

ECOLOGY AND AGRICULTURAL PATTERN: A GEOGRAPHICAL STUDY OF BUNDELKHAND REGION

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Abstract

The changing agricultural behavior in the agro-region of Bundelkhand has been on the verge of rapid change which is among the major factors which are responsible for the changing ecological balance of the region. In the recent few decades, natural calamity like drought and water deficiency is been major problems in the Bundelkhand Region, which is uniform in terms of geography, ecology, culturally and regional variability. The main crop combination is been affected in the recent years with the changing graph of water availability in the region. The local and regional challenges are also restructuring human activity patterns in the proportional relationship, which can be reflected in terms of crisis outlined by the manmade factors. The living conditions became thinner with deepening agricultural drawbacks which region is experiencing since independence to present time where planning is been imposed without caring the need of the region. Researchers and scholars have to come to rescue for the situation by suggesting mitigation steps and options which satisfies the regional need and geography to make sure relationship of optimum utilization of available resources present in the ecology with its population pressure.

Keywords: Agro region, Ecology, Natural Calamity, Mitigation, Optimum Resource.

I. Introduction

The region of Bundelkhand, which carries a sensitive ecological set-up, where forests, livestock, water bodies and living condition is in critical stage which is creating space for the natural calamities like drought and flood and putting pressure on surrounding ecosystem in the region. The agricultural practices in Bundelkhand are also under unrest due to the nature of the region. The rainfall in this region is considered as one of the lowest in India. The last 2018 data shows the adverse scenario through which region is passing, is the very basis of the poor agricultural condition in the region in present days (Table: 1). Rainfall more or less depends upon the geographical setup and forest cover percentage. Lack of vegetation followed by gully erosion and the regional slope creates higher runoff and results in the flash off the surface soil which is the important part of the soil for the agriculture. Depleting ground water is also very common due to low rainfall and poor management to hold the water as surface water so that it can percolates down to the surface and recharge the groundwater table. Due to deepening water table, all districts of Bundelkhand are facing acute drinking water problem whereas, water for irrigation is a far away dream for more than 90% farmers. This results in the peculiar gap in agricultural net cropping and net sown area of Bundelkhand in comparison to rest of the India. This also establishes the initial challenges in front of agricultural community to take on other practices than agriculture under the compulsion of natural restraint, which eventually affects the crop selection, crop combination pattern of the region. Since the region is a water deficient zone in which water table and rainwater receiving ends are in thinner condition, people are using available water resources at the cost of ecological setup of the region. The drastic decrease in the number of livestock in the region is because of poor availability of water for drinking. The ecology is also been hampered by natural factors. Like, Monsoon. Comparatively less Rainfall is been seen in last two year and followed by the deficiency of monsoon in the current year too. It is irony such that the region is full of rivers, streams and channel, yet failed to get water, even for drinking purposes. The rivers, streams and channels of the

region only serve as a catchment area for the River Yamuna. For Bundelkhand the policy side is also not been eye catching in terms of solving the ecological challenges which is been in the region for so many years. Region has never been the priority area for previous government, either local or national. Restrained from the policy map and budget allocation has also not been parallel to the problems and unable to make sure the ecology in its good state. The present critical water crisis especially due to low rainfall and summer heat waves, has put the ecology of the region in red zone, due to which large scale of migration has taken place from the nearest places around of Bundelkhand region. The poor literacy rate, infant mortality rate, per capita income and human development index, condition of roads, electricity, personal and social sanitation are in the backward condition. Other than these issues, economy and environmental condition are also taking last breath in this region making living conditions even harder.

II. Objectives of the study

The questions of the research paper are:

- i. To analyze the relationship between ecological variables and Agriculture practices.
- ii. To describe the factors through which agricultural patterns have changed and impact is been made on ecology.
- iii. To assess the change in living conditions in last few years due to change in agriculture pattern with the change in ecological atmosphere in the region.

