नमामि गंगे

QUALITY COUNCIL® OF INDIA
Creating an Ecosystem for Quality

# REPORT ON
# CENSUS SURVEY OF
# WATER BODIES
## UTTAR PRADESH


QUALITY COUNCIL® OF INDIA

Creating an Ecosystem for Quality

# MR. ADIL ZAINULBHAI

## Chairman,
## Quality Council of India

The Ganga is a conduit for spirituality and faith for the people of India. To preserve and rejuvenate this sacred entity, the National Mission for Clean Ganga (NMCG) was instituted by the Ministry of Jal Shakti, and it has been an honour for QCI to collaborate with the Ministry for the mission.

Given the severe inequality of access to clean drinking water, which disproportionately impacts India's most vulnerable and marginalised communities, the mandate entrusted to the NMCG has become ever more important.

With India's ponds, reservoirs and other water bodies drying up, the Government of India highlighted the need for an accurate data on the number of water bodies existing in the villages within the Ganga basin. QCI took up the responsibility to address this critical gap along with the NMCG. This led us to undertake the Census Survey of Water Bodies.

Through this project, we made sure to collect most accurate data throughout the assessment, which lasted 140 days. A team of 41 assessors evaluated a total of 2,569 villages and mapped 1,100 water bodies in the Ganga basin, through which we derived 23,100 data points.

Owing to the norms of COVID-19 pandemic, we made sure that our processes were digitalised to ensure maximum coverage. This led us to collect geo-tagged picture-based evidence with approximately 1,49,346 pictures received.

Our past experiences in working with the government ministries have indicated that an in-depth study of data unveils useful information and provides a greater insight into any issues that exist. Hence, this project's highlight was “Drone-based assessment”. Through this, water bodies were geo-mapped to calculate certain parameters like size, depth and circumference of the water bodies within the Ganga basin present in four states namely, Uttar Pradesh, Bihar, Uttarakhand and Jharkhand.

Due to geo-mapping and tagging, the Ministry can now track the water bodies across the Ganga districts through a unique identity given to them. This makes each water body accessible to districts so that they can take necessary measures at village level.

This resulted in an impressive methodology, making the assessment more holistic as well as accurate. Also, it was made sure that the best practices were paid attention to, thoroughly.

I would like to congratulate all for putting their best foot forward in preserving this sacred symbol. Let's keep our collective efforts of working on this cause of keeping the water bodies safe and clean. Remember, this is just one step of making India healthier, brighter and better each day. Jai Hind!

# DR. RAVI P. SINGH

## Secretary General,
## Quality Council of India

Ganga is a symbol of faith, culture and hope for the people of India as well as a major source of irrigation, agriculture, employment and electricity across the nation. Keeping the social, religious and economic aspects of the river in view, the National Mission for Clean Ganga (NMCG) was launched by the Ministry of Jal Shakti. It is a delight to note that the Ministry entrusted Quality Council of India with the responsibility of conducting its detailed study of the inland water bodies situated in villages of five states – Uttar Pradesh, Bihar, Uttarakhand, Jharkhand and West Bengal.

When we speak about conservation and preservation of water resources in developing nations, we make sure there are positive steps being implemented for the development of water bodies and, in turn, betterment of local communities and shelters depending on them. While conducting the study, it was brought to our notice that many villages lacked ecosystem benefits from the water bodies due to its inaccessibility and contamination. It was imperative for us to conduct this study as undertaking the Census not only highlighted the underlying importance of water resources and conservation of clean drinking water but also provided a real chance at improving the lives of several Indian communities relying on the river Ganga for livelihood in a tangible way.

While conducting the survey, QCI faced several challenges. Be it the COVID-19 pandemic or the massive landslides and floods in Chamoli district of Uttarakhand – these led to a delay in the beginning of the assessment process. The inaccessibility to several villages in many states stood as another major challenge.

However, with great support provided to the team by the Ministry. The team tackled all the issues very mindfully. Several inaccessible villages in many states were later covered with the help and support of the locals. We also formed a special group that visited the villages of Chamoli for assessment of water bodies considering the severity of the situation.

Today, it is a pleasure to announce that a team of 41 assessors engaged in the functioning of this project, including conducting the surveys, analysing the gathered data and recommending remediation for conservation, beautification and preservation of the water bodies. We could gather approximately 23,100 data points over the course of 140 days of rigorous research and assessment, covering 2,569 villages and mapping 1,100 water bodies in Ganga basin. The on-ground assessment methodology was framed in a way that it brought the real picture of water bodies to our notice via assessors. This is how we recommended the best remedial measures for the revival/replenishment of water bodies according to their condition.

I would like to thank the Ministry for providing us with enough resources and assistance to work for an initiative of great national importance and development. QCI would like to extend its support in further times for such initiatives as well. We believe that when India's water bodies will be clean, its communities will shine even brighter!

# XXX

## XXX
## XXXXXXX

Dummy Text

Dummy Text

# Contents

# Figure Index

# Table Index

# Glossary

| | |
|---|---|
| **Aesthetic Enhancement** | Park, benches, floral beautification, footbridge, structure/statues around the water body region. |
| **Biological Remediation** | Use of microbes or plants such as canna, Cyprus or any suitable plant and (Another method: Geo-Netting) to clean up contaminated water body, soil and groundwater. It is recommended in order to keep Water body peripheral ecosystem robust. |
| **Blockage mapping** | Mapping of roads and drains in around the water body blocking the drainage flow |
| **Catchment Area** | An area of land where water collects when it rains finding its way into streams and down into the soil, eventually feeding the water body. |
| **Catchment Yield** | The total quantity of surface water that can be expected in a given period from a stream at the outlet of its catchment is known as yield of the catchment in that period[1]. |
| **Contour Mapping** | Delineation of any property in map form by constructing lines of equal values of that property from available data points[2]. |
| **Defunct Borewells** | Borewells that are no longer in purpose due to reduced groundwater levels. |
| **Domestic Wastewater Secondary Treatment Plant** | Secondary treatment is the removal of biodegradable organic matter (in solution or suspension) from wastewater through a series of chamber consisting of Sand charcoal or Activated carbon and Coarse gravel at the edge of the water body entrance. The aim is to achieve a certain degree of effluent quality of wastewater. This is achieved with physical phase separation to remove settleable solids followed by a biological process to remove dissolved and suspended organic compounds. |
| **Drainage Basin Alteration (Contour Bunding)** | Geographical method such as slope modification, contour bunding, construction of trenches, terracing for protection against soil/wind erosion and restoring water quality and quantity. |
| **Drainage runoff** | Flow of wastewater into the water body |
| **Dredging** | Process of removal of silt and other material deposited at the bottom of the water body as a result of drainage or run off. |

[1] www.theijes.com

[2] Contour mapping | geography | Britannica

| | |
|---|---|
| **Eutrophication** | Gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients causing structural changes to the aquatic ecosystem such as: increased production of algae and aquatic plants, depletion of fish species, general deterioration of water quality and other effects that reduce and preclude use |
| **Green Buffer zone** | Area that is created or demarcated to enhance the protection of a specific sensitive conservation area, often peripheral to it from negative external pressures. These areas in the context of water body will act as a filter on nutrients in the underground water and surface water. |
| **Leachate** | Toxic liquid that is formed from the breakdown of wastes at the landfill area that percolate into the ground. |
| **Non-Point Source Pollution** | Nonpoint source pollution refers to water pollution from diffuse sources. It negatively influences water bodies from sources such as polluted runoff from agricultural areas draining into a water body.<br>Nonpoint source pollution may derive from many different sources with no specific solution able to rectify the problem, making it difficult to regulate. It is therefore difficult to control because it comes from everyday activities, such as fertilizing a lawn, using a pesticide, or constructing a road or building. |
| **Open Defecation** | Human practice of excreting in the open in fields, bushes, forests, streets, canals, waterways, ditches, or other open areas. |
| **Orthomosaic Images** | A geometrically correct aerial image that is composed of many individual overlapping still images that are stitched together[3]. |
| **Oxygen Saturation levels** | Oxygen saturation is a ratio of the concentration of "dissolved oxygen", to the maximum amount of oxygen that will dissolve in that water body, at the temperature and pressure, which constitute stable equilibrium conditions. |
| **Riparian Vegetation** | An interface area between land and water body that slows and dissipates floodwater, prevent erosion and ensures high water quality of water body. |
| **Settlement/ Encroachment** | Development on waterbodies and buffers areas around them encompassing removal of vegetation, or an alteration of topography, consequently impacting the functions and values in such natural areas such as a decline in water quality, loss of habitat (both aquatic and terrestrial), disruption of equilibrium (or naturally stable) conditions, loss of flood attenuation, or reduction of ecological processes. |

[3] Orthomosaic Map

| | |
|---|---|
| **Silt Management** | Measures adopted to trap the silt before entering the water body by digging trenches in the catchment area. |
| **Sludge Management** | Processes and technologies that |
| **Total Dissolved Solids** | Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions[4]. |
| **Total Suspended Solids** | Total Suspended Solids (TSS) refers to any particles that are suspended in the water column. These particles can include silt, algae, sediment, and other solids floating in the water (both organic and inorganic). These particles are defined as being large enough to not pass through the filter (through the filtration process) used to separate them from the water. Suspended solids absorb heat from sunlight and as a result, the water temperature increases resulting in a deprivation of dissolved oxygen in the water, which can be disastrous to aquatic life if levels are too high. TSS can be measured in ppm, mg/L, g/L and %[5]. |
| **Turbidity** | Turbidity is the amount of cloudiness in the water varying from a river full of mud and silt where it would be impossible to see through the water (high turbidity), to a spring water which appears to be completely clear (low turbidity). |
| **Waste weir** | A waste weir is a slatted gate on each canal level or pound, to remove excess water and to drain the water for repairs. This differs for a reservoir, for which a waste weir is another name for a spillway, i.e. not having the boards to adjust the water height nor the paddles to drain all the excess water. |
| **Wastewater drainage** | Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff, and any sewer inflow or sewer infiltration. |
| **Water body – Natural and Artificial** | Natural water body means a pond, spring or stream that was historically present in a natural state but may have been physically altered over time.<br>Artificial water bodies are man-made water bodies such as Kunds, Irrigational reservoir and a pond constructed for occupational use. |
| **Water Body Peripheral Ecosystem** | Geographic area or near the periphery of a water body where plants, animals, and other organisms, as well as weather and landscape, work together to make the ecosystem robust. |

[4] WHO

[5] TSS

| | |
|---|---|
| **Water Hyacinth/ Duckweed** | Water hyacinth is a free-floating perennial invasive aquatic plant, highly popular due to its beauty and ability to absorb excess nutrients from the pond in order to control and conserve environmental condition. It can absorb excess minerals and inorganic substance from wastewater entering into a water body.<br>Duckweeds are the smallest flowering plants known which has a property to purify water. It also maintains the habitat by providing enough shade to keep the growth of oxygen-robbing algae down. |

# Abbreviations

| | |
|---|---|
| **NMCG** | National Mission for Clean Ganga |
| **QCI** | Quality Council of India |
| **CSWB** | Census Survey of Water Bodies |
| **CAPI** | Computer-Assisted Personal Interviews |
| **DGCA** | Directorate General of Civil Aviation |
| **DM** | District Magistrate |
| **ADM** | Additional District Magistrate |
| **SDM** | Sub-Divisional Magistrate |
| **DFO** | District Forest Officer |
| **DPRO** | District Panchayati Raj Officer |
| **DO** | Direct Observation |
| **OD/OU** | Open Defecation/Open Urination |
| **DM** | Depth Measurement |
| **KII** | Key Informant Interview |
| **WBD** | Water Body Details/Documents |
| **CF** | Citizen Feedback |
| **CT/PT** | Community Toilet/Public Toilet |
| **SLWM** | Solid Liquid Waste Management |
| **SONAR** | Sound Navigation  Ranging |
| **NABCB** | National Accreditation Board of Certification Authorities |
| **IB** | Inspection Bodies |
| **DTM** | Digital Terrain Model |
| **DSM** | Digital Surface Model |
| **GVP** | Garbage Vulnerable Points |
| **SWM** | Solid Waste Management |

# 1. EXECUTIVE SUMMARY

'Census Survey of Water Bodies (CSWB) in Ganga basin' under 'Namami Gange' encapsulated 100 per cent mapping of the water bodies across 31 districts (3,189 villages) spread across Uttar Pradesh, Uttarakhand, Bihar, Jharkhand and West Bengal. With challenges abound, one of the major ones being geo-tagging of the water bodies, the National Mission for Clean Ganga (NMCG) entrusted the Quality Council of India (QCI) for assisting it with the quest of assessing all water bodies and create a baseline data for all the 31[6] Ganga districts.

The three main objectives of this study were to (a) map the water bodies present in villages, (b) assign a unique code to the water bodies for identification and (c) formulate Water body Cleanliness Index. The identified thrust area includes all water bodies in the Ganga district, which are either dried-up or have water less than their full water holding capacity. This survey includes two major components:

- Identification & Mapping: QCI leveraged the network of National Accreditation Board for Certification Bodies (NABCB) accredited inspection bodies in conducting the survey through Computer-Assisted Personal Interviews (CAPI). It involved 2 sub-components (a) Key Informant Interview, and (b) Direct Observation.
- Estimation of water holding capacity: In order to acquire size, depth and volume of the water bodies the aerial survey using drones and floating depth measurement device were used. The aerial survey provided precise physical properties of the water bodies taking into account the area, periphery, vegetation, settlement and additionally, depth of dried-up water bodies from orthomosaic images and contour maps.

The total number of villages allocated and the total number of water bodies found are mentioned in the table below:

| Description | Uttar Pradesh | Jharkhand | Bihar | Uttarakhand | West Bengal | Total |
|---|---|---|---|---|---|---|
| Total number of villages allocated | 691 | 66 | 220 | 222 | 1990 | 3189 |
| Total number of water bodies found | 329 | 56 | 113 | 44 | 558 | 1100 |

*Table 1: Survey figures*

[6] Districts covered under 'Jal Shakti Abhiyan' were excluded from the survey, which brought down the number of districts from 52 to 31 in five Ganga states. Two districts in West Bengal: Howrah and Murshidabad were not covered, as official permission were not granted for the survey of the waterbodies in these districts. Several villages in Malda district did not exist in their respective Gram Panchayats. This concomitantly reduced the total number of villages actually assessed during the survey.

Through the study, it is concluded that the water bodies in villages of Uttarakhand tops the chart among the five states with an average score of 200.63. While, Bihar with an average score of 164.43 ranked last.

The study is followed with the creation of dashboard for data visualization and pictorial representation of all the five states including the district, block and village level data, which includes layered maps and static data of the water bodies. The CSWB not only provides a full database of water bodies but also provides appropriate measures and recommendations for rejuvenation of the water bodies present in the villages of five Ganga states.

The geospatial data of all the water bodies in selected 5 states has been stored and displayed in the dashboard which has been collected and processed using a drone and on-field assessments. The data has been visualized in a flow such as National- State- District- Block- Village- Water body with assessment photographs.

Following data will be visualized in the dashboard:

1. Category of the water body
2. Scores of the water body
3. Water body Cleanliness Index
4. Water body-wise codes
5. Volumetric assessment[7] data (Water holding capacity)
6. Satellite/Map view of the water bodies

This data will be accessed by district administration in each of the 5 states. The district officials can view the recommendations and undertake action based on the data in the portal and thereafter upload the 'Action Taken' status data, which includes few text fields and photographs, against each waterbody.

7. It was a cumbersome process for our team to get approval for flying a drone in West Bengal. Our team went on-field to get the required permissions from the respective District offices but drone approval could not be obtained due to lack of cooperation.

# 2. RESEARCH METHODOLOGY

The deliverables of the assessment were structured in two phases, as the 'On-field assessment' followed by the 'Drone assessment'.

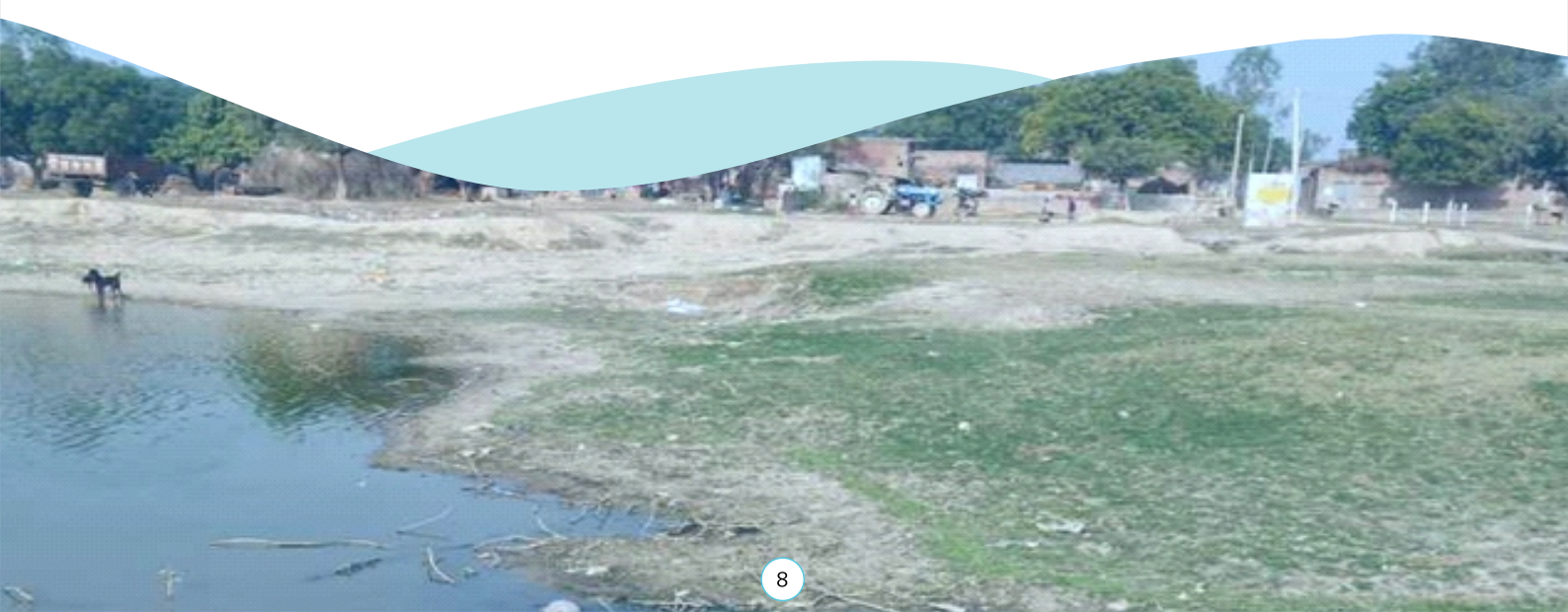
The On-field assessment assisted in determining current health of the water bodies and helped in understanding the socio-economic values that these water bodies hold within the local communities.

The second phase of assessment was achieved through an Ariel survey by using drone technology that demarks the physical properties and surrounding structures of a water body. Properties of a water body like its peripheral, area, volume/depth and surrounding terrains were easily fetched with the help of drones without compromising on the quality and accuracy. The aerial survey was conducted as per the approval by NMCG and in compliance with the DGCA guidelines.

The following table depicts the total number of Districts, Blocks, Gram Panchayats and Villages covered under the CSWB assessment in five Ganga States:

| State | District | Block | Gram Panchayat | Villages |
|---|---|---|---|---|
| Bihar | 6 | 28 | 119 | 219 |
| Jharkhand | 1 | 6 | 26 | 66 |
| Uttar Pradesh | 11 | 50 | 435 | 689 |
| Uttarakhand | 7 | 30 | 130 | 222 |
| West Bengal | 4 | 28 | 128 | 1373 |
| **Total** | **29** | **142** | **838** | **2569** |

*Table 2: Sample size of the survey*



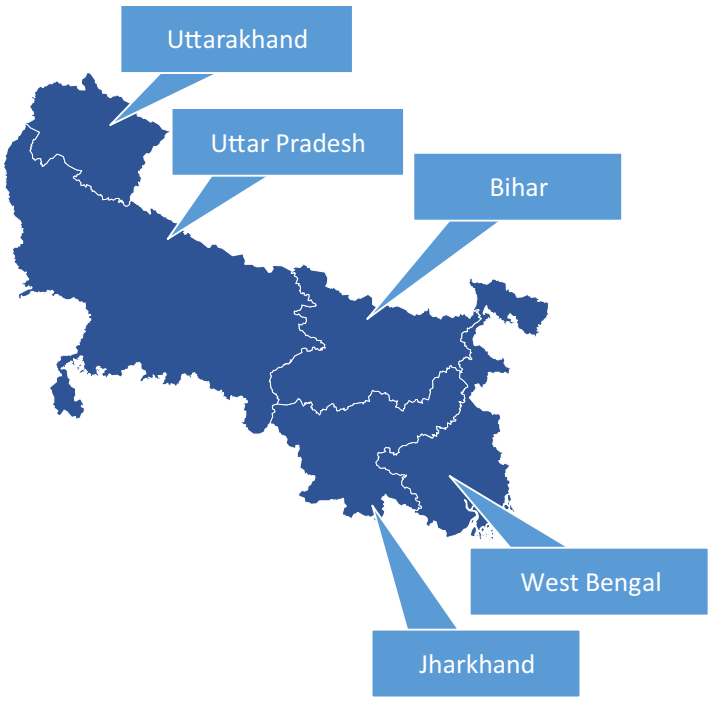



*Figure 2.1. : Surveyed Ganga states*

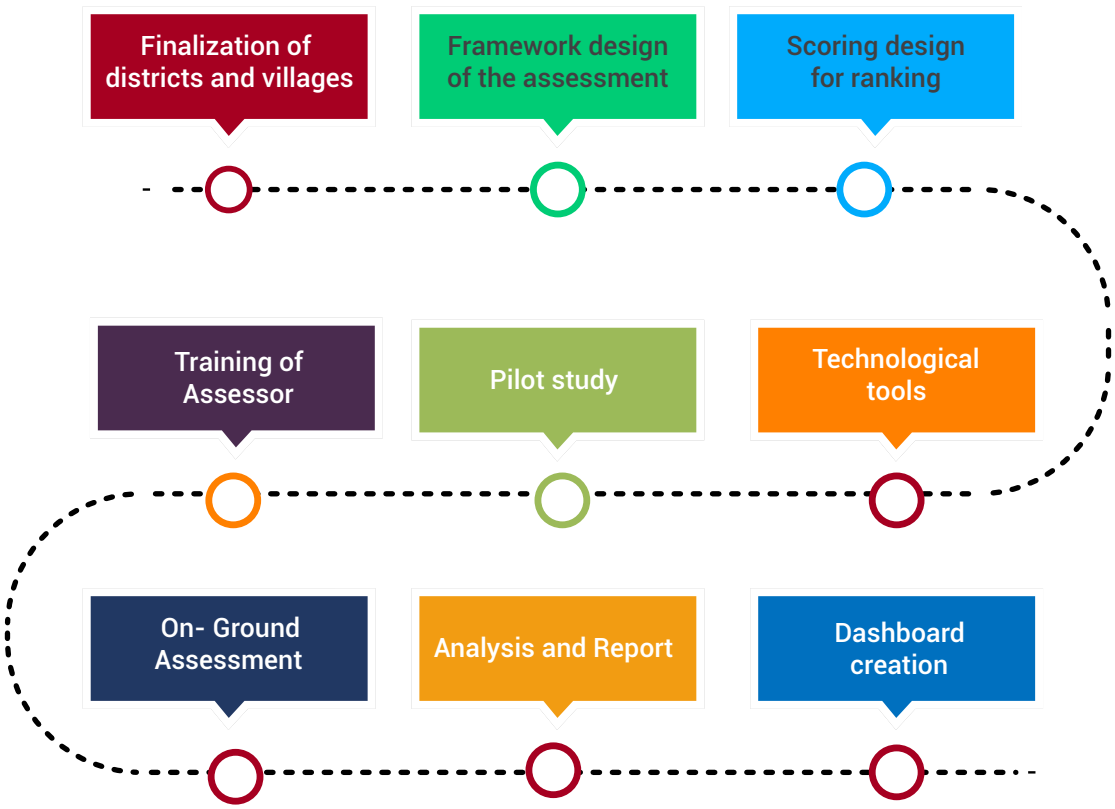



*Figure 2.2. : Project Methodology*

## Step 1: Finalization of District and Villages for assessment

Initially, QCI was allocated 31 districts in 5 Ganga states for the assessment but due to various limitations[8] only 29 districts could be covered.

## Step 2: Framework design of the assessment

Process followed for the development of 'Assessment Framework':

1. In order to begin with the survey of the water bodies, all probable stakeholders were identified to derive a holistic view from the assessment. Our stakeholders included DMs, ADMs, SDMs, DFOs, DPROs, Pradhans, Tehsildar, Patwari, Lekhpal and village locals at Village and Gram Panchayat level and District levels.
2. Detailed questionnaires were prepared in consultation with NMCG. The questionnaires consisted the following sections-
   a. **Direct Observation (DO):** The on-field assessors provided a status and health of the water bodies as perceived on the following parameters of Condition/ State, Infrastructure, Aesthetics, Quality, Solid Waste, Wastewater, and OD/OU.
   b. **Depth Measurement (DM):** Average depth of a water body from all cross-sectional areas were found out by subdividing the water bodies into 4 checkpoints. Depending on the size of the water body either 4 or 6 checkpoints were defined and 4 throws were made from each cross-sectional area using depth measurement meter. Over all 16-24 repetitive observations were made in order to ensure data accuracy of average depth.
   c. **Key Informant Interviews (KII) and Citizen Feedback (CF):** To validate the information received during on-ground assessment of water bodies, the authorized government official at the village, panchayat or at the block level issued an undertaking. Verbatims were taken from the identified stakeholders as a double confirmation about availability and actual status of water bodies along with the problems that had been addressed by the villagers using CAPI.
   d. **Water Bodies Details/ Documents (WBD):** Reviewed the documents (subject to availability) received from the village officials on utility benefits gained by locals, cleaning, spread-out area, storage capacity and various other critical information about water bodies.

## Step 3: Scoring design for ranking of States, Districts and Blocks

On-ground assessment of the water bodies was conducted on the basis of various key indicators such as Condition/State, Infrastructure, Aesthetics, Quality, Solid waste, wastewater management, and OD/OU. A weightage against each of these was evaluated as a part of scoring. These key indicators formed the 'Water body Cleanliness Index' based on which the Ganga districts and their respective blocks are ranked.

[8]. Refer 'Project Challenges'

| Category | Sub-category | Question Wise Marks | Total | Section Total |
|---|---|---|---|---|
| Water Body Cleanliness Index | Condition/ State | Adequacy | 10 | 40 |
| | | Settlement | 20 | |
| | | Septic tanks | 10 | |
| | Infrastructure | Condition of fencing | 20 | 50 |
| | | Outlet | 10 | |
| | | Road connected to water body | 10 | |
| | | CT/PT | 10 | |
| | Aesthetics | Aesthetic enhancement | 10 | 10 |
| | Quality | Turbidity | 10 | 50 |
| | | Eutrophication | 20 | |
| | | Foam | 20 | |
| | Solid Waste | Waste Inside | 20 | 80 |
| | | Leachate | 20 | |
| | | Waste Around | 20 | |
| | | Dustbins | 10 | |
| | | Flies | 10 | |
| | Wastewater | Washing around water body | 20 | 50 |
| | | Drainage present | 30 | |
| | OD/OU | Faecal matter around water body | 20 | 20 |

*Table 3: Summary of Scoring Toolkit*

| Descriptors | Intervals | Maximum Range | Minimum Range |
|---|---|---|---|
| **Best** | 300.00-240.00 | 300.00 | 240.00 |
| **Good** | 239.99-180.00 | 239.99 | 180.00 |
| **Average** | 179.99-120.00 | 179.99 | 120.00 |
| **Poor** | 119.99-60.00 | 119.99 | 60.00 |
| **Very Poor** | 59.99-0.00 | 59.99 | 0.00 |

*Table 4: Water body Cleanliness Index*

# Intervention Methology

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| Eutrophication | Physical infrastructure | Fencing | Bio fencing required | High |
| | | | Wooden/vinyl required | Medium |
| | | | Barbed wires/small-metal/ cemented | Low |
| | | Road | - | - |
| | | | Drains and roads are blocking the flow of Water Bodies | Medium |
| | | | Periphery of water body | Low |
| | Drain Mapping | Drainage | Black water flow | High |
| | | | Grey water flow | Medium |
| | | | Other water or no drain found | Low |
| | | Bar screen | Drainage pipes directly connected to water body | High |
| | | | No screen/net-mesh/grill found | Medium |
| | | | - | Low |
| | Catchment area | Agriculture fields/Habitat | Agriculture fields or habitat found | High |
| | | | - | - |
| | | | Both agriculture fields and habitat not found | Low |
| | | SLWM | Solid waste found on the surface of water body | High |
| | | | Solid waste present around the water body | Medium |
| | | | No solid waste found | Low |
| | | SLWM (Animal waste) | Cattle waste/dung found | High |
| | | | - | - |
| | | | - | - |
| | Inner structure | Dredging | Needs to be done for 04 metre (approx.) | High |
| | | | - | - |
| | | | - | - |
| | | Pal/berms | Not found for big size water body | High |
| | | | Not found for small size water body | Medium |
| | | | Found on the circumference of water body | Low |
| | | Inlet | Not present | High |
| | | | Present but needs the required shape | Medium |
| | | | - | - |

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| | Sustainability plan | Biological remediation | Designing of floating treatment wetland | High |
| | | | - | - |
| | | | - | - |
| | | Filtration | Rain/storm water mapping and cleaning process | High |
| | | | - | - |
| | | | - | - |
| | | Rotation of cleaning | Preferably each year | High |
| | | | - | - |
| | | | Happening within 6 months | Low |
| | | Eutrophication prevention | Removing the Eutrophied water and cleaning the water bed | High |
| | | | - | - |
| | | | - | - |
| | | Utility benefits | No data provided | High |
| | | | | - |
| | | | | - |
| Healthy | Physical infrastructure | Fencing | - | - |
| | | | Bio fencing required | Medium |
| | | | Wooden/vinyl or Barbed wires/small-metal/cemented | Low |
| | | Road | - | - |
| | | | found on the circumference of water body | Medium |
| | | | If drains and roads are blocking the flow of water body | Low |
| | Drain Mapping | Drainage | - | - |
| | | | Black water flow | Medium |
| | | | Grey water or Other water or no drain found | Low |
| | | Bar screen | - | - |
| | | | Drainage pipes directly connected to water body | Medium |
| | | | - | - |

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| Healthy | Catchment area | Agriculture fields/Habitat | - | - |
| | | | Agriculture fields or habitat found | Medium |
| | | | Both agriculture fields and habitat not found | Low |
| | | SLWM | - | - |
| | | | Solid waste found on the surface of water body | Medium |
| | | | Solid waste present around the water body or No solid waste found | Low |
| | | SLWM (Animal waste) | - | - |
| | | | Cattle waste/dung found | Medium |
| | | | - | - |
| | Inner structure | Dredging | - | - |
| | | | - | - |
| | | | Clearing the mud/silt from the bottom of the water body | Low |
| | | Pal/berms | - | - |
| | | | Not found for big size water body | Medium |
| | | | Not found for small size water body or found on the circumference of water body | Low |
| | | Inlet | - | - |
| | | | Not present | Medium |
| | | | Present but needs the required shape | Low |
| | Sustainability plan | Biological remediation | - | - |
| | | | - | - |
| | | | Preventing from Non-Point source pollution | Low |
| | | Filtration | - | - |
| | | | - | - |
| | | | Rain/storm water mapping and cleaning process | Low |
| | | Rotation of cleaning | - | - |
| | | | Preferably each year | Medium |
| | | | Happening within 6 months | Low |

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| | | Eutrophication prevention | - | - |
| | | | - | - |
| | | | Not Eutrophied | Low |
| | | Utility benefits | - | - |
| | | | No data provided | Medium |
| | | | - | - |
| Water Hyacinth | Physical infrastructure | Fencing | Bio fencing required | High |
| | | | Wooden/vinyl required | Medium |
| | | | Barbed wires/small-metal/ cemented | Low |
| | | Road | - | - |
| | | | - | - |
| | | | Found on the circumference of water body or If drains and roads are blocking the flow of water body or No road found | Low |
| | Drain Mapping | Drainage | Black water flow | High |
| | | | Grey water flow | Medium |
| | | | Other water or no drain found | Low |
| | | Bar screen | Drainage pipes direct connect to water body | High |
| | | | No screen/net-mesh/grill found | Medium |
| | | | - | - |
| | Catchment area | Agriculture fields/Habitat | Agriculture fields or habitat found | High |
| | | | Both agriculture fields and habitat not found | Medium |
| | | | - | - |
| | | SLWM | Solid waste found on the surface of water body | High |
| | | | Solid waste present around the water body | Medium |
| | | | No solid waste found | Low |
| | | SLWM (Animal waste) | Cattle waste/dung found | High |
| | | | - | - |
| | | | - | - |
| | Inner structure | Dredging | Needs to be done for 04 metre (approx.) | High |
| | | | - | - |
| | | | - | - |

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| | | Pal/berms | Not found for big size water body | High |
| | | | Not found for small size water body | Medium |
| | | | Found on the circumference of water body | Low |
| | | Inlet | Not present | High |
| | | | Present but needs the required shape | Medium |
| | | | - | - |
| | Sustainability plan | Biological remediation | Designing of floating treatment wetland | High |
| | | | - | - |
| | | | - | - |
| | | Filtration | Rain/storm water mapping and cleaning process | High |
| | | | - | - |
| | | | - | - |
| | | Rotation of cleaning | Preferably each year | High |
| | | | Happening within 6 months | Medium |
| | | | - | - |
| | | Eutrophication prevention | - | - |
| | | | Removing the hyacinth by thrashing and cleaning the water bed | Medium |
| | | | - | - |
| | | Utility benefits | No data provided | High |
| | | | - | - |
| | | | - | - |
| Dried up | Physical infrastructure | Fencing | Bio fencing required | High |
| | | | Wooden/vinyl required | Medium |
| | | | Barbed wires/small-metal/ cemented | Low |
| | | Road | Found on the circumference of water body | High |
| | | | If drains and roads are blocking the flow of water body | Medium |
| | | | No road found | Low |
| | Drain Mapping | Drainage | Black water flow | High |
| | | | Grey water flow | Medium |
| | | | Other water or no drain found | Low |
| | | Bar screen | Drainage pipes direct connect to water body | High |
| | | | No screen/net-mesh/grill found | Medium |
| | | | Other water or no drain found | Low |

| Type Of Water Body | Particulars | Sub - Parameter | Recommendation | Intervention |
|---|---|---|---|---|
| | Catchment area | Agriculture fields/Habitat | Agriculture fields or habitat found | High |
| | | | Both agriculture fields and habitat not found | Medium |
| | | | - | - |
| | | SLWM | Solid waste found on the surface of water body | High |
| | | | Solid waste present around the water body | Medium |
| | | | No solid waste found | Low |
| | | SLWM (Animal waste) | Cattle waste/dung found | High |
| | | | - | - |
| | | | - | - |
| | Inner structure | Dredging | Needs to be done for 04 metre (approx.) | High |
| | | | - | - |
| | | | - | - |
| | | Pal/berms | Not found for big size water body | High |
| | | | Not found for small size water body | Medium |
| | | | Found on the circumference of water body | Low |
| | | Inlet | Not present | High |
| | | | Present but needs the required shape | Medium |
| | | | - | - |
| | Sustainability plan | Biological remediation | - | - |
| | | | - | - |
| | | | - | - |
| | | Filtration | Rain/storm water mapping and cleaning process | High |
| | | | - | - |
| | | | - | - |
| | | Rotation of cleaning | Preferably each year | High |
| | | | Happening within 6 months | Medium |
| | | | - | - |
| | | Eutrophication prevention | - | - |
| | | | - | - |
| | | | - | - |
| | | Utility benefits | No data provided | High |
| | | | - | - |
| | | | - | - |

*Table 5: Intervention Methodology*

## Step 4: Technology tools

1. **CAPI:** Hand-held devices were used for on-field assessment to capture the responses of the stakeholders based on the final questionnaires. All the evidences were geo-tagged with date and time stamp for real-time data quality check. Geo-tagged location facilitated the drone pilots in identifying water bodies for aerial survey.
2. **Depth measurement device:** A Floating device based on SONAR technology was used to capture the depth of water bodies for 'Volumetric assessment'. The Depth measurement device was a set of two devices: (a) Part flows on the surface of the waterbody and measures the depth of the waterbody through ultrasonic waves and (b) depth measurement meter, a hand-held device which displays the depth readings.
3. **Drone technology:** Drone technology was used to capture high- resolution images, final-scaled geo-positioned orthomosaic images with demarcations, and the contour maps. The drone is operated with a mobile device on a pre-planned path set by the pilot. It hovers over the water body to collect multiple geo-tagged points. Area (in acres) of water bodies were measured through GIS compatible drawing file. Shape files of roads, trees, buildings, farmlands were also produced to measure the distance between closest roads, vegetation or agricultural fields from the water body.

## Step 5: Pilot Study

1. To understand the process of water body mapping and ascertaining the framework of the project, a pilot study was conducted in Haridwar district of Uttarakhand and Amroha district of Uttar Pradesh wherein four villages from each district were chosen randomly.
2. Pilot studies for drone assessment were conducted in four villages of Chandauli district of Uttar Pradesh namely Diya, Nagwa, Papraul and Puracheta Dube to test the relevance and efficiency of the framework and survey tools. Corrective measures were taken based on the same before the final Drone assessment.

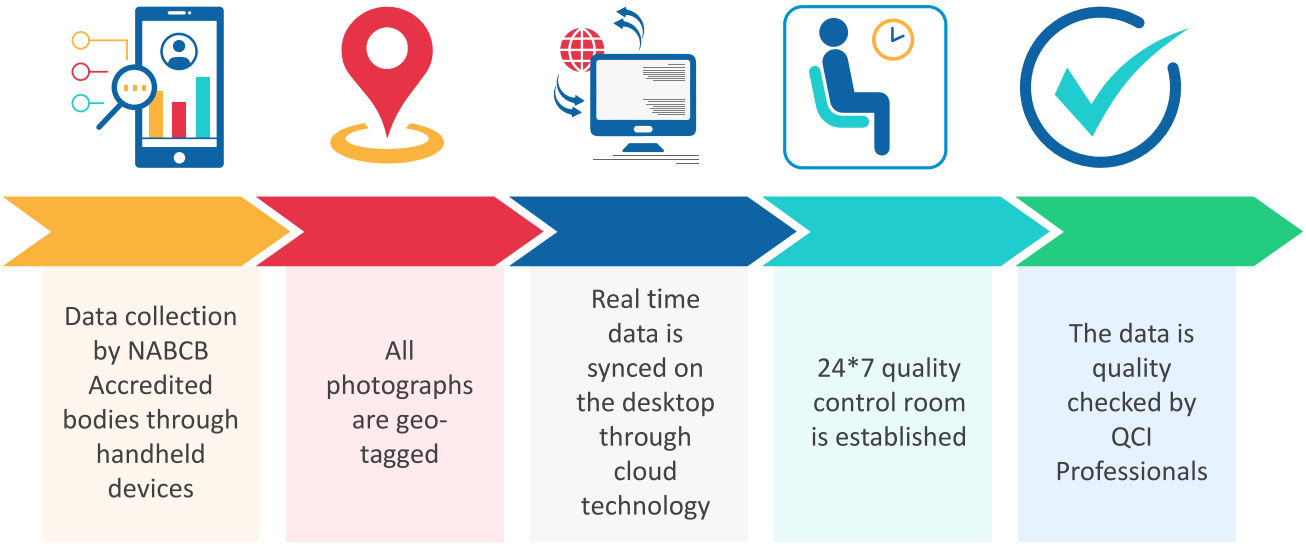
## Step 6: Training of Assessor

National Accreditation Board of Certification Authorities (NABCB) certified Inspection Bodies (IBs) were selected based on their relevant experience in the field of assessment and scale of operations. Detailed classroom and field trainings for the assessors were conducted in Kolkata, West Bengal and Bhubaneshwar, Odisha. Thereafter, the assessors were selected on the basis of a test and personal interview.

## Step 7: On-ground assessment

The on-ground assessment was carried out in two stages: (a) The first stage involved capturing responses of all stakeholders through personal interviews and evaluation of the water bodies based on the questionnaires using CAPI and depth measurement using the floating device, and (b) In the second stage aerial survey was conducted.

**The process of assessment is as below:**




### Data monitoring and Control

A 24*7 war room was set up at Delhi office of QCI to monitor the daily progress, consistency and quality of the survey. The survey results were monitored on a real time basis and the queries of the field assessors was resolved promptly by the team through an 'Assessor help desk'.

The data collected by on field assessor underwent a thorough and rigorous three-layer quality checks:

**Level 1:** Trained assessor collects the data on-ground and uploaded it on a real time basis through mobile application

**Level 2:** Quality check coordinator (stationed at QCI headquarters) who is mapped to an assessor monitored the survey and validated the information received at the back end.

**Level 3:** A senior QCI team member at the control room re-evaluated the field data collected

## Step 8: Analysis and Report

QCI leveraged the expertise of Indian Statistical Institute in analyzing and interpreting statistical data. Data analysis was carried out using software such as Excel or R.

## Step 9: Dashboard creation

A dashboard has been created to display the pictorial data of the key findings of the water bodies in each Ganga basin district. Layered maps include Geo tagged feature, Orthomosiac Map, Contour Map, Ortho Feature map (Circumference, trees, farmlands, residential area), Shape file, Drawing file, DTM, and DSM. Each water body can be identified from their unique codes. The details of all the parameters assessed along with the scores and images of the water bodies could be fetched from the dashboard. Additionally, state of rejuvenation of the water body can also be found. The study has also listed down type of interventions and recommendations for each water body for their protection and rejuvenation which can also be referred from the dashboard.

# 3. PROJECT CHALLENGES

1. **Official support:**

Due to on-going COVID and other issues, few district authorities did not cooperate in providing the required permissions for on-ground assessment. Two districts in West Bengal: Howrah and Murshidabad were not covered, as official permission was not granted for the survey of the waterbodies in these districts.

2. **Obstacles during Turbidity test and Depth Measurement:**

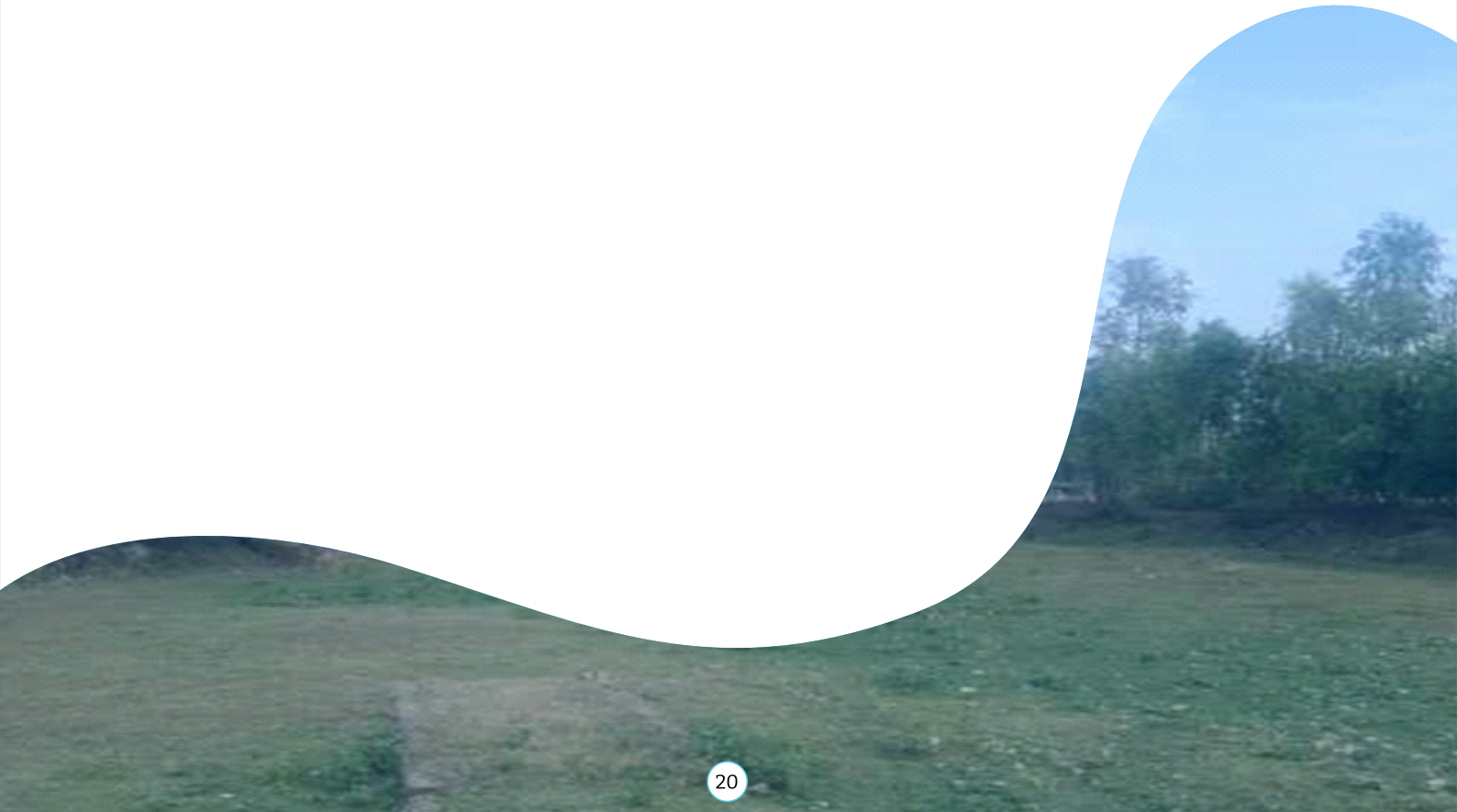
The presence of muddy edges, dense bushes, and thick water hyacinth caused hindrances to collect physical parameters of the water body by the on-field assessors.

3. **Drone Approval:**

It is a cumbersome process to take the approval for flying a drone. QCI professionals went on the field to get the required permissions from the respective District offices.

4. **COVID-19 Pandemic:**

Both the first and second wave had disrupted the on-field operations. Many district officials and key informants were reluctant in interacting with the assessors. Covid-19 also led to hike in drone service charges across the nation and non-availability of the desired standard of drones.



# 4. ASSESSMENT OVERVIEW: State And District

## 4.1 UTTAR PRADESH

### 1.1.1 Introduction

A total of 689 villages in 11 districts situated in Ganga basin were covered in the survey conducted in Uttar Pradesh. A total of 329 water bodies were found in 245 Ganga villages during the survey.

Below table depicts the bifurcation of total number of water bodies identified and mapped on the basis of Districts and in their subsequent Block-wise Villages:

| District | Number of Blocks | Number of Villages with water bodies | Number of water bodies found |
|---|---|---|---|
| Ballia | 5 | 20 | 20 |
| Chandauli | 3 | 22 | 28 |
| Farrukhabad | 5 | 12 | 12 |
| Ghazipur | 9 | 38 | 56 |
| Hardoi | 4 | 9 | 14 |
| Amroha (Jyotiba Phule Nagar) | 4 | 17 | 19 |
| Kasganj (Kanshi Ram Nagar) | 3 | 33 | 46 |
| Sant Ravidas Nagar (Bhadohi) | 5 | 40 | 73 |
| Shahjahanpur | 2 | 8 | 10 |
| Unnao | 8 | 17 | 20 |
| Rae Bareli | 5 | 29 | 31 |
| Total | 53 | 245 | 329 |

*Table 6: District-wise configuration table of Uttar Pradesh*

As per the on-ground data collection, resultant figures came out to be contradictory. Only 35.6 per cent of the villages had water bodies present in them as compared to the total villages assessed in Uttar Pradesh.

District-wise percentage distribution of water bodies is shown in the graph below:

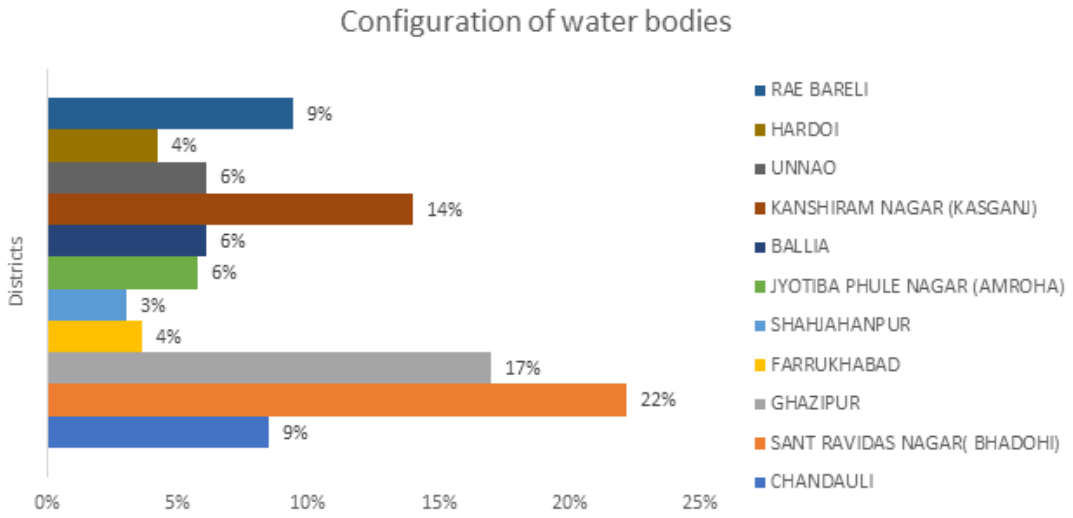



Figure 4.1: District-wise configuration of water bodies

As per the collected data, the Maximum percentage of water bodies were found in Sant Ravidas Nagar (Bhadohi), which accounted for 22 per cent (73). However, the minimum percentage of water bodies were found in Shahjahanpur, which accounted for 3 per cent (10).

With a count of 103 villages, the Maximum number of villages were assessed in Ghazipur district, wherein a total count of 56 water bodies were identified. On the other hand, with a count of 12, the least number of villages were assessed in Shahjahanpur wherein, 10 water bodies were identified.

The following six blocks in their respective Ganga districts did not have water bodies:

| District Name | Block with No Water body |
|---|---|
| Ballia | Sohanv |
| Farrukhabad | Kamalganj |
| Ghazipur | Saidpur |
| Unnao | Ganj moradabad |
| Unnao | Sikandarpur sarausi |
| Unnao | Sumerpur |

*Table 7: Blocks of Uttar Pradesh with no water bodies*

## 4.1.2 Scorecard: Uttar Pradesh

### 4.1.2.1 District-wise scores and descriptors

Below table depicts a tabular representation of the scores backed by each district of Uttar Pradesh along with performance descriptor and its rank:

| State: Uttar Pradesh | | | |
|---|---|---|---|
| **Rank** | **District** | **Score (300)** | **Descriptors** |
| 1 | Chandauli | 202.93 | Good |
| 2 | Shahjahanpur | 202.23 | Good |
| 3 | Unnao | 188.58 | Good |
| 4 | Ghazipur | 188.54 | Good |
| 5 | Kanshiram Nagar (Kasganj) | 181.91 | Good |
| 6 | Hardoi | 180.93 | Good |
| 7 | Sant Ravidas Nagar (Bhadohi) | 180.28 | Good |
| 8 | Ballia | 177.32 | Average |
| 9 | Jyotiba Phule Nagar (Amroha) | 173.44 | Average |
| 10 | Farrukhabad | 173.08 | Average |
| 11 | Rae Bareli | 165.24 | Average |

*Table 8: District-wise scores and descriptors*

### 4.1.2.2 Graphical representation of District-wise score of Uttar Pradesh

Scores have been summarized on the basis of all the seven indicators mentioned in scoring methodology, which were considered as the key factors for evaluation of the water bodies. As per the evaluation, Uttar Pradesh stands with an average score of 183.13 out of 300.

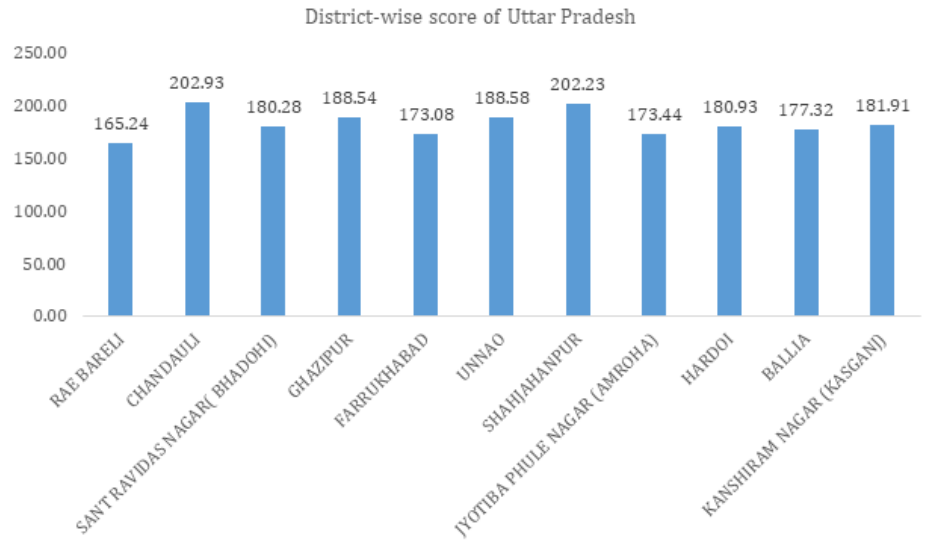



*Figure 4.2: District-wise scores of Uttar Pradesh*

The resultant score indicates an overall 'Good' performance by the State. Chandauli was found to be the best performing district with a score of 202.93. However, Rae Barelli with a score of 165.24, found to be the worst performing district of Uttar Pradesh.

### 4.1.2.3 Indicator-wise scores of Uttar Pradesh

The figure given below represents indicator-wise comparison of the State average and National average scores. Evaluation of scores and grades was done on the basis of seven key indicators mentioned in the graph below:

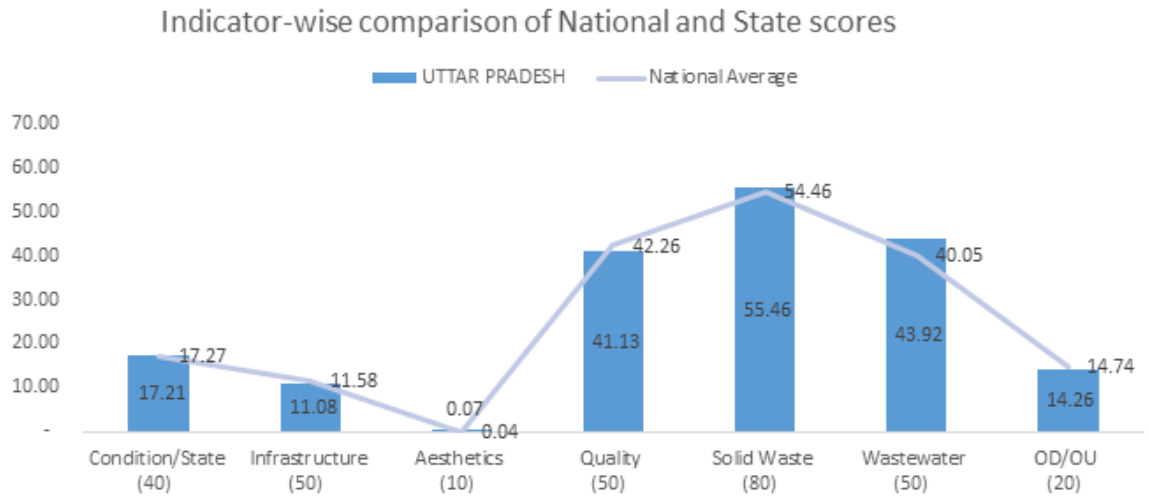



*Figure 4.3: Indicator-wise comparison of National and State scores*

1. **Condition/state,** which plays a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the condition of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, bridges, religious architectures/idols, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depict indicator-wise National average of the survey and the bar graph represents the indicator wise scores of Uttar Pradesh.

- Indicators of Uttar Pradesh namely, Condition/State, Infrastructure, Aesthetics, Quality and OD/OU maintains the mean score corresponding to the National score
- Whereas, in terms of Solid waste disposal, score of Uttar Pradesh is better than the National score. Also, score of Uttar Pradesh in terms of Wastewater drainages is good as compared to the National score
- However, in terms of 'Quality', the state didn't perform well.

### 4.1.2.4 Performance based descriptors of Uttar Pradesh

Water bodies found in various districts of Uttar Pradesh were lying under different descriptors as per their performances. These descriptors are characterized by seven indicators for evaluation of water bodies, which denotes 'Water body Cleanliness Index'.

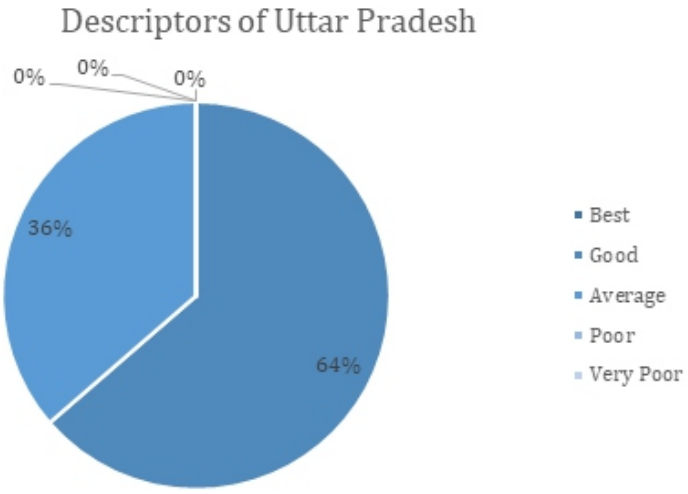



*Figure 4.4: Performance based descriptors of Uttar Pradesh*

'Best' and 'Good' indicates that lower level of intervention is required for the water bodies, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of the water bodies. In addition, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 64 per cent of the water bodies falls under 'Good' descriptor which requires less of revival and more measures of sustainability. Whereas, 36 per cent of water bodies lie in the 'Average' band. These require medium level of intervention for rejuvenation.

## 4.1.3 Key findings

The data was thoroughly revised and underwent a rigorous three-layered quality check so that important findings of the study could be highlighted for each state or district.

'Figure 4.5' summarizes all the key findings with respect to the selected 11 Districts of Uttar Pradesh situated in Ganga Basin. Across these districts, a total of 689 villages have been assessed by QCI. Out of which, a total of 329 water bodies were found in 245 Ganga villages during the survey. The percentage figures highlight that how many water bodies had the presence of below-mentioned parameters out of the total water bodies surveyed. These figures may be attributed to the performance of a water body in the 'Water Body Cleanliness Index'.

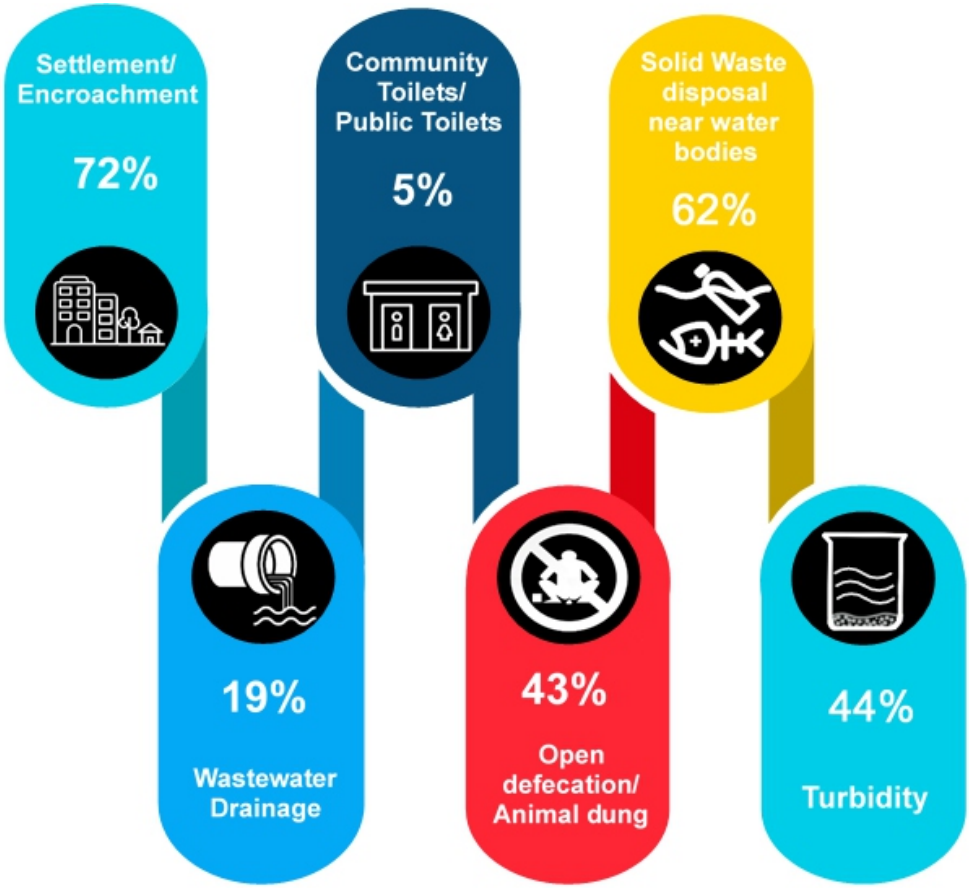



*Figure 4.5: Key finding of water bodies found in Uttar Pradesh*

### 4.1.3.1 Categorization of water bodies (Healthy/ Water hyacinth/Eutrophied/ Dried up)

Categorization constitutes the total number of water bodies found in each state based on their condition. This helps in determining the 'Level of Intervention' required. As per the data collected from on-field assessment, water bodies are divided into 4 categories.

Figure mentioned below is with respect to the categorization of 329 water bodies assessed during the survey:

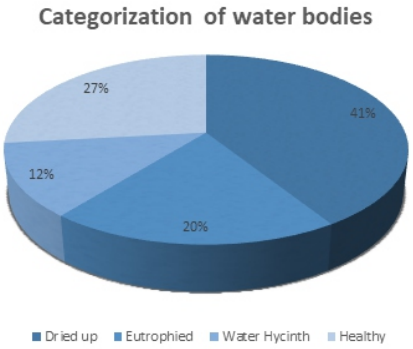



*Figure 4.6: Categorization of water bodies*

In Uttar Pradesh, only 20 per cent of the water bodies were found to be healthy and 12 per cent had Water hyacinth present in them. The study also found that, these water bodies had socio-economic benefits attached with them. For example: Domestic usage, Irrigation purposes, drinking water for cattle and pisciculture.

However, 41 per cent of the total water bodies were Dried-up. These water bodies were converted into dumping sites by the villagers according to the photographs received on assessment portal. Also, 27 per cent of the water bodies were found to be Eutrophied i.e. water bodies having algal blooms/layers and low oxygen saturation levels. It was found that villagers living nearby these water bodies, were not able to use water for any domestic or commercial benefits. Only Ground-water recharge could be done as per the key informants.

The results based on these findings indicated towards a dire need to implement rejuvenation plans to sustain the existing water bodies present in the Ganga basin.

### 4.1.3.2 Settlements under Catchment area

Catchment area of a water body plays a crucial role in determination of its overall health. Either it becomes a reason for its replenishment through sources like Storm water drainages or it can become a cause for its depletion due to contamination from Wastewater drainages, Industrial effluents and Solid waste disposal, which constitutes as factors of non-point source pollution. Hence, dense settlements in the catchment area can alter the status of the water bodies.

**a.** Figure mentioned below is with respect to the 'Settlements (within 250m)' found out of 329 water bodies assessed during the survey:

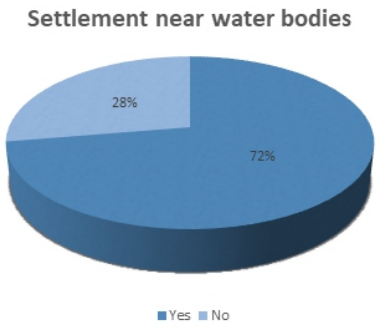



*Figure 4.7: Settlement near water bodies*

Settlements were found near 72 per cent of the total water bodies which can become a major reason for its contamination. Moreover, cases of illegal possession of land around the water bodies were found according to the citizen feedbacks.

**b.** Figure mentioned below is with respect to the percentage distribution of Settlement found near 238 water bodies across 11 districts:

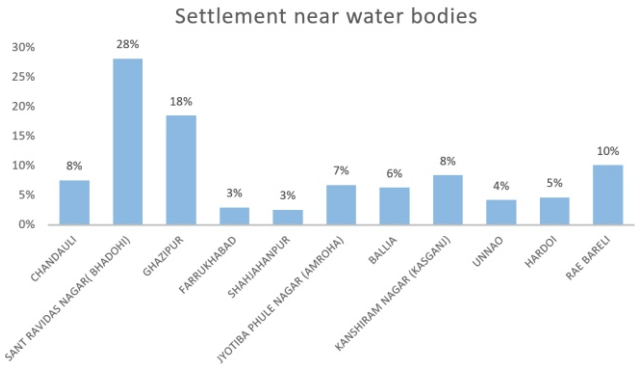



*Figure 4.8: Settlement near water bodies (District-wise)*

- Highest percentage of settlements was found near water bodies present in Sant Ravidas Nagar (Bhadohi) district with 28 per cent.
- Lowest percentage of Settlements was found near water bodies present in Districts: Shahjahanpur and Farrukhabad with 3 per cent each.

**c.** The figure mentioned below is with respect to the 'Percentage distribution of Type of Settlements' found near 238 water bodies across 11 districts:

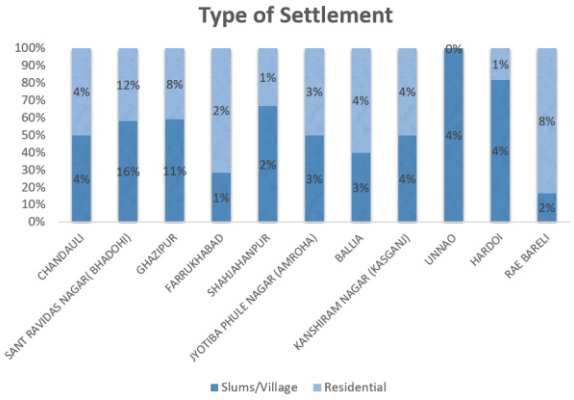



*Figure 4.9: Type of Settlement (District-wise)*

- Highest percentage of Slum/Village and Residential settlements was found in Sant Ravidas Nagar (Bhadohi) with 16 per cent and 12 per cent respectively
- Lowest percentage of Slum and Residential settlements was found in Farrukhabad and Unnao with 1 per cent and Zero percent respectively

About, 59 per cent of the water bodies having settlements nearby, were found to be non-functional. Hence, health of the water bodies present in these villages depended upon factors like Washing, Bathing, Leachate, Septic tank and its Drainage run-off.

**Note:** No Commercial settlement was found nearby water bodies assessed in Uttar Pradesh.

### 4.1.3.3 Drainage

A part of this survey focused on 'Wastewater' drainages found near the water bodies and their impacts on the Catchment area. These drainages had their outlets connected from nearby households, space available for washing/bathing, construction sites, small-scale factories and agricultural fields. Wastewater drainage is one of the major causes of contamination, which disturbs the ecosystem of a water body. On the other hand, Rain and Storm water drainages were found to be Natural sources for its replenishment.

**a.** Figure mentioned below is with respect to the 'Wastewater drainage' found out of 329 water bodies assessed during the survey:

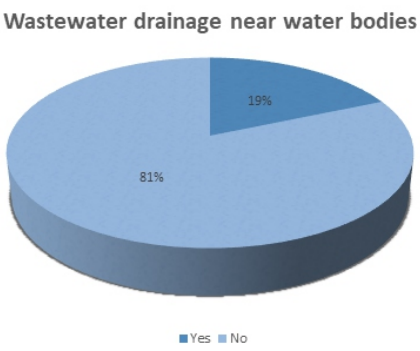



*Figure 4.10: Wastewater drainage near water bodies*

About 19 per cent of the total water bodies found in Uttara Pradesh were found having Wastewater drainage on its edge/nearby or connected in a way that it inflicted them primarily. Drainage run-off directly into the water bodies turned out to be one of the major factors for Algal blooms and Low oxygen saturation levels present in it.

**b.** Figure mentioned below is with respect to the percentage distribution of Wastewater drainage found near 61 water bodies across 11 districts:

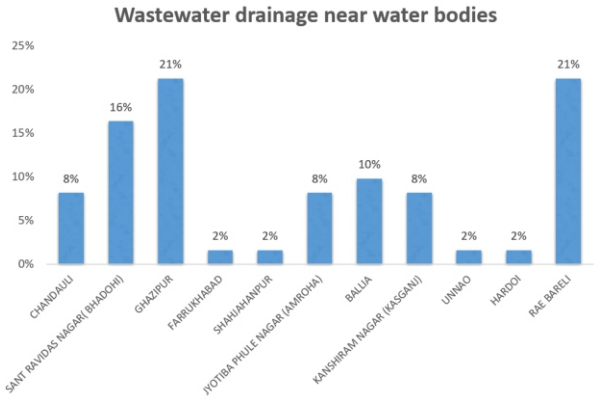



*Figure 4.11: Wastewater drainage near water bodies (District- wise)*

- Highest percentage of wastewater drainage was found near water bodies present in the Districts: Ghazipur and Rae Bareli with 21 per cent each
- Lowest percentage of wastewater drainage was found near water bodies present in the Districts: Shahjahanpur, Farrukhabad, Unnao and Hardoi with 2 per cent each

**c.** Figure mentioned below is with respect to the 'Drainage' near 61 water bodies assessed during the survey:

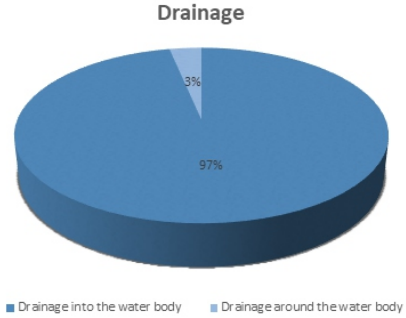



*Figure 4.12: Drainage*

About 97 per cent of the drainage directly flow into the water bodies. However, only 3 per cent of the total drainages flows around/on the edge of water bodies.

This study states that flow of Storm-water drainage directly into the water bodies replenished them. On the other hand, flow of wastewater drainage directly into water bodies is harmful for its health. Moreover, it was observed that Secondary treatment plant or Filtration mechanism were not found near water bodies.

As per the assessment, only two water bodies present in the Bhanwarkol block of Ghazipur with drainage outlets were found to have Screens/Mesh/Grills/Bars at its openings. This implied that the rest 99 per cent did not have any such screens at the opening of its drainage. Hence, paving the way for accumulation of solid waste and excessive nutrients into the water bodies.

### 4.1.3.4 Correlation

Correlation of dried-up water bodies with road connectivity came out as 0.4356. It can be interpreted that construction of road is one of the causes of water bodies ending up dried.

### 4.1.3.5 Solid waste found around/on the surface of water bodies

Absence of dustbins near water bodies resulted in increased accumulation of wet and dry waste that subsequently led to its contamination. Additionally, leachate formed due to accumulation of dry and wet waste causes foul smell and foaming, which directly affected heath of the water bodies.

**a.** Figure mentioned below is with respect to the Solid Waste present around/on the surface out of 329 water bodies assessed during the survey:

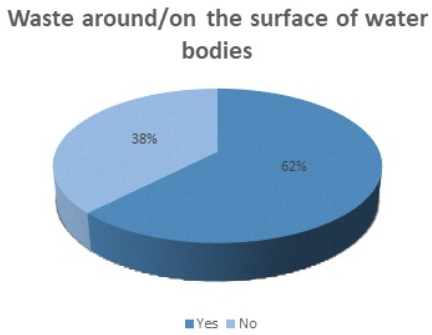



*Figure 4.13: Waste around/on the surface of water bodies*

Out of 329, 205 water bodies had solid waste present around/on its surface. Furthermore, it was found that, there were no methods of Fine mechanisms or Anti-littering signage near public water bodies to discourage such unhealthy activities.

Hence, it is observed that awareness campaigns were primarily needed to be conducted to avoid such uninhabitable conditions.

**b.** Figure mentioned below is with respect to the percentage distribution of Solid waste found around/on the surface of 205 water bodies across 11 districts:

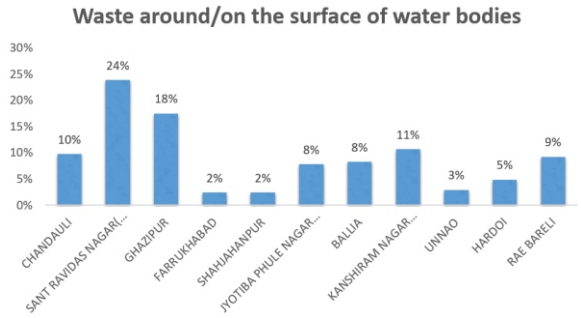



*Figure 4.14: Waste around/on the surface of water bodies (District-wise)*

Solid waste was found around/on the surface of 205 water bodies. District-wise bifurcation of the same is mentioned in the above figure.

- Sant Ravidas Nagar (Bhadohi) was found with highest percentage of solid waste around/on the surface of water bodies with 24 per cent
- Farrukhabad and Shahjahanpur were marked with lowest percentage of solid waste found around/on the surface of water bodies with 2 per cent each

### 4.1.3.6 Community toilet/Public toilet management near water bodies

**a.** Figure mentioned below is with respect to the 'Community toilet/Public toilet' found out of 329 water bodies assessed during the survey:

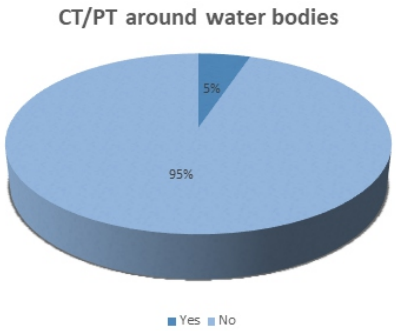



*Figure 4.15: CT/PT around water bodies*

Community/Public toilets found near the water bodies in Uttar Pradesh were not in a condition to be called proper or usable. In the name of toilets, small cubicles were found during the assessment, which constitutes only five per cent of the total water bodies.

The toilets should be made at a distance of 50 meters at least, so that it does not lead to open defecation and open urination near water bodies. Furthermore, septic tank waste can be prevented from entering the water bodies and safe disposal could be ensured.

Hence, non-availability of the same leads to Open Defecation and Open Urination nearby water bodies.

**b.** Figure mentioned below is with respect to the 'Percentage distribution of Community/ Public toilet' found near 17 water bodies across 11 districts:

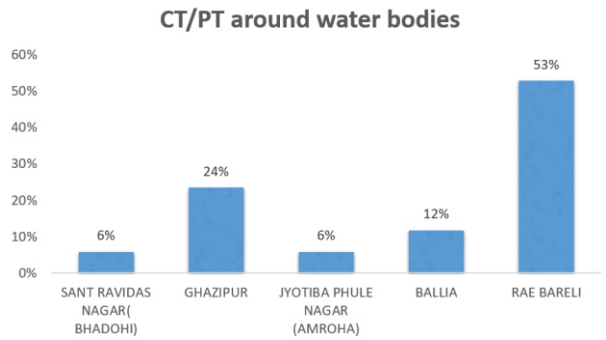



*Figure 4.16: CT/PT around water bodies (District-wise)*

- Highest percentage of community/public toilet was found near water bodies present in Rae Bareli which accounts to 53 per cent.
- Lowest percentage of community/public toilet was found near water bodies present in Districts: Sant Ravidas Nagar (Bhadohi) and Jyotiba Phule Nagar (Amroha) with 6 per cent each.

**Note:** Water bodies found in Chandauli, Hardoi, Unnao, Kanshiram Nagar (Kasganj), Shahjahanpur and Farrukhabad did not have any community/public toilet nearby.

### 4.1.3.7 Open Defecation (Animal dung/ Human faecal matter) found

**a.** Figure mentioned below is with respect to the 'Open Defecation' found out of 329 water bodies assessed during the survey:

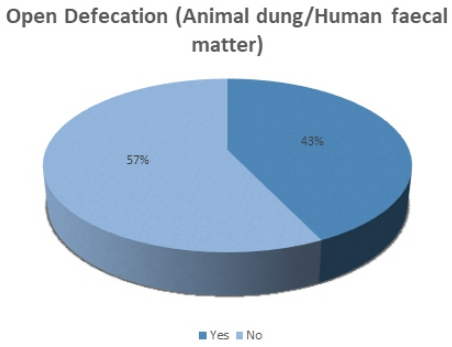



*Figure 4.17: Open Defecation (Animal dung/Human faecal matter)*

Open Defecation was found around 43 per cent of the total water bodies that were found in Uttar Pradesh. Rest of the water bodies did not have any sign of Animal dung or Human faecal matter around them.

During such practices, excessive nutrients which constitutes a major proportion of Nitrogen and Phosphorus, enters the water body through Animal dung and Human feces. This turns out to be a reason for excessive plants and algal growth in water bodies. Such conditions can lead to sickness and poor health in humans.

**b.** Figure mentioned below is with respect to the percentage distribution of Open Defecation' found near 141 water bodies across 11 districts:

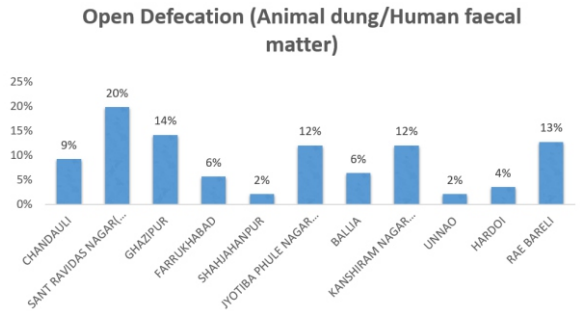



*Figure 4.18: Open Defecation: Animal dung/Human faecal matter (District-wise)*

- Highest percentage of Open Defecation was found near water bodies present in Sant Ravidas Nagar (Bhadohi) with 20 per cent.
- Lowest percentage of Open Defecation was found near water bodies present in Districts: Shahjahanpur and Unnao with 2 per cent each.

### 4.1.3.8 Turbidity assessment (Water quality)

Turbidity test could be undertaken for 61% (Healthy + Water Hyacinth + Eutrophication) of the total water bodies found in Uttar Pradesh.

Figure 4.19 mentioned below is with respect to 'Turbidity (Beaker test)' of water present in 201 water bodies during assessment:

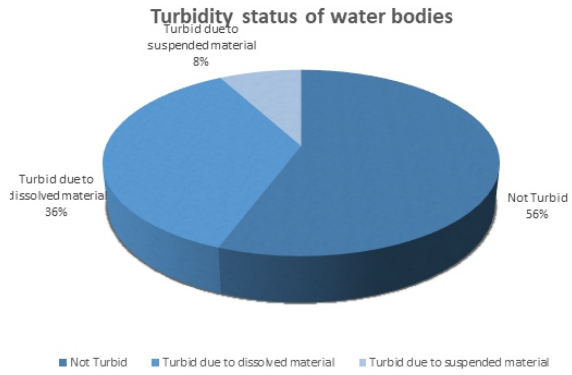



*Figure 4.19: Turbidity status of water bodies*

Non-point sources of pollution like Agricultural fields, Industry/factory and Construction sites discharging excessive nutrients/ minerals, harmful chemicals/effluents and Silt respectively, were found to be directly affecting the water quality. On the other hand, local habitat activities such as Washing, Drain connect, Open Defecation played a direct role in worsening the water body's health.

About 56 per cent of the total water bodies were found to be 'Not Turbid'. This implied that the quality of water is good whereas, 36 per cent of the water bodies were found to be 'Turbid due to dissolved material'. It means, mud/silt is present is present in huge amount.

Only 8 per cent of the water bodies were found to be 'Turbid due to suspended material', which defines the presence of heavy siltation, small pebbles and other solid waste. However, a scientific exception stating presence of temporary siltation and small stones/pebbles was not considered damaging the health of water bodies.

These factors lead to the Eutrophication (formation of layers of Algae), which by time lowers the oxygen saturation levels, blocks sunlight to reach water body's bed and ultimately damages its eco-system. Accumulation of solid waste on the surface of water bodies and its Bed majorly disrupts daily utility benefits, which the local inhabitants enjoy. Some of the major disruptive activities includes pious activities, Idol immersion, disposing Clothes, Leather, Plastics, Tin, etc.

### 4.1.3.9 Additional indicators

Figure 4.20 depicted below is with respect to some other indicators of 329 water bodies that were assessed during the survey:

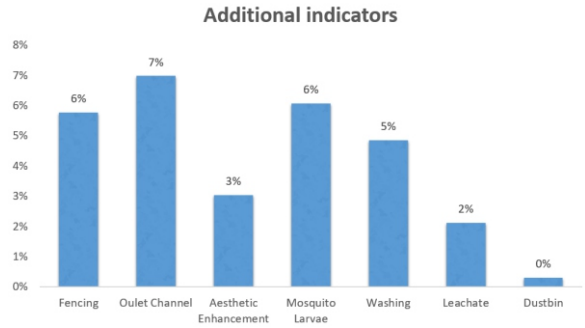



*Figure 4.20: Additional indicators assessed during the survey*

**Fencing** can be metal, Cemented, Barbed wire, Wooden, Vinyl or made of Plant (Bio-fencing) to restrict unwanted entry of cattle near water bodies. On-ground assessment indicates that only 6 per cent of the total water bodies had fencing on its periphery. Bio-fencing plays a major role in maintaining health of a water body and works as a shield against non-point sources of pollution. In addition, small trees on the edges of a water body holds the Pal (Boundary) in order to maintain the water body's depth.

7 per cent of the total water bodies had **Outlet channels** to deal with the overflow and flood like conditions. Cemented and Mud-pitched type outlet channels were found during the survey, which is a good sign for any water body.

Villagers find it inconvenient to get utility benefits from water bodies especially during high temperatures in absence of sheds, as per the survey. It was observed that only 3 per cent of the total water bodies have **Aesthetic enhancement**/ beautification around them, which might include benches, bridges, fencing, sheds and grass/gardening.

**Mosquito Larvae** was found in 6 per cent of the total water bodies. It was majorly detected through Turbidity tests undertaken by assessors in a transparent beaker or transparent disposable container. Villagers do not consume this water due to its high contamination level/load of pollutants as well as the fact that the area is prone to diseases like Malaria, Dengue and Chikungunya.

**'Washing'** (under 50m) as an activity was observed around/on the edges of 5 per cent of the total water bodies. This contaminated the water bodies directly as per direct observation. 'Grey water' is claimed to be harmful for water bodies as it enters without any secondary treatment or filtration process. In a similar manner, 2 per cent of the total water bodies were found to be contaminated by direct flow of **leachate.**

Only 0.3 percent of the total water bodies have **dustbin** present nearby for Solid Waste Management (SWM). Absence of dustbins leads to accumulation of waste around and on the surface of water bodies, which is harmful for its health.

## 4.1.4 District Overview: Report card and Scorecard

### 4.1.4.1 DISTRICT REPORT: CHANDAULI

#### Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

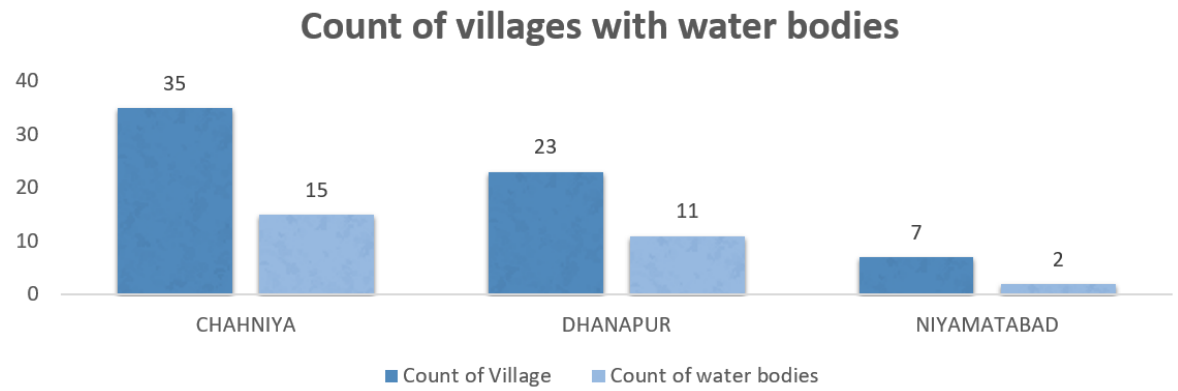



*Figure 4.21: Count of villages in Chandauli with water bodies*

Three blocks of Chandauli district were found to have water bodies within Ganga basin. 28 water bodies were identified during the survey of 65 villages in Chandauli.

- 35 villages were assessed in Chahniya where, 15 water bodies were found.
- 11 water bodies were found in 23 villages of Dhanapur and only 2 water bodies were found in the 7 villages of Niyamtabad block.

#### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

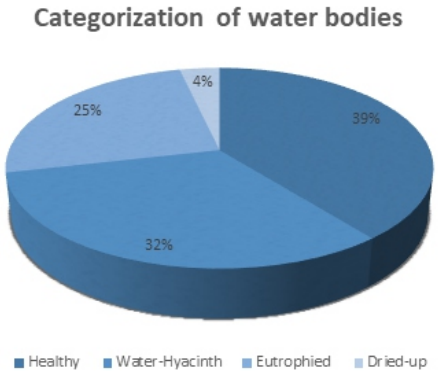



Figure 4.22: Categorization of water bodies in Chandauli

The study found that 4 per cent of the total water bodies fall under Dried-up category while 25 per cent were Eutrophied. In addition, 32 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

## Turbidity

Turbidity test was undertaken for 24 water bodies of Chandauli district, as per the availability of water.

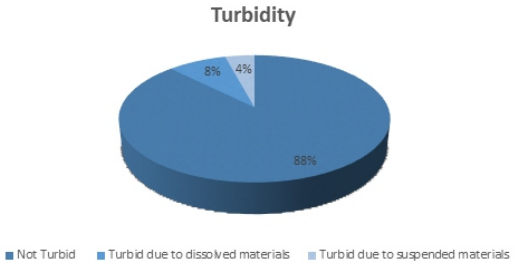



Figure 4.23: Turbidity in water bodies of Chandauli

As per Figure 4.23, 88 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas 4 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 8 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

## Settlement near water bodies

**Figure 4.24** depicts block-wise 'Percentage distribution of Settlement' found in Chandauli district. 100% accountability has been captured under 2 blocks with a total count of 18 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies, which were found in Blocks: Niyamtabad

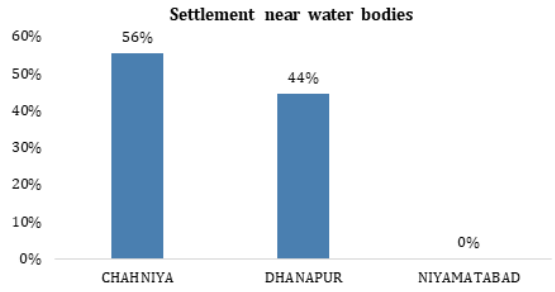



Figure 4.24: Settlement near water bodies in Chandauli

**Figure 4.25** configures two types of settlement, which denotes that Slums/village has 50 per cent occupancy and another 50 per cent of the water bodies were surrounded by Residential households.

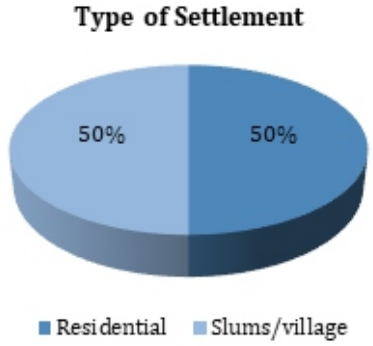



Figure 4.25: Type of Settlement around water bodies in Chandauli

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

## Wastewater drainage and Solid waste

Pie-chart, **Figure 4.26** represents Wastewater drainage present near water bodies assessed in Chandauli, where 18 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

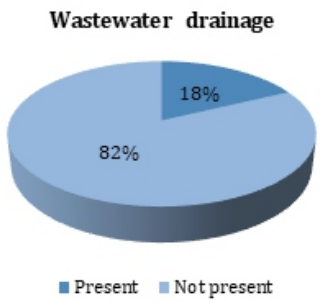



*Figure 4.26: Wastewater drainage in and around water bodies in Chandauli*

As per **Figure 4.27,** it was observed that,

- Chahniya accounts for the highest total as 53 per cent of the water bodies had solid waste present in/around them
- Whereas, Dhanapur and Niyamatabad accounts for 37 per cent and 10 per cent of the water bodies having solid waste in/around them

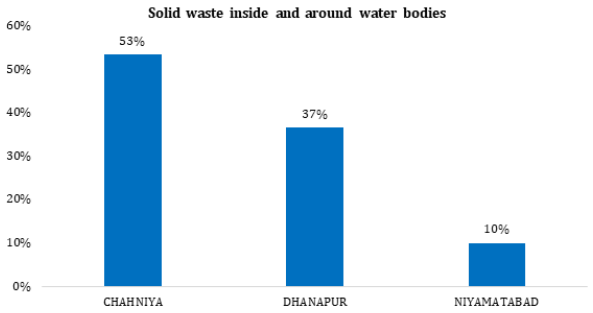



*Figure 4..27: Solid waste inside and around water body in Chandauli*

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: Chandauli

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Chandauli along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Niyamatabad | 220.0 | Good |
| 2 | Dhanapur | 195.2 | Good |
| 3 | Chahniya | 193.6 | Good |

*Table 9: Ranking of Blocks in Chandauli based on scores*

### Graphical representation of block-wise scores of Chandauli

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

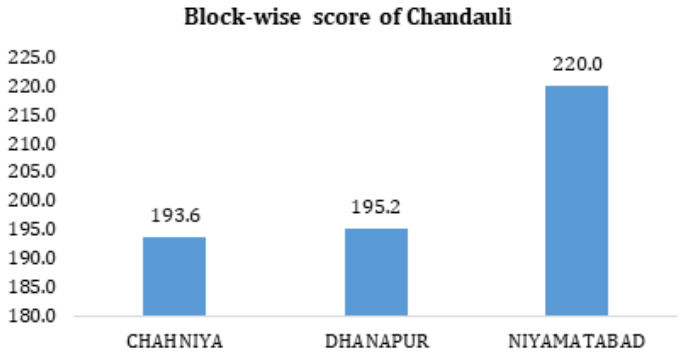



*Figure 4.28: Block-wise score of Chandauli*

On the basis of performance, it was found that water bodies present in various blocks of Chandauli stands with an average score of 202.9 out of 300. The resultant score indicates a 'Good' performance by Chandauli district.

- Niyamatabad tops the chart among other three blocks, by obtaining an average score of 220 out of 300.
- Lowest score has been attained by Chahniya as 135.6 among the three blocks.

## Indicator-wise scores of Chandauli

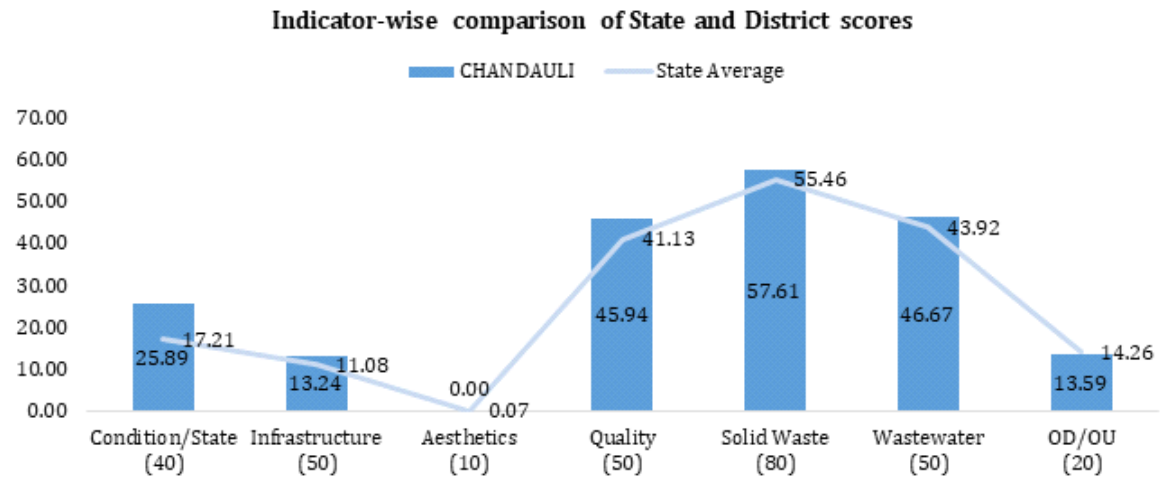



*Figure 4.29: Indicator-wise scores of Chandauli*

Above bar graph represents the overall score of Chandauli district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Chandauli district.

- Indicators of Chandauli namely, Aesthetics and OD/OU maintains the mean score corresponding to the State score.
- Whereas, in terms of Condition/State, Infrastructure, Quality, Solid waste disposal and Wastewater drainages, score of Chandauli is better than the State score.

**Performance based descriptors of Chandauli**

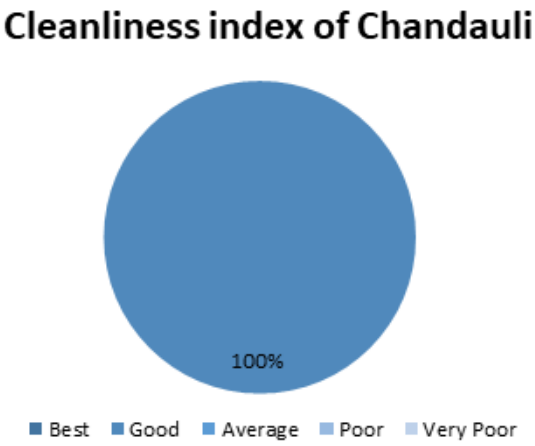


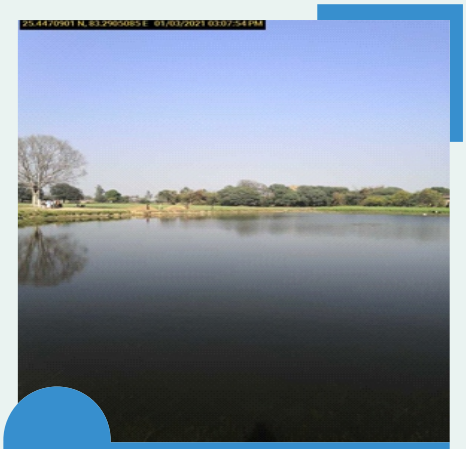

*Figure 4.30: Cleanliness index of Chandauli*

Water bodies found in various blocks of Chandauli were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 100 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Hence, no water body lied under any other descriptor.

# Images of water bodies in CHANDAULI

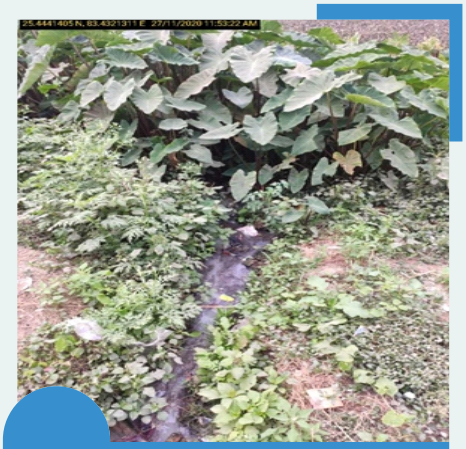


Healthy
UP_DIYA_206976_006041_W1

Water Hyacinth
UP_MAHARUARA_206955_005781_W1

Dried up
UP_NADI NIDHAURA_206817_005811_W1

Eutrophication
UP_MAHUARI KALAN_206863_005792_W2



Drainage connected
UP_PAPRAUL_207007_006182_W2

Not turbid
UP_KAWAR_206952_005771_W1

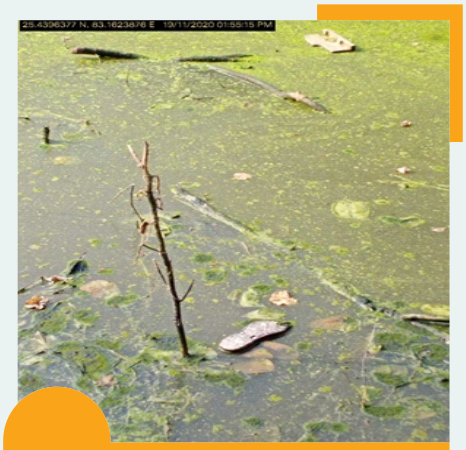
OD
UP_PAPRAUL_207007_006182_W2

Settlement nearby | UP_PURASEETA MISHRA _Tmp512890_027551_W1

Turbid due to dissolved material
UP_PURA GANESH_206850_005861_W1

Turbid due to suspended material
UP_SARAI_111081_005921_W1

Waste around
UP_PAPRAUL_207007_006182_W2



Waste on the surface
UP_MAHUARI KALAN_206863_005792_W2

## 4.1.4.2 DISTRICT REPORT: Shahjahanpur

### Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

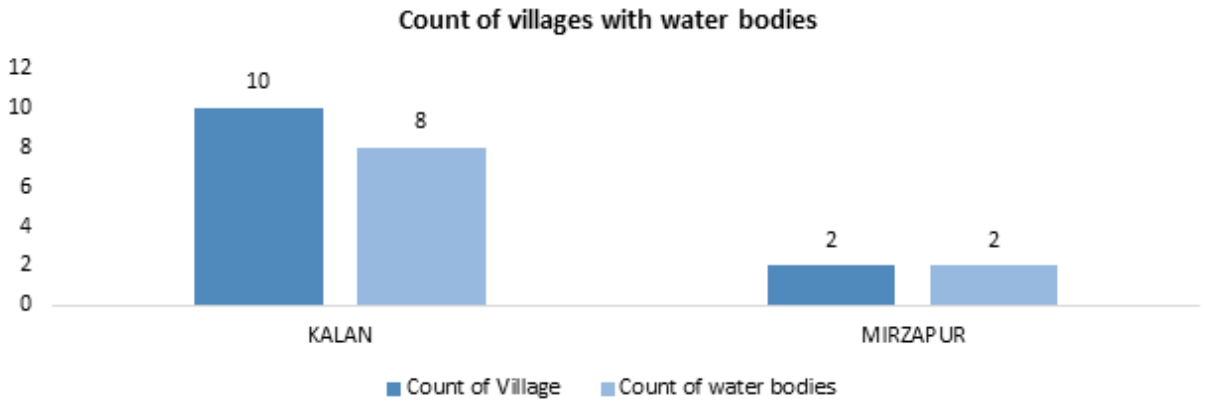



Figure 4.31: Count of villages in Bhagalpur with water bodies

Two blocks of Shahjahanpur district were found to have water bodies within Ganga basin. 10 water bodies were identified during the survey of 12 villages in Shahjahanpur.

- 10 water bodies were identified during the assessment in 8 villages of Kalan block.
- 2 villages were assessed in Mirzapur block and only 2 water bodies were found.

**Categorization of the water bodies**

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

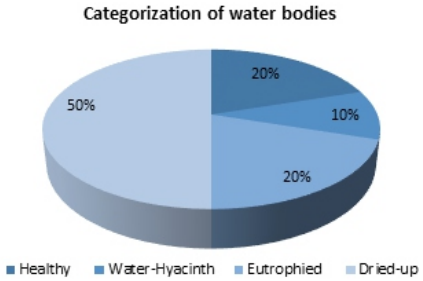



Figure 4.32: Categorization of water bodies in Bhagalpur

The study found that 50 per cent of the total water bodies fall under Dried-up category and 20 per cent were Eutrophied. In addition, 20 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 5 water bodies of Shahjahanpur district, as per the availability of water.

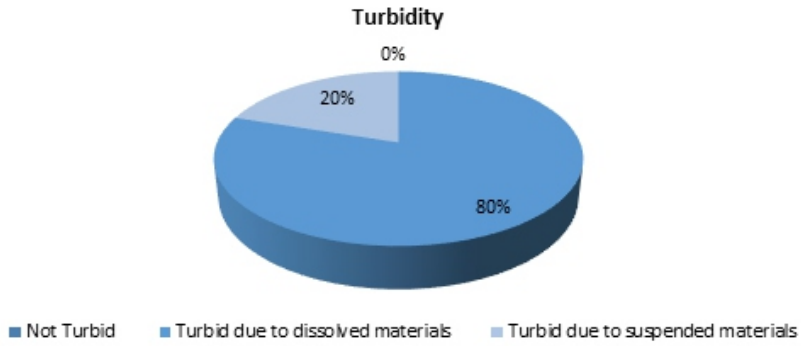



*Figure 4.33: Turbidity in water bodies of Shahjahanpur*

As per Figure 4.33, there was not a single water body which can be called as 'Not Turbid'. It denotes that clear and transparent water was not present in the water bodies, which is not good for usage and health of habitat situated nearby.

Whereas, 80 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 20 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.34 depicts block-wise 'Percentage distribution of Settlement' found in Shahjahanpur district. 100% accountability has been captured under 2 blocks with a total count of 6 Water bodies, having settlement present within 200-250 meters of its radius.

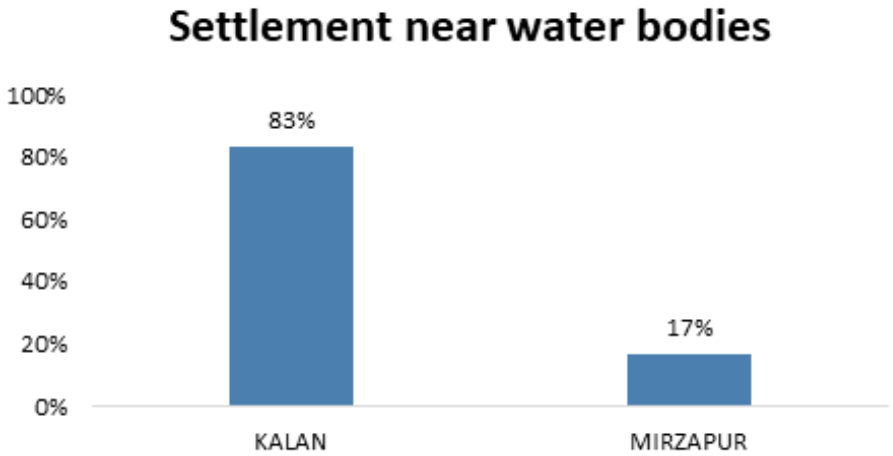



*Figure 4.34: Settlement near water bodies in Shahjahanpur*

Figure 4.35 configures two types of settlement, which denotes that Slums/village has 67 per cent occupancy and 33 per cent of the water bodies were surrounded by Residential households.

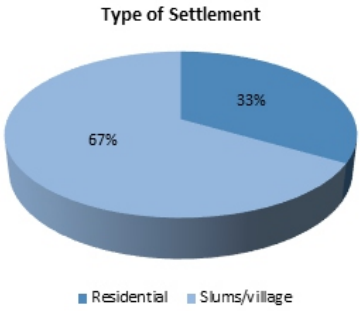



Figure 4.35: Type of Settlement around water bodies in Shahjahanpur

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.36 represents Wastewater drainage present near water bodies assessed in Shahjahanpur, where 10 percent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

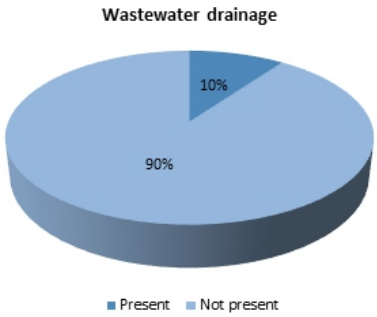



Figure 4.36: Wastewater drainage in and around water bodies in Shahjahanpur

As per figure 4.37, it was observed that,

- Kalan accounts for 83 per cent of the water bodies having solid waste present in/around them.
- Mirzapur accounts for 17 per cent of the water bodies having solid waste present in/around them.

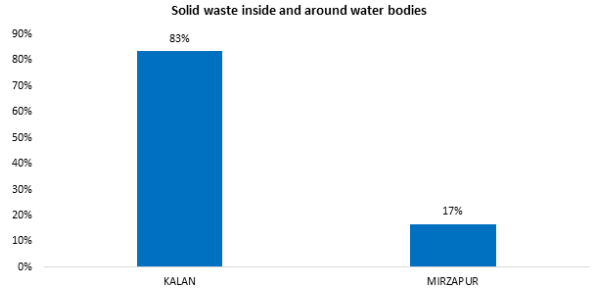



Figure 4.37: Solid waste inside and around water body in Shahjahanpur

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

# DISTRICT SCORECARD: SHAHJAHANPUR

## Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Shahjahanpur along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Mirzapur | 212.5 | Good |
| 2 | Kalan | 192.0 | Good |

*Table 10: Ranking of Blocks in Shahjahanpur based on scores*

## Graphical representation of block-wise scores of Shahjahanpur

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

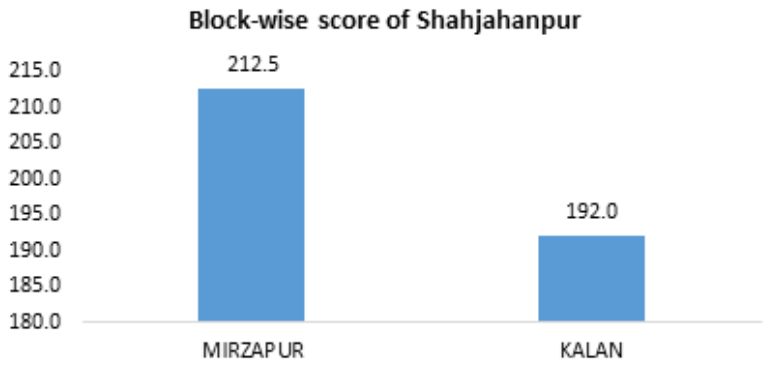



*Figure 4.38: Block-wise score of Shahjahanpur*

On the basis of performance, it was found that water bodies present in various blocks of Shahjahanpur stands with an average score of 202.2 out of 300. The resultant score indicates a 'Good' performance by Shahjahanpur district. Mirzapur scored the highest as 212.5. However, Kalan attained 192 out of 300.

## Indicator-wise scores of Shahjahanpur

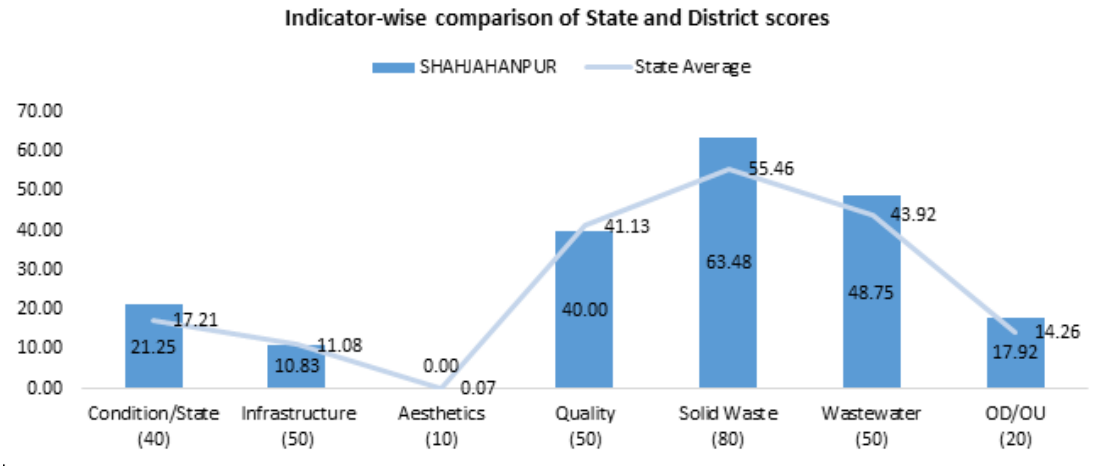



*Figure 4.39: Indicator-wise scores of Shahjahanpur*

Above bar graph represents the overall score of Shahjahanpur district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Shahjahanpur district.

- Indicators of Shahjahanpur namely, Infrastructure and Aesthetics maintains the mean score corresponding to the State score.
- Whereas, in terms of Condition/State, Solid waste disposal, Wastewater drainages and OD/OU, score of Shahjahanpur is better than the State score.
- However, Shahjahanpur performed poorer than the State in terms of Quality.

**Performance based descriptors of Shahjahanpur**

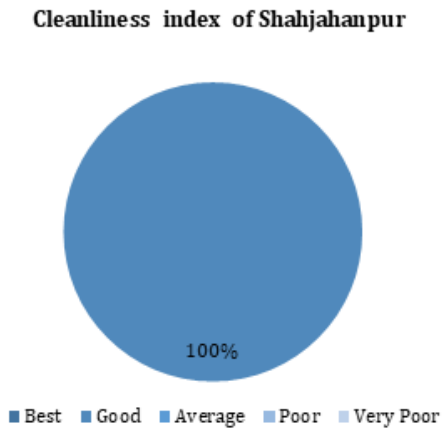



Figure 4.40: Cleanliness index of Shahjahanpur

Water bodies found in various blocks of Shahjahanpur were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 100 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. However, no water body fall under other four descriptors.

# Images of water bodies in SHAHJAHANPUR

Healthy
UP_HATAMPUR_114087_010422_W2

Water Hyacinth
UP_DOSHPUR THOK_134701_010491_W1

Dried up - UP_JAHANABAD KHAMERIYA_134600_010431_W1

Eutrophied
UP_USMANPUR_110677_010462_W2

Drainage connected
UP_USMANPUR_110677_010462_W2

OD
UP_USMANPUR_110677_010461_W1

Road connected
UP_CHARNOK_134606_010471_W1

Settlement nearby
UP_HATAMPUR_114087_010422_W2

Turbid due to dissolved material
UP_HATAMPUR_114087_010422_W2

Turbid due to suspended material - UP_DOSHPUR THOK_134701_010491_W1

Waste around UP_USMANPUR_110677_010461_W1

Waste on the surface UP_USMANPUR_110677_010461_W1

## 4.1.4.3 DISTRICT REPORT: UNNAO

### Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

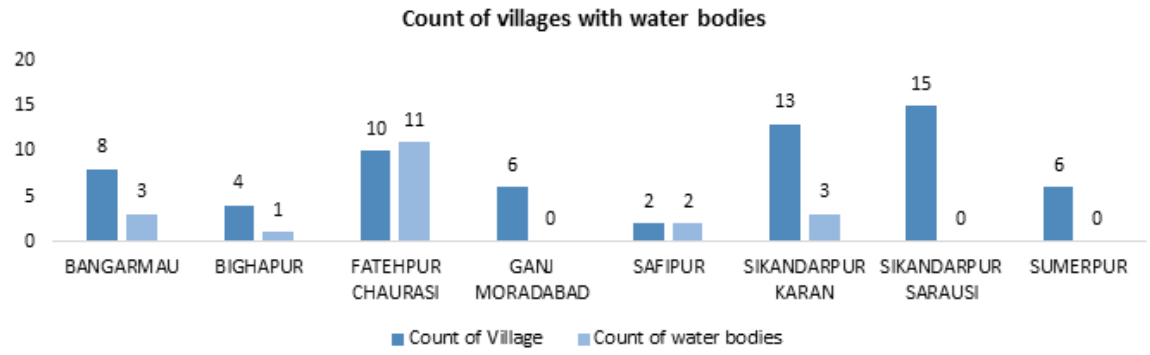



Figure 4.41: Count of villages in Unnao with water bodies

Eight blocks of Unnao district were found to have water bodies within Ganga basin. 20 water bodies were identified during the survey of 64 villages in Unnao.

- Maximum count of water bodies as 11, were identified during the survey of 10 villages in Fatehpur Chaurasi.
- Only 3 water bodies were found in 13 villages of Sikandarpur Karan.

No water bodies could be found in Blocks: Ganj Moradabad, Sikandarpur Sarausi and Sumerpur. Hence, no parameters could be assessed for these blocks.

#### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

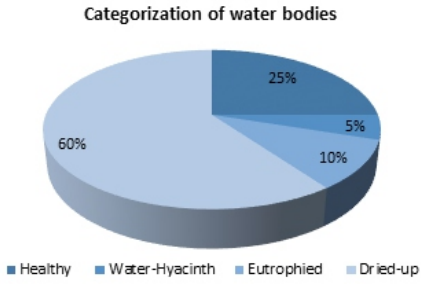



Figure 4.42: Categorization of water bodies in Unnao

The study found that 60 per cent of the total water bodies fall under Dried-up category and 10 per cent were Eutrophied. In addition, 5 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 9 water bodies of Unnao district, as per the availability of water.

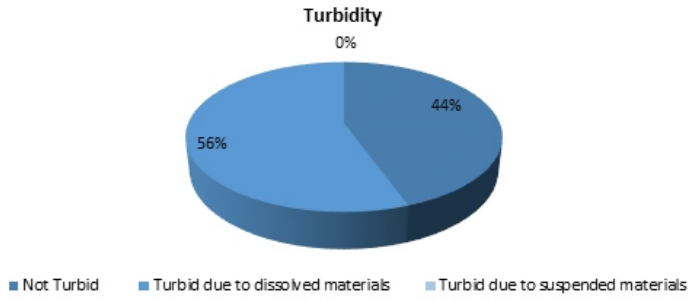



Figure 4.43: Turbidity in water bodies of Unnao

As per Figure 4.43, 44 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby whereas, 56 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

Whereas, no water bodies was found as 'Turbid due to Suspended material' which could have contained heavy particles of silt and thick traces of algae.

### Settlement near water bodies

**Figure 4.44** depicts block-wise 'Percentage distribution of Settlement' found in Unnao district. 100% accountability has been captured under 4 blocks with a total count of 10 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies, which were found in Blocks: Ganj Moradabad, Safipur, Sikandarapur Karan and Sumerpur.

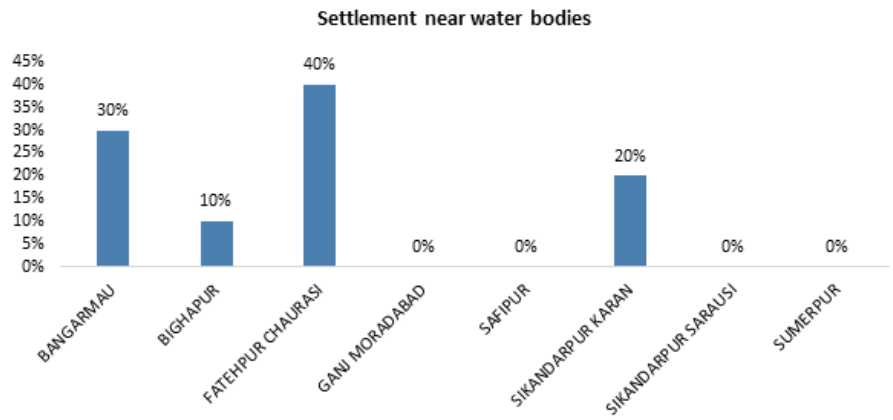



Figure 4.44: Settlement near water bodies in Unnao

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

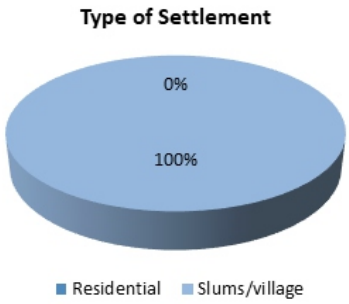



Figure 4.45:Type of Settlement around water bodies in Unnao

Figure 4.45 shows that the type of settlement in Unnao district was 100 per cent Slums/Villages. However, No Residential type of settlements were found near water bodies present in the district.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.46 represents Wastewater drainage present near water bodies assessed in Unnao, where 5 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

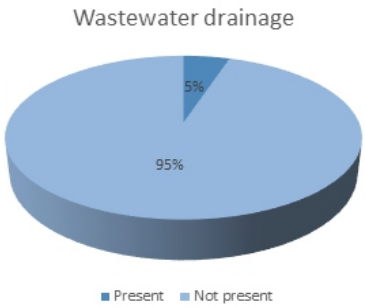



Figure 4.46: Wastewater drainage in and around water bodies in Unnao

As per Figure 4.47, it was observed that,

- Bangarmau, Ganj Moradabad, Safipur, Sikandarapur, Sumerpur were found to have 0 per cent solid waste present in/around the water bodies
- Bighapur accounts for 17 per cent of solid waste present in/around water bodies
- Fatehpur accounted for the highest total as 50 per cent of the water bodies had solid waste present in/around them.
- Sikandarapur Karan weighs for 33 per cent of solid waste present in/around its water bodies.

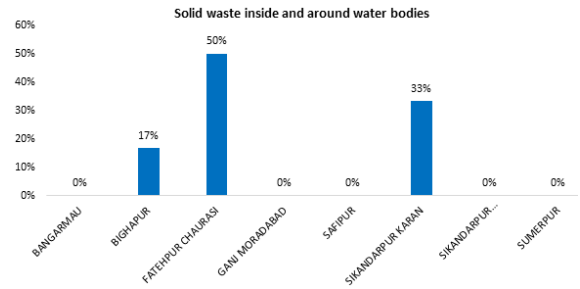



Figure 4.47: Solid waste inside and around water body in Unnao

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: UNNAO

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Unnao along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Safipur | 210.0 | Good |
| 2 | Fatehpur Chaurasi | 206.3 | Good |
| 3 | Bighapur | 185.0 | Good |
| 4 | Bangarmau | 178.3 | Average |
| 5 | Sikandarpur Karan | 163.3 | Average |

Table 11: Ranking of Blocks in Unnao based on scores

### Graphical representation of block-wise scores of Unnao

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

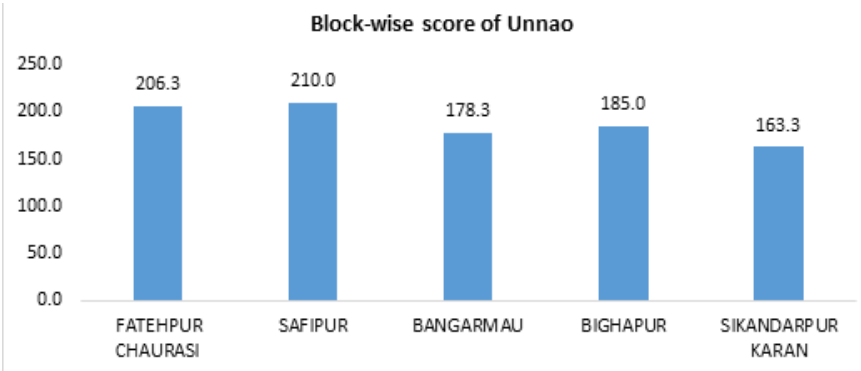



Figure 4.48: Block-wise score of Unnao

On the basis of performance, it was found that water bodies present in various blocks of Unnao stands with an average score of 188.6 out of 300. The resultant score indicates a 'Good' performance by Unnao district.

- Saifipur tops the chart among other five blocks, by obtaining an average score of 210 out of 300.
- Lowest score has been attained by Sikandarpur Karan as 163.3 among the five blocks

## Indicator-wise scores of Unnao

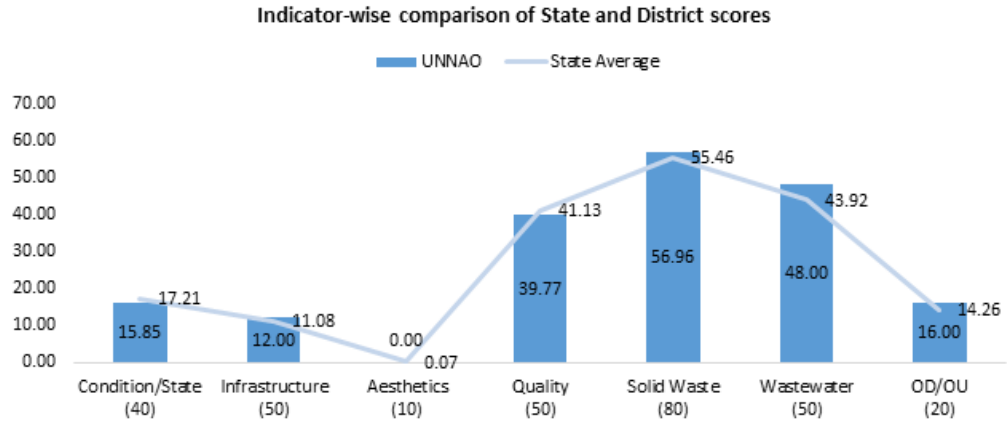



Figure 4.49: Indicator-wise scores of Unnao

Above bar graph represents the overall score of Unnao district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Unnao district.

- In terms of Aesthetics, Unnao maintains the mean score corresponding to the State score.
- Whereas, in terms of Infrastructure, Solid waste disposal, Wastewater drainages and OD/OU, score of Unnao is better than the State score.
- However, Unnao performed poorer than the State in terms of Condition/State and Quality.

**Performance based descriptors of Unnao**

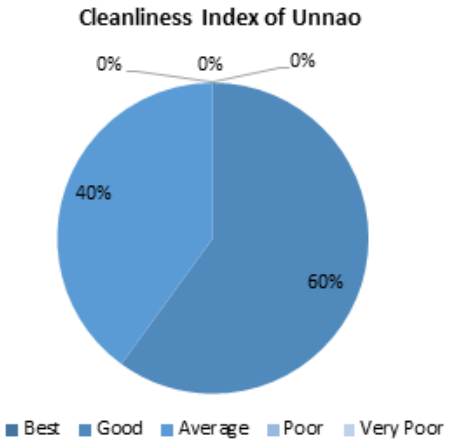



Figure 4.50: Cleanliness index of Unnao

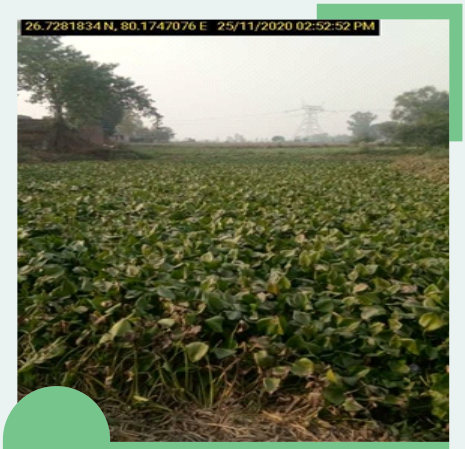
Water bodies found in various blocks of Unnao were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 60 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 40 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in UNNAO

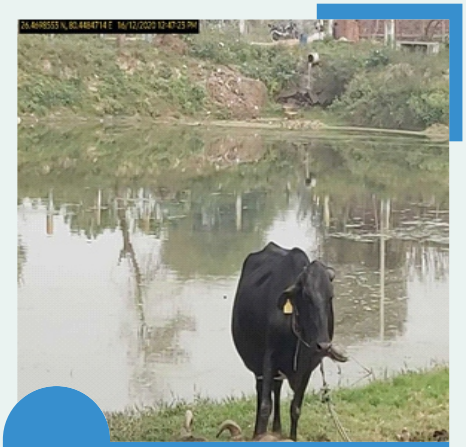

Healthy | UP_SAHARIA SALEMPUR ISTMURARI_Tmp512951_028171_W1




Water Hyacinth UP_ARJUN PUR_141382_010621_W1


Dried up UP_JAIT PUR_141356_010651_W1


Eutrophied UP_KHAIRA GADHA_Tmp512952_028184_W4



Drainage UP_RAJWA KHERA_142315_010831_W1

Fencing UP_SARWAGAR_Tmp512957_028231_W1

Not turbid UP_RAJWA KHERA_142315_010831_W1

OD UP_RAJWA KHERA_142315_010831_W1

Settlement nearby UP_RAJWA KHERA_142315_010831_W1


Turbid due to dissolved material
UP_LOKIABAD PUR_141350_010661_W1

Waste around
UP_RAJWA KHERA_142315_010831_W1


Waste on the surface
UP_KHAIRA GADHA_Tmp512952_028184_W4

## 4.1.4.4 District Report: Ghazipur

### Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

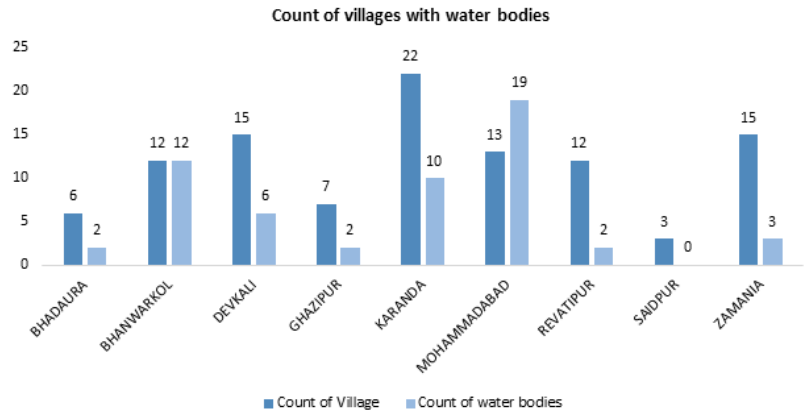



Figure 4.51: Count of villages in Ghazipur with water bodies

Eight blocks of Ghazipur district were found to have water bodies within Ganga basin. 56 water bodies were identified during the survey of 105 villages in Ghazipur.

- 12 villages were assessed in Bhanwarkol and Revatipur each. During the survey, 12 and 2 water bodies were found in Bhanwarkol and Revatipur blocks respectively.
- 7 villages were assessed in Ghazipur block but only 2 water bodies were found.
- 10 water bodies were found in 22 villages of Karanda block.
- Maximum count of water bodies as 19, were identified during the survey of 13 villages in Mohammadabad.

No water bodies could be found in Saidpur block. Hence, no parameters could be assessed for Saidpur.

#### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A **water body** is categorized as Healthy if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

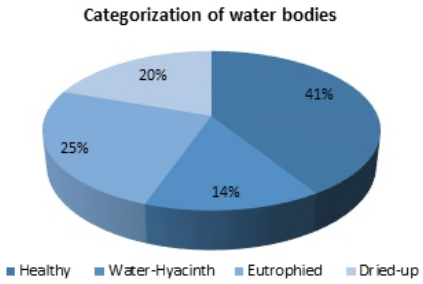



Figure 4.52: Categorization of water bodies in Ghazipur

The study found that 20 per cent of the total water bodies fall under Dried-up category and 25 per cent were Eutrophied. In addition, 14 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 44 water bodies of Ghazipur district, as per the availability of water.

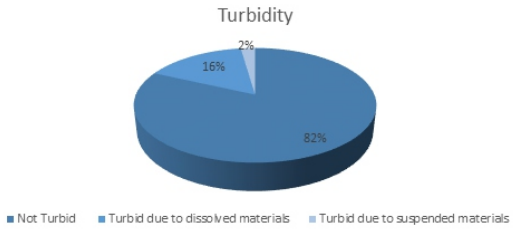



Figure 4.53: Turbidity in water bodies of Ghazipur

As per Figure 4.53, 82 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas, 2 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 16 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.54 depicts block-wise 'Percentage distribution of Settlement' found in Ghazipur district. 100% accountability has been captured under 7 blocks with a total count of 44 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies, which were found in Blocks: Revatipur and Saidpur.

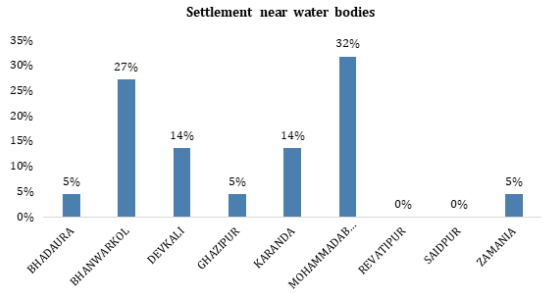



Figure 4.54:Type of Settlement around water bodies in Ghazipur

Figure 4.55 configures two types of settlement, which denotes that Slums/village has 41 per cent occupancy and 59 per cent of the water bodies were surrounded by Residential households.

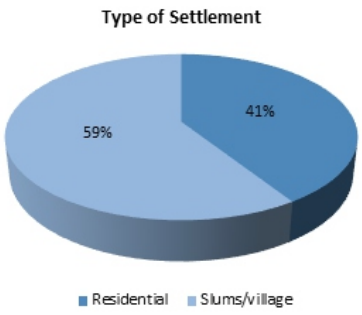



Figure 4.55: Wastewater drainage in and around water bodies in Ghazipur

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.56 represents Wastewater drainage present near water bodies assessed in Ghazipur where 23 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.


Figure 4.56: Wastewater drainage in and around water bodies in Ghazipur

As per Figure 4.57, it was observed that,

- Mohammadabad accounts for the highest total as 33 per cent of the water bodies had solid waste present in/around them.
- No solid waste present in/around the water bodies found in Revatipur.
- Ghazipur accounts 2 per cent of water bodies having solid waste present in/around them.

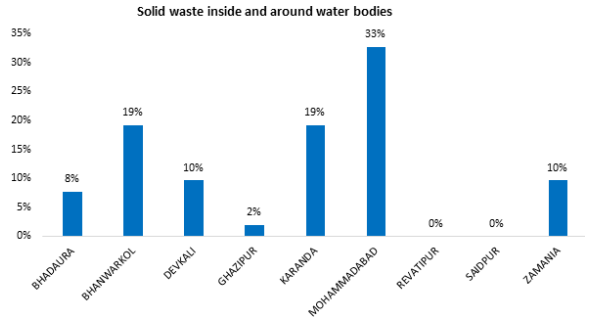



Figure 4.57: Solid waste inside and around water body in Ghazipur

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: GHAZIPUR

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Ghazipur along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Revatipur | 235.0 | Good |
| 2 | Karanda | 191.5 | Good |
| 3 | Ghazipur | 187.5 | Good |
| 4 | Zamania | 186.1 | Good |
| 5 | Devkali | 181.5 | Good |
| 6 | Mohammadabad | 179.8 | Average |
| 7 | Bhanwarkol | 173.9 | Average |
| 8 | Bhadaura | 173.0 | Average |

Table 12: Ranking of Blocks in Ghazipur based on scores

### Graphical representation of block-wise scores of Ghazipur

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

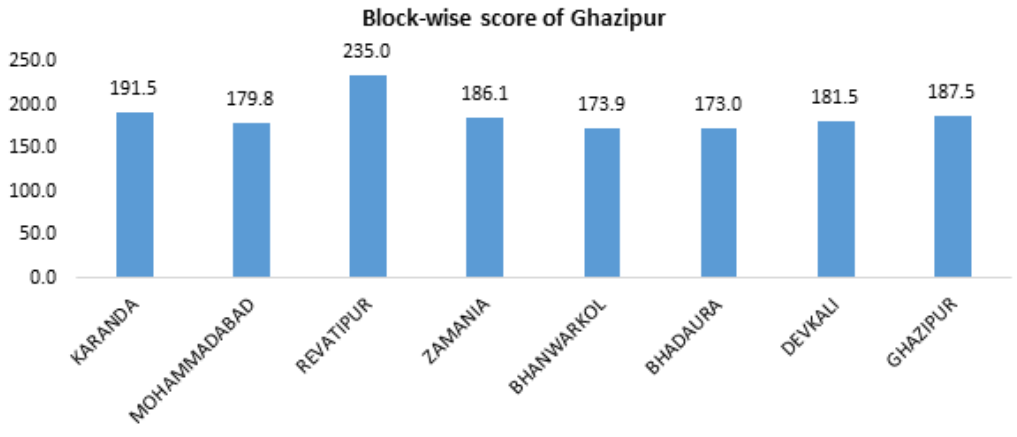



Figure 4.58: Block-wise score of Unnao

On the basis of performance, it was found that water bodies present in various blocks of Ghazipur stands with an average score of 188.5 out of 300. The resultant score indicates a 'Good' performance by Ghazipur district.

- Revatipur tops the chart among other eight blocks, by obtaining an average score of 235 out of 300.
- Lowest score has been attained by Bhadaura as 173 among the eight blocks.

### Indicator-wise scores of Ghazipur

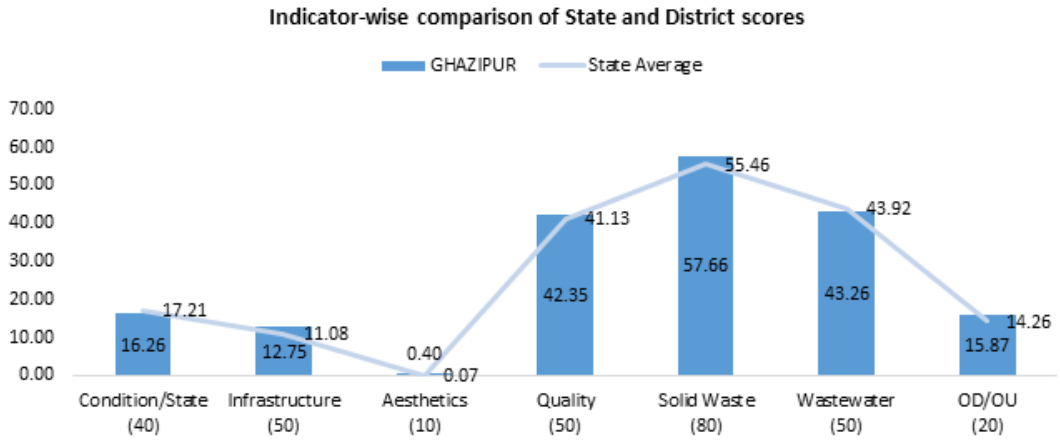



Figure 4.59: Indicator-wise scores of Ghazipur

Above bar graph represents the overall score of Unnao district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.

7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Ghazipur district.

- In terms of Aesthetics, Ghazipur maintains the mean score corresponding to the State score.
- Whereas, in terms of Infrastructure, Quality, Solid waste disposal and OD/OU, score of Ghazipur is better than the State score.
- However, Ghazipur performed poorer than the State in terms of Condition/State and Wastewater drainage.

**Performance based descriptors of Ghazipur**

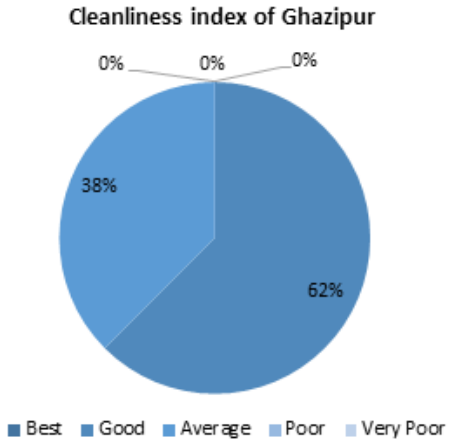


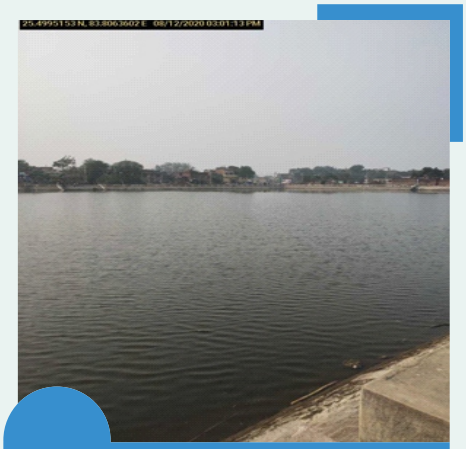

Figure 4.60: Cleanliness index of Ghazipur

Water bodies found in various blocks of Ghazipur were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 62 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 38 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in GHAZIPUR



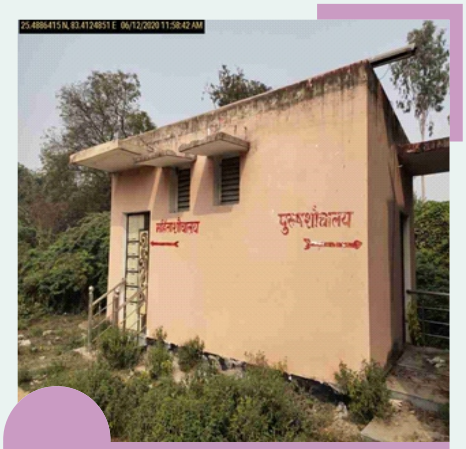
Healthy
UP_GAHMAR_206711_006851_W1

Water Hyacinth
UP_BARESAR_206541_007681_W1

Dried up
UP_SUAPUR_205195_007391_W1

Eutrophied | UP_BALUWA
TAPA KATHUT_206095_007411_W1

Aesthetic Enhancement
UP_GAHMAR_206711_006852_W2



CT or PT nearby
UP_SUAPUR_205195_007391_W1

Drainage connected
UP_GAHMAR_206711_006852_W2

Not turbid | UP_HARIBALLAMPUR
URF ALAWALPUR_206092_007491_W1

OD | UP_BALUWA
TAPA KATHUT_206095_007411_W1

Settlement nearby
UP_BIRPUR_111726_006911_W1

Waste around | UP_HARIBALLAMPUR
URF ALAWALPUR_206092_007492_W2

Waste on the surface
UP_GAHMAR_206711_006851_W1

## 4.1.4.5 DISTRICT REPORT: KASGANJ (Kanshiram Nagar)

### Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

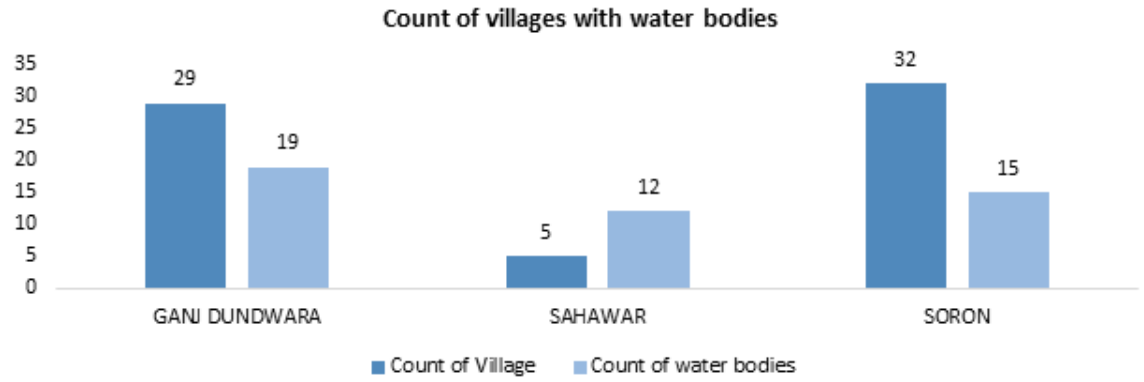



Figure 4.61: Count of villages in Kasganj with water bodies

Three blocks of Kasganj district were found to have water bodies within Ganga basin. 46 water bodies were identified during the survey of 66 villages in Kasganj.

- Maximum count of water bodies as 19, were identified during the survey of 29 villages in Ganj Dundwara.
- 12 water bodies were found in 5 villages of Sahawar block.
- Out of the 32 villages of Soron, 15 water bodies were found.

#### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

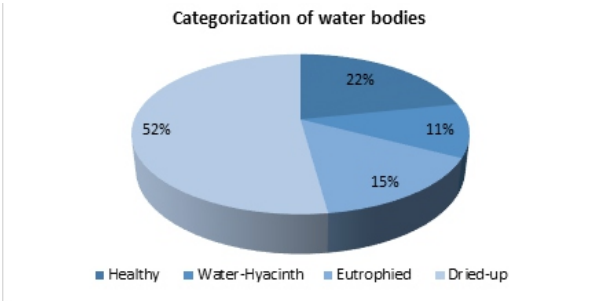



Figure 4.62: Categorization of water bodies in Kasganj

The study found that 52 per cent of the total water bodies fall under Dried-up category and 12 per cent were Eutrophied. In addition, 11 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 25 water bodies of Kasganj district, as per the availability of water.

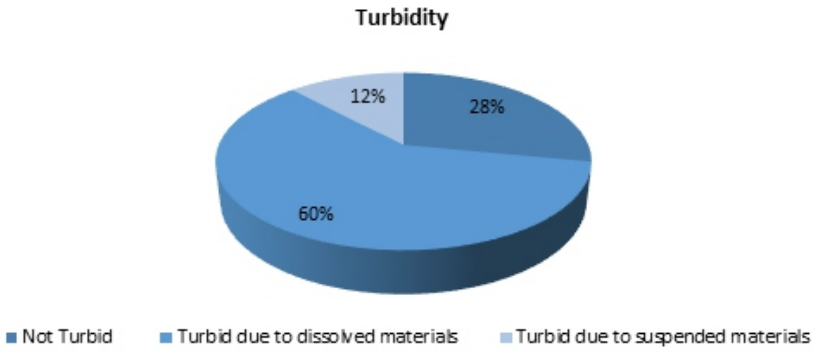



Figure 4.63: Turbidity in water bodies of Kasganj

As per Figure 4.63, 28 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas 12 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 60 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

The Figure below depicts block-wise 'Percentage distribution of Settlement' found in Kasganj district. 100% accountability has been captured under 3 blocks with a total count of 20 Water bodies, having settlement present within 200-250 meters of its radius.

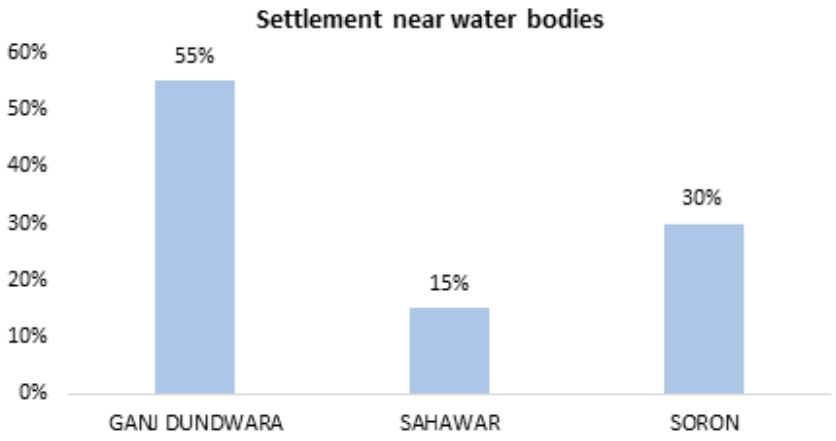



Figure 4.64: Settlement near water bodies in Kasganj

Figure 4.65 configures two types of settlement, which denotes that Slums/village has 50 per cent occupancy and 50 per cent of the water bodies were surrounded by Residential households.

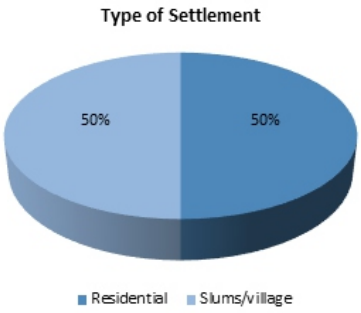



Figure 4.65:Type of Settlement around water bodies in Kasganj

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

**Wastewater drainage and Solid waste**

Pie-chart, Figure 4.66 represents Wastewater drainage present near water bodies assessed in Kasganj, where 11 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

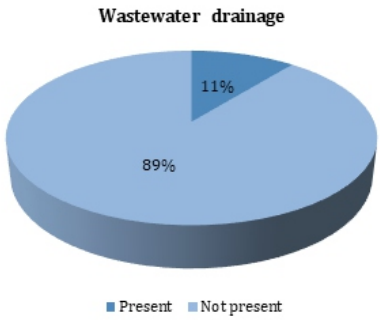



Figure 4.66: Wastewater drainage in and around water bodies in Kasganj

As per Figure 4.67, it was observed that,

- Gang Dundwara accounts for the highest total as 47 per cent of the water bodies had solid waste in/around them.
- Soron weighs for 36 per cent of the water bodies having solid waste present in/around them.
- Sahawar accounts for 17 per cent of the water bodies having solid waste present in/around them.

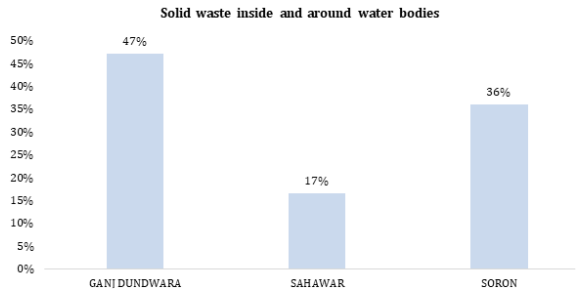



Figure 4.67: Solid waste inside and around water body in Kasganj

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: KASGANJ

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Kasganj along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Sahawar | 169.2 | Good |
| 2 | Soron | 137.7 | Average |
| 3 | Ganj Dundwara | 178.46 | Average |

Table 13: Ranking of Blocks in Kasganj based on scores

### Graphical representation of block-wise scores of Kasganj

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

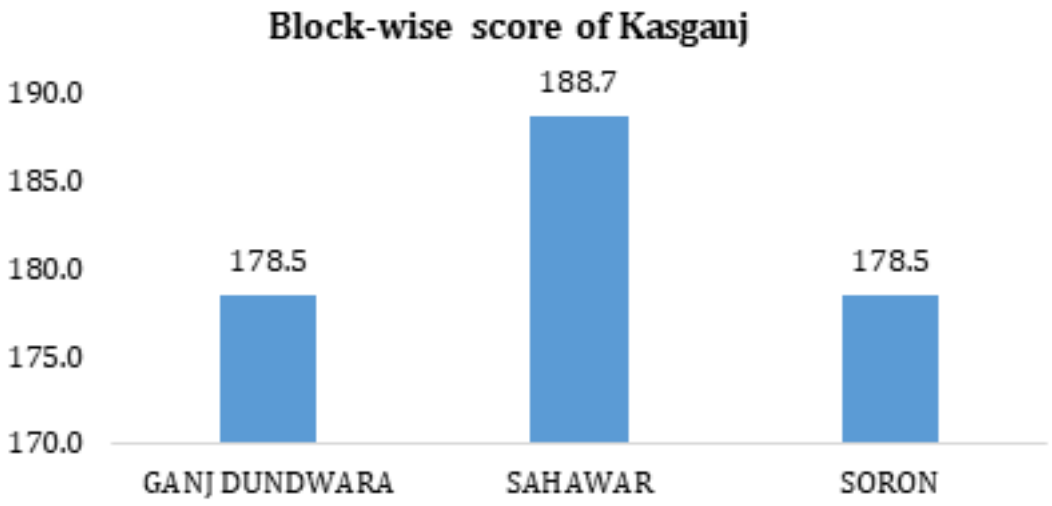



Figure 4.68: Block-wise score of Kasganj

On the basis of performance, it was found that water bodies present in various blocks of Kasganj stands with an average score of 181.9 out of 300. The resultant score indicates a 'Good' performance by Kasganj district.

- Sahawar tops the chart among other three blocks, by obtaining an average score of 188.7 out of 300.
- Lowest score has been attained by Ganj Dundwara as 178.46 among the three blocks.

## Indicator-wise scores of Kasganj

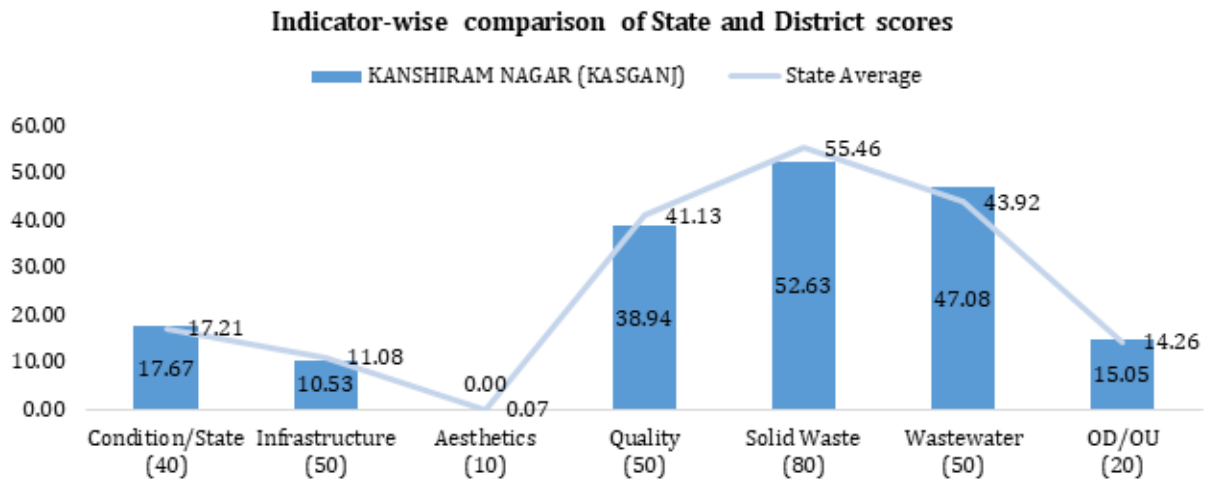



Figure 4.69: Indicator-wise scores of Kasganj

Above bar graph represents the overall score of Kasganj district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Kasganj district.

- Indicators of Kasganj namely, Condition/State, Infrastructure and Aesthetics maintains the mean score corresponding to the State score.
- Whereas, in terms of OD/OU and Wastewater drainages, score of Kasganj is better than the State score.
- However, Kasganj performed poorer than the State in terms of Solid waste disposal and Quality.

**Performance based descriptors of Kasganj**

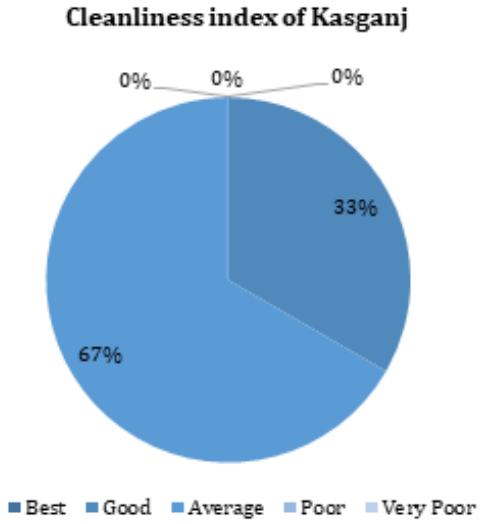



Figure 4.70: Cleanliness index of Kasganj

Water bodies found in various blocks of Kasganj were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 33 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 67 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in KASGANJ

Healthy
UP_QUADAR GANJ KHAM_215775_008561_W1

Water Hyacinth
UP_NEOLI_135652_008723_W3

Dried up | UP_PITAMNAGAR HADAURA_215798_008551_W1

Eutrophied | UP_MANIKAPUR PUKHTA_215621_008701_W1

Drainage connected | UP_TARAPUR NSIRPUR PUKHTA_215304_009002_W2

Not turbid | UP_QUADAR GANJ KHAM_215775_008562_W2

OD
UP_KADARBARI_215312_008901_W1

Settlement nearby
UP_BARONA_215733_008451_W1

Turbid due to suspended material
UP_DHARAMPUR 1_111771_029241_W1

Turbid due to dissolved material
UP_BANUPUR PUKHTA_215297_008761_W1

Waste around | UP_QUADAR GANJ PUKHTA_215776_008581_W1

Waste on the surface
UP_INDAJASHANPUR_215784_008501_W1

# 4.1.4.6 DISTRICT REPORT: HARDOI

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

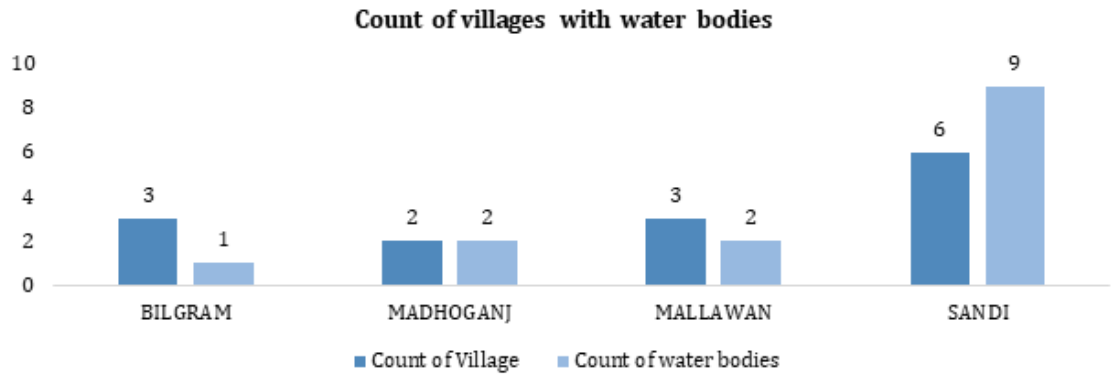



Figure 4.71: Count of villages in Hardoi with water bodies

Four blocks of Hardoi district were found to have water bodies within Ganga basin. 14 water bodies were identified during the survey of 14 villages in Hardoi.

- Only 1 water body was identified during the assessment in 3 villages of Bilgram block.
- 2 water bodies were found in Blocks: Madhoganj and Mallawan each.
- Maximum count of water bodies as 9, were identified during the survey of 6 villages Sandi block.

### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

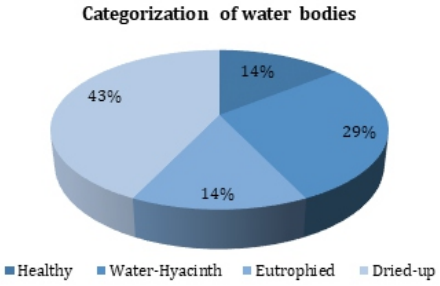



Figure 4.72: Categorization of water bodies in Hardoi

The study found that 43 per cent of the total water bodies fall under Dried-up category and 14 per cent were Eutrophied. In addition, 29 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively very low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 7 water bodies of Hardoi district, as per the availability of water.

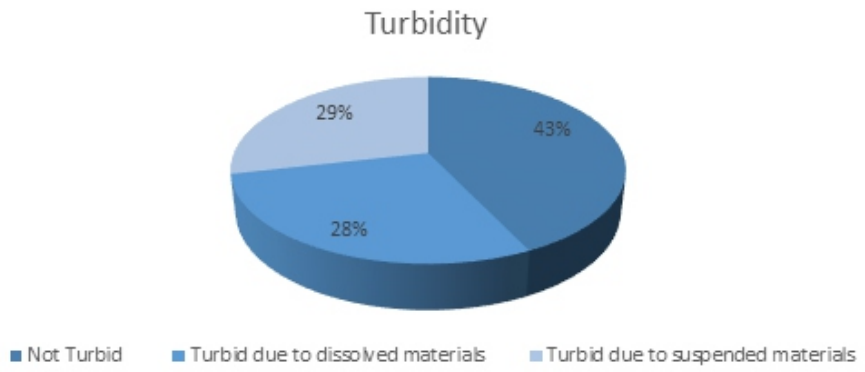



Figure 4.73: Turbidity in water bodies of Hardoi

As per Figure 4.73, 43 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas 29 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 28 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.74 depicts block-wise 'Percentage distribution of Settlement' found in Hardoi district. 100% accountability has been captured under 3 blocks with a total count of 11 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies, which were found in Bilgram block.

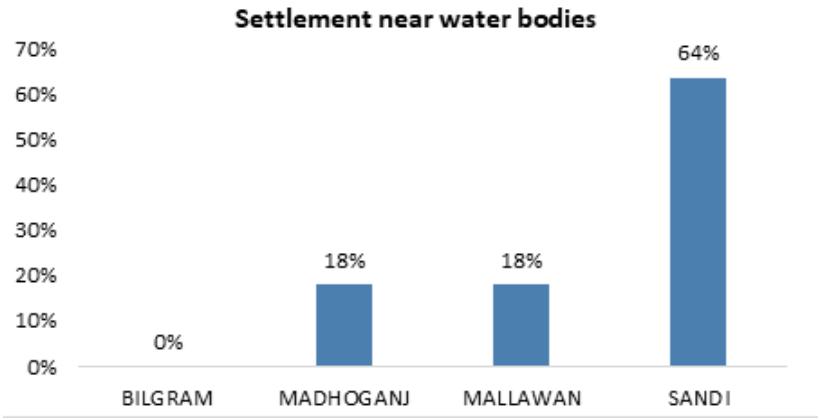



Figure 4.74: Settlement near water bodies in Hardoi

Figure 4.75 configures two types of settlement, which denotes that Slums/village has 82 per cent occupancy and 18 per cent of the water bodies were surrounded by Residential households.

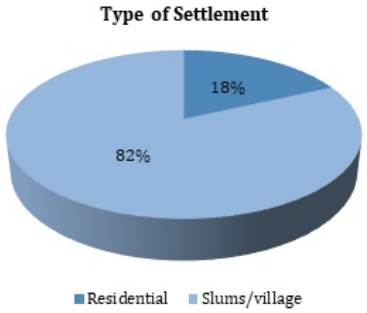



Figure 4.75:Type of Settlement around water bodies in Hardoi

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.76 represents Wastewater drainage present near water bodies assessed in Hardoi, where 7 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

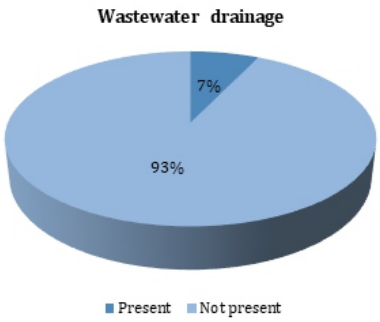



Figure 4.76: Wastewater drainage in and around water bodies in Hardoi

As per Figure 4.77, it was observed that,

- Sandi accounts for the highest total as 64 per cent of the water bodies had solid waste present in/around them.
- Malwan accounts for 21 percentage of the water bodies having solid waste in/around them
- Bilgram and Madhoganj weighs for 7 per cent of the water bodies having solid waste present in/around them.

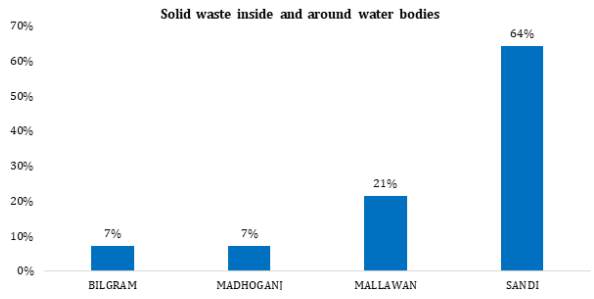



Figure 4.77: Solid waste inside and around water body in Hardoi

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: HARDOI

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Hardoi along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Madhoganj | 200.0 | Good |
| 2 | Sandi | 195.4 | Good |
| 3 | Bilgram | 185.0 | Good |
| 4 | Mallawan | 143.4 | Average |

Table 14: Ranking of Blocks in Hardoi based on scores

### Graphical representation of block-wise scores of Hardoi

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

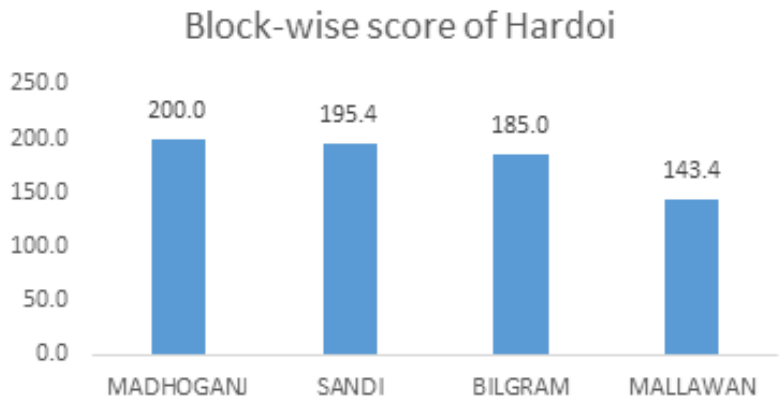



Figure 4.78: Block-wise score of Hardoi

On the basis of performance, it was found that water bodies present in various blocks of Hardoi stands with an average score of 180.9 out of 300. The resultant score indicates a 'Good' performance by Hardoi district.

- Madhoganj tops the chart among other four blocks, by obtaining an average score of 200 out of 300.
- Lowest score has been attained by Mallawan as 143.4 among the four blocks.

### Indicator-wise scores of Hardoi

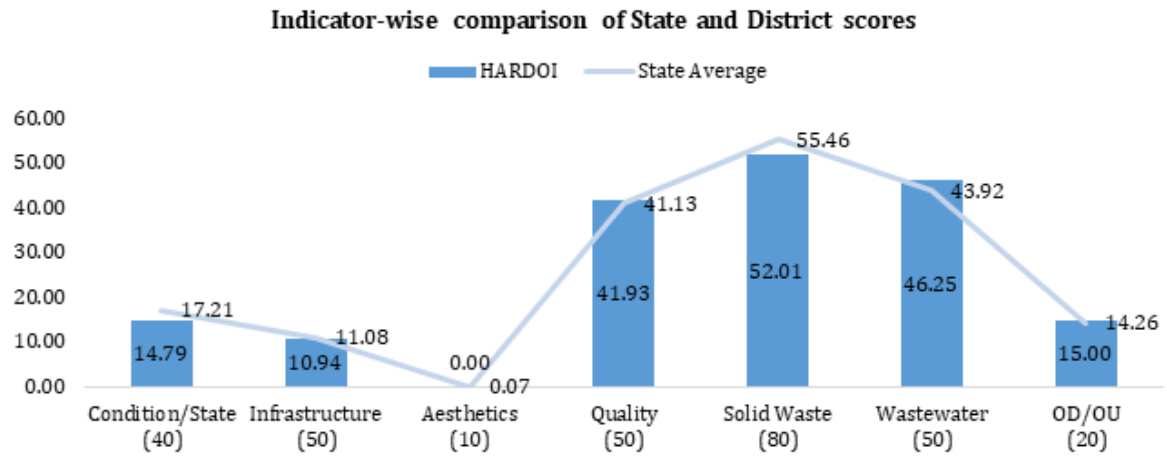



Figure 4.79: Indicator-wise scores of Hardoi

Above bar graph represents the overall score of Hardoi district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

**1. Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.

**2. Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.

**3. Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.

**4. Quality as** an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.

**5. Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.

**6. Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.

**7. OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Hardoi district.

- Indicators of Hardoi namely, Infrastructure, Aesthetics and Quality maintains the mean score corresponding to the State score.
- Whereas, in terms of Wastewater drainages and OD/OU, score of Hardoi is better than the State score.
- However, Hardoi performed poorer than the State in terms of Solid waste disposal and Condition/State.

**Performance based descriptors of Hardoi**

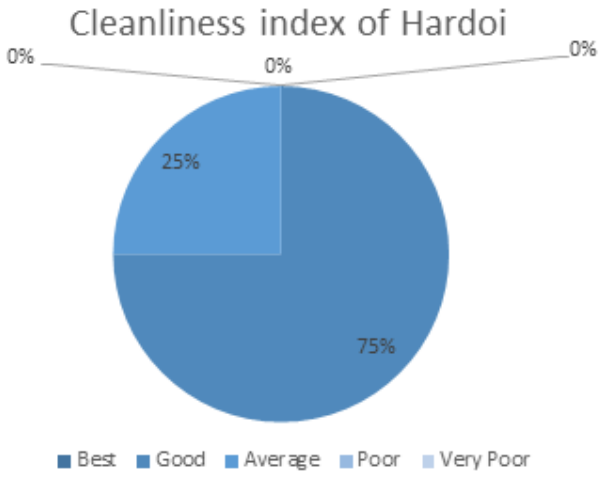



Figure 4.80: Cleanliness index of Hardoi

Water bodies found in various blocks of Hardoi were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 75 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 25 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in HARDOI

Healthy
UP_MANSOORPUR_109527_007934_W4

Water Hyacinth
UP_MANSOORPUR_109527_007933_W3

Dried up | UP_SHAHPUR PAWANR SISALA_140737_007901_W1

Eutrophied
UP_MANSOORPUR_109527_007932_W2

Drainage connected
UP_MANSOOR NAGAR_139502_007881_W1

Not turbid
UP_MANSOORPUR_109527_007934_W4

OD
UP_MANSOORPUR_109527_007934_W4

Settlement nearby
UP_MANSOOR NAGAR_139502_007881_W1

Turbid due to dissolved material
UP_MANSOORPUR_109527_007933_W3

Turbid due to suspended material
UP_MANSOORPUR_109527_007931_W1

Waste around
UP_MANSOORPUR_109527_007931_W1

Waste on the surface
UP_MANSOORPUR_109527_007932_W2

# 4.1.4.6 DISTRICT REPORT: SANT RAVIDAS NAGAR (Bhadohi)

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

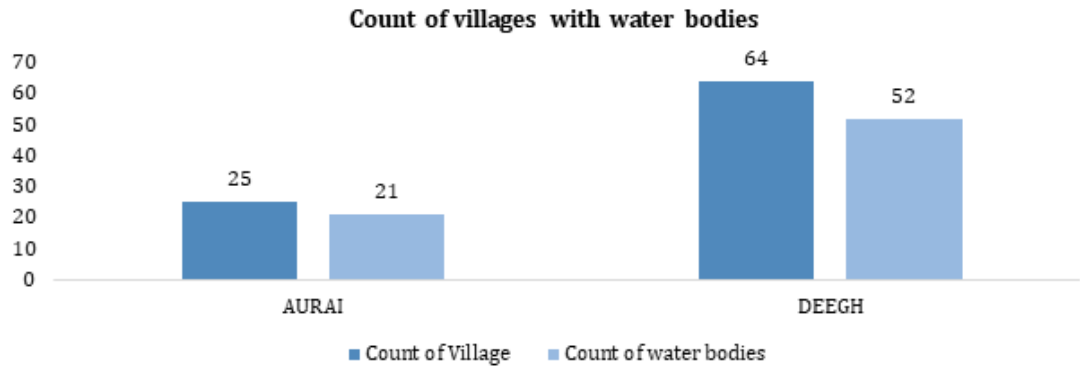



Figure 4.81: Count of villages in Sant Ravidas Nagar with water bodies

Two blocks of Sant Ravidas Nagar (Bhadohi) district were found to have water bodies within Ganga basin. 73 water bodies were identified during the survey of 89 villages in Sant Ravidas Nagar (Bhadohi).

- 21 water bodies were identified during the assessment in 25 villages of Aurai block.
- 64 villages were assessed in Deegh block where 62 water bodies were identified present in Ganga basin.

**Categorization of the water bodies:**

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

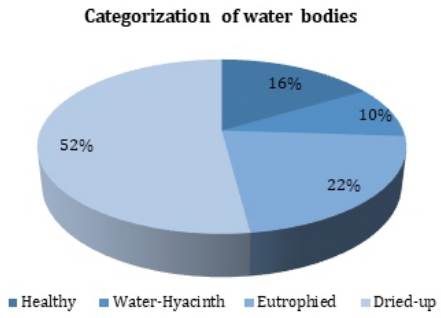



Figure 4.82: Categorization of water bodies in Sant Ravidas Nagar

The study found that 52 per cent of the total water bodies fall under Dried-up category and 22 per cent were Eutrophied. In addition, 10 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 37 water bodies of Sant Ravidas Nagar (Bhadohi) district, as per the availability of water.

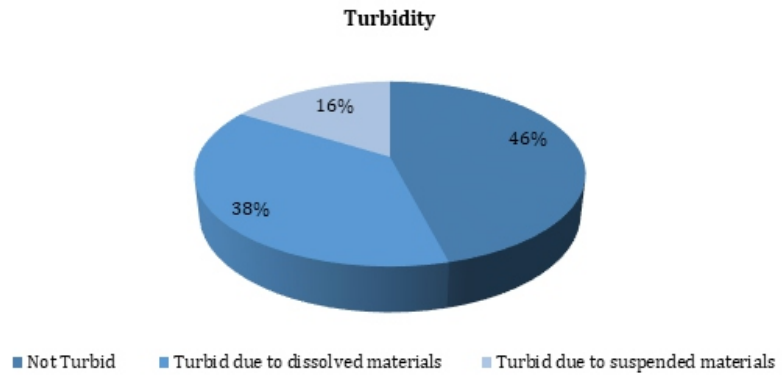



Figure 4.83: Turbidity in water bodies of Sant Ravidas Nagar

As per Figure 4.83, 46 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas 16 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 38 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.84 depicts block-wise 'Percentage distribution of Settlement' found in Sant Ravidas Nagar (Bhadohi) district. 100% accountability has been captured less than 2 blocks with a total count of 67 Water bodies, having settlement present within 200-250 meters of its radius.

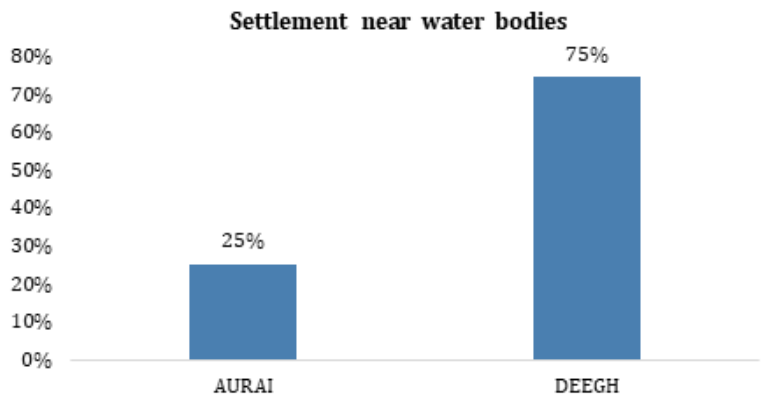



Figure 4.84: Settlement near water bodies in Sant Ravidas Nagar

Figure 4.85 configures two types of settlement, which denotes that Slums/village has 58 per cent occupancy and 42 per cent of the water bodies were surrounded by Residential households.

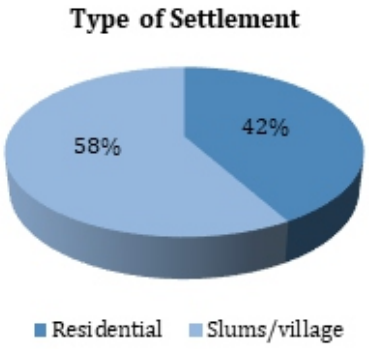



Figure 4.85:Type of Settlement around water bodies in Sant Ravidas Nagar

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary.

**Wastewater drainage and Solid waste**

Pie-chart, Figure 4.86 represents Wastewater drainage present near water bodies found in Sant Ravidas Nagar (Bhadohi), where 14 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

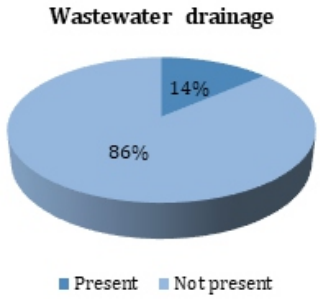



Figure 4.86: Wastewater drainage in and around water bodies in Sant Ravidas Nagar

As per Figure 4.87, it was observed that,

- Aurai block accounts for 25 per cent of the water bodies having solid waste present in/around them.
- Deegh accounts for highest total as 75 per cent of the water bodies had solid waste in/around them.

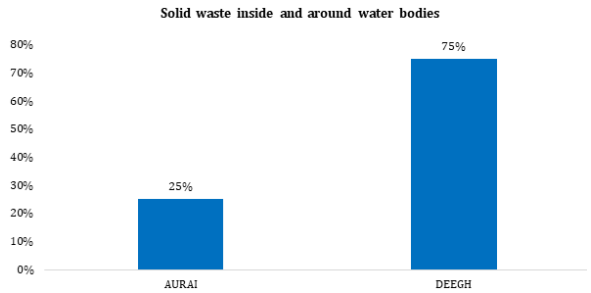



Figure 4.87: Solid waste inside and around water body in Sant Ravidas Nagar

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: SANT RAVIDAS NAGAR

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Sant Ravidas Nagar (Bhadohi) along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Aurai | 185.1 | Good |
| 2 | Deegh | 175.5 | Average |

Table 15: Ranking of Blocks in Sant Ravidas Nagar based on scores

### Graphical representation of block-wise scores of Sant Ravidas Nagar

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

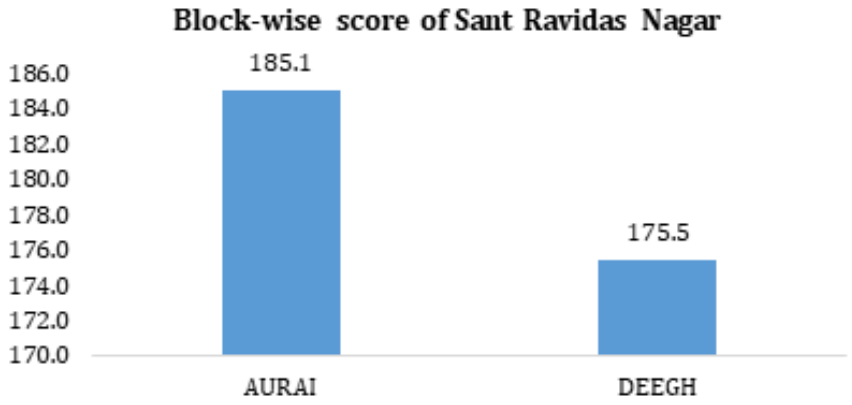



Figure 4.88: Block-wise score of Sant Ravidas Nagar

On the basis of performance, it was found that water bodies present in various blocks of Sant Ravidas Nagar (Bhadohi) stands with an average score of 180.3 out of 300. The resultant score indicates a 'Good' performance by Sant Ravidas Nagar (Bhadohi) district. Aurai scored the highest as 185.1. However, Deegh attained 175.5 out of 300.

## Indicator-wise scores of Sant Ravidas Nagar (Bhadohi)

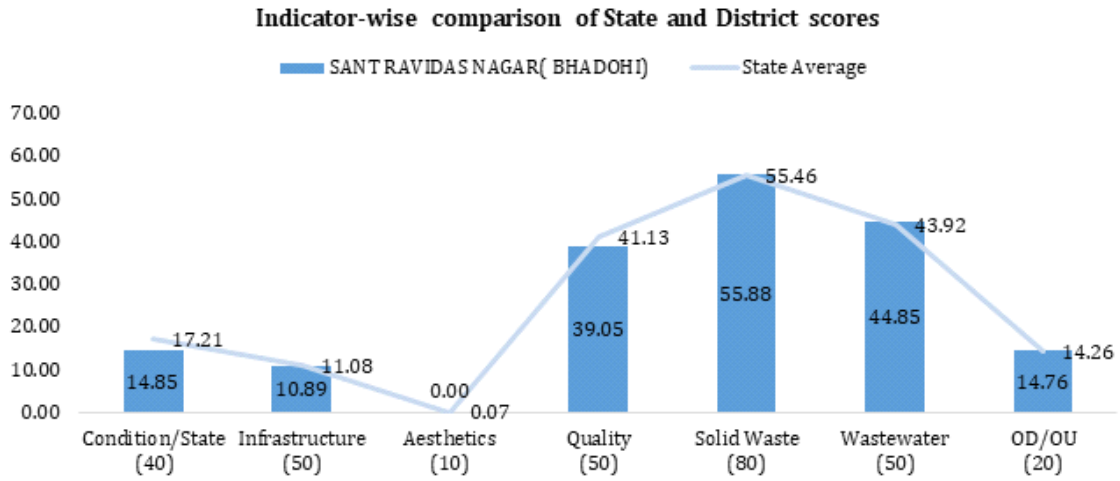



Figure 4.89: Indicator-wise scores of Sant Ravidas Nagar

Above bar graph represents the overall score of Sant Ravidas Nagar (Bhadohi) district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

**1. Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.

**2. Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.

**3. Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.

**4. Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.

**5. Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.

**6. Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.

**7. OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Sant Ravidas Nagar (Bhadohi) district.

- Indicators of Sant Ravidas Nagar (Bhadohi) namely, Infrastructure, Aesthetics, Solid waste disposal and OD/OU maintains the mean score corresponding to the State score.
- However, in terms of Wastewater drainages, score of Sant Ravidas Nagar (Bhadohi) is better than the State score.
- However, Sant Ravidas Nagar (Bhadohi) performed better than the State in terms of Quality and Condition/State.

**Performance based descriptors of Sant Ravidas Nagar (Bhadohi)**

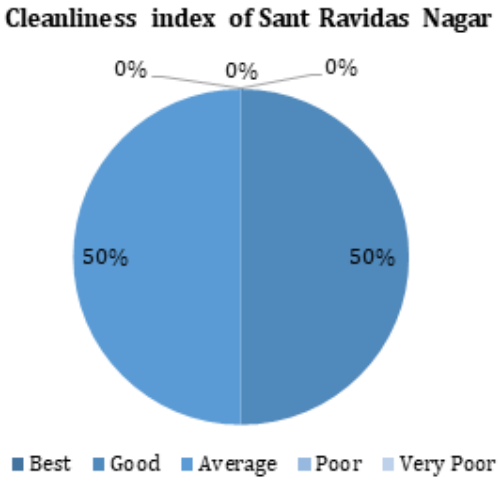



Figure 4.90: Cleanliness index of Sant Ravidas Nagar

Water bodies found in various blocks of Sant Ravidas Nagar (Bhadohi) were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 50 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 50 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

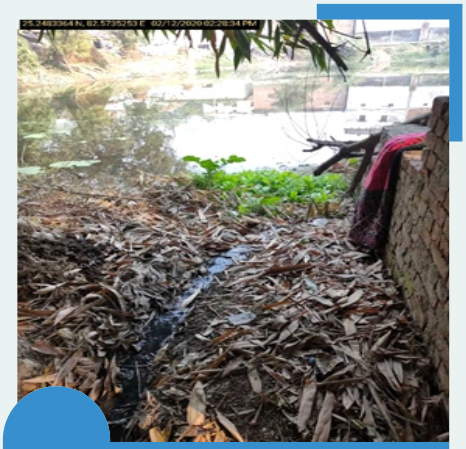
# Images of water bodies in SANT RAVIDAS NAGAR (BHADOHI)

Healthy
UP_DERAWA_184794_009632_W2

Water Hyacinth | UP_BIHAROJPUR
UPARWAR_210605_009963_W3

Dried up | UP_SAHASEPUR
HARCHAHAR PATTI_210798_009752_W2

Eutrophied | UP_MULAPUR
UPARWAR_210759_009731_W1

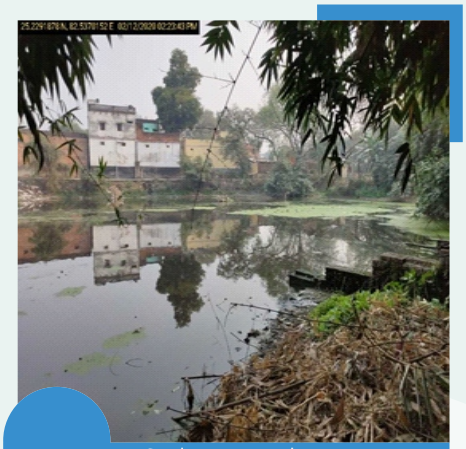


Drainage connected
UP_BITTHALPUR_202516_009593_W3

Fencing | UP_ARAI UPARWAR
N. BARIPUR_210463_009821_W1

Not turbid | UP_ITAHARA
UPARWAR_210476_010171_W1

OD | UP_DHAN
TULSI UPARWAR_210506_010021_W1



Settlement nearby
UP_BITTHALPUR_202516_009593_W3

Turbid due to suspended material
UP_KATHARI_149557_009693_W3

Waste around | UP_LAKHANPUR
BHADRAN UPARWAR_210482_010261_W1

Waste on the surface
UP_BITTHALPUR_202516_009592_W2

# 4.1.4.6 DISTRICT REPORT: BALLIA

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

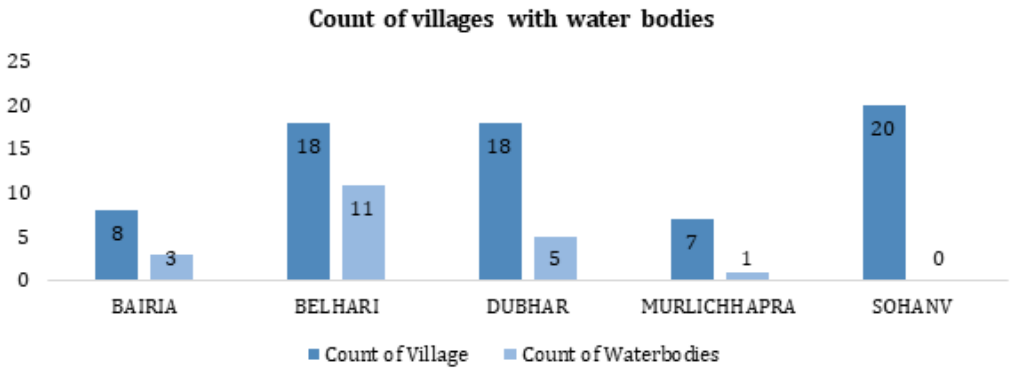



Figure 4.91: Count of villages in Ballia with water bodies

Four blocks of Ballia district were found to have water bodies within Ganga basin. 20 water bodies were identified during the survey of 71 villages in Ballia.

- Only 3 water bodies were identified during the assessment in 8 villages of Bairia block.
- 18 villages were assessed in Belhari and Dubar each. During the survey, 11 and 5 water bodies were found in Belhari and Dubhar blocks respectively.
- A single water body was found in 7 villages of Murlichhapra.

In spite of having maximum village count, no water bodies could be found in Sohanv block. Hence, no parameters could be assessed for Sohanv.

### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

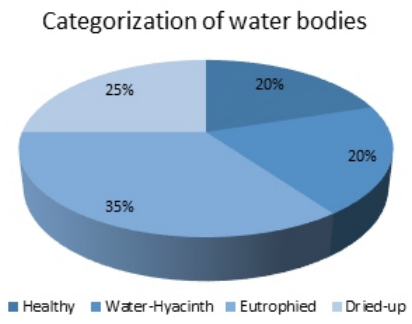



Figure 4.92: Categorization of water bodies in Ballia

The study found that 25 per cent of the total water bodies fall under Dried-up category while 35 per cent were Eutrophied. In addition, 20 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

**Turbidity**

Turbidity test was undertaken for 16 water bodies of Ballia district, as per the availability of water.

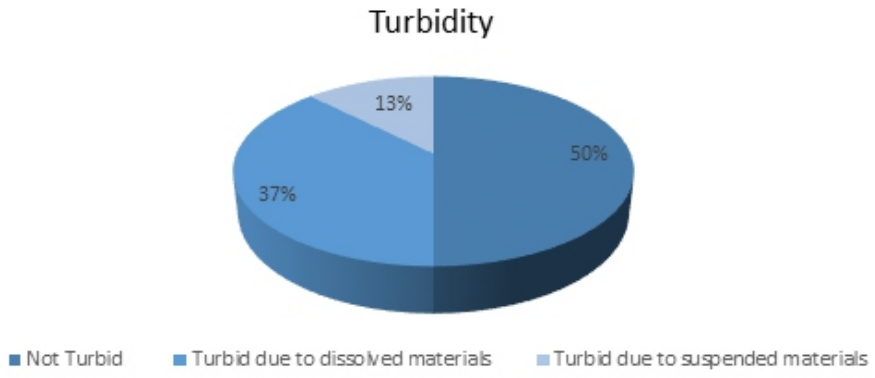



Figure 4.93: Turbidity in water bodies of Ballia

As per the above figure, 50 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas, 13 per cent of the water bodies were found as 'Turbid due to Suspended material' which contains heavy particles of silt/small pebbles and thick traces of algae. In addition, 37 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and small particles of silt.

**Settlement near water bodies**

Figure 4.94 depicts block-wise 'Percentage distribution of Settlement' found in Ballia district. 100% accountability has been captured under 3 blocks with a total count of 15 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies which were found in Blocks: Murlichappra and Sohanv.

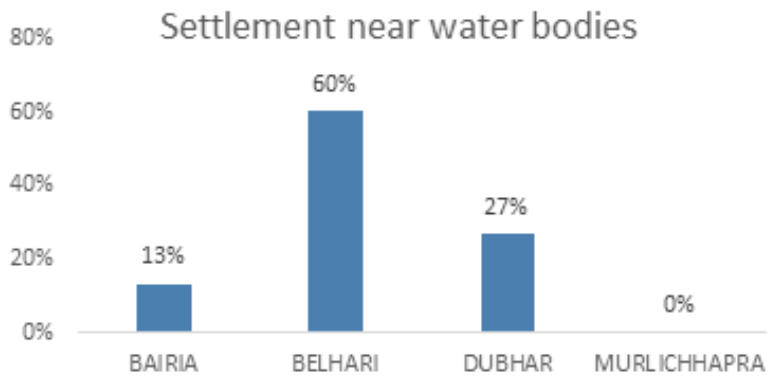



Figure 4.94: Settlement near water bodies in Ballia

Figure 4.95 configures two types of settlement, which denotes that Slums/village has 40 per cent occupancy and 60 per cent of the water bodies were found surrounded by Residential households.

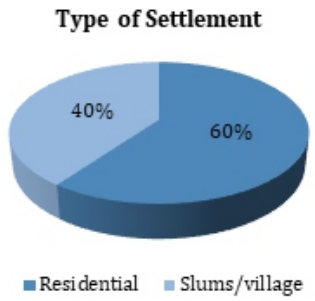



Figure 4.95:Type of Settlement around water bodies in Ballia

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination.

However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.96 represents Wastewater drainage present near water bodies assessed in Ballia, where 30 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

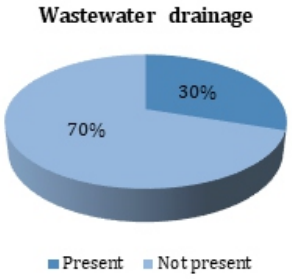



Figure 4.96: Wastewater drainage in and around water bodies in Ballia

As per Figure 4.97, it was observed that,

- Bairia district accounts for 18 per cent of the water bodies having solid waste present in/around them.
- Belhari accounts for the highest total as 53 per cent of the water bodies had solid waste in/around them.
- Dubar weighs for 29 per cent of the water bodies having solid waste present in/around them.

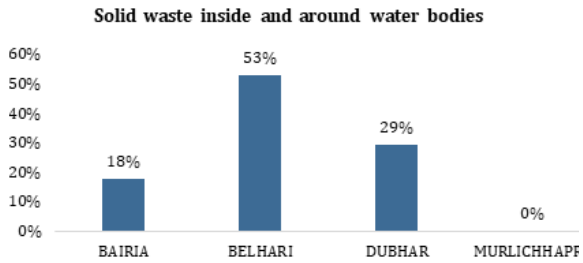



Figure 4.97: Solid waste inside and around water body in Ballia

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: BALLIA

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Ballia along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Murlichhapra | 235.00 | Good |
| 2 | Dubhar | 177.00 | Average |
| 3 | Belhari | 161.70 | Average |
| 4 | Bairia | 135.57 | Average |

Table 16: Ranking of Blocks in Ballia based on scores

### Graphical representation of block-wise scores of Ballia

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

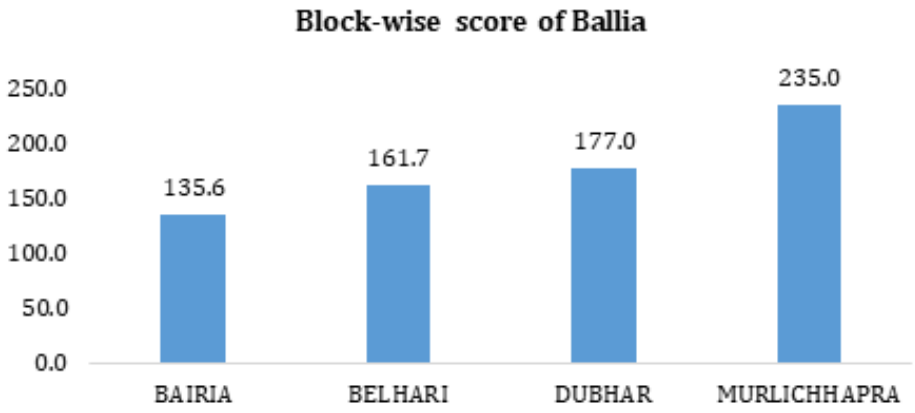



Figure 4.98: Block-wise score of Ballia

On the basis of performance, it was found that water bodies present in various blocks of Ballia stands with an average score of 177.3 out of 300. The resultant score indicates an 'Average' performance by Ballia district.

- Murlichhapra tops the chart among other four blocks, by obtaining an average score of 235 out of 300.
- Lowest score has been attained by Bairia as 135.6 among the four blocks.

### Indicator-wise scores of Ballia

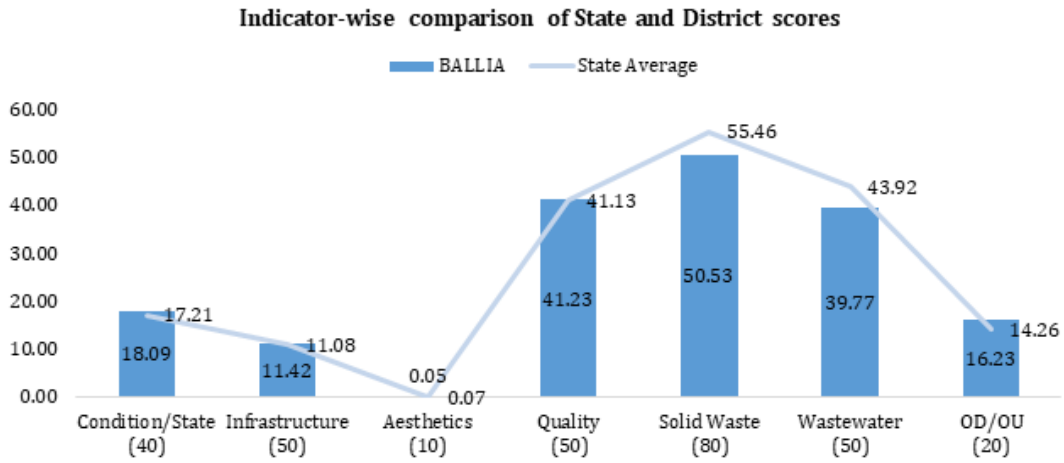



Figure 4.99: Indicator-wise scores of Ballia

Above bar graph represents the overall score of Ballia district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Ballia district.

- Indicators of Ballia namely, Infrastructure, Aesthetics and Quality maintains the mean score corresponding to the State score.
- Whereas, in terms of Condition/State and OD/OU, score of Ballia is better than the State score.
- However, Ballia performed poorer than the State in terms of Solid waste disposal and Wastewater drainages.

**Performance based descriptors of Ballia**

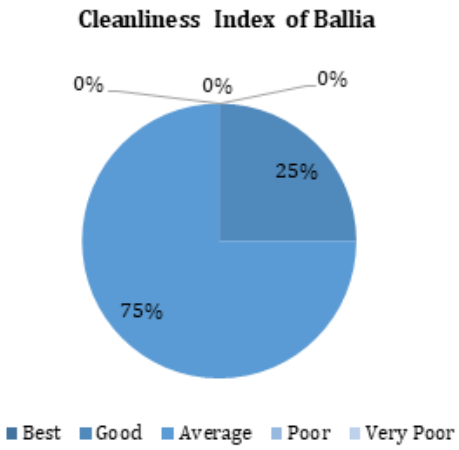



Figure 4.100: Cleanliness index of Ballia

Water bodies found in various blocks of Ballia were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 25 per cent of the water bodies fall under 'Good', which requires less of revival and more of sustainability. Whereas, 75 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in BALLIA

Healthy
UP_BAGHOONCH_199320_005081_W1

Water Hyacinth
UP_BAHADURPUR_108955_005091_W1

Dried up
UP_GOPALPUR_111920_005011_W1

Eutrophied

Aesthetic Enhancement
UP_HALDI_199356_005181_W1

Drainage connected
UP_GOPALPUR MAFI_199975_005021_W1

Not Turbid | UP_UDAIVANT CHHAPRA_199375_005241_W1

OD
UP_BAGHOONCH_199320_005081_W1

Settlement nearby UP
NANDPUR_110312_005221_W1

Turbid due to dissolved material
UP_GOPALPUR MAFI_199975_005021_W1

Waste around
UP_GOPALPUR MAFI_199975_005021_W1

Waste on the surface
UP_REPURA_151913_005231_W1

# 4.1.4.6 DISTRICT REPORT: AMROHA (Jyotiba Phule Nagar)

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

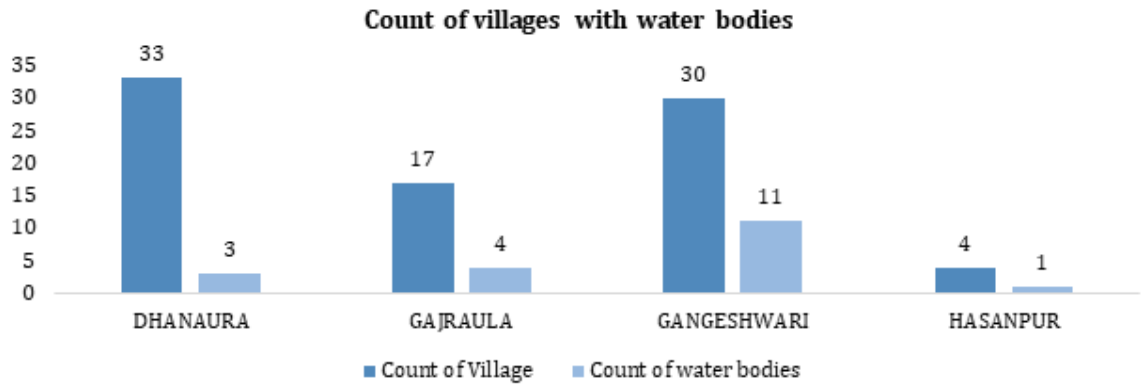



Figure 4.101: Count of villages in Amroha with water bodies

Four blocks of Amroha (Jyotiba Phule Nagar) district were found to have water bodies within Ganga basin. 19 water bodies were identified during the survey of 84 villages in Amroha (Jyotiba Phule Nagar).

- Only 3 water bodies were identified in 33 villages of Dhanaura block.
- Maximum count of water bodies as 11, were identified during the survey of 30 villages in Gangeshwari block.

### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

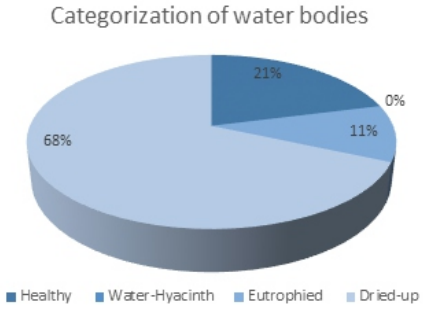



Figure 4.102: Categorization of water bodies in Amroha

The study found that 68 per cent of the total water bodies fall under Dried-up category and 11 per cent were Eutrophied. However, no water body lied under the category of Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 7 water bodies of Amroha (Jyotiba Phule Nagar) district, as per the availability of water.

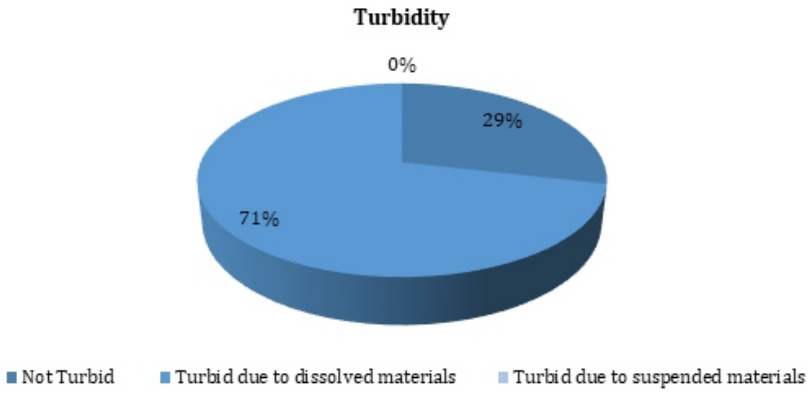



Figure 4.103: Turbidity in water bodies of Amroha

As per Figure 4.103, 29 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

Whereas, no water bodies was found as 'Turbid due to Suspended material' which contains heavy particles of silt and thick traces of algae. In addition, 71 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.104 depicts block-wise 'Percentage distribution of Settlement' found in Amroha (Jyotiba Phule Nagar) district. 100% accountability has been captured under 3 blocks with a total count of 16 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies, which were found in Hasanpur block.

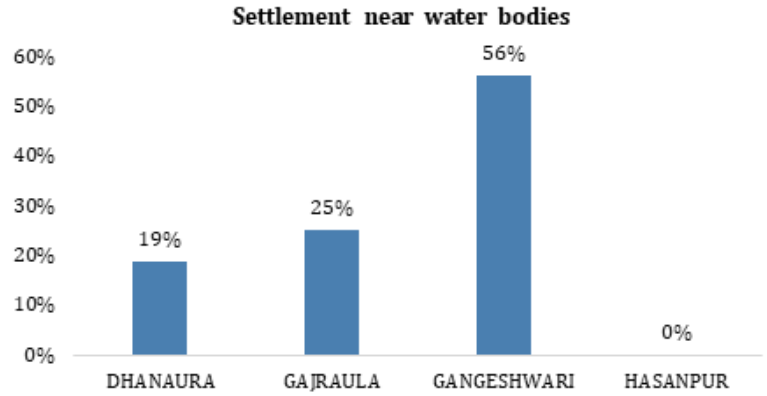



Figure 4.104: Settlement near water bodies in Amroha

Figure 4.105 configures two types of settlement, which denotes that Slums/village has 50 per cent occupancy and 50 per cent of the water bodies were surrounded by Residential households.

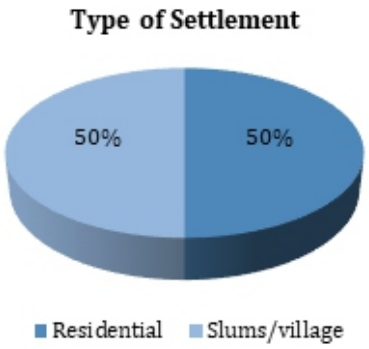



Figure 4.105:Type of Settlement around water bodies in Amroha

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.106 represents Wastewater drainage present near water bodies assessed in Amroha (Jyotiba Phule Nagar), where 26 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

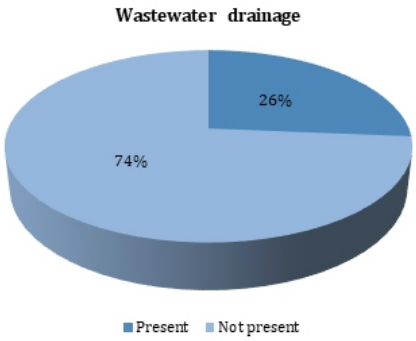



Figure 4.106: Wastewater drainage in and around water bodies in Amroha

As per Figure 4.107, it was observed that,

- Dhanaura accounts for 10 per cent of the water bodies having solid waste present in/around them.
- Gajraula accounts for 30 per cent of the water bodies having solid waste present in/around them.
- Gangeshwari accounts for the highest total as 55 per cent of the water bodies had solid waste present in/around them.
- Hasanpur accounts for 5 per cent of the water bodies having solid waste present

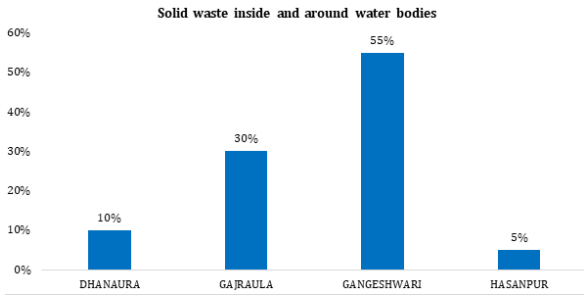



Figure 4.107: Solid waste inside and around water body in Amroha

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: AMROHA

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Amroha (Jyotiba Phule Nagar) along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Hasanpur | 185.0 | Good |
| 2 | Gajraula | 170.4 | Average |
| 3 | Gangeshwari | 170.0 | Average |
| 4 | Dhanaura | 168.3 | Average |

Table 17: Ranking of Blocks in Amroha based on scores

### Graphical representation of block-wise scores of Amroha (Jyotiba Phule Nagar)

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

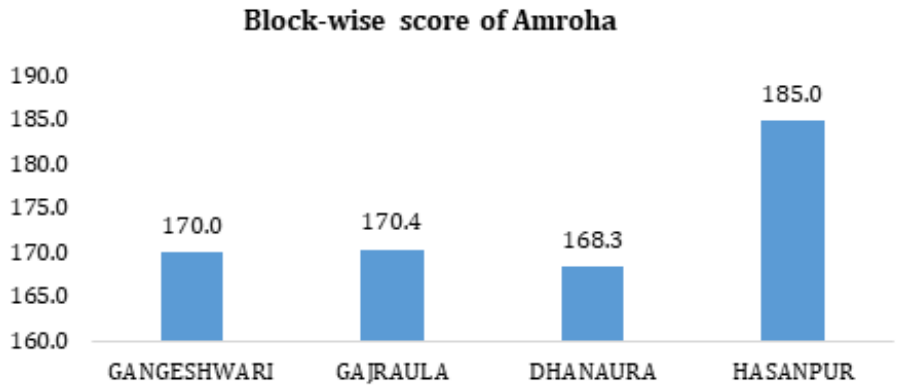



Figure 4.108: Block-wise score of Amroha

On the basis of performance, it was found that water bodies present in various blocks of Amroha (Jyotiba Phule Nagar) stands with an average score of 173.4 out of 300. The resultant score indicates an 'Average' performance by Amroha (Jyotiba Phule Nagar) district.

- Hasanpur tops the chart among other four blocks, by obtaining an average score of 185 out of 300.
- Lowest score has been attained by Dhanaura as 168.3 among the four blocks.

### Indicator-wise scores of Amroha

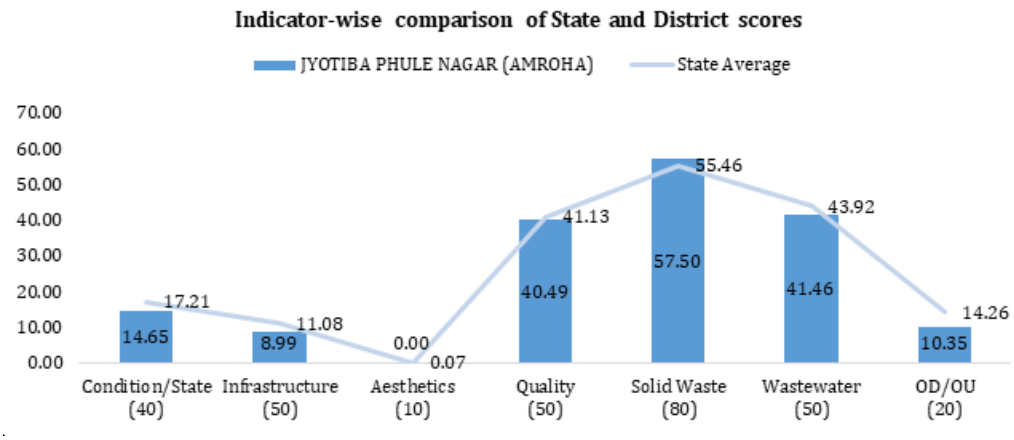



Figure 4.109: Indicator-wise scores of Amroha

Above bar graph represents the overall score of Amroha (Jyotiba Phule Nagar) district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Amroha (Jyotiba Phule Nagar) district.

- In terms of Aesthetics, Amroha (Jyotiba Phule Nagar) maintains the mean score corresponding to the State score.
- Whereas, in terms of Solid waste disposal, score of Amroha (Jyotiba Phule Nagar) is better than the State score.
- However, Amroha (Jyotiba Phule Nagar) performed poorer than the State in terms of Condition/State, Infrastructure, Quality, Wastewater drainages and OD/OU.

**Performance based descriptors of Amroha**

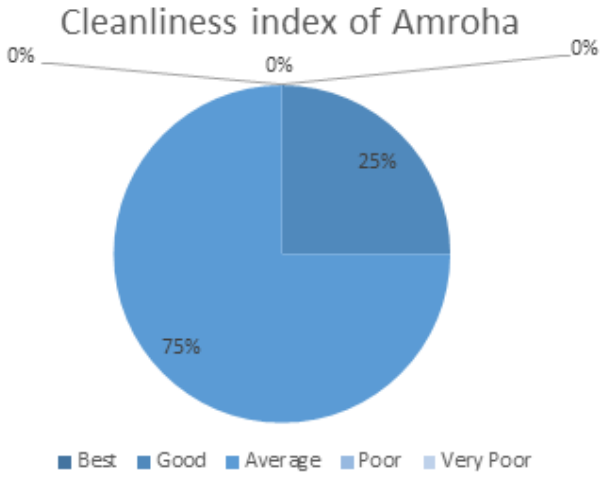



Figure 4.110: Cleanliness index of Amroha

Water bodies found in various blocks of Amroha were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

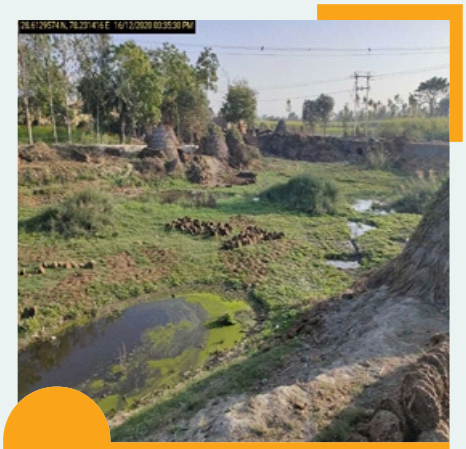
'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 25 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 75 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in AMROHA

Healthy | UP_PIPLOTI KALAN MUSTAHKAM_118422_008371_W1

Waste on the surface | UP MOHAMDABAD MUSTAH._118206_008271_W1



Dried up | UP_JEWDA MUSTAHKAM_Tmp512928_027942_W2

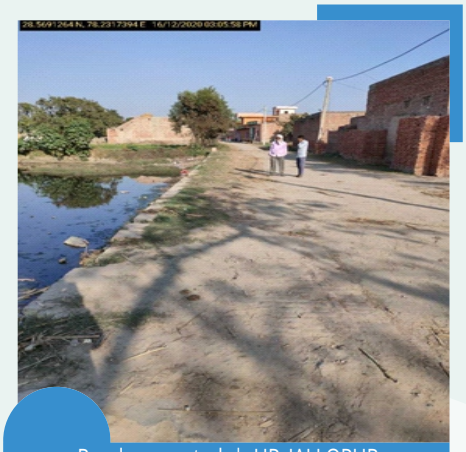
Eutrophied | UP_CHAKANWALA MUSTAHKAM_117509_008041_W1


CT or PT nearby | UP_DHAURIYA AHTAMALI_Tmp512911_027771_W1

Drainage connected UP_WAJIDPUR_109641_008221_W1

Not turbid | UP_OSITA MUSTAHKAM_118208_008281_W1

OD | UP_OSITA MUSTAHKAM_118208_008281_W1



Road connected | UP_JALLOPUR MUSTAHKAM_Tmp512926_027921_W1

Settlement nearby UP_JALLOPUR MUSTAHKAM_Tmp512926_027921_W1

Turbid due to dissolved material UP_MOHAMDABAD MUSTAH._118206_008271_W1

Waste around | UP_MOHAMDABAD MUSTAH._118206_008271_W1

# 4.1.4.6 DISTRICT REPORT: FARRUKHABAD

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

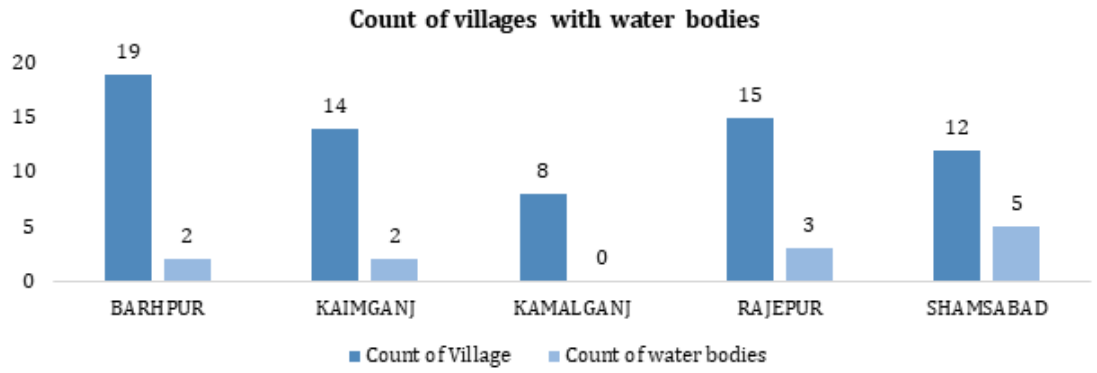



Figure 4.111: Count of villages in Farrukhabad with water bodies

Four blocks of Farrukhabad district were found to have water bodies within Ganga basin. 12 water bodies were identified during the survey of 68 villages in Farrukhabad.

- 19 villages were assessed in Barhpur but only 2 water bodies were found during the survey.
- Only 2 water bodies were found in 14 villages of Kaimganj.
- 3 water bodies were found in 15 villages of Rajepur. Whereas, 5 water bodies were found in 12 villages of Shamsabad.

In spite of having a decent amount of village count, no water bodies could be found in Kamalganj block. Hence, no parameters could be assessed for Kamalganj.

### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

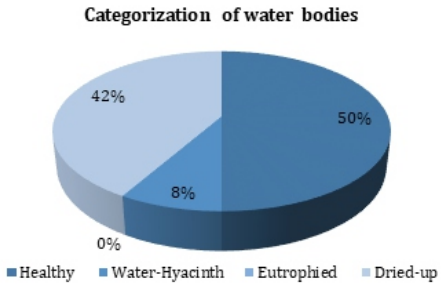



Figure 4.112: Categorization of water bodies in Farrukhabad

The study found that 42 per cent of the total water bodies fall under Dried-up category and no water body was Eutrophied. In addition, 8 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively good, which is a sign of good catchment yield and awareness among the locals.

### Turbidity

Turbidity test was undertaken for 8 water bodies of Farrukhabad district, as per the availability of water.

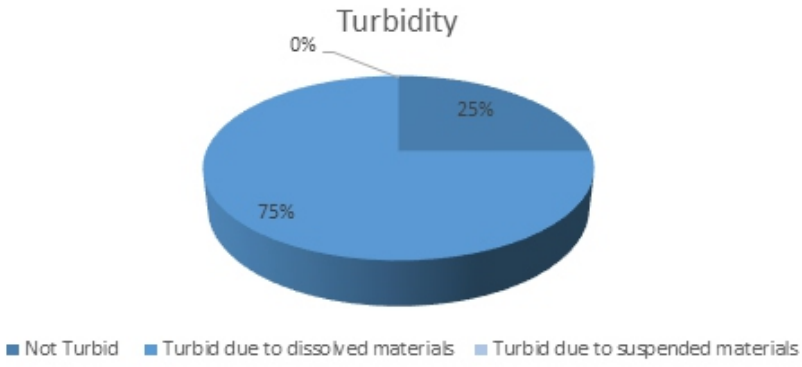



Figure 4.113: Turbidity in water bodies of Farrukhabad

As per Figure 4.113, 25 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat around the water body. Whereas, 75 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

No water bodies was found as 'Turbid due to Suspended material' which could have contained heavy particles of silt and thick traces of algae.s

### Settlement near water bodies

Figure 4.114 depicts block-wise 'Percentage distribution of Settlement' found in Farrukhabad district. 100% accountability has been captured under 3 blocks with a total count of 7 Water bodies, having settlement present within 200-250 meters of its radius.

No settlement was available near water bodies which were found in Blocks: Barhpur and Kamalganj.

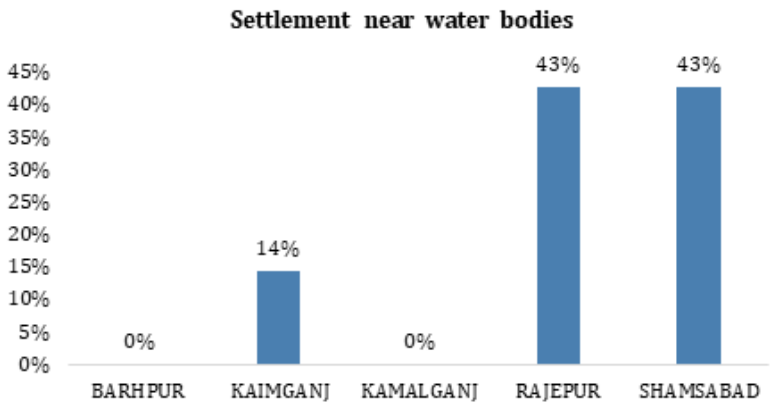



Figure 4.114: Settlement near water bodies in Farrukhabad

Figure 4.115 configures two types of settlement, which denotes that Slums/village has 29 per cent occupancy and 71 per cent of the water bodies were surrounded by Residential households.

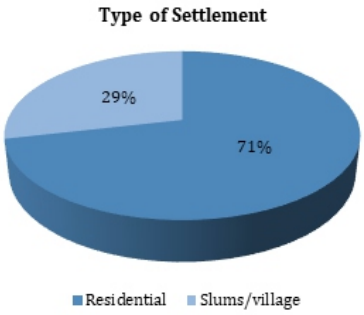



Figure 4.115:Type of Settlement around water bodies in Farrukhabad

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.116 represents Wastewater drainage present near water bodies assessed in Farrukhabad, where 8 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

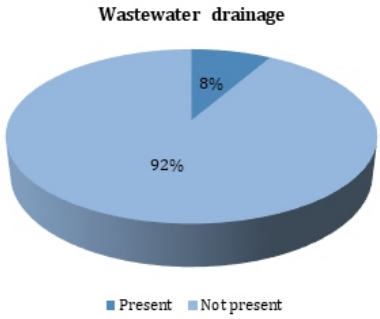



Figure 4.116: Wastewater drainage in and around water bodies in Farrukhabad

As per Figure 4.117, it was observed that,

- Shamsabad accounts for the highest total as 50 per cent of the water bodies had solid waste present in/around them.
- Kaimganj and Rajepur accounts for 25 percentage of the water bodies having solid waste in/around them.
- Barhpur and Kamalganj weighs for 0 per cent of the water bodies having solid waste present in/around them.

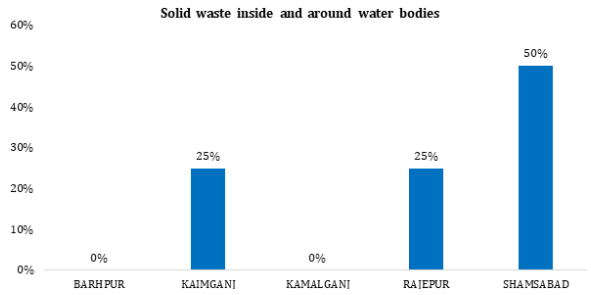



Figure 4.117: Solid waste inside and around water body in Farrukhabad

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: FARRUKHABAD

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Farrukhabad along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Shamsabad | 185.7 | Good |
| 2 | Barhpur | 185.0 | Good |
| 3 | Rajepur | 171.7 | Average |
| 4 | Kaimganj | 150.0 | Average |

Table 18: Ranking of Blocks in Farrukhabad based on scores

### Graphical representation of block-wise scores of Farrukhabad

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

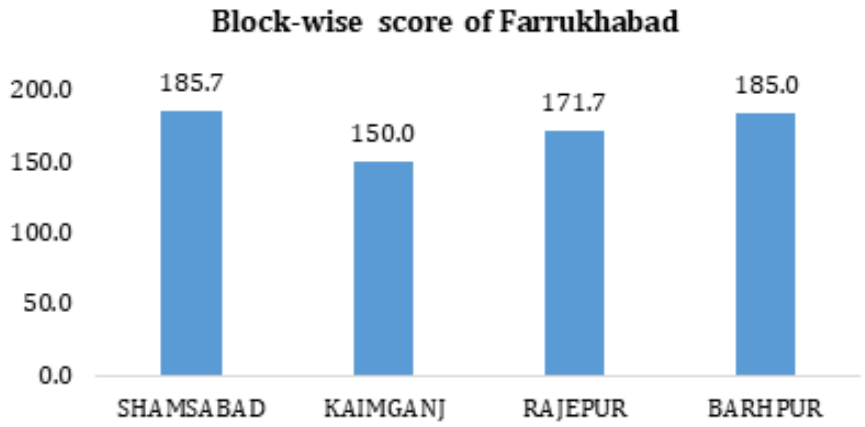



Figure 4.118: Block-wise score of Farrukhabad

On the basis of performance, it was found that water bodies present in various blocks of Farrukhabad stands with an average score of 173.1 out of 300. The resultant score indicates an 'Average' performance by Farrukhabad district.

- Shamsabad tops the chart among other four blocks, by obtaining an average score of 185.7 out of 300.
- Lowest score has been attained by Kaimganj as 150 among the four blocks.

## Indicator-wise scores of Farrukhabad

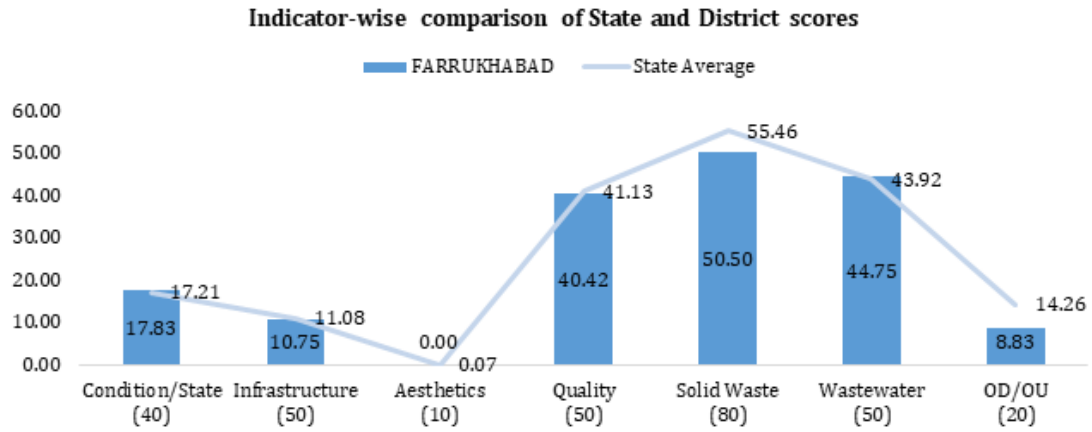



Figure 4.119: Indicator-wise scores of Farrukhabad

Above bar graph represents the overall score of Farrukhabad district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

**1. Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.

**2. Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.

**3. Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, religious architectures, sheds, grass/gardening, etc.

**4. Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.

**5. Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.

**6. Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.

**7. OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Farrukhabad district.

- Indicators of Farrukhabad namely, Infrastructure and Aesthetics maintains the mean score corresponding to the State score.
- Whereas, in terms of Condition/State and Wastewater drainages, score of Farrukhabad is better than the State score
- However, Farrukhabad performed poorer than the State in terms of Solid waste disposal, OD/OU and Quality.

**Performance based descriptors of Farrukhabad**

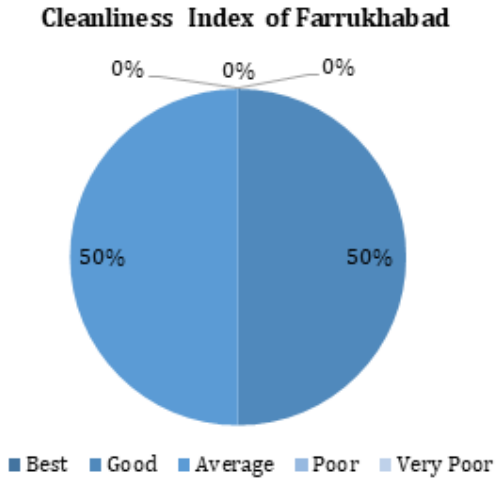



Figure 4.120: Cleanliness index of Farrukhabad

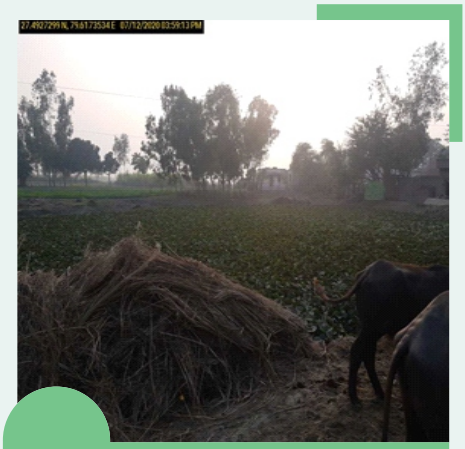
Water bodies found in various blocks of Farrukhabad were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 50 per cent of the water bodies fall under 'Good' which requires less of revival and more of sustainability. Whereas, 50 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation.

# Images of water bodies in FARRUKHABAD

Healthy
UP_CHAURAHAR_Tmp512902_027671_W1



Water Hyacinth | UP_BHAUPUR CHAURASI_146069_006661_W1

Dried up | UP_GADIYA HAIBATPUR_145959_006801_W1

Drainage connected | UP_AKAKHEDA MOHMADIPUR_Tmp512891_027561_W1

Not turbid | UP_KANCHAN PUR_146099_006701_W1

OD | UP_KAILIYAI Tmp512903_027681_W1

Settlement nearby
UP_BEHTABALLU_145847_006781_W1

Turbid due to dissolved material
UP_CHAURAHAR_Tmp512902_027671_W1

Waste around
UP_KANCHAN PUR_146099_006701_W1

# 4.1.4.6 DISTRICT REPORT: RAE BARELI

## Configuration

The following bar graph represents the count of water bodies along with the number of villages assessed in a particular block.

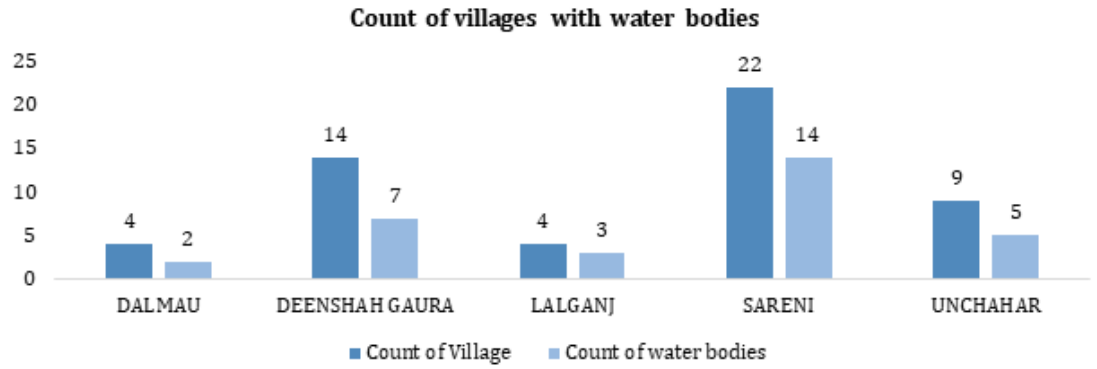



Figure 4.121: Count of villages in Rae Bareli with water bodies

Three blocks of Rae Barelli district were found to have water bodies within Ganga basin. 31 water bodies were identified during the survey of 53 villages in Rae Bareli.

- 4 villages were assessed in Dalmau and Lalganj each. During the survey, 2 and 3 water bodies were found in Dalmau and Lalganj blocks respectively.
- Maximum count of water bodies as 14, were identified during the survey of 22 villages in Sareni.

### Categorization of the water bodies

Water bodies have been categorized in four groups based on their status: Healthy, Water-Hyacinth, Eutrophication, and Dried-up.

A water body is categorized as **Healthy** if the general appearance is clean and traces/layer of algae is not present in it.

Presence of **Water-hyacinth** is safe for the water bodies until it is present in controlled amount. This plant requires threshing to prevent blockage, so that sunlight could reach the water body bed and it does not become a home for disease-carrying mosquitoes.

A **dried-up** water body indicates that the catchment yield and inlet systems for its replenishment are not active or blocked.

**Eutrophication** is caused due to presence of excessive nutrients like Phosphorous and Sulphur in water bodies, which can enter through non-point sources of pollution. This leads to increased amount of plant and algal growth, which damages the aquatic life and ecosystem of the water bodies. Water bodies under such condition are on the verge of depletion and requires higher level of intervention.

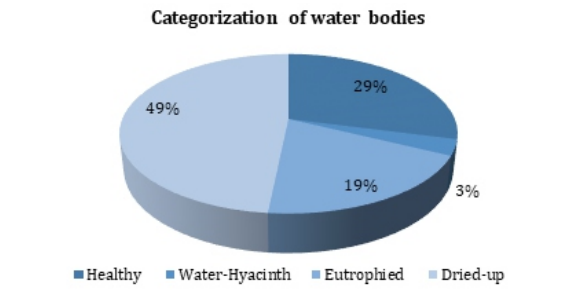



Figure 4.122: Categorization of water bodies in Rae Bareli

The study found that 49 per cent of the total water bodies fall under Dried-up category and 19 per cent were Eutrophied. In addition, 3 per cent of the total water bodies have Water hyacinth.

Hence, proportion of water bodies lying under Healthy category was found to be comparatively low, which is a sign of poor catchment yield and lack of awareness among the locals.

### Turbidity

Turbidity test was undertaken for 19 water bodies of Rae Bareli district, as per the availability of water.

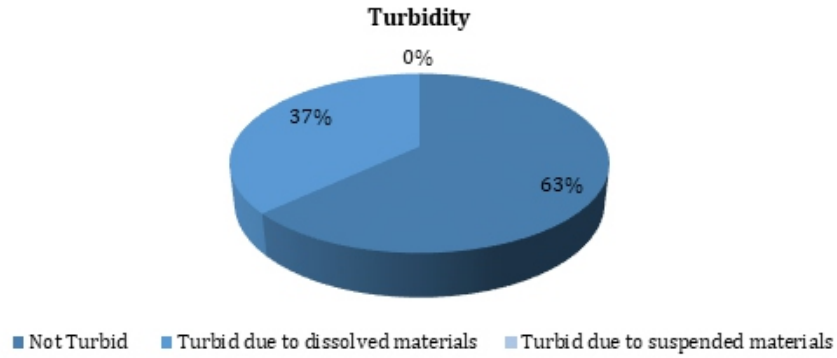



Figure 4.123: Turbidity in water bodies of Rae Bareli

As per Figure 4.123, 63 per cent of the water bodies came out to be 'Not Turbid' that denotes clear and transparent water which is good for usage and health of habitat situated nearby.

No water body was found as 'Turbid due to Suspended material' which could have contained heavy particles of silt and thick traces of algae. In addition, 37 per cent of them hold their status as 'Turbid due to dissolved material' that contains a major proportion of mud and silt.

### Settlement near water bodies

Figure 4.124 depicts block-wise 'Percentage distribution of Settlement' found in Rae Bareli district. 100% accountability has been captured 5 blocks with a total count of 24 Water bodies, having settlement present within 200-250 meters of its radius.

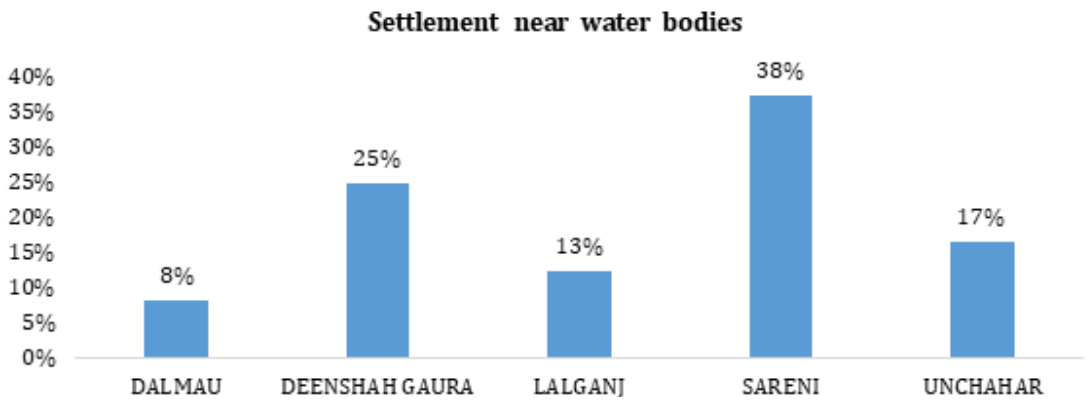



Figure 4.124: Settlement near water bodies in Rae Bareli

Figure 4.125 configures two types of settlement, which denotes that Slums/village has 17 per cent occupancy and 83 per cent of the water bodies were surrounded by Residential households.

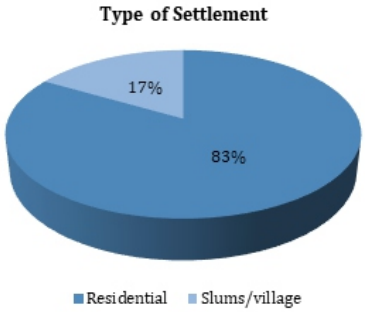



Figure 4.125:Type of Settlement around water bodies in Rae Bareli

Type of settlement plays a major role in determining the catchment yield of a water body. Difference in type and load of pollutants was observed through a Slum area and a Residential area. For example: Animal dung, chemical/fertilizers from Slum/village area becomes the cause of pollution in water bodies and on the other hand Solid waste, Silt from under-construction sites in Residential areas are the causes of contamination. However, in exceptional cases the load of pollutants entering into a water body may not vary as per our Project Expert.

### Wastewater drainage and Solid waste

Pie-chart, Figure 4.126 represents Wastewater drainage present near water bodies assessed in Rae Bareli, where 42 per cent of the water bodies get contaminated through wastewater drainage as a cause of direct run-off.

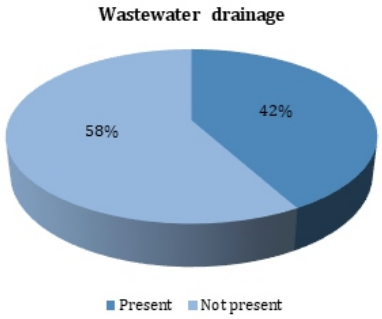



Figure 4.126: Wastewater drainage in and around water bodies in Rae Bareli

As per Figure 4.127, it was observed that,

- Sareni accounts for the highest total as 46 per cent of the water bodies had solid waste present in/around them.
- Dalmau and Lalganj accounts for 7 per cent of the water bodies having solid waste in/around them.
- Deenshah Gaura weighs for 18 per cent of the water bodies having solid waste present in/around them.
- Unchahar accounts for 21 per cent of the water bodies having solid waste present in/around them.

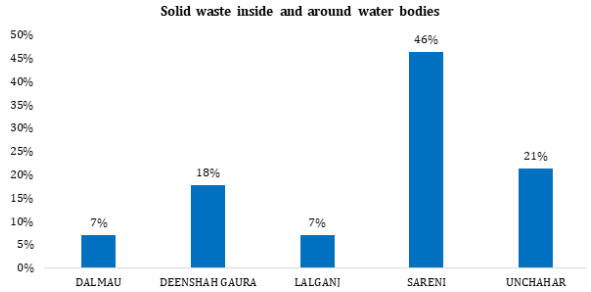



Figure 4.127: Solid waste inside and around water body in Rae Bareli

Wastewater drainages present in residential area settlements may cause accumulation of solid waste near and on the surface of water bodies. Screens/mesh/bars restricts solid waste from entering into the water body. However, pollutants which enters the water bodies along with the solid waste and wastewater drainages deteriorate the quality of water present in it. Excessive nutrients like Phosphorus and Sulfur coming from these non-point sources of pollution leads to eutrophication, which damages the overall health of the water bodies.

## DISTRICT SCORECARD: RAE BARELI

### Block-wise scores and Descriptors

Below is a tabular representation of the scores backed by each block of Rae Bareli along with its grade and rank.

| Rank | Block | Score | Descriptors |
|---|---|---|---|
| 1 | Deenshah gaura | 176.8 | Average |
| 2 | Sareni | 169.7 | Average |
| 3 | Lalganj | 166.8 | Average |
| 4 | Dalmau | 160.9 | Average |
| 5 | Unchahar | 152.1 | Average |

Table 19: Ranking of Blocks in Rae Bareli based on scores

### Graphical representation of block-wise scores of Rae Bareli

Scores have been summarized on the basis of all the seven indicators which were considered as the key factors for evaluation of the water bodies out of a total marks of 300.

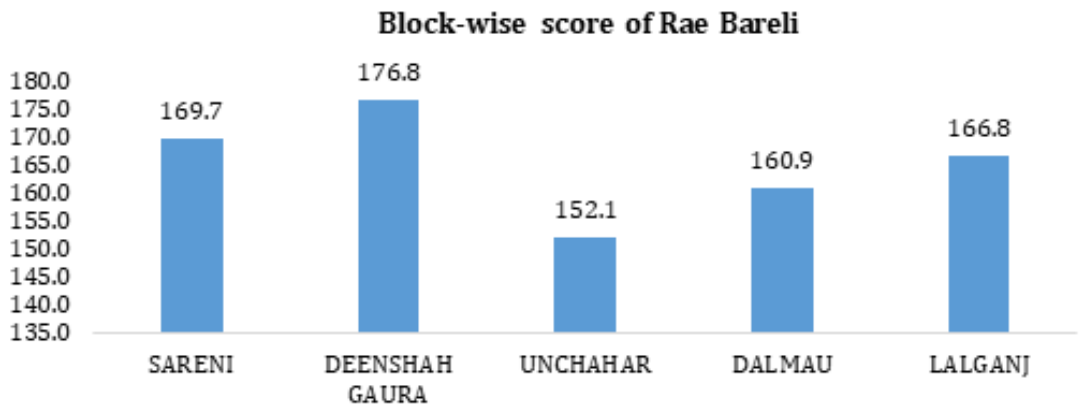



Figure 4.128: Block-wise score of Rae Bareli

On the basis of performance, it was found that water bodies present in various blocks of Rae Bareli stands with an average score of 165.2 out of 300. The resultant score indicates an 'Average' performance by Rae Bareli district.

- Deenshah Gaura tops the chart among other five blocks, by obtaining an average score of 176.8 out of 300.
- Lowest score has been attained by Unchahar as 152.1 among the five blocks.

### Indicator-wise scores of Rae Bareli

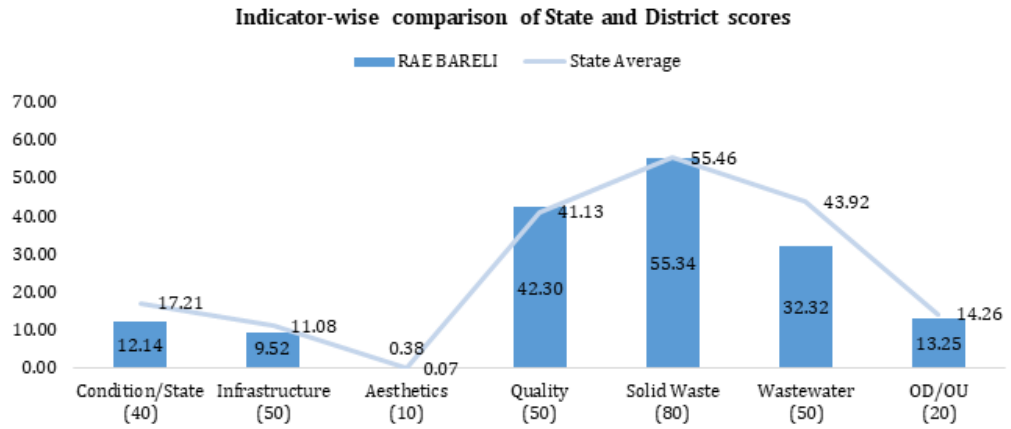



Figure 4.129: Indicator-wise scores of Rae Bareli

Above bar graph represents the overall score of Rae Bareli district. Evaluation of scores and grades was done on the basis of seven key indicators mentioned below:

1. **Functionality,** which play a significant role in determining overall health a water body and the reason for its rejuvenation or depletion. Factors affecting the functionality of water bodies are types of settlement and septic tanks present near them.
2. **Infrastructure** signifies the physical structure of a water body, which includes the condition of fencing, road connectivity around the water body and outlet channel to ensure drain-out of overflow. This indicator plays a vital role in resolving the issue of water bodies being dried-up.
3. **Aesthetics (Aesthetic enhancement)** includes beautification around the water bodies, which includes benches, bridges, religious architectures, sheds, grass/gardening, bridges over the water body, etc.
4. **Quality** as an indicator comprise of factors like turbidity status, eutrophication, and formation of foam, which comprehends the severity in terms of quality of water present in a water body.
5. **Solid Waste** includes waste present around/on the surface of water bodies. It checks on factors like availability of the dustbins, flies over the Garbage Vulnerable Points (GVPs) and leachate coming out from it, which might directly contaminate a water body.
6. **Wastewater** includes the status and type of drainage run-off and direct contamination of water body due to it.
7. **OD/OU** indicator indicates the presence of the human faecal matter, animal dung and urination around water body. It acts as a major role behind the growth of algae and plants into the water body.

The line graphs depicts indicator-wise State average of the survey and the bar graph represents the indicator wise scores of Rae Bareli district.

- Indicators of Rae Bareli namely, Aesthetics and Solid waste disposal maintains the mean score corresponding to the State score.
- In terms of Quality, score of Rae Bareli is better than the State score.
- However, Rae Bareli performed poorer than the State in terms of Condition/State, Infrastructure, Wastewater drainages and OD/OU.

**Performance based descriptors of Rae Bareli**

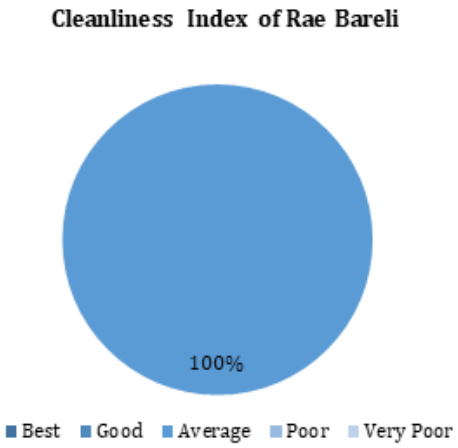



Figure 4.130: Cleanliness index of Rae Bareli

Water bodies found in various blocks of Rae Bareli were lying under different descriptors as per their performances. These descriptors are characterized by different water body indicators, which denotes water body Cleanliness Index.

'Best' and 'Good' indicates that lower level of intervention is required, whereas, 'Poor' and 'Very Poor' signifies that higher level of intervention is needed for rejuvenation and sustainability of a water body. Furthermore, medium level of intervention is required for water bodies lying under 'Average' category.

As per the figure, 75 per cent of water bodies lie in the Average band. These require medium level of intervention for rejuvenation. However, no water body fall under any other descriptor.

# Images of water bodies in RAE BARELI

Healthy | UP_HAZARATPUR
URF KHWAJA JAHANPUR_145051_009091_W1

Water Hyacinth
UP_DALMAU MU._144970_009041_W1

Dried up | UP_JAGANNATHPUR
MU._144720_009361_W1

Eutrophied
UP_PURANPUR_118111_009371_W1

Aesthetic Enhancement
UP_NISGAR MU._144713_009401_W1

Drainage connected | UP_KHARAULI
MUSTAKIL_145240_009541_W1

Not turbid
UP_KHEMA NANDPUR_145050_009101_W1

OD
UP_NISGAR MU._144713_009402_W2

Settlement nearby
UP_NISGAR MU._144713_009401_W1

Turbid due to dissolved material
UP_GEGASO MU._144865_009221_W1

Waste around
UP_SAIDAPUR_133466_009441_W1

Waste on the surface
UP_NISGAR MU._144713_009401_W1

# A. ANNEXURE DETAILS

## a. Detailed Scoring Toolkit

| Category | Sub Category | Question | Options | Updated Marks Breakup | Updated Total Marks |
|---|---|---|---|---|---|
| | Condition / State | Does the water body have adequate water (not dried up)? | Yes | 10 | 10 |
| | | | No | 0 | |
| | | Does the area around the water body has any settlement? | Yes | 0 | 20 |
| | | | No | 20 | |
| | | Do you see any septic tank within 100m of the water body | Yes | If Yes, then following scoring | 10 |
| | | | No | 10 | |
| | | If yes, How far is the septic tank located? | 10-30 | 0 | |
| | | | 30-50 | 0 | |
| | | | 50-100 | 5 | |
| | Infrastruct-ure | Do you see any fencing around the water body | Yes | If Yes, then following scoring | 20 |
| | | | No | 0 | |
| | | If yes, What is the condition of fencing? | Complete fencing | 20 | |
| | | | Partially fenced | 15 | |
| | | | broken | 10 | |
| | | Is there any Outlet channel in the water body? | Yes | 10 | |
| | | | No | 0 | |

| Category | Sub Category | Question | Options | Updated Marks Breakup | Updated Total Marks |
|---|---|---|---|---|---|
| Water Body Index | | What is the condition of Outlet channel? | Clear | 10 | 10 |
| | | | Partially Blocked | 5 | |
| | | | Blocked | 0 | |
| | | Is there any road connected or near to the circumference of waterbody? | Yes | 0 | 10 |
| | | | No | 10 | |
| | | Is there a CT/PT near the water body? | Yes | 0 | 5 |
| | | | No | 5 | |
| | | Is the disposal system of the CT/PT connected into water body? | Yes | 0 | 5 |
| | | | No | 5 | |
| | Aesthetics | Any kind of aesthetic enhancement done around the waterbody? | Yes | If Yes, then following scoring | 10 |
| | | | No | 0 | |
| | | what kind of aesthetic enhancement do you see around the waterbody | A park | 2 | |
| | | | Just a few benches | 2 | |
| | | | Floral beautification | 2 | |
| | | | A footbridge | 2 | |
| | | | Religious architecture | 2 | |
| | | Turbidity of the water | Turbid due to suspended materials | 5 | 10 |
| | | | Turbid due to dissolved materials | 0 | |

| Category | Sub Category | Question | Options | Updated Marks Breakup | Updated Total Marks |
|---|---|---|---|---|---|
| | Quality | | Not turbid | 10 | |
| | | Is the water body Eutrophied? | Yes | 0 | 20 |
| | | | No | 20 | |
| | | What type of Eutrophication in the water body? | Traces of Algal blooms in the water body | 10 | |
| | | | A thin layer of Algal blooms | 5 | |
| | | | A thick green layer of Algal bloom and slime (blocking sunlight) | 0 | |
| | | Do you see any foam on the surface of the water body | Yes | 0 | 20 |
| | | | No | 20 | |
| | | If Yes, what is the volume of foam? | Foam present at only one checkpoint | 10 | |
| | | | Foam present at two checkpoints | 6.7 | |
| | | | Foam present at three checkpoints | 3.3 | |
| | | | Foam present at all checkpoints | 0 | |
| | | Do you see any kind of waste around the water body? | Yes | 0 | |
| | | | No | 20 | |

| Category | Sub Category | Question | Options | Updated Marks Breakup | Updated Total Marks |
|---|---|---|---|---|---|
| | Solid Waste | If Yes | Present around only one checkpoint | 10 | 20 |
| | | | Present around two checkpoints | 6.7 | |
| | | | Present around three checkpoints | 3.3 | |
| | | | Present around all checkpoints | 0 | |
| | | Do you see leachate coming out of the dump | yes | 0 | 20 |
| | | | no | 20 | |
| | | If Yes, Is leachate following into the water body? | Yes | 0 | |
| | | | No | 10 | |
| | | Do you see any dustbins around the waterbody | Yes | 10 | 10 |
| | | | No | 0 | |
| | | Do you see flies around the dump | Yes | 0 | 10 |
| | | | No | 10 | |
| | | Do you see any waste on the surface of the water body? | Yes | 0 | 20 |
| | | | No | 20 | |
| | | If yes | Present at only one checkpoint | 10 | |
| | | | Present at two checkpoints | 6.7 | |
| | | | Present at three checkpoints | 3.3 | |
| | | | Present at all checkpoints | 0 | |

| Category | Sub Category | Question | Options | Updated Marks Breakup | Updated Total Marks |
|---|---|---|---|---|---|
| | Wastewater | Does any kind of washing take place (50m) around the water body? | Yes | 0 | 20 |
| | | | No | 20 | |
| | | Do you see any kind of wastewater drain | Yes | If Yes, then following scoring | 30 |
| | | | No | 30 | |
| | | If yes | Drainage into the waterbody | 0 | |
| | | | Drainage around the waterbody | 10 | |
| | | Do you see screen mesh/grill/net at the opening of the drainage | Yes | 10 | |
| | | | No | 0 | |
| | OD/OU | Do you see any human faecal matter or animal dung around the waterbody | Yes | 0 | 20 |
| | | | No | 20 | |
| | | If yes | Present around only one checkpoint | 10 | |
| | | | Present around two checkpoints | 6.7 | |
| | | | Present around three checkpoints | 3.3 | |
| | | | Present around all checkpoints | 0 | |

## c. Standard operating Procedure: Aerial Survey of water bodies

# STANDARD OPERATING PROCEDURE FOR DRONE ASSESSMENT (AERIAL SURVEY)

| | | |
|---|---|---|
| QUALITY COUNCIL OF INDIA | Date: | 10th March 2021 |
| | Document Number: | QCI-SOP-DS-0002 |
| | Version: | 2.0 |
| STANDARD OPERATING PROCEDURE FOR AERIAL SURVEY OF WATER BODIES USING DRONES | Prepared By: | |
| | Reviewed By: | |
| | Approved By: | |
| | Authorized signatory: | |

# 1. Objective

## 1.1 General

A drone survey refers to the use of a drone, or unmanned aerial vehicle (UAV), to capture aerialdata with downward-facing sensors. During a drone survey with an RGB camera, the water body is photographed several times from different angles, and each image is tagged with coordinates. This report presents the technical information about the survey aspects of the project located in India.

## 1.2 Scope of Work

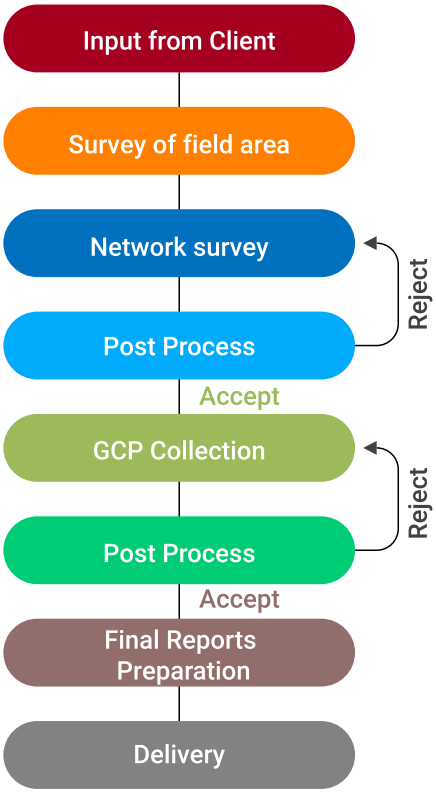
The objectives of the drone survey are as follows:

- Data acquisition
- Data processing
- Topo drawing (Contour Mapping)
- Area of the water body

## 1.3 Methodology

The methodology adopted for the drone survey is data acquisition using drone to get data in the form of images will be acquired by the drone. Check points are laid to improve the accuracyof the dataset. Photogrammetry combines images that contain the same point on the ground from multiple vantage points to yield detailed 2D and 3D maps.

# 2. Process flow




## 2.1 Drone Survey

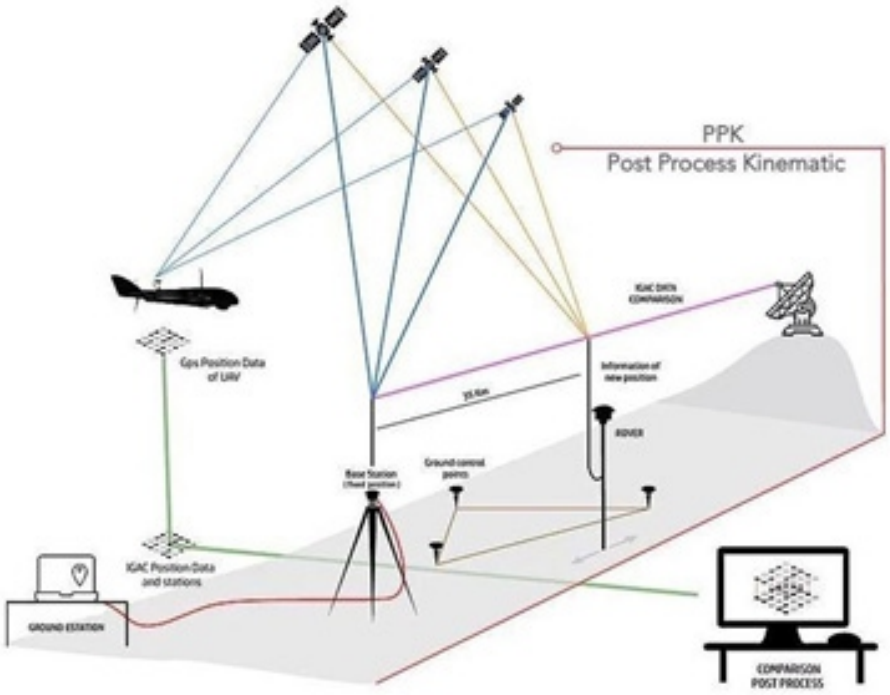
Most of the photogrammetry and LiDAR surveys requires a lot of Ground Control Points (GCPs) to georeferenced the data accurately. But with the GNSS PPK (Post Processing Kinematics) technology which is very scientifically integrated with the Skylark's UAS platforms, the need of Ground Control Points (GCPs) is reduced by 90% and the rest of the 10% of the GCPs will be used to transform the geographical coordinate system to another reference plane and for ensuringthe accuracy levels. Every time an image is captured, the system provides very high precision camera position. This provides a whole trajectory of the image capturing coordinates of the camera, which can be used at real time or during the post processing time. The system requires two units, one of the units is base station and other is called as rover, which in this case will be UAS. The base station and rover will be continuously connected with each other as well with the GPS and GLONASS satellites. PPK provides centimeter level accuracy. Eventually, with PPK system following advantages can be observed when compared to very conventional method of justusing Ground Control Points (GCPs) to obtain accuracy:

1. Better absolute accuracy (5-7 cm in X, Y and 8-10 cm in Z) wherein only using GCPs limitsthe accuracy in Z to 15-20 cm

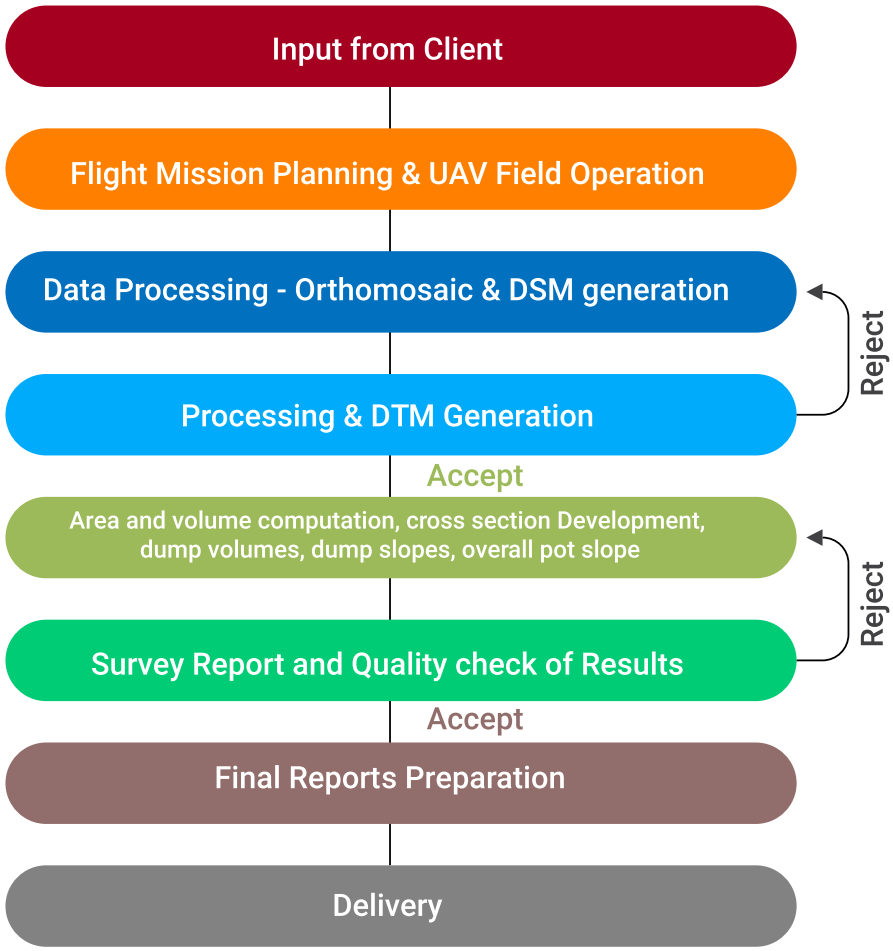
2. Lower number of GCPs (only 3-4) whereas avg. 7-8 GCPs are required per 100 Hectare when PPK is not used.

3. Consistent accuracy throughout the area whereas in case of only GCP approach, accuracies (10-12cm) are concentrated around the GCPs and deviates in areas away from GCPs

4. Lower processing time as PPK geo-tag enables faster alignment of images and does not relyonly on image feature identification-based alignment which consumes multiple times higher time.




## Process Flow



## 2.2 Accuracies achieved in Photogrammetry

In photogrammetry, accuracy depends majorly on the following factors:

- Scientific practices (GCP placement, Path planning etc.,)
- Image resolution
- Image position accuracy
- Flying conditions
- Ground Control Point accuracy
- Data processing practices

Unlike manned aircraft, which cannot fly at low altitudes, UASs can provide fantastic image resolutions even with simple digital camera. If all the above factors are carefully tackled, the accuracies can be as good as 3-4 cm in in X, Y plane and 5-6 cm in Z plane using the photogrammetry technique. To achieve these accuracies, we at Skylark follow extremely scientific methods which include extensive new age research and methodologies of our own. A lot of on-board UAS sensor data (viz., attitude, location, state etc.,) are continuously stitched with images to obtain survey grade results and accuracies.

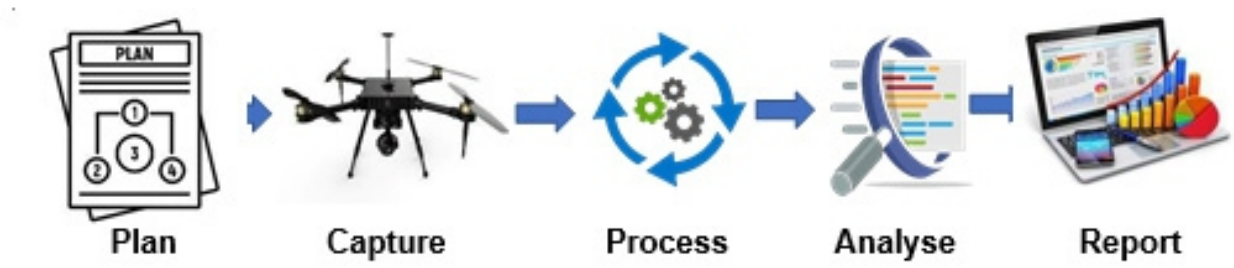
## PPK Technology Vs Ground Control

| Parameter | Non PPK Drone | PPK Enabled Drone | Advantage |
|---|---|---|---|
| X, Y and Z Absolute Accuracies without GCP's | >50 cm | 7-9 cm in X and Y, 12-15 cm in Z | Better accuracies without GCP's |
| Best Accuracies with GCP's | 5-10 cm in X and Y, 10-15 in Z | 3-4 cm in X and Y, 7-8 cm in Z | Up to 2times better accuracies with GCP's |
| Number of GCP's per Sq. Km for above accuracies | 8-10 | 1-2 | Less dependency on other factors and more area coverage per day |
| Relative Accuracies | Higher Accuracy near the GCP, Accuracy decreases as we move farther | Accuracies remain same through the data irrespective of GCP's | For large areas PPK is more useful than any other technology |

*Table: Comparison of accuracy and GCP requirements for PPK and Non-PPK drone*

## 2.3 The Typical UAV Workflow

A typical survey workflow for photogrammetry using a Drone/UAS appears following:




## 2.4 Preflight Checklist

| Pre-Flight Checklist | Version | Revision |
|---|---|---|
| Project Code | Date | Client |
| PM/TL/PIL/GCS | Mission Id | UAV ID |
| Parameter | Checklist/Value | Remarks |
| UAV Preparation | | |
| Landing time | | |
| Disarm UAV by push safety button switch | | |
| Plug out the battery | | |
| Turn off the RC Transmitter | | |
| Disconnect Mission Planner from drone | | |
| Launcher Preparation | | |
| Distance travelled | | |
| Flight time | | |
| Battery ID | | |
| Camera Battery ID | | |
| Battery Preparation | | |
| Weather condition | | |
| Temperature | % | |
| Altitude | V | |
| Wind Speed | V | |
| Camera Preparation | | |
| Camera ID | | |
| Camera Battery ID | | |
| Camera SD Card ID | | |
| Camera condition is good, and setting is adjusted | | |
| Battery camera level>50% | % | |
| Memory card is empty and inserted | | |
| Lens and UV filter are cleaned properly | | |

| | | |
|---|---|---|
| Camera active gimbal structure is good | | |
| Camera is installed on UAV and connected to the system | | |
| GCS Preparation | | |
| Computer Battery is sufficient >50% | % | |
| Modem is positioned properly | | |
| Mission planner software is working properly | | |
| Flight Mission | | |
| Waypoints position and height are correct | | |
| Mission length <70 km | km | |
| Mission altitude > 200 m | m | |
| Final Preparation | | |
| Turn on UAV by plug in battery | | |
| Mission Planner is connected with telemetry signal > 90% | | |
| Current mission uploaded | | |
| Set camera mount to "Neutral" mode | | |
| Camera trigger system is checked | | |
| MP Battery percentage indicator >95% | % | |
| MP Battery voltage indicator >16.5 v | V | |
| GPS satellite count >7 sat | sat | |
| HDOP value is sufficient <2.0 | | |
| IMU indicator is good | | |
| UAV is mounted to the launcher with roll orientation to launcher <2° | | |
| UAV mount no-slip at 100% throttle and rotary direction is checked | | |
| All servos respond to roll, pitch and deflection is | | |
| checked | | |
| UAV's mode "FBW-A" | | |
| Take-off direction adjusted to headwind | | |
| Take-off time | | |
| Condition | | |
| Weather condition | | |
| Temperature | °C | |
| Humidity | % | |
| Pressure | mmHg | |
| Altitude | m | |
| Wind Speed | m/s | |
| Wind Direction | ° | |
| UAV Condition | | |
| Additional Remark and Illustrations | | |

## 2.4 Preflight Checklist

| Pre-Flight Checklist | Version | Revision |
|---|---|---|
| Project Code | Date | Client |
| PM/TL/PIL/GCS | Mission Id | UAV ID |
| Parameter | Checklist/Value | Remarks |
| Recovery and Preparation | | |
| Landing time | : | |
| Disarm UAV by push safety button switch | | |
| Plug out the battery | | |
| Turn off the RC Transmitter | | |
| Disconnect Mission Planner from drone | | |
| Release the camera from housing | | |
| Copy all the photos to GCS | | |
| Parameters | | |
| DAN/OAN | | |
| Distance travelled | km | |
| Flight time | min | |
| Battery ID | | |
| Camera Battery ID | | |
| Camera Battery percentage | % | |
| Camera SD Card ID | | |
| Number of photos | | |
| Condition | | |
| Weather condition | | |
| Temperature | °C | |
| Altitude | m | |
| Wind Speed | m/s | |
| Wind Direction | ° | |
| UAV Condition | | |
| **TL:** | **GCS:** | **REMARKS:** |

# 2 Procedure

## 3.1 Data Acquisition Using Drone

### 3.1.1 General

To obtain good images suitable for processing, it is very important to design a data acquisitionplan considering: type of project (aerial, terrestrial, mixed), type of terrain / object, type of camera, purpose of the project, image rate that the images are taken, distance (flight height) atwhich the images are taken and with which angle to take the images, path(s) to follow to take the images, etc.
For aerial projects, this also implies selecting corridor path or regular grid and/or circular grid, deciding whether terrestrial images will be used, if more than one flights are needed to cover the full area.

### 3.1.2 Mission Planning

A data acquisition plan is made specific to the site that needs to be surveyed. It depends on the type of terrain / object to be reconstructed. Flight polygons are designed, and data acquired is as per this plan. The flying altitude is designed to capture resolution which best fits the project.

**Table 1: Details of Mission Plan**

| Parameters | Details |
|---|---|
| Drone Phantom | 4 RTK |
| Flying Altitude | 50 - 100 m |
| Ground Sampling Distance | 1.0 - 2.0 cm |
| Overlap (%) | 70/70 |
| Data type | RGB images |

Planning involves fixing AOI, placing GCP's across the AOI, and fixing the flight parameters such as Ground Sampling Distance (GSD) or spatial resolution, Frontal overlap, Side overlaps according to project requirements.


*Figure: Drone AOI with GCP placement*

### 3.1.3 Check Points Planning

Check Points (CP) are markers laid on the ground which will be incorporated in the photogrammetry processing to improve the accuracy of the dataset. Distance between them isobtained with traditional surveying methods in the field. CPs are necessary for orientation andplacement of aerial photographs in the spatial coordinate system.


*Figure: Sample GCP, placement on ground and taking reading on it*

### 3.1.4 Field Data Collection:

**DGPS Survey:**

Data Collection involves preliminary reconnaissance survey around the AOI for placing GCP's. Once the GCP's were placed DGPS survey will be conducted to observe the placed GCP's.

*Figure: GCP Banner from Field Survey*

### 3.1.5 Drone Data Collection:

Base will be established to collect drone data. Drone will be flown from the ground station. Following our AOI kml in a Grid in mission planner software.

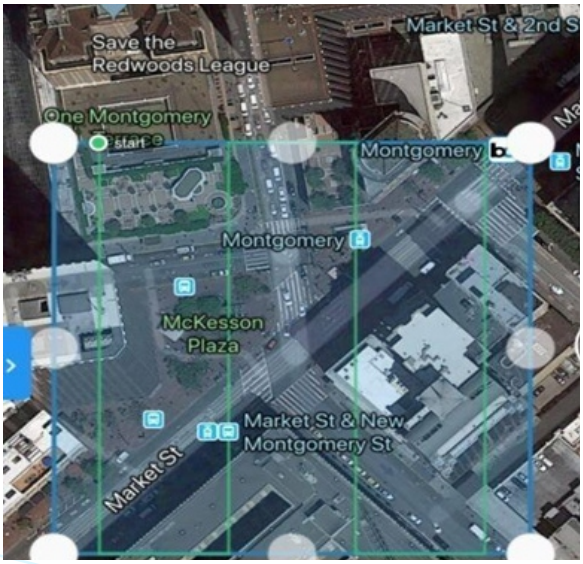



*Figure: Drone Planning in Drone Deploy*

Key points to consider and keep in mind during field survey

a. Ensure that permission letters are handy and printouts available in person

b. Be aware of the surroundings

c. Fly as per DGCA guidelines to ensure safety

d. Make sure the operator has the right PPE kit

e. Always keep an eye on the drone

f. Keep people a safe distance away from drone take-off and landing site. Once it lands, image data and rover will be downloaded to the computer.

## 4. Data Processing

### 4.1. General

The data acquired from the drone survey and the DGPS survey is processed using the technique called Digital Photogrammetry. Entire drone data is stitched together to produce quality outputsof the site. All the outputs can be viewed/downloaded from the vendor data platform.

### 4.1.1 Initial Processing

Using Photogrammetry software, the tie points and key points have been extracted inthe initial processing by Aerial triangulation and Bundle block adjustment techniques.

### 4.1.2 Aerial triangulation

It is the process of piecing together the block of overlapping aerial images in an objective to determine the position and orientation of each image in the mapping frame.

### 4.2. Aligning Cameras

Each drone image has a collection of unique features which differentiate it from other images.These are known as key points. Key points from each image are extracted using automatic computer vision algorithms. Extracted features are then searched (in the nearby images) and matching is performed. Using GPS data to search relevant images makes the matching process much faster and accurate. From matched features, fundamental matrix is derived and the relative position between two cameras is estimated. Relative position estimated from the fundamental matrix is generally prone to errors. Bundle block adjustment is used to simultaneously refine the 3D coordinates (Latitude, Longitude, Elevation), orientation parameters (Yaw, Pitch, Roll), and the optical characteristics (distortion parameters) of the camera(s) employed to acquire the images. Bundle block adjustment is a nonlinear iterative optimization process where the objective function is Mean Re-projection Error (MRE) and parameters are the position, orientation and camera distortion coefficients.

### 4.2.1. Interior Orientation:

It is the transformation of 2D image coordinate system to 3D Camera coordinate system. Parameters of interior orientation come from camera calibration such as lens distortion, principal point, fiducial marks and focal length etc.

### 4.2.2. Exterior Orientation:

Exterior orientation is establishing relationships between ground and images based on the six parameters (The position of the camera (X,Y,Z) andorientation of the camera (Omega,Phi,Kappa).

### 4.2.3 Absolute orientation:

Stereo model that was measured from relatively oriented images is transformed into the ground coordinate system.

### 4.2.4 Tie Point:

A point in a digital image or aerial photograph that represents the same location in an adjacent image or aerial photograph. Tie-points are neededto link images in relative orientation of bundle block adjustment.

## 4.3. Densing To Build Point Cloud

Depth value is estimated for every pixel in the image using Multi-View Stereo algorithms. Individual depth map of an image is fused together with the depth map of the neighboring image to obtain a 3D point. These points are often called as the dense point cloud. It may evenconsist of greater than 1 crore points for a relatively smaller area. 3D points are triangulated to create Digital Elevation Model (Raster). Every pixel in raster has latitude, longitude and elevation information. Interpolation technique like IDW is used to do 3D point cloud to obtainthe elevation model.

## 4.4 Orthomosaic & Digital Elevation Models

A digital elevation model (DEM) is a 3D representation of a terrain created from its elevation data. A digital surface model (DSM) represents the earth's surface and includes all objects on it. The digital terrain model (DTM) represents the bare ground surface without any objects likeplants and buildings.

# 5. Drone Survey Outputs

## 5.1. General

The major outputs from photogrammetry processing include Orthomosaic for visual representation, Digital Surface Model and Digital Terrain Model for elevation values throughout the site.

## 5.2. Digital Surface Model

A digital surface model (DSM) represents the earth's surface and includes all objects on it. The DSM is generated using the densified 3D point cloud. Software which you can use to visualise this data: QGIS.

## 5.3. Orthomosaic

Orthomosaic can be used to measure true distances, because it is an accurate representation ofthe Earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt. Orthorectification step involves creating a visibility or occlusion map with respect to each image. The orthomosaic is generated based on the DSM. Software which you can use to visualise this data: QGIS.

The raster DSM (using Interpolation techniques such as IDW, Triangulation based on the terrain surface) and Ortho-mosaic from the obtained point cloud has been generated.
The resolution of outputs depend on the GSD which further decreased to higher resolution using GIS software.

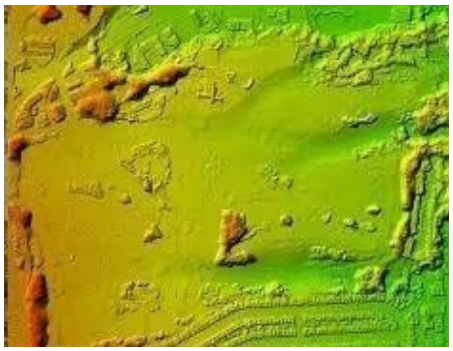


*Figure: Ortho and DSM processed from software*

## 5.4. Digital Terrain Model

The digital terrain model (DTM) represents the bare ground surface without any objects like plants and buildings. The DSM is further processed to remove vegetation and buildings in orderto create a DTM. Software which you can use to visualise this data: QGIS.

## 5.5. Point Cloud

Point clouds are a collection of points that represent a 3D shape or feature. Each point has its own set of X, Y and Z coordinates. The Point cloud will be generated from extracted Tie Points at point density of 30-50 pointsper sq.m. Point cloud density can be varied based on the GSD and processing setup.

*Figure: Point Cloud processed from Images*

## 5.6 Topographic Drawing

From the photogrammetry outputs, the topography of the site is represented as a drawing. Thisdrawing includes quantitative representation of terrain using contours and spot levels. Apart from these, it also represents both natural and man-made features on the site. Software which you can use to visualise this data: AutoCAD.

Point clouds, Orthomosaic can be further processed to extract digitised boundary layers, contours, Digital Terrain Model etc.

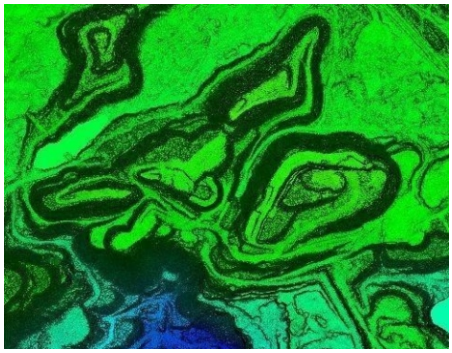


*Figure: DTM cleaned and extracted from Point cloud*

Software suites currently used after data acquisition are as follows:

1. Pix4D: Image processing to generate 2d Orthomosaic and 3d Point clouds
2. Bentley Microstation: Point Cloud Classification, DTM Generation
3. Global Mapper: ECW conversion, Image Tiling, cropping etc. Quality checks, 3DAnalytics, Digitization
4. ArcGIS: Digitization, Image Tiling
5. AutoCAD Civil/Map3d: Digitization, Volumetric analysis

# 6. Annexure

## 6.1. Permits

Before starting the aerial survey, permits are required from District Magistrates in coordination with the concerned ministries. District Magistrate enforces the orders received from ministries to the SP after which SP informs the local police stations and the concerned government officials under his jurisdiction and parallelly District Magistrate informs the same to their Block Development Officer under his jurisdiction.

## 6.2 Safety Hazards

Before starting the aerial survey, we shall identify operational drone safety hazards separated into “active failures” and “latent conditions”, both of which occur or might occur during the flight operations.

1. Loss of control
2. Loss of transmission
3. Collision with buildings, power lines, structures etc.
4. Partial failure or loss of navigation systems
5. Severe weather or climatic events
6. Take-off and landing incidents as undershooting or overrunning

## 6.3. Points to be considered

The following must be kept into consideration before deploying the team for aerial survey

1. Travelling in extremely rural areas can be a challenge as the pilot has to go off- road to reach the exact waterbody location.
2. There should be a team of 2 members pilot and a co-pilot with at least one of them fluent with the local language which will help them to communicate with the locals, find out the exact water body and seek help in case of any emergencies.
3. Raw Data Collected by drone is heavy and transferring the same to the data processing team can be a challenge due to poor internet connectivity in the Rural Areas.
4. As drone equipment is bulky, drone operator is required to travel with four-wheel vehicle.

## 6.3. Points to be considered

| Photogrammetry Outputs | Data Provided | |
|---|---|---|
| 1 | Orthomosaic Model Map | Yes/No |
| 2 | Digital Surface Model Map | Yes/No |
| 3 | Digital terrain Model Map | Yes/No |
| Topographic Drawings | Data Provided | |
| 1 | Topographic Drawing | Yes/No |
| 2 | Contour Map | Yes/No |
| Survey Outcomes | Data Provided | |
| 1 | Analysis of Site (Waterbody Area) | Yes/No |
| 2 | Feature Map of Waterbody | Yes/No |
| 3 | Farmland Details | Yes/No |
| 4 | Trees Details | Yes/No |

सत्यमेव जयते

# National Mission for Clean Ganga

(Registered Society, Under Act 1860)

Ministry of Jal Shakti

Department of Water Resources, River Development & Ganga Rejuvenation

Government of India