



WHITE PAPER

LANDSCAPE APPROACH

LAND - WATER - COMMUNITY SECURITY

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Executive Summary

Introducing landscape approach

The *landscape approach* aims to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change (Scherr et al. 2012; Milder et al. 2012; Sayer et al. 2013; Harvey et al. 2014). It also aims at balancing competing demands on land through the implementation of adaptive and integrated management systems. These include not only the physical characteristic features of the landscape itself, but all the internal and external socio-economic and socio-political drivers that affect land use, particularly related to conservation, forestry and agriculture (Sayer et al. 2013). **In short, landscape approach seeks to address the increasingly complex and widespread environmental, social and political challenges that transcend traditional management boundaries (Reed et al. 2014).**

Why Landscape approach in mid-Gangetic belt of UP: rationale for the study

The landscape approach, aiming to allocate and manage land to achieve balanced socioeconomic- ecological outcome, calls for recognition of multiple stakeholders, conflicting goals, and land use practices that have implications for the physical environment, habitat and natural resources. The mid-ganga basin in Uttar Pradesh is witness to this pressure and consequent impact on the riverine resource system. The river in the middle parts largely entering the plains and supporting intense agricultural activities through canal systems impacts the flow downstream. Along the stretch several towns, industries and agricultural activities contribute to point and non-point sources of pollution. A general degradation in the river system is caused by riverside cash crop farming (example: sugarcane), indiscriminate sand/gravel mining, riverbed farming, unscientific fishing, open defecation etc. (CPCB, 2013). Rapid urbanization along the river banks is imposing additional pressure on the already degrading resources. In general, the nature of use of water resource has affected both the flow and the quality of water in the mid Ganga basin. The short and long-term consequences of this impact shall be felt both by the physical environment and the society and is of great significance for this densely populated state where almost 40 percent of the population is below the poverty line.

Aim of the study

The study helps to embed the landscape approach into river basin management. It suggests that planning for a robust socio-ecological system requires that resource decisions (and consequent tradeoffs) be based on sound

principles of equity, efficiency and participation while balancing these with ecological principles such as resilience. The study was conducted in the two districts of mid-Gangetic plain i.e., Hardoi, Lakhimpur Kheri and Kanpur. The specific objectives are:

- To understand the decadal change in land use and its implication on different physical components such as evapotranspiration and groundwater recharge at watershed level.
- To understand the socio-economic and gender dynamics at village level and resultant pressure on resource systems
- To understand the soil, water and crop linkages at village level
- To analyze the industry-resource (water) interlinkage and understand best practices

DISTRICTS HARDOI AND LAKHIMPUR KHERI		
KAZIBADI	BHARKHANI	SEMAR GHAT
<ul style="list-style-type: none"> ➤ This is a small village in Todarpur Panchayat, with approximate population of 1630 (Census of India, 2011) residing in close to 400 households. ➤ Majority of the population belongs to the OBC category. ➤ The primary occupation is agriculture and labour. Most of the farmers are in medium and small category. ➤ Major crops grown are sugarcane and wheat. Village is unelectrified without safe drinking water supply or sanitation facilities. 	<ul style="list-style-type: none"> ➤ This is a block village and Panchayat and has population of 5681 residing in 888 families (Census, 2011; the villagers however estimated the population as approximately 10,000 in 1200 households in 2017). ➤ This is a multi-caste village inhabited by general, OBC and SC categories. Farmers primarily cultivate wheat while few have also started growing sugarcane. ➤ Land distribution is skewed and there are many large farmers, especially among the upper caste (general category). ➤ The village is electrified and has limited development infrastructure also (roads, shop, medical store, drains etc). ➤ Bharkhani has a woman Sarpanch. 	<ul style="list-style-type: none"> ➤ This is a Panchayat village located in Mohammadi Tehsil of Lakhimpur Kheri. ➤ As per Census 2011, the village had a population of 1205 in 251 households (the villagers however stated the population as approximately 2500 in about 200 households as per data collected in April 2017). ➤ The village population is a mix of general, SC and OBC categories. The village also had a few Sikh families that had settled almost 5 decades back and have large landholdings. ➤ The main occupation include agriculture, dairy and labour. Main crops grown in the village include sugarcane and wheat. ➤ The village is electrified, though supply is erratic. The village also has better infrastructure facility as compared to Hardoi villages.
DISTRICTS KANPUR DEHAT AND KANPUR NAGAR		
SHEIKHPURA	AIMA GRAM PANCHAYAT	
<ul style="list-style-type: none"> ➤ This is in the district of Kanpur Nagar and is surrounded by the banks of river Ganga. ➤ As per census, village comprises of 109 households with its estimated population of 558 people. ➤ Agriculture is mainstay of the population. It largely depends on CETP canal water and rainfall for irrigation with very few pump connections. Though the groundwater level is good, but the quality of water is poor. ➤ This is due to the presence of high chromium level and other chemicals which are released through the CETP canal water. It has various health impacts such as frequent stomach ache, presence of worms in intestine, degeneration of limbs etc. 	<ul style="list-style-type: none"> ➤ This is in the district of Kanpur Nagar; the village falls under the Sarsol block. ➤ As per 2011 Census, village comprises of 276 households with its estimated population of 1509 people. ➤ Agriculture is the dominant occupation. It largely depends on the groundwater and rainfall for irrigation. ➤ Segregated social groups mark the territorial boundary of the village. Thus, out of the five villages - Aima, Karbi, Gadiyampurva, Bagicha and Karankhera; first three were selected for this study to represent General, SC and OBC categories 	

