PREFACE

With the aim to adopt a river basin development and management approach to address concerns related to water in an integrated and socially and environmentally sustainable framework, and to ensure the concept of basin development and management to be deeply rooted, Uttar Pradesh Water Sector Restructuring Project (UPWSRP) was initiated in May 2001. Phase-I of the Project focused on Ghagra-Gomti basin for initial implementation of both water sector and drainage sector reform programmes. Under this phase, GoUP has created: (i) State Water Board (SWB) under the Chairmanship of Chief Secretary, GoUP and Principal secretaries of all concerned departments and finance department as members, (ii) State Water Resources Agency (SWaRA) to provide a State level capability for inter-sectoral water allocation, planning, management and optimal use of surface and ground water based on comprehensive and environmentally sustainable river basin plans, (iii) State Water Resources Data and Analysis Centre (SWaRDAC) to assist SWaRA in collection, compilation, scrutiny and analysis of all water, land and other natural resource data, (iv) Enacted Participatory Irrigation Management Act, (v) Initiated process for State Water Management and Regulatory Commission (UP-SWaMReC), and (vi) created Ghagra-Gomti Basin Development and Management Entity (GGBDME). SWaRA has been entrusted with the responsibility to develop a basin Master Plan for Ghagra–Gomti Basins, develop a Decision Support System (DSS) for Jaunpur Branch Canal System, and an environmental and social basin assessment (BESA) and social and environmental management plan (SEMP) for Ghagra – Gomti basin.

Phase-I of the project is likely to close in October 2009. Since the UPWSRP was initiated with a long term perspective of 12-15 years to cover entire State, GoUP has decided to continue the efforts of Phase- I under Phase-II; propose and include Bundelkhand region of the State to study and implement IWRM in order to reform the water and agriculture sector there with emphasis to mitigate droughts and rehabilitate this region in long term perspective. This region has recently witnessed severest prolonged drought for the first time in the recorded history. This paper, therefore, concentrates to develop the concept, identify the issues that concern UP-Bundelkhand region and suggest strategies to be adopted for implementation of IWRM in the short, medium and long term perspectives.

I would like to place on record my appreciation to the dedicated efforts put in by Shri A.S. Dhingra, former Commissioner, CAD, Ministry of Water Resources, Government of India, presently Mathematical Modelling Expert, SWaRA, in studying the problems of the region, and suggesting innovative ideas and in preparing the manuscript of this paper in a record time.

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IWRM for Rehabilitation of Bundelkhand Region of Uttar Pradesh

(A Concept Paper for inclusion of the project under Phase –II of the UPWSRP)

Introduction

State of Uttar Pradesh is gifted with plentiful water resources but because of rising population and thereby increasing demand of water for various purposes; its dearth is becoming evident and getting more pronounced day by day. Besides, there are regional imbalances on account of spatial and temporal distributions. Conspicuous to frequent climatic and hydrological droughts, the Bundelkhand region in Uttar Pradesh (and also in Madhya Pradesh) experiences severe agricultural droughts. With majority of population living below poverty line and their livelihood dependant on agriculture and livestock rearing, severe scarcity of food grains and fodder has hit hard on their lives.

Administratively, Uttar Pradesh portion of Bundelkhand region (herein after called as UP-Bundelkhand) comprises of 48 blocks under the jurisdiction of 7 districts. The geographical area of the UP-Bundelkhand is 2.94 Mha which is about 12.21% of that of the State. Depending upon the economic considerations and infrastructure development, UP-Bundelkhand is the poorest region in comparison with western, central and eastern regions of the state. Natural and other resources are distinct and abundant in case of western, central and eastern regions; southern region, i.e., UP-Bundelkhand has only 4.96% of the State's Population, low population density of 280. This region is prone to frequent floods and droughts; only recently, a severe continuous four year cycle drought (2004-08) has been witnessed in the region.

State Water Policy (1999)

Government of Uttar Pradesh (GoUP) adopted progressive State Water Policy (SWP) in May 1999 with the prime objective to:

(a) Ensure preservation of the scarce water resources and optimize its utilization;
(b) Bring about qualitative improvement in water resources management;
(c) Maintain water quality, both surface and ground;
(d) Promote formulation of projects with basin/sub-basin as a unit treating water as a unitary resource and ensuring multi-purpose use of water resource;
(e) Promote 'equity and social justice' among beneficiaries in allocation of water and its management;
(f) Ensure self sustainability in water resources development and management;
(g) Promote effective river basin management organization with legislative authority to manage the water resources of its rivers;
(h) Develop adequate information and knowledge base;
(i) Promote research and training facilities in water sector;
(j) Provide mechanism for the resolution of conflicts between various users;
(k) Close linkage to agricultural sector activities to intensify agricultural production; and
(l) Greater private and reduced public sector involvement in irrigation and drainage systems.

Uttar Pradesh Water Sector Restructuring Project (UPWSRP)

UPWSRP - Phase-I - To achieve the above objectives of SWP, UPWSRP was initiated in 2001 with financial assistance of US$ 150 million from World Bank (WB). The development objectives of UPWSRP are : (i) to set up enabling institutional and policy frame work for water sector reform in the

state for integrated water resources management (IWRM); and (ii) to initiate irrigation, agriculture and drainage sub-sector reforms in the state to increase and sustain water and agricultural productivity.

With the aim to adopt a river basin development and management approach to address all issues related to water in an integrated and socially and environmentally sustainable framework, and to ensure the concept of basin development and management to be deeply rooted, a 5 year long Phase-I was initiated in May 2001. Phase-I focused on Ghagra Gomti basin for initial implementation of both water sector and drainage sector reform programmes. Under this phase, GoUP has created the following institutional set up:

(i) State Water Board (SWB) under the Chairmanship of Chief Secretary, GoUP and Principal secretaries of all concerned departments and finance department as members;
(ii) State Water Resources Agency (SWaRA) to provide a State level capability for inter-sectoral water allocation, planning, management and optimal use of surface and ground water based on comprehensive and environmentally sustainable river basin plans. SWaRA is also working as a secretariat to the SWB. SWB and SWaRA are required to facilitate and guide the implementation of IWRM in the State.
(iii) State Water Resources Data Analysis Centre (SWaRDAC) to assist SWaRA in collection, compilation, scrutiny and analysis of all water, land and other natural resource data.
(iv) Enacted an Act on Uttar Pradesh Water Management and Regulatory Commission Act, 2008. The institutional set up of State Water Tariff Regulatory Commission (SWaTReC) delineated under the Act is under progress.
(v) Project Activity Core Team to implement the project.
(vi) Ghagra-Gomti Basin Development and Management Entity (GGBDME). SWaRA has been entrusted with the responsibility to develop a basin Master Plan for Ghagra–Gomti Basins IGGB), develop a Decision Support System (DSS) for Jaunpur Branch Canal System, and an environmental and social basin assessment (BESA) and social and environmental management plan (SEMP) for Ghagra – Gomti Sub basin.

Phase-I of the UPWSRP has been extended second time upto October 2009.

UPWSRP - Phase-II – Since the UPWSRP was initiated with a long term perspective of 12-15 years to cover entire State, GoUP has decided to continue the efforts already initiated under Phase –I for funding from WB under Phase-II; propose and include Bundelkhand region of the State to study and implement IWRM in order to reform the water and agriculture sector there with emphasis to mitigate droughts and rehabilitate this region in long term perspective. This region has recently witnessed severest prolonged drought for the first time in the recorded history.

This paper, therefore, concentrates to develop the concept, identify the issues that concern UP-Bundelkhand region and suggest strategies to be adopted for implementation of IWRM in the short, medium and long term perspectives. The concerns and issues are first discussed and subsequently the activities to be performed under Phase –II of UPWSRP are enlisted.

Bundelkhand Region

Bundelkhand region in central plains in India is situated between longitude $78^{o}20'$N and $81^{o}40'$N and latitude $23^{o}20'$E and $26^{o}20'$E and comprises of 13 districts covering 7.08 Million Hectares (Mha), out of which six districts comprising of 4.12 Mha are in Madhya Pradesh and seven districts comprising of 2.94 Mha are in Uttar Pradesh. The districts in Madhya Pradesh are Sagar, Damoh, Datia, Panna, Chattarpur, and Tikamgarh and in Uttar Pradesh are Jhansi, Lalitpur, Jalaun, Hamirpur, Banda, Mahoba and Chitrakoot. The area is bounded by Vindhyan Plateau in south to river Yamuna in north, river Ken in east and rivers Betwa, Sindh and Pahuj in west. Plate-I shows the administrative districts of the Bundelkhand region in the two states.

While the geographical area of Bundelkhand region in Madhya Pradesh is 39% more than that in Uttar Pradesh, population in Bundelkhand region of Madhya Pradesh is around 28 % lesser than that in Uttar Pradesh. Despite the fact that normal rainfall in Madhya Pradesh portion is 17 % more than that in Uttar Pradesh and rainfall pattern being more drought prone in Uttar Pradesh as compared to Madhya Pradesh, higher percentage of population in Uttar Pradesh is attributed to age old and higher level of development of irrigation in Uttar Pradesh. About 82% of the population is dependent on agriculture in both the States.

While the Yamuna flows from west to east, its first order tributaries viz., Betwa, Ken, Sindh, Pahuj, Gharara, Bagain and Paisuni flow from south to north. Second order tributaries of the Yamuna namely, Dhasan, Jamuni, Birma, Sonar, Patna, Bewas, Kopra etc., also drain the area. The entire drainage forms a part of Ganga basin. The region generally slopes from south to north. The elevations in the area range from 600 m above mean sea level (amsl) in southern part to 150 m amsl near the Yamuna. The area in Madhya Pradesh is conspicuous of undulating rocky ravine topography coupled with level plains, while the area in Uttar Pradesh gradually slopes from mild ravines to level plains near the Yamuna. Almost entire region of Bundelkhand (UP and MP) is prominently of Vindhyan rocks in southern part and Granites of different kinds at different depths with alluvium soils on top mixed with rocky and boulder outcrops here and there. The geology, hydro-geology, hydrology, soils and the climatic distribution are directly responsible to the agricultural growth and consequently to the livelihood of people in Bundelkhand (both UP and MP). Plate-II shows the physiography and the drainage systems prevailing in the Bundelkhand region in two States.

Bundelkhand Region in Uttar Pradesh (UP-Bundelkhand)

As already mentioned, UP-Bundelkhand region is drained by a number of rivers, mostly originating in Madhya Pradesh. The region in Uttar Pradesh generally slopes from south to north. The elevations in the area range from 300 m above mean sea level (amsl) in southern part to 150 m amsl near the Yamuna. UP-Bundelkhand region gradually slopes from mild ravines with rocky outcrops here and there to level plains near the Yamuna (see Plate-II). The region has prominently red sandy soils in the southern reaches and alluvium soils in northern belt.

Demographic and Economic Setup

Uttar Pradesh with a population of 16.62 Crores is India's most populist State. The economy of Uttar Pradesh is mostly dominated by agriculture and allied activities. UP-Bundelkhand region having 12.21% of the State's area is under-populated with population density of 280 when compared to 690 in the State and 325 as National average. Little less than 5% of the State's population lives there. The UP-Bundelkhand region is under developed, most backward and frequent flood and drought ridden, where people live mainly at the mercy of nature and climate. According to 2001 census there are only 4 cities with population greater than one lakh; these are Lalitpur Municipal Board (MB) (111892), Jhansi (MB) (383644), Orai (139318) and Banda (134839). Jhansi is the only city with population more than 3 lakh.

District wise Distribution of Population in UP-Bundelkhand (2001)

District/ Region/ State/ Country	Area (Sq. Km.)	Percent of State Area	Population	Percent of State Population	Population Density per sq. Km.	Below Poverty Line (BPL) Population	BPL population as percent of district/ region/ state/ country
Lalitpur	4460	*1.85*	977734	*0.59*	340	261551	*26.75*
Jhansi	3164	*1.31*	1744931	*1.05*	250	374746	*21.48*
Jalaun	4282	*1.78*	145452	*0.88*	241	538487	*37.02*
Hamirpur	4565	*1.89*	1043724	*0.63*	319	371591	*35.60*

Mahoba	5024	*2.09*	708447	*0.43*	348	128753	*18.17*
Banda	5039	*2.09*	1537334	*0.93*	194	528315	*34.37*
Chitrakoot	2884	*1.20*	766225	*0.46*	249	390235	*50.93*
UP-Bundelkhand	29418	*12.21*	8232847	*4.96*	280	2593678	*31.50*
UP-State	240928	*100.00*	166052859	*100.00*	690	49606616	*29.87*
India	3287240	-	1028737436	-	325	260200000	*25.29*

Source: Web site of National Informatics Centre

State of Uttar Pradesh is considered to be poor state compared to India as a whole where about 30% of the population lives below poverty line (BPL). Uttar Pradesh portion of Bundelkhand is still poorer where about 31.5 % of the people are BPL. Chitrakoot District is the poorest district in the state with BPL population of almost 50.93%. Jalaun, Hamirpur and Banda are the other three districts where BPL population is more than 30%%.