III. Methodology

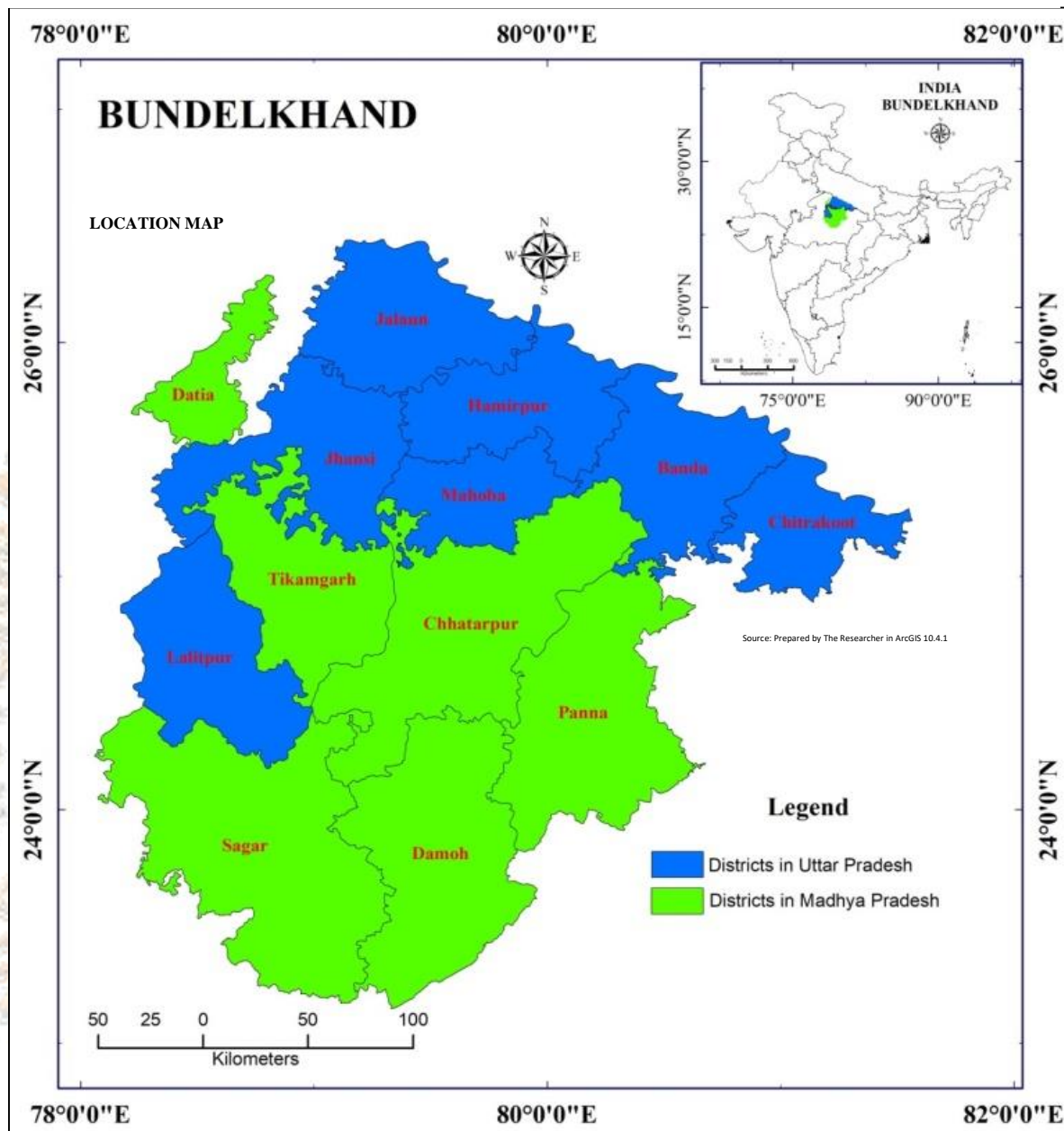
The research will be based on three types of data sources:

- i. Primary Sources; which will include local survey based on interviews and discussions with people.
- ii. Secondary Sources; which will comprises temporal population, groundwater and surface water, agricultural data from Census, Groundwater board and agricultural department respectively.
- iii. Tertiary data set will comprises images from remote sensing satellite and other processed data sources.

