes of estimation of energy involved in lifting one m^3 of water for different heads of pumping, the details are shown in Table A-11.1.4.

Assuming that lifts are used mainly for *rabi* irrigation and taking into account the qualitative aspects of energy supply. The lift surcharge over and above the gravity rates in the case of pump canal in the first instance is proposed Table A-11.1.5.

Two points need to be explained:

(1) The economic cost of energy in 2002 was Rs.5.00/kwh than Rs. 2.50/kwh as assumed here. However, irrigation pumping is normally allowed only outside the peak hours, so that the system load peak does not increase. Although tariffs to meet such a situation are not available in India, we value this off peak energy only at 50 per cent of the normal.

(2) The target of meeting full O & M including energy costs by the terminal year would require very high surcharge of 500 per cent and above for lifts beyond 50 m. In the present situation, this appears impracticable and hence lower surcharges are proposed. These would have to be increased beyond the terminal year. Also, the very costly water obtained through high lifts needs to be used as a precious commodity entirely through drips and sprinklers for high value crops. Rather than subsidising energy perpetually, the government needs to subsidise such transformation in a more effective way in the lift commands.

Based on the above rationale the pricing of water for irrigation purposes is proposed as follows. These rates are applicable for the Schedule-I systems and crops. Proportionate changes could be affected for the remaining three Schedules.

In addition to the above basic rates and surcharges the following prints would be of special interest.

1. Where the run-off the river distribution system has water obtained both by gravity and lift, a lower rate of surcharge based on the proportion of lift to the total water may be charged on the entire command.

2. Areas requiring lifting of water by the cultivators at their costs in a gravity canal system are presently being charged at 50 per cent of the applicable rates. This should be done away with in view of the following:

   i) Such areas are insignificant in comparison to the overall total command of the gravity system;

   ii) The market rates are much higher than the administered rates. In any case, the logic of the subsidy is perhaps based on a concept of social obligation in both providing irrigation to these lands, and of not penalising a farmer

TABLE A-11.1.4

Lift systems in Uttar Pradesh

Lift(Metre)	Average Lift(Metre)	Net Engineering Unit	Net kwh(1 kwh = 367.1 Tonne Metre	Gross Energy Assuming 70% Efficiency	Cost of Energy at Rs.2.50 Per KwH.
0 – 20	10	10 tonne metre	.027	0.038	0.095
20 – 50	35	35 - do -	.0095	0.135	0.335
50 – 100	75	75 - do -	0.20	0.20	0.70
100 and above	130	130 - do -	0.35	0.5	1.25

TABLE A-11.1.5

Lift Surcharge over and above the Gravity Rates

Range of Lifting Head Metre	*Energy CostRs/m^3*	*Basic Virtual Volumetric Rate for Rabi*	*Energy Cost in Terms of Percentage of Basic Rabi Rate*	*Proposed Energy Surcharges for Lifting over Basic Rates*
0 – 20	0.095	0.14	67.8%	60%
20 – 50	0.335	0.14	239%	150%
50 – 100	0.70	0.14	500%	200%
100 and above	1.25	0.14	892%	

for his cost of lifting. This does not seem to hold good now.

iii) There is possibility of false recording at the lower level.

iv) It would avoid unauthorised use and wastage of water by obstructing the normal flow conditions.

However, in general in the changed scenario of availability of energy for lifting in the past 50 years, over reliance on gravity has to reduce and pumping by low lifts need to be encouraged, even if subsides are removed.

3. The state water policy has recommended setting up of a tariff regulatory authority for water. The state is presently in the process of setting up such an authority. The authority when constituted should make recommendations for irrigation water rates keeping the proposals made above in-view. "With the proposed transfer of Minor and Distributory systems to the WUA's, the Regulatory Authority would ultimately decide on the rates for volumetric supplies to the WUA's whereas the WUA's need to be free to decide their own rates for irrigation waters which they will recover from their members/customers to match the O & M requirement along with the payments for supplied water."

   For non irrigation uses, the details of which are given in the subsequent paras, the Tariff Regulatory Authority when set up should continue to decide on such rates. But even here, considering the eventual transfer to market mechanism, the virtual volumetric basis rates should be similar, unless a better quality of service at reliability is being attached to the non-irrigation uses, to justify higher volumetric rate.

4. In Uttar Pradesh, water rates are based on different 'Schedules'. Schedule-I is for normal reliable irrigation and Schedules-II, III, etc. depict poorer service. Attempts need to be made for upgrading the service and bringing all systems under Schedule-I. In any case, downgrading of a system to a lower schedule should not be allowed.