Principal Demographic Indicators representing UP-Bundelkhand (2001)

District	Total Population (2001)	% Rural Population	Area in Sq. Km.	% Rural Area of Bundelkhand	Rural/ Urban Ratio	% Decadal Growth (1991-01)	Population Density No./Sq. Km	Rural Population density No./Sq. Km.
Lalitpur	977447	*85.51*	5039	*99.59*	5.89	*29.98*	194	292
Jhansi	1746715	*59.15*	5024	*98.66*	1.45	*23.23*	348	208
Jalaun	1455859	*76.51*	4565	*99.60*	3.27	*19.39*	319	247
Hamirpur	1042324	*83.46*	4282	*99.55*	5.01	*17.85*	241	204
Mahoba	708831	*78.09*	2884	*97.96*	3.57	*21.80*	249	167
Banda	1500253	*86.21*	4460	*99.22*	5.30	*18.49*	340	292
Chitrakoot	800592	*86.14*	3164	*99.66*	9.01	*34.33*	250	219
UP-Bundelkhand	8232071	*77.62*	29418	*99.17*	3.47	*22.55*	280	194
UP-State	166052859	*79.20*	240928	-	3.81	*25.80*	690	219
India	1028737436	*72.17*	3287240	-	2.60	*21.56*	329	-

Source: Web site of National Informatics Centre

Uttar Pradesh portion of Bundelkhand is spatially very highly rural based where over 80% population (except Jhansi where more migratory population lives) is living in villages in an areal extent of 99%. Against National figure of Rural/Urban ratio of 2.6, UP state has this ratio as 3.81 depicting overall poverty in the state. In case of 7 districts of UP-Bundelkhand region this ratio is as high as 9.0 for Chitrakoot, amid 5.0 to 5.9 for Hamirpur, Banda, and Lalitpur and close to state average in case of Mahoba and Jalaun depicting extreme poverty in 4 out of 7 districts of UP-Bundelkhand. Jhansi (MB) is the only growing urban area of the district by the same name. Overall population growth rate for 1991-01 in case of UP-Bundelkhand region is almost close to National rate and is high in case of Lalitpur and Chitrakoot but lower in case of Jalaun and Hamirpur.

Other Demographical Indicators representing UP-Bundelkhand (2001)

District	Scheduled Castes as % of Total Population	Scheduled Tribes as % of Total Population	Sex ratio Females per 1000 Males	Sex ratio Females per 1000 Males (0-6 yr Group)	Percent Literacy (Males)	Percent Literacy (Females)
Lalitpur	24.93	0.00	883	930	63.81	32.97
Jhansi	28.07	0.06	871	885	78.76	50.16
Jalaun	27.04	0.01	849	889	77.39	49.21
Hamirpur	22.79	0.02	851	903	71.87	40.14
Mahoba	25.78	0.01	866	901	67.74	36.41
Banda	20.83	0.00	860	916	69.28	36.78
Chitrakoot	26.34	0.00	873	928	77.69	50.30
UP-Bundelkhand	25.25	0.02	865	907	72.36	42.28
UP-State	21.17	0.07	898	916	70.23	42.98
India	16.20	8.20	933	927	75.30	53.70

Source: Web site of national Informatics Centre

Average sex ratio is around 865 females against 1000 males. The Gender ratio is more or less uniformly distributed in rural and urban areas of the seven districts but is distinctly lower when compared to the State and National figures. Though overall sex ratio in UP-Bundelkhand is much lower, in the child group (0-6) it has improved significantly, suggesting poor maternal health facilities for women in rural areas. Compared to National as well as state figure, proportion of Scheduled Caste population is higher in UP-Bundelkhand. However, proportion of Scheduled Tribe population is insignificant. The literacy rate (upto Primary level) is close to State rate among males and is extremely low among females.

Distribution of Small and Marginal Farmers in UP-Bundelkhand (2005-06)

District	Marginal Farmers (0 to 1 ha)				Small farmers		Large farmers					
	< 0.5 ha		0.5 to 1 ha		1 to 2 ha		2 to 4 ha		4 to 10 ha		> 10 ha	
	% Far-mers	Aver plot size	% Far-mers	Aver plot size	% Far-mers	Aver plot size	% Far-mers	Aver plot size	% Far-mers	Aver plot size	% Far-mers	Aver plot size
Lalitpur	35.78	0.27	22.77	0.74	20.45	1.46	13.32	2.82	6.96	6.08	0.71	14.00
Jhansi	35.97	0.26	25.71	0.71	20.44	1.40	10.96	2.74	5.69	5.97	1.24	16.22
Jalaun	21.87	0.30	26.12	0.81	27.23	1.56	14.77	2.81	8.95	5.91	1.05	13.01
Hamirpur	40.37	0.33	19.09	0.72	18.79	1.43	13.58	2.78	7.61	5.94	0.57	12.70
Mahoba	26.34	0.27	27.96	0.71	23.18	1.44	14.77	2.78	7.26	5.83	0.50	13.28
Banda	26.22	0.30	23.56	0.72	23.92	1.44	15.92	2.76	9.29	5.88	1.09	13.22
Chitrakoot	16.93	0.29	24.80	0.73	33.78	1.45	16.68	2.77	6.75	5.83	1.05	14.90
UP-Bundel-khand	29.61	0.29	24.13	0.73	23.65	1.46	14.30	2.78	7.49	5.92	0.83	13.96

Source: Web site of National Informatics Centre

Distribution of land holding size is highly skewed. About 30% of the farmers own land holding of 0.29 ha. About 56% of the farmers belong to marginal (< 1 ha) category with land holding size of 0.49 ha. Another 23.65% farmers belong to small (1 to 2 ha) category with land holding size of 1.46 ha. Majority of these farmers are engaged in agriculture for subsistence. Fourteen percent of the farmers have a land holding of 2.78 ha; 7% have 5.92 ha while less than 1% has greater than 10 ha. While all districts have more than 75% small and marginal farmers, Jhansi alone has more than 82%.

Rural Infra Structure Development

Services	Lalitpur	Jhansi	Jalaun	Hamirpur	Mahoba	Banda	Chitra-koot	UP-Bundel-khand
No. of inhabited villages	697	764	937	521	421	682	545	4567
Water Supply								
Drinking Water	669	750	916	512	403	675	524	4449
Safe Drinking Water	669	750	916	512	403	675	524	4449
Electric Supply								
Village	352	518	618	345	172	438	270	2713
Domestic	237	354	436	206	148	238	156	1775
Agriculture	39	101	188	99	14	133	53	627
Education								
Primary School	569	657	822	464	358	590	430	3890
Middle School	155	203	259	189	99	246	135	1286
Secondary School	14	40	77	24	11	35	38	239
College	0	4	10	1	0	4	8	27
Health								
Medical Facility	164	285	317	264	131	191	138	1490
Primary Centre	13	15	22	17	8	14	17	106
Sub-Centre	19	41	52	65	24	33	18	252
Communications								
P&T/Phone	247	381	475	245	134	243	124	1849
Bus Service	201	146	139	120	54	112	57	829
Roads								
Paved	300	435	514	353	197	374	211	2384

Mud	420	410	573	230	253	390	324	2600

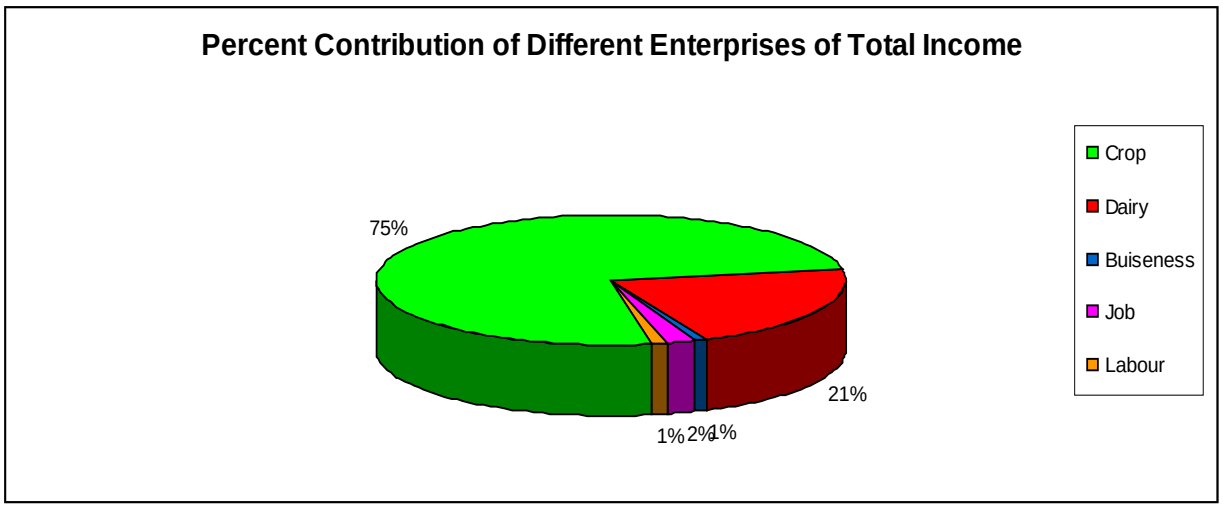
Source: Census of India 2001

Comparatively infrastructure development facilities in UP-Bundelkhand in rural sector have lacked with respect to rest of the state. Except drinking water facility level of development in all areas is less than 50%. With majority of the farmers depending on ground water resource, extremely low coverage of electric supply for agriculture leaves farmers to look for diesel use, there by increasing cost of cultivation many folds. Besides, the supply is erratic and prone to voltage fluctuations, with the result; it is difficult to carry on agricultural activities. Communications and road links also cause difficulties to farmers in carrying out agriculture operations as well as selling their produce. Number of Markets and Mandis in Rural UP-Bundelkhand is very meager and occasionally work.

Above demographic indicators suggest lower state of development in UP-Bundelkhand when compared to rest of Uttar Pradesh. All future development strategies that required to be framed in respect of UP-Bundelkhand will have to be pro-poor.

Economy and Livelihood Pattern

The economy of Bundelkhand region in both the States is predominantly agrarian; over 80% of population is dependent on agriculture, livestock, usufructs from forest and outsourcing income by seasonal migration after Rabi sowing. Livelihood analysis of Jhansi District in Uttar Pradesh carried out in 2002 is quite representative of Bundelkhand region.



Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

On an average 96% of the farmers' income is being earned from crop and livestock enterprise alone. While main enterprise of small and marginal farmers is dairy, the crop component increases and that of dairy decreases with rising land holding size. Landless villagers mainly depend on labour and dairy. Table given below shows livelihood analysis of Jhansi district in Uttar Pradesh in the year 2002:

Category	Contribution by Sector
Landless	Labour (Mainly), Livestock (minor)
Marginal farmers	Crops (60%), Livestock (35%)
Small farmers	Crops (67%), Livestock (26%)
Medium farmers	Crops (77%), Livestock (20%)
Large Farmers	Crops (84%), livestock (12%)
15-20% Seasonal migration even in normal rainfall years	

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

Mining of stones, sand, gravel and building material, represent very low industrial activity and limited employment potentials for reducing dependence on agriculture.

With surface water irrigation more or less developed and ground water irrigation developed to the extent of 25.8% of its resources in UP-Bundelkhand, inadequate maintenance and inappropriate management of these resources coupled with age old technologies of agriculture development and under nourished and low yielding bovine population renders the people to remain poor, more than 90% of which depend on these activities.

Land Use

Land use statistics of seven districts in Bundelkhand region of UP as reported during 2005-06 are given below:

Land Use Area (ha) in UP portion of Bundelkhand (2005-06)

District	Geographical Area (GA)	Forest Cover	Aver. Forest Cover as % of Geographical Area	Barren and Uncultivated Land	Land put to non Agricultu re Use	Barren/ Culti-vative Waste	Land Cover under Misc. Trees & Grooves	Present / other Fallow land	Net sown Area
Lalitpur	507500	76160	*15.01*	15043	39164	60103	3540	45627	267863
Jhansi	501327	34378	*6.86*	31662	42130	15701	1812	48847	326797
Jalaun	454434	28177	*6.20*	11966	37360	1767	1912	24634	348618
Hamirpur	388180	21521	*5.54*	9257	30461	3760	1114	23408	298659
Mahoba	327429	16213	*4.95*	8357	37870	11390	640	14906	238053
Banda	438767	5228	*1.19*	11397	29431	11216	1576	37484	342435
Chitrakoot	338897	59723	*17.62*	22154	28343	10623	22391	19361	171302
UP-Bundelkhand *(% of GA)*	2956534 *(100%)*	241400 (8.16%)	*8.16*	109836 (3.72%)	244759 (8.28%)	114560 (3.87%)	31585 (10.68)	155764 (5.27%)	1993727 (67.43%)
UP-State	24201294	1687777	*6.97*	529748	26548503	529748	407199	1790711	16596765*
India (000'ha)	328726	68980	*20.98*	19512	22803	9929	11496	13589	142581

** - (2002-03) Source: Statistical Diary, 2007, Economical and Statistical Department, State Planning Institute, Uttar Pradesh.*

Forest area in the districts covered in Bundelkhand is much lower when compared to that in districts covered under MP-Bundelkhand region. Compared to Madhya Pradesh portion of Bundelkhand, where, average forest cover is around 26.2% (mainly because of Panna National Park), forest cover in UP-Bundelkhand is around 8.16 % with higher concentration in Lalitpur (15%) and Chitrakoot (17.62%) districts. Forest cover in remaining 5 districts is less than 7%. About 3.72% of the land is barren and is not cultivable, a portion of which can be brought under cultivation with some extra effort. A major chunk of land not being cultivable at present can be brought under cultivation within the overall perspective of intensification. *Remote sensing and GIS mapping can help identify such areas.*

Area under Cultivation (2005-06) (ha)

District	Gross Sown Area (GSA)	*GSA as % of GA*	Net Sown Area (NSA)	*Net Sown Area as % of GA*	Net Irrigated Area (NIA)	*Net Irrigated Area as % of NSA*	Gross irrigated Area	*Gross Irrigated Area as % of NIA*
Lalitpur	362209	*71.37*	267863	*52.78*	240778	*89.89*	242399	*100.67*
Jhansi	418653	*83.51*	326797	*65.19*	196078	*60.00*	200491	*102.25*
Jalaun	412268	*90.72*	348618	*76.71*	204995	*58.80*	214425	*104.60*
Hamirpur	328202	*84.55*	298659	*76.93*	98719	*33.05*	101995	*103.32*
Mahoba	281922	*86.10*	238053	*72.70*	104402	*43.86*	107135	*102.62*

Banda	405954	*92.52*	342435	*78.04*	117609	*34.34*	160108	*136.14*
Chitrakoot	189334	*55.87*	171302	*50.55*	45596	*26.62*	48102	*105.50*
UP-Bundelkhand	2398542	*81.13*	1993727	*67.43*	1008177	*50.57*	1074655	*106.59*
UP-State (000'ha)	25105	*104.20*	16683	*69.205*	13176	*79.00*	18345	*139.23*
India (000'ha)	194758	*59.24*	142581	*43.37*	53100	*37.24*	193034	*135.36*

Source: Statistical Diary, 2007, Economical and Statistical Department, State Planning Institute, Uttar Pradesh.