IV. Study Area

This research papers describes Bundelkhand, a distinct ecological, geological and geomorphological region full of perennial and seasonal water streams, minerals, and agricultural resources. Bundelkhand extends between 23° 10' and 26° 27' N latitude and 78° 4' and 81° 34' E longitude. The Region lies in the central Indian and its extent is shared by two biggest states, Uttar Pradesh and Madhya Pradesh (Map: 1).

Map: 1; Location Map of Bundelkhand



Source: Census of India, 2011

The region is surrounded in the north by the Ganga plain and Yamuna River, whereas in the south the Narmada and tributaries of the Ken and Betwa, in the east side Vindhyan hills and Panna-Ajaygarh ranges are present and in the west Sindh and Chambal rivers and the Malwa and Udaipur-Gwalior regions are present. This region comprises total 13 districts, out of which 7 districts Jalaun, Jhansi, Lalitpur, Chitrakoot, Hamirpur, Banda and Mahoba falls in Uttar Pradesh and 6 districts Sagar, Damoh, Tikamgarh, Chhatarpur, Panna And Datia from Madhya Pradesh (Map: 1). The region covers an area of 70 sqkm out of total area of India.

V. Ecology and Ecological Variables in Bundelkhand Region

Ecology word was given by a German biologist Ernest Hackle in 1869. The word was derived from Greek work “Oikos-Logos” which means House/Habitat/Place of living- To study. It is also defined as,

- Interaction between Biotic and Abiotic Components.
- Interrelationship of different organism with each other and with their environment.

The concept of Ecology in Bundelkhand and rest of the agrigarian part of the country co-exists with the practices inside the respective geographical boundaries. Ecology plays as an umbrella status to carry out different practices which decides the fate of the people of the region.

The variables of the ecology in Bundelkhand region can be discussed under four headings, these are:

1. Physiography
2. Population
3. Socio-economic
4. Technology

Further these headings are classified and discussed;

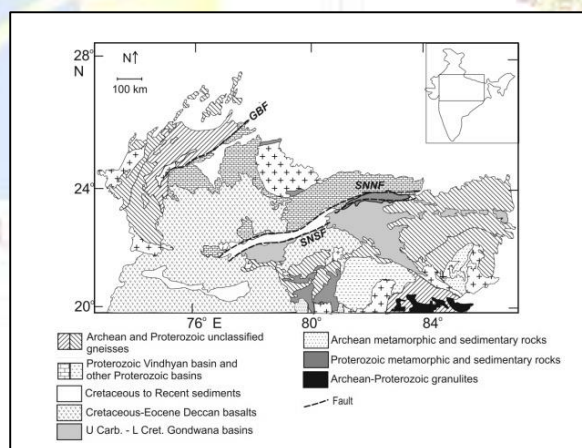
PHYSIOGRAPHY

Geomorphology

As per geological classification Bundelkhand is been the outcome of four major stages:

- i) Archaean: Composed of crystalline, non-permeable or hard igneous and metamorphic rocks with low porosity and high run off potential.
- ii) Vindhyan: Composed of larger sized sandstone and limestone escarpments and have comparatively higher groundwater capacity.
- iii) Transitional: Explained by post Aravali and pre Vindhyan period of sedimentary stratum of sandstone and limestone which having enough porosity.
- iv) Recent: Made up of extensive alluvial deposits by the rivers and streams and having higher porosity.