Methodology & findings

I. Land use/land cover change and its impact on existing water resource:

The analysis was carried out using remotely sensed data (30-meter spatial resolution) for two-time steps (decadal data for three seasons), topography, soil and meteorological variables for the two study sites (industrial belt of Kanpur and sugarcane belt of Hardoi and Mohammadi). The daily meteorological data from 2000-2016 were used for the analysis.

Industrial belt	Sugarcane belt
<ul style="list-style-type: none"> ➤ In Kanpur district, there has been increase in urban area and decline in cultivated land over last one decade. Most of the industrial expansion has occurred near Kanpur city leading to increase in urban area (3160 ha) over the last 10 years. These changes have occurred mostly on the land used earlier for either agriculture/pasture activities or were left barren/fallow. ➤ Most of the decline in cultivated area are the lands where Rabi and Kharif crops were grown. However, there has been an increase in summer (Zaid crop) which could be due to increase in the number of tube wells in the area. ➤ The overall loss in vegetated land for urban expansion may have serious implications on water resource due to decline in groundwater recharge capability of the area. This was also found in the hydrological parameters estimated using Soil Water Assessment Tool (SWAT) model. There has been increase in surface water run-off and decrease in ground water recharge in one watershed delineated under this study. Importantly, the decline in groundwater could have serious impact if the trend continues, as this is the main source for irrigation amounting to 74% in the Kanpur Nagar (DPC, 2008). 	<ul style="list-style-type: none"> ➤ In Hardoi district and Mohammadi tehsil of Lakhimpur, there has been substantial decrease (almost three times) in cultivated land (mostly Rabi and Kharif crop) and increase in total area under fallow/barren over last one decade. ➤ Most of these transitions have occurred in the western part of Hardoi that lack proper canal network and groundwater resources. This study area has three watersheds: two wet and one dry watershed. ➤ The dry watershed lies in western side of the Hardoi district. The hydrological parameters estimated using SWAT model suggest relative increase in the runoff potential and decline in groundwater recharge in the three watersheds. These changes in surface run off and groundwater recharge potential could be attributed to the increase in fallow land and decline in vegetation cover in this region.

I. Socio-economic and gender analysis

Mixed method approach was used to collect data on socio-economic dynamics and gender aspects. **Primary data** was collected using short surveys, semi-structured interviews, PRA techniques, focus-group discussions and non-participant observation. Expert interviews included interview with the CETP officials, irrigation department officials, officials from the sugar mill and the village sarpanch. **Secondary data** included Census

data, Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) reports on water quality issues in Ganga, study reports etc.

Purposive sampling was done to categorize the respondents on dimensions of occupation, caste and gender. Data was analyzed based on occupational categories to understand the community resource interactions and institutional dynamics. Gender dynamics and aspects of gender-resource interaction were captured separately.

Broad thematic categories and aspects covered (variables used)		
Physical infrastructure	<ul style="list-style-type: none"> ➤ Settlement pattern (house type) ➤ Roads & electrification ➤ Water sources 	<ul style="list-style-type: none"> ➤ Waste management (infrastructure and use) ➤ Toilets
Social infrastructure	<ul style="list-style-type: none"> ➤ Education, health ➤ Conflict resolution ➤ Kinship ties 	<ul style="list-style-type: none"> ➤ Institutional credit facilities (banks or other financial institutions, moneylenders)
Livelihood and resources	<ul style="list-style-type: none"> ➤ Land holding, livestock & other asset ➤ Costs and prices, wage rates/income earned ➤ Food security and consumption, natural resources availability like pastureland, ponds etc. 	<ul style="list-style-type: none"> ➤ Occupation
Institutional infrastructure	<ul style="list-style-type: none"> ➤ Rules and regulations pertaining to village administration and resource management ➤ Presence of self-help groups and other such community institutions 	
Gender & caste dynamics	<ul style="list-style-type: none"> ➤ Gender division of labour ➤ Participation in workforce ➤ Institutions and decision making 	<ul style="list-style-type: none"> ➤ Socio-economic well-being