Net sown area as percent of geographical area varies from about 50 % in Chitrakoot to about 78% in Banda. Net irrigated area as percent of NSA is very high in Lalitpur (89.89%), Jhansi (60%), and Jalaun (58.80%) and extremely small in Chitrakoot (26%). In all 28 major and medium schemes and 37 lift irrigation schemes are in operation at present contributing to about 16.17% of the canal irrigation. Gross irrigated area as percent of NIA is lower as compared to the State and national average. Minor irrigation sector comprises of about 28.9% of the irrigation out of which 26.7% is from ground water source alone. Overall irrigation is of the order of 45.6%. Remaining 35.5% of the NSA is rainfed (mainly Hamirpur, Mahoba, Banda and Chitrakoot districts), a major portion of which has the potential to be brought under irrigation from additional surface water development from Ken and Dhasan river systems and a large number of possibilities of developing watershed schemes to help harvesting water. There does not seem to be much scope for further ground water development. These aspects are discussed in detail in subsequent sections. Net irrigated area as % of NSA is very small due to lower level of irrigation development in Hamirpur, Banda and Chitrakoot.

Geology

Central Ground Water Board (CGWB) has carried out extensive geological and hydro-geological surveys in the Bundelkhand region. As quoted from their report '*Hydrogeology in the Bundelkhand Region*' the geological formations in this region are from Archaeans to recent origin. The crystalline rocks of Achaeans consist of granite, gneiss and quartz reefs. The Vindhyan are represented by sand stone, lime stone and shale. The rocks are dominant in the region while the unconsolidated formations of recent (Quaternary) consisting of sand, silt and clay occupy northern parts of the region along the river Yamuna in the districts of Jalaun, Hamirpur, Banda, Panna and parts of Chitrakoot. The underlying Archaeans is mostly composed of basal crystalline, mostly granites, popularly known as 'Bundelkhand Granite' and metamorphic, mostly gneisses. These are fractured jointed and weathered. The thickness of weathered zone depends upon the topography, drainage & vegetation cover. The granites are pink to grey coloured and are coarse to fine grained. The Granites are normally sloping northerly towards the Yamuna.

The Vindhyan, are represented by a pile of Precambrian sedimentary rock, consisting of sub-horizontal and weakly folded beds of sand stone, shale and limestone. These sediments, attaining thickness of more than 4000 m are laid over Achaean rocks. The Vindhyan are exposed in Damoh and parts of Panna district in Madhya Pradesh and Banda district of Uttar Pradesh. In Chitrakoot granite hillocks are capped by lower Vindhyan rocks and Kaimur sandstone. The limestones extending towards the Yamuna are highly cavernous. Large size of cavities also occurs in limestones in Panna district of Madhya Pradesh.

Alluviums on the other hand comprise mainly of clays, silt and sand stone mixed with gravel and kankar. These formations have a thickness of about 130 to 150 m over the eroded base of Bundelkhand Granite. The alluvium deposits are mostly found in Hamirpur, Jalaun and parts of Jhansi district near the Yamuna and northern parts of Datia and Panna districts in Madhya Pradesh.

Hydrogeology

As per the report of the CGWB, the nature and the extent of the aquifer bodies and their hydro-geological properties in relation to the ground water flow characteristics, the formations can be broadly classified in two regions of Bundelkhand, *Consolidated and Unconsolidated*.

The Consolidated Formations, composed of granite, gneisses and quartz reef etc. These are hard rocks and compact with negligible porosity resulting into poor aquifers. The porosity of these rocks varies from 0 to 0.3%, and, therefore, these formations are incapable of holding and transmitting water. However, along the planes of weakness and fractures, joints, and shear planes, the weathering and decomposition provides appreciable porosity to up to 30 to 50%. Generally dug wells in these zones have a depth of 5 to 30 m with water levels between 3 to 15 m below ground level (bgl). The yield of such wells can range from 40 to 135 m^3 per day.

The Vindhyan formations on the other hand are composed of sand stones, shale and limestones. The sandstones and shale are hard and compact hence form poor aquifer. The ground water occurs in these formations under water table conditions in fine interstice of the weathered zones and joint planes. Deeper sandstone zones are compact and impervious and generally do not bear water and are thus unsuitable for ground water development. The cavernous zones and cavities in limestones on the other hand are generally potential repositories of ground water and provide copious discharge when tapped. Wells in limestones can yield up to 100 to 500 m^3/day. Unless tapped, both these formations leak water which flows fast towards the Yamuna.

The Unconsolidated Formations occur south of the Yamuna in Jalaun, Hamirpur, Banda and parts of Chitrakoot district in Uttar Pradesh. Unconsolidated formations are characterised by generally north-east sloping planes formed by the drainage system of Yamuna river. The sediments mainly comprise clay-kankar-silt with intercalation of sand and gravel lenses of varying thickness and inter-granular porosity. Thickness of these deposits is about 50-150 m. Ground water in these strata generally occurs in the upper zones of about 40 m. and under semi-unconfined conditions at deeper level below 40 m. Wells between 30 to 40 m of granular aquifer can yield 50-65 litres per second (lps) (4000 to 5000 m^3/day). Hydro-geology of the Bundelkhand region is shown in Plate-III. The patterns of depth to water levels in a good year like 1998-99 in the pre monsoon and post monsoon periods are sketched in Plates-IV & V respectively.

Soils

Broadly there are four types of soils in the region namely (i) Red sandy soils, (ii) Shallow black soils, (iii) Mixed red and black sand, and (iv) Alluvial soils.

Red sandy soils, commonly known as *Rakar* soils contains quartz, orthoclase, microcline etc and exists in districts of Jhansi and Lalitpur in Uttar Pradesh and Datia, Tikamgarh, Chattarpur and parts of Panna in Madhya Pradesh. These soils are shallow, gravelly and extremely porous with low organic matter and have poor water holding capacity and are thus not much suitable for main stream agricultural activities.

Shallow black soil, also locally known as *Parwa* soils, which are coarse grained clayey in nature and mostly grey to grayish brown in colour, usually occurs in low lying areas of the district Jalaun, Hamirpur and Banda. The particle size of this soil varies from fine to medium and has high water retaining capacity and is thus suitable for plant growth and crop cultivation.

Mixed red & black soils also called *Kabar* soils in Tikamgarh, Chattarpur & Panna districts in Madhya Pradesh consists of quartz, orthoclase, microcline etc.

The alluvial or *Mar* soil occurs in northern parts of region in the districts of Jalaun and Hamirpur in Uttar Pradesh and parts of Panna in Madhya Pradesh. The soil is brown in colour with medium depth. This soil is generally less rich in organic matter. Plate-VI shows gradually changing behaviour of the

soil pattern and has an important bearing on hydrology, hydro-geology, and agronomy resulting into a typical livelihood pattern of the people.

Due to lower moisture carrying capacities, agricultural practices mainly depend on soil types and therefore, future strategic options would require detailed investigations of soils and under ground geological mappings of the Bundelkhand area.

Rainfall

The rainfall pattern in Bundelkhand region is typically monsoonic and the area normally gets around 800 to 950 mm of rainfall. Extreme variations in the rainfall pattern are observed with over 90% of the rainfall occurring between June to September and non-monsoon period of 8 months practically getting short spells of scanty rainfall of less than 10%. River systems draining the area such as Ken, Betwa and Dhasan are perennial as their catchments lie in the higher rainfall zones in Madhya Pradesh. Other Rivers are mostly seasonal.

Plate – VII shows normal isohyets (mm) in the entire Bundelkhand region and the district wise annual normal and reported annual rainfall in last four drought affected years is given below:

Distribution of Meteorological Drought in UP-Bundelkhand

S. No.	District	Normal Rainfall	2004-05	2005-06	2006-07	2007-08
			% Deviation	% Deviation	% Deviation	% Deviation
1	Lalitpur	879	-19	-34	-54	-40
2	Jhansi	880	-39	-39	-52	-61
3	Jalaun	787	-23	-24	-47	-55
4	Hamirpur	851	-30	-37	-51	-50
5	Mahoba	851	-30	+02	-52	-57
6	Banda	945	-14	-08	-22	-60
7	Chitrakoot	940	-19	-40	-21	-66
Average UP-Bundelkhand		876	-25	-24	-43	-56

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

Recent past four years had been conspicuous of prolonged drought. Deficit in rainfall increased from 24% in 2004 to 56% in 2007 and it became a case of accumulated drought. Long term records of annual rainfall can reveal that such a long spell of drought has never occurred in the past recorded history, although droughts of one year spell of small intensity are common in Bundelkhand region, both in Madhya Pradesh and Uttar Pradesh. The intensity of the droughts in the recent four years had been so severe that majority of dugwells, ponds, tanks as well as small rivers/nallahs had dried up. The effect of the drought had been severe in Chitrakoot, Banda, Mahoba and parts of Hamirpur as compared to other irrigated districts.

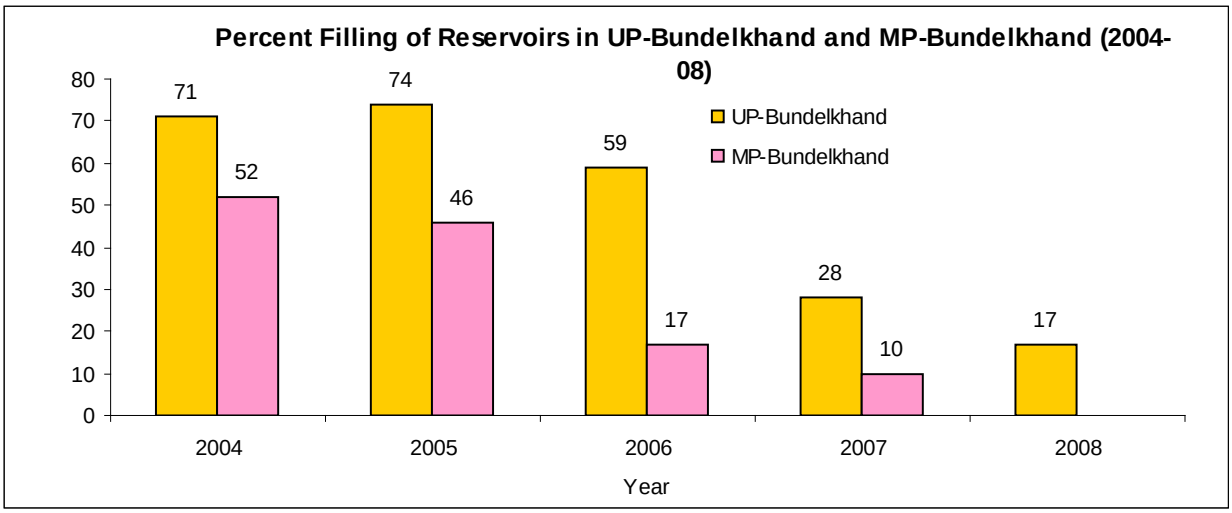
Severe Environmental Concerns

Drought Occurrence in UP-Bundelkhand - There have been only twelve drought years in Bundelkhand during 19th and 20th century, thus making a drought cycle of once in 16 years. Frequency of droughts during 1968-1992 increased to one to three in 16 years. During 2004-07 continuous droughts like situation prevailed in some parts of Bundelkhand (both in MP and UP).

More than 19% deficit in the normal rainfall, late withdrawal of rains, long breaks in rain spells, and their permutations and combinations are some of the reasons of triggering meteorological droughts. During 2004-07 there had been a shortfall of more than 25% and deficit continued for about four years. Rainfall failure exceeded nearly 55% in Jalaun, Mahoba, Jhansi, Banda and Chitrakoot in 2007-08. Table given above shows district wise deviations of rainfall from normal in last four years.

Cummulative build up of meteorological drought caused hydrological drought when reservoirs getting inflows from upper catchment failed to attract adequate storages. Table-1 at the end of this report

shows status of storages in all 28 major and medium reservoirs in UP-Bundelkhand. Against total capacity of 2013 million cubic meters (MCM), actual filling during the period of 2004-07 progressively decreased to 17%. Situation in case of MP reservoirs was even worst.



Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP

Meteorological and hydrological droughts in Bundelkhand lead to loss in sown area, productivity, failure of crops already grown, non availability of forages, grass and fodder. During 2004-07 drying of tanks, ponds, dug-wells and fall in water level in ground water table clearly indicated hydrological drought both in UP and MP. Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP has mentioned NSA in UP-Bundelkhand dwindling to about 60% in 4 years.

Future strategies of Integrated Water and Land Resources Development has thus to consider short, medium and long term mitigation of droughts in the UP-Bundelkhand.

Other important environmental concerns are discussed subsequently.