Bundelkhand is situated in the Vindhyan plain in between the River Yamuna and Northern Scarp. Geological background is extensive in nature throughout the region, in which districts like Datia, Jhansi, Lalitpur, Tikamgarh, Chhatarpur, Panna and Sagar districts and Southern portion of Chitrakoot and Mahoba Districts having granite geology, which makes it rich in mineral resources. Due to rich in mineral resources the over exploitation is been done. The Bundelkhand region is full of small patches of small hills ranges small to large are the unique geomorphological features (Map: 2). The Bundelkhand region also experiences unique geographical and geomormological features, which have large effect on human development in this region, Mountains, Perennial and seasonal Rivers, forest area with, trees and herbal plants and rich fertile alluvial plains are natural gifts to this region which serves the agricultural need of the region. In the past the region was a densely forested area but presently characterized by the hilly terrain with less vegetation in patches. Besides this, the region is known for a tribal homeland, and due to this Bundelkhand is known as a cultural repository pool of folk dances, folk songs, local festivals, and for the countless monumental sites that includes unique landscape, Gwalior, Kalinjar and Govind Mahal forts, the famous Khajuraho temples and the outstanding and rare Chaturbhuj and Dashavatara temples. But in the present time this region became one of the poorest regions of the country, where around



Map: 2; Geology of Bundelkhand

60% population practices agriculture as their main work of the year. Industries are absent in this region and the region is dominated by low urbanization rate followed by lower standards of life. According to Tendulkar Committee Report, 2009 estimates of poverty line and HDR 2004-05 with recurring drought and failure in agriculture, the level of poverty in rural areas has increased since a large number of farmers depend on rain fed agriculture (Planning Commission, 2009 & CSO, 2010).

Climate

The region experiences semi-arid and sub-humid climate in the western and eastern region respectively. In the start of year where, in January average temperature accounts 7°-22°C whereas average rainfall is 50-100 cm. The soil is of mixed nature having Red, Yellow and Black soils for the crops Millets and Gram, Barley, Wheat and Sunflower and Cotton respectively. The forest having very high sensitivity towards the side-effects of changing climate. The rapid change in climate is going to disturb the natural cycle such as hydrological, bio-chemical, which will further degrade in the forest cover and the forest productivity. Which will result into loss of animal habitat and their habitat shift will take place with the shifting forest cover. This can be seen in the Panna district where interference in the tiger zone is been seen. The loss of forest cover also accounts increase in wasteland in the region with decreasing soil fertility which lowers the grazing land proportion, introducing problems for livestock population. The agriculture fed by rainfall upon which more than 65% population depends, will get affected and will experience the water availability issue (Gosain 2011).

Soil

Soil types in Bundelkhand are a mix of black and red; the latter being relatively recently formed, gravelly and shallow in depth, and thus unable to retain moisture well. The rakar soils are residual, slightly acidic, coarse-grained, shallow and excessively permeable. The parua soils are alluvial and mildly alkaline. The black soils, mar and kabar extend for up to 40 inches and are confined to low lying landscapes, have a fine texture and the property of shrinking on drying and expanding when wet. Red soils are more predominant in the north-western region and are usually gravelly and shallow, with poor moisture retention. The characteristics of these soils make them vulnerable to over irrigation. Conversely, black soils, which are found mostly in the south, retain water better and are therefore preferred for wheat, gram and sugarcane cultivation.

Table-1: Soil types in Bundelkhand

Soil Association	Local Name
Bundelkhand-coarse grained reddish brown soil	Rakar
Bundelkhand-coarse grained gray to grayish brown soil	Parua
Bundelkhand-clay loom black soil	Kabar
Bundelkhand-fine clayey black soil	Mar

Source: District Gazetteers, different districts, Govts. of UP and MP

Drainage

Bundelkhand region is drained by many rivers which exist from Yamuna river system. The main rivers are Yamuna in the north, Ken in the east and Betwa and Pahuj in the west. The river Yamuna flows from west to east and its first order tributaries – the Betwa, Ken, Pahuj, Baghain, and Paisuni flows from south to north. Numerous second order tributaries of the Yamuna such as the Dhasan, Jamni, Birma, Sonar, Katne, Bewas, and Kopra drain the area. Also flowing along the west is the Sindh and Chambal rivers, with the Narmada flowing in the south.