HARDOI:

- The **physical infrastructure** was poorly developed, with some areas still being unelectrified; most areas lacking basic sanitation and waste management facilities; poor connectivity to towns and inadequate access to market infrastructure. Groundwater was used for domestic (self-installed handpumps) as well as agricultural purposes. While the water levels had declined only a few respondents complained of declining quality, mostly felt through colour and taste. Caste based analysis revealed that the SC community lacked access to basic infrastructure as compared to OBC and General category members.
- With respect to **social infrastructure**, the villages suffered from poor education levels, poor access to health institutions, low social capital and high caste discrimination. Economically the General caste farmers were better off with larger land holdings, followed by OBC and SC (who were most deprived). The average annual income from farming was approximately INR 1,67,769. However, this was subject to the land holding of the farmer. The input cost per acre for wheat and sugarcane was INR 4895 and INR 17500 respectively. Total revenue for wheat and sugarcane per acre was INR 17500 and INR 94500 respectively. However, farmers preferred to grow a combination of wheat and sugarcane for reasons of food security.
- Livestock holding was more like a risk measure except in Semraghat where larger number of livestock yielded higher income to upper caste farmers. Savings was not a common habit. Almost 60% of the farmers availed loans for productive purposes but only a mere 19% had crop insurance. **Overall, most of the income was from farming but highly subject to risk and lack of access to institutional credit, market institutions, storage infrastructure and a resultant low bargaining power. The villages had no functional institutions and therefore low levels of awareness and social capital.** Panchayat was not strong and therefore police was resorted to solve even minor conflicts in the village.

- In Hardoi, **strong discrimination was found in women's access to social, economic and political institutions.** There was strong gender stereotyping where women were restricted to reproductive roles and men associated with productive roles. Concepts of women's access to space and freedom of choice were alien. Most of the women were uneducated and faced restricted participation in workforce and market institutions. There was no tenurial security and inheritance followed patrilineal systems.
- **Decisions pertaining to education of children, household expenditure, marriage and family planning were taken jointly by male and female members of the households.** However, **women did not have any say in decisions pertaining to resources, like property, crop choices, savings and investment.** While women found very little space in decision making role at the household level, the representation and participation in village governance was dismal. Only one village (Barkhani) had a woman Sarpanch. However, the functional office was held by her husband. The participation was lowest among the SC member, who also faced severe caste discrimination.

KANPUR:

- The **physical infrastructure** but again highly differentiated in terms of caste dynamics.
- Access to **social infrastructure** was better in Kanpur, however, incidence of disease was common. This included chronic diseases like arthritis, tuberculosis, diabetes, filaria, anemia, joint pain, blood pressure irregularities and fistula. Other common ailments included diarrhea, fever, hepatitis, intestinal worm, kidney stone, chicken pox and typhoid. Respondents preferred private facilities to public owing to better infrastructure. **Groundwater was the common source for drinking and irrigation in Aima as compared to Sheikhpura that had access to piped water for drinking and CETP canal water for irrigation.** In Sheikhpura, respondents faced health conditions like presence of worms in intestine, and degeneration of limbs. Economically, the General and OBC category respondents were better off in terms of occupational diversity, land holding size, asset ownership and livestock holding.
- Agriculture was the primary occupation for General category farmers while OBC and SC categories practiced subsistence farming and supported their income through labour and other activities. The major crops grown in the villages were wheat, *jowar*, *barsheen* and roses. **Farmers in Sheikhpura specified high use of pesticides but low use of fertilizers, attributing it to the presence of heavy metals in water that gave "a lot of power".** **Access to storage infrastructure and market was poor. Thus, farmers had very low bargaining power.** The youth did not show interest in farming due to low profitability and preferred to work in private or government sector. In Aima, a few farmers were said to have sold land to tannery owners (perceiving the upcoming tannery cluster close to the village).
- Livestock provided a steady source of income but there was no organized market for sale of milk. Although, all the respondents had bank account, savings habit was again not very common. Farmers had access to

banks and used Kisan Credit Cards to borrow money for agriculture purposes. **Institutionally, the villages did not seem very robust in ensuring access to good infrastructure or accountability mechanisms** (though the Aima Sarpanch took lot of credit in construction of toilets).

