सत्यमेव जयते

National Mission for Clean Ganga
Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Government of India

SAMARTH GANGA

ARTH GANGA FRAMEWORK AND ITS APPLICATION– CASE STUDY OF BULANDSHAHR DISTRICT

DECEMBER 2021

cGanga
Centre for Ganga River Basin Management and Studies

National Mission for Clean Ganga (NMCG)

NMCG is the implementation wing of National Ganga Council which was setup in October 2016 under the River Ganga Authority order 2016. Initially NMCG was registered as a society on 12th August 2011 under the Societies Registration Act 1860. It acted as implementation arm of National Ganga River Basin Authority (NGRBA) which was constituted under the provisions of the Environment (Protection) Act (EPA) 1986. NGRBA has since been dissolved with effect from the 7th October 2016, consequent to constitution of National Council for Rejuvenation, Protection and Management of River Ganga (referred to as National Ganga Council).

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Centre for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this it is also responsible for introducing new technologies, innovations and solutions into India.

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Acknowledgment

This document is a collective effort of a number of experts, institutions and organisations, in particular MIs and PIs of cGanga, NMCG and Jal Shakti Ministry, GoI. Contributions to the photographs and images for this vision document by individuals are gratefully acknowledged.

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PREFACE

India's National River Ganga, whose basin holds more than 40% of India's population and which is revered by Indians since ancient times, has been a major focus of governmental action for decades. Ever since the Ganga Action Plan was launched in the 1980s, followed by the setting up of the National Mission for Clean Ganga (NMCG) in this millennium, billions of rupees have been spent in trying to restore River Ganga, that has been substantially impacted by anthropogenic actions, to its earlier wholesome state. The Ganga River Basin Management Plan (GRBMP) – submitted to the NMCG in the year 2015 by a Consortium of 7 IITs ("Indian Institute of Technology"s) – set a clear direction and action-framework for this purpose. But progress on its implementation was tardy, perhaps partly due to the fact river restoration and conservation are necessarily slow processes and warrant allocation of huge resources. Also, GRBMP recommendations were broad-based strategic measures to some extent.

In the above context, Hon'ble Prime Minister Shri Narendra Modi, in the National Ganga Council meeting held in December 2019, invoked the ancient term "Arth Ganga", and urged the Council to attempt to relate restoration and conservation of River Ganga to strengthen the Indian economy. Since then, the concept of Arth Ganga has stirred the minds of many national institutions/ agencies and individuals, and various attempts are being made to implement the idea in practice. Taking up the matter in full earnest, the weeklong 5th India Water Impact Summit (IWIS-2020), organised jointly by cGanga and NMCG in December 2020, was devoted to the theme of Arth Ganga, combining river restoration with national development. The Summit proved to be a milestone in the development of the Arth Ganga policy.

The extensive deliberations and brainstorming by scores of national and international delegates in IWIS-2020 threw up numerous ideas on the true meaning of "Arth Ganga" and its actualization by synchronizing developmental thrusts with the restoration and conservation of rivers and waterbodies. Sifting through the many ideas and issues that surfaced during IWIS-2020, and combining them with cGanga's own expertise and other national and international knowledge inputs, the "Arth Ganga Framework" has been formulated by cGanga to enable systematic and unfettered progress towards realizing the national goal of restoring and conserving our rivers and waterbodies conjointly with national development, which over time leads to "Samarth Ganga" – the Able Ganga that can not only sustain itself fully but also generate immense benefits for the nation. The present document is a methodical presentation of the "Arth Ganga Framework" applied to formulate a development-synchronized river basin management model for District Bulandshahr leading towards Samarth Ganga.

This document was prepared by cGanga with ideas and inputs from various stakeholders, experts, and governance agencies who gave their valuable inputs unreservedly on many aspects of this document. This document is, therefore, the outcome of a synergistic effort of cGanga with numerous other visionaries.

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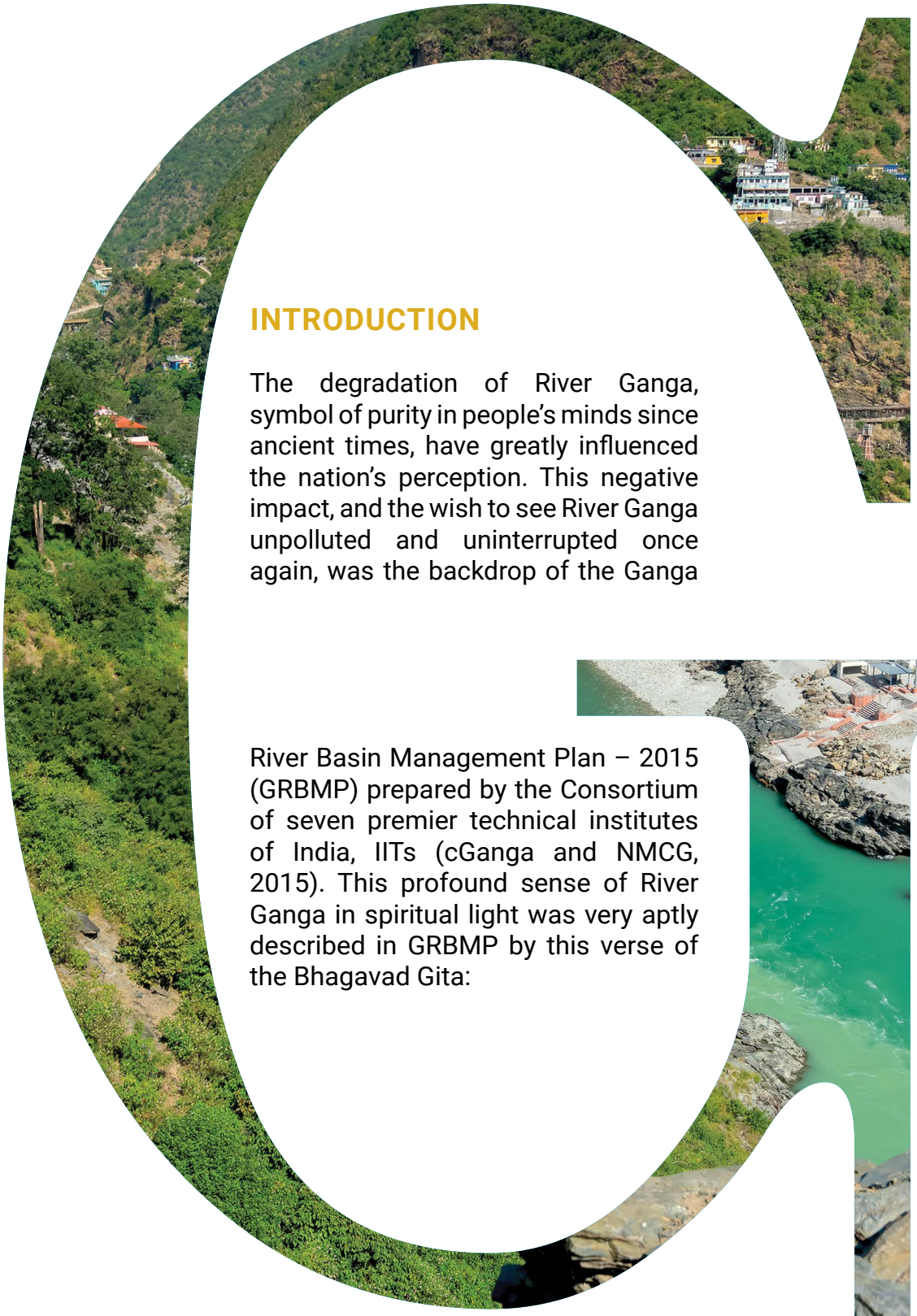


INTRODUCTION

The degradation of River Ganga, symbol of purity in people's minds since ancient times, have greatly influenced the nation's perception. This negative impact, and the wish to see River Ganga unpolluted and uninterrupted once again, was the backdrop of the Ganga

River Basin Management Plan – 2015 (GRBMP) prepared by the Consortium of seven premier technical institutes of India, IITs (cGanga and NMCG, 2015). This profound sense of River Ganga in spiritual light was very aptly described in GRBMP by this verse of the Bhagavad Gita:

पवनः पवतामस्मि रामः शस्त्रभृतामहम्।
झषाणां मकरश्चास्मि स्रोतसामस्मि जाह्नवी।।

“AMONG THINGS SACRED,
I AM THE WIND;
AMONG THE WIELDERS OF WEAPONS,
I AM RAMA;
AMONG AQUATIC CREATURES,
I AM THE CROCODILE;
AND AMONG RIVERS,
I AM GANGA.”

BHAGAVAD GITA, VERSE 31, CHAPTER 10

The inimitable qualities of the Ganga waters as recorded in ancient literature were also noted in GRBMP as follows:

अस्या जल्स्य गुणा: शीतत्वम्,स्वादुत्वम, स्वछत्वम,
अत्यन्तरूच्यत्वम्, पथ्तत्वम्, पावनत्वम्, पापहारित्वम्,
तृष्णामोहध्वंसत्वम्, दीपनत्वम, प्रज्ञाधारित्वंच, इति राजनिर्घण्ट:

The qualities of Ganga water are: Coolness, sweetness, transparency, high tonic property, wholesomeness, potability, ability to remove evils, ability to resuscitate from swoon caused by dehydration, digestive property, and ability to retain wisdom."

– Rajanirghanta (~300 AD)

The ancient scriptures not only describe the exemplary qualities of River Ganga, but also throw light on the sanctity of other rivers by referring to the physical form of bathing, which probably communicates to common people the then prevailing understanding of the effects and safety aspects of different rivers, thus:

त्रिभि: सारस्वतं तोयं सप्ताहेन तु यामुनम्।
सद्य: पुनाति गांगेयं दर्शनादेव नार्मदम्।।

Bathing for three days in River Saraswati, seven days in River Yamuna, and only one day in River Ganga bestows sacredness, but humans become sacred merely by the sight of River Narmada.

– Matsya Purana, 185/10-11]

It is also noteworthy that, in order to protect the quality of Ganga water from harmful anthropogenic effects, Sanskrit verses compiled from Brahmandapuram prohibit fourteen kinds of actions by humans in various prohibited activities while coming to or near the Ganges river: the following edict in Sanskrit, as compiled from Brahmandapuranam for various restricted activities by human beings while approaching river Ganga, prohibited fourteen types of actions: (1) defecation, (2) gargling, (3) shampooing (4) throwing of used religious offerings, (5) rubbing of filth, (6) flowing bodies (human or animal), (7) frolicking; (8) acceptance of donations; (9) obscenity; (10) considering other shrines to be superior, (11) praising other shrines, (12) discarding garments; (13) hurting anyone, and (14) making noise:

गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत्।
शौचमाचमनं सेकं निर्माल्यं मलघर्षणम्।
गात्रसंवाहनं क्रीडां प्रतिग्रहमथे ष्टतिम्।
अन्यतीर्थरतिचैव: अन्यतीर्थ प्रशंसनम्।
वस्त्रत्यागमथाघातं सन्तारंच विशेषत:।।

Ancient traditional knowledge such as that cited above, provided valuable insights and useful support to the deliberations that went into a scientific approach to Ganga River Restoration and Conservation. The conservation imperative was viewed in terms of the present-day need to revive the river to enable healthy progress of the nation. In other words, the development of the nation was implicit in the Plan, viewed as sustainable development. Or development that benefits both the nation (or society) and its ecosystems in the long run. This sense of sustainable development is also implicit in the notion of "Arth Ganga" voiced by our Prime Minister, Shri Narendra Modi, in the National Ganga Council meeting held in December 2019. It is worthwhile, therefore, to explore ways and means to develop and apply the concept of Arth Ganga in the context of "development with river conservation".

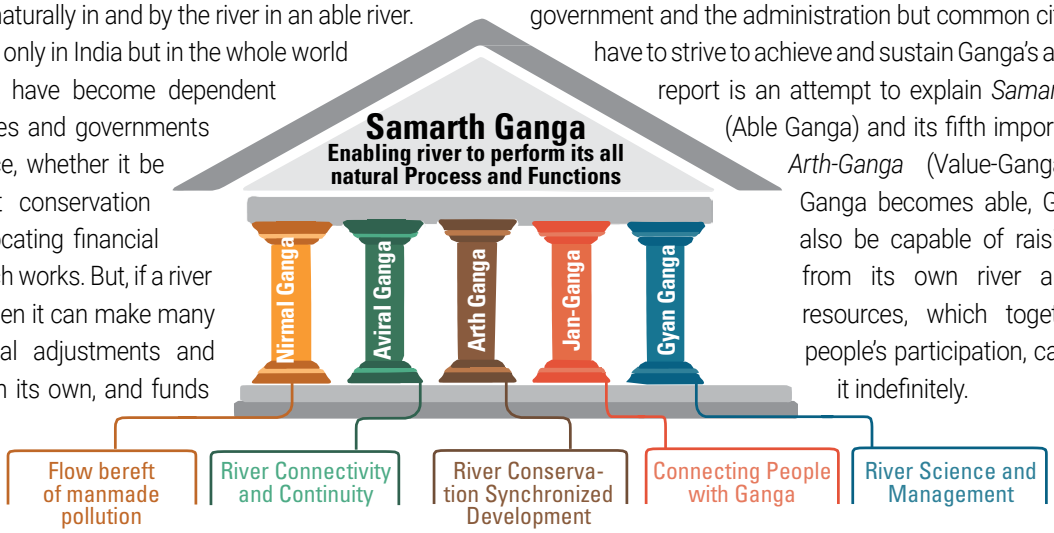
Samarth Ganga (Able Ganga)

King Bhagirath's determined efforts for the salvation of his ancestors led to the mighty Ganga's descent on earth – so it is believed. But the once formidable River Ganga's ability to perform its many valuable tasks in the basin has declined significantly in recent times due to a host of manmade reasons. Scientifically judged, the changes in the river have affected its flow capacity – whether of water or of silt/ sediments, the availability of essential elements and other conditions needed by riverine organisms, and its ability to absorb the surging volumes of water during heavy monsoon rains. Such deficiencies are, in fact, common for most rivers of our country.

For sustainable use and conservation of river resources, it must be understood that that rivers need to be restored close to their original or pristine conditions, because river processes and functions occur naturally in and by the river in an able river.

Today, it is not only in India but in the whole world that most rivers have become dependent on public attitudes and governments for their existence, whether it be for carrying out conservation works or for allocating financial resources for such works. But, if a river becomes able, then it can make many needed functional adjustments and improvements on its own, and funds can be used for various works needed to maintain sustainability of the basin. Hence, both from cultural and scientific points of view, definite measures should be taken to ensure that rivers can maintain their abilities.

We may consider five main pillars to be needed for Samarth Ganga. As shown in the following picture, these pillars are: (1) *Nirmal Ganga* (i.e. Unpolluted Ganga), (2) *Aviral Ganga* (i.e. Continuously Flowing Ganga), (3) *Ganga-Gyan* (i.e. Ganga Knowledge), (4) *Jan-Ganga* (i.e. People-Connected Ganga), and (5) *Arth-Ganga* (i.e. Value-Ganga). To make Ganga "*Samarth*", while it is necessary to make it unpolluted and continuously flowing, it is equally necessary to make people aware of both ancient knowledge and the latest science related to Ganga and other rivers. Because, in order to impart ability to Ganga to reinvigorate her, it is not only the government and the administration but common citizens too have to strive to achieve and sustain Ganga's ability. This report is an attempt to explain *Samarth Ganga* (Able Ganga) and its fifth important pillar, *Arth-Ganga* (Value-Ganga). Once Ganga becomes able, Ganga will also be capable of raising funds from its own river and basin resources, which together with people's participation, can sustain it indefinitely.



2. Arth Ganga: The Concept

2.1 Arth Ganga

Arth Ganga signifies the overall valuation of a river, that is the river's tangible values – physical or economic (goods such as water, sediment, nutrients, biodiversity, etc., and services such as flood drainage, navigation, etc.) and intangible values (unquantifiable benefits such as aesthetic, mystical, spiritual, and other timeless qualities). These tangible and intangible values together comprise the absolute value of the river – which reveals the true meaning of *Arth Ganga*. Among the above two types of values, only tangible values can be quantified in terms of human use or economics. It may be noted, however, that in their totality the *tangible values* are also a reflection of the *intangible values*; Any healthy river can have the highest levels of both tangible and intangible values, whereas when a river deteriorates both these values drop significantly. Thus, the tangible and intangible values are significantly related, and their maximum values cannot be achieved without river conservation.

The focus of deliberations on Arth Ganga in the 5th India Water Impact Summit (IWIS 2020) held in December 2020 was on tangible, economically quantifiable values of waterbodies of the Ganga Basin and other river basins. Additionally, emphasis was on discussing and understanding the implementation aspects of the concept of *Arth Ganga*, and communicate that understanding to all concerned.

To understand the importance of rivers and waterbodies in the above perspective some immediate questions naturally arise, viz.:

1. Is there any established method of economic valuation of goods and services (tangible value) received from all rivers and waterbodies in the Ganga River Basin area? If not, then how can this task be completed in a precise and scientific manner?
2. **(a)** How can the intangible values of rivers be estimated? Can this be done by taking advantage of the knowledge, wisdom and dialogue with masses of eminent artists (such as painters, writers and poets, playwrights, stage artists and movies), religious Gurus (teachers), and social elders and dignitaries?

(b) How can the share of intangible values be included in the evaluation of rivers and river conservation?

Figure 1: River Conservation and Development as Two Faces a Coin

2.2 River Conservation and Development

Anthropogenic activities in the Ganga River Basin – as well as other River Basins of India – have been changing gradually ever since industrialization began, and the changes have both accelerated and multiplied with India's rapid development. These changes have often had significant adverse effects on rivers and waterbodies, which vary in different parts of the basin depending on their biophysical environment and the nature of the activities carried out. The need to conserve our rivers and waterbodies is, therefore, essential both to sustain the pace of development and to maintain healthy river functioning to ensure their benefits stably over the long term. Thus, it is imperative that river conservation and development need to be seen as two faces of a coin, which is aptly and simply communicated by the phrase "Arth Ganga" as depicted in **Figure 1**.

2.3 Arth Ganga and Sustainable Conservation

There is an in-principle consensus on the need to conserve rivers. In such circumstances, the human and economic resources needed to conserve rivers must come from different sections of society. Evidently, unlimited resources cannot be spent unless comparable gains are achieved from river conservation. In other words, the value addition to society and the nation from investments in river conservation (in terms of economic gains) alone can make river conservation works sustainable and long-term. The practical meaning of Arth Ganga can be understood from this fact.