Ground Water Resources Development

According CGWB study, the total ground water resources of the Bundelkhand region in Uttar Pradesh is 4632 MCM. Utilizable potential for irrigation is 3544 MCM. There are 4604 (3.6%) deep tubewells, 44870 (35%) shallow tube wells and 78476 (61.3%) dugwells. Present level of utilization in Uttar Pradesh is 1019 MCM and balance ground water available for future development is thus 2525 MCM (53%). Present level of development is reported at 26%. District wise details are given below:

Ground Water Resource and Irrigation Potential

S. No.	District	Total Replenishable ground water recharge (MCM)	Utilisable GW Resources for irrigation (MCM)	Net Draft (1998) (MCM)	Balance GW Resource (MCM)	Level of Development (%)	Corres-ponding Utilisable Irrigation Potential (ha)
District wise Ground water Resource and Irrigation Potential in UP portion of Bundelkhand							
1	Banda *	1400.89	1071.68	291.66	780.02	24.49	2679.20
2	Hamirpur**	969.20	741.44	201.69	539.75	24.48	1853.60
3	Jalaun	1020.18	780.44	149.81	630.63	17.28	1951.10
4	Jhansi	641.63	490.85	183.68	307.17	33.68	1227.10
5	Lalitpur	600.45	459.35	191.69	267.66	37.56	1148.30
	Total	4632.35	3543.76	1018.53	2525.23	25.80 (Avg.)	8859.30***

* includes Chitrakoot ** includes Mahoba ***0.44% of net sown area

Source: Report on Hydrogeology of the Bundelkhand Region – CGWB, GoI, (2000)

It appears to be a rosy picture but recent drought cycle of four years (2004-07) has completely depleted the available resource in the absence of recharge from rainfall and it is likely to take quite a few years to replenish aquifers if good rainfall is restored. The yield and re-charging rate are poor and ground water development is apparently economically unsustainable.

There are 78476 dugwells irrigating 8.9% of the net sown area in UP-Bundelkhand. There is a tremendous scope to extend the water availability in dug wells by their recharging. CGWB has suggested that additional dug wells can be opened. The concept of farm ponds, if developed can help to harvest ground water thus recharging dugwells in a big way.

There are about 44870 shallow tubewells and 4604 deep tubewells in UP-Bundelkhand, mostly developed through private efforts. Tube well development in UP-Bundelkhand is more pronounced in alluvium belt near Yamuna. Average area irrigated per structure varies from 2.1 ha in case of dugwells to 37.5 ha in case of deep tubewells.

Region	Deep Tube Wells	Shallow Tube Wells	Dug wells	All Structures
Number				
UP-Bundelkhand	4604	44870	78476	127950
Average area irrigated (ha) per structure				
UP-Bundelkhand	37.5	3.5	2.1	3.9

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

Distinct variation in yield rates is primarily due to the hydro-geological characteristics dominant in Bundelkhand. District wise ground water extent and yield in Bundelkhand region are given below:

Ground water extent and Yield in UP-Bundelkhand (area in %)

S. No.	District	Ground water yield (liters per second (lps))			
		< 1	1-10	10-25	25-40
1	Lalitpur	100	-	-	-
2	Jhansi	-	20	80	-
3	Jalaun	80	20	-	-
4	Hamirpur	-	70	30	-
5	Mahoba	65	35	5	-
6	Banda	-	70	30	-
7	Chitrakoot	55	-	35	10

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

Water Yields expected from Geo-hydrological formations in Bundelkhand (both UP and MP) and corresponding irrigation potential (ha/day) is given below:

Geo-hydrological formation in Bundelkhand Region

S. No.	Geological Formation	Water Yield (lps)	Irrigation Potential ha/day
1	Crystalline rocks (granite, Gneiss and Quarts)	1-5	0.1-0.2
2	Vindayans (sand stone, Shale, and Limestone)	5-25	0.2-1
3	Unconsolidated (Clay, Gravel, Silt)	20-40	2-3

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP.

In Bundelkhand region about 70 to 80% of the aquifer is poor yielding and remaining 20 to 30% is already exploited. According to the CGWB study, there is a lot of variation in water output and drawdown of the strata and between two geological formations and chances of ending up into a successful bore well are very low. Better aquifers are already utilized and the remaining ones are not

dependable and investments into tube-wells could be risky. However, additional dug-wells could be opened for harnessing lower yields in hard rock area. *Thus shallow tube wells should be considered only for selected areas and that too for drinking water purpose only.*

Surface Water Resources Development

According to 3rd Census of Minor Irrigation Schemes (2000-01) about 16.7% of net sown area of is irrigated by surface water major and medium schemes. Another 28.9 % of the net sown area is being irrigated through minor schemes; 2.2% from surface water and remaining 26.7% from ground water source. Total irrigation is of the order of 45.6% of net sown area of which Kharif irrigation is about 25% and Rabi about 74% and Zaid and perennial crops are practically negligible. Rest of 54.4% of net sown area is rainfed.

Uttar Pradesh region of Bundelkhand has developed majority of its irrigation schemes of its water share. About 28 surface water major and medium dams are already in position (see Table-I and Plate VIII). About 37 SW lift irrigation schemes are already in operation. A number of schemes are in pipeline; about six are under construction while another 15 are planned. Canals, including lift canals are the main source of irrigation followed by tubewells, dug wells and surface water ponds/tanks. The general feature of the rivers in UP-Bundelkhand is that these swell during monsoon and almost dry up during summer. While Yamuna, Ken, Betwa (including Dhasan) are perennial, many of their tributaries and other small streams are not. Table given below shows irrigation from different sources:

Irrigable Area and Area irrigated from different Source ('000 ha)

District Name	Geographical Area	Cultivable Area	Net Sown Area	System Canals	Minor Irrigation (MI) Area Under Different Source						Irrg. from all sources
					Ground Water Wells /Tube wells			Surface Water		Total MI Irrg. Area	
					Dug	Shallow	Deep	Flow	Lift		
Lalitpur	386.52	324.76	299.66	27.45	11.34	45.75	59.66	1.38	2.43	120.54	147.99
Jhansi	313.29	219.27	199.86	13.62	9.61	15.75	1.62	4.68	3.90	35.55	49.16
Jalaun	401.40	324.21	303.86	37.92	10.90	34.52	37.74	2.00	3.46	88.60	126.52
Hamir pur	457.76	371.44	337.13	118.09	7.16	26.71	61.00	1.03	0.51	96.41	214.50
Mahoba	483.96	356.17	305.98	57.24	41.43	30.71	8.76	0.83	5.51	87.25	144.48
Banda	509.87	387.68	213.34	46.74	52.08	2.06	3.80	0.17	2.85	60.97	107.71
Chitrakoot	277.95	203.73	194.05	8.83	31.95	2.22	0.30	10.63	0.87	45.97	54.80
Total	2830.74	2187.24	1853.87	309.89	164.46	157.71	172.88	20.71	19.51	535.27	845.16
Percent of Net Sown Area				*16.7*	*8.9*	*8.5*	*9.3*	*1.1*	*1.1*	*28.9*	*45.6*

Source – Third Minor Irrigation Census (2000-01)

Majority of the surface water resource mainly constitutes of three main rivers flowing across the region; Betwa & its major tributary Dhasan and Ken Rivers. While Inter-State agreements exist between Uttar Pradesh and Madhya Pradesh for Betwa and Ken Basins, Dhasan is practically untapped, where there has been no agreement on sharing of its waters.

The 75% dependability of flows in these three rivers at prominent locations is briefly discussed below:

The Betwa at Rajghat - As per agreement between the two States, about 3370 MCM (119 TMC) of water is available at 75% dependability, out of which about 250 MCM (9 TMC) or 7.4% is meant for downstream committed use and another 750 MCM (26.5 TMC) or 22.2% each is reserved for down stream use in both Uttar Pradesh and Madhya Pradesh. Remaining 1500 MCM (53 TMC) or 44.4% is reserved for use by Madhya Pradesh upstream of Rajghat dam. Remaining 120 MCM (4 TMC) are planned losses from reservoir. Rajghat is a joint venture of the two States, which is nearly complete and its command is now under development. There are agreements on sharing of use of Betwa system

between the two co-sharing States. *Conservation and Management of water resource of this basin is the prime concern. Decision support system (DSS) for optimal management of resources of Rajghat and Betwa basin should be developed.*

The Dhasan - Details on flows of this river are not immediately available. It is reported that Government of Uttar Pradesh has almost completed irrigation development in the basin while Government of Madhya Pradesh is yet to develop its resources. In the absence of agreement among co-sharing states, quantum of water being put to use in UP is likely to change in future as and when development of the basin in MP takes place. *Re-assessment of the flows, respective shares of two states, joint operation and basin planning of the Dhasan system to identify alternative options in MP and UP are the key issues.*

The Ken at Daudhan Dam site - As per information put up by NWDA on its web site, out of the total water availability of 6188 MCM (218.5 thousand million Cubic feet (TMC)) at 75% dependability at proposed Daudhan dam site on the Ken, presently 205 MCM (7.25 TMC, i.e. *3.3%)* is being utilized by M.P. and 1050 MCM (37 TMC, i.e. *17.0 %)* is being utilized by UP in Banda & Chitrakoot districts from Bariyarpur barrage mainly during Rabi season. In this way nearly 79.7% water is yet to be utilized by Madhya Pradesh. NWDA has proposed a Ken-Betwa Link project (described subsequently) and recently a fresh agreement on sharing of Ken waters, including some adjustments in Betwa allocations are signed between the two States. In addition, MP is yet to plan irrigation and water supply schemes upstream of proposed Daudhan dam. *The key issues requiring immediate attention are basin planning and management including flood management of the basin. In order to optimize resources a Basin Model and a DSS for planning of Ken- Betwa River schemes as well as its operation and management has to be developed for the mutual benefit of both the States. Large scale afforestation measures in the basin, mainly Panna National Park are envisaged.*

Other Rivers - In addition, a large number of small rivers/streams/nallahs like the Paisuni, Gunta and the Baghain etc. originate within Utter Pradesh and have comparatively small contributions for use within Uttar Pradesh which are nearly utilized. The reservoirs on these schemes most of the time do not fill up to FRL and often dry up during Rabi. Practically there is a low level of Kharif on these systems. *Interlinking of canals/streams of these reservoirs system can definitely increase availability of flows, particularly during drought periods. Study of basin plans of these systems, interlinking options and development of DSS for integrated system of these reservoirs would be the key areas of interest.*

Joint projects of Madhya Pradesh and Uttar Pradesh

Rajghat dam – a joint project of the two states - Out of 119 TMC of waters available at Rajghat dam site, 53 TMC *(44.5%)* is reserved for use in upstream cathchment by Madhya Pradesh. From the 62 TMC of live storage at Rajghat dam site, 9 TMC *(7.5%)* is to be used for committed downstream use in UP and MP, 50% of balance storage i.e., up to 26.5 TMC plus half of the losses from dam to be utilized by UP and balance and excess over 23.5 TMC is for use in Madhya Pradesh in Datia district. *To utilize respective shares, the two States are developing their respective commands, which should be given highest priority. Optimal management through development of micro irrigation, implementation of command area development and participatory programmes are priority areas for this system.*

Ken-Betwa Link project – a Proposal of NWDA - To utilize the untapped waters of the Ken basin, National Water Development Agency (NWDA) has proposed in its feasibility report, diversion of Ken waters to water deficit Betwa basin through a 232 km. long link canal of 72 Cumecs discharge capacity, which will pass through water deficit areas of Chattarpur, Tikamgarh districts. Water is proposed to be diverted after considering basin demands and down stream commitments of both MP

and UP. The link canal will provide irrigation to water short areas of upper Betwa basin of MP by way of substitution and also to enroute areas of MP and UP The command envisaged in the earlier proposed Ken Multipurpose project (KMPP) by MP is also to be irrigated from this project for which a dam with revised live capacity of 2753 MCM is proposed on the Ken at Daudhan 2.5 km upstream of existing Gangau weir. The net water availability at dam site after accounting for committed and proposed requirements is 2225 MCM, out of which, 850 MCM is provided to U.P. and 1375 MCM to M.P. for use in KMPP command as per inter-state agreement of 1981 on river Ken. Plate-IX shows layout map of the Ken – Betwa link project as proposed by NWDA. Pattern of utilisations proposed is as under:

Existing utilisations upstream of the dam	42.31 MCM (Medium Projects)
Ongoing projects upstream of the dam	69.10 MCM (Minor projects)
Proposed Projects upstream of the dam	842.70 MCM
Direct use in M.P.	1375.00 MCM
Direct use in U.P.	850.00 MCM
Irrigation use enroute ken-Betwa link Canal	312.00 MCM
Drinking purpose in the vicinity of link for both MP and UP	11.75 MCM
Transmission losses	37.25 MCM
Transfer of water to U.P. in lieu of use in 4 projects upstream of Rajghat dam in Betwa Basin)	659.00 MCM
Power Generation	72.00 MW

Source: Website of NWDA, Govt. of India, Ministry of Water Resources

Annual Irrigation on full development as proposed by NWDA is as under:

Irrigation benefit to M.P. in Raisen and Vidisha districts	1.27 lakh ha
Irrigation in M.P. enroute Ken-Betwa-Link canal	0.47 lakh ha
Irrigation in M.P. under Ken Command	3.23 lakh ha
Total	4.97 lakh ha

Source: Website of NWDA, Govt. of India, Ministry of Water Resources

Ken Betwa link project and the ongoing and proposed projects upstream of the proposed Daudhan dam on full development are likely to transform the entire belt of Sagar, Damoh, Panna, Chattarpur and parts of Tikamgarh districts in M.P. and Banda, parts of Mahoba and Chitrakoot districts in U.P. to water rich areas. *Water deficit felt during past four years due to deficit rainfall in the Panna, Chattarpur, Tikamgarh, Mahoba, Bandha, can be effectively mitigated through link canals and the two states should give a serious thinking on enroute development. A comprehensive and coordinated development of this project can mitigate the crisis like the present one to a thing of the past. Therefore, it is utmost important that Ken-Betwa Link Project and projects planned upstream of the Daudhan dam in Panna, Sagar and Damoh districts must be taken up on priority. It is understood that NWDA has finalized the Detailed Project Report of the Project.*