- **Gender roles were also restricted to associating reproductive role with women and productive role with men.** Women were mainly responsible for tasks like cooking, cleaning, fetching water, taking care of animals and other domestic chores. They could voice their opinions in matters like savings and expenditures. However, in most matters like family planning, education, marriage, financial planning and crop choice, women were not able to take decisions. All agricultural related tasks, market transactions, decisions pertaining to farming and decisions pertaining to property was in the realm of the male members. **By their responsibilities, women came closest to the natural resources, but their role in managing natural resources was limited.** They had no access to property; they were “missing” from institutions; and lacked a ‘voice’ even after affirmative steps through reservation.
- The study in Aima GP found that despite a woman Sarpanch, **the presence of women in institutions was rare.** This was an extension of gender norms that were fixed at household and community level. As a result, women themselves had started perceiving their insignificance in institutional matters, often labeling it as “*a man’s business*”. In absence of sufficient numbers, even those women who were interested in attending meetings were unable to participate. The study could not see active involvement of women in community level decisions. Their presence only assumed significance during elections. Women in Sheikhpura were relatively more exposed, yet their mobility and decision spheres were limited. They could only visit the market and other town facilities in the company of a male family member. Such discrimination manifested in their educational and economic status.

II. Soil Water Crop Linkages

It is well known that different agro-ecological zones have diverse types of soil and nutrients. They are also climatologically different and support different vegetation and crops. It is thus essential to select the right crop for the area, to optimize the crop yield and crop water requirements. To understand soil-water-crop linkages, soil analysis, water analysis and crops grown were studied.

The use of canal water in Sheikhpura village of Kanpur district has led to increased levels of chromium in soil and plant roots and shoot. Since canal effluent flows from the combined effluent treatment plant (CETP), though it is mixed with treated domestic sewage effluent, it has high salinity (it is very challenging to reduce salinity of tannery effluent). As we move away from the immediate vicinity of the canal, the soil and plants both exhibit low chromium content. Owing to this, the village has started growing flowers, clearly showing a linkage between water quality- soil condition and cropping pattern.

- High concentration of chromium is observed in soil samples taken from farms close to the canal.
- Elevated level of calcium and sodium is directly responsible for introducing alkalinity in the soil.
- Chloride concentration at various sites indicates towards the saline nature of soil, adjacent to the canal.
- Presence of chromium could be seen in all the plant samples.
- Semi-submerged plant has high chromium content.

Though farmers in Hardoi have shifted to sugarcane cultivation, the soil nutrient balance does not seem to be too adversely affected. This could be because such shift is recent and at smaller scale. However, it is important to consider that this area of Hardoi is not served by Sharda canal and is entirely dependent on ground water. The surface water bodies have also dried up in absence of proper management. Therefore, in the absence of any artificial recharge facilities, this could be a cause of concern in future and impact productivity. The following analyses were drawn from the soil, water and plant sample tests.

- Lack of high values for NPK contents indicates that most of the nutrients have been used up during growth period as the soil samples were taken after harvesting. Therefore, soil is healthy with low electrical conductivity.
- No overuse of fertilizers was seen in these 4 villages, which is also seen from the test results of soil organic carbon content.
- The ground water test results show that water is of reasonably excellent quality as per the test parameter which are below standard limits. However, wherever the bore wells are old, not maintained well, rusting has resulted. This is reflected in the iron content of water
- The water balance in these watersheds will show a negative result if ground water is used continuously without efficient ground water recharge facilities.

Conclusion & recommendations

Landscape approach calls for reconciliation between the conservation and development objectives with the aim of balancing socio-economic and environmental outcomes in any geographical context. In the mid-Ganga context under discussion, which is under twin pressures from agriculture and industrial and urban expansion, managing the multifunctionality along with sustainability is a vast challenge. The land use and soil and water analysis in this region showed several trends like: shrinking green cover; decline in water bodies and ground water table; chromium and salinity problems in canal water that is used for irrigation; concern with water balance in watersheds in future within the current scenario of water use and management.

Land use/land cover change and its impact on existing water resource

The land use/ land cover change analysis of the region suggests that the different transitions have a significant impact on the current water resources. In both industrial belt as well as sugarcane belt there has been increase in surface run off and decline in ground water recharge due to decline in total vegetated cover. **Therefore, there**

is need to put effort in the direction of development of green belt around Ganga.