Water resources

The main water sources in the region are perennial rivers and rivulets, the numerous lakes formed through embankments built along the lower side of the valley and the traditional ponds that are found in almost every village. The Betwa contributes around 50 percent of the water available in Bundelkhand uplands and in the Bundelkhand plains sub-regions; the Ken contributes around 25 percent of the water. Both the rivers are inter-state rivers, originating in MP, and flowing through UP, to join the Yamuna.

POPULATION

Change in demographic characteristics during 2001 to 2011 is recorded in all the districts of UP and MP in general and particular in Bundelkhand region. Bundelkhand region comprises 13 districts from both MP and UP. Urbanization, sex ratio, literacy rate, work participation rate has increased from 2001 to 2011 in Bundelkhand region whereas child sex, agricultural labour and household workers has declined during same periods. Adolescent and youth population has increased with disabilities. Proportion of rural and male population is higher than urban and female population. Migration rate was recorded highest during 1991 to 2001 in Bundelkhand region.

Distribution

Total population of Bundelkhand is 18.3 million out of which 79.1% of the population lives in rural areas (Census 2011) whereas more than 1/3rd of the households in these areas are in the category of Below the Poverty Line (BPL). The poverty scenario in the region has become extremely critical in the past few years due to two main factors; one, lack of employment generation and decreasing employment opportunities, whereas; second, the loss in the agricultural business even on smaller farmers stages. The insecurity in the basic living conditions and lack of supportive governmental planning has resulted in terms of forced large-scale migration of the local population in the surrounding big cities like Delhi, Meerut, Gwalior, Kanpur, Allahabad, Jhansi, Kota, Jaipur, etc. the region extends its agricultural practices mainly in Kharif season. In this region rural economy gets 90% input from the crop production, animal husbandry and migration on seasonal basis in the Bundelkhand region.

Table: 2; Social Indicator Conditions in Bundelkhand Region

District	LR	IMR	PCI	HDI	Ranking
Jhansi	75.05	41	37999	0.592	1
Mahoba	65.27	46	34661	0.538	2
Hamirpur	68.77	45	26941	0.511	3
Jalaun	73.75	65	29476	0.473	4
Sagar	76.46	69	29028	0.466	5
Banda	66.67	55	24540	0.465	6
Datiya	72.63	73	29307	0.443	7
Damoh	69.73	71	27999	0.437	8
Chattarpur	63.74	63	27999	0.425	9
Lalitpur	63.54	73	28989	0.417	10
Tikamgarh	61.43	61	21502	0.412	11
Chitrakoot	65.05	67	24011	0.399	12
Panna	64.79	85	23170	0.347	13
UP-Bundelkhand	69.30	56	29884	0.493	-
MP-Bundelkhand	68.70	69	25893	0.430	-
Bundelkhand	69.00	63	29021	0.464	-
UP	67.70	68	26513	0.397	-
MP	69.30	62	33028	0.463	-
India	74.00	44	54042	0.632	-

NORMAL

MODERATE

CRITICAL

Study of several survey and data sets, outlines presence of extreme natural and manmade droughts which has been experienced continuously over the last four years. The natural and social restraint of the region has significant role in shaping the human capital, in order to take care the current scenario of agricultural and ecological imbalances by raising current human capital value, which stops the improvement in the living conditions of the rural region which is severely much affected from the imbalances due to some of the social indicators having lower statistics which includes literacy rate, Infant Mortality rate, Per capita Income and human Development Index. Table: 2, shows statistical scenario which pictures the regional human risk condition very well. It is very clear that unless increase in people’s living standard it will be hard to make society resilience for the calamities like shortage of rainwater, sudden flood and drought.