(a) Basic Rates

Crop	*Present Rate in Rs./Ha*	*Proposed Rate on Virtual Volumetric Basis Converted to Rs./Ha.*				
		1st Year	*2nd Year*	*3rd Year Over the Basic Rate*	*4th Year*	*Terminal Year of Revision*
Paddy	287.0	400	440	460	480	500
Wheat	287.0	500	550	610	650	700
Barley	287.0	500	550	610	650	700
Arhar	212.0	300	330	360	390	420
Gram	212.0	300	330	360	390	420
Rapeseed /Mustard	212.0	410	450	470	500	560
Jowar	173.0	180	200	200	210	220
Bajra	173.0	180	200	200	210	220
Maize	173.0	180	200	200	210	220
Potato	356.0	400	450	470	500	650
Sugarcane	474.0	800	950	1100	1250	1400

(b) Storage Surcharge

Present	*Proposed Percentage Increase for Gravity Rate Systems Based on Storage Dams*				
	1st Year	*2nd Year*	*3rd Year*	*4th Year*	*Terminal Year*
Nil	10% of basic rate of the correspon-ding year	15% of basic rate of the correspon-ding year	20% of basic rate of the correspon-ding year	- do -	20% of basic rate

(c) Energy Surcharge

Present Rate Range of Pumping Head	*Present Rate*	*Proposed Percentage Increase for Lift Schemes*				
		1st Year	*2nd Year*	*3rd Yearover*	*4th Year the Basic Rates*	*Terminal Year in % of Basic Rate*
0 – 20 m	Nil	20	40	50	60	60%
20 – 50 m	Nil	50	100	120	140	150%
50 – 100 m above 100 m	Nil	80	120	150	180	200%

7. Water Charges for Non-agricultural Use

The linking of the price of water to the use of water is perhaps a result of the legacy of administrative water prices for social good. Market prices could vary with the quality of service and product but would not be linked to the use. The water uses of the non-agricultural sector which can be charged are as follows:

1. drinking water,
2. domestic and municipal use,
3. power plants thermal and nuclear,
4. industries, and
5. recreational use.

For the drinking and domestic supply sector the Uttar Pradesh Jal Nigam apart from developing its own resources, which are mostly underground, takes water from public irrigation system through the existing storages/canals. Cooling water for thermal power plants and water for industrial use is generally arranged through irrigation works. The mode and prices of supply for non-agricultural use are illustrated in Box A-11.1.2.

Prior to 1985 supplies for non-agricultural purposes were generally made from irrigation outlets and rates charged as per provisions of the Irrigation Manual of Order. This system was suitable for small supplies as they did not warrant any new construction for the supply of water nor was there any significant loss of irrigation. Providing cooling water to thermal power stations posed a new set of situations where not only sufficient quantity of water was to be supplied but also control and delivery structures were required to be constructed. A similar situation subsequently developed in the case of drinking water requirements and industrial use.

In view of the various problems faced in arranging the supply of water and also recovery of costs thereof the GoUP vide order no 1056 Sa. Kha/ 85-23-Si-3 dated 16-4-85 issued detailed orders for supply of water for non-agricultural uses and fixed the rates also. As per the provisions of this order, after having ascertained the availability of water to be supplied for the specific purpose the government would issue an order to that affect. The Irrigation Department will charge the capital cost of all necessary structures, cost of compensation of quantity of water and capitalised value for maintenance (10 years). In addition royalty charges at Rs. 50000 per cusec (cubic feet per second) per year shall also be charged. Drinking water schemes would be exempt from royalty charges. The government vide order no 1192/98-27-Si-4-5w date 20-5-98 had revised the royalty charges to Rs. 150000 per cusec per year.

The state water policy has suggested the setting up of a tariff regulatory body in the state to deal with the problem of water pricing for various use sectors. In the case of urban water supply, the O & M is being done by the Jal Sansthan or other local bodies and they are collecting revenue as a part of the house and land tax. This amount is not linked with the O & M requirement norms. For O & M of rural water supply, through India- mark II hand pumps or piped supply, the charges are fixed by GoI but the recovery from the users is almost nil. Multiplicity of agencies and highly variable standards of services in this sector are also some of the causes for non fixing of uniform rates for urban supplies. Rural supply is also highly subsidised.