3. Arth-Ganga: Application of the concept

3.1 Important Developmental Activities

Rapid urbanization and human habitat development, hydropower projects, agriculture (including irrigation), engineering measures for flood control, tourism, and commercial river navigation are some of the modern human activities that affect river systems most. Due to non-integration of river conservation with these activities, the potential tangible and intangible values of the river systems have reduced. Most of these activities have not necessarily been evaluated in terms of their effects on rivers or river conservation, and therefore the extent of their impacts on rivers and waterbodies is uncertain (except for the impact of industrial pollution on waterbodies where some studies and estimates have been made). Keeping this in mind, the 5th India Water Impact Summit (IWIS-2020) was focused on synchronising these developmental activities with river conservation as depicted in **Figure 2**. Following the discussions in the Summit, the special issues which need to be resolved are as follows:

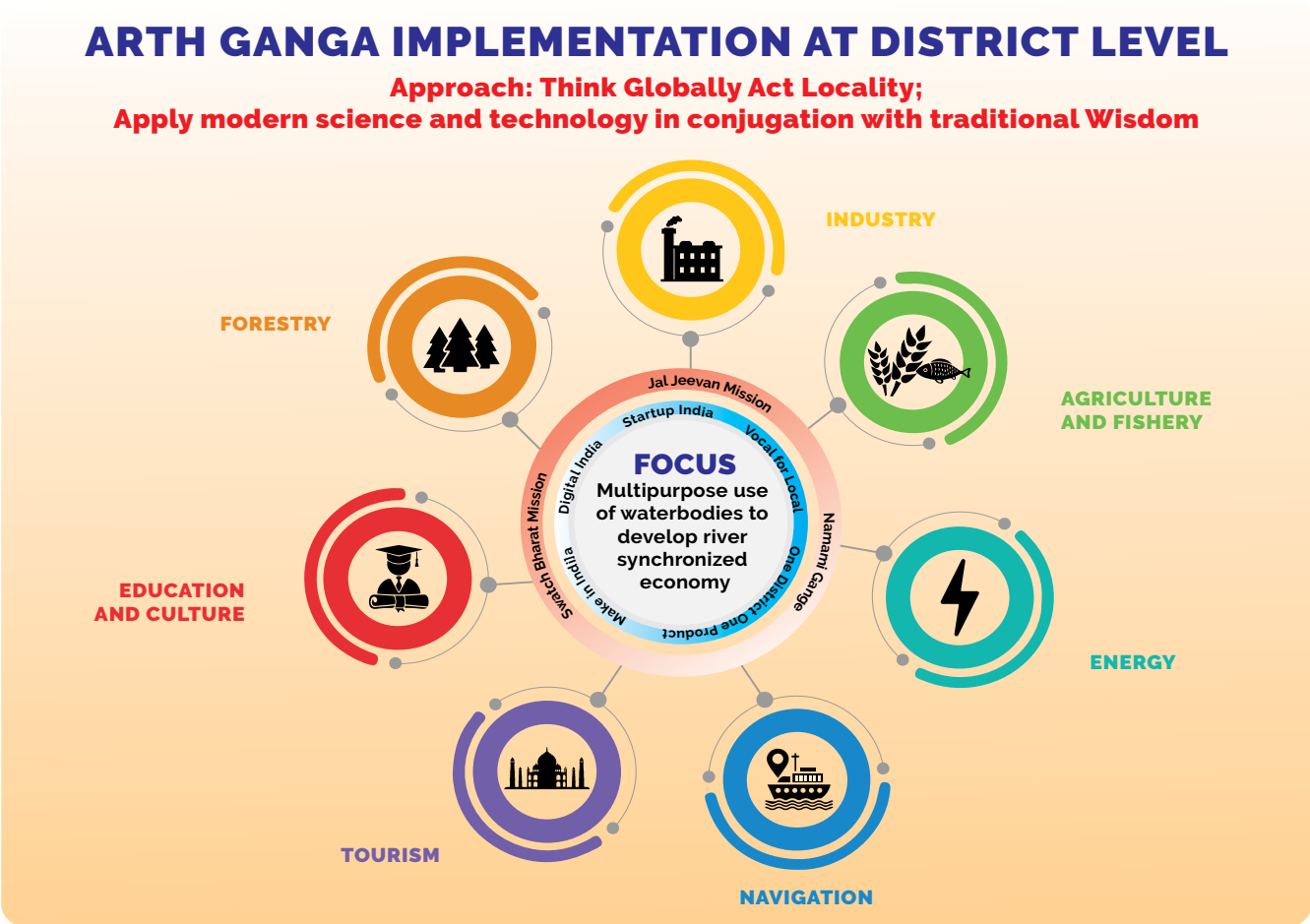


Figure 2: Arth Ganga concept realization from the development potential inherent in healthy river system through implementation across the geographical scale of district administrative boundaries.

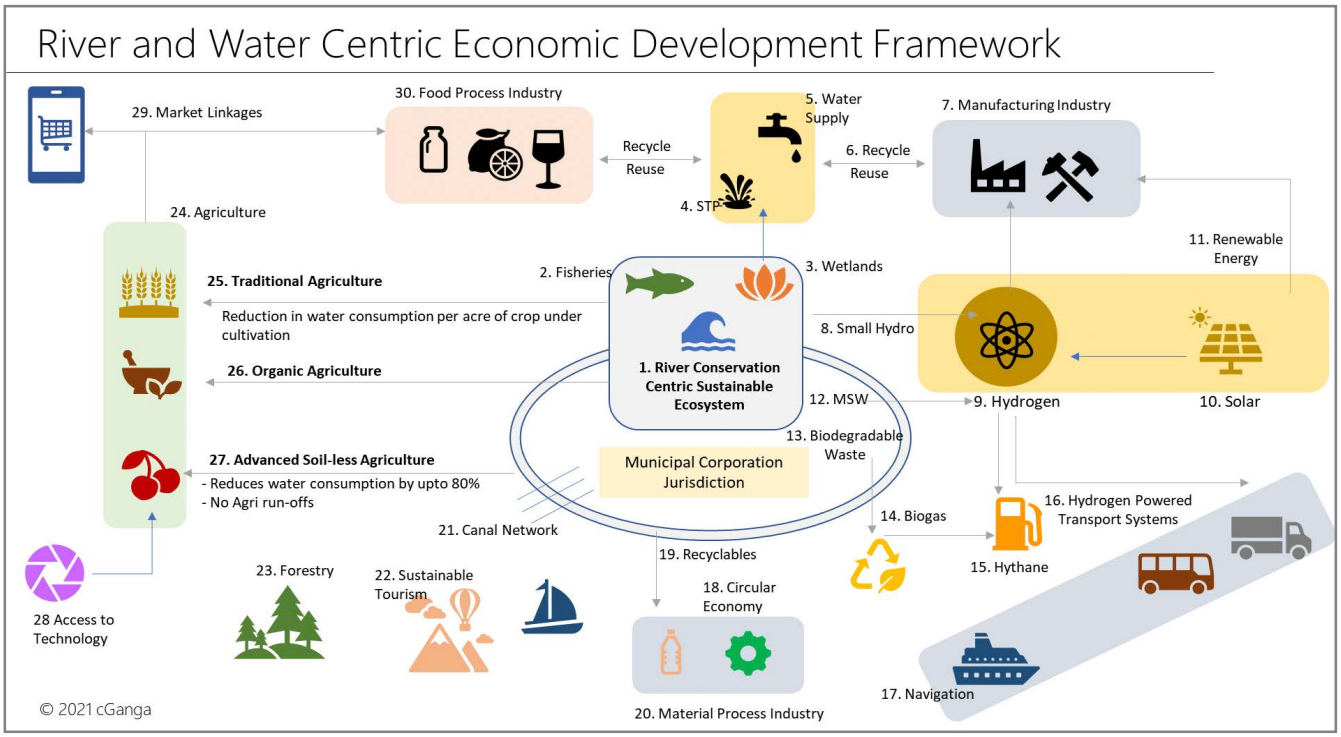


Figure 3: Elements of developmental activities included in river conservation.

1. *Identifying important development sectors in Ganga basin that are closely linked to river conservation and river values.*
2. *Identifying alternative developmental options for each of these sectors.*
3. *Identifying the linkages of developmental options with river conservation.*
4. *Identifying potential bottlenecks in adopting alternative developmental options in sync with river conservation.*

3.2 Goods and Services from Rivers

Many goods and services for human needs are available from healthy rivers such as water for domestic, institutional and industrial use, water and nutrients for agriculture, sand for construction, fish and other biotic products, navigation and transport, tourism, recreation, hydropower, drainage of flood waters from basin, groundwater recharge, aquatic, amphibian and avian biodiversity, rejuvenation of floodplains by periodic flooding, water purification, and waste removal. The economic value of such goods and services of rivers need to be quantified in order to make a judicious choice of developmental options. While economic valuation of these goods and services of river ecosystems is essential, until such valuation is done, provisional measures or qualitative assessment of their improvements/ depreciations need to be carried out from time to time to assess the overall progress in river conservation in keeping with the goal of Arth Ganga.

3.3 Whole River System

Due to intense developmental activities in their catchments, many small rivers and waterbodies of the Ganga river system have degraded or undergone very negative changes. These small rivers, in turn, have affected the larger rivers into which they flow, setting off a cascading effect for the entire river system. Hence, Arth Ganga's river conservation objective can only be achieved by a bottom-up approach of reviving and conserving small rivers and not vice versa of directly conserving the main-stem river. The conservation of small rivers and associated waterbodies will make it easier to conserve the main stem of the river. Integration of river conservation and development should therefore be coordinated at various geographical and administrative levels to conserve the entire river system. Various elements of developmental activities that need to be included in river conservation are schematically presented in **Figure 3**.

4. Water Management Framework

The term Arth in the concept of Arth-Ganga refers to the total (tangible and intangible) value of goods and services obtained from rivers, and Ganga represents all rivers. Now, in the context of river conservation, it is necessary to identify all water resources in the basin area that have an impact on the river directly or indirectly. To understand river conservation comprehensively, it is necessary to consider water movement across the boundary by means of which water flows in or out of a given area. If river restoration and conservation works are planned only within administrative boundaries, then water flows need to be considered across the administrative boundaries, which may not match with river basin boundaries. Instead, an administrative boundary may be only part of a large river basin or it may be the combined watershed areas of more than one small river.

Through the complete accounting of water within the administrative limits, information about its various uses can be compiled, which will help in making reliable estimates of the actual availability and status of water (water budget). If the amount of water coming and/or going from/to outside the administrative limits is estimated, as well as the amount of water needed for human use, then the actual water use, water demand and water availability will be known. In following subsections, an attempt has been made to present a framework to estimate the "actual water requirement" and availability for various human uses in an area.

The 'actual water requirement/ expenditure' refers to that part of water that goes out of its 'local cycle' either naturally or through human use. However, this part of the water in some form can be helpful in completing the hydrological cycle elsewhere. Minus this water that has left, the remaining water will be 'Available Water' which can be used in different ways. To properly understand all these components of the hydrological cycle, it is necessary to prepare a water budget, by doing which water management can be strengthened at the local level.

4.1 Water Balance

Water balance refers to estimation of the overall status of water, so that the water inputs and outputs in a geographical area and water consumption/ use for various purposes can be correctly estimated. Through this method, the potential use can be balanced by making estimates about the water available in the water sources of the area. From basic principles (continuity equation), the water available within a given area is equal to the amount of water coming in minus the water going out of that area over a given time period. Among incoming and outgoing flows, surface water flows across geographical boundaries can be measured comparatively easily, but subsurface (mostly groundwater) flows across geographical boundaries are difficult to estimate. The components of water balance calculation are broadly as stated below.

Change in water storage = incoming water- outgoing water

4.1.1 Water Inputs

a) **Rain Water:** Rainfall is the most important and primary form of water inflow into the local water cycle. After reaching the land surface through the hydrological cycle, the water flows into various surface waterbodies

(or water sources) like ponds, rivers and lakes, where it serves the needs of different ecosystems. The rate of water storage in different waterbodies in any geographical area depends on the difference between the inflow and outflow rates of water in that area.

b) **Surface Flows (Rivers and Canals):** While rain water is the main source of water inflows, surface water flows can also bring water from one geographical area to another area. Rivers flowing in a geographical area bring water from upstream areas into downstream basin areas, which is/can be used by the latter areas. In this way, rivers in a geographical area can bring external water into the area and also convey the water received from rainfall in the area. Through canals, water is carried from one area to another by artificial routes. If canals end in a certain area, or if they pass through it, then they bring external water into the area, but if canals start from an area, then they send water out of the area.

c) **Sub-surface Flows:** If two regions are hydraulically connected through groundwater, some water may exit or enter the area through groundwater flow from another geographical area, feeding the water sources of the area that they enter. It is not necessary that such inflow/outflow in/from an area should always be in the same direction (inward/outward); it may change direction at different times of the year. Such flows can be approximately estimated according to the groundwater levels and hydro-geological characteristics of the two areas.

4.1.2 Water Outputs

Transpiration and evapotranspiration can be major forms of water losses in a given geographical area, although much depends on factors including temperature and humidity of that area. River or canal flows out of a geographical area should also be used in this calculation. Some small rivers and canals that originate from a geographical area may carry its water out of the area. By estimating the water flowing out of the area to another area, it should be plausible to assess water losses and include that in the area's water budget.

a) **Evaporation and Evapotranspiration:** In any small geographical area water vapor from the surfaces of waterbodies, water before or after use for various purposes, and water in the discharges of humans, other organisms and plants are lost into the atmosphere.

b) **Surface Flows (Streams and Canals):** Rivers bring water into an area and also remove water. Canals that abstract water from rivers may not affect the rainwater input into a particular geographical area, but canals that drain from lakes and ponds and go out of that area necessarily cause water loss in the area. It is necessary to note here that the number of such canals in India (from natural lakes or ponds) is very small, and so are the ones that are probably also of short length which do not flow very far from their point of origin. If a river originates

from an area, then it drains water out of the area.

c) **Sub-surface Flows:** As mentioned earlier, groundwater may be incoming or outgoing in an area at different times of the year, its flow direction depending on many factors. Groundwater is also an important part of the local water budget, but for the present calculation, considering its slow flow, the total groundwater flow may be considered to be negligible.

4.1.3 Water Storage

The difference between the quantum of water coming into an area from outside and that going out of the area over a certain time period is the change in water storage for that area. Such storage can be in surface waterbodies (manmade reservoirs, lakes, ponds, swamps, etc.) or in groundwater aquifers and soils. **Figure 4** illustrates the water inflows and outflows and storages in a given geographical area. Water in canals and rivers is constantly flowing, due to which they have not been considered as waterbody storage.

Figure 4: Depiction of various components to carry out water balance in a geographical area

Some of the assumptions and limitations of water budget and water storage in an area can be as follows:

1. In any area surface water may flow in or out by rivers, streams and canals, namely:
   - A river brings water from outside into a geographical area and flows out of the area again; in this case the water loss from the area can be calculated by measuring the water flow at both its entry and exit points in the area (water flowing out through the river).
   - If a river comes from outside and discharges into a surface waterbody or any other river of the area, then the inflowing water can be calculated by estimating the flow at the point of entry in its area.
   - If a river originates from a surface waterbody or from any major river of the area, then the outgoing water can be calculated by estimating the water flowing out from the area at its exit point.
2. It may be noted that aquifer boundaries seldom match with river basin boundaries, and hence flows into or out of river basins and groundwater bodies may not correlate. Since groundwater flows are relatively slow compared to surface flows (such as streamflow and surface runoff), change in groundwater storage over short periods have been ignored. Groundwater leakages have also been considered negligible in the calculation.
3. The water balance equation has been mainly computed as the difference between precipitation (as gain or input) and evaporation and transpiration (as loss or output) minus the storage (as surplus).

Figure 5 presents typical variation in some of the components of water balance computation for a given geographical area.

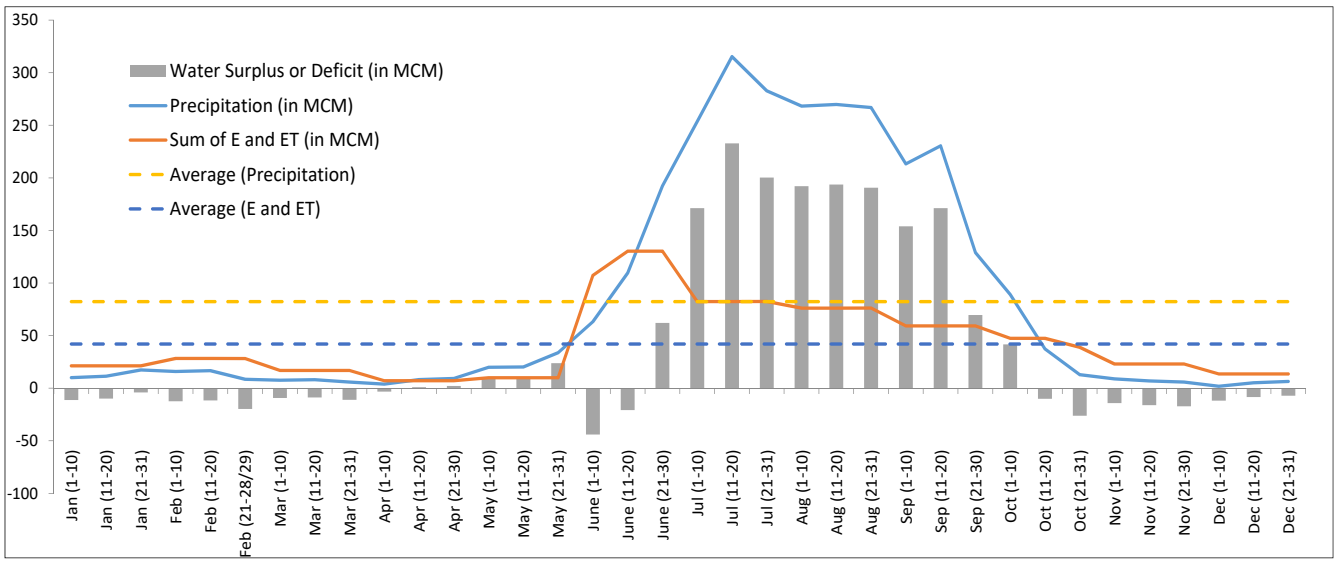


Figure 5: Typical variation in some of the components of water balance computation for a given geographical area

4.2 Water Bodies

Computation of water balance components for different waterbodies is essential for calculating the water budget of any region. These entities may be of the following types:

- **Rivers and Streams:** Rivers, whether they flow into an area from outside, originate in the area and flow out, or originate within the area and join any other water source of the area, estimation/ calculation of their water flows at different places is necessary. This will help in estimating the water budget correctly. First of all, the different types of rivers in the area need to be identified, after which their flow paths, sizes, types, their water uses for human and animal should be correctly estimated. As far as possible all this information should be preserved in a digital medium like GIS.
- **Canals:** Like rivers, it is necessary to study the water coming in through different types of canals, and its effects on those sources and their biodiversity. For water budget computations, information about water flows in the canals, their periods and different uses of the water in the area can prove helpful.
- **Surface Water Storage:** Information about the status of surface water storage, whether in natural or artificial reservoirs, sources, the water coming in every year, and the change in storage conditions with annual rainfall, etc., are essential for water budgeting. In any critical situation, this water storage is helpful in water supply, so it is necessary that its correct information is available so that its proper usage can be determined in keeping with various components in the water budget.
- **Groundwater:** Estimation of groundwater source and groundwater level, its lowest possible level in the year, possible level at the time of scanty rainfall, etc. – based on the available data and with actual measurements – should be used in the water budget computations as per needs.
- **Wetlands:** Wetlands and wetland ecosystems play a significant part in water and water budget, because while preparing water budget, not only the water availability for human use has to be considered, but it should also be combined with the water needs of aquatic life and other terrestrial organisms.