Specifically, in Kanpur district, there has been increase in urban area and decline in cultivated land over last one decade. The overall loss in vegetated land for urban expansion has led to decline in groundwater recharge capability of the area. Although currently not so significant, but the increase in surface run-off and decline in ground water recharge, if continued, could have serious impact on agricultural activities where groundwater is the main source for irrigation. The study also shows that there has been decline in the groundwater table due to withdrawal for irrigation in absence of canal network in the area and industrial use (around 400 leather tanning industries withdraw groundwater for their processing operations).

In Hardoi district and Mohammadi tehsil of Lakhimpur, most of the land use/land cover transition has occurred in the western part of the region that lack proper canal network and groundwater resources. Loss of vegetated cover and increase in fallow land in the study area has led to reduction in soil infiltration capability. Thus, there is an increase in the runoff potential and decline in the groundwater recharge in all three watersheds. The study also shows a decline in the water bodies that were present in the southern tehsil of Hardoi district. Therefore, an extension of the canal in the western part and the revival of water bodies could be considered in this region.

Soil water crop linkages

In Kanpur, the study showed an increased level of chromium in soil, plant roots and shoots adjacent to CETP canal. As one moves away from the immediate vicinity of the canal, the soil and plants both exhibit low chromium content. This has enabled the villages to grow flowers, clearly showing a linkage between water quality-soil conditions and cropping patterns.

Both chromium and salinity problems in the canal water flowing from CETP are closely linked to industrial practices. While the CETP capacity has not been enhanced, there has been unregulated increase in the number of tanneries. Removal of chemicals used in the tanning processes after processing of hide is also a major challenge. **Therefore, it is recommended that by following best practices as shown in the Kanpur tannery case study, pretreatment of effluent may be practiced before it reaches the CETP inlet.**

However, in Hardoi the cropping pattern in the villages is gradually changing to include sugarcane cultivation as the neighboring sugar mills provide a ready market for the farmer's produce. **Since sugarcane cultivation requires intensive irrigation, more groundwater is extracted.** The results from various soil tests, including electrical conductivity and organic content analyses reveal that the soil is in good health though the water consumption is high. The study area fell under a semi-arid zone, **it is recommended to revive existing water**

bodies and reduce groundwater consumption to address water stress condition that may develop in near future.

Though the farmers in Hardoi have shifted to sugarcane cultivation, the soil nutrient balance does not seem to be too adversely affected. This could be because such shift is recent and at smaller scale. However, it is important to consider that this area of Hardoi is not served by Sharda canal and is entirely dependent on ground water. The surface water bodies have also dried up in absence of proper management. Therefore, in the absence of any artificial recharge facilities, this could be a cause of concern in future and impact productivity.

Community resource interactions

The socio-economic and institutional analysis added complexities to the above findings and suggests that given these ecological trends, if the institutional intermediation does not address the socio-economic vulnerabilities, it will lead to further marginalization of certain communities and enhance resource degradation. **The parameters for micro/village level analysis included livelihood sources and income, food and water availability, asset holding, agricultural practices and backward and forward linkages, settlement type, sanitation and waste management facilities, health/health infrastructure, education, institutional opportunities and participation, gender roles and women's inclusion and resource management practices.**

The findings from Hardoi and Mohammadi tehsil of Lakhimpur showed that most of the income was from farming but it was highly subject to risks in absence of institutional credit, market institutions, storage infrastructure and resultant low bargaining power. The major crops grown in this area included wheat and sugarcane; but there was greater willingness to shift to sugarcane due to assured market and higher prices. This would benefit the farmers but concerns like lack of irrigation facilities, groundwater abstraction cost, energy prices, institutional credit requirements and weather risks might enable the better off farmers to gain in the long run. In absence of appropriate institutions, resource sustainability would be threatened by declining vegetative cover and diversity, dying surface water bodies, groundwater abstraction rate, recharge rate and energy subsidies. The study also showed that the socio-economic status was strongly influenced by caste and gender dimensions. Thus, land distribution was skewed in favor of the General and OBC categories while women did not have property rights. Institutions were weak and participation in institutions was nominal, particularly for the lower caste groups. The Panchayat was not active and thus even minor village disputes were taken to the police. Women were mostly uneducated and faced restricted participation in workforce, market and political institutions. Their role in decision making at household level was meagre and faded at community level. Thus, even though they were closest to the resource albeit in a nurturing role, they were "absent" from the community and resource based institutions. Social infrastructure was poor as studied through literacy status, awareness

levels, access to health institutions, and social capital. The study did not locate any intervention through civil society organizations in any of these realms.