Suggested modifications in design parameters of Ken-Betwa Link Project - Central belt of Bundelkhand region both in Madhya Pradesh and Uttar Pradesh receive normal rainfalls close to threshold for triggering severe droughts. Small deviations in rainfall recurring beyond two years could trigger severe drought conditions as meager ground water potential dwindles fast and takes much longer to recoup. Recent droughts have demonstrated that geology and hydro-geology do not permit long term sustainable use of ground water in the absence of assured recharge. As detailed designs of the Ken Betwa Link are under progress, peculiar characteristics of the soils, geology, hydro-geology, rainfall, prevailing irrigation practices and likely diversification expected in the proposed cropping pattern should be effectively integrated in the designs at this stage. Present cropping pattern, which is mainly Rabi dominant, is likely to change once assure irrigation becomes available. Both the states

should, therefore, consider some adjustments to the allocations of flows already made at this stage to increase enroute requirements of irrigation and water supplies especially in the light of likely changes expected in recharge patterns in aquifers. *Systematic and comprehensive assessment and studies integrating future return flows, which are more or less assured, are called for. Irrigation enroute in UP-Bundelkhand should be increased and clubbed and designed for conjunctive use with part Rabi irrigation from existing tube wells/ dug wells. Deficiencies due to re-allocations, if any should be planned to be met from adaptation to pressure systems and savings from other water conservation measures.*

Net working of Rivers and Canal systems in Bundelkhand region of Uttar Pradesh - Rivers Betwa, Ken, Baghain, Paisuni, Gunta, and their tributaries Dhasan, Chandrawal, Ohen along with a large number of other nallahs run mainly from south to north direction out-falling into the Yamuna, approximately parallel to each other and can be easily net-worked within Uttar Pradesh. Reservoirs built on large rivers with catchments in high rainfall zone in Madhya Pradesh are not seriously affected during droughts as is demonstrated in the first two years of recent deficient rainfalls. Reservoirs on small streams originating with in Mahoba, Chitrakoot and parts of Banda districts of Uttar Pradesh, on the other hand could not withstand droughts during first two years as well mainly due to small storages, lower rainfalls and ground water resource depleting fast. Had there been some possibilities of diverting water from Ken and Dhasan to these areas, drought impact could have been arrested to some extend. Such linkages are not only desired during deficit rainfall/runoff period, but also during normal years in order to share equitable resources in an optimal manner, particularly so when the fertile alluvium soils are limited and should be made use of in the best possible manner for optimizing production/productivity.

Proper networking of rivers and canals within Uttar Pradesh are also desirable for efficient utilization of waters during normal times. A systematic management study of proper assessment of all Bundelkhand surface and ground water resources as well as their utilisations could precede the suggested networking of canal systems.

Performance of Surface Water Schemes during recent Droughts

Gravity Irrigation - Barring Rajghat, which is a joint project of the two States, 28 surface water irrigation projects are providing irrigation in Bundelkhand region of Uttar Pradesh out of which 3 are in Madhya Pradesh. A live storage of 2013 MCM (71 TMC) is provided while in a good year actual effective storage is of the order of 70 to 75%. Another 19 dams are proposed. Table-I at end of the report provides performance of 28 reservoirs through post monsoon storages which indicates that during 2004 and 2005, storages in the reservoir was about 71to 74 % and was considered as normal (These reservoirs do no fill beyond 75% in a normal year). On the other hand reservoirs could not be filled up during 2006 and 2007 as post monsoon storages dwindled to 28% in 2006 and 17% in 2007 and canal supplies for irrigation had to be curtailed drastically. It may be noticed that performance of many of the schemes during 2004-05 and 2005-06 was good mainly due to low level of development of resources in MP and the pattern is likely to change once MP develops its resources.

In all 23 canal systems are fed from 28 reservoirs. Table given below shows the performance of the canal tails. Out of 1050 tails in 23 canal systems, water could be fed to only 566 (54%) tails in 2006-07 and 37 (3.5%); tails in 2007-08 primarily due to curtailed water supplies.

Performance of Canal Tails

Canal System	No. of Tails	Year-wise Tail Feeding			
		2006-07		2007-08	
		Target	Achievements	Target	Achievements
Jhansi	160	81	81	-	19
Jalaun	291	289	289	-	16
Lalitpur	119	80	95	-	-
Banda	184	8	9	-	-
Mahoba	97	21	36	-	-
Hamirpur	100	28	28	-	-
Chitrakoot	88	17	22	-	-
Portion in Madhya Pradesh	11	6	6	-	2
Total	1050	530 *(50.4%)*	566 (*53.9%)*	199 (*19.0%)*	37 *(3.5%)*

Source: O/O CE, (Betwa), UPID, GoUP

Table-2 at end of the report gives canal wise performance of irrigation during recent drought years. It is observed that as against planned Kharif irrigation of 126 thousand hectares (Tha), the same was supported only in an area of 71 Tha *(56%).* On the other hand, as against planned Rabi of 428 Tha, the same is supported in 527 Tha *(123%).* It may be seen that despite no water in the reservoirs and canal systems during drought years, irrigation could be supported by assured ground water recharge from irrigation/return flow. In spite of deficit rainfall and acute shortage of water in reservoirs, it seems farmers are capable of handling the situation through private tube wells or dug wells, a large number of which exists in the alluvium belt near the Yamuna. Therefore, assured return flow in the system is playing an important role in stabilizing the irrigation during uncertain drought years and should be planned or managed as an important conjunctive use component. *Conjunctive use, though uncontrolled at present, if assessed and managed spatially and temporally, can help in revising rosters for canal net works. Alternatively integrated SW and GW rosters should be developed.*

Lift Irrigation - In all 37 lift irrigation schemes (LIS) are in operation in the region catering 17.79 Tha against which irrigation of 16.58 Tha is reported. Majority of these were in working condition and have reported about 93% performance even in drought year (2006-07) mainly due to their location on banks of perennial rivers of Yamuna, Betwa, Dhasan and Ken. Table given below shows the performance of these lift schemes during 2006-07.

Performance of Lift Irrigation Schemes in 2006-07

District	No. of Minor LIS	Command Area in (Tha)	Irrigation in a near normal year (1998-99) (Tha)	Irrigation in 2006-07 (Tha)
Jhansi	4	8361	3639	3735
Jalaun	6	2494	1068	1027
Lalitpur	-	-	-	-
Banda	8	12229	3036	2745
Hamirpur	10	10660	5794	4984
Chitrakoot	8	10860	4255	4093
Mahoba	1	2832	-	-
Total	37	47436	17792	16584

Source: O/O CE, (Betwa), UPID, GoUP

Measures for Conservation of Water

With the completion of ongoing Rajghat Project, Uttar Pradesh is going to utilize almost entire of its surface water in Betwa Command. Indirect benefits accruing to the state due to under utilization by

MP will also evaporate due to developments in that state. Therefore, improving efficiencies of its water share and system is the only way to meet incremental demands in future. Following suggestions may be considered:

- Completion of the subsidiary systems of the main canal of Rajghat project and command development needs highest priority to avoid future delay in flows to the beneficiaries.
- The canal infrastructure and Warabandi system should be made compatible to sprinkler, drip and other micro irrigation techniques. *The system being developed in Rajasthan for Narmbada canal waters from Sardar Sarovar may be considered to raise water utilization efficiency.*
- Possibilities of conjunctive use of surface and ground water may be optimized.
- Land leveling, promoting cropping and irrigation in ridge and furrow irrigation system can save 30-40% of water. However, proper machinery, tools implements on custom hiring basis may be promoted. After all, every where most of the combine harvesting operations of crops are on custom hiring basis only. Something can also be done for mechanization of agriculture in Bundelkhand region. It is only a question of mind set of all stake holders and policy decisions.
- Cultivation of water guzzling crops like mentha, sugarcane, rice may be discouraged in the canal commands of UP-Bundelkhand and their growth should be regulated through high tariff.
- Management of flows in rivers should also be governed from ecological concerns.

Shift to Pressure systems wherever feasible - At present enough water is available in Betwa system and this system is practically running at half of its efficiencies (See Table-2). Wherever feasible, diversification to low water intensive crops, shift to drip/sprinkler should be attempted. Some of the new canals in Rajghat commands, where Command area is yet to be developed, can be designed using pressure systems for shift to sprinkler/drip. Savings on waters can be easily re-allocated.

Bundelkhand Agro Climatic Zone

ICAR has divided the country into 127 different agro climatic zones and according to this classification, 13 districts of Bundelkhand in UP and MP comprise of Bundelkhand agro-climatic zone. According to this classification Bundelkhand zone is characterized by hot climate, undulating topography, residual and low depth of soil, poor exploitation of ground water because of hard impermeable rock on the surface. It has semi-arid climate with average rainfall of 876 mm and the temperature ranges from 3.0^{o}C to 48.7^{o}C. The relative humidity in this zone ranges from 26% to 88%. As described above Bundelkhand Agro-climate zone has 4 broad soil groups, namely, Raker, Parwa, Kabar and Mar. The prominent crops are wheat, gram, bajra, and sorghum. Other crops are pigeon pea (which is now partly replaced by pea), lentil and rice. Ginger and beetle vine cultivation is prominent in this zone. Amongst fruits, citrus fruits are cultivated and tomato and brinjal are main vegetables.

Cropping Pattern

Planned cropping pattern in UP-Bundelkhand comprises mainly of wheat, pulses and oilseeds. Normal Kharif cultivation is around 25 % of the total sown area while Rabi is around 74%. Portion of sugarcane and Zaid crops are meager.

Traditionally farmers prefer jowar-bajra in Kharif due to uncertainties of rainfall. Wherever some irrigation is available, some shift to urd, groundnut, soybean, sesame and maize is observed. Paddy area is meager. In Rabi, gram, lentil are the main crops. Mixed cropping in some areas is also practiced to mitigate uncertainties. Wherever some assured irrigation is available, there appears to be some shift in favour of peas. Of late there is some tilt towards mentha during Zaid in alluvium belt

near Yamuna river, where assured canal irrigation is available. But area under Mentha is not adequately reported.

Due to severe drought like situation in Bundelkhand during 2004-08, gross sown area dwindled to less than 60% in 2006-07. Pattern of crops sown during 2005-06 shows that out of the total sown area in 2005-06, only 25.41% was sown in Kharif, remaining 74.22% was sown in Rabi. Area sown in Zaid and sugarcane was less than 1%. District wise Kharif comprised of 19% to 30% of total sown area. This practice of keeping farms fallow for cattle grazing has been traditionally followed due to *Anna pratha* (described in a subsequent section). Table given below shows cropping patterns as observed in 2005-06.

During Kharif rice is traditionally grown in Banda and Chitrakoot where assured irrigation from Bariyarpur project on Ken River is available since about a century. Jowar and bajra is more popular in Hamirpur, Banda and Chitrakoot. In Lalitpur Maize is more preferred cereal among farmers. Among Kharif pulses, urd is more preferred to moong and arhar in all districts except in case of Hamirpur, Banda and Chitrakoot where arhar is more preferred. Among Kharif oilseeds, groundnut is more preferred in Jhansi. Among Rabi cereals, wheat is mainly grown in all seven districts and the areal extent varies from 20% of annual area sown in Mahoba to 33% in Banda. Among Rabi pulses, lentil, gram and pea are more preferred in all districts except Chitrakoot, where, only gram is sown. Rabi oilseeds are also grown in all districts but the quantum is small. Sugarcane is grown in very small area. Table given below provides district wise preference of crops by farmers during 2005-06.

Area Sown (ha) in Uttar Pradesh portion of Bundelkhand (2005-06)

Crop Sown in Kharif	Area Sown in Kharif	*% of Kharif Area*	Crop Sown in Rabi	Area Sown in Rabi	*% of Rabi Area*	Area Sown in Zaid	Sugarcane	Total Sown Area
Cereal Crops								
Rice	67961	*11.12*	Wheat	636335	*35.64*	-	-	-
Jowar	80960	*13.25*	Barley	26745	*1.50*	-	-	-
Bajra	23127	*3.78*	-	-	-	-	-	-
Maize	30391	*4.97*	-	-	-	-	-	-
Total Cereals	202439	*33.12*	-	663080	*37.14*	-	-	865519
Pulses								
Urd	167943	*27.48*	Lentil	278508	*15.60*	-	-	-
Moong	19068	*3.12*	Gram	427623	*23.95*	-	-	-
Arhar	68290	*11.17*	Pea	339075	*18.99*	-	-	-
Total Pulses	255301	*41.77*	-	1045206	*58.54*	-	-	1300507
Oilseeds								
Til	66937	*10.95*	Rapeseed/ Mustard	32146	*1.8*	-	-	-
Groundnut	44166	*7.23*	Linseed	26435	*1.48*	-	-	-
Soybean	6017	*0.98*	-	-	-	-	-	-
Total Oilseeds	117120	*19.16*	58581	58581	*3.28*	-	-	175701
Other Crops								
Other crops	36389	*5.95*	Other crops	18550	*1.04*	-	-	54939
Perennial Crops								
Sugarcane	-	-	-	-	-	-	8777	8777
All Crops	611249	*100.00*	All Crops	1785417	*100.00*	9662	8777	2405443
(% of Annual Sown Area)	*(25.41)*	-	-	*(74.22)*	-	*(0.40)*	*(0.36)*	*(100.00)*

Source: Website of National Informatics Center

District Level Crop Preference in Uttar Pradesh portion of Bundelkhand

(% of annual sown area in the district in 2005-06)