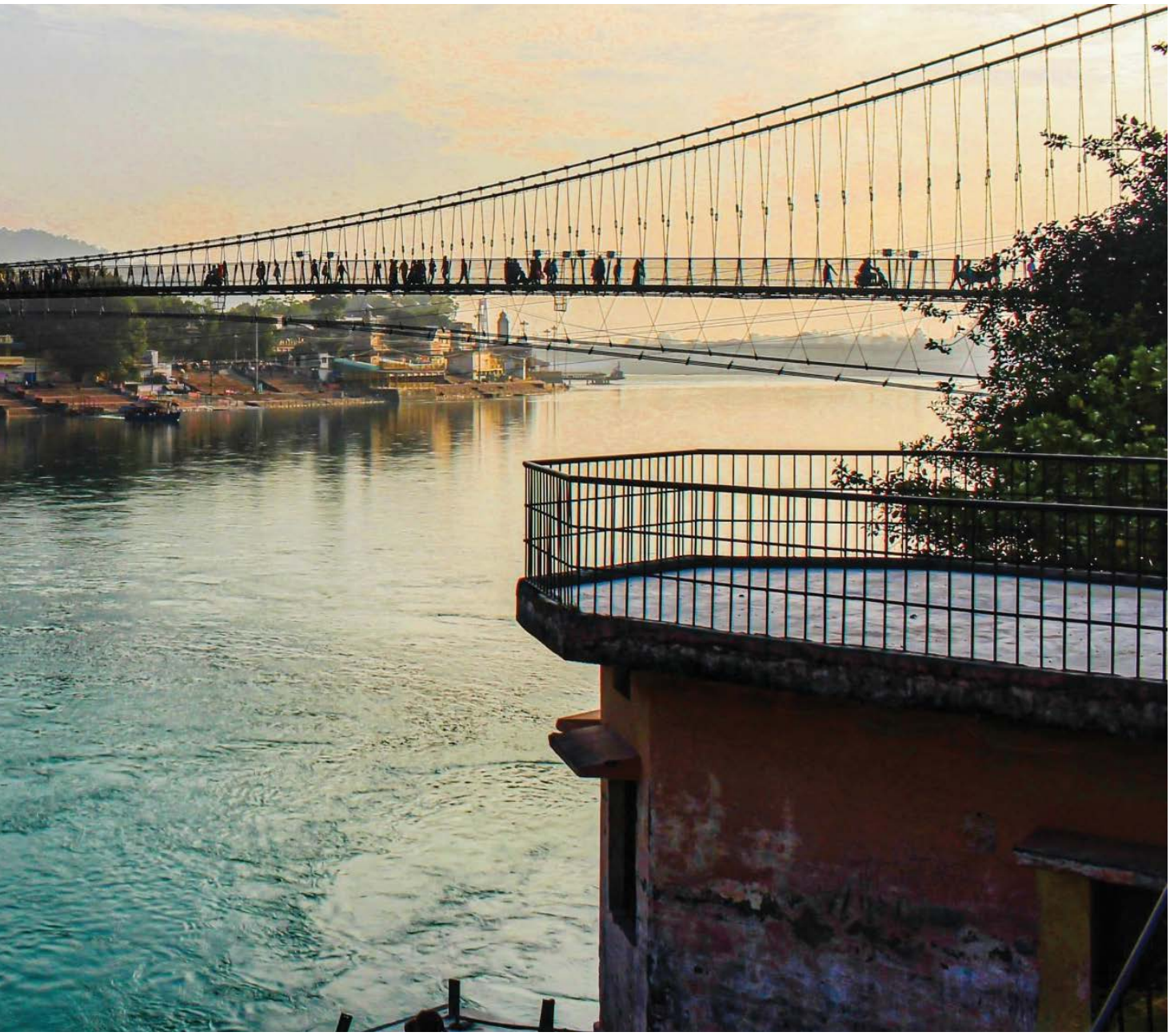
Through the above steps, correct information about the water status, usage and availability of water for other uses in all water sources of an area fulfils the needs for water budget. Proper maintenance of water resources is also very important and such information should also be compiled as much as possible. It is also very important to store all the information in a proper format in digital medium.

4.3 Water Resource Network

All waterbodies in a basin are hydrologically interconnected, and hence – in principle – they constitute a single water resource system or a water resource network. Each waterbody in the network has its own importance and functions, and it is necessary that the water status of the waterbodies in the network should be adequate for it to fulfil its natural functions which may have been otherwise affected by human actions. Hence, to ensure the water adequacy of the waterbodies, they should be interconnected as much as possible. Such interconnections of local waterbodies within a water resource system not only ensures healthy waterbodies but also enables their maximum anthropogenic use.

4.4 Water Quality and its Management

While calculating the local water budget, it is necessary to know the physical and chemical qualities of water along with the quantity of water, so that the available quantity of water of the right quality can be determined for use as per requirements. For example, it is not necessary that the quality of water used in agriculture and industry should also be the same as of potable water; in such a situation if the quantity of potable water available is limited, then such sources should be considered only for drinking water supplies, while comparatively low quality water can be used for other purposes. Similarly, if there be many sources of low quality water, then the quality of water can be made usable through proper treatment process as per requirements. Therefore, it is necessary that from time to time the water quality of various sources are assessed/ studied, directly or indirectly.



4.5 Aquatic Biodiversity: Monitoring and Upkeep

An indirect but useful estimation of water quality in waterbodies can be done on the basis of the population and status of aquatic organisms and micro-organisms in a waterbody. A flourishing biodiversity is necessarily an indication of the water quality being fit life. Hence the actual condition of any water source can be gauged from the status of aquatic organisms that populate it.

Thus, an indirect but useful assessment of a waterbody's water quality can be done through biomonitoring of the waterbody, and detailed biomonitoring can even indicate possible uses of the water such as for municipal water supplies, or for recreation, industrial or agricultural usages. Biomonitoring would also yield useful information on biodiversity resources of waterbodies and help in maximizing their benefits (e.g., optimum fishery production).

5. Closing the Loop at Appropriate Geographical Scale for Sustainable Development

Along with conservation of rivers and waterbodies, steady and sustainable development is possible only when the principles of symbiosis and participation are fully integrated. Just as every life has a cycle and during the completion of that cycle, the organism adapts and interacts with various other organisms, similarly the cycle of the elements of developmental activities is also completed when water conservation as well as economic growth through local employment are also integrated as much as possible. It is not possible to complete the cycle of all elements at the local level, but activities at the local level can play an important role in completing their cycle. Those activities whose loop cannot be closed locally can contribute to the next appropriate higher level of the cycle, thus completing the cycle on a larger scale. The continuity of this cycle becomes equally probable if any element/ component is likely to be completed at a short distance from the point of origin/ manufacture to the point of its maximum possible use. On this principle, efforts are being made in India like 'Make in India', 'Vocal for Local', and 'One District One Product'. Such possible cycle in water conservation is shown in the **Figure 6**:

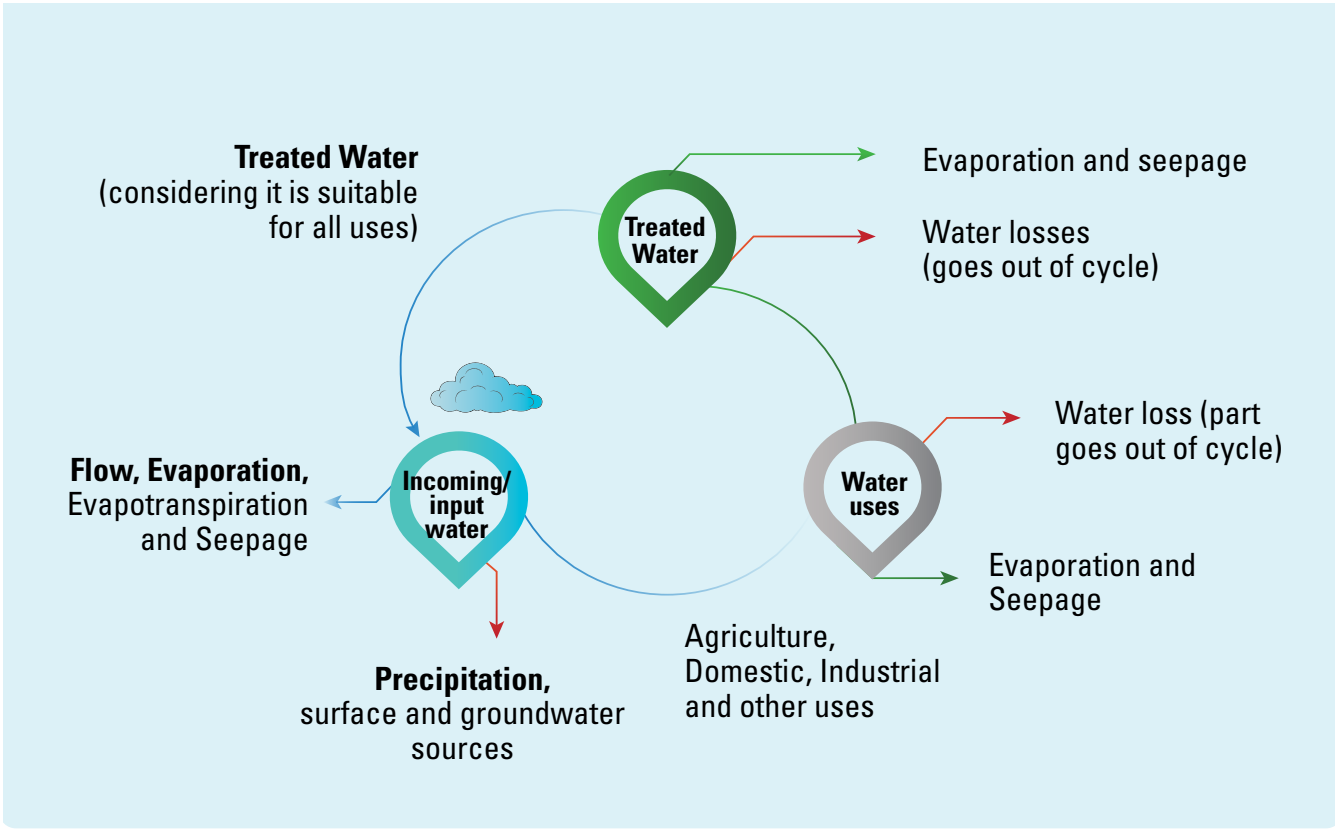


Figure 6: Local Water Cycle

As shown in the above example, the total utilization of treated water locally, and the part of used water that cannot be recycled as water again or that part is neither in the form of waste water nor evaporation and effluent need to be included to complete the water cycle in some form. At any local level, per capita water loss can be calculated by calculating the inflow of water at the local level and its drainage. This water loss can in reality be called the water requirement of that locality.

Just as some other cycles, such as purification, evaporation, emissions, agriculture and human use, etc., contribute to the completion of the water cycle, other cycles can also be completed at the local and regional levels. For example in solid waste management, the energy generated can be used domestically, commercially or in transportation. Efforts should be made to complete any cycle at the local level as much as possible; however, there may be instances in which the by-products or waste products in various cycles can play an important role in completing other cycles.

6. Creating an Enabling Environment

Governments and local administrations can make significant contributions to synchronize development with river conservation and execute projects on the ground for this purpose. The success of such efforts however depends also on the cooperation of stakeholders. Hence there is a need to create an enabling environment so that all stakeholders are readily co-opted and involved in these ventures. Some of the following steps may be considered to fulfil this task: -

6.1 Education and Culture

Ground-level knowledge of the people are vital in the diagnosis of any problem. Understanding of water and its related issues have existed in Indian culture since ancient times, but due to changes in cultures over time some important knowledge which are very relevant in present times have been neglected. Some such knowledge from traditional wisdom has been cited at the beginning of this document. In addition, there have been changes with changing times which may have been impractical to check immediately. To counter such adverse changes, the use of science and technology is necessary to reduce as much as possible the deterioration in the quality and quantity of water and its sources. As has also been mentioned in GRBMP, traditional knowledge (which is a part of culture) and modern science need to be combined harmoniously to advance in the field of rivers and water management. It is necessary that such traditional knowledge should be disseminated among common people so that they feel connected with Arth Ganga or similar other innovations in the water sector. Beneficial results can also be obtained by incorporating ancient knowledge in modern education system. Some of the following points in this sequence can be included in the action plan.

- At every stage of primary, secondary and higher education, water resource knowledge of the past, present and possible future situation should be introduced, water related problems, their causes and appropriate solutions should be explained to students based on practical knowledge. In this sequence, group discussions, debates, contests etc. among students can also be helpful.

- Historical/ archaeological knowledge related to water available at various sources should also be included in the syllabus (experimental/practical form) as far as possible.
- Students of appropriate levels should be involved in the monitoring of water resources. By doing this, their understanding of hydrology and related ecosystem will be increased.
- To explain various topics of water-related science, it should be demonstrated practically by visiting water sources. The cultural importance of water and rivers should be explained.
- It is necessary for all above-mentioned tasks that teachers should be educated and sensitized on the subject. Such institutions of the country, which have extensive knowledge and information about rivers and water, should provide the required help and guidance in this matter.

6.2 Social and political

In order to achieve the goals defined above, the contribution of social and political leadership is very important to promote and propagate essential education and culture. It should be the responsibility of religious leaders, politicians and other respected social leaders of the country that such policies can be made that create awareness of water conservation and conservation-synchronized development among the general public. Leading faith and social dignitaries, along with promoting these policies, should also contribute to the change in the policies as per appropriate suggestions received from the common citizen. The success of any society is based on mutual coordination, so understanding and explaining water-synchronized development can be done in a simple way with social and political support. Experiments such as local river basin management organizations

THE SUCCESS of any society is based on mutual coordination, so understanding and explaining water-synchronized development can be done in a simple way with social and political support.

and river/ water resource management suggested by cGanga may prove to be helpful in this. Apart from this, some of the following steps can also be of help.

- To explain to common citizens the possible direct and indirect effects of water on life. The severity of water crises can be explained by giving examples of tragedies like the Corona epidemic at the present time.
- Water budget should be made at the local level so that the priority of related works can be decided according to the existing hydrological situation from local to state and nation levels.
- Ensure participation of local people in any new water and river-related projects, not only to solve problems reliably but also to connect the local populace to their neighbouring waterbodies.
- Hydrological and cultural complexes and museums in every district should be built by connecting all religious leaders to it, and maximum possible information about regional water history and the current status of water and aquatic ecosystems can be shared with common citizens.
- Economic aspects related to water should be apprised through various means and possible employment opportunities should be increased in the water sector, which can prove helpful in water/ river-synchronised development.

6.3 Science and technology

With changing times, nature has also changed due to anthropogenic impacts, and scientific understanding needs to constantly increase to availing the multiple

THE NEED is to find optimal, new and comparatively best solutions and promoting them depending on the specific time, context and location.

benefits of nature continuously. At the same time, it is also important that our present understanding does not cause misfortune or problems for the future; hence pursuing evidence-based scientific knowledge and technology is necessary. In this context, cGanga also tries to use ancient concepts and understanding and traditional knowledge with in all its studies. In doing so, we can develop better technology with proper use of science which can be important in ensuring the sustainability of water-synchronized development. When developing and using technology, it must be kept in mind that all the important aspects of conservation and development have been thoroughly investigated and possible impacts have been well analyzed. This science and technology should be understandable and accessible to all stakeholders, which can also facilitate the way to achieve the goals of synchronizing development with river conservation. Some suggestions may be as follows:

- Balanced use of a combination of natural and modern scientific treatment processes – such as the four-stage treatment cycle suggested by cGanga – can effectively improve water treatment and reuse.
- Efforts should be made as much as possible to close the cycles of various water-related products at the local level, which is necessary for sustainable development.
- Water requirement, purification requirement and effective mechanism should be developed according to the water-impacting industries and water-dependent industries.
- There is a need to explain science to the common citizen by combining it with culture, ancient knowledge, social understanding and practical uses.

6.4 Recent and Best solutions

Grasping the meaning of Arth Ganga in its fullness, it is necessary to understand how the means to achieve it can be made smooth and continuous. For this, the need is to find optimal, new and comparatively best solutions and promoting them depending on the specific time, context and location. It is not always possible to have sustainable solutions only by finding a new solution, but if the solution is innovative and is superior to other available solutions, and it does not appear to have any possible side-effects, then the goal of Arth-Ganga can be achieved by making it sustainable. For this to happen, knowledge, science, culture and society – as well as regional economic aspects – should be considered as far as possible. At every level, whether it be local (urban or rural), state, or nation level administration, suitable solutions should be worked out only by comparative analysis.

- Individuals and institutions should be encouraged to find innovative solutions in the field of environment and water conservation.
- Impact of suggested solutions on water conservation/ purification and/or large-scale water requirements testing must be accepted.

6.5 Economic Framework

In designing the economic framework of an eco-system schematically illustrated in Figure 3, the policy must revolve around a single tenet, that is the value inherent in any eco-system is not unlimited and that when humans extract this value for consumptive

purposes or in a manner that compromises any intangible values, it cannot be done so using the zero-sum framework. Human gains cannot come at the expense of nature's loss. Thus, the overall economic framework must include the following key aspects:

- Defining and continuously evolving the finite capacity of goods and services that the eco-system can provide;
- Defining the scope and limits of economic development activities that can take-place in the eco-system;
- Defining how those activities will be governed, monitored, measured and approved;
- Defining how those activities will be funded including funding from public and private sources;
- Defining how the economic activities deriving benefits from the eco-system pay for ongoing maintenance and upkeep of the eco-system;
- And most importantly, defining the mechanism by which the funds generated for conservation must be channelled back into the eco-system for conservation purposes. The funds cannot and must not be pooled into a central melting pot to cross subsidise other activities.

Integrating a Sustainable Development Approach in Economic Development in and around Eco-Systems

Much of the demand on nature comes from eroding forest cover to make space for urbanization or industrialization. In the context of river systems, this leads to over-exploitation of surface and sub-surface waters as well as increased pollution loads entering the waters. It is a difficult balancing act for Governments to provide livelihood opportunities to communities living in rural or bio-diversity rich areas. Standard developmental practices have been linear in their approach almost always degrading the environment. However, with greater awareness, recognition and acceptance of environmental sustenance, the narrative to integrate Sustainable Development practices has never been stronger than it is now.

Implementation of such approaches must always be bottom up as local applications enable a faster roll-out and activation of a feedback loop. With time our collective knowledge of managing complex eco-systems will increase as we will be able to generate the necessary data which will provide the requisite evidence to support decision-making.

When designing the economic and financial framework, two key models can be used. These are:

a) **Consumptive Approach:** Any goods or services provided by the eco-system should be replenished and the cost to do so must be derived from a "consumption tariff" which may be derived via a number of instruments such as a fee, tax, cess or a capacity charge.

b) **Preservation Approach:** Provision of goods or services by eco-systems that are marked super-essential or critical must also be compensated for by a "preservation tariff" which again may be derived via specific instruments such as "preservation credits". These credits must be made available to local stakeholders such a communities and preservation authorities who may monetise the instruments to generate the necessary finance.

The following illustration (**Figure 7**) depicts stakeholder interaction as well as a range of financial instruments including preservation credits, impact bonds and standard equity/ debt mechanisms.