The study in Kanpur showed that the area was better endowed in terms of physical infrastructure but ridden with complex caste dynamics. This was reflected in various dimensions of economic well-being, where the General and the OBC categories were better off in terms of occupational diversity, land holding size, asset ownership, and livestock holding. Agriculture was primary occupation for General category farmers, while others supported their income from other sources like labour, employment in tanneries and other unorganized units. Crop diversity was noticeable where farmers were also engaged in floriculture (particularly roses) along with regular crops like wheat and *jowar*. Yet, agriculture remained mostly of subsistence nature due to lack of backward and forward linkages. In absence of storage infrastructure and formal marketing linkages, farmers had low bargaining power. In addition to agriculture, livestock rearing also yielded a steady income but in absence of organized market for sale of milk and institutional support, this remained as a subsidiary source of income only. Unlike Hardoi and Lakhimpur Kheri, access to formal financial institution was better but savings and investment habit seemed lacking, even amongst those with steady source of income. Resource management practices and institutional support for the same could result in not just scarcity in future but further socio-economic vulnerability. In Aima, groundwater was used for drinking and irrigation purposes. While water table was reportedly receding and issues of quality surfaced, there were perceptible caste based differences where the high-income households could address quality issues by abstracting 'sweet' water from 150 to 180 feet while low income groups could not. Surface water sources were filled, eutrophied or dried up due to mismanagement. In Sheikhpura, farmers used CETP canal water for irrigation. They reported using less fertilizer owing to the presence of heavy metals in water that gave 'a lot of power', but used more pesticides since the crops were prone to pest attacks. While incidence of both chronic and common ailments was common to both areas, there was a perceived correlation (which could not be statistically verified) between canal water and health conditions in Sheikhpura.

The access to social infrastructure (in terms of schools, markets, institutional linkages etc.) was better than Hardoi and Lakhimpur Kheri, yet institutionally the study villages did not seem robust as reflected through participation rate, accountability mechanisms and existing social capital. Women came closest to the natural resources, but their role in managing natural resources was limited. They had no access to property; they were 'missing' from institutions; and lacked a 'voice' even after affirmative steps through reservation. The social set up was so replete with gender stereotypes that women themselves had started perceiving their insignificance in institutional matters, often labeling it as 'a man's business'. The study could not see active involvement of women in community level decisions.

Overall, the socio-economic and gender analysis at the village level, with reference to natural resources (specifically water resource) suggests that the development planning in the region has not adequately considered the socio-economic vulnerability of the local communities and therefore decisions pertaining to trade-offs prioritize certain land use over ‘not so productive’ use (like agriculture in many places). Agriculture itself is highly politicized agenda in the state, whereby, certain sections ‘capture’ the subsidized resource access (state has free electricity in many areas; there is no regulation pertaining to groundwater use; procedure for institutional credit is unclear); while others still await even basic irrigation and credit requirements. In Kanpur, some of the farmers have also sold land preempting industrial sector growth. Considering low productivity and absence of jobs, the youth are willing to engage in other occupations and migrate to the city. This is indicative of the larger trend where we also see expansion of the urban sprawls and declining green cover.

The overall scenario suggests that the resource governance considerations need to factor the socio-economic vulnerabilities, livelihood diversification and backward and forward linkages for agriculture. In the long run inventions require greater stakeholder engagement, effective governance structure and better institutional coordination. More specific decisions pertaining to resource need to address efficiency issues and institutional coordination. The sugar mill study is a case in point where they seem to be adopting a ‘co-benefit’ approach while working with the farmers, thus not just providing a market for produce but also promoting better resource management practices like mulching etc. The study of tannery suggests techno-political interventions with a mix of better treatment facilities and stricter regulations and enforcement mechanisms. The study has tried to amalgamate various considerations through the landscape principles that is illustrated in a matrix form (with broad and specific recommendations).

PRINCIPLE 1 & 2: RECOMMENDATION		
Continual and management	learning adaptive	<u>Broad Recommendations</u> <ul style="list-style-type: none"> ➤ Changes in landscape attributes (ecological, land use and socio-economic changes) must inform decision-making. ➤ Dynamic interactions across scale to foster new understanding and knowledge which become a basis for revised strategies.
		<u>Specific Recommendations</u> <ul style="list-style-type: none"> ➤ Continuous research to enhance sustainable production (particularly sugarcane) and to suggest crop rotation to maintain the soil health. ➤ Rejuvenation of water bodies which shall maintain water balance in the area.