Crop (Area sown (ha) in the District >)	Lalitpur (362316)	Jhansi (426595)	Jalaun (414236)	Hamirpur (331647)	Mahoba (283958)	Banda (406653)	Chitrakoot (189710)
Kharif Cereals							
Rice	*1.11*	*0.95*	*0.18*	*0.08*	*0.12*	*11.20*	*6.84*
Jowar	*0.35*	*0.96*	*1.81*	*6.47*	*1.39*	*6.23*	*9.17*
Bajra	*0.00*	*0.01*	*3.01*	*0.17*	*0.00*	*0.53*	*0.96*
Maize	*7.75*	*0.54*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Kharif Pulses							
Urd	*14.67*	*12.46*	*4.28*	*4.09*	*8.98*	*0.85*	*0.72*

Moong	*0.67*	*1.16*	*0.28*	*0.72*	*1.96*	*0.38*	*0.55*
Arhar	*0.00*	*0.57*	*1.66*	*6.11*	*1.46*	*4.53*	*8.50*
Kharif Oilseeds							
Til	*1.50*	*4.33*	*6.52*	*2.01*	*2.58*	*0.37*	*0.27*
Groundnut	*2.26*	*6.27*	*0.03*	*0.12*	*2.76*	*0.20*	*0.02*
Soybean	*1.02*	*0.32*	*0.17*	*0.01*	*0.03*	*0.03*	*0.00*
Rabi Cereals							
Wheat	*26.97*	*23.94*	*28.62*	*22.14*	*20.78*	*32.95*	*27.14*
Barley	*1.74*	*0.72*	*1.70*	*0.39*	*0.85*	*0.31*	*2.83*
Rabi Pulses							
Lentil	*11.25*	*7.98*	*11.11*	*16.12*	*10.97*	*13.00*	*1.65*
Gram	*8.71*	*9.39*	*12.43*	*25.84*	*23.32*	*26.05*	*24.59*
Pea	*19.65*	*23.13*	*20.96*	*8.60*	*18.23*	*0.38*	*0.28*
Rabi Oilseeds							
Rapeseed/Mustard	*0.97*	*1.55*	*2.24*	*1.68*	*1.04*	*0.42*	*1.33*
Linseed	*0.05*	*2.17*	*0.13*	*1.31*	*2.85*	*0.71*	*0.60*
Other Crops (Both Kharif and Rabi)							
Other crops	*1.14*	*3.24*	*2.65*	*3.04*	*0.78*	*1.63*	*2.04*
Zaid Mainly Vegetables							
Zaid	*0.16*	*0.28*	*1.72*	*0.05*	*0.05*	*0.06*	*0.09*
Perennial							
Sugarcane	*0.03*	*0.01*	*0.48*	*1.06*	*0.72*	*0.17*	*0.20*

Source: Website of National Informatics Center

Use of fertilizers, pesticides, seeds, varieties grown traditionally and newer varieties

The application of chemical fertilizers in Bundelkhand region is very poor – about 44 Kg/ha compared to 136 Kg/ha as state average. Application of pesticides is relatively very low in comparison to other intensified regions of Uttar Pradesh. Table shown below gives district-wise average consumption of chemical fertilizers (NPK) in UP-Bundelkhand.

Consumption of Per Ha Chemical Fertilizers (NPK) in UP-Bundelkhand (2004-05) (kg)

District	Kharif	Rabi	Total
Lalitpur	17.51	25.08	23.42
Jhansi	20.60	36.98	34.23
Jalaun	17.99	71.39	63.64
Hamirpur	20.93	74.92	69.75
Mahoba	27.72	43.46	41.25
Banda	17.13	51.05	39.07
Chitrakoot	29.58	28.09	31.54
UP-Bundelkhand	20.62	49.70	44.08
UP-State	109.21	107.48	136.16
India	?	?	?

Source: Statistical Division, Department of Agriculture, GoUP

Traditional seeds are still used in large scale but in sorghum and bajra hybrids are used. High yielding varieties of gram, arhar, soybean, pea, lentil and mustard are used by progressive farmers. Seed replacement rate (SRR) is about 20% in wheat and oilseeds and 12% in pulses, which needs to improve to harvest good yield. Suitable crop varieties of cereals, pulses and oilseeds for this region have been developed by various research centers.

Poor SRR is affecting the crop productivity which is linked to lack of irrigation facilities. Traditional varieties are preferred by small and marginal farmers as these ensure some yield even in drought and adverse conditions which occur frequently.

Accelerating productivity and production is a matter of priority in UP-Bundelkhand, therefore, need a dynamic approach oriented towards achievable strategy. Growth oriented agriculture would demand easy access to critical inputs such as quality seeds, fertilizers, bio-control agents and bio-pesticides, increased use of farm machinery and equipments, creation of silos and cold storage facilities to avoid post harvest losses. For input availability seed village production programme should be promoted, where need based early maturing, resistant varieties should be grown. For quality produce integrated pest management (IPM) should be promoted. For the ensured bio agents availability at local level IPM labs should be established in the region.

Technology dissemination is the most critical issue. In addition to awareness and training programmes, field demonstrations on total packages of practices (Integrated Crop Technical Demonstrations) should be organized according to suitability of the crops and varieties e.g. duram wheat, pulses, oilseeds, etc. For organic farming development farmers should be encouraged for organic compound production e.g. NADEP composing, vermi composing, green manure etc. For the awareness generation exposure visits, field days, farmers fair, farmer led extension (Farmer Field School), Farmer-scientist interaction etc., should be organized.

Diversification & Intensification

Bundelkhand region in UP is scarce in water resources, which leads to lower productivity of crops and even limited choices of crops. Unfortunately, here farmers face the economic, ecological, technological and social problems. Increasing population has put high pressure on low fertile land. All this collectively resulted in inadequate income and tumbling employment opportunities. In this situation diversification and intensification is an approach to increase the farm income and employment generation options. For this purpose, identification of high untapped agriculture potential and develop them into high economic return zone.

Addition of high value crops, low water required crop, mono-cropping to multiple cropping, mono-cropping to farming system approach (Crop-Animal Husbandry- Fisheries-Beekeeping etc.) value addition and processing of crops are the basic component of diversification.

Bundelkhand region has not been able to reap the good harvest of Green Revolution due to above said limitation, whereas better opportunities lies in this region. For farming system approach limited water is also concern to adoption of diversification. Here rationalization of area under different crops taking into account, the needs of farmer, technological possibilities and agro–ecological systems are prime need.

For the vigorous development high productivity zone can adopt more diversification and value addition , low productivity and high potential zone can increase gross cropped area (GCA), farm supportive infrastructure low productivity zone to water management, soil conservation, integrated nutrient management and ecologically fragile zone need alternative cropping, horticulture and agro forestry.

In addition to above, organic farming opportunities are maximum in Bundelkhand region. Medicinal and Aromatic Plants (MAPs) can be grown organically in this region which is more income providing with the Bundelkhand agro-eco- situation.

Agriculture uses about 70-80% of total available water, so crop specific water use planning is required. Simultaneously proper soil and water conservation technologies need to adopt which can increase agri-production by about 50-100%. (Undulating area - erosion - silting of tanks - needs specific plantation)

For food security, nutrient security as well as income security crop diversification (horizontal diversification and vertical diversification), multiple cropping can play a significant role for livelihood supports and income generation of farmers.

Kharif versus Rabi Sowing (Anna Pratha) – In Uttar Pradesh portion of Bundelkhand traditionally 25% area is sown in Kharif and 74% in Rabi. Similarly in MP portion of Bundelkhand, 38% area is sown in Kharif. Scientifically, this practice is followed due to low probability of rains in rainfed and non-canal areas thereby making Kharif as potentially non-assured. In that case Rabi is atleast assured through residual moisture and ground water in rock ridden dugwells, which forms main source of irrigation. Almost every farmer has a dugwell in his house as well as at his farm.

Traditionally this practice is linked to the paradox of age old practice of *Annapratha*. The farmers generally leave their fields fallow for free range grazing system in Kharif season, which makes cultivation difficult. These livestock, generally sheep, goat and indigenous cattle, having low productivity are let loose for grazing. This needs changing mindset which needs massive extension efforts to address increasing demands on the land, rainfall and water resources. Many a time farmers are reluctant to sow during Kharif as stray cattle are likely to damage crops. *An Australian company has developed a device to which passes 40-50 volt current generated through solar energy. It does not harm the animals but due to fear of flowing current, animals get scared. Fodder scarcity may to be dealt appropriately through assured fodder produce, alternatively through block level fodder banks. Cattle grazing camps during Kharif are not popular among farmers.*

Another reason of lower level of sowing in Kharif could be manual weed management of high infestation, thereby limiting farmers to sow in limited area. Use of herbicides and weedicides can remove this bottleneck. *There is an ample scope of intensification through promoting Kharif crops.*

Major occupation of rural community in Bundelkhand region is crop production and livestock rearing. Usufruct rights in forests, other common properties or open access resources and migration for income out sourcing are the minor livelihood opportunities in agrarian economy of Bundelkhand in both MP and UP. Crop cultivation and animal rearing alone constitutes more than 90% of the over all livelihood. Crop residues contribute 67% of the animal fodder and coping mechanisms for mitigating vulnerability to drought has to be farming centric. Traditionally, the crops grown are coarse cereals, dual purpose varieties for grain and fodder, inter-cropping, staggering sowing over time, short duration varieties, mixed farming, share cropping, agro-forestry and enterprises etc.

Future options under diversification are to address competitive and emerging economic and social transformations. To mitigate droughts, Dwarf hybrid varieties of Pearl millet (Bajra), Shorghum (Jowar), Bt cotton, improved varieties of soybeans, chickpeas (gram), pigeon peas, lentils and mustard etc. have increased inputs and productivity as well as risks and distress. Hybrids of castor, sunflower, improved varieties of safflowers, mustard, ground nut etc. require one or two critical irrigation for harvesting economic yields.

Water guzzling mentha, sugarcane etc. are becoming popular in irrigated areas at the cost excessive depletion of ground water and inequality of sharing canal irrigation. Sesamum (til) could easily survive recent drought of 4 years but the returns were very low.

Newer options available to mitigate droughts could be Chickpeas, wheat, sorghum, paddy, maize, barley, seasame, lentils, linseed, mustard, ryes, ground nut, peas, urd, moong, tomato, onions, and other vegetable with combinations of amla, guava, lemon, mango etc.

Animal Husbandry - Bovine and small ruminants rearing are an integral part of agrigarian economy of Bundelkhand and contribute significantly to the livelihood of farmers especially women headed, landless and small farmers. Animal Husbandry plays a major role in farmer economy here but the yielding capacity of animals is very poor due to poor breeding, feeding and management. The total population of livestock and poultry is 5.85 million. Cattle population is double of goat or buffalo population but cross bred cattle account for only 0.5% against the National average of about 15% non descript indigenous cattle of very low productivity account for major population.

Bovine Population in UP-Bundelkhand

District	Cattle	Buffalo	Sheep	Goat	Poultry	Pigs
Lalitpur	425	163	12	154	65	4
Jhansi	294	182	56	219	187	14
Jalaun	226	239	30	257	50	26
Hamirpur	261	133	26	129	80	25
Mahoba	536	148	31	242	77	26
Banda	378	232	13	151	45	18

Chitrakoot	414	138	19	96	20	10
UP-Bundelkhand	2535	1238	186	1248	524	123

Source: Report of the Inter-Ministerial Central Team on Drought Mitigation Strategy for Bundelkhand Region of UP and MP

In this region free range grazing system (stray animal) is very prevalent especially goat, sheep and indigenous cattle. Stall feeding is limited only to buffalo, basically in irrigated area. Poultry rearing is to a very limited extent. Under nourishment during recent drought of 4 years have made the bovine population relatively infertile.

Livestock posses long dry period and calving interval. Due to improper or underfeeding they become infertile leading unproductiveness. These problems occur due to lack of proper nutrition & disease management. Number of vetenary hospitals and animal insemination (AI) centers are very limited in comparison to large number of live stocks. Dairy and meat processing plants are also needed to encourage the dairy development activities.

Need for Fodder Banks – Crop residues contribute around 60% of the fodder, and *Kadbi* is an important factor for cultivation. During droughts, shortage of the fodder had been the main concern of farmers as the residues of crops diminished and the grass had dried up almost every where. Major source of fodder comes from crop residues of wheat, rice, and legume straw with *Kadbis* of jowar and bajra. Since quantum of bhusa of the crop residues is only limited to about 60% of fodder requirements, it lasts upto February or so. During droughts, options to shift animals to cattle camps were not found favourable among farmers. *Therefore, remedial schemes in the form of Block-wise fodder banks on the basis assessment of requirements need immediate attention.*

Horticultural Practices

In this region bael, aonla, guava, ber, citrus in fruit trees and green pea, coriander, cabbage, chilies, ginger in spices are grown. Productivity of both vegetables and fruit crops are very poor. In addition to fruits and vegetables medicinal and aromatic plants (MAPs) have a big opportunity to grow and harvest good yield and especially organic horticulture can be promoted in big way. Effort should be made to prevent post harvest loses which ranges 25-30% even upto 60% in tomato.

Micro Irrigation

Israel has done pioneer work in field of micro irrigation and harvest good yields. Proper irrigation has increased yield of crops several folds. In Bundelkhand situation, water scarcity is common, so by adoption of micro irrigation system, high quality produce with higher production can be achieved. If agro-sector is to be developed in this region, this technology should be fully utilized, especially in high value crops. In micro-irrigation system energy and fertilizer requirements also can be minimized. Research observation reflects that drip irrigation system increases yield 40-130% and water use efficiency to 65%. Drip irrigation system is more useful in wide spacing crops whereas; sprinklers can be utilized in close spacing corps. Most crops of vegetables, flowers and fruit trees can give excellent response. Crops may be sugarcane, cotton, potato, chilies, onion, groundnut, bael, papaya, citrus, mango, guava, water melon and flowers.

Marketing & Mandis

Agriculture sector needs well functioning markets to stimulate growth, employment and economic prosperity in rural areas. In order to provide dynamism and efficiency in the marketing system, large investments are required for the development of post harvest and cold chain infrastructure near the farmer's field.