Introduction: Impact Bonds > Outcome Based Funding

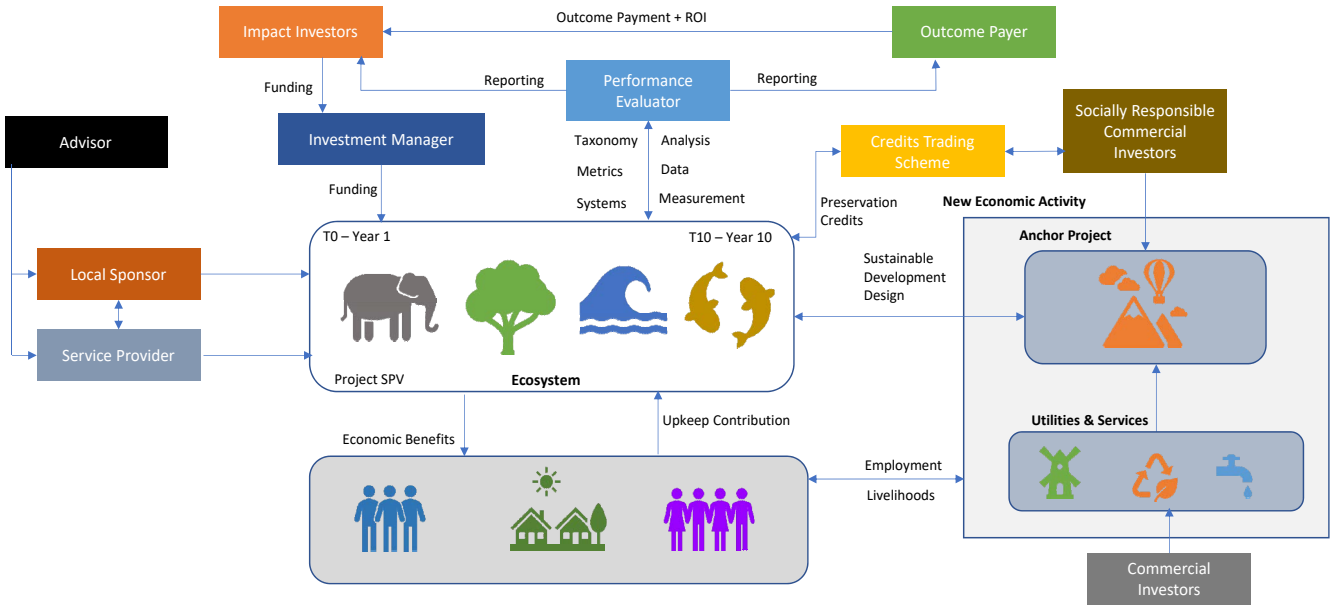


Figure 7: Schematic Representation of Stakeholder Interaction as well as a Range of Financial Instruments Including Preservation Credits, Impact Bonds and Standard Equity/Debt mechanisms

6.6 Financial Management

With the guiding economic framework in place, establishing the financing framework requires establishing a dedicated central authority that plays a dual role of a regulator as well as an economic development agency. This authority must be empowered with either a Central government backstop and/or an endowment fund that acts as a guarantor to enabling all downstream financing of projects.

On establishment of the guarantee-framework, the various instruments, platforms and structures that can be used to finance the projects are:

1. **Impact Bonds:** These will play the most significant role in eco-system financing in decades to come. Impact Bonds, particularly those that are outcome based, bring in a range of investors who are ready to provide necessary capital today for conservation or developmental activities. The investors are able to redeem these at the end of the term and receive a yield that provides financial as well as environmental returns.
2. **Pooled risk and financing facilities:** Building knowledge and critical mass of projects will only be possible for agencies that have large areas under their coverage. Smaller entities will struggle to find talent and attract large institutional investors who need minimum placement thresholds to make their investments. Thus pooling risks into aggregate vehicles will provide a vehicle that enables risk-issuers to tap into capital markets that provide cheaper financing. The pooled facility will also build knowhow over a period of time that will make implementing the financing structures progressively more efficient.
3. **Insurance and Guarantee wrappers:** For projects where revenue models aren't clearly defined or the benefits are more intangible in nature, establishment of insurance and guarantee instruments in form of wrappers or back-stops become

very critical. A strong government backing also sends a signal of commitment to market.

4. **Conservation Credits Trading Markets:** The most effective way to bring citizen and stakeholder participation is to establish a Credits trading market that enable holders of the instruments to monetise them via a variety of investors. Credits' schemes can be developed around whole eco-systems or narrow resource/area categories. Examples include:
   - Carbon Trading scheme for carbon sinks and other initiatives
   - Water Quality and Quantity trading schemes
   - Preservation credits trading schemes

5. **Waste Commodity Exchange:** A major downside of consumption is generation of immense volumes of waste that has been going to landfills or rivers/oceans in an unsustainable manner. The onset of circular economy models allows to accord an economic value to waste. Establishment of trading platforms will make the markets more efficient and transparent that support more capital investment that can go towards waste management industry.
6. And traditional debt and equity financing instruments that will support standard project activities.

6.7 Summary of Economic and Financial Framework: A 10-points Action Approach

1. All economic activity should be done keeping in mind river, water and eco-system conservation
2. Circular Economy Integral to the framework
3. Hydrogen and renewables become the central energy sources
4. Technology, Knowhow, Finance and Market-Linkages have to be delivered centrally
5. Anchor Economic Project with ancillary sub-projects
6. Incentivising water conservation through centralised trading credits
7. Harmonisation of policies
8. Data Driven monitoring and subsequent investment release
9. Integrating all government schemes
10. Innovative financial instruments

7. Involvement of Stakeholders in the Realization of Arth Ganga

7.1 Awareness Creation

The regeneration and conservation of rivers and waterbodies to avail their goods and services over time should be coordinated with India's developmental priorities and programs. Hence, the integration of river conservation with development is very important in India's governance policies. Such policies should not only be for the Central and State governments, but also to ensure meaningful participation of Local Governance Bodies, local communities and the common citizens to participate meaningfully in the work of river conservation, since they are all stakeholders of all rivers and waterbodies in different ways. As already mentioned in GRBMP, this work calls for raising the awareness of stakeholders.

7.2 Jurisdiction

After analyzing various points and possibilities in this document, it can be said that in order to achieve the goals and tasks outlined above in full, it is important to keep in mind that fundamentally new thinking in defining the national developmental journey. And the approach should be included so that the evaluation of environmental factors – that are often overlooked in long-term development – are also considered. For sustained development, the role of various stakeholders such as local body governments and even small stakeholders like common citizens – which till now have been only in terms of restrictions and controls – should also be included in policy formulation and planning. Since sensitization is meant to develop a passion for river conservation, all small and big stakeholders have to participate diligently in the same way as people looking after their own home gardens or voluntary work ("shramdaan") in public gardens. This requires that all small stakeholders be empowered. In other words, it may be said that the policies should be changed in such a way that there is decentralization of power with adequate empowerment and substantial participation in river conservation of stakeholders. It is only in this manner that the continuance of benefits derived from rivers and the realization of Arth Ganga in its full sense can be assured. An important question that needs to be addressed here is: How can various stakeholders be empowered to actively participate and cooperate in river conservation?

THE POLICIES should be changed in such a way that there is decentralization of power with adequate empowerment and substantial participation in river conservation of stakeholders. It is only in this manner that the continuance of benefits derived from rivers and the realization of Arth Ganga in its full sense can be assured.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8. Conclusion: Monitoring, Evaluation and Feedback to make Arth Ganga possible and sustainable

It is not always possible to define a clear path from the beginning. However, once a comprehensive framework of action has been established, barriers to progress in short-term and medium-term goals can be overcome at various stages through continuous monitoring, evaluation and feedback of the achievements and failures. When each development plan or initiative is coupled with such monitoring, evaluation and feedback mechanism by stakeholders,

achieving the goal of Arth Ganga will be early and certain.

In the above context, it is important to resolve some of the questions below:

1. What monitoring and evaluation mechanism should be adopted to develop the synchronization of development with river conservation?
2. What policies and programs should be adopted to integrate development with river conservation at national, state and local levels?

BULANDSHAHR

A CASE STUDY

Contributors

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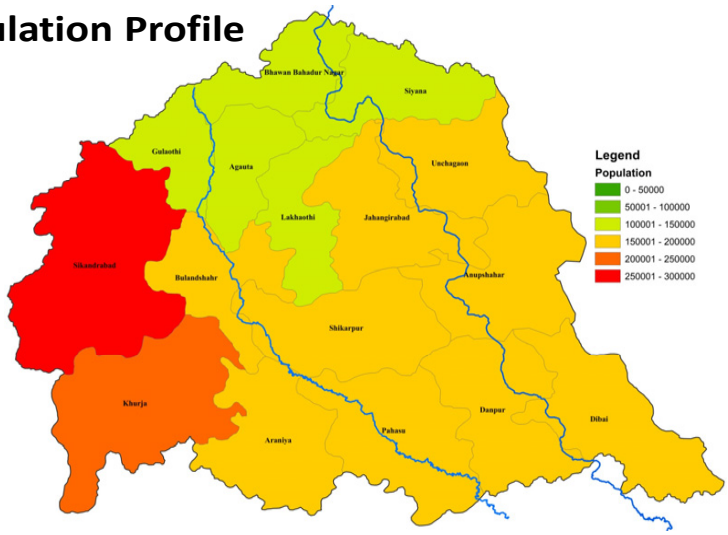
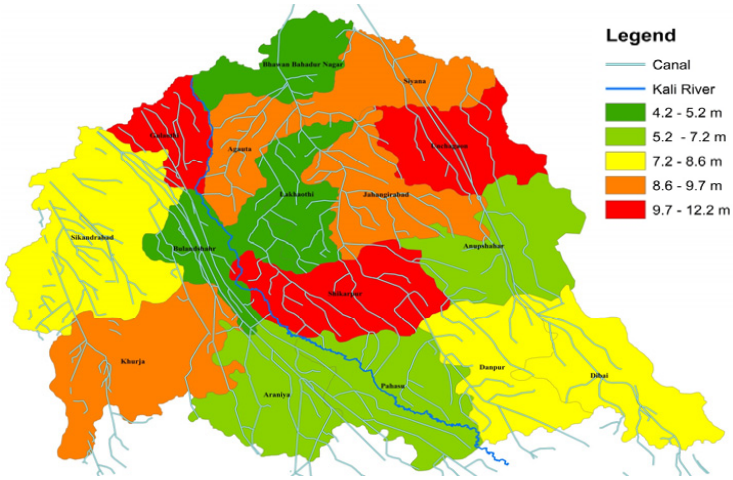
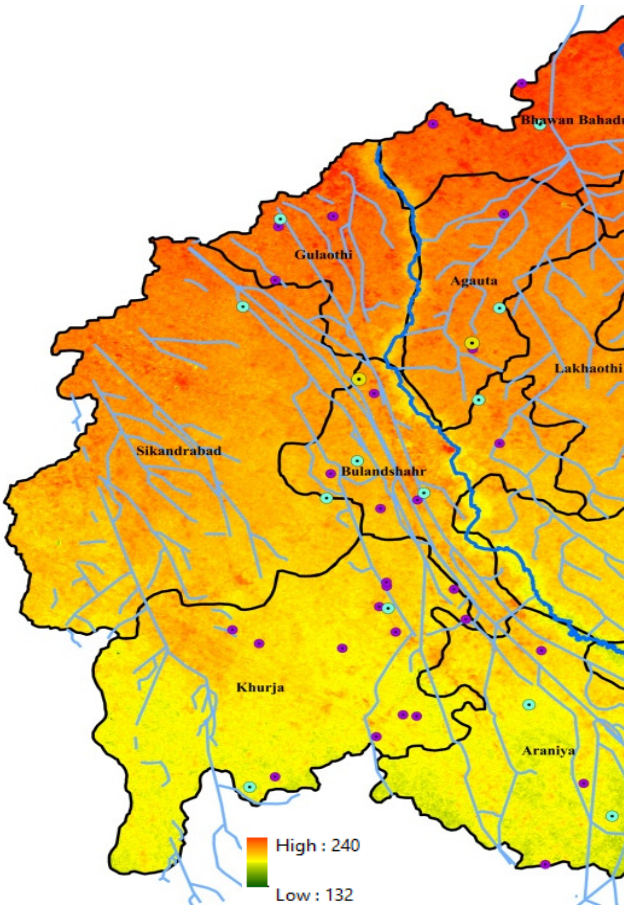
Population Profile



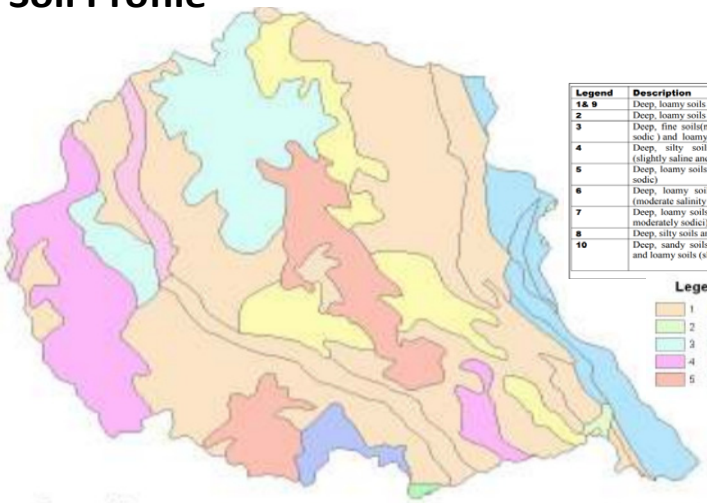
Bulandshahr

Ground water Profile





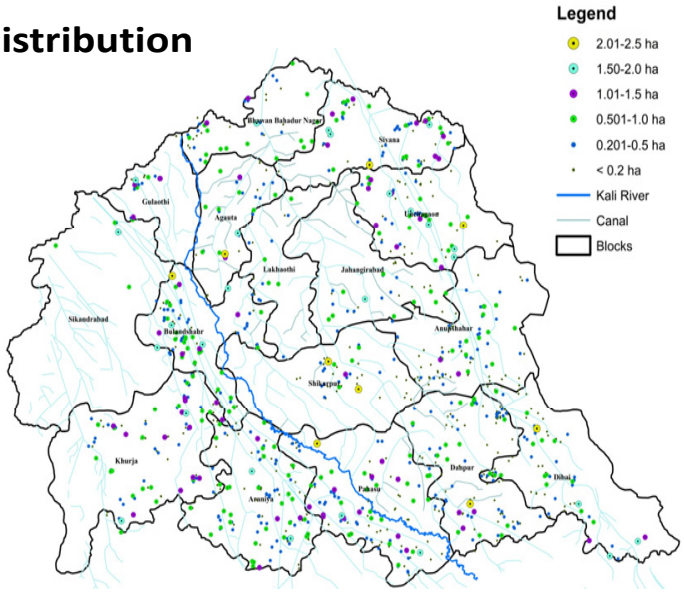
Soil Profile

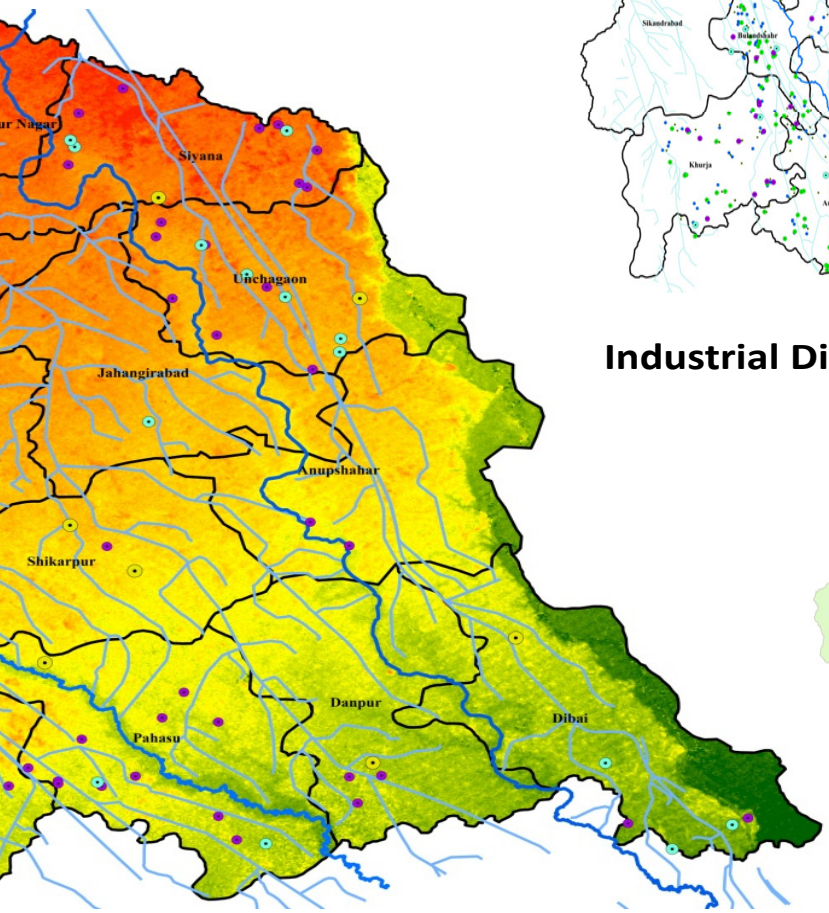


Legend	Description
1& 9	Deep, loamy soils
2	Deep, loamy soils and silty soils
3	Deep, fine soils(moderately saline and sodic) and loamy soils
4	Deep, silty soils and loamy soils (slightly saline and slightly sodic
5	Deep, loamy soils (moderate saline and sodic)
6	Deep, loamy soils and loamy soils (moderate salinity and sodicity).
7	Deep, loamy soils (slightly saline and moderately sodic) and silty soils
8	Deep, silty soils and fine soils
10	Deep, sandy soils (moderate flooding) and loamy soils (slight flooding)

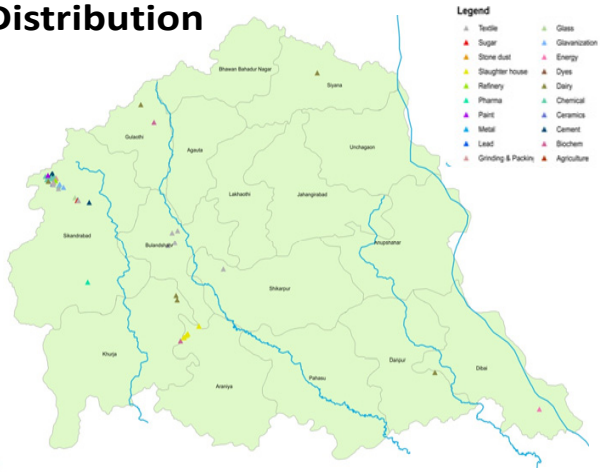
Legend
1 2 3 4 5 6 7 8 9 10

Water bodies Distribution

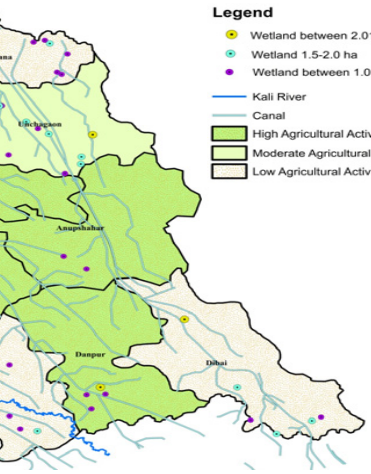


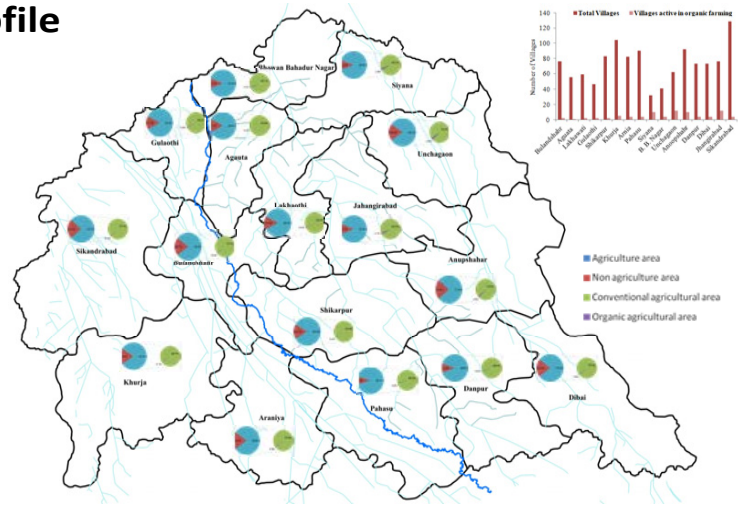


Industrial Distribution



Agriculture Profile





1.0 DISTRICT AT A GLANCE

Bulandshahr is one of the 75 districts of the state Uttar Pradesh located between 28.4° and 28.0° north latitudes and between 77.0° and 78.0° east longitudes under Meerut division. It lies in the upper doab region of the Ganga and Yamuna and shares its borders with the districts of Badaun, Moradabad, GautamBuddha Nagar, Meerut and Aligarh. It occupies ~1.48 percent of the total area of the state. The total population residing in the district is 3499171, during the year 2001-2011 with the growth rate of 13.03 percent for rural and 28.30 percent for urban area respectively (as per the provisional figures of Census India, 2011). The eastern boundary of the district is bordered by the mighty river Ganga. District economical potential is privileged through both agricultural and industrial activities. The major industrial activities flourishing in Sikandrabad and Khurja blocks. The detailed attributes of the district are illustrated in **Figure 1** and **Table 1.**