	<ul style="list-style-type: none"> ➤ Capacity building of government and other staff on best practices in agriculture under changing soil and water conditions
Common entry point	<p><u>Broad Recommendations:</u></p> <ul style="list-style-type: none"> ➤ Understanding & accepting different stakeholder interest, diverse values & beliefs. ➤ Adopt socio-ecological approach to address socio-economic vulnerabilities and resource degradation <p><u>Specific Recommendations:</u></p> <ul style="list-style-type: none"> ➤ Address water demand and management issues through extending/reviving canal networks in the south-western side; strengthening ground water management with allocation system; recharge through abandoned wells ➤ Extend infrastructure and institutional support for farming (reference to storage facility, institutional credit and market linkages could be an excellent entry point to sustainable farming technique adoption among farmers) ➤ Initiate interventions on allied livelihood options (opportunity for animal husbandry-by taking care of breed improvement, veterinary services, marketing and pricing aspects).

PRINCIPLE 3,4 & 5: RECOMMENDATIONS

Multiple scale	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Cross-scale participatory planning; inclusion of independent experts, organizations and local participants that can facilitate exchange of learnings ➤ Spatial-temporal mapping to capture the changes in natural resource and adapt planning in accordance with resource status. ➤ Development of 'bottom- up' community intervention strategies to improve land use practices <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Spatial mapping using multiple resolution earth observation dataset (few centimeters to few kilometers spatial resolution) ➤ Water allocation must be decided at each level (village, panchayat/municipality and industry) and collectively as well ➤ Creating awareness and including citizens in resource monitoring and planning
Multi functionality	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Change in vision on agriculture from 'cultivated landscapes' to multi-valued socio-ecological units/multi-functional socio-ecosystems ➤ Proper assessment and valuation of ecosystem services at landscape level

	<p>(including water, land, vegetation) to plan for better risk diversification</p> <ul style="list-style-type: none"> ➤ Building a green corridor along the river Ganges at Kanpur, along with decentralized treatment facilities. <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ The potential of floriculture and agro-forestry remains unexplored-this could be taken up to support household income. ➤ Diversify from pure farm based livelihood system to allied and non-farm occupation (like livestock rearing, small enterprise development) ➤ Quality of treated tannery effluent, which is used for agriculture, needs to be improved and its health impacts must be properly assessed ➤ Continuous monitoring and assessment of crop productivity (particularly sugarcane) to improve crop yield through proper management rather than being focused on cultivated area expansion.
Multi stakeholder	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ An area/landscape planning approach that brings together all stakeholders and mobilizes resources ➤ Create multi-stakeholder dialogue platforms that brings together stakeholders <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Kanpur: Include Panchayat members (with representation from all caste groups), Kanpur Nagar Nigam officials, tannery owners and CETP officials in seasonal water allocation and management planning ➤ Hardoi: Include Panchayat members (with representation from all caste groups), Block Development official, Sugarcane commissioner, Sugar mill owners, Irrigation Department in seasonal water allocation and management planning ➤ Create local institutions with active involvement of NGOs/CSOs to generate awareness on soil and water quality, build capacity for resource monitoring and management and ensure equitable resource allocation.