Farmers should be provided multiple choices for sale of produce. Regularization of markets-APMC Act will be helpful to farmers for better prices of their produce. Market would provide storage

infrastructure, thus offering a choice to trade at a future date to the farmers. To offer one stop solution that provides logistics support including transport services and cool chain supports and facility for storage, facility for cleaning, grading, sorting, packaging of produce and extension support and advisory to farmers.

Inland Fisheries

According to a note on ' Farm Sector in Uttar Pradesh' prepared by Shri Sunil Kumar of Department of Planning, Government of Uttar Pradesh in October 2005 (downloaded from Web site) Uttar Pradesh has about 11.52 lakh ha of water bodies, a majority of which are located in UP-Bundelkhand. Presently a little above 50% are covered for fisheries development. According to the report, average production of inland fish in the state is around 2.77 lakh metric tones, which is a peanut when compared to West Bengal (8.66) and Andhra Pradesh (5.96). Per capita consumption of fish in the state is around 3.46 kg/annum whereas as per Indian Council of Medical Research it should be 13.9 kg.

Thus, there is a greater scope for blue revolution in the state and SHGs in a large scale can be promoted to take up these activities through micro financing. Policies in this regard need complete change.

Agriculture Machinery and Implements - Machinery and implements can assist in increasing the yield level of crops. Inland preparation, conservation tillage should be promoted. Zero till machine implement to turn the green manures crops & soils, sowing implement (Seed drill), implement for spray, immediate soil testing devices, harvesting implements are the most needful to farmers. Micro-irrigation system should be popularized to increase yield and quality of produce. Soybean processing plant, ground nut digger, potato digger like agri-implements will increase the efficiency of farmers and save the time. Post harvest implements and processing units for different produces will be helpful to farmers for increasing marketing efficiency.

Command Area Development Betwa, Gursarai and Ken Commands - Under the command area development programme of the Ministry of Water Resources, Betwa and Gursarai canal projects and Ken projects have been included for on-farm development works in the respective commands. The works are carried out by Land Development and Water Resources Department of Government of Uttar Pradesh. Under the programme earthen field channels are constructed while some portion (around 20%) of the field channels is lined. Field drains, link roads for farms, water control structures are also built as a part of the programme. Osrabandi (Warabandi) is encouraged in these commands. Software activities like field demonstrations, farmers' fairs, exchange programmes, training of personnel, horticulture and animal husbandry programmes, establishment of growth centers and maintenance of OFD works are also taken up. Evaluation studies done on these canal systems have demonstrated overall positive impacts, though not optimal. While there had been some benefits of the programme, the level of productivities and production are still on lower side. There appears to be an urgent need to improve conveyance efficiencies. Systematic demand-side approach is required for management of all the canal systems in a holistic manner taking full advantage of the Programme with participatory efforts. Rajghat system and the remaining of Betwa, Gursarai and Ken systems should also be brought under the purview of CADWM programme of MoWR. Wherever feasible, gradual shift to pressurized systems (drip and sprinkler) should be attempted to ensure conservation and efficiency of operation. *Delineation of jurisdiction of water users associations, GIS mapping of jurisdiction, appropriate allocations, on-farm infrastructure development, systematic shift to warabandi can help promote Participatory efforts in improving field efficiencies, production and productivity.*

Participatory Irrigation Management in Uttar Pradesh - Government of Uttar Pradesh has drafted a Bill on participation of beneficiaries for efficient use and maintenance of its resources by shifting management to WUAs, which are presently formed under 'Societies Registration Act' as Kolaba Samitis. Draft rules and manuals are in pipeline. While there has been an appreciable effort, much needs to be done in bringing various departments to converge and work together in unison in this direction. *Better understanding of irrigation, agriculture, extension, revenue, land resources development and other departments/agencies is required at grass root level with stakeholder's involvement to promote volumetric assessment and supplies, equitable use, bringing efficiencies in operation and management of all canal systems through participated efforts for optimum production.*

Empowerment of women in agricultural and allied sectors - Goal of development of human beings is extension of human capacity, which can make life more useful, but here is a great disparity. Women has no such equal opportunities e.g., education, health, economic welfare etc. In welfare family women often pay more contribution whereas men are centered to subsistence income by contact with outer society.

Women are responsible for more than 75% of agricultural work. Reality is that some times they do not participate in available employment options but by adverse conditions e.g., inadequate earning of husband / head of family, spend more expenses on illness. Women are paid at the lower rate for the same work in employment market as compared to men. Women are not involved in decision making processes. Overall gender disparity is the resultant of economic, social, cultural and political disparity.

To empower women, the disparity should be eliminated. Here in the project, most important step is to improve all possibilities including economic development and involvement in decision making processes.

Self Help Groups (SHGs) - Majority of rural people still depend on rural money lenders for their financial requirements. They pay very high interest even upto 20% per month. In this situation the SHG movement had its origins in the context of non-assess to finance from commercial banks for the credit needs of a vast section of population, particularly the women who are otherwise careful in their spending , diligent in their saving habits, intelligent to understand the productive links. *SHGs are capable of addressing their own credit needs and also capable as micro-entrepreneurs. In the proposed project activities may be performed by the path of SHG. These SHG will also be developed and promoted for income generating activities at the village level.*

Micro Financing - SHG formation is made for many of its livelihood and other programmes. These groups will promote savings and internal circulation of funds. These groups will be linked to the banks for saving purposes. The members are required to meet and deposit savings every month. After few months of saving, SHGs will be linked to banks. NABARD can also assist the group under specific programmes e.g., woman empowerment programme. Two types of institutions will be involved. (i) In narrow sense – small local financial institutions are required; and (ii) In wider sense – national or regional banks and development financial institutions (DFIs) with micro finance services for small servers and borrowers are essential. *Easy credit and appropriate insurance cover at Government level can only help growth of SHGs.*

Migratory labour versus Loss of agriculture

UP-Bundelkhand region has more than double migration in comparison to National average, particularly in post Rabi season. To check this practice, option of farming round the year and increase in the production efficiency provide the opportunities of employment at regional basis to promote small entrepreneurs.

Women in traditional income generating activities (IGA) can help in preventing the migration. *Better opportunities and production for WSHGs will lead to more income; more income will promote diversification of agriculture which needs more labour. This employment will be able to provide satisfactory income level. By special efforts (employment cycle) of on-farm and non-farm practices, migration can be checked.*

Reforms in Agri-Sector

Department of Planning, GoUP, vide note of Shri Sunil Kumar and on the basis of recommendations of the National Farmers Commission has suggested following reforms to be initiated in agriculture sector in UP:

i. Initiate steps to improve self-esteem of farmers, i.e., publicly honour farmers;
ii. Improve seed replacement rate;
iii. Improve extension activity in the state;
iv. Devise schemes to increase profitability of farmers with holding size of 1 acre (0.4 ha) or less;
v. Prepare various 'farm models' for different types of farmers in different agro-climatic zones;
vi. Take effective steps for restoring soil health;
vii. Use remote sensing data to prepare micro-plans for increasing crop intensity;
viii. Optimize use of water for irrigation;
ix. Progressively reduce dependence on exploitation of ground water for irrigation;
x. Promote cultivation of bio-fuel plants like Jetropha to increase income of farmers from non-productive land holdings and reduce input costs of diesel;
xi. Reform agri-marketing;
xii. Improve availability of agricultural credit;
xiii. Implement schemes on pattern of National Horticulture Mission in remaining districts of Uttar Pradesh;
xiv. Increase capital investment in dairy sector;
xv. Increase investments in animal husbandry sector;
xvi. Increase investment in fisheries sector;
xvii. Increase funding of agricultural universities; and
xviii. Introduce health insurance schemes for farmers.

It is pertinent to note that all above recommendations are urgently needed in UP- Bundelkhand as well, particularly post drought period. Thus, these issues need be examined at greater depth in order to review the agriculture policy for UP-Bundelkhand.

Domestic and Industrial Water Development in UP-Bundelkhand

Population of Uttar Pradesh has almost doubled since 1971. Going by this trend, population of UP-Bundelkhand was almost half at that time of what it is today. Bovine population of UP- Bundelkhand has also been risen many folds since 1971. There is a consistence rise in demand for subsistence produce, both food grains and fodder, not to talk of commercial crops. Many of the fields reports state that Bundelkhand was capable of meeting its domestic and irrigation water demands in early 1970s through traditional methods of water harvesting despite being drought prone. It was a feeble ecological relation where forests helped recharging and regulating rain water flow and the vast network of tanks, ponds, dug-wells captured water for use in lean periods. Many of the ponds and tanks acted as recharge pits. Consistent neglect of these structures clubbed with deforestation has distorted the entire set up. UP-Bundelkhand meets more than 90% of its drinking water supply from ground water source alone. With rise in population, drinking water and irrigation demand has increased, overall recharge has reduced.

Out of Utilisable ground water resource of 3544 MCM, about 25% of it has been exploited so far. Failure of rainfall during recent drought (2003-08) clubbed with extensive use of water for irrigation without recharge dried up all sources of water, so much so that more than 40 percent of villages had no drinking water supplies, more than 70% ponds/tanks dried up, about 70% of dugwells and shallow tubewells dried up, inflows in reservoirs went down to the tune of 40% and canal supplies dwindled. Thousands of hand pumps went defunct. There was no scope of deepening dug-wells and shallow tubewells because of rocky bed underneath. With diminishing quantity, quality of water also suffered. A large number of migrations occurred in UP- Bundelkhand, primarily because of non availability of domestic supplies.

A small deviation of normal rainfall can tilt the situation in future also. Replenishable ground water resource cannot be recouped with one good monsoon. Rabi sowing 2008 is already under attack from many of the cattle abandoned by farmers for no more being productive due to under nourishment in the past 4 to 5 years. Problems of contaminated drinking water and inadequate sanitation facilities are adding to the woes of people.

Recent drought of 2003-08 has brought to forefront an important question; how to ensure drinking water supplies in future. Policies in this regard need rethinking, particularly from long term perspective. Clear example is water supply to the Mahoba town with population of about 70000 which meets its requirements from Madan sagar tank. Madan sagar tank is reported to have dried up for the first time in the history of 900 years. The tank is supported by supplies from Urmil Reservoir, which also went dry. So much so, Government had to pump water from the dead storage of the Urmil reservoir and supply through a newly laid pipeline. *Assured and safe drinking water supplies apart from full coverage of sanitation programmes are to be the first priority of the Government. Mismatch between ground water extraction and recharge has to be reversed. Alternative supplies from canal sources wherever possible, revival of harvesting ponds, digging tubewells and dugwells wherever possible for drinking water supplies need priority. Deforestation has to be stopped; large scale afforestation measure to be taken up. Mining of stones which leads to deforestation of hill slopes should be curbed.*

Considering long term perspective, ground water and its quality has to be preserved for drinking and irrigation should be designed very carefully. Rainfall harvesting, including roof water harvesting, rehabilitation of tanks/ponds and integrating of canals and traditional tanks should be given priority to meet exigencies of severe and continuous droughts.

There is no large scale industry in UP-Bundelkhand except uncontrolled mining for building material. To increase the livelihood options future industrial base has to be agro-based. *Therefore, proper policy and planning of industrial development has also to be linked with domestic needs, imports and exports from the region, as Government of UP has already decided to give Industrial supplies a second priority in non-allocated areas.*

<u>Promotion of Soil Conservation, Watershed Development Programmes in UP-Bundelkhand</u>

Report of the Central Team mentions that participatory integrated management of inputs and natural resources including social capital, innovative institutions and involvement of community are prioritized for Bundelkhand due to various reasons. Only 45% of the NSA is fully developed, about 50% of which is utilized, and remaining area depends on uncertainties of rainfall. About 90% of runoff occurs in 3 to 4 months within 30-40 rainy days runoff generated in the undulating topography can go waste if appropriate water conservation measures are not adopted. Ground water resource in many parts of UP-Bundelkhand is inadequate with poor yield due to typical geological formations of impervious rocks with low porosity. More than 80% of the strata is hard crystalline with a yield of 1 to 5 liter per second in Mahoba, Lalitpur and Jalaun. Another 10% area having sand stone, shales and lime stones in parts of Jhansi, Banda and Hamirpur yield about 15-25 litres per sec but occurrence is patchy and boring of wells at exact locations is not an easy task. Borings done in 2007 even after

resistivity surveys and hydro fracturing was in Tikamgarh (MP) adjoining to UP-Bundelkhand was hardly 40% successful. It is only 10% of the alluvium belt which can yield good drafts; a major portion of which is already exploited.

Report of the central team has, therefore recommended that conservation of rain water; soil and vegetation by watershed based interventions will improve potentiality of the stream flows to provide value added surface irrigation. The team has made further suggestions that Renovation of resources like tanks, ponds and other water bodies, dug wells and ground water can help generating income, employment and livelihood. Therefore, renovation, repairs, desilting, raising embankments and crest heights to increase storage capacity of check dams, tanks, ponds, deepening and recharging through dug wells, cleaning of irrigation channels etc. can be taken up through various schemes such as NREGS, BRGF, RRR of ponds/tanks, Artificial Recharging and other schemes. The report further suggests digging trenches, constructing gulley plugs, check dams, loose boulder check dams and gabions in non-arable land is the first step to improve bio-mass productivity. *In situ* conservation of rains by land shaping, contouring/field bunding and other practices consolidate the gains of upper catchments. Farm ponds in black soils can also help in storing rain water for providing irrigation at critical stages not to talk of On-farm recharging ground water and reviving dug wells.

Sensitizing and organizing communities and other stake holders into various institutions, participatory planning, complementation, and exit protocols may be observed for long term solutions.