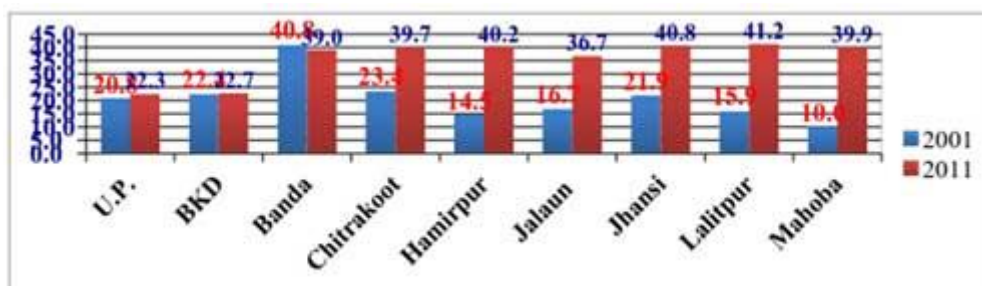
Migration

Bundelkhand region having seven districts of southern Uttar Pradesh and six districts of northern Madhya Pradesh has a historical background as drought prone region in the country, but the frequency and intensity of drought has increased over past few decades (Gupta et al. 2014). The region contributes to the highest rural to urban migration in central India (Census, 2011).

Growth Rate

Growth rate of urban population in Bundelkhand region, in 2001 and 2011 is on the increasing trend which illustrates the population pressure on the Bundelkhand region. The follow table shows the increase along the Uttar Pradesh districts further;

Table-3: Decadal Population Growth of Bundelkhand



Source: Census of India, 2011

SOCIO-ECONOMIC ORGANIZATION

Education

According to Indian Census, literate are those who can read, write with understanding in any language. Literacy rate has increased across the country. Literacy rate has increased by 10 percent point during 2001 to 2011. There are 40 per cent literacy has increased in 10 years in Bundelkhand region which is higher than state average (UP). It is happy to note that female literacy has changed positively by 104 per cent in Lalitpur district followed by Mahoba (92.7) and Banda (79) whereas this percentage in rural areas is higher i.e., 128.8, 114.1 and 93.5 per cent respectively.

Health

Health conditions in Bundelkhand in are showing a positive picture is in terms of improvements in health sector. Vaccine preventable diseases are on the verge of decrease. But situation is still not satisfactory. According to National Family Health Survey (1992), 34% of adolescence children have not received any vaccination against six preventable diseases in Bundelkhand Region. The health situations are the same in backward and remote regions of Bundelkhand. There are urban-rural variations also. While there are 43% of Children in urban areas

fully vaccinated, only 26% of rural children are fully vaccinated. Boys are more likely to have got a vaccination than girls. Vaccination coverage is lowest among ST and only 19% of ST children are fully vaccinated.

Livelihood

In the villages of the study area, the socio-economic setting is been found to be adverse against the poor. The poor were on the losing front in their fight against different social odds to adjust and access towards a livelihood base. The up-gradational pattern in rural economic factors like; agriculture, animal husbandry, horticulture, livestock, fisheries, poultry, forest and rural non-farm sectors are found to be in poor state. There is huge gape of institutional mechanism to transfer and apply new and efficient range of available technologies. The initiatives has been taken by few NGOs, though, have limited impact on the people’s life. The study underlines that there is significant space for enhancing productivity in livelihoods conditions of the region if proper and efficient set of improved technological inputs are drawn to ground zero.

TECHNOLOGY

Transport

Being situated in the core of the country, Bundelkhand, naturally lies in the network of main network of commerce which is criss-crossed through the region. It is strategically positioned in the central geographical region. Due to this it was known as “Gateway of the South India”.it is easily accessible from all direction from the north to south and east to west. The system of transport in this region continuously on the changing pattern and resulted an evolution of Transportation of this region.