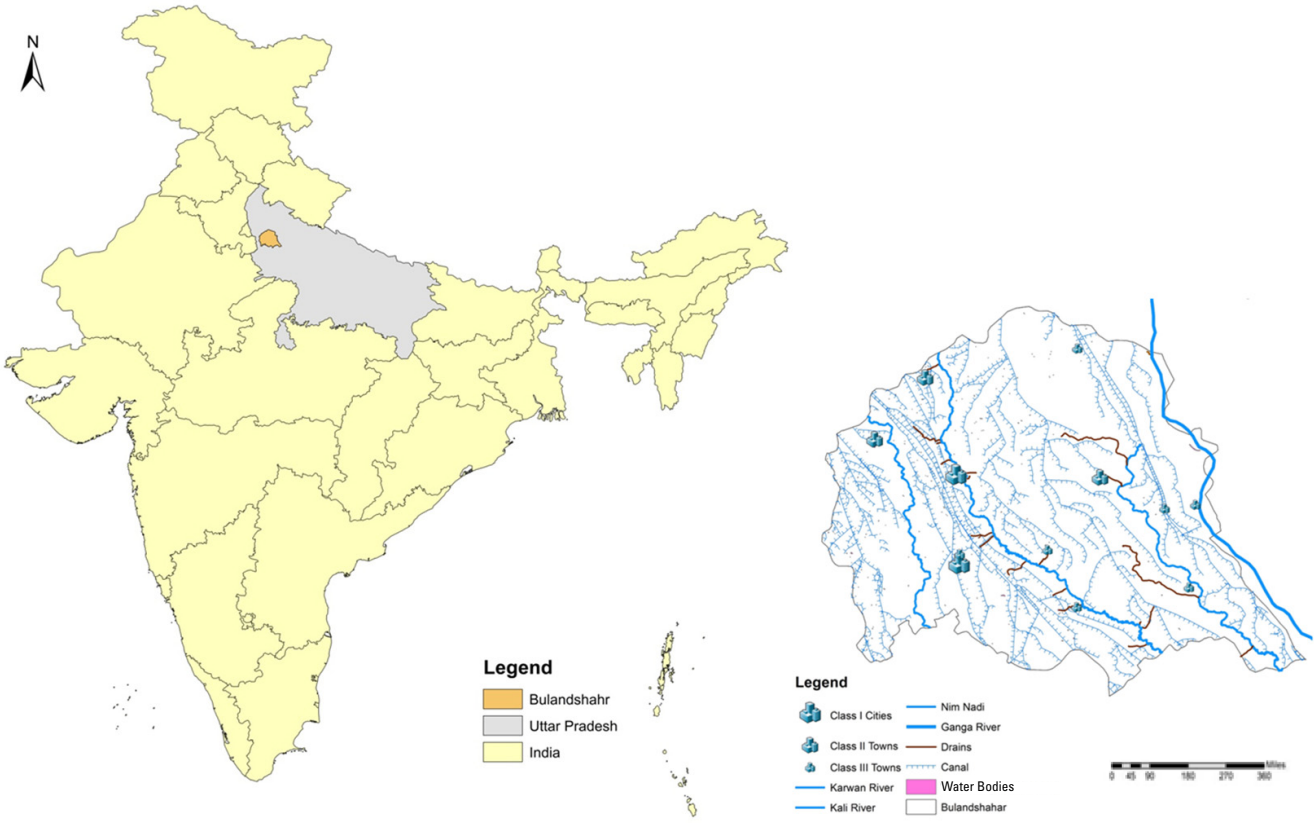


Figure 1: Bulandshahr district rivers, drain network, water bodies and major towns

Table 1: District attributes

Division	Meerut
Agro Climatic Zone (NARP)	Western plain zone
Total Area	4353 sq. km
Urban Area	122.8 sq. km
Rural Area	4230.2 sq. km
Population (Census of India 2011)	3499171
Population Density (Census of India 2011)	776 people per sq. km.
ODF Villages	1176
Total Villages	1246
Panchayat Samitis	5706
Ganga Grams	39
Class I, II and III Towns	2, 3 and 8
Blocks	16 (Bulandshahr, Agauta, Gulaothi, Lakhaoti, Sikandrabad, Khurja, Araniya, Anoopshahr, Jhangirabad, Shikarpur, Pahasu, Siyana, Unchagaon, B B Nagar, Dibai, Danpur)
Tehsils	7
Major Rivers	Ganga, Kali, Karwan, Nim
Agriculture Area	364974 ha
Canal Length	1880 km
Forest Area	7726.6 ha
Wetlands	3647
Climate	Sub-humid, dry atmosphere except during southwest monsoon season
Annual Rainfall (Yearly)	826 mm
Humidity	Mean monthly morning relative humidity: 65% Mean monthly evening relative humidity: 45%
Topography and Terrain	Monotonous plain with occurrence of sand dunes, sandy ridges and depression close to river Ganga; fertile cultivable soil expanses broken by barren flat expenses of user lands
Soil	All combination from pure sand to stiff clays; Loamy sand (78%), Sandy loam (17%), Sandy silt loam (5%); Younger and older alluvial sediments; Major soil types: Bhur, Matiar, Dumat, Kallor and Kemp

Source: Census (2011); DSRB (2019); NICRA (2012); District Bulandshahr web-portal: https://bulandshahar.nic.in/at-a-glance/

1.1 LAND USE AND LAND COVER TRANSFORMATIONS, LAND CAPABILITY, WATER NEXUS AND OTHER ATTRIBUTES

According to the land use data of National Remote Sensing Centre (NRSC), the total cultivable area and land under non-agricultural use in the district are ~90 percent and ~7 percent, respectively. The area under the wetlands and inland water bodies accounted for ~2.3 percent. The forest cover of the district is far less in comparison with the overall state forest area of 6.2 percent. Maximum forest area (~9.0 percent) is reported under Anoopshahr block due to the imposed conservation regulations under Ramsar convention. The barren and uncultivable land accounted for nearly 1.8 percent having either moderately saline and/ or sodic soil or facing moderate flooding. The land utilization pattern of the district is illustrated in **Figure 2**. Demographic changes, urbanization and anthropogenic activities are the potential drivers to change the land and water resources utilization at local and regional scale. The spatial population distribution in the district indicates that a large proportion is inhabited in Sikandrabad and Khurja blocks as they are located in close proximity to the Delhi NCR which provide a ready market available for consumption of products (refer: **Figure 3**).

DEMOGRAPHIC changes, urbanization and anthropogenic activities are the potential drivers to change the land and water resources utilization at local and regional scale

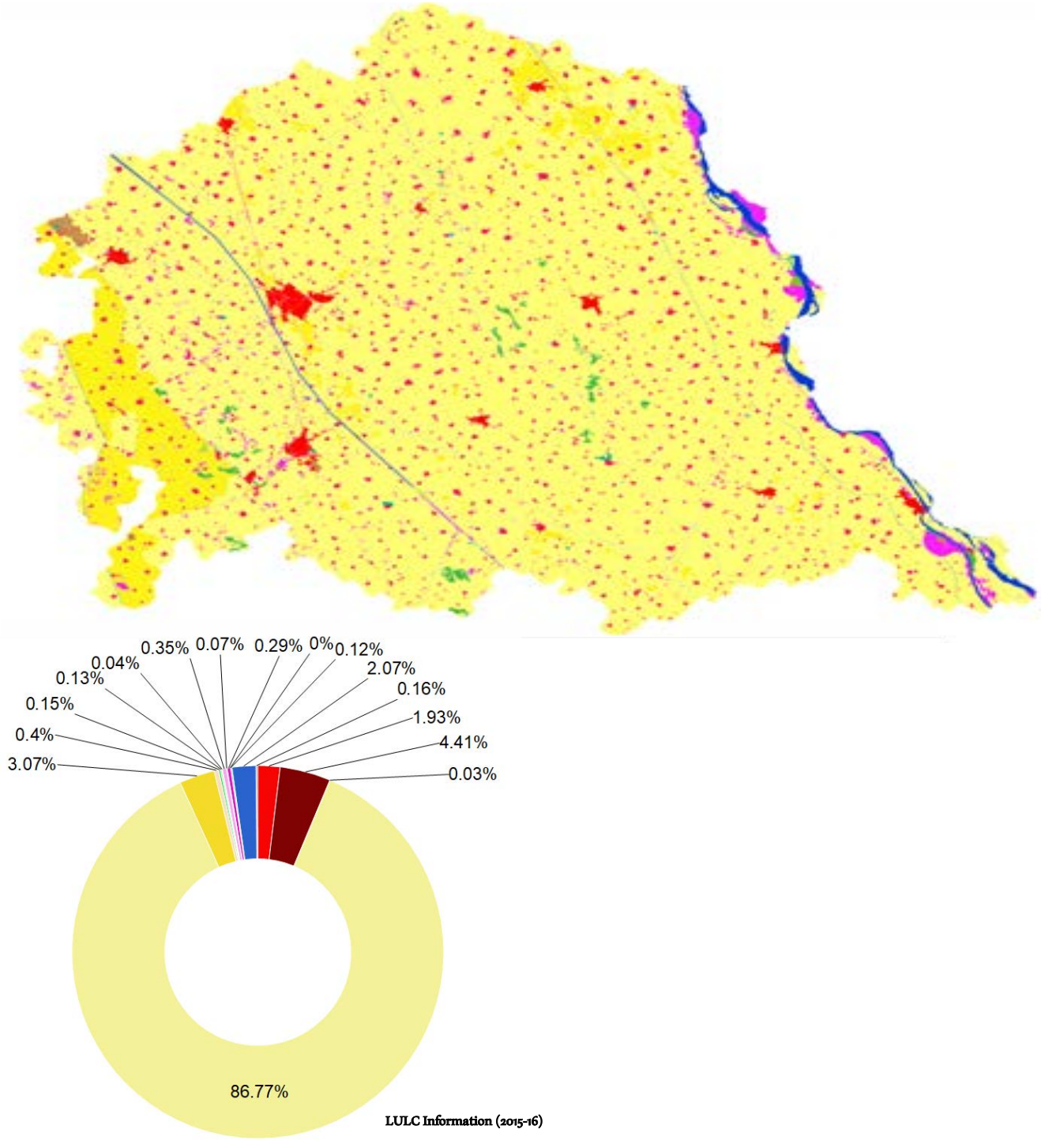


Figure 2: Land use land cover profile (Source: NRSC data, Resourcesat-2 LISS III, 2015-16)

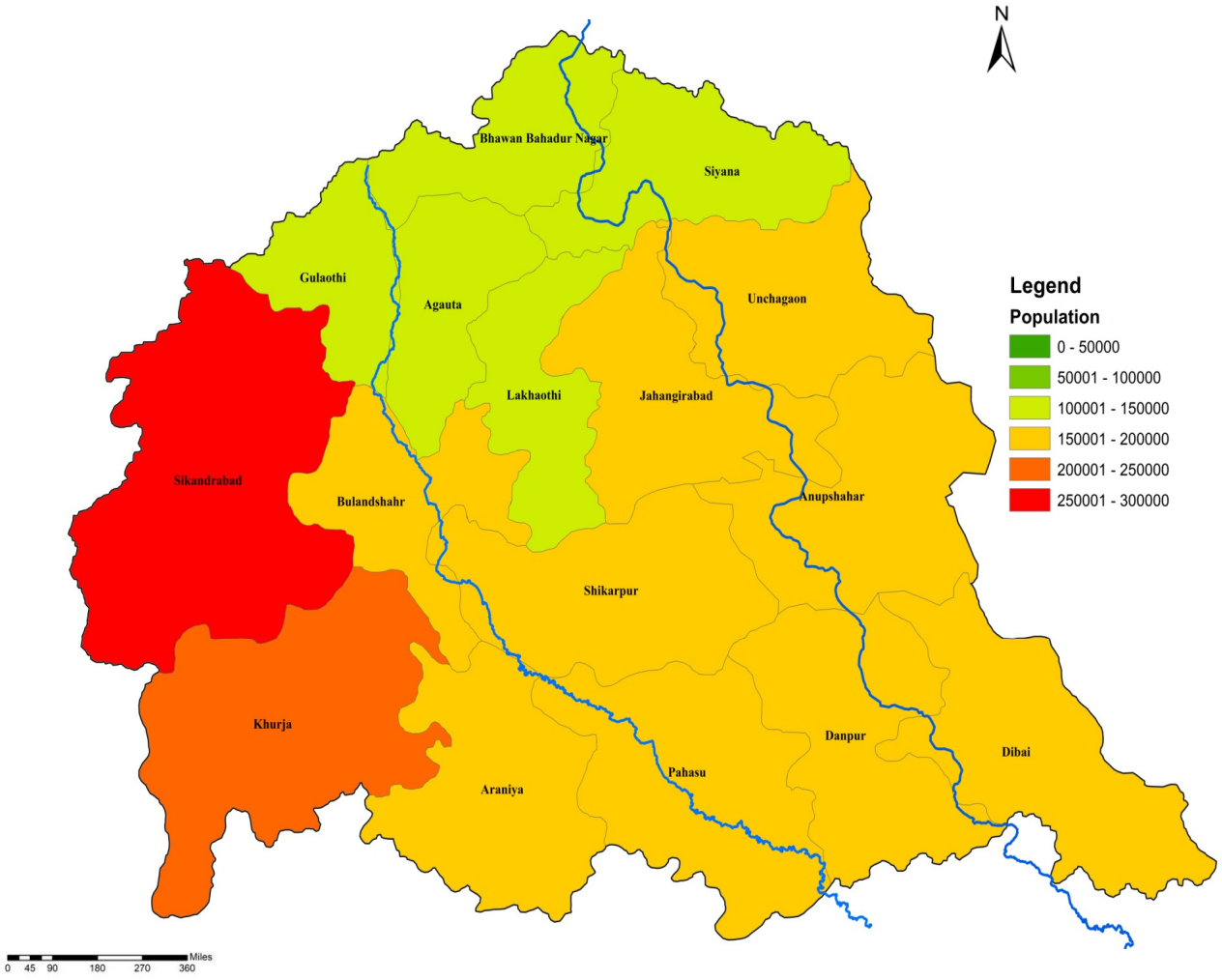
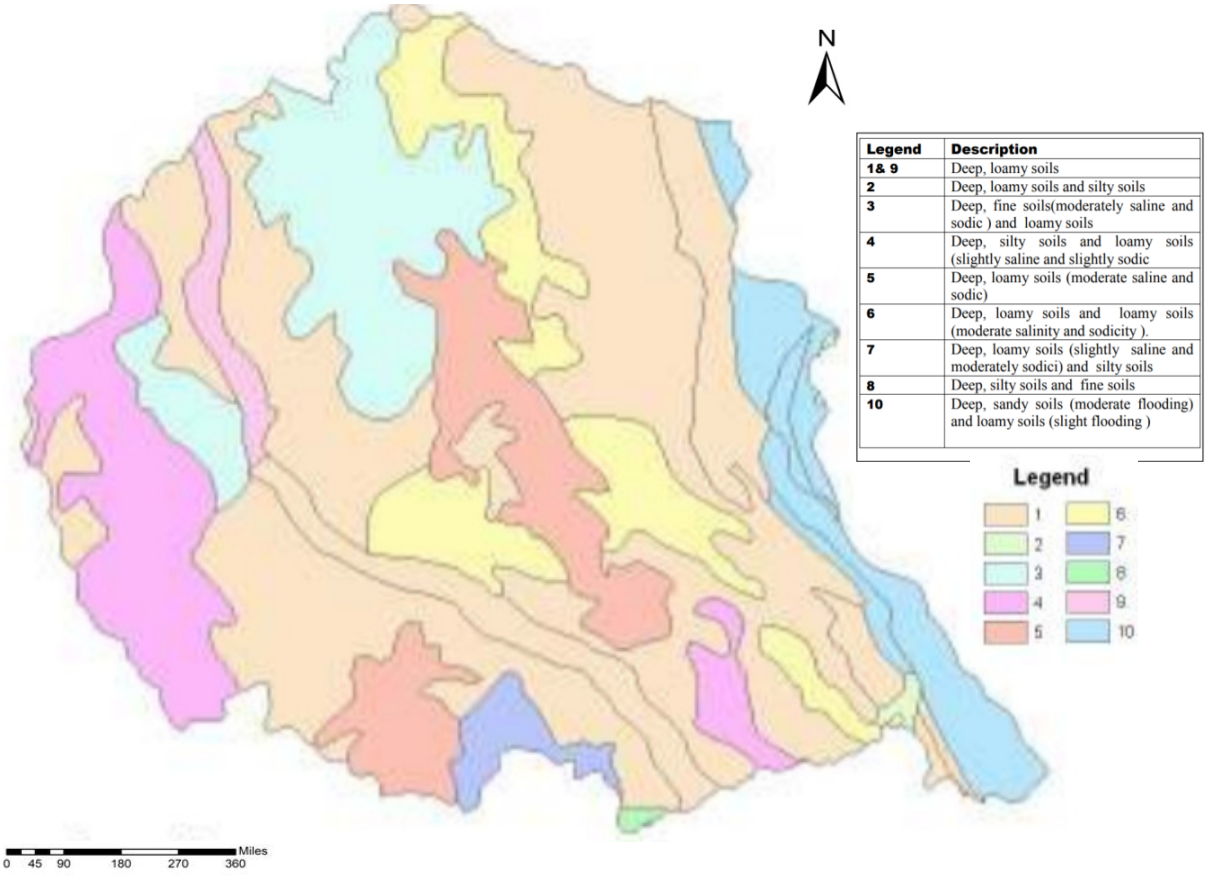


Figure 3: Demographic profile

THE CANAL network of 1880 km comprises main branches, distributaries and minors of Upper Ganga Canal and Middle Ganga Canal deliver water for irrigation, canal -based drinking water supply and for other miscellaneous usage

A variety of soils found in the district are the combination of pure sand to stiff clays. The major soil types are Bhur, Matiar, Dumat, Kallor and Kemp. Dumat is the soil having high agricultural productivity while Kallor is used to denote the patches with least agricultural potential (Bhartariya 2012). The areas prone to salinity and flooding in the district are shown in the soil profile map (refer: **Figure 4**).