PRINCIPLE 6, 7 & 8: RECOMMENDATIONS

Negotiated transparent logic	and change	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Need to generate higher social capital; better accountability mechanisms; higher transparency in functioning of state and non-state units ➤ Institutional measures more important- stricter real-time monitoring framework linking it to graduated sanctions (this must be a participatory effort) <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Capacity building of farmers and other stakeholders through regular trainings and workshops, to understand the resource condition, trends and involved in regular monitoring of resource
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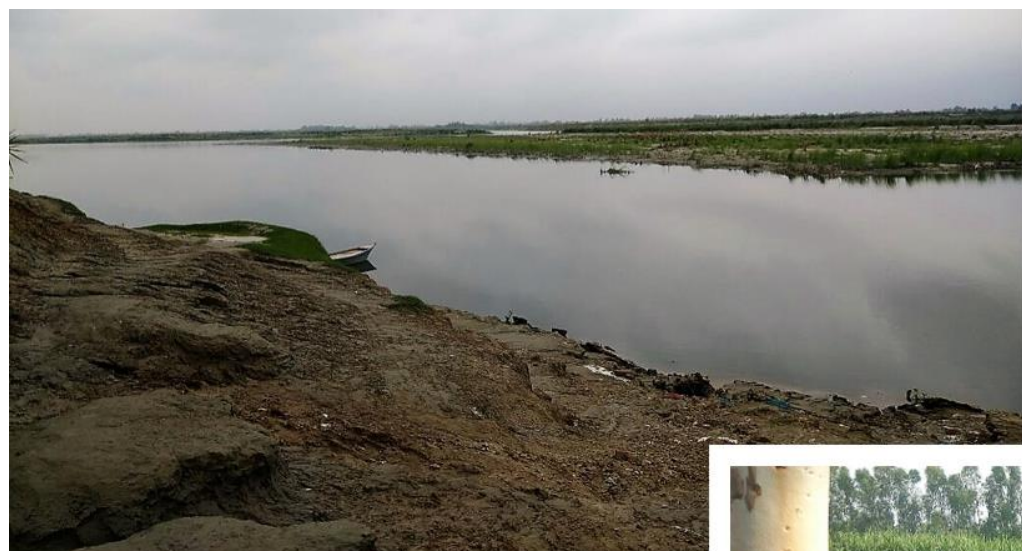
	<ul style="list-style-type: none"> ➤ Improving governance by clear accountability mechanisms; ensuring transparency in projects and planning; grievance redressal mechanisms to be developed with proper access rules.
<i>Clarification of rights and responsibilities</i>	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Creating a state level autonomous institution that becomes the nodal agency for coordination, planning, monitoring, compliance and dispute resolution. The scope for planning for this agency should be at a watershed scale. ➤ It becomes the mandate of this institution to consult all stakeholders (including local institutions), assess and prioritize demands based on resource condition and maintain a centralized database which is also freely accessible to the public. ➤ This autonomous institution can create sub-units for enforcement and monitoring at district/block or other levels, as required. ➤ Clear tenurial rights, including focus on women's property rights <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Well-defined resource and institutional boundaries- ensure that every person/institution has clarity on his/her rights and responsibilities ➤ Well-defined property rights with equal entitlement for male and female members of the household. ➤ Considering close interaction of women with natural resources, stress on greater women membership and involvement in village institutions and decision making
<i>Participatory and user-friendly monitoring</i>	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Local stakeholders and government agencies can learn and adapt together ➤ Recognizing validity of different knowledge systems- Collecting and managing data from multiple sources that can be integrated and information thus created can be used by various stakeholders ➤ Developing citizen science based approach for continuous resource monitoring and adaptive planning <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Creating mobile app which can be used by citizens to provide data at appropriate scales ➤ Capacity building amongst stakeholders to monitor and interpret water and soil quality parameters and adapt land use practices ➤ Affirmative steps to include villagers and women in decision making

PRINCIPLE 9 & 10: RECOMMENDATIONS

<p><i>Resilience</i></p>	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Ecological resilience ➤ Maintaining soil and water health through active monitoring and restoration mechanisms ➤ Devising a landscape level geo-spatial framework for continuous annual scale monitoring of general land use, crop patterns and water resources with threshold based alert systems ➤ Community resilience: ➤ Enabling risk diversification mechanisms through livelihood interventions ➤ Ensuring backward and forward linkages where farming is practiced <p><u>Specific recommendations:</u></p> <ul style="list-style-type: none"> ➤ Considering semi-arid characteristics in Hardoi, preservation of natural soil nutrient levels is crucial to ensure resilience ➤ Use of mulch, manure from sugar mills, produced as by product in sugar mills to maintain sustainable soil moisture and nutrient levels. ➤ Rejuvenation/restoration of dried up surface water bodies to ensure continuous water supply ➤ Active consideration of groundwater recharge to maintain sustainable ground water levels ➤ Regular monitoring of water and soil quality and impact of effluents on crops and health of farmers ➤ Regular monitoring of cropping pattern and providing suggestion on right mix of crops ➤ Floriculture in Kanpur region should be encouraged considering high salinity and presence of chromium in effluent canal water that is used for agriculture ➤ Proactive intervention in alternative livelihood sources (allied and non-farm activities- for example: livestock rearing, small enterprise development) to support household income levels ➤ Promote self-help groups and other local institutional interventions to mobilize farmers and promote collective action ➤ Ensure better risk preparedness among women members (through education, capacity building and property rights)
<p><i>Strengthened stakeholder capability</i></p>	<p><u>Broad recommendations:</u></p> <ul style="list-style-type: none"> ➤ Strengthened stakeholder (including local institutions) capacity for participatory resource mapping, data assimilation and database management ➤ Need to increase literacy level and educate farmers on resource use efficiency ➤ Active education programmes and skill building particularly among the youth groups to enhance employability

Specific recommendations:

- Skill training, capacity building among different government and local institutions on resource management, monitoring and citizen science approaches
 - Enable handholding to small tanneries and industrial units for decentralized waste treatment facilities
 - Encourage local innovations and development of 'bottom- top' community intervention strategies to improve land use practices
 - Awareness strategies for water conservation. Educating citizens on depleting soil and water resources
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