Communication

Majority of farmers doesn’t uses demonstration (69.25%), kisan mela (52.25%) and kisan gosthi (48.50%) as source of information. Once in a year, these sources were used by farmers ranging from 15%-32%. Use of popular and effective sources of information such as demonstration, kisan mela and krishak gosthi was very low due to different reasons, which need to be coloured by programmes in different pockets involving the farmers (Pal, Singh and Singh, 2009).

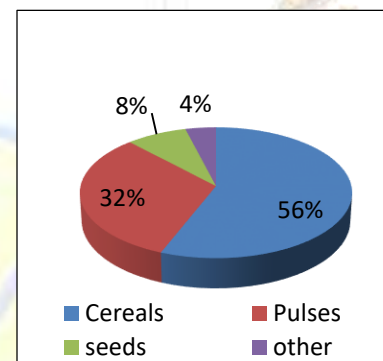
Information Technology in the Bundelkhand

Type of Information	Use
Climatic and hydrological information	IITM used the PRECIS model based on the Hadley Centre Coupled Model to develop three simulations for the A1B scenarios for the period 1961–2098. The Soil and Water Assessment Tool (SWAT) model was used in order to generate the river flow models in various river basins.b The SWAT model was developed to provide continuous-time simulations with a high level of spatial detail by allowing the further division of a watershed or river basin into hundreds or thousands of sub-watersheds.
Satellite imagery	Analysis and classification of satellite imagery indicated that the region’s agricultural sector is heavily dependent on rainfall and supplemented by groundwater.

Biophysical information	Climatic data sets were integrated with edaphic (soil) and crop physiology data using CROPGRO soybean and CERES wheat physiological models to generate the crop impact models under A1B scenario of climate change in 2030.
Socioeconomic information	Climatic and hydrological information, satellite imagery, and biophysical information was overlaid with the socioeconomic conditions on ground in the Bundelkhand region, based on expert opinion and stakeholder consultation (including with farming communities). The aim was to identify adaptation options that are feasible in the region giv
Stakeholder information	Source: WRI Report 2012 climate impacts and socioeconomic conditions.

Agriculture

In the Bundelkhand where only 45% land is under cultivation, crop production, animal husbandry and migration on seasonal basis contribute 90% input in the economy of the Bundelkhand. Under the total agricultural production 56% of cereals, 32% of pulses, 8% of oil seeds and 4% other crop shares their part (Graph: 1). It's been observed during the interview and discussion session with local people, it was concluded that the agriculture pattern in Bundelkhand region depends upon mainly on rainwater because the region having less than 25% net cropped area (NCA) under the irrigation facility, this makes the region diverse in nature, complex in terms of crop selection where water born crops such as sugarcane and



Graph: 1; Crop Production

rice are seen as secondary crops and grown in those areas where irrigation facilities are present. The under-invested irrigation extension in the region also makes impact on agricultural production as well as on ecological balance. Layers of administration has failed in terms of proper planning and management, but the people's poor participation due to lower Per Capita Income (PCI), risky production patterns and vulnerable nature due to natural calamities like inefficient rainfall, depleting surface fertility and status of groundwater. Further, the regional flood prawn status makes the human ecosystem more fragile by nature, which encourages large scale migration in the form of centripetal. Excess water during the flash flood in the Monsoon season increases of surface runoff and subsurface erosion turns the agricultural land totally into wasteland due to deposition of non-fertile soil materials on it. The region comes under the category of arid and semi-arid agro-region with poor soil profile and low productivity, further increases the problem of food production which eventually adds a grave threat to ecology.

Information Technology

There is a need for communicating climate change conditions in the Bundelkhand region in the culturally appropriate ways. This can enable the formulation of adaptation strategies based on long term impacts and solutions suited to the local populace. Another gap that needs to be addressed is the failure to engage with indigenous ecological knowledge as a valuable source of adaptive practice and a pathway to integrate new approaches to adaptation.