Other Environmental and Ecological Concerns

Flood Management and Drainage Control - Based on recommendations of the Task force constituted to study the suggestions of National Flood Commission (RBA-1976); both structural and non structural measures have been taken by States to fight floods. Total flood prone area in Uttar Pradesh is around 7.34 Mha i.e., 22% of the country, out of which about 1.53 Mha till 1993- NCIWRD has only been covered through flood protection works and a large chunk is yet to be covered. More than half of it is affected every year. About 1811Km. of embankments, 3593 km of drainage channels, have been built so far, 64 towns and about 4511 villages have been given protection. Separate details in respect of UP-Bundelkhand are not readily available, but it is emphasized that except for Betwa, where a series of reservoirs have been built, almost major and medium level rivers/streams bring a large amount of flood waters laden with silt. Majority of the rivers in UP-Bundelkhand are flashy and inundate vast tracts of land in the lower reaches and cause huge damages to life and property. Of these, Ken river system is most notorious as practically no storages are bit in upper catchment.

NWP has stressed that each basin should have a Master Plan for Flood Control and Management for each flood prone area. Sound watershed management through extensive soil conservation, catchment area treatment, preservation of forests and increasing the forest area and construction of check dams, should be promoted to reduce the intensity of floods. Adequate flood cushion should be provided in storage projects wherever feasible, to facilitate better flood management. An extensive network of flood forecasting network should be established for timely warning to the settlements in flood plains, along the regulation of settlements and economic activity in the flood plain zones, to minimize the loss of life and property on account of floods.

NCIWRD has recommended that a permanent machinery need be set up for preparing a comprehensive plan of action for (a) flood management, (b) Flood forecasting and flood warning, (c) Flood routing over reservoirs and (d) taking structural and non- structural measures for flood control. Important action points suggested by NCIWRD are (i) Enactment of legislation for flood plain zoning and delineating zones corresponding to 25, 50 and 100 year floods; (ii) flood proofing - devising emergency action plan not involving evacuation, e.g., providing raised platforms, relocating civil and public utility installations above flood levels and relieving flood congestion by appropriate operation of sluice gates, pumping etc. wherever necessary; (iii) flood insurance – for re-distribution of flood damages over larger population, e.g. crop insurance, (iv) disaster management and preparedness – to

minimize the loss to life and property by advance warning and alerting flood fighting and to mobilize flood protection machinery at short notice; model action plan need be prepared for each flood prone area; (v) people's participation – participation of people including stakeholders at all stages of undertaking flood protection and disaster management measures including relief and rehabilitation measures is essential; and (vi) ensure central assistance.

In order to examine the effectiveness and performance of embankments, and ensuring the efficacy of dams, flood protection and drainage works, various preventive measures such as pre flood inspections, dam safety and required repairs are taken up. However, not much attention is being given to morphological mapping, and assessment & movement of sediment flows, both floating and bed loads. There is a need to periodically observe behaviour of rivers, of assess flows including sediment loads, track meandering and movement of shoals etc. through GIS network and take necessary preventive measures through adequate Flood Management Information System (FMIS). Encroachments of flood plains should be removed as early as possible and flood zones clearly defined. Also it would be desirable to review the plans prepared for all major, medium and small streams in UP-Bundelkhand, review gate operation during floods in case of reservoirs, ensure effective mechanism to operate gates as per schedules. Master plans for floods in case of all rivers in UP-Bundelkhand should be devised after incorporating specific dynamic flow studies using established mathematical and physicals models.

<u>*Degradation due to Deforestation*</u> - Report of the Central Team on 'Drought Mitigation Strategies' (2008) mentions that integrated conservation and management of rainfall, soil, biomass, livestock, and social capital in undulating topography of Bundelkhand region (both MP and UP) should follow the natural sequence of treatments from ridge to valley. Tops of Hillocks are mainly occupied by forests [Panna – 38%, Damoh – 36.5%, Sagar – 28%, Chattarpur -19.5% in MP and Chitrakoot – 18%, Lalitpur 11% in UP]. About 50 to 60% of the forests in MP and UP are open, degraded and scrub with less than 40% canopy.

In situ conservation of rains, eroded soil, nutrients, seeds and vegetative propagules by digging staggered contour and limited irrigation of adjoining farm land can enlist people's participation. Trenches on sloping land and loose boulder or gabion check dams in nallahs (streams) should be the foremost intervention, Recharging and water harvesting structures for livestock, wild life, supporting regeneration of vegetation, afforestation

Afforestation Measures Require Planting of fruits, fuel and fodder trees, shrubs, seeding of grasses or pasture legumes to improve forage, transparent sharing of goods and services should be an essential component of joint forest management Committees (JFMCs). Fodder trees like Albizzia Lebbek, A. Procea, Hardwickia binnata, Leucaenia Leucocephola (k&S24), Sesbania grandifolia/aegyptica, Ficus sps, and Acacia should be included in the plantation. Grasses like Cenchrus ciliaris, Guinea grass and legumes like Stylosanthes hamata, Clitoria termatea should be seeded on soil exvavated from trenches and on barren spots. For this purpose, IGFRI Jhansi of ICAR may be consulted for seeds or sapling of fodder trees, grasses and forage legumes etc.

Sharing produce with participant community may be examined and negotiated with stakeholders. The packages should be developed and implemented through NGOs and JFMCs. About 60,000 ha of degraded and scrub forests can be treated in Bundelkhand region of Uttar Pradesh with short term perspective of 3-4 years.

<u>*Water logging*</u> – Incidences of water logging have been observed along canals in alluvium belts in Hamirpur, Banda and parts of Mahoba, though there are no large scale problem in UP- Bundelkhand, where ever it is occurring, it has helped in overall recharging to the area and has indirectly benefited farmers through conjunctive use, which is more or less uncontrolled. However, this concern can aggravate in future and cause large scale menace. Remote sensing/*GIS mapping and study of the*

problem areas, identification of the source and delineation of the extent can held in devising integrated rosters for surface and ground water supplies.

Mining – Mining of stones, sand, gravel and building material, represent the only industrial activity in Bundelkhand with limited employment potentials for reducing the dependence on agriculture. Unprecedented and uncontrolled mining of rocks and soils has resulted into large scale erosion of soils and degradation of forest areas, hill slopes etc. *There is a need to frame in some policies in this regard*

Ground Water Quality – Report of the CGWB on 'Hydrogeology of Bundelkhand Region' mentions that the ground water in Bundelkhand (both UP and MP) is weakly basic in nature and in general, it is bicarbonate type. The minimum and maximum chemical characteristics of shallow ground water by CGWB are as below:

S. No.	Chemical Constituents	Concentration (Mg/l)		Maximum Allowable Concentration BIS (1991)
		Minimum	Maximum	
1	pH	7.95	8.89	-
2	EC (μmhos per cm at 25°C)	85	2930	3125
3	Chloride	11	618	1000
4	Bicarbonate	31	1019	-
5	Total hardness	40	1150	600
6	Nitrate	0.21	464	100
7	Sulphate	2	400	400
8	Fluoride	0.1	2.36	1.50
9	Calcium	6	226	200
10	Magnesium	2	212	100
11	Sodium	2	370	-
12	Potassium	0.2	185	-

Source: Report on Hydro-Geology of Bundelkhand, CGWB, Ministry of Water Resources, GoI.

Major part of the Bundelkhand region (both MP and UP) is non saline The EC is less than 750 in μmhos/cm in Banda (including Chitrakoot), Hamirpur, Lalitpur and Jhansi in UP-Bundelkhand. However, there are some isolated pockets of brackish water in rest of the region. Flouride concentration is more or less within safe limits; from public health point of view, nitrate concentration is relevant, some isolated pockets of Chitrakoot, Banda, Hamirpur, Mahoba, and Jhansi, where excess use of nitrate fertilizers are used, the nitrate concentration is considered safe in shallow waters. Details of Arsenic concentrations are not available.

Despite the fact that the UP-Bundelkhand water is more or less safe, it would be desirable that a systematic assessment of all water quality parameters is made through length and breadth of the region and an 'Environmental Plan' at Block level is devised.

Sodic and other waste lands – A Note on ' Farm Sector in Uttar Pradesh' prepared by Shri Sunil Kumar of Department of Planning, Government of Uttar Pradesh in October 2005(downloaded from Web site) mentions that UP-State has about 5.18 lakh ha of agricultural and another 16 lakh ha of fallow lands. The paper quotes from Sodic Reclamation project that sodic lands covers about 5.95 lakh ha, out of which about 1.5 lakh ha is reclaimed. It also mentions that about 3.37 lakh ha of sodic lands and other agricultural waste lands located in UP-Bundelkhand and UP-Bhagelkhand (Mirzapur, Sonebhadra etc.) belts.

There is a need to identify these lands through Remote sensing/GIS mapping at Block level and provide suitable treatments options with the overall objective to reduce the gap in potential, increasing productivity and intensity of irrigation.

Activities proposed in UP-Bundelkhand under Phase-II of the UPWSRP

The institutional mechanism and the infrastructure already developed under Phase-I of UPWSRP is proposed to be strengthened to gear up for added responsibility for UP-Bundelkhand. The existing organizations like SWaRA, SWaRDAC, SWaTReC, PACT etc., shall continue to execute the UP-Bundelkhand project from headquarters at Lucknow. However, a small unit each of PACT and SWaRA is proposed to be stationed at Jhansi to coordinate the support activities related to UP-Bundelkhand. The following activities are proposed:

1. Set-up UP-Bundelkhand Basin Development and Management Board (UPBDMB) on lines of Jaunpur Sub-Basin Development and Management Board (JBSBDMB) as were done under Phase-I of UPWSRP.
2. Develop remote sensing/GIS based mapping at appropriate scale for entire Bundelkhand region (upto district level for MP and upto Block level for UP) to delineate administrative boundaries, demographic set up, rural infrastructure, topography, river system, surface and ground water resource potential, rainfall, climate, land use, geology, hydro-geology and soil mapping.
3. Develop remote sensing/GIS mapping, at appropriate scale for UP-Bundelkhand only to delineate agriculture & allied parameters, irrigation, soil conservation, watershed, water harvesting, environmental, ecological, social, and political and other characteristics etc.
4. Update data and knowledge base of SWARA and SWaRDAC extending it to entire UP-Bundelkhand and develop GIS based information system for agriculture, hydrological, hydro-geological, environment, ecological, flood, drought, economics etc.
5. Re-assess block wise ground water resource, utilizations, replenishable yield, existing structures (both shallow and deep) and irrigation potential created so far and that utilized.
6. Re-assess surface water resource, utilizations, yields at different dependabilities, irrigation infrastructure created, irrigation potential created so far and that utilized.
7. Review and develop social, environmental, agricultural, hydrological, hydro-geological, irrigation, rainfed policy frameworks and devise appropriate implementation plans and programmes.
8. Re-assess the present, future (both short and long term perspectives) requirements and development plan for all uses including, irrigation, hydropower, sustainable safe and assured drinking and industrial supply, recreation, environmental and ecological uses for UP- Bundelkhand region.
9. Devise Social and Environmental Assessment and Management Plans for UP-Bundelkhand on similar lines as was done for GGB under Phase-I of UPWSRP.
10. *Develop a mathematical model for assessment and mapping of ground water resource, possibilities of recharge and conjunctive utilization of GW with SW.* Appropriate linkages with SW modelling at serial no. 10 below be devised and future spatial and temporal possibilities of exploitation examined.
11. *Develop a generalized decision support system (DSS) for integrated operation of a system of reservoirs* to meet various demands keeping demand side approach for all uses in view.
12. *Develop an Integrated River Basin and Management Plan for Integrated Operation of Projects both for planning, management and real time operation for all uses including flood mitigation, using demand side approach and exploiting both surface and ground water conjunctively and considering use of gravity and pressurized (sprinkler and drip) systems* for:

    (i) Rajghat and Betwa System,
    (ii) Ken System including simulation of operation of Ken-Betwa Link Project,
    (iii) Other medium irrigation schemes including lift irrigation schemes on rivers directly falling into the Yamuna in isolation or in an integrated manner.

13. Devise GIS based spatial and temporal information system for conjunctive use of surface and ground water (outcome of DSS models proposed above), workout appropriate policy, guidelines, rules, rosters for both SW and GW and provide implementation programmes to WUAs. Also make suggestions for installations of shallow/ deep tubewells and dugwells.
14. Develop strategy for mitigation of floods, ensure policy and regulatory frame work for appropriate flood plain zoning and prepare flood management information system for implementation by UPID.
15. Develop strategy for mitigation of droughts; ensure policy and regulatory framework for sustainable short, medium and long term solution covering all aspects of agriculture, irrigation, animal husbandry, and other allied sectors.
16. Identify and implement possible economic, employment and entrepreneur opportunities in irrigation, agriculture, animal husbandry, fisheries, food processing and other areas; link with possible livelihood programmes create SHGs and provide technical need for Participatory efforts in Irrigation Management with specific emphasis on employment generation, Livelihood Programmes, Fisheries, marketing, and financial support. Develop suitable strategy to arrest migration of labour; suggest alternative possibilities of employment generation at village level, in agriculture sector and other possible livelihood options for implementation under NREGA.
17. Devise GIS based maps including infrastructure already developed for conservation of soils, to arrest forest degradation, delineate watershed schemes, bandis, check dams, terracing etc. Delineate areas where additional possibilities of harvesting of ground water are possible and suggest additional efforts required to conserver additional soil and water.
18. Develop GIS based resource maps of WUAs for Bundelkhand region to promote Participatory Irrigation Management in irrigation commands, community based ground water development and village level management of rural infrastructure development and management.
19. Devise suitable policies/ reform mechanism for strengthening of concerned institutional organizations of UP-Bundelkhand for coordinated efforts at SWaRA level.
20. Devise and suggest suitable reform processes for irrigated and rain-fed agriculture sectors, animal husbandry and other allied sectors.
18. *Devise Master Plan for UP-Bundelkhand Region considering all above aspects.*

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