भारतीय वन्यजीव संस्थान
Wildlife Institute of India

नमामि गंगे

DIGITAL VILLAGE MICROPLANS: MAINSTREAMING GANGA BIODIVERSITY CONSERVATION IN LOCAL DEVELOPEMNT PLANNING USING DIGITAL TECHNOLOGY

BIODIVESITY CONSERVATION AND GANGA REJUVENATION

Component 5: Community Based Conservation Programme for Species Restoration in Ganga River

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LIST OF ABBREVIATIONS/ ACRONYMS

ADO.Net	-	ActiveX Data Object
AJAX	-	Asynchronous JavaScript and XML
CBD	-	Conservation of Biological Diversity
ESRI	-	Environmental Systems Research Institute
FGDs	-	Focus Group Discussions
GIS	-	Geographical Information System
ICTs	-	Information and Communication Technologies
IT	-	Information Technology
Jscript	-	JavaScript
JSON	-	JavaScript Object Notation
MNREGS	-	Mahatma Gandhi National Rural Employment Guarantee Scheme
MoA	-	Memorandum of Agreement
NMCG	-	National Mission for Clean Ganga
NYKS	-	Nehru Yuva Kendra Sangathan
PRAs	-	Participatory Rural Appraisals
QGIS	-	Quantum GIS
RESTful	-	Representational state transfer web service
SDGs	-	Sustainable Development Goals
SHGs	-	Self Help Groups
SPSRD	-	Software Package for Sustainable Rural Development
SPMG	-	State Project Management Groups
SQL	-	Structured Query Language
UN	-	United Nations
WII	-	Wildlife Institute of India
XHTML	-	eXtensible HyperText Markup Language
XML	-	eXtensible Markup Language

"Namami Gange" one of the major flagship programme of the Government of India (GOI), is presently leading the efforts towards conservation and restoration of major river systems in the country including the populous Ganga River basin. Traversing through five Indian states namely; Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal covering three Biogeographic zones, the Ganga River encompasses a rich & diverse natural and cultural heritage.

Issues related to the conservation and restoration Ganga River requires a multidimensional coherent conservation strategies involving multiple stakeholders to address the ecological and social challenges faced by the National River Ganga and restore its ecological integrity. As a part of this programme, the National Mission for Clean Ganga, Ministry of Jal Shakti, Government of India and the Wildlife Institute of India initiated a poject titled Biodiversity Conservation and Ganga Rejuvenation" developed a comprehensive approach for preparing a science based conservation plan for the Ganga River integrated with engagement and capacity building of multiple stakeholders who are directly or indirectly dependent or can influence the Ganga River conservation.

For successful implementation of conservation or development goals, participation of communities and institutions representing various strata of the society is of the essence. It is the need of hour to streamline biodiversity conservation of the Ganga River in the local development planning as well as scientifically empower the local communities for effective decision making and implementation process. In order to maximize the participation and efforts for Ganga River conservation, it is imperative to understand the crucial role of communities and local institutions in actualizing the vision of conserving and restoring the Ganga River.

This chapter on "**Digital Village Microplans: Mainstreaming Ganga Biodiversity Conservation in Local Development Planning Using Digital Technology"** is a representation of inter-linkage between conservation of the Ganga River and sustainable development of the villages. The main aim of this study was to mainstream biodiversity conservation of the Ganga River in local development planning and create a digital framework and a repository of village microplans. A Village Microplanning Guideline has been developed elucidating the

aim, process of microplanning and role of various stakeholders including agencies and institutions (government and non-government departments, local communities and other line agencies) in implementing the village microplans. Based on the guideline, 12 village microplans have been prepared for the villages located in the three stretches (Upper, Middle and Lower) along the Ganga River. These village microplans are prepared after rigorous consultations with multiple stakeholders including local communities representing different socio-economic backgrounds, members of local governments, block administration and local institutions. With an approach of integrated participatory framework, these village microplans address Ganga River conservation, social-economic challenges of the villages and discuss the potential future actions and recommendations for strengthening the engagement of multiple stakeholders and institutions. In preparation and implementation of the village microplans, active role of Gram Panchayats, local institutions and community participation ensures the execution and monitoring of the action plans in a sustainable manner.

Using the digital platform, a framework has been developed using various softwares and applications of Information and Communication Technologies for digitalizing the village microplans. All the activities being conducted at a large scale entails an accurate and adequate repository in the form of baseline data which will help in assessing and monitoring the effectiveness of the activities. Therefore, this novel initiation was carried out by the WII in strengthening the social-ecological aspect of Ganga River conservation by digitalizing the 12 village microplans.

The digital village microplans are representations of the nested- inter-linkage between conservation of the Ganga River and sustainable development of the village. For digitalizing village microplans all the identified social, economic and ecological issues were categorized under nine strategic themes out of which three were under generic category i.e. community awareness, biodiversity conservation and hygiene and sanitation and other six themes i.e. livelihood and skill development, community based institution, renewable energy, agriculture, fishery and animal husbandry were under trust building category. These nine strategic themes have been identified on the basis of the current scenario of the village pertaining to development and conservation.

This technological intervention of digitalizing village microplans will play a major role in a) creating awareness and dissemination of knowledge to a large number of stakeholders, b) building a groundswell for combining the experiences and expertise of various stakeholders on a common platform, c) meticulously manage and monitor the effectiveness of the activities being undertaken by multiple stakeholders and d) facilitate transparency, accountability and bridge gaps across multiple disciplines and sectors. The initiative of digitalizing village microplans was carried out to contribute in identifying, prioritizing and developing feasible and effective interventions and action plans for sustainable rural development which is in consonance with biodiversity conservation.

1. INTRODUCTION

Devolution of responsibilities and power from higher or central government to regional or local government, also known as decentralization has occupied the centre stage in development and conservation planning, decision and policy making processes, especially in the developing countries. There are three major categories of decentralization namely political, administrative and fiscal decentralization (Manor, 1999; Francis and James, 2003). In today's state of affairs, with respect to development planning, transfer of power administration and governance to local authority is believed to be beneficial; as it entails a comprehensive and all- inclusive participatory approach. Therefore, decentralization has been recognized as one of the major government reforms (Burki et al., 1999; Blair, 2000; World Bank, 2000; Bardhan, 2002; Kessy and McCourt, 2010; Kowler et al., 2016). Being a multi-faceted framework, it attempts to enhance accountability and credibility of the local communities, manage efficient resource allocation, and optimization and effective responsiveness, while, maintaining the political interest (Hadingham, 2003; Vincent & Stephen, 2015; Wahid et al., 2017).

Globally there are examples, wherein role of communities and local institutions have become catalysts in local development planning and resource management (Pomeroy, 1995; Hadingham, 2003; Lane and McDonald, 2005; Pike et al. 2015; Hadgu 2017; Malinga et al., 2017; Prabawati & Pradana, 2018). According to MDGD/UNDP (2000a) report, decentralization programmes have been carried out extensively in Africa, Arab states, Asia and the Pacific, Europe, Latin America and the Caribbean wherein the political and legal reforms, fiscal administration, strengthening of local governance, gender equity, resource mobilization and management, capacity building, social service planning and delivery and natural resource management are addressed (Livingstone and Charlton, 2001; Work, 2002; Francis and James, 2003; Ojambo, 2012).

The inter-governmental finance systems and other fiscal challenges have impacted: resource mobilization & allocation; decision making process; political partaking in capacity building of local administration; weak outreach; unavailability of government schemes; or reduction in the implementation of many government schemes and benefits introduced for

the development and well-being of communities at the grassroots level (Adedire, 2014; Smoke, 2015; Wahid et al., 2017).

Therefore, the extent of decentralization depends on the political, fiscal and administrative structure of the governments at all tiers. At the same time, it also depends on the constitution of local government, participatory practices, presence and influence of local institutions, advocacy groups, community mobilization and participation (Work, 2002).

With time decentralization and local governance have evolved at both spatial and temporal scales. Main ideology of decentralization is to maintain efficiency, accountability, transparency and participation at governance and administration systems starting from the grassroots level, thereby aligning with the concept of good governance (Francis and James, 2003; Malinga et al., 2017). It has a significant role in achieving goals of sustainable development, as it ensures participation from multiple stakeholders at all governance, administration and implementation levels. However, until today decentralization as a form of governance is a debatable issue trying to establish its stand in the system. Major reasons as mentioned can be inadequate capacity of skilled and trained representatives, insufficient fiscal decentralization, lack of accountability and transparency (Johnson, 2001; Francis and James, 2003). A framework focussed on fortification of methodology, planning and facilitation, capacity building and training of local administration, institutions and communities, governance and equity sharing, accountability, robust monitoring and evaluation systems, seamless linking with community managed funds in local and higher government systems is inevitable (Dahal et al., 2002; Kumar, 2005).

In today's dynamic development and socio-economic set-up around the world, there cannot be one universal model for decentralization across all the countries. Therefore, a realistic framework of decentralization customized and translated according to the existing national, state and regional priorities along with the cultural and institutional aspects of the communities at the local level is imperative (Work, 2002).

As we approach towards development, the concern of conserving and securing our natural heritage enters a volatile state. In today's scenario much is being anticipated about development planning systems, wherein it becomes crucial to understand the compatibility and sustainability of development with conservation of natural resources. It is evident from

various studies that different ecosystems support and sustain wide ranging rich biodiversity including human sustenance, therefore, impact of any change in the environment or ecosystem, or loss of any natural resource directly affects the social and economic well being of human sustenance.

Amongst the most threatened ecosystems is the freshwater ecosystem. Across the globe, increasing anthropogenic pressures on natural resources, especially on rivers and freshwater have called forth on the much needed attention and pro-active participation from different stakeholders and institutions. Various conservation targets and goals of national and international importance such as 2030 Agenda for SDGs, CBD and UN Environment Freshwater Strategy (2017-2021) are working towards the conservation of rivers, wetlands, aquifers and lakes.

Globally, the value of freshwater biodiversity and the urgent need for its conservation including species and their habitats, genetic and functional diversity, communities and stakeholders is being recognized (Dudgeon et al., 2006; Thieme at al., 2007; Geist, 2011; Dudgeon, 2014; Angeler et al., 2014; Bunn, 2016). Conservation of freshwater ecosystems have reached the pinnacle of conservation priorities due to considerable anthropogenic and developmental pressures (Saunders et al., 2002; Dudgeon et al., 2006; Darwall et al., 2009; Boon and Raven, 2012; Collen et al., 2014; Campos-Silva and Peres, 2016; Gelcich and O'Keeffe, 2016; Hermoso et al., 2016). These ecosystems including rivers not only sustain the aquatic biodiversity, but are also crucial for maintaining the terrestrial biodiversity (Millennium Assessment, 2005; Nel et al., 2009). Increasing anthropogenic and developmental pressures along with climate change has led to deterioration of the ecosystem at a rate, faster than the regeneration capacity of the River (Saunders et al., 2002; Boon and Raven, 2012; Gelcich and O'Keeffe, 2016; Hassan et al., 2020). Studies are being conducted focusing on strengthening of freshwater conservation planning (Nel et al., 2009; Geist, 2011; Linke et al., 2011; Nel et al., 2011; Turak and Linke, 2011; Hermoso et al., 2012; Hermoso et al., 2013). Among the major rivers across the globe, the most threatened are the Nile in Egypt, the Ganges in South Asia, the Amu Dar'ya and Syr Dar'ya in central Asia, the Yellow River in China, and the Colorado River in North America (Saunders et al., 2002).

1.1 Conservation of the Ganga River

In India, the Ganga River, a multi-faceted river with national importance is a unique ecosystem due to its geographical, historical, social, cultural, ecological and economic significance. It represents a vulnerable ecosystem with dynamic social-ecological system wherein, social dependency, ecological relationships along with biophysical and developmental interactions forms a complex system.

It is challenging for the decision makers, managers and policy makers to confront these issues alone, therefore, ensuring involvement of multiple stakeholders is crucial for long term sustainability. An integrated and comprehensive approach needs to be established for developing holistic solutions in order to address development and conservation complexity of river basin management (Tippett et al., 2005). A shift in the perception towards communities and institutions at the grassroots level being efficient enough to safeguard the natural resources especially in the development planning processes is necessitated.

Apparently, the conventional top- down governance system especially in nature conservation has been strongly contemplated and discussed at various national and international policy forums, supporting the practice of decentralization in the matters of nature conservation and management (Ghimire and Pimbert, 1997; Zachrisson, 2009a; Fauchald et al., 2014; Hongslo et al., 2016; Sharma et al., 2019). Decentralization in environmental governance and natural resource management has contributed in escalating efficiency at the local levels by encouraging participation, accountability and promoting decision making at the grassroots level (Ribot and Larsen, 2013; Kiwango et al., 2015).

Considering the current scenario of anthropogenic pressures and human dependence on the Ganga River the question is that, a) Does local development planning processes consider natural resource management (here concerns about the conservation of Ganga River ecosystem)? b) To what extent do local communities and institutions are able to exercise their role in the development and conservation planning and implementation? c) What are the implications of decentralization in Ganga River conservation and how does it sustain the conservation goals in development planning in ensuring participation, transparency and accountability from multiple stakeholders on a single platform?

1.2 Microplanning: An integrated approach for conservation and development

Integration of Ganga River conservation in village development planning was carried out through village level microplanning. It is an all inclusive process, involving local communities and village councils known as Gram Panchayats in identification, prioritization, planning, decision making and implementation stages of development and conservation planning along with establishing alliances and convergence with institutions, concerned departments and stakeholders. The entire process entails awareness, training, capacity building of local communities in social organization and institutional development at the grassroots level (Bhatewara et al., 2006-010). It ascertains the participation from local communities and other stakeholders, motivate people to ponder over potential solutions and encourage them to implement the action plan prepared by them.

Some successful case studies of microplanning includes micro level planning for sustainable development of village ecosystems in Uttar Kannada; Sutirpar Bolgaon Eco-development Committee in Laokhowa Wildlife Sanctuary, Nagaon District, Assam, an initiative by Mahila Gram Sabha in Bukharaka village in Mewat, Haryana (Sehgal Foundation, 2014); preparation of micro level water distribution model in Rajasthan, microplan created for efficient energy utilization in Rajasthan (Deshmukh & Deshmukh, 2009) and the Joint Forest Management in Maharashtra (Barnes & Van Laerhoven, 2013).

During the microplanning process, an enormous amount of social, ecological and economic information about village in collated, therefore, it becomes challenging in communicating the same with the concerned government departments, institutions and other line agencies, while maintaining the transparency of the data. Use of technology, such as IT tools and GIS have contributed in planning, administration and governance at the grassroots level. GIS supports creation of multi thematic layered micro level database for the micro administration units such as villages aiding decentralisation (Bariar et al., 2004). Technology can largely upscale initiatives and enhance popularity. It has influenced new trends in mapping and GIS leading to democratisation of spatial data and maps (Kraak, 2004). GIS based village information systems have been developed for various villages like: Moga, Punjab; Nelvoy Vellore, Tamil Nadu (Singh et al., 2009; Gopal et al., 2009). It provides

decision makers robust alternatives by forecasting possible planning options and development scenarios.

1.3 Digital interventions for balancing conservation and development

Taking an example MNREGS programme of Government of India started in 2006. As, the programme was financed by the Central government and implemented by the local administration that is Gram Panchayat, focused on improving the livelihoods of rural population by providing unskilled manual labour per year at minimum wage (Banerjee et al., 2016). Due to uncertainties and ambiguities in the administrative and financing systems, the programme faced a lot of challenges leading to lack of execution of the programme and fulfilment of its objectives efficiently. To obtain funds the local official had to go through two higher hierarchical tiers (District and State), followed by manual entry of the justification of previously spent money, which was then finally fed into the electronic database. Banerjee et al., (2016), worked on making this financial management structure of transferring funds into a robust electronic system which contributed to a transparent, easier and effective auditing process with minimum involvement of higher officials and timely release of funds in the account of Gram Panchayat. The introduction of digital platform in the programme eased the transfer of authorized funds from the state directly into Gram Panchayat account with efficient tracking mechanisms. It led to an organized distribution of money into local accounts of all the beneficiaries with systematic release of funds by the state to the district and block authorities for the purchase of materials in MNREGS, followed by a transparent and methodical documentation of all the beneficiaries and associated work and payments on the electronic public database by the Gram Panchayats (Banerjee et al., 2016). During the MNREGS, software known as SoftWare Package for Sustainable Rural Development (SPSRD) was designed that focussed on integration of spatial information technology and MNREGS for the sustainable rural development (Sacria and Vijayan, 2012). Similarly, there are many studies such as Barnwal (2014); Muralidharan et al., (2016); Lewis-Faupel et al., (2016) as discussed by Banerjee et al., (2016), focussing on use of information technology and e-governance reforms for efficient and effective government systems. E-governance as a reformed tool enhances both administrative and financial efficacies (Banerjee et al., 2016).

Even though much optimism has been shown in implementing digital applications in conservation, still there are many fields wherein its application has not been explored much such as social-ecological studies in microplanning. With the new era of digital age, nature conservation has also progressed in shaping new discourses providing opportunities to think and practice new approaches and ideas. The term 'digital conservation' came into public use in the year 2011 (Van der Wal and Arts, 2015). Various digital applications such as digital public engagement, citizen science, crowd sourcing, e-learning, data connectivity, and decision-making support systems have gained prominence and are being applied in diverse ecological scenarios influencing perceptions of different stakeholders in engaging with nature (Arts et al., 2015). Use of digital technologies have significantly contributed in cost effectiveness, time management, data handling and sharing in various fields (Dunleavy et al., 2006; Milakovich, 2005; Obi, 2007; West, 2005; Milakovich, 2014). To improve the effectiveness and management of necessary actions, it is essential to make the data accessible and interoperable at all times in real time along with the examples and case studies for implementers, administrators and governments at all levels (Milakovich, 2012b; Milakovich, 2014). Ensuring good governance practice and regulation is also crucial in developing frameworks for digital conservation (Maffey et al., 2015; Arts et al., 2015).

In the present study digitalization of village microplans was carried out with an objective to mainstream biodiversity conservation of the Ganga River in development planning and decision making processes. It is an endeavour to strengthen the inter-departmental coordination and transparency in implementation of the village microplans and address the current gaps in conservation more efficiently and effectively, thereby, streamlining the conservation outcomes.

The aim of this study is to develop a digital framework and a repository of village microplans for biodiversity conservation and sustainable development using applications of Information Technology. Since, fewer studies have been carried out in comprehending the use of technology in social- ecological study like this, therefore, this study attempts to blend technological intervention with the conservation goals.

The integration of numerous villages onto a common platform is a tremendous and time intensive process. The use of technology, power of internet, database management and GIS

technology can prove to be useful tools. Use and practice of digital technologies and applications in various sectors of economic and social development is being promoted especially in Indian governance as a means to embark upon the issues of transparency and accountability (Malhotra, 2016). Emerging new technologies have facilitated and paved a new way in the field of conservation science and resource management as well as continuing to contribute in strengthening decentralized form of governance and advocacy efforts by reaching out to a broad spectrum of stakeholder (Levitt and Vilsack, 2002). Many conservation scientists, practitioners, mangers, policymakers increasingly rely on the technological interventions such as GIS, Remote Sensing, Information and Communication Technologies (ICTs) to assess and monitor the present ecological status, challenges, risks, vulnerabilities, possible future interventions, its impact and scenarios in order to effectively plan conservation actions striving to balance between human well-being and preservation of natural resources (Emmanuel and Lwoga, 2007; Palumbo, 2017).

At the same time it is mandatory to provide appropriate training to the users and end users in these various technological applications. Since, it involves a trans-disciplinary approach therefore, capacity building of users is imperative so that best implementation and appropriate result can be obtained. Various computer application and other ICTs have immense potential in the rural areas, where accessibility is a major concern (Emmanuel and Lwoga, 2007). With increasing popularity of mobile phones and internet access, providing training for improved digital literacy and enhanced technical skills can be achieved.

Aligning with the Government of India's initiative of 'Digital India' that was launched in 2015 with the endeavour to digitally transform India into an empowered and knowledgeable society (Malhotra, 2018) this effort of digitalizing village microplans is a contribution in mainstreaming conservation planning into local development planning using a digital platform. This initiative will provide a single platform for inter-departmental and cross-sectoral coordination, involving various government and non-government stakeholders and institutions at all levels.

For Ganga River conservation, a trained cadre of volunteers from the villages located along the Ganga River has been established known as Ganga Praharis under the NMCG-WII Biodiversity Conservation and Ganga Rejuvenation project. These Ganga Praharis are trained

by the WII in conducting awareness and cleanliness programmes, plantation drives, ecological surveys, rescue of distressed aqualife and are often assisting during field activities conducted by various institutions. This cadre of volunteers will also be trained in using the digital microplans.

In one of the recent article by Down To Earth, Tare says if the governance is to be improved the programme has to be decentralised. The article also quoted that "It is highly centralised as of now with the government sitting at the top deciding what to do? People who are living in the Ganga basin have to be involved to achieve the required results. The programme can't succeed unless it has a bottom-up approach (Kaur, 2018)."

2. APPROACH

The development of village microplans is based on an integrated participatory model framework, providing a platform for interaction between multiple stakeholders on social, ecological, conservation and developmental issues, conflicts, as well as institutional challenges (Figure 1). For a comprehensive local development plan, it is crucial to mainstream conservation planning, into the process that synergistically identifies sustainable developmental strategies through research, capacity building of multiple stakeholders, research and knowledge sharing, information dissemination and policy advocacy. The process also includes strengthening of institutional structure and enhancing community mobilization in natural resource management. Throughout the process, capacity building of stakeholders and institutions at all stages is carried out in order to augment their capabilities in supporting the decision making processes and implementing the recommended actions and initiatives at the grassroots level.

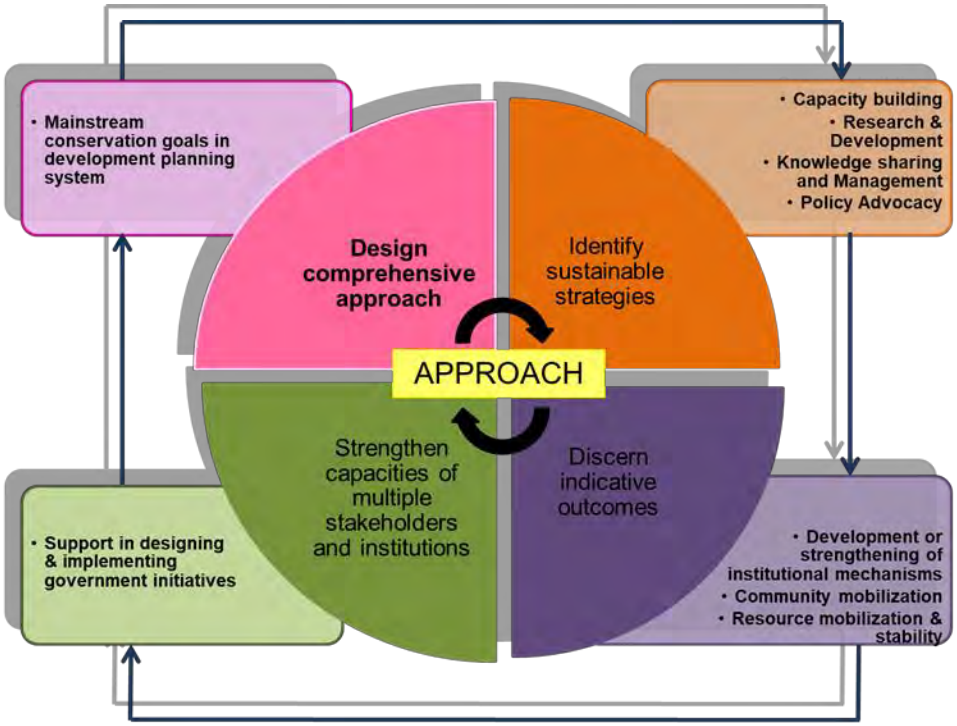


Figure 1: Approach for conservation sensitive village development planning

3. METHODOLOGY

The method involved three steps, 1) development of microplanning guideline, 2) preparation of village microplans and, 3) digitalizing the village microplans using various Information Technology software.

3.1 Development of Village Microplanning Guideline:

3.1.1 Literature Review:

An extensive review of literature was carried out on decentralization, community based conservation, village level microplanning, local development planning, various digital technologies used in nature conservation, case studies on village microplans across different landscapes and communities around the globe.

3.1.2 Development of Microplan Guidelines:

A national level workshop on "Finalization of Village Microplanning Guidelines on Biodiversity Conservation and Ganga Rejuvenation" was conducted on 06th March 2017 to review the microplan guideline with representation from 15 institutions such as SPMGs, District Administration, NYKS (Annexure 1). The workshop addressed different aspects of

microplans such as gender and awareness, livelihood and skill development, convergence with departments and line agencies and, digital linkages. Suggestions and comments were incorporated to finalize the guidelines.

Plate 1: Workshop on finalization of village microplanning guideline on biodiversity conservation and Ganga rejuvenation

3.2 Preparation of Village Microplans

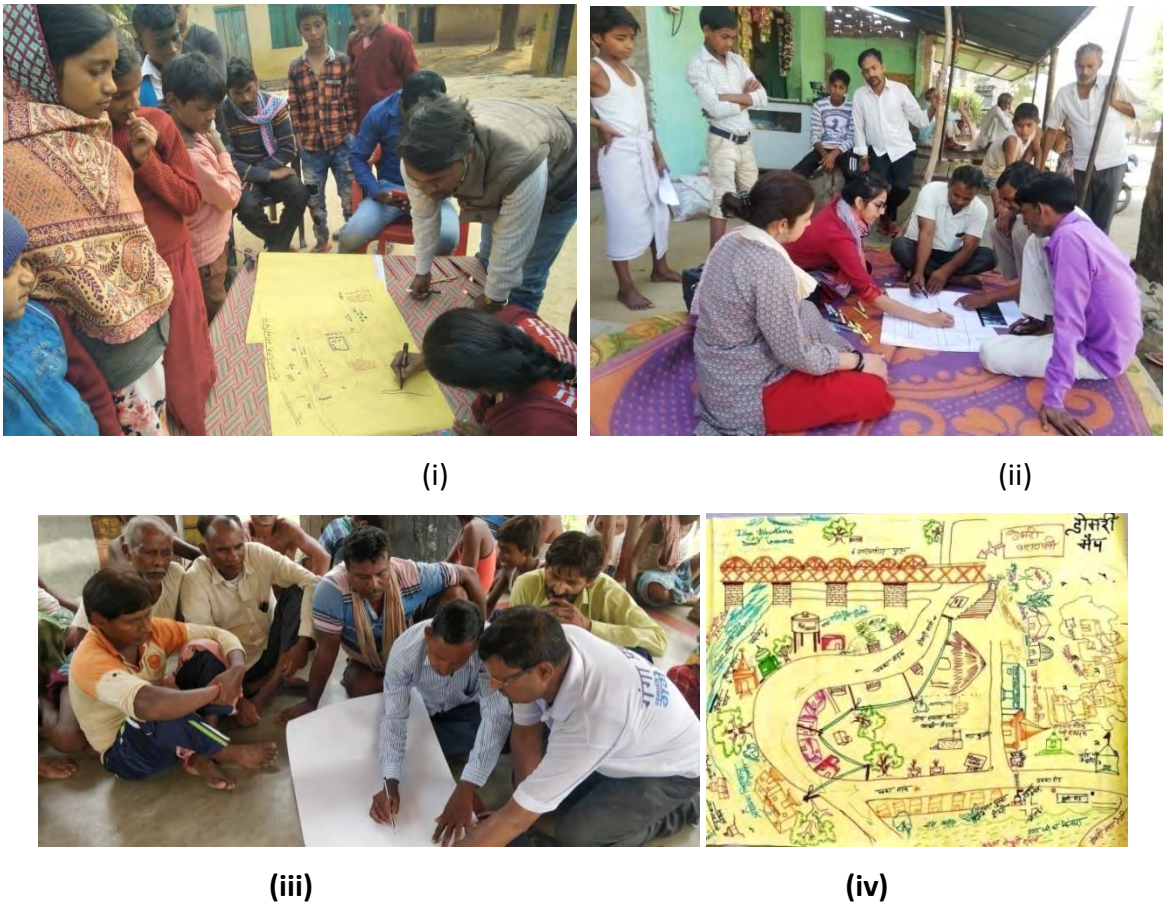
3.2.1 Identification of Select Villages and Participatory Rural Appraisals:

Based on the microplanning guideline, village microplans were prepared for the selected villages. For the study, the selection of the villages was based on four criteria: 1) the distance of the villages from the Ganga River, 2) biodiversity value of the area, 3) dependence of the local communities on the River for their livelihood security and, 4) their willingness towards participating in biodiversity conservation activities for the Ganga River.

Before starting the process of developing village microplans, Memorandum of Agreement (MoA) mentioning about the project activities that will be carried out with the local communities and institutions in the village was prepared. The MoA is signed by the Gram Pradhan (Village Head) of the respective Gram Panchayat (village) showing his/her support for conducting the project activities in the village. To collect the information on present social and ecological challenges prevalent in the village, interactions were conducted through formal questionnaire survey, stakeholder meetings, and FGDs with various groups including Gram Panchayat and ward members, women and youth groups, fishermen,

farmers and shopkeepers. Consultative meetings were held with the block development office, different departments of district administrations and local institutions.

Social, resource and institution mapping were also carried out with the members of the local communities in the presence of the Gram Pradhan to design the microplan in a holistic manner (Figure 2).



(i) (ii)

(iii) (iv)

Plate 2: Social mapping by members of local communities of (i) Village Dhaka, Block Cholapur, District Varanasi, Uttar Pradesh (ii) Village Udaigarhi, Block Dibai, District Bulandshahr, Uttar Pradesh and (iii) Village Ghat Jamni, Block Rajmahal, District Sahibganj, Jharkhand and (iv) Social map prepared by the local communities and Gram Pradhan of Gram Panchayat Domari, Block Kashi Vidyapeeth, District Varanasi, Uttar Pradesh

3.2.2 Finalization of Village Microplans:

The recommendations from the local communities were incorporated, after collecting the information through Participatory Rural Appraisals. Analyzing the data potential future interventions and associated concerned departments were also integrated into the microplans. The draft microplan was discussed in detail for its feasibility and finalized by the Gram Pradhan, ward members and other members of the local communities. As an approval

for support and implementation of the microplan, Gram Pradhan signed a letter of consent (Figure 2).

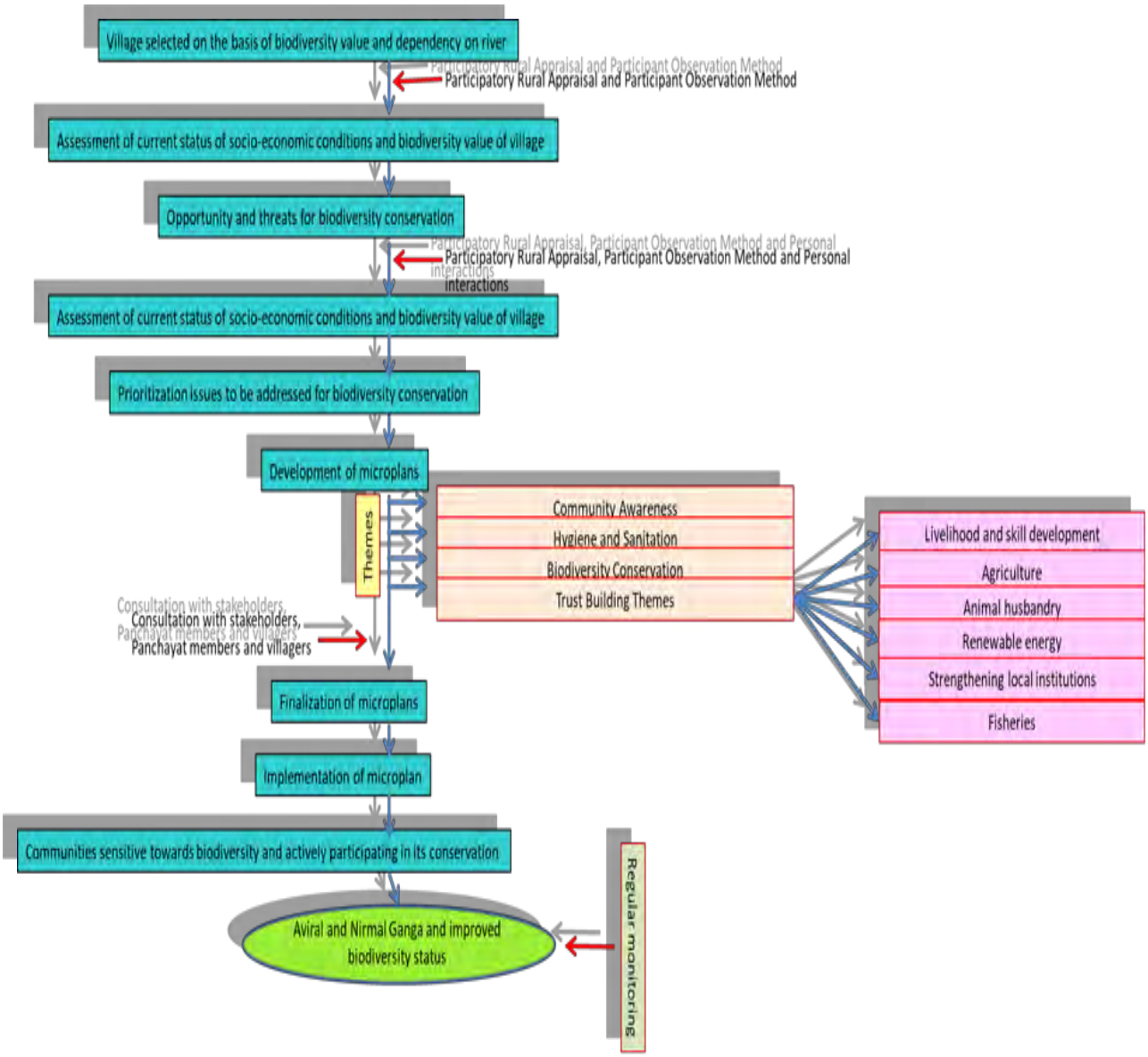


Figure 2: Flowchart depicting the approach adopted for preparation of village Microplan

Plate 3: Finalizing the village microplan with local communities, ward members and Gram Pradhan of Gram Panchayat Rajghat, Block Dibai District Bulandshahr, Uttar Pradesh

3.3 Development of Digital Framework of Village Microplan

On digital platform using the SQL server a relational database was created for village microplans. This digital framework consists of overall demographic, geographic, social, economic and ecological information of the village (Figure 3). In this relational database the identified conservation and development challenges of the village have been categorized into nine strategic themes. Out of which six themes i.e. livelihood and skill development, agriculture, animal husbandry, fisheries, renewable energy and community based institutions are under the trust building category and three themes i.e. community awareness, hygiene and sanitation and biodiversity conservation are under the generic category. For each theme indicators and sub-indicators have been identified which are measured using scoring method. These indicators and sub - indicators assess the present status and impacts of the activities on the Ganga River.

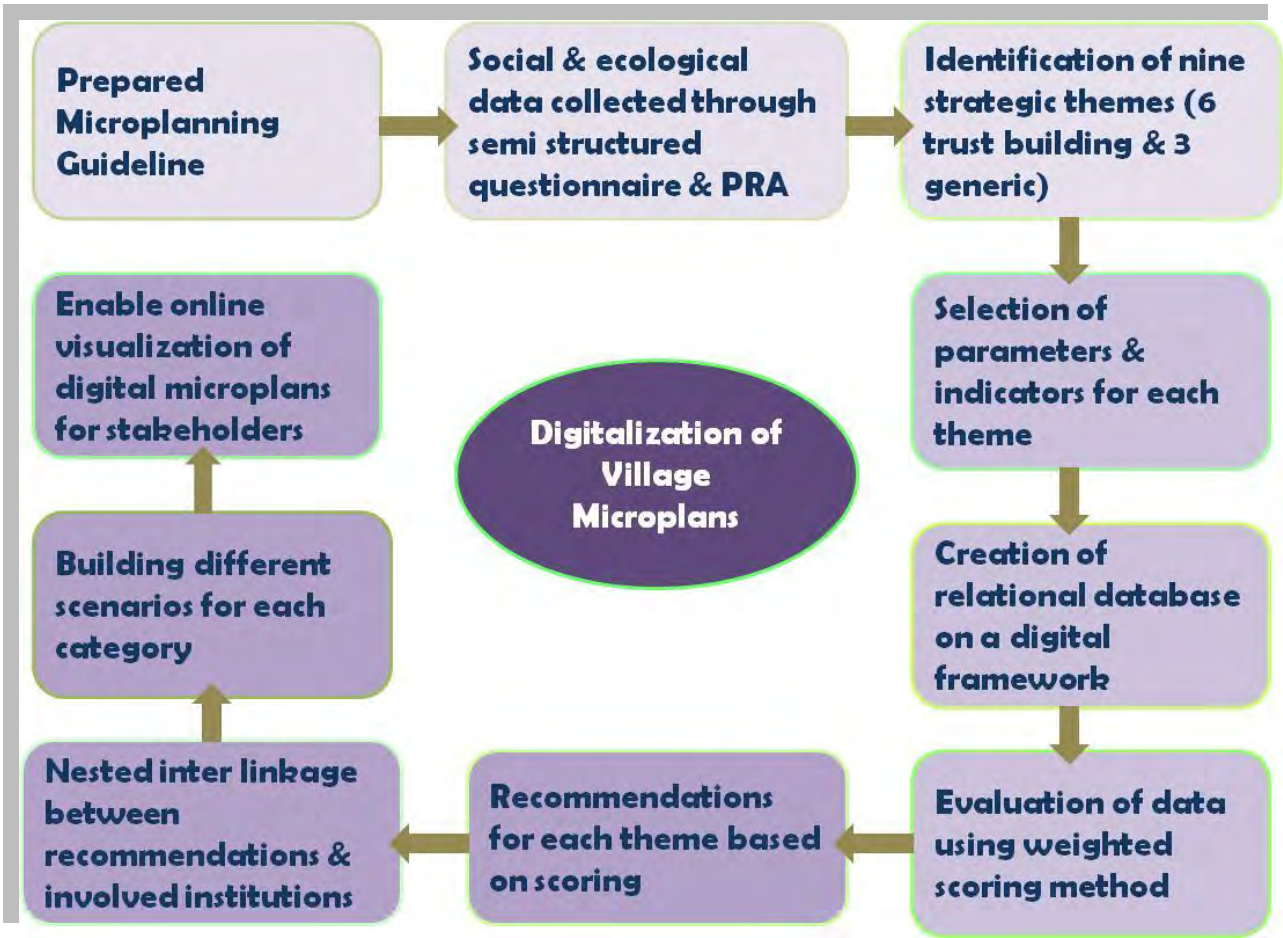


Figure 3: Overview of digitalization of village microplans

For digitalization**,** the proposed system was developed through a case study approach using free and open-source tools for spatial analysis, visualization, and decision models for

manipulating user's preferences or expectations. The methodology includes: Data management, Software, GIS platform, Web Interface Mobile, Security, Testing, Maintenance and Backup. These components are organized into three-layer client-server architecture (Figure 4):

i) Data layer information is stored in the form of multiple tables, views and stored procedures.

ii) Service layer coordinates the application, process commands, connecting with different tables and perform calculations.

iii) Presentation layer is the primary function of the interface, which translates a task to facilitate the user.

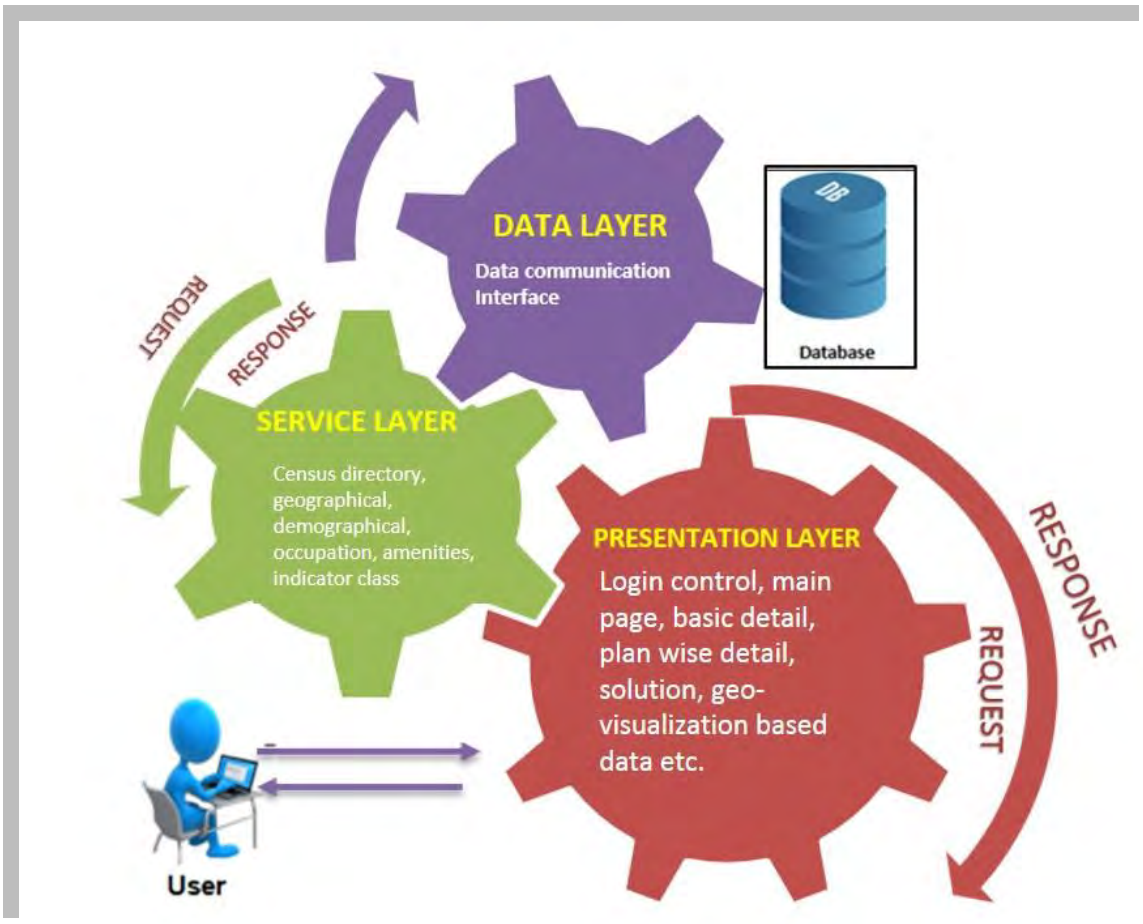


Figure 4: Three- layer client-server architecture for Digital Framework of Village Microplan

3.3.1 Data Management- It has two essential quality assessment steps which are:

a) Data Curation–To meet quality standard, using data lineage and data profiling methods

b) Data Enrichment- To make the data asset more valuable. The data are checked and corrected for positional accuracy, attribute, logical accuracy, and completeness.

3.3.2 Software- For managing spatial and non-spatial data, PostGIS and SQL Server 2012 have been used respectively (Table 1). As both are the Pluggable Storage Engine, it leaves very little room for errors. Also, both are best for indexes and joins and allow changing tables in SQL without requiring locking for every operation. Programming language used in this application are Visual Studio.Net C#, AJAX, XML, XHTML, Jscript, RESTful web services XML and JSON. ADO.Net has been used for connection between database and front end.

3.3.3 Data Products and software Used

Table 1: Data type used in development with source of data

Data Product	
Type of Data	**Source of Data**
Community Survey Data	NMCG WII Project team
Village Demography	Census India
Village Boundaries	Georeferenced Cadastral Map, District Land Record Office
District Boundaries	Data Meet GitHub
Google map, Open Street map, Satellite and Terrain view	Open source base maps
Software Used	
Software used	**Source**
• **ArcGIS 10.1, QGIS** • **Microsoft Visual Studio 2017, HTML Notepad++** • **pgAdmin version 4 Management tools for PostGIS, SQL server 2014** • **IIS Server 2012 R2**	Licensed Versions from respected organsation at Wildlife Institute of India, Dehradun under WII-NMCG project and Open Source

A GIS based database of villages is prepared, adequate with administrative boundaries of the block, district and state. The database includes multiple tables of indicators, sub-indicators, solution and track records.

3.3.4 Conceptual Design-

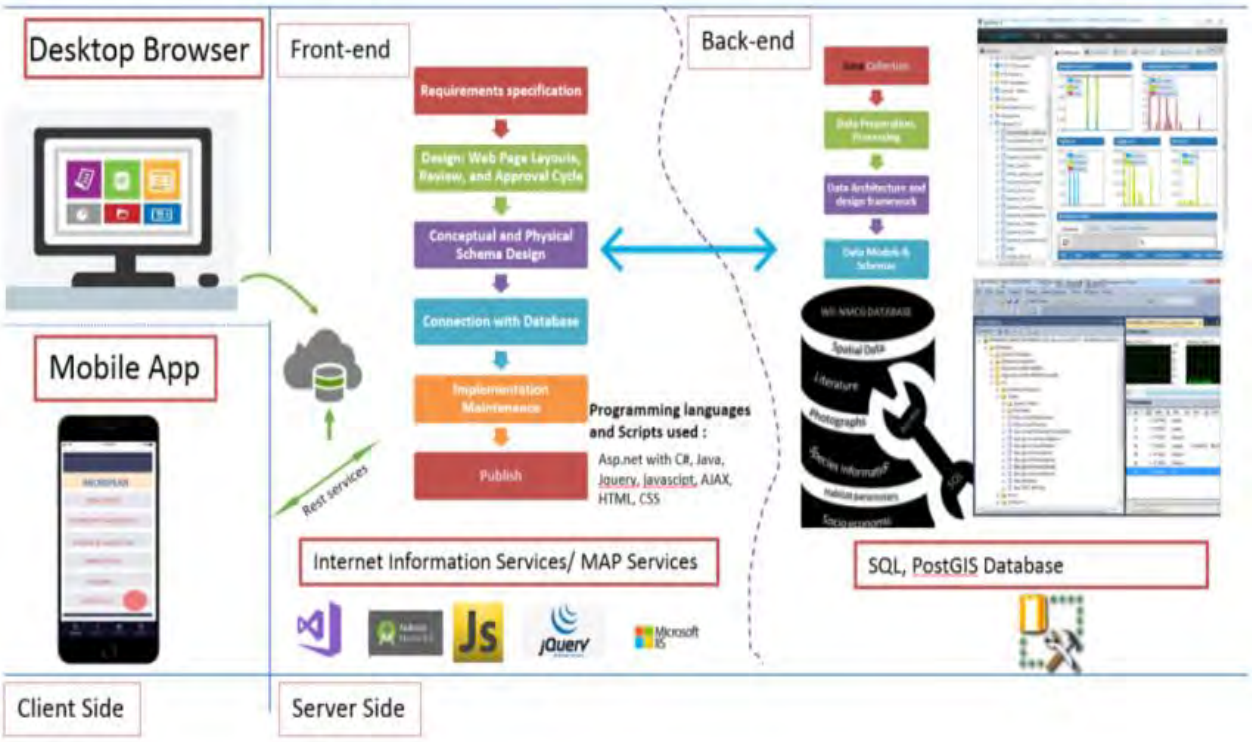


Figure 5: Conceptual framework and schematization of dynamic data process and digital flow

Application- The client - side comprises of Android based mobile application and desktop browser. The mobile app (Figure 5a) is developed for uniform and integrated data collection. The data is collected through a mobile application (both online and offline), door-to-door questionnaire surveys, Panchayat meetings, field visits or meetings with authorities. The user fills the village information for both general and nine strategic plans. The desktop browser (Figure 5b) provides visualisation and management of the collected data.

The server side comprises of tightly coupled, front-end (Figure 5c) and back end (Figure 5d). Once data are collected, it directly comes to the database server in the back end, where it gets integrated with secondary data like GIS - based layers, administrative boundary, census data etc. The data collected through a mobile application will directly integrate into the

database server, and offline data can be exported as an excel spreadsheet to the database. The mobile app and web based application will also provide visualization and management of the collected data.

Databases such as SQL and PostGIS facilitate the integration of spatial and non-spatial datasets. The back end (Figure 5c) server - side manages data architecture and design framework, data models & schemas and data preparation and processing. The front-end (Figure 5d) server - side manages requirements specification, designing of web page layouts, review, and approval cycle, publishing, connection with the database and implementation maintenance.

Processing: Once the data are collected it directly feeds and integrates into the database server in the back end (Figure 5d). To meet quality standards and to make the data assets more valuable, curation is done with data profiling methods. The data is being checked and corrected for both positional accuracy and attribute accuracy. Once data are found suitable, it is integrated with secondary data like GIS based layers, administrative boundaries, and census data. All the indicators and sub - indicators are coded to form a nested inter-linkage. The scale is defined as the measurement unit from 1 - 10 where 7-10 is high, 4-6 is medium and 1-3 is assigned a low score. Each variable obtained is calculated with respect to household data. The back end (Figure 5c) server side manages data architecture and design framework, data models & schemas and data preparation and processing.

Algorithm: An algorithm has been developed based on a statistical method known as Weighted Scoring to process the data, integrate with secondary data, problems identified, institutions or departments involved, possible suggestions and derive scale for individual sub - indicator with respect to biodiversity conservation and sustainable development. The average of each similar categorical sub-indicator will be the output of indicator value. Furthermore, after achieving the value of sub-indicator, a scenario based model with multiple approaches will connect with the solution table, which is already present in the database which. An individual score of indicator, sub-indicator with respective solutions is developed.

All the data flowing gets stored as part of the inventory. After the first survey, where the user will fill online all the activities that happened post survey, a tracker feature has

developed. Comparison analysis and gap analysis can be done based on the data. which will help in monitoring the impact of interventions. The success or effectiveness of the activities can be inferred from the score of respective sub-indicator after the implementation of the recommended activities.

3.3.5 Security:

In the mobile app only authenticated users can insert and update the survey data. In the web-based application, there are two different login authenticated users. The first type of user can insert the survey data. And second type of user as administrator can update the survey information as well as having the control to insert and update users.

The MD5 hashing algorithm used for generating hash value, to login in a solution web page with three steps i.e.: data padding, appending length for 64 bit representation, hexadecimal fixed buffer initialisation. After writing the programs/codes, the process, modules/programs are tested by running the entire system for both mobile and web based applications. Modular testing has implemented during the run time; the test process has taken a long time and many system errors have been detected and corrected. Errors were like the database connection or issues related to graphical user interface rendering.

Table: 2 List of Strategic Themes and Indicators

Indicators	Sub Indicator
Community Awareness	Awareness on terrestrial species found in the area
	Awareness on wetlands in the area
	Awareness on aquatic species found in the Ganga River
	Awareness on threats to the Ganga River
	Awareness on waste segregation and waste management
	Awareness on impact of using chemical fertilizers and pesticides on river and human health
	Awareness on roles and responsibilities in conservation of Ganga river
Community based institution	Frequency of meetings conducted
	Representation of women and marginal community
Livelihood and skill development	Schemes implemented
	Benefit through training centres
	Representation of women in centres
Hygiene and sanitation	Construction and use of toilets
	Access to dustbin installed by Gram Panchayat

	Implementation of schemes
	Solid and liquid waste management
Renewable energy	Dependence on fuel wood
	Accessibility to renewable energy sources
Biodiversity conservation plan	Activities conducted for biodiversity conservation
	Biodiversity Managing Committees
Agriculture	Organic farming
	Riverbed farming
Animal husbandry	Conservation of species habitat
	Source of fodder
Fishery	Sustainable fishing

Identified indicators for each of the nine strategic themes (Table 2) are further linked to more than 20 sub-indicators to assess the present status and impacts of the activities on the River. A centralized database has created for entering the primary village data by using various secondary data sources (Table 1). The user can view multiple indicators, sub indicators as charts, bar graph, multimedia, view through maps, browse through categorical view etc.

The data is uploaded from Android based mobile application or web forms, passing through the database server after curation and enrichment. The attribute tables and views in the database have linked to the village census code. All the indicators and sub indicators are coded to form a nested inter-linkage. The scale is defined as the measurement unit from 1 to 10. Each variable obtained is calculated corresponding to village data. Use of the statistical method has carried out to derive the scale.

4. RESULT

4.1 Development of Village Microplanning Guideline:

A village microplanning guideline elucidating the significance and procedure for preparation of village microplans has been developed (Figure 6). The document has been prepared after consultations with multiple stakeholders and implementers on challenges of Ganga River conservation and sustainable development of the village. The guideline also comprises of the list and roles of concerned departments and line agencies whose involvement in the implementation of the microplans is crucial, along with the participation of local

communities and institutions at the grassroots level. The microplanning guideline will serve as a fundamental reference document for developing village microplans (Annexure 2).

Figure 6: Village Microplanning Guideline

4.2 12 Village Microplans for Biodiversity Conservation and Sustainable Development of the Village:

Based on the microplanning guideline and 30 FGDs 12 village microplans have been developed for villages located along the Ganga River (Figure 7).

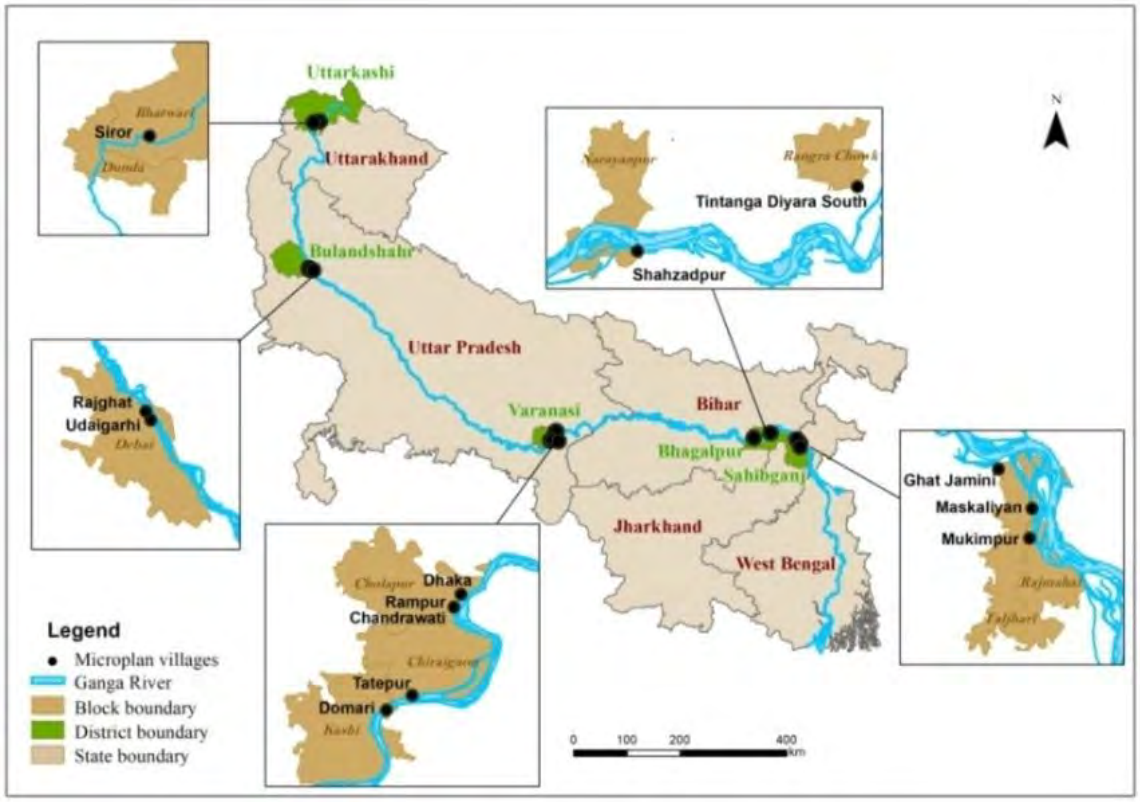


Figure 7: Locations of 12 villages along the Ganga River for which microplans have been developed

The 12 villages are located in three stretches of the Ganga River, having different landscapes comprising of varied ecological and social diversity (Table 3). These village microplans are representing the current social-ecological status of the respective villages and elaborate on the resource dependency of local communities on the Ganga River, conservation challenges of the Ganga River ecosystem, wetland conservation, presence of local institutions, livelihood concerns and other social and economic challenges that need to be addressed by the concerned departments and local institutions. After rigorous PRAs and FGDs, potential future interventions and recommendations by the communities and other stakeholders have been highlighted (Figure 8 and Annexures 3 to 14). The village microplanning guideline and five village microplans were launched by Hon'ble Minister of Jal Shakti Shri Ganjendra Singh Shekhawat, Shri. U.P Singh, Secretary, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti, Shri. Rajiv Ranjan Mishra, Director General, NMCG along with other dignitaries during World Environment Day Celebration on 05th June 2019 held in New Delhi.

Figure 8: Snapshots of village microplans developed for five villages across the Ganga River

Table 3: List of Gram Panchayats for which village microplans have been developed

S.No.	Name Of The Village (Gram Panchayat)	Latitude Longitude	Block	District	State	Stretch
1	Sirour	30.75582 78.492535	Bhatwari	Uttarkashi	Uttarakhand	Upper Ganga Stretch
2	Rajghat	28.242131 78.360286	Dibai	Bulandshahr	Uttar Pradesh	Middle Ganga Stretch
3	Udaigarhi	28.229664 78.36832	Dibai	Bulandshahr	Uttar Pradesh	
4	Domari	25.315447 83.028574	Kashi Vidyapeeth	Varanasi	Uttar Pradesh	
5	Rampur	25.461948 83.12477	Cholapur	Varanasi	Uttar Pradesh	

6	Dhaka	25.480117 83.134981	Cholapur	Varanasi	Uttar Pradesh	
7	Tatepur	25.336609 83.065205	Chiraigaon	Varanasi	Uttar Pradesh	
8	Shahzadpur	25.21706 86.946436	Narayanpur	Bhagalpur	Bihar	Lower Ganga Stretch
9	Teentanga Diyara	25.341274 87.221088	Rangra Chowk	Bhagalpur	Bihar	
10	Masakaliyan	25.161065 87.763884	Taljhari	Sahibganj	Jharkhand	
11	Ghat Jamini	25.234908 87.699997	Rajmahal	Sahibganj	Jharkhand	
12	Mokhimpur	25.107529 87.756958	Rajmahal	Sahibganj	Jharkhand	

4.3 Digital Framework for Village Microplans:

Based on the 12 village microplans, a digital framework has been developed for microplans using various computer applications and softwares. The digital framework addresses multiple issues of village development and Ganga conservation, which are categorized into nine strategic plans i.e. Community Awareness, Community based institution, Livelihood and skill development, Hygiene and sanitation, Renewable energy, Biodiversity conservation, Agriculture, Animal husbandry, Fishery. Following are the digital pages developed for data entry and analysis of the village microplans.

- **Main Screen of Digital Village Microplan:**

The main screen of the digital microplan showcases the Ganga River basin with district and block level boundaries. Using the location marker on ESRI map, it highlights the villages for which village microplans have been developed (Figure 9). It is an active screen wherein the user can click on the marker and obtain details e.g. basic information about the village which includes its location and demographic information. The base map can be changed to geographic, street and satellite views. On this screen there are other links available through hyperlink functions wherein the user can fill the village details and find the recommendations for each of the nine strategic plans.

However, some pages are only accessible to identified users and administrators for providing relevant information based on the data fed into the forms. At present, the digital microplan is functioning on the intranet services of the Wildlife Institute of India.

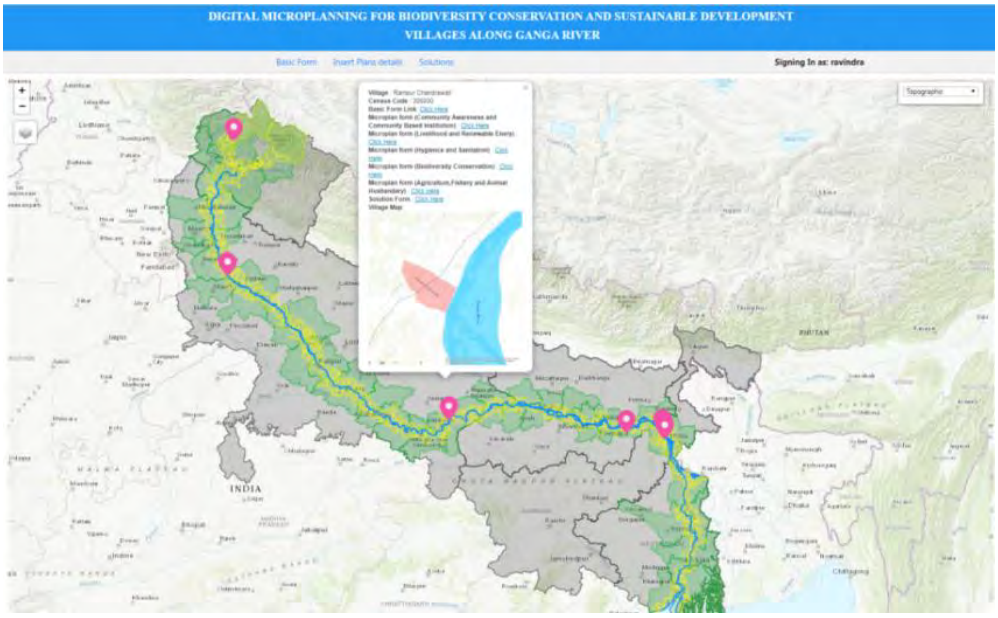


Figure 9: Snapshot of main screen of digital village microplan highlighting the locations of villages (in pink) for which the village microplans are developed

- **Basic Information Form of Digital Microplan:**

This page explicitly collects the basic information of the village, categorized into four sub-categories i.e. village geography, demography, occupation and community structure and basic amenities. The village geography category includes census code, village administrative boundary, geographical coordinates, climate information and distance of the village from the Ganga River. The demographic category consists of information on households, gender ratio, literacy rate, etc. whereas the occupation category includes information on percentage households involved in various professions as their primary and secondary occupation such as agriculture, business, jobs, fishing, animal husbandry and others. The last basic amenities category collects data on the presence of basic infrastructural facilities present in the village such as road networks, railway stations, bus stands, hospitals, banks, schools, post office, primary health care etc. (Figure 10).

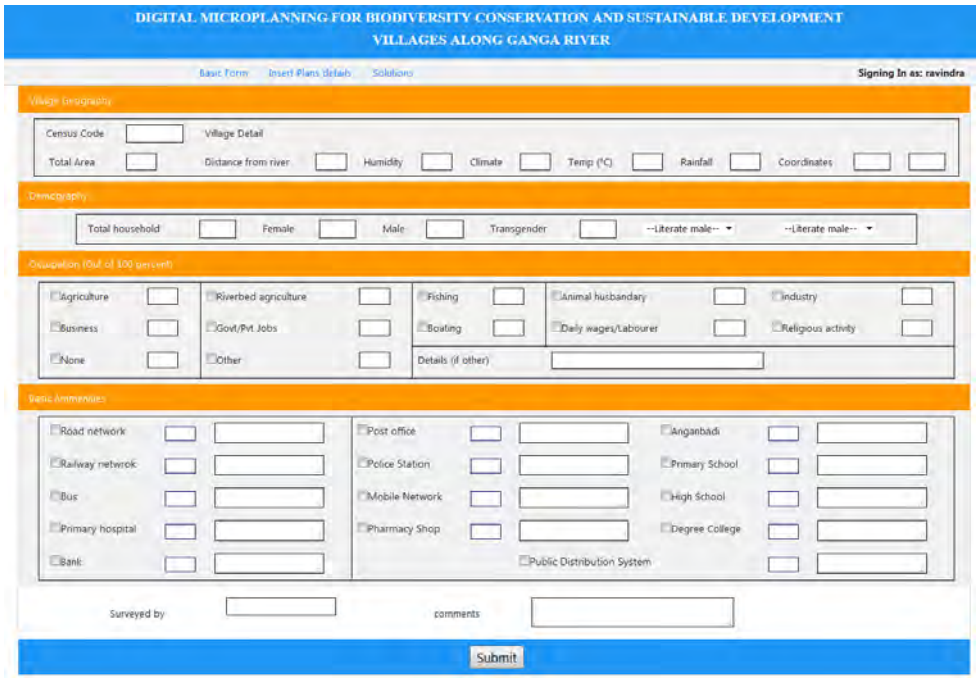


Figure 10: Snapshot representing the basic form of the digital microplan for collecting basic information of the village

- **Indicator forms of Digital Village Microplan:**

For each of the nine strategic plan that is community awareness, community based institution, livelihood and skill development, hygiene and sanitation, renewable energy, biodiversity conservation, agriculture, animal husbandry, fishery indicators have been developed (Figure 11(a), 11(b), 11(c), 11(d), 11(e)). Each indicator helps in assessing the current status of the respective plan (Table 2). The user has to fill in the data for each of the indicators under all the categories followed by which the ranking and weighted scoring method is used for analysis.

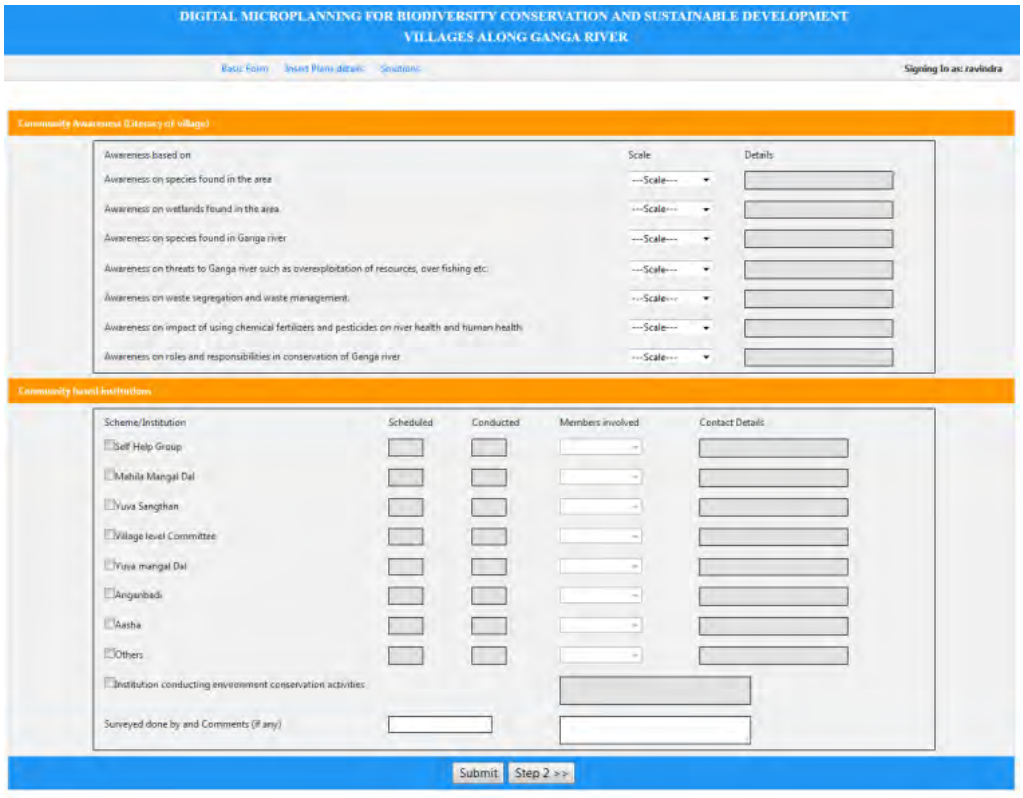


Figure 11 (a): Prototype of indicator form for Community Awareness and Community Based Institutions Strategic Plans

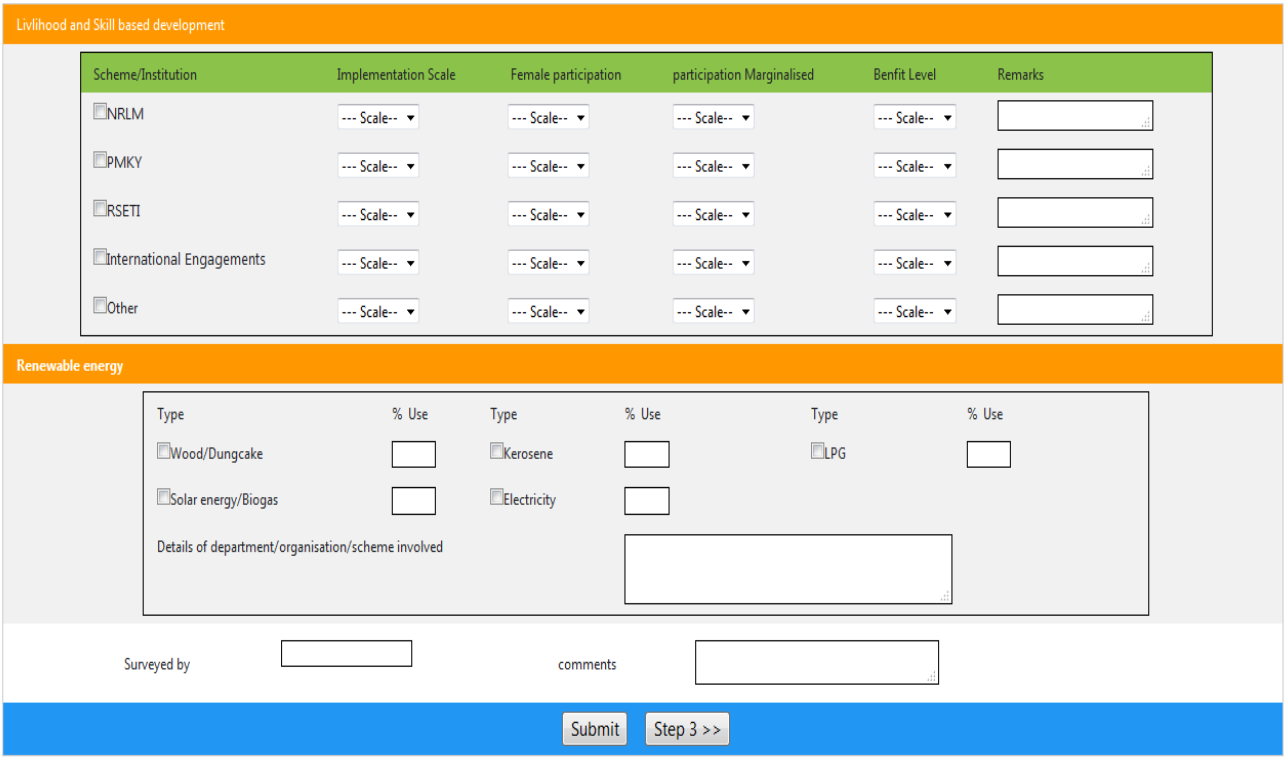


Figure 11 (b): Prototype of indicator Form for Livelihood and Skill Development and Renewable Energy Strategic Plans

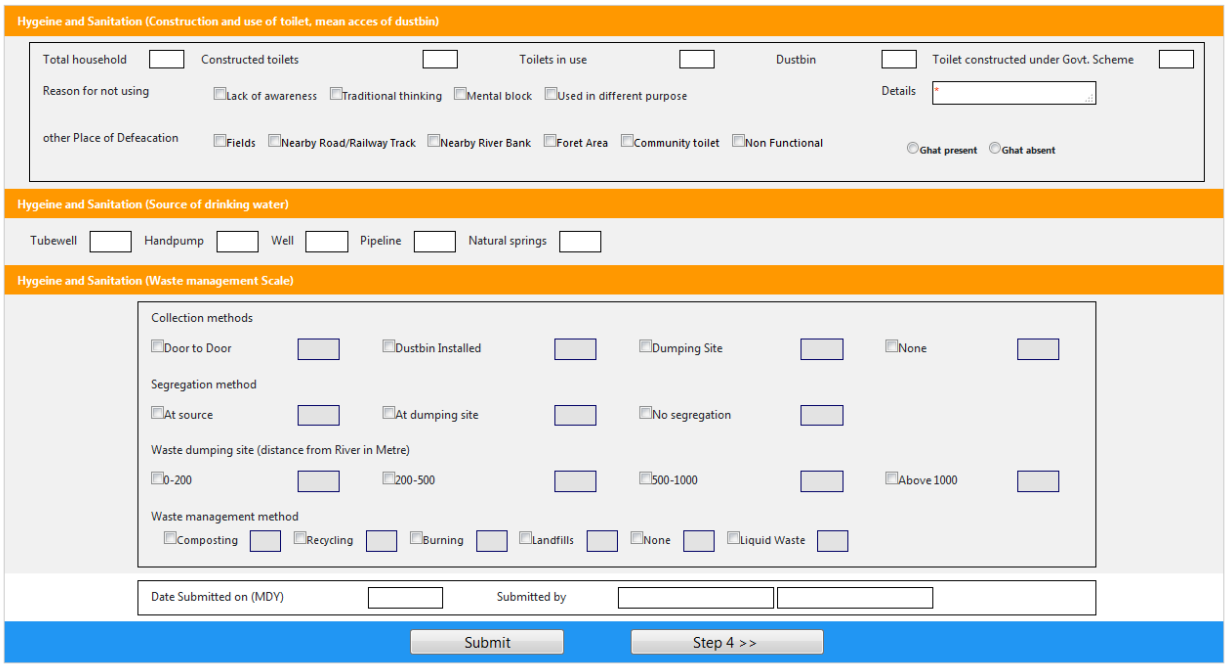


Figure 11 (c): Prototype of indicator Form for Hygiene and Sanitation Strategic Plan

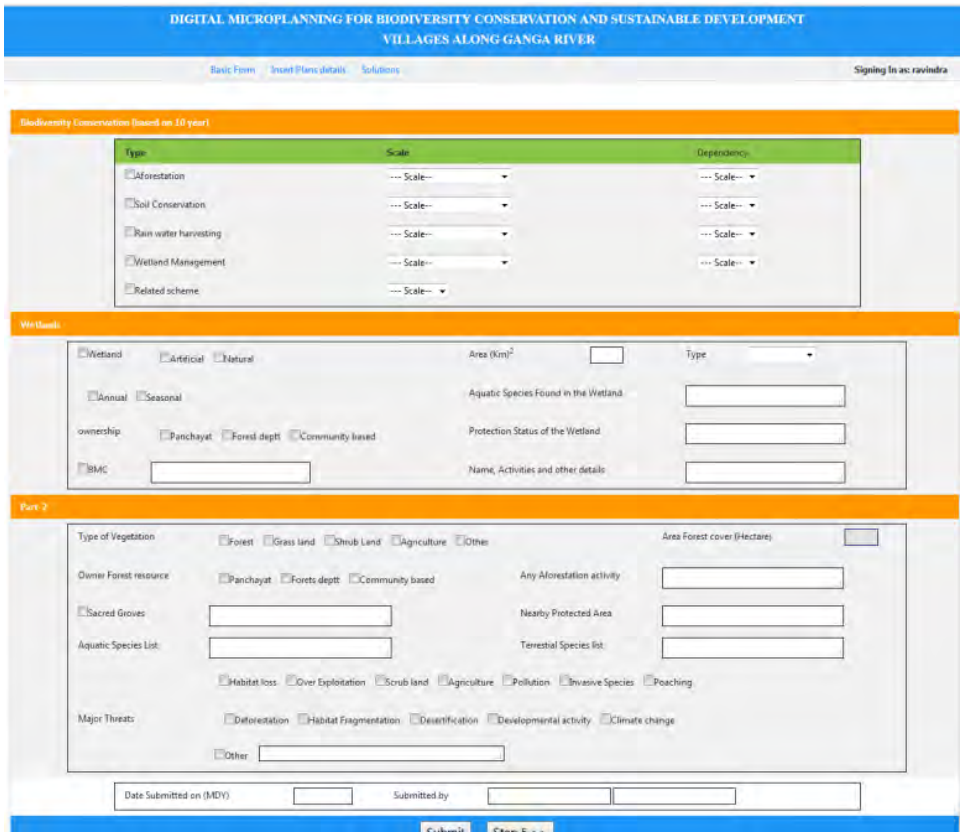


Figure 11 (d): Prototype of indicator Form for Biodiversity Conservation Strategic Plan

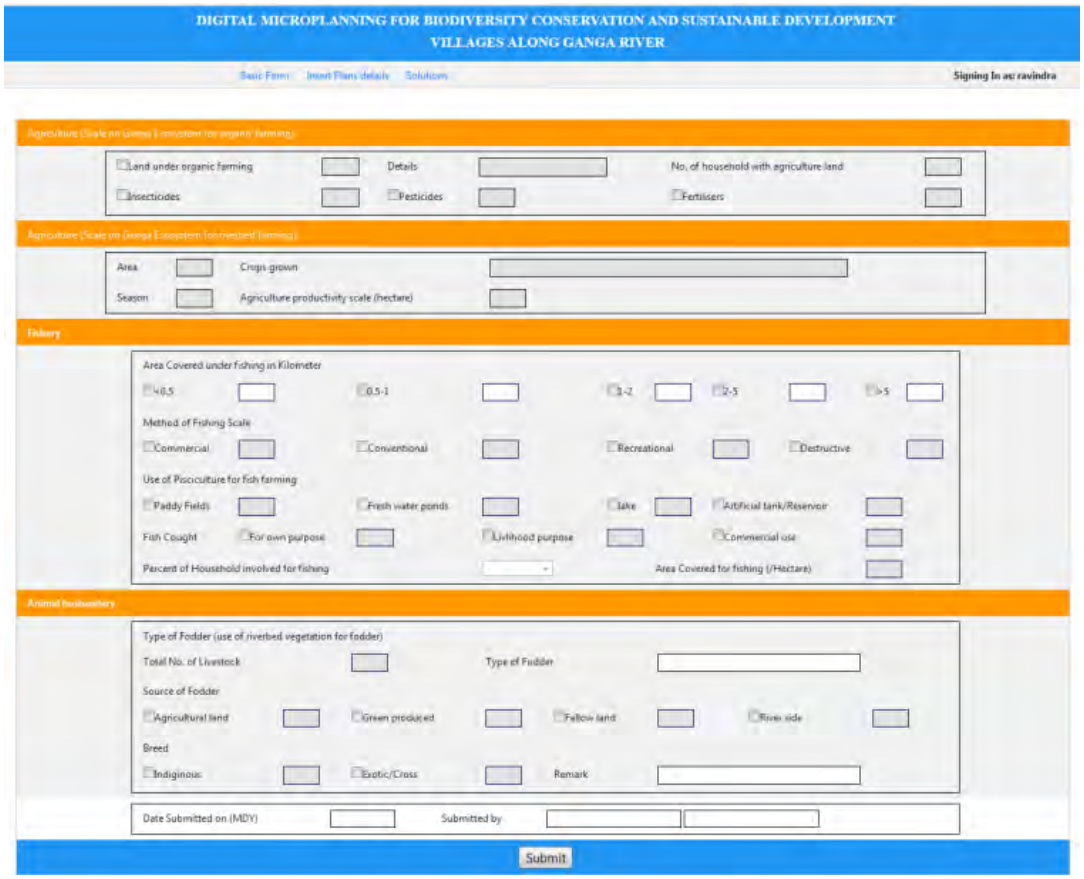


Figure 11 (e): Prototype of indicator Form for Agriculture, Animal husbandry and Fishery Strategic Plans

- **Solution Page of Digital Village Microplan:**

Once the data has fed into the basic information page and nine strategic plans, a computer-based solution is generated on the solution page of the digital village microplan. A list of activities has been recommended, that can be undertaken in the village pertaining to Ganga conservation and sustainable development. All the suggested activities have been divided into three categories i.e. high, medium and low under each of the nine strategic plans (Figure 12).

This page also highlights the roles of different stakeholders who can support in implementing the activities on ground.

Figure 12: Snapshot of Solution Page for Community Awareness showcasing the recommended solutions under High, Medium and Low Categories

- **Activity Tracker:**

The activity tracker is an online repository tool, which will record and track the details of activities conducted by the local communities, Gram Panchayat, local institutions and other stakeholders. The user can obtain the information of village by entering the census code (Figure 13). An activity form will appear on the screen with village basic details. The user has to select one of the activity types from the following list: awareness activity, cleanliness drive, plantation drive, cultural activity, ecological survey, livelihood activity, plantation activity, rescue and rehabilitation, socio economic survey, pollution monitoring, social meetings, training on biodiversity for further information. In the next step, user has to enter the details of the activity done within 500 words followed by further details on stakeholders or institutions involved, date of activity, activity filled by and other remarks. The success or effectiveness of these activities can be inferred from the score of indicators in post surveys. This tool will also contribute in conducting gap analysis and planning for further activities.

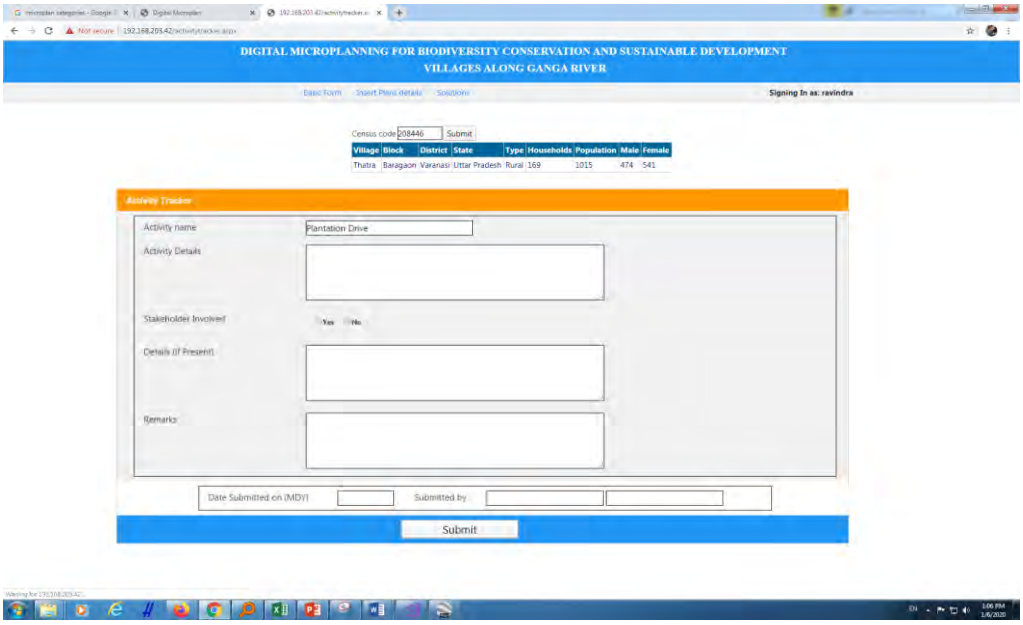


Figure 13: Snapshot of Activity Tracker of Digital Village Microplan

4.4 Outcomes of the Strategic Plans:

- For instance, in digital village microplan format, data assemblage of one of the nine strategic plans i.e. Hygiene and Sanitation carried out for eight villages: Siror in Uttarakhand; Rampur Chandrwati, Domari, Dhaka and Tatetpur in Uttar Pradesh; Tintanga Diyara in Bihar; and Ghat Jamini and Mokhimpur in Jharkhand. They represent, the three stretches of the Ganga River (Upper, Middle, and Lower Ganga stretch). There are three sub indicators under this plan i.e. a) construction and use of toilet (MP0401), b) mean access of dustbin installed by Gram Panchayat (MP0402), and c) waste management (MP0403). The information on constructed toilets, accessible toilets and waste collection method was collected from questionnaire surveys, interactions with the Gram Panchayat and local communities through various PRAs and FGDs. The data collected was fed into indicators and sub indicators, scoring of each sub-indicator were carried out followed by scaling on a 1 to 10 scale. For every village the same procedure was carried out (Figure 14).

For the waste management sub-indicator (MP0403) weighted scoring method used for calculating percentage of each collection method such as door to door collection, dustbin installed, dumping site or no collection. Rank has been given to every waste collection method according to their positive and negative impacts, e.g.: door-to-door collection is considered as a best way for waste collection and ranked highest, whereas,

least marks for no collection. The average of all the collection methods is the final score for waste collection for that particular village. Based on the analysis of the three sub-indicators of health and hygiene plan, the current scenario of eight villages has depicted in the graph below (Figure 14).

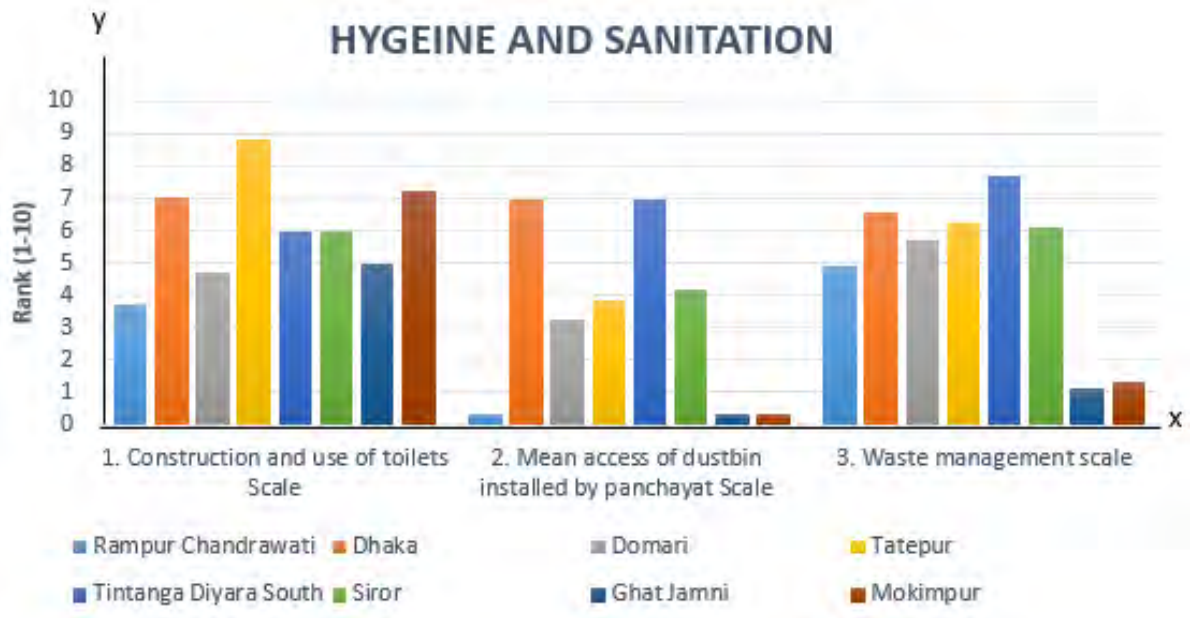


Figure 14: Current scenario of health and hygiene in the eight villages

The above graph (Figure 14) represents that village Ghat Jamni in Sahibganj district, Jharkhand secured the lowest, and Tintanga Diyara South of Rangra Chowk block in the Bhagalpur district of Bihar had achieved the highest score out of the eight villages on waste management. The possible reasons could be lack of accessibility to dustbins as shown in the sub-indicator access to the dustbins and lack of provision for management of waste. The toilets are constructed in all the villages, which indicates that the local communities have access to toilets, the highest being Mokhimpur village, Sahibganj district, Jharkhand. A list of activities recommended under each plan, are categorized as three categories that are High, Medium and Low depending upon the scoring result for each village under the nine strategic plans (Figure 15).

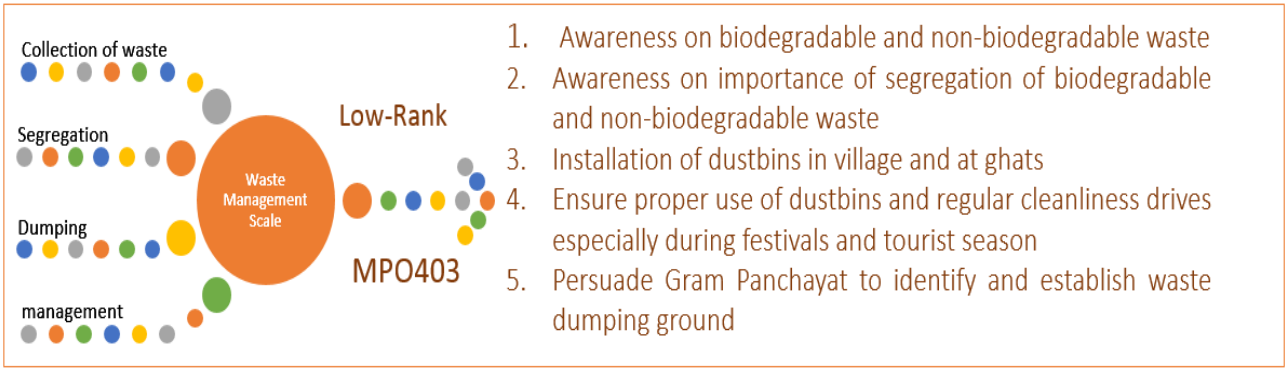


Figure 15: Solutions for low rank in waste management scale

- In case of community based institution strategic plan, the main aim of the plan is to find out the existing institutions or stakeholders which are actively involved in conservation practices, strengthening of existing institutions and establishment of new institutions if needed, members of local communities associated with the institutions especially women and marginalized communities. It was found out that institutions like SHGs, Mahila Mandal Dal, Yuva Sanghathan, Village level Committee, Yuva Mangal Dal, Anganbadi, AASHA are currently active in some villages. There are two sub-indicators under this plan i.e. a) frequency of meetings (MP0201), and b) scale of members involved (MP0202). The eight villages were assessed for the presence of these institutions in the villages, the number of meetings scheduled and conducted. A graph has been plotted based on the benefits gained by the community due to these institutions (Figure 16). In the current scenario, village Dhaka of Cholapur Block in Varanasi district of Uttar Pradesh had the highest rank and village Ghat Jamini of Rajmahal Block in Sahibganj district of Jharkhand had the lowest rank as shown in the figure for both sub-indicators. This indicates that strengthening of existing institutions and enhancing community participation in the activities of the institutions are needed.

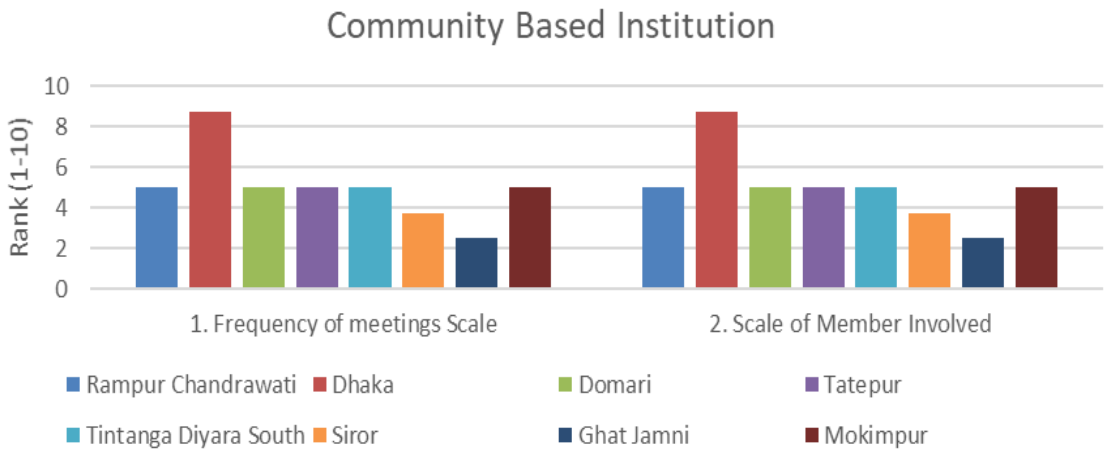


Figure 16: Current scenario of community based institutions in the eight villages

- The community awareness strategic plan falls under the generic category. It has seven sub indicators from MP01 to MP07. In this, the level of awareness among local communities on biodiversity values, challenges and responsibilities in Ganga conservation, knowledge on species found in the Ganga River and its role in maintaining the ecosystem health, use and impacts of fertilizers and pesticides, waste management practices, sustainable fishing is calculated. Community meetings, FGDs, with different groups were conducted. It was found out that village Siror, Block Bhatwari, District Uttarkashi, Uttarakhand secured the highest score in each of the sub-indicators of this plan whereas village Dhaka, Block Cholapur, District Varanasi, Uttar Pradesh secured the lowest rank (Figure 17). This indicates that continuous and rigorous awareness programmes and information dissemination workshops need to be carried out in the villages for sensitizing the local communities and empowering them to contribute to the conservation initiatives.

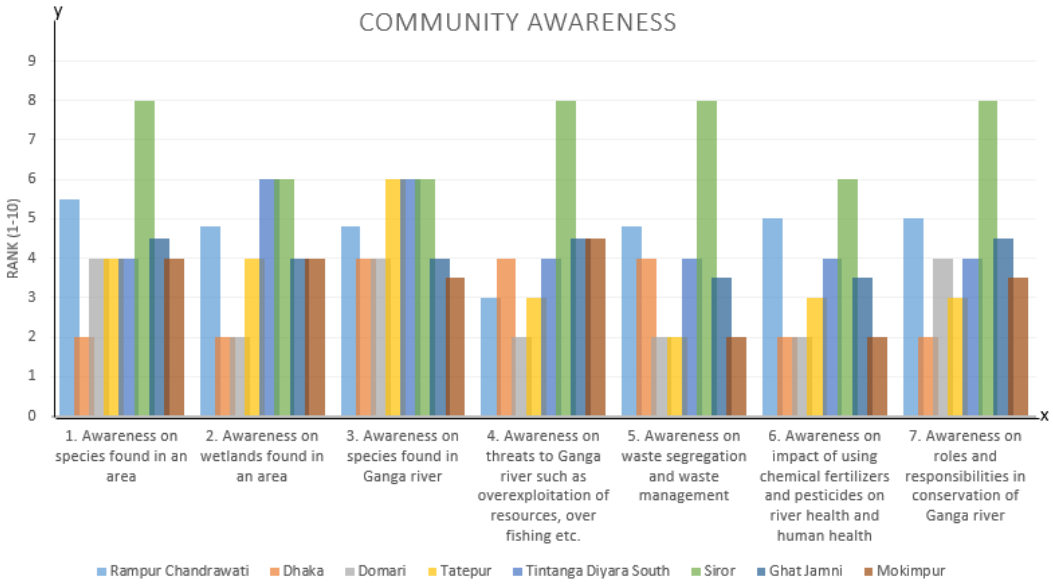


Figure 17: Current scenario of community awareness in the eight villages

4.5 Roles and responsibilities of multiple stakeholders

In the village microplans, nine strategic plans have identified the roles and responsibilities of multiple stakeholders at all levels (Figure 18). These village microplans prepared for the biodiversity conservation of the Ganga River and sustainable development of the village provides information on the roles of different institutions, departments and agencies for conducting various conservation and social and economic developmental activities at the grassroots level.

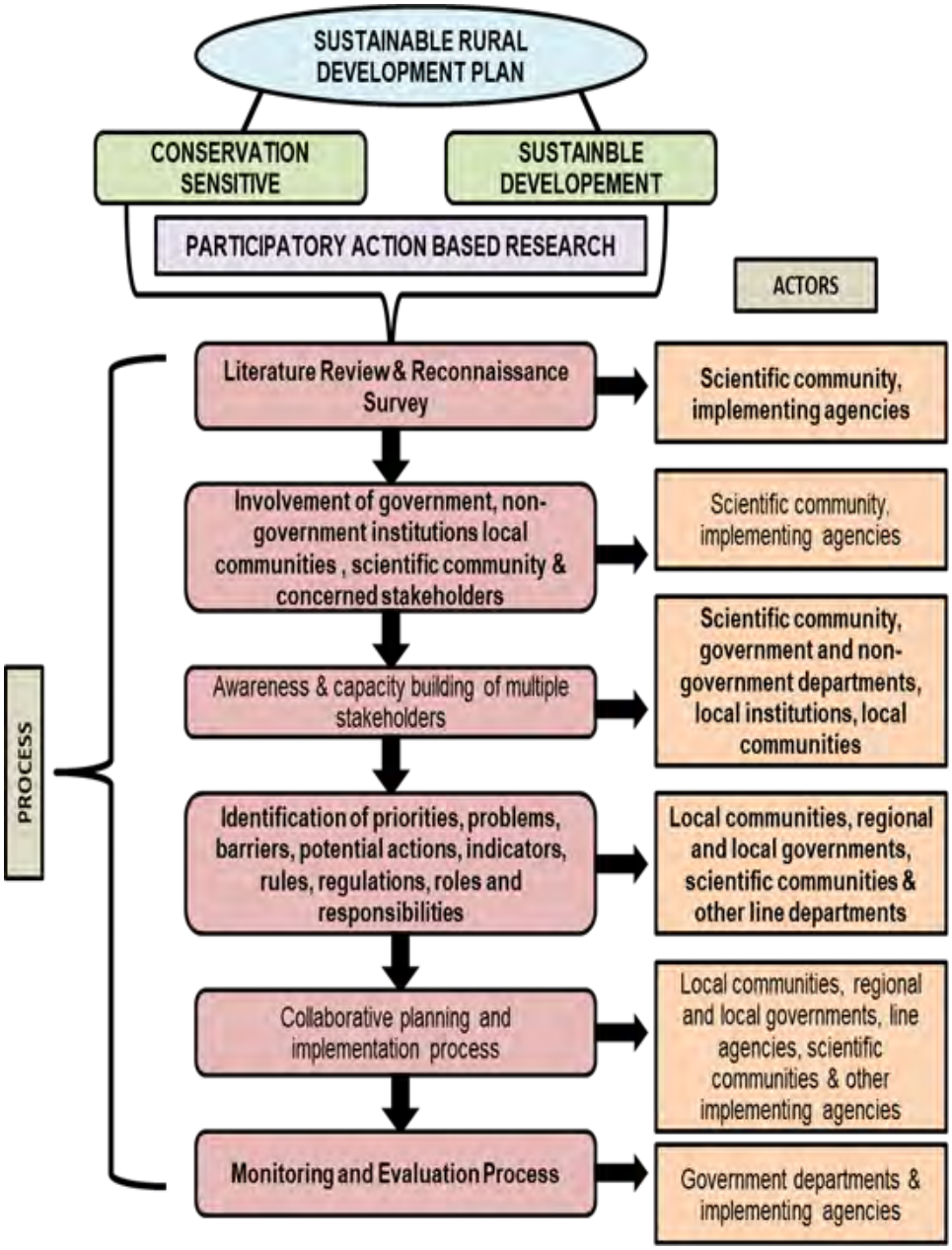


Figure 18: Roles and responsibilities of stakeholders in developing conservation sensitive rural development plan

The involvement of communities, local level institutions and other stakeholders in the planning, decision making, implementation and policy formulation processes not only ensures ownership, responsibility and effective implementation at the grassroots level but also through a wide range of knowledge and experience it enhances the quality of decision making and policy outcomes . Involvement of communities and institutions at the grassroots level facilitates the development of conservation sensitive strategies that are in sync with

sustainable development and ensures implementation and long term sustainability of natural resource management.

5. DISCUSSION

The role of communities and local institutions in conservation has always been pivotal and irreplaceable. Community based conservation facilitated by participation from the local level institutions, regional and state government have become the paradigms of conservation. Developing participatory village microplan for biodiversity conservation of the Ganga River and sustainable development of the village was conceived to understand and ensure involvement from local level stakeholders in identifying, prioritizing and mitigating conservation and development concerns of the village and strengthen their participation in implementing the actions suggested by them.

Decentralization provides an opportunity to synergistically involve communities, planners, decision makers and administrators in identifying the challenges at the grassroots level, developing sustainable means to access services and economic opportunities and ensuring community participation in implementation processes. In many nations decentralization has proved to be an essential strategy for achieving development goals, providing public services and embarking upon environmental concerns (Agrawal and Ostrom, 2001; Diduck et al. 2007; Kiwango et al. 2017). As observed, it is important to function in a cohesive and synergistic manner in order to understand the capabilities and opportunities for enhanced human well being and strong ecological stability. Some actions will require a concerted international effort while for some solutions a bottom-up approach including local communities, local government and regional administration, scientific community, decision and policy makers at various levels would be necessitated. Therefore, the role of every stakeholder (governments, private sector and civil society) is crucial (Gigliotti et al. 2019).

As discussed above, during the first phase of the project duration (2016-2019) a microplanning guideline has been developed for the preparation of village microplans focussing on Ganga conservation and sustainable development of the village. Based on the guidelines, village microplans have been developed for 12 villages located along the Ganga River. The 12 selected villages comprise of different landscapes covering two varied bio-geographic zones (Himalayas and Gangetic plains), comprising of distinct cultural and

natural heritage along with diverse social, ecological and economic diversity. These 12 villages include- Sirour in Uttarakhand, Rajghat, Udaigarhi, Domari, Tatepur, Rampur and Dhaka in Uttar Pradesh; Shahzadpur and Teentanga Diyara in Bihar and Maskaliyan, Ghat Jamni and Mokhimpur in Jharkhand located in the upper, middle and lower stretches of the Ganga River. Based on consultative meetings, questionnaire based surveys, interviews, FGDs and PRAs various social and ecological issues were identified by the local communities, stakeholders and local institutions that are discussed in the village microplans (Table 4).

On the digital platform, the 12 village microplans are digitalized using various computer applications and ICTs. All the issues discussed in the village microplans were categorized into nine strategic themes of which three were under generic theme that is Community Awareness, Hygiene and Sanitation and Biodiversity Conservation and six were under trust building themes that is Livelihood and Skill Development, Community Based Institutions, Renewable Energy, Agriculture, Fishery, Animal Husbandry.

Based on the data collected digital village microplans, it was observed that their dependence on the Ganga River was more or less similar across 12 villages (Table 4). For instance, the dependence on the Ganga River for its religious and cultural significance is very prominent across the five states. In such case, the role of local communities and religious leaders in protecting and conserving the resources of the Ganga River becomes extremely crucial. Another major concern from the Ganga conservation point of view was the dependence on the Ganga River for agriculture and river bed faming especially in the villages located in the Indo-Gangetic Plains. Increasing use of pesticides and chemical fertilizers has impacted the quality of water of Ganga River as agricultural run-off, for which it was suggested that awareness, appropriate trainings and implementation of the government schemes of the in organic farming can be carried out in collaboration with the agricultural and horticultural department and a section of agricultural land can become the demonstration sites for organic farming. As the Ganga flows in the state of Uttar Pradesh, Bihar and Jharkhand, the local communities are dependent on the River for fishing as their livelihood option. In this case, it is imperative to provide the communities with alternative livelihood options based on the need - based assessments and their willingness, followed by organizing various skill development trainings, strengthening the existing institutions, establish market availability in order to reduce their direct dependence on the River and

also secure their source of income. Another major concern is observed across 12 villages was the challenge of improper waste management (solid and liquid) in the villages, which in turn has been impacting the health of the Ganga River ecosystem in many severe ways. Therefore, in consultations with the participants involved in preparation of microplans recommended that more awareness on waste management and liaison with the local level institutions such as Nagar Palikas and district administration has to be established and strengthened for installation of adequate number of dustbins in the village and on the Ghats, followed by allocation of areas for waste segregation and management along with trained human resources.

Aligned actions, fostering collaborations with various institutions at local, regional, state, national and international forums for synergistic implementation broadens and strengthens the opportunities for conservation and sustainable development. Recognizing the crucial role of SDGs at both national and international forum, the achievement of SDGs have received considerable attention and have been of prime importance for both human well being and ecological stability (de Jong et al. 2018). The issues addressed in the 12 village microplans are strategically planned, aligning with the SDGs (Table 4). SDGs 4 (Quality Education), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), , 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 15 (Life on Land) and 17 (Partnerships for the Goals) are directly affecting the Ganga biodiversity conservation, whereas, SDGs 1 (No Poverty), 2 (Zero Hunger), 5 (Gender Equality), 8 (Decent Work and Economic Growth)and 13 (Climate Action) are interlinked with the other goals and targets making it equally significant to address issues of environmental degradation and ecosystem adaptation at all levels. To underpin the implementation of conservation actions and goals including SDGs, and reinforce it at both policy and practice levels, it is indispensable to understand the vulnerabilities with respect to sustenance of communities and ecological stability which is supported by strong partnerships with wide array of actors (Elder and Olsen, 2019).

With respect to convergence and coordination between various departments and institutions at all levels, the digital framework of village microplan will contribute in eliciting the engagement of multiple stakeholders in implementation and, provide an opportunity to strengthen cross-sectoral and inter-departmental coordination. This will also open the way

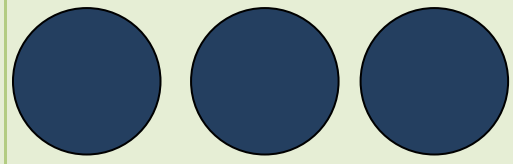
for knowledge and experience sharing while maintaining accountability and transparency in information dissemination by various agencies and efficient monitoring of the implementation of the village microplans. Depicting a nested inter-linkage between nine comprehensive strategic plans the digital village microplans address various conservation and development challenges faced at the grassroots level along with the potential future actions that can be implemented in a holistic manner. Currently, the digital village microplans are operating on the WII intranet services.

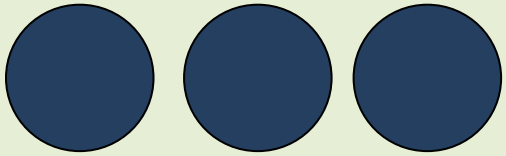
Ascertaining efficient institutions is a fundamental process in societal development (Holzhacker et al. 2016). This novel idea of digital village microplans contributes to strengthening the existing institutional structures and open up the way for building and fostering institutions with Ganga conservation as one of their major goals in the societal and infrastructure development planning systems. According to Kumar et al. (2008), decentralization can play a crucial role in making e-governance pertinent and dynamic with the involvement of multiple stakeholders including government officials, local institutions, private and public sectors and civil society in the process.

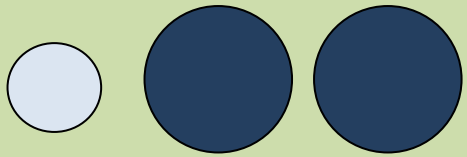
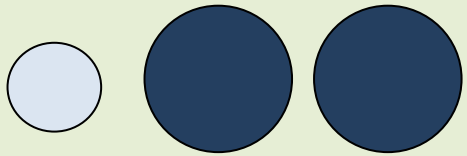
Recognizing the crucial role of implementers at all levels of governance especially at the grassroots and regional level, these digital village microplans will not only raise awareness among planners, policymakers, implementers at all levels but also contribute in formulating actions and techniques which are combined with robust scientific knowledge, thereby, building resilient and holistic strategies for Ganga conservation.


गंदी नालियां न गंगा में बहाओ,
यह परम तीर्थ है सबको समझाओं

Table 4: Summary table depicting the list of issues identified and potential strategies developed in 12 microplans of villages located across the Ganga River

S.No.	ISSUES IDENTIFIED	STRATEGIES DEVELOPED	SDGs ADDRESSED
1.	**LACK OF AWARENESS AMONG STAKEHOLDERS ON GANGA BIODIVERSITY CONSERVATION ISSUES** **EXTENT OF THE ISSUE**  **UGS MGS LGS**	• Sensitization and training workshops for local communities and multiple stakeholders. • Providing information dissemination material. • Use of conventional methods of communication i.e. wall paintings, slogans, songs, poems, radio shows, television, rallies. • Capacity building of Ganga Praharis and Bal Ganga Praharis cadre.	
2.	**DEPENDENCE ON RESOURCES OF GANGA DUE TO LACK OF LIVELIHOOD ALTERNATIVES** **EXTENT OF THE ISSUE**  **UGS MGS LGS**	• Need based and market assessments, availability of raw materials and local produce for livelihood trainings. • Liaison with non - government and government programmes for skill enhancement and alternative livelihood development programmes. • Capacity building workshops of local communities in various skill enhancement trainings and green entrepreneurial development.	
3.	**NON-FUNCTIONAL AND LACK OF LOCAL**	• Strengthening existing villages level institutions such as	

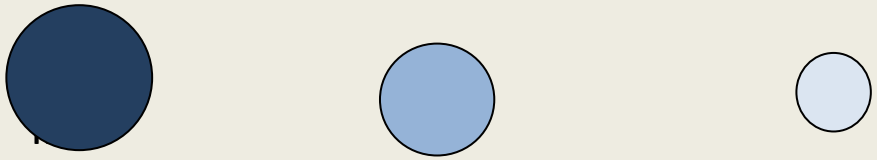
	INSTITUTIONS **EXTENT OF THE ISSUE**  **UGS** **MGS** **LGS**	Self Help Groups (SHGs) • Liaison with district and block administration for establishing new institutions and implementation of various government schemes and programmes such as PMKVY, RSETI, NRLM. • Capacity building of local communities in skill development such as production of value added products from waste, micro-financing, green entrepreneurship, marketing etc., with support from the government departments, non-government organizations and other line agencies. • Promote inclusion of conservation goals and actions in the mandate or agenda of the local institutions.	 
4.	**IMPROPER WASTE MANAGEMENT AND DISPOSAL OF RELIGIOUS ITEMS INTO THE RIVER** **EXTENT OF THE ISSUE**  **UGS** **MGS** **LGS**	• Awareness programmes, meetings and trainings on waste management for stakeholders such as religious and local level leaders, tourism department, hotel and water sports association, local level institutions, boatmen, market/ shopkeeper association, tourists, visitors etc. • Liaison with district level Ganga Committee, *Nagar Palikas* and district administration for waste disposal and management and forming of stringent rules and regulations to control the improper waste disposal especially in tourist areas. • Installment of dustbins in the villages and at ghats. • Training of local people for organic and inorganic waste segregation. • Training of women, SHG groups, and local level	 

		institutions on making value added products from waste. • Encourage the local shopkeepers, religious leaders, local communities to use innovative biodegradable products made up of paper, straws, and leaves instead of plastic.	
5.	**OVER EXPLOITATION OF BIOLOGICAL RESOURCES E.G. FISHING** **EXTENT OF THE ISSUE**  **UGS MGS LGS**	• Awareness among fishermen community about sustainable fishing. • Development of alternative livelihoods opportunities. • Liaison with government departments for trainings on sustainable fishing, use of proper fishing gear, rules and regulations of fishing. • Encourage sustainable fishing such as pisciculture.	
6.	**AGRICULTURAL RUNOFF** **EXTENT OF THE ISSUE**  **UGS MGS LGS**	• Awareness among farmers on impacts of chemical fertilizers on the human health and river ecosystem. • Trainings on sustainable, organic, climate resilient and water efficient farming. • Linkage with government departments and other line agencies such as Horticultural dept., Agricultural dept. for trainings, capacity building and demonstrations. • Awareness and trainings on agro-forestry with support from state forest departments.	
7.	**CONVERGENCE BETWEEN DEPARTMENTS AND SECTORS FOR IMPLEMENTATION**	• Liaison with various government and non-government departments, programmes and schemes. • Consultative meetings and workshops with government departments and line agencies.	

	EXTENT OF THE ISSUE  **UGS** **MGS** **LGS**	• Development of village microplans for Ganga conservation and sustainable village development. • Development of digital village microplans for transparency in information sharing, cross-sectoral and inter-departmental coordination in implementation, monitoring and evaluation of the schemes related to development in consonance with the conservation goals.	  

KEY FOR REFERENCE

1) Extent of the Issue Identified in the Ganga Stretch



HIGH **MEDIUM** **LOW**

2) UGS- Upper Ganga Stretch **3) MGS- Middle Ganga Stretch**
4) LGS- Lower Ganga Stretch

6. CONCLUSION

Conservation of the Ganga River is a multifaceted challenge with its social, ecological, economic and cultural significance and concerns. Multidimensional conservation strategies involving multiple stakeholders are needed to address the challenges in a comprehensive and holistic manner. Development of participatory village microplan for biodiversity conservation of the Ganga River and sustainable development of the village is a step towards an effective and efficient rural development planning and implementation.

As observed that each of the nine comprehensive strategic plans in 12 village microplans has a direct or indirect impact on the conservation of the Ganga River. These village microplans provide an opportunity to synergistically address the conservation and developmental challenges, wherein the development priorities are aligned with the Sustainable Development Goals and conservation targets. Liaison and alliances with local level institutions, government departments and non-government organizations through village microplans will contribute in strengthening the implementation of various policies and programmes of the government and non-government organizations in a robust, effective and efficient manner. These village microplans for Ganga conservation and sustainable village development can prove to be a reliable platform for the decision and policy makers in identifying, prioritizing and mitigating conservation and development concerns at the grassroots level.

The digitalization of these village microplans has been envisaged with an aim to enhance and ensure the engagement of multiple stakeholders in the implementation of microplans along with the cross-sectoral and inter-departmental coordination and management by defining and strengthening the roles and responsibilities of various institutions. It contributes in maintaining accountability and transparency between multiple stakeholders at all levels (national, state, regional and local). The initiation of the digitalization of village microplans has the potential to become a stepping stone in the field of conservation especially in the field of social- ecological studies. Digital village microplans provides a single platform for scientists, conservationists, planners, decision makers, policy makers, implementers and user groups for reviewing and developing enhanced, innovative and sustainable initiatives for developing conservation sensitive rural development plans while

facilitating smooth and transparent information sharing, monitoring and evaluation of the various programmes and policies implemented at the grassroots level.

Further, it will contribute in strengthening the implementation, surveillance and reinforcement of the various programmes and schemes provided by the government, non-government organizations on ground. Also, it will broaden the future possibilities of policy analysis and interventions, regional planning and decision making processes with respect to biodiversity conservation and sustainable development in the village.

LIST OF ANNEXURES

S.No.	Title
1	Report on finalization workshop on microplanning guideline
2	Village microplanning guideline
3	Village microplan for Gram Panchayat Sirour (Block Bhatwari, District Uttarkashi, Uttarakhand)
4	Village microplan for Gram Panchayat Rajghat (Block Dibai, District Bulandshahr, Uttar Pradesh)
5	Village microplan for Gram Panchayat Udaigarhi (Block Dibai, District Bulandshahr, Uttar Pradesh)
6	Village microplan for Gram Panchayat Domari (Block Kashi Vidyapeeth, District Varanasi, Uttar Pradesh)
7	Village microplan for Gram Panchayat Rampur (Block Cholapur, District Varanasi, Uttar Pradesh)
8	Village microplan for Gram Panchayat Dhaka (Block Cholapur, District Varanasi, State Uttar Pradesh)
9	Village microplan for Gram Panchayat Tatepur (Block Chiraigaon, District Varanasi, Uttar Pradesh)
10	Village microplan for Gram Panchayat Shahzadpur (Block Narayanpur, District Bhagalpur, Bihar)
11	Village microplan for Gram Panchayat Teentanga Diyara (Block Rangrachowk, District Bhagalpur, Bihar)
12	Village microplan for Gram Panchayat Masakaliyan (Block Taljhari, District Sahibganj, Jharkhand)
13	Village microplan for Gram Panchayat Ghat Jamni (Block Rajmahal, District Sahibganj, Jharkhand)
14	Village microplan for Gram Panchayat Mokhimpur (Block Rajmahal, District Sahibganj, Jharkhand)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