VI. Problems and Prospects

Dynamic and cash-crop based agricultural practices has brought important changes in the living conditions of people's life in last few years which has been responsible for the change in human ecology in the region which further transferred in to changes in ecological atmospheric conditions. These are brought down the developmental dimension and established certain problems in front of people.

i. Drinking water

Regional variability of water resources in the region is thinner from other water drawn region of the country. Rainfall below average doesn't allow people to address their water problem and water for irrigation both. The increasing demand from the agro-activities has enabled the ecological imbalances which has affected every stakeholder of the ecology in the region. In the process of ecological imbalances, water need is been affected as first order of problems, which later on spreads on to second and third order i.e., for agricultural and Industrial purposes. With each increasing order the ecology starts crumbling down and at the end losses it's all constituent elements.

Sources of Water	% of respondents using
Well	45
Reserved rainwater in ditches and ponds	35
Hand pump	20

Table: 1; Water sources in the region

Above table shows a brief summary of water used by the people in the region, which underlines the dependency of mass people on community sources of water. If these common sources won't be taken care, it will make the people's life much harder.

ii. Other Problems

Regional ecological setup and available resources underlines several problems, which are responsible for the current situation. The individuals of weaker sections such as women and children and marginal section such as tribal and disable people are at larger risk in the region. A woman has to travel bare foot for several kilometers for the drinking water collection. Children are getting affected by many diseases due to available water contamination. Parents are forced to marry their daughters in early ages due to acute shortage of food and water, so that it can make space for other family members in the house.

iii. Anthropogenic Reason

In the region of Bundelkhand human is the most important factor in terms of both, contributor as well as component. Activities like deforestation overuse of natural resources like water and soil, Water rich food crop cultivation, Uncontrolled Mining and other has made a grave impact over the time in the region. With large number of borewells establishment by rich people does not serves the need of water for all. Also unplanned and uncontrolled mining of Sand, Stone, Gravel and other construction materials has affected the regional ecology very much. Being the main and only industrial activity, Mining and distribution of Construction materials, large scale highland slopes are been overused, large amount of soil erosion, which not only affecting flora and fauna but also changing the habitat of the man and animal respectively. Bundelkhand has very poor prospects of employment which is limited in nature, which fails to relax the agricultural dependency. High dependency on agriculture has also forced the ecological imbalances to make impact over the human at the end.

Conclusion

All above information points out towards a human concern for socioeconomic sustainability of the ecology and ecological balance of the region which will make capable the environmental justice which the region needs badly. Meteorological disaster management particularly for the drought has to come up with a path breaking hydrological plan to rejuvenate and recharge the surface and ground water resources. As I owe from the neighboring region around Bundelkhand and have experienced the migration pattern on surrounding cities due to ground realities of water crisis, ecological imbalances and livelihood challenges. People are not aware of steps and processes through which they can help in the reconstruction of ecology into its initial form. To take care the human health problems, Project Shristipath is been started as a holistic approach, which will take care of followings:

- Health facility for the rural population,
- Educational Facility to poor class of children,
- Trading and Marketing of Rural products,
- Skill Development for rural youth population
- Employment,
- Information and Communication Facilities,
- Legal Aid,
- Orphan and Old Age Home,
- Village Tourism, and
- Environment Conservation.

Initiative like this is changing ecology of the region where human interactions to the abiotic elements are increasing day-by-day. The interrelationship between ecological variables and primary activities such as agriculture which has more than 65% dependency on natural or abiotic elements such as air, water, vegetation, soil and wildlife. It can be concluded from above discussions, that natural factors are the need of the hour to sustain the regional ecology used to upgrade agricultural practices by using new scientific techniques where biodegradable pesticides and add-on will be used to make sure the ecological balance between the species. There is an urgent set of factors, which needs to be addressed by the Researchers, Environmentalists, Planners, Development agencies, Institutions of Government and Private nature and most importantly the local people, by taking initiatives on voluntary level to empower the local communities to go and accept the beneficial initiatives for the all round development in the groundwater and land cover statistics to overcome the backwardness of the Bundelkhand region.

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