BOX A-11.1.2

Water Supply for Non-agricultural Use

Use	*Agency*	*Source*	*Price paid by Agency*
Drinking Water	Uttar Pradesh Jal Nigam for infrastructure development and O&M of rural area: Jal Sansthan for O&M of systems in urban areas	i) Public systems (storage/canal) from the Irrigation Department. ii) Jal Nigam owned surface development. iii) Jal Nigam owned under ground development.	i) All capital cost & capitalised O & M. ii) No royalty. iii) Cost of scheme to produce new water resource of equivalent quantity. No well established system. No royalty. Do-
Industrial Water and Thermal Cooling Water	Mostly Irrigation Department for large establishments.	From public canals or storages.	As per above plus royalty on supplies.

APPENDIX A-11.2

Possible Model for Institutional Restructuring

11.1 Objectives

11.1.1 The Main Objective of Restructuring Would be

(a) Consolidation of all water related concerns in a unified process of policy planning and decision making, but not in a single entity.

(b) Encouraging decentralised decision making with stakeholder participation at the lowest possible level.

(c) Encouraging joint water management, in the O & M mode instead of line departments administrating though their set procedures.

(d) Encouraging inter disciplinary teamwork.

(e) Capacity building through HRD for sustainability.

(f) Encouraging excellence and professionalism.

(g) Encouraging continuous performance review, policy analysis and policy modification.

11.2 Outline of Institutional Restructuring

The main or key need seems to be the establishment of an umbrella Water Resources Department, which within itself would have the line departments. Again some of the line departments could be mainly coordinating departments, since the real action would be within the local self governments, while others would be functional departments. The umbrella water resources department would, in a unified way deal with the following three main functions.

1. information, performance overview and policy functions,
2. personnel and capacity building functions, and
3. line functions of planning, design implementation and maintaining facilities.

institutional arrangements for these are discussed below in brief:

BOX A-11.2.1

Institutional Arrangements of Different Wings

(A) Functions of the Performance Overview and Policy Analysis Wing

1. Data and Information

- Hydrometric data
- Water use data for different users
- Land use data
- Project constitution information
- Information about floods
- Productivity related information
- Information about groundwater extraction

These functions could best be done within the line departments.

2. Performance Overview

- Water account of water use systems
- Water balance for surface and groundwater
- Return flow regulation
- Annual water accounts for the state
- Sectoral reviews of costs and benefits
  - Social
  - Economic
- Post projects review of costs and benefits
- Review of progress of construction and development activities.

These can best be done especially by the line departments and by independent agencies. It would be helpful if annual tabling of such reports in the legislation is provided for.

3. Policy Research and Analysis

This needs to be done through active cooperation of line departments, government supported public autonomous institutes as well as public institutes not controlled by the state government. The resulting studies need to be available in public domain.

4. Modification and Evaluation of Water Policies

This is clearly a high level governmental function, but this needs to be based on published information about items 2 and 3 above mentioned, and a reasoned synthesis of these into policy options and choices.

(B) Functions of the Personnel and Capacity Building Wing

The main functions of this wing would be:

1. Framing and affecting personal policies which increase the satisfaction level and facilitate specialisation and professionalism. This would have to be done by:
   (a) Large scale training programmes through a training policy with emphasis on attitudinal changes.
   (b) Preferring and encouraging additional academic qualification and training.
   (c) Changing from water administration to joint water management (with stakeholder) in regard to O & M of irrigation and water supply.
   (d) Policies making training, research, design experience compulsory for some postings. Opening fast track promotion channels.
   (e) Having a placement and transfer policy which discourages manipulation and encourages specialisation in distinct areas, like planning, design and construction, O&M, etc. and discouraging movement amongst specialisations.
   (f) Judging personal performance through achievement of goals and objectives and through user satisfaction.
   (g) Changing recruitment policies to ensure that at all levels are properly trained and qualified persons are recruited. And basing promotions on acquisition of knowledge and skills.
   (h) Having a policy for right sizing of the departments, including VRS. Weeding of inefficient persons, transfer of functions to stakeholder managed institutions and facilitating appointment of experienced staff to these institutions.
2. Establishing a human resource development system for training of water sector personnel. WALMI and such other institutes have to be strengthened and made centres of excellences. Training, not directly in specialised water resource related areas e.g. computer skills and management skills, etc., can be done through private institutes.
3 Having a large R & D programme. The R & D activities can be both inhouse or parcelled. The needs have to be judged through policy analysis and performance overviews.

Line Departments and Activities

The main thrust of institutional restructuring for the line activities would be:

(i) allowing functional specialisation by separating functions of planning, design construction and O&M, and

(ii) creating environment for inter-disciplinary teamwork by not making any function as a single discipline function.

The likely form of the restructured line departments could be as given in the schematic, in Figure A-11.2.1.

FIGURE A-11.2.1

A Possible Restructured Water Resource Department