Legend	Description
1& 9	Deep, loamy soils
2	Deep, loamy soils and silty soils
3	Deep, fine soils(moderately saline and sodic) and loamy soils
4	Deep, silty soils and loamy soils (slightly saline and slightly sodic
5	Deep, loamy soils (moderate saline and sodic)
6	Deep, loamy soils and loamy soils (moderate salinity and sodicity).
7	Deep, loamy soils (slightly saline and moderately sodici) and silty soils
8	Deep, silty soils and fine soils
10	Deep, sandy soils (moderate flooding) and loamy soils (slight flooding)

Figure 4: Soil profile (NICRA 2012)

The district falls in the doab of Ganga and Yamuna rivers (Ganga and Yamuna basin) and drained by rivers like Ganga, Kali, Karwan and Nim flow in SE course through the district. The river Ganga drained 27.9% of the total area of the district (DSRB 2019). The district is also blessed with 3647 wetlands of varying capacity which were identified in the major types as fish farms, tanks, ponds and reservoirs. A catalogue of 1263 traditional water bodies in the district were drawn by Division of Forest, Bulandshahr. The ponds of the district have maximum contribution towards fisheries production. The distribution of the ponds in different blocks of the district with their capacity is shown in **Figure 5**. The canal network of 1880 km comprises main branches, distributaries and minors of Upper Ganga Canal and Middle Ganga Canal deliver water for irrigation, canal -based drinking water supply and for other miscellaneous usage. The surplus monsoon water of the Ganga during Kharif is utilized in the two dry pockets between Anupshahr branch and Upper Ganga Canal and between Upper Ganga Canal and Karwan Nadi in the lower command of Upper Ganga Canal (refer: Planning Commission Report). A substantial amount of groundwater is contributed through the Upper Ganga Canal in the district (Bhartariya 2012).

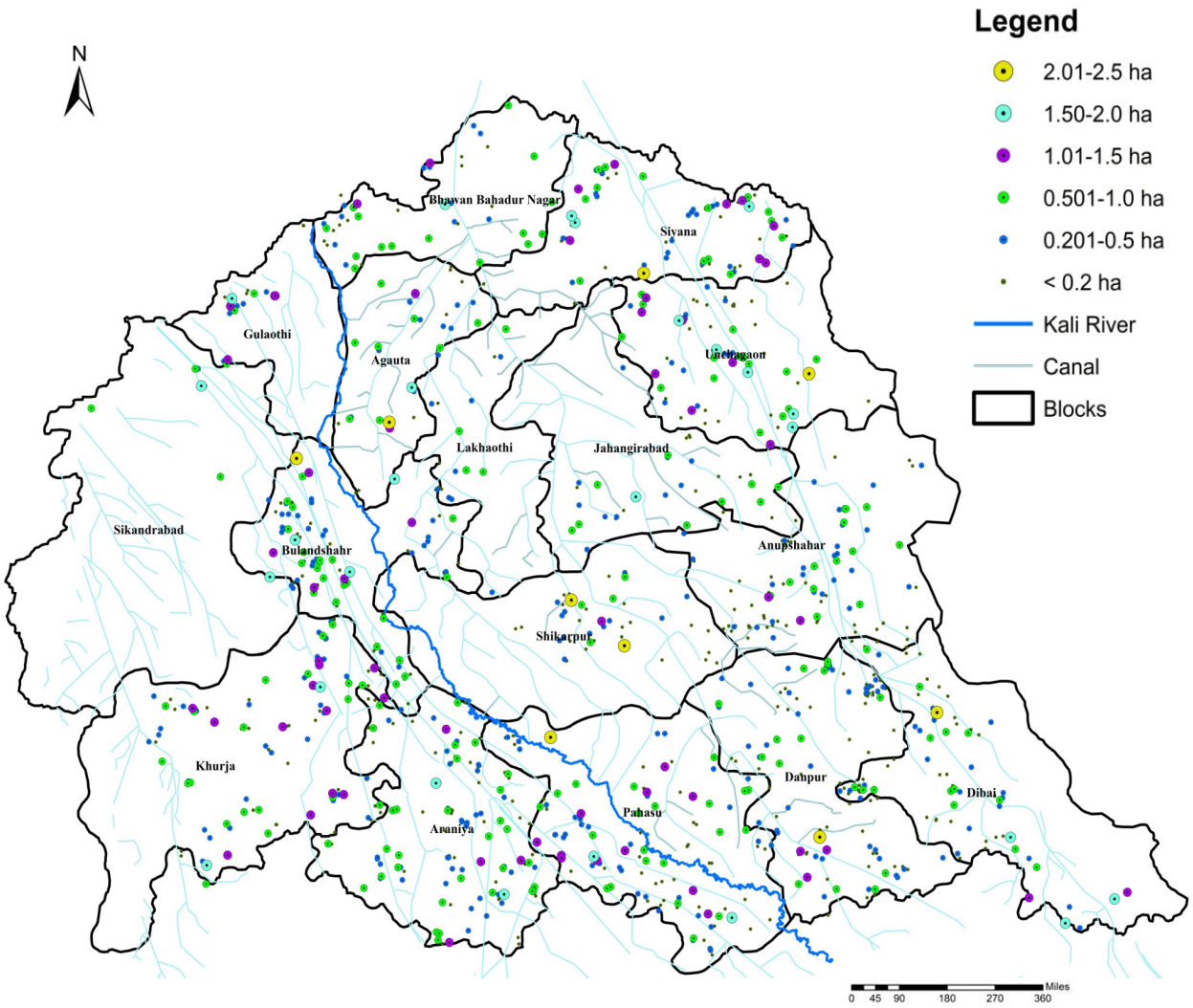


Figure 5: Distribution of wetlands and canal network

The scenario of ground water regime upto the year 2009 revealed that Gulaothi and Khurja blocks of the district fall under critical category while Agauta, BB Nagar, Pahasu and Sikandarbad blocks was categorized under semi-critical category (Bhartariya 2012). For preparation of maps and interpretation purpose, the depth to ground water data was categorized into various ranges beginning with 4.2 m. The depth to water level varies from 4.2 to 12.2 m in different blocks of the district (Bhartariya 2012). The similar seasonal groundwater level range was reported in the year 2015-16 on the basis of DWL (Depth to water level) data of ground water monitoring wells by Central Ground Water Board (CGWB) (CGWB 2016). Deeper groundwater levels ranging from 8.6 to 12.2 m were recorded for Agauta, Siyana, Gulaothi, Khurja, Jhangirabad, Shikarpur and Unchagaon blocks (refer: **Figure 6**). The DEM profile of the district for canal network and water bodies above 1 ha is shown in **Figure 7**.

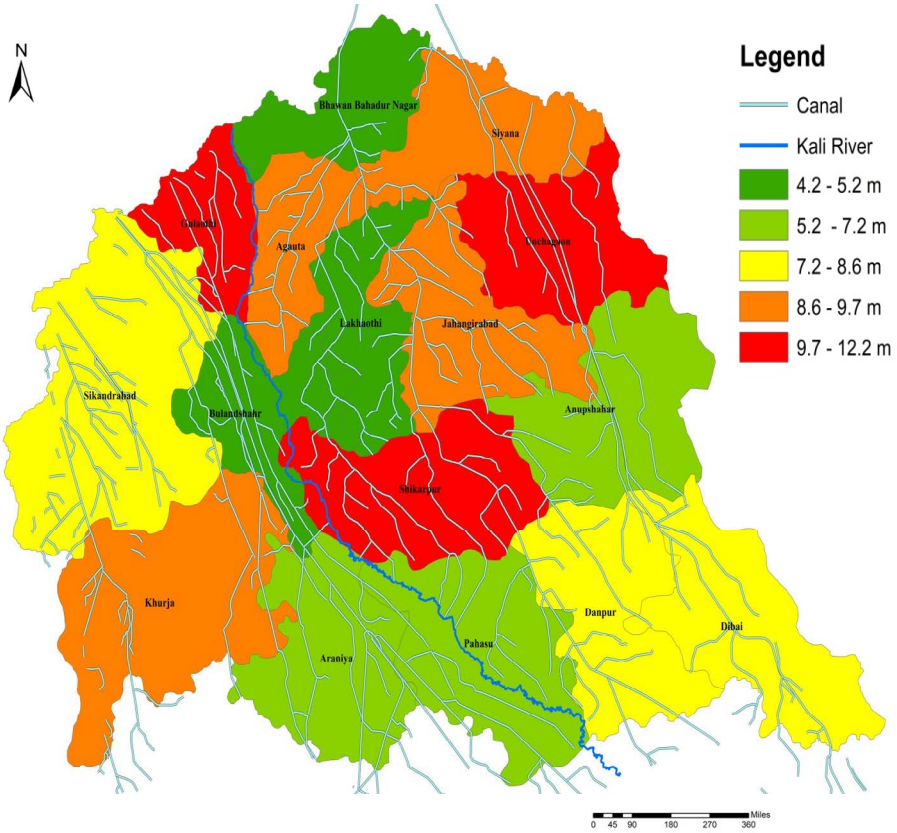


Figure 6: Ground water potential of Bulandshahr blocks

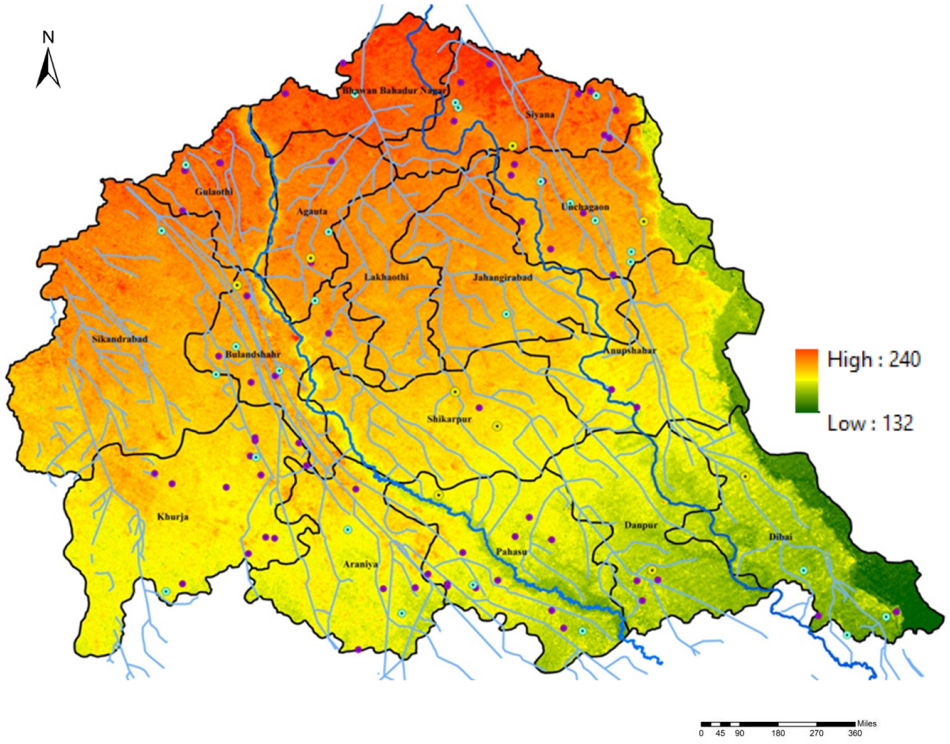


Figure 7: DEM profile with canal network and water bodies above 1 ha

2.0 ARTH GANGA APPLICATION: RIVER CONSERVATION SYNCHRONIZED DEVELOPMENT FOR "DISTRICT BULANDSHAHR"

"Arth Ganga" is, essentially the Meaning or Value of River Ganga or any other river. It is the total value of River Ganga or any other river or water bodies, that is the sum of the tangible and intangible values. The concept of Arth Ganga is explained above in detail in the section 2 "Arth Ganga: The Concept" (refer: Page 11). To understand the concept of Arth Ganga in totality, a deep insight on river centric major economic sectors linked directly or indirectly with water bodies in the district Bulandshahr and their status, developmental issues, gap analysis of available infrastructure with, planning and monitoring framework of each sector is illustrated through SWOT analysis in the subsequent sections of the document.

2A. WATER ASSOCIATED ECONOMIC ACTIVITIES

Bulandshahr has abundant natural resources and suitable agro-climatic conditions for agriculture, horticulture, and fisheries. Other important sectors linked directly and indirectly in support with the economics of the district are allied activities of agriculture, tourism, forests and forestry and industries. Understanding of interlinking of all these sectors are essential in framing policies for water resource management which ultimately provides a larger vision and purpose not only to river rejuvenation and conservation but also in the refurbishment of other water bodies in the district. Bulandshahr district administration has undertaken a series of initiatives aimed to improve the water status of the district under different sectors and proposed the diversified water linked investment proposals to central and state governmental agencies. Some of them under different sectors are listed in **Table 2**.

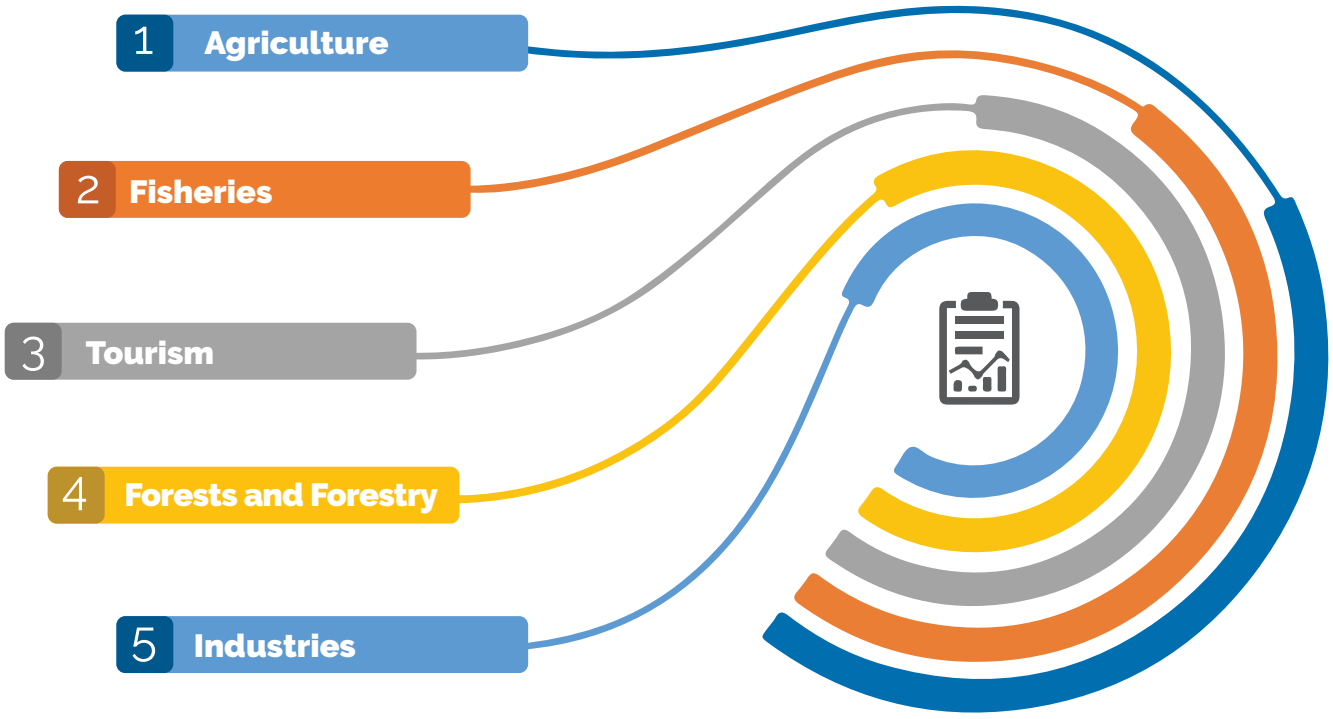
IMPORTANT sectors linked directly and indirectly in support with the economics of the district are allied activities of agriculture, tourism, forests and forestry and industries

Table 2*: Administrative initiatives under different sectors

Sector	Initiatives
Agriculture	Initiation of a program to give incentives to the people for agriculture diversification and sensitize the farmers for organic farming along the banks of the river
	To improve the agriculture economy with strategic diversification, the district started practicing diverse cropping, but happening in only ~8.2 percent of the agriculture area
	The district began to develop organic farming corridors in the area along the rivers covering 1605.9 ha fertile land of river Ganga
	To meet the organic manure requirement of the district, 3522 vermicomposting units were installed
Fisheries	Identification of the ponds/ lakes for aquaculture on the basis of the minimum standard requirement
	"Recirculating Aquaculture System" was initiated to promote aquaculture
	Under Blue Revolution scheme "Neel Kranti Mission". Four fish seed rearing units were established and 4.45 lakh fingerlings were distributed to the fishers
	Strengthen the fisheries sector under "Pradhan Mantri Matsya Sampada Yojana" a fish hatchery, fish feed mill, a fish feed plant, large and medium RAS (Recirculating Aquaculture Systems) and Biofloc systems were proposed
	Financial assistant and/or alternate livelihood assistance to the fishers in the lean season and/or fishing ban period under PMMSY scheme were proposed
Tourism	Proposals have submitted to state and central agencies to encourage the tourism activities along the river Ganga in the district: - Nature Trail Ahar in Ahar - Infrastructure development project at Anoopsahar and Karnvaas
	Proposal for "Common facility center in Ahar" has been submitted to NMCG for consideration
	Cultural calendar to restore the cultural identity of the district has been prepared on the basis of information collected from Gram Panchayat
Forests and Forestry	Proposal for Ramghat Biodiversity Park
	355 ha plantation area under Ganga Van
	Ganga upvan established at Karanwas
	Plantation at the bank (235.5 ha) under Namami Gange Program
	Ecotourism initiative through Ahar Nature Trail

*Based on the sectoral information shared through concern agencies/ departments

The status in brief for all the important sectors influencing the district economics are stated below:



2.1. AGRICULTURE SECTOR

STATUS

Agriculture potential of the district is dependent on frequent (economic viability, government policies, technology, etc.) and moderately (soil conditions, climate, water availability etc.) changing factors. Agricultural allied activities are the major driving force for the economic development of the district with 63 percent of the engaged population. Agriculture is also dominating in land use patterns in all the blocks of the district. The net cultivated area in the district is 297587 ha with cropping intensity of nearly 171.5 percent. The district has a net irrigated area accounting for 259269 ha. The canal irrigation and well irrigation constituted 59 percent and 7 percent of the total irrigated area, respectively (NICRA 2012). The agriculture area varies between 76.7 percent to 90.6 percent in different blocks of the district. The percentage agricultural area in Sikandrabad block (76.7 percent) is much lower than other blocks of the district due to their higher industrialization activities and lower number of wetlands. The agricultural attributes of the

district is compiled in **Table 3**.

The traditional cropping trend was in practice in the years before and mid of 2011-13 in most of the regions of the district with over more than 90 percent of the area in rabi season and kharif season accounts for foodgrain crops. The data revealed a shift in the trend of cultivation practices in the year 2018-20 as the area of foodgrain crops was shared with non-food grain crops. These non-food grain crops required comparatively less water demand than the traditional practices. In spite of the continuous efforts to increase the coverage area for non-food grain crops, the area is still negligible. Small and medium farmers of the region can't afford emerging technologies and they also not want to take the risk of the crop failure by growing alternative crops using alternative technologies. The villages under Siyana, Unchagaon, Anoopshahr and Jhangirabad blocks initiated organic farming in nearly 2.3 to 3.4 percent of their agriculture land (refer: **Figure 8**).

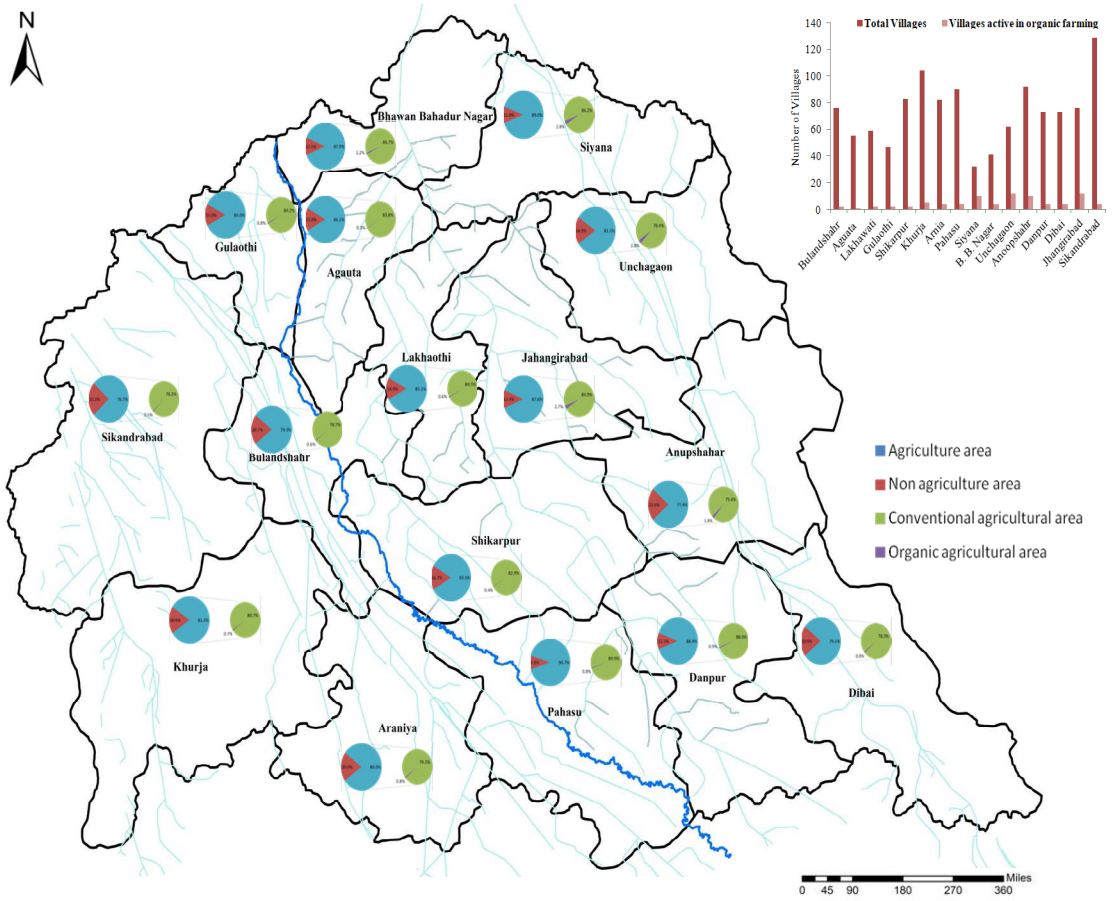


Figure 8: Agriculture area distribution, farming practices and villages under organic farming in different blocks

Wheat and rice are the two main foodgrain crops in Rabi and Kharif season, respectively. Barley and maize are the second principal crops in the respective seasons. An analysis shows that the productivity of agricultural commodities and other associated activities varies across different blocks within the district. The agricultural activities in the Jahangirabad, Anoopshahr, Shikarpur, Danpur and Gulaothi were evaluated higher in comparison with the other blocks based on the study conducted by Singh and Ashraf (2012) (refer: **Figure 9**).

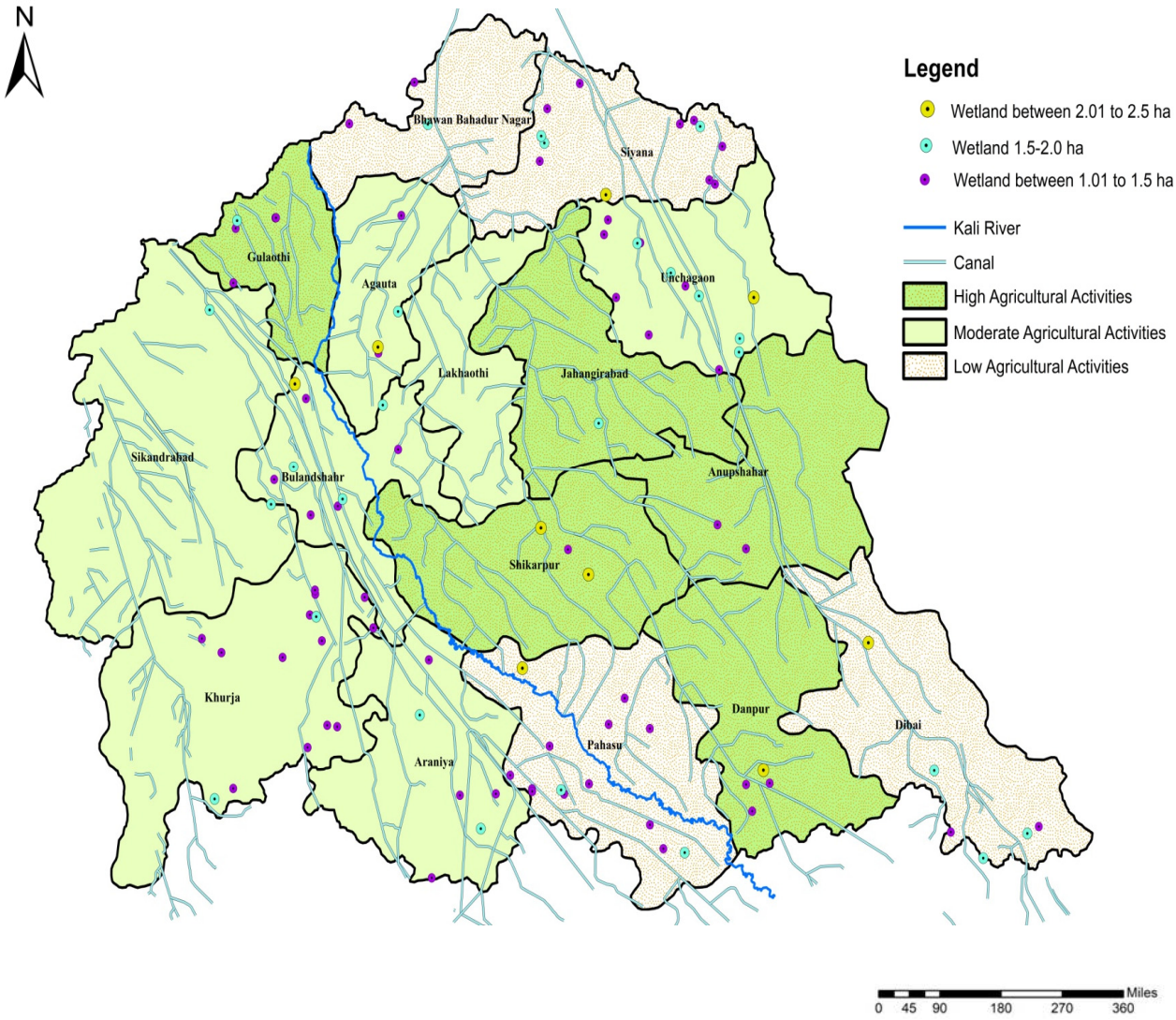


Figure 9: Agricultural activity profile of the district (Singh and Ashraf 2012)

Table 3: Agricultural attributes

Net Cultivated Area (ha)	297587
Net Irrigated Area (ha)	259269
Major Crops	Wheat, Rice, Maize
Number of Solar Pumps	705
Number of Bore well, Well, Tubewell	76754
Total Length of Canal (km)	1880
Total Canal Command Area (ha)	270155
Vermicompost Unit	3522
Agriculture Area Under Mixed Horticulture (ha)	30022
Agriculture Area Under Organic Farming (ha)	
▪ Namami Gange Programme	1700
▪ Private Ownership	2000
Dairy farms, Dairy farms Livestock, Employed People	154, 4725, 376

Source: NICRA (2012); shared information "District Agriculture Department, Bulandshahr 2021"

AGRICULTURAL allied activities are the major driving force for the economic development of the district with 63 percent of the engaged population

Development of Agriculture Associated Activities

S

- Bulandshahr district offers a very conductive soil and climate for agricultural activities with more than 80 percent land and 65 percent workforce allocation.
- The district comprises 16 blocks with heterogeneous resources that led to diverse agricultural performance.
- The district has very close proximity to national capital Delhi with 16 million population and provides a ready market for agricultural goods.
- District has an extensive irrigation canal network of 1880 km with 270155 ha canal command area.
- The district has 23 Farm Machinery Banks and 24 societies for crop residue management and 1 Krishi Vigyan Kendra associated with Sardar Vallabhbhai Patel University of Agriculture, Meerut for capacity and knowledge development of farmers.

W

- The total sodic land in the district is 15854 ha with limited yield potential.
- Framers practicing traditional cropping techniques and cultivate foodgrain crops using fertilizers and pesticides.
- The medium and small farmers neither afford the new technologies nor take risk of the crop failure in growing alternative crops using alternative/ latest methodology.
- 1880 km network of Canal used only as a water carrier.
- Low water use efficiency of the surface irrigation system due to the inadequate maintenance and mismanagement.
- Excessive use of groundwater in the district with expansion of high-water requirement crops such as rice and sugarcane (area coverage for rice: 52.6% in 2011 to 62% in 2019).
- Low agricultural activities in moderately flooding areas.
- High emigration rate.
- Lack of proper management of agriculture residues.

O

- Scope for agroforestry and diverse cropping in the selected zones.
- Promote drought resistant cropping in stress facing areas.
- Scope to promote organic farming in the blocks along other rivers to increase groundwater storage.
- Incentivize and promote organic farming along the rivers other than Ganga in the selected stretches under "Paramparagat Krishi Vikas Yojna".
- Enhance groundwater recharge potential by retarding surface runoff.
- Enhance water productivity by managing irrigation scheduling.
- Water pricing / subsidy to increase water potential.
- Scope to promote local water bodies networking.
- Promote canal utilization in intangible economic and regulatory activities (refer: **Figure 10**).
- Linking of the project schemes such as "National Bamboo Mission" to raise Agriculture economics and floodplain management.
- Establish components under Mission for Integrated Development of Horticulture (MIDH) sub-schemes.
- Formal arrangement to enhance marketing potential and strategies for organic farming.
- Integrate and enhance the coverage area of micro-irrigation practice for small and marginal farmers under Pradhan Mantri Krishi Sinchayee Yojana through the schemes "Har Khet Ko Pani" and "Per Drop More Crop".
- Agro-residues based power generation projects such as "Programme on energy from urban, industrial, agricultural wastes/ residue and municipal solid waste" and "Schemes to support promotion of biomass-based cogeneration in sugar mills and other industries in the country" should be promoted.
- Small size biogas plants should be promoted in rural and semi urban areas through "New National Biogas and Organic Manure Program".

T

- Market instability
- Farmer economics could be affected by production glut
- Inadequate post harvesting infrastructural support
- Lack of adequate operational funding
- Challenge of economic weed control, control of pests and disease in organic sources
- Increase ground water extraction during dry season
- Pollution due to floodplain agriculture runoff

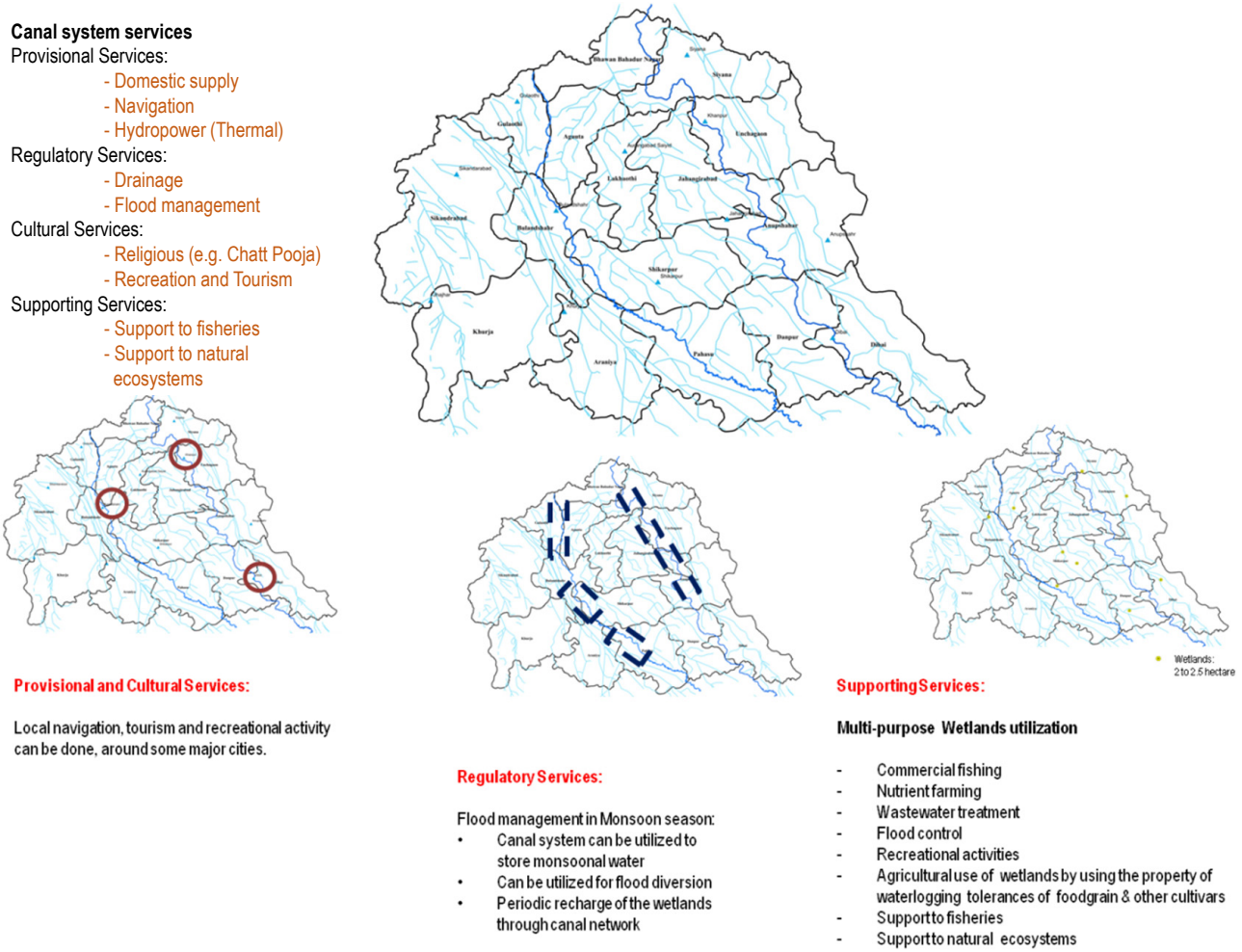


Figure 10: Multipurpose utilization of canal system under various services

2.2. FISHERIES SECTOR STATUS

The fisheries sector in the country supports the livelihoods of millions of people. The district also has several private and community ponds engaged in freshwater aquaculture. District is blessed with 3647 wetlands but still only ~26.5% of the total is utilized in fish production. The river stretches and other reservoirs in the district are also utilized for fish production. The resources utilized for fisheries and aquaculture in the district is compiled in **Table 4**.

The recent survey conducted by district administration could be exploring the untapped resource for aquaculture production in the district which if utilized wisely would increase the aquaculture production many fold. Currently, 1600 fishers of 450 families earn an average of 10,000-15,000 per month in the district. The fishers are motivated through the "Kisan Credit Card Scheme" and "community pond lease". A glimpses of the developmental activities under fisheries sector is presented in Plate 1.

Table 4: Water area infrastructure for Fisheries in the district

Fisheries GDP contribution in the state (for last 10 years)	1.5 – 1.8%
Growth rate in Fisheries sector in the district (for last 10 years)	8 – 10%
Community Pond	Area: 835.917 ha (Number 1050)
Fisheries Department Pond	Nil
Reservoirs Managed by Fisheries Sector	Area: 10 ha (Number 1)
Reservoirs Managed by Irrigation Department	Nil
Water bodies under Forest Department	Nil
Private Pond	Area: 46.1 ha (Number 32)
Waterlogged Area	
Fisheries Estates	Area: 10 ha (Number 1)
River	98 km
River Ganga	13.2 km
Canal	1897 km
Potential Spawning and Breeding area	13.2 km stretch of river Ganga
Fish Seed Hatcheries in Private Sector and Government Sector	Nil
Mega Fish Hatcheries of U.P.M.V. Nigam	Nil
Fish Seed Rearing Units in Private Sector	Area: 4 ha (Number 4)
Fisheries Department Farms	Nil
Fish Haat (cluster of 10 shops)	1
Wholesale Fish Mandi	Nil
Fish Cum Demonstration Units	10
Major Fish Species	*Labeo rohita*, *Catla catla*, *Cirrhinus, mrigala, Ctenopharyngodon idella*, *Cyprinus carpio*
Fish Production (in 2020-2021) Pond: River:	 5231 tons from 560 ponds with an average of 4500 kg/ha/year 6 tons from 13.2 km river Ganga stretch

Source: Department of Fisheries (2013); shared information "District Fisheries Department 2021"

Development of Fisheries Associated Activities

S

- Aquaculture is a popular activity with approximately 8-10 percent of growth rate in the fisheries sector during the last decade.
- The district is bestowed with more than 1000 ponds engaged in fisheries activity and a 13.2 km stretch of river Ganga with rich fish and fishery resources.
- High fish diversity in the region.
- Support from ongoing schemes in the fish and fisheries sector such as Pradhan Mantri Matsya Sampada Yojana and MGNREGA.

W

- Severely polluted and/or dried non-perennial rivers.
- Only 13.2 km of river Ganga stretch is utilized for fishing.
- Major river (Kali, Karwan, Nim and other tributaries) stretches covering more than 200 km is unutilized for different purposes.
- Only ~26.5% of the total ponds are utilized in fish production.
- Canal network is unutilized for fish and fisheries related activities due to the less canal depth (< 5 feet).
- Inadequate nursery and rearing tank.
- High emigration rate.

O

- Development of integrated water resources.
- Develop an integrated fish farming system.
- Promote non-consumptive water-based sectors i.e, fisheries, navigation, etc.
- Water farming in the areas unfavorable for agricultural and allied activities.
- Development of a block specific fisheries enhancement model.
- Development of reservoir fisheries.
- Enhancing fish production and productivity of floodplain/wetland fisheries.
- Promote recreational fishing in the selected river stretches.
- Canal utilization for commercial and recreational fishing.
- Development of marketing and storage infrastructure for small and medium fisher.
- Subsidize or provide support from other schemes such as MGNREGA programme to enhance small scale fisheries.
- Selected site can be converted into fish sanctuary.
- Implementation of separate value chain approach for smallholder fish farmers and commercial fish farmers.
- Rehabilitation of riverine fisheries through community participation.
- Integrate local traditional and agricultural calendars to organize farmpond labour as well as harvests.
- Feasibility studies, practical training and sensitization of farmer groups.
- Implementation of technology interventions in small and medium size ponds.
- Develop pilot scale aquaponic farming.

T

- Low groundwater levels in certain blocks in the dry season hinder the fisheries development.
- Shortage and unavailability of fry and fingerling to stock ponds.
- Unavailability of Mega fish hatcheries and fisheries department farms.
- High pressure on wetlands resources.
- Spread of invasive species.

Plate 1: A. Community pond for small scale aquaculture; B and C. Fish harvest; D, E and F. Recirculating Aquaculture Systems (RAS) in Sikri village, Khurja

2.3. TOURISM SECTOR

STATUS

The district has been a place of attraction for tourists in the areas along the mighty river Ganga. The diverse cultural heritage is located at the bank of river Ganga in Rajghat, Ahar, Karnavas and Anoopshahr. A significant number of devotees visit in these places throughout the year and take bath in holy river Ganga. The Avantika Devi temple fair, Aankeshwar Mahadev temple fair, Narora Ganga barrage fair or Ganga Snan at Ahar, Anoopshahr, Belon-wali Mata temple, Rajghat are the well-known fairs congregate devotees around the river Ganga. These fairs are also responsible for the dynamic change in the state economy. Many ancient and famous temples are found throughout the district. Sikandrabad, a historical city along the Karwan river has several ancient monuments. The district also has architectural masterpiece Ahmadgarh fort near Sikarpur currently stands in ruins and is in very poor structural condition. The 13.2 km stretch of river Ganga, one of the river/stream wetland type declared as Ramsar site in the district supports threatened ecological communities and is the home of species *(Platanista gangetica, Lutra lutra, Gavialis gangeticus* and *Crocodylus palustris)* protected as Schedule I of Wildlife protection Act 1972. The sites along river Ganga in the district have huge potential to increase tourist's footfall. Some of the major tourist places are marked in **Figure 11**.

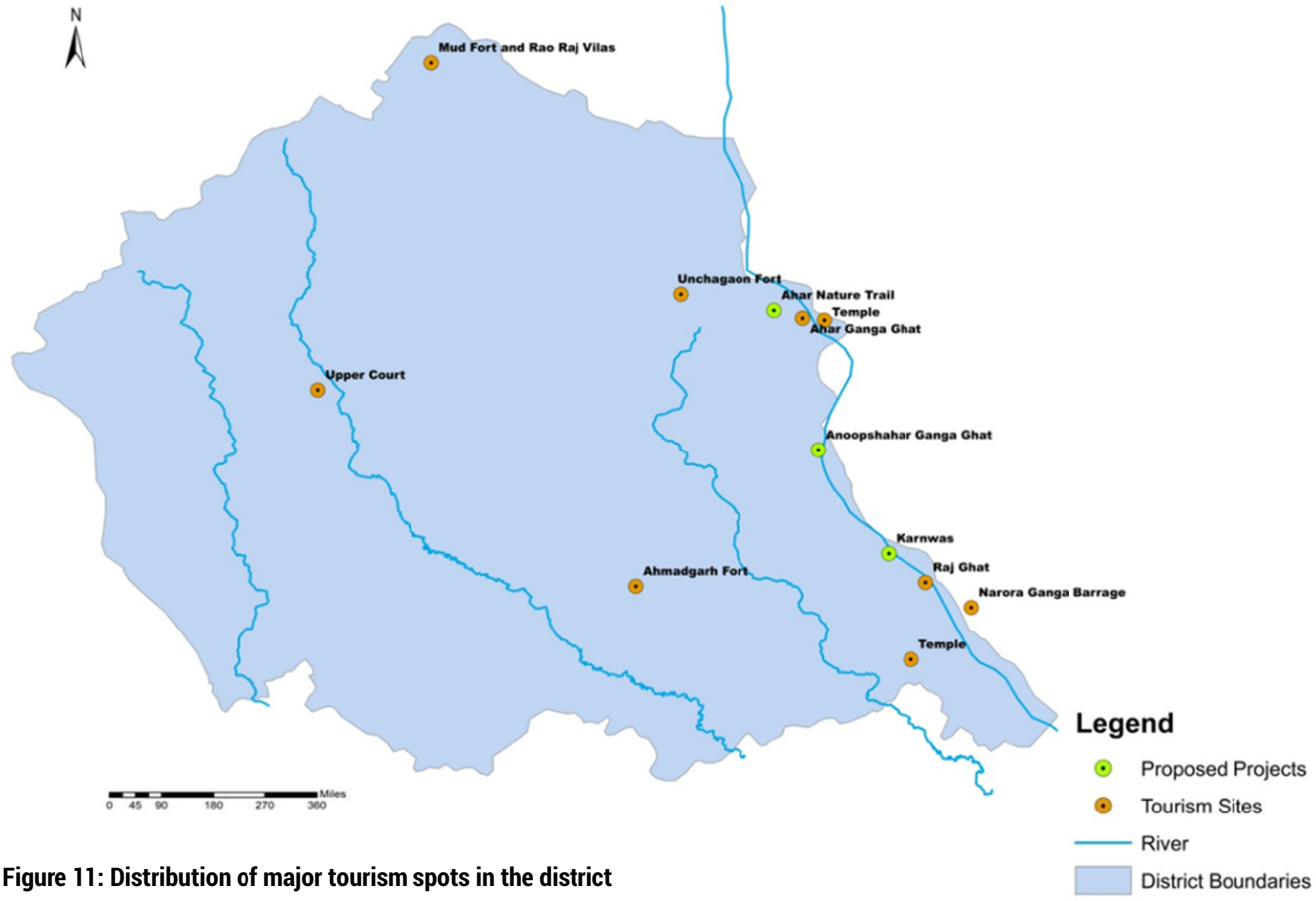


Figure 11: Distribution of major tourism spots in the district

Development of Tourism Associated Activities

S

- Presence of unique historical and archaeological places.
- Unique biogeolophysical diversity.
- Favorable administrative initiatives to promote eco-tourism.
- Unique and well established traditional Indian pottery.
- High aquatic biodiversity in river floodplain associated wetlands.
- High religious value of the Ghats associated to river Ganga.
- Establish river reach as Ramsar site.
- Most of the tourism activities in the district are lie along river Ganga.

W

- Rural areas are unexplored and unpromoted for river or pond related cultural activities.
- Lack of experienced workforce to promote rural tourism.
- Substandard transport infrastructure.

O

- Promote biodiversity and natural resources linked tourism activities.
- Initiate the activities focusing other local rivers i.e., Kali, Nim, Karwan.
- Cultural identity of the district should be utilized to promote tourism.
- Development of a knowledge hub near rejuvenated urban ponds utilized for recreational fishing.
- Establish subsidize trade zones near tourist places.
- Generate employment for local communities.
- Establish e-marketing for nature-based tourism.
- The archeological monuments under ruin and in very poor structural condition can be explore as potential tourist activities.

T

- Excessive tourism activities create conflict of interest with existing aquatic life forms.
- Lack of awareness about sustainable tourism.

Plate 2: An initiative to promote riverbank tourism from the District Forest Department

2.4 FORESTS AND FORESTRY SECTOR

STATUS

The total forest area of the district is 7726.57 ha while 2744.25 ha are under afforestation in various government schemes. During 1996-97 the total forest area was 166557 hectares which is 4.6 percent of the total area (Census 2001). The current percent forest cover ~2.2 percent is far less in comparison with the overall state forest area of 6.2 percent (FSI 2019). Maximum forest area is under Anupshahr (2433 ha), followed by Araniya (1654 ha) and Khurja (1236 ha). The distribution of forest cover in the blocks of the district is illustrated in **Figure 12**.

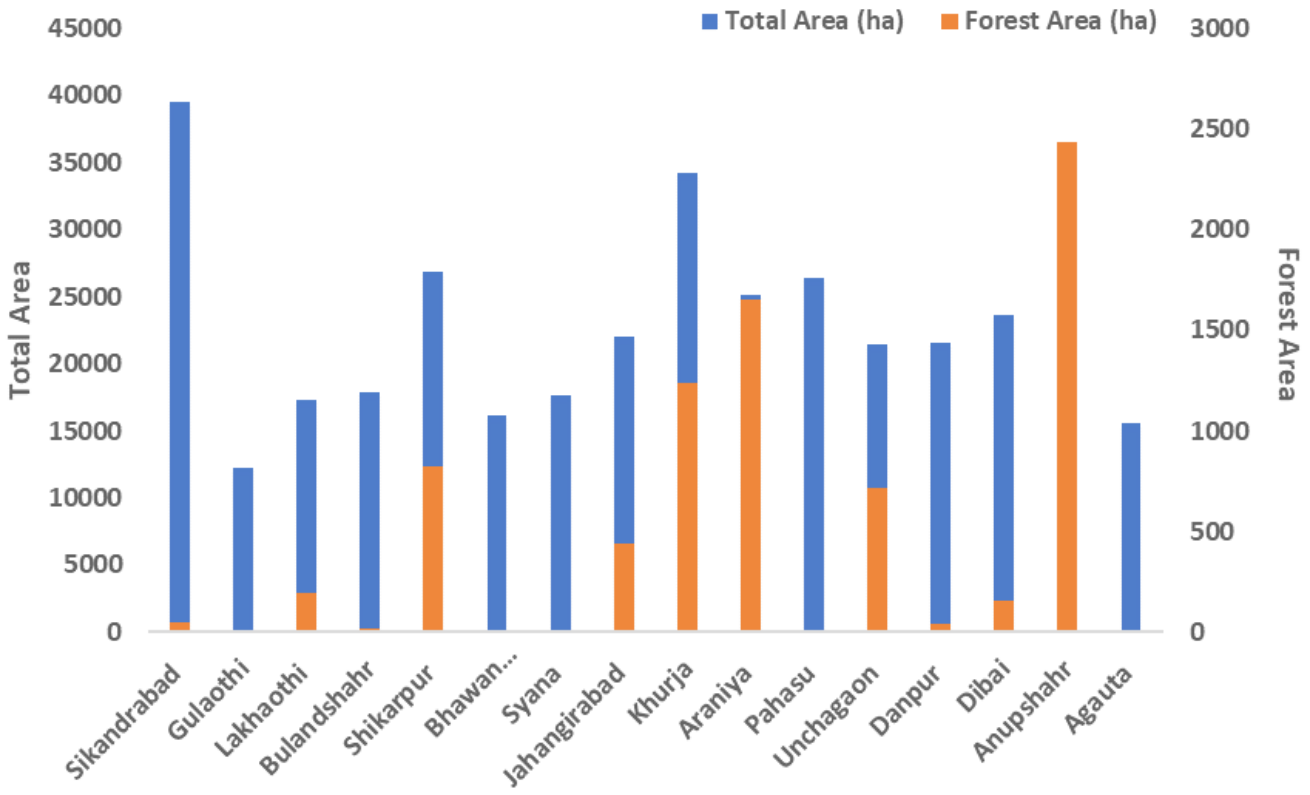
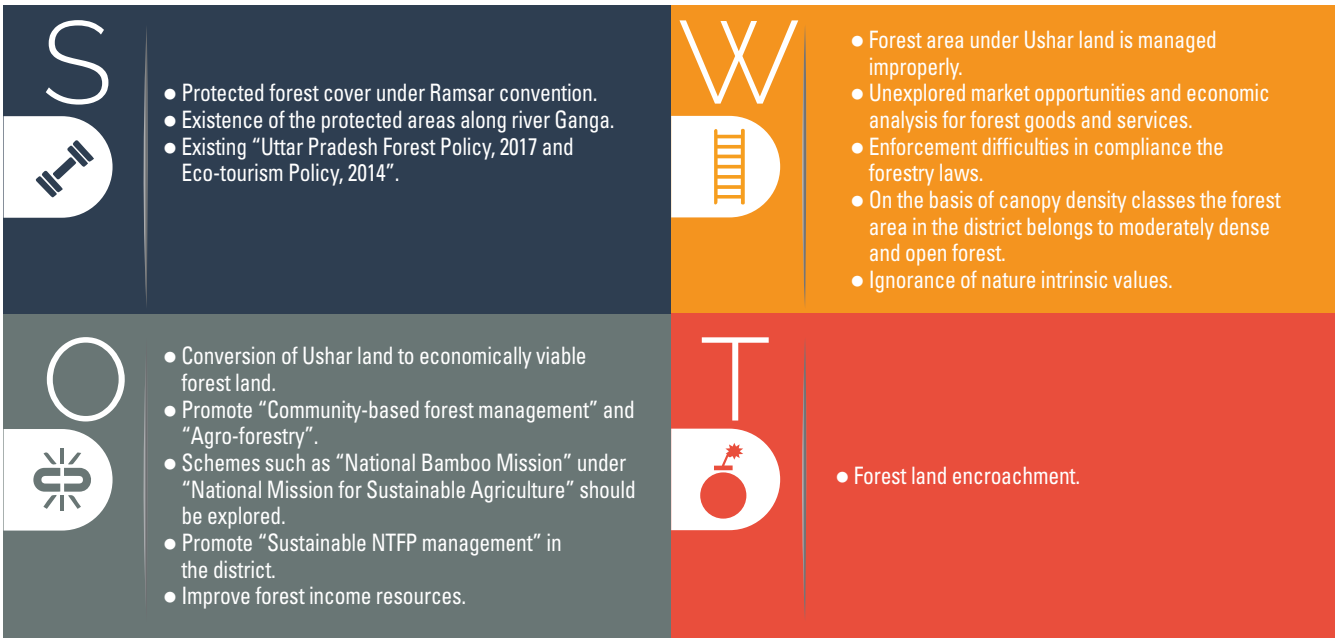


Figure 12: Block wise forest area coverage in different blocks (Bhartariya 2012)

THE CURRENT percent forest cover ~2.2 percent is far less in comparison with the overall state forest area of 6.2 percent

Development of Forestry Associated Activities



2.5. INDUSTRIAL SECTOR STATUS

Industrial sector in the district is one of the major sources of employment and occupation. The effluent from industries mainly discharge into the rivers Kali and Karwan. The prominent industrial sectors in the district are Textile, Dairy, Slaughterhouse, Sugar, Distillery, Ceramics, Cement, Metal surface treatment, Steel and Tubes. These sectors play a key component in economic development and generate strong growth opportunities for other sectors such as water and wastewater management, solid waste management and associated sectors on which policy makers are relied to prepare policies and decision making. Most of the industries under the Bulandshahr, Sikandrabad and Khurja block deal with the major export items such as Pottery, Pottery Painting, Ceramics, Ceramic Tiles, Bone China, G.I. and M.S. Pipe. The industrial clusters in the mentioned blocks accommodate the water-based industries that come under the red category based on relative pollution potential of the sector. The industries under red category are marked in **Figure 13**.

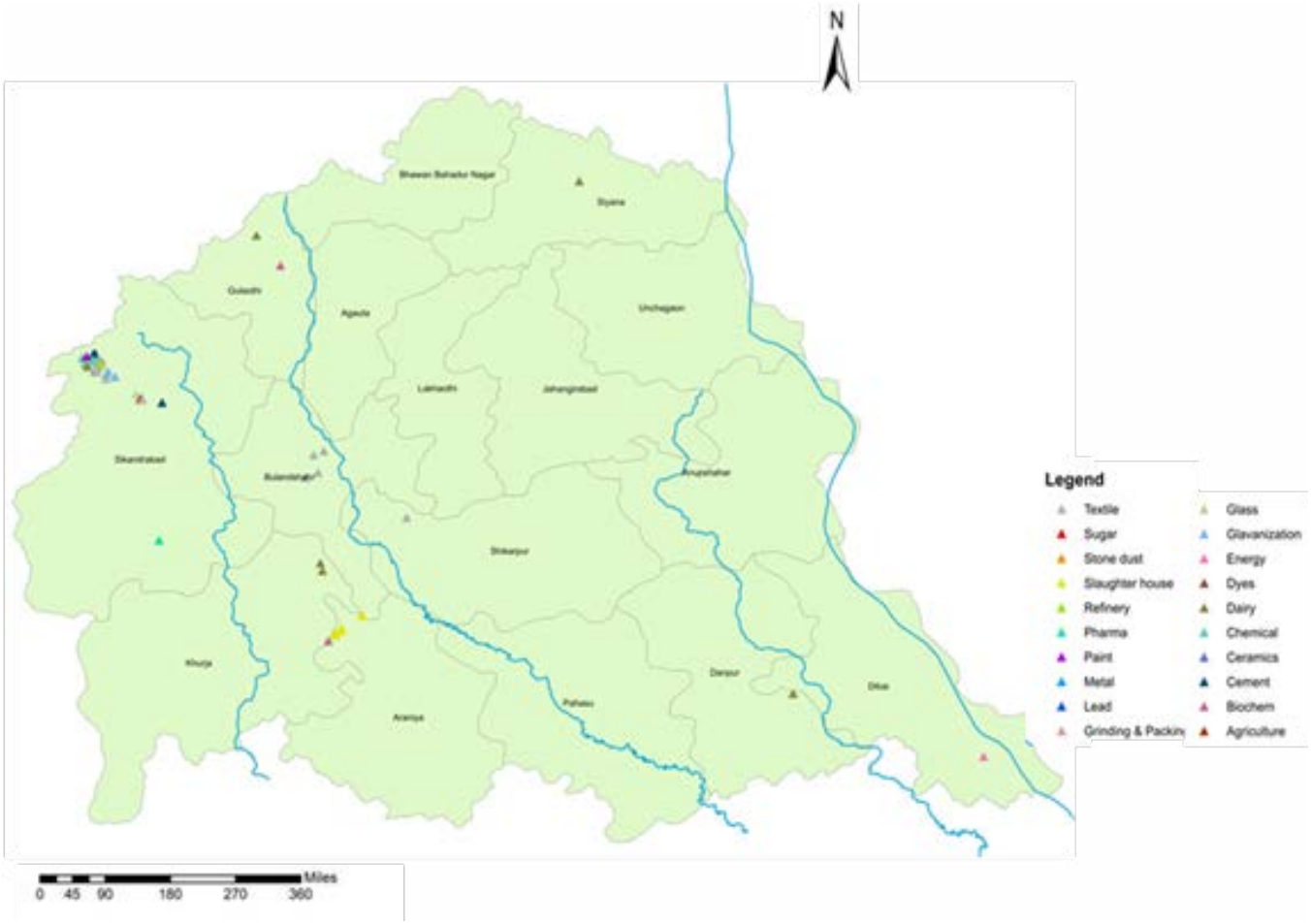


Figure 13: Distribution of industries under red category in the region

THE PROMINENT industrial sectors in the district play a key component in economic development and generate strong growth opportunities for other sectors such as water and wastewater management, solid waste management and associated sectors on which policy makers are relied to prepare policies and decision making.

Development of Industry Associated Activities

3.0 PROPOSED ACTION PLAN

Rapid transformation of major economically viable sectors directly or indirectly influenced by the total water resource availability of the district requires a sectors or sub-sectors wise vision, goals and roadmap for the district. Pursuing the vision of Hon'ble Prime Minister of India, Shri Narendra Modi, the action plans identifies 'low-hanging fruit' sectors as well as listed divergent sectors facing most severe challenges that require a long term vision.

4.0 PLANNING AND MONITORING FRAMEWORK

"Arth Ganga" projects, planning, implementation and monitoring committee should have following three tier structure of various components:

STATE LEVEL ARCHITECTURE
State Level Committee (SLC) chaired by State Minister.

- Representation from concerned line Departments and Boards like Agriculture, Fisheries, Forests, Revenue, Pollution, etc.
- State Level Technical Committee (SLTC): Representatives of National Level Research Institutes like ICAR, CIFRI, NBFGR, FRI, Institute of Town Planning, etc.
- Representation from District Level Committee (DLC).

DISTRICT LEVEL ARCHITECTURE:
The District Level Committee (DLC) may be headed by

District Magistrate or CDO, Rural Development with representatives from concerned line Departments.

- Representatives from the Associations, Marketing Agencies, Banks, Non-Government Organizations etc.
- Subject expert/consultant from each field and also engaged with the SLTC for Preparing the Implementation Plan, Annual Action Plan and Technical Supervision.
- Representation from Block Level Committee (BLC).

BLOCK LEVEL ARCHITECTURE:

Block Level Committee (BLC) may be headed by Block Development Officer.

- Representatives of Nagar Palika Parishad / Nagar Panchayat.
- Community representatives.

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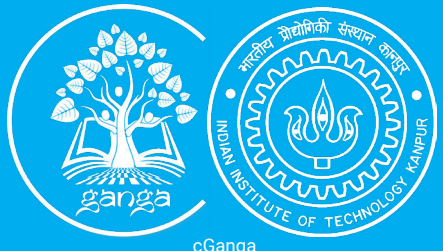

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