Resource Management and Sustainable Rural Livelihood in Post-Pandemic Era – An IGIF Driven Approach

Soumya K Ghosh, Pulak Mishra, Sayak Roychowdhury
skg@cse.iitkgp.ac.in, pmishra@hss.iitkgp.ac.in, sroychowdhury@iem.iitkgp.ac.in

Indian Institute of Technology Kharagpur, India
Preamble

- Major challenge in the Post-Pandemic period (particularly in Rural India) - To bring in. *socioeconomic stability and rejuvenate the development process with adequate emphasis on conservation and judicious use of the critical natural resources*

- While addressing these aspects requires interventions through appropriate policies and institutional arrangements, designing and successful implementation need detailed analysis using diverse datasets (from both primary and secondary sources) that are harvested and analyzed at various levels.

- Integrated Geospatial Information Framework (IGIF) backend Spatial Data Infrastructure (SDI) and Geo-Analytics module may be an ideal platform
Household Level Survey (Primary data)

Study Area: Paschim Medinipur district of West Bengal state (India)
Blocks: 4 Villages: 16 Households: 400

Core Information
- Human Capital
  - Household details
  - Education / Skill / Training
  - Earner / Dependent / Learner
- Social Capital (Protection Schemes of the Government)
  - Basic Security – Food, Health, Education, Housing
  - Economic Security
  - Social Security
- Physical Capital - Productive Assets
- Infrastructure – Electricity, Transport
- Natural Capital - Grazing Land, Forest, Water Bodies, Open Space
- Financial Capital

Socio Economic Condition
- Education
- Health
- Standard of Living

Sources of Livelihood
- Labour (Including Migrant Workers)
- Migrant Workers – Information
- Activities Pursued by the Household
- Agriculture / Production / Trading
- Earning from Livestock
- Migrant Workers – Information
- Activities Pursued by the Household
- Agriculture / Production / Trading
- Earning from Livestock

Household Consumption

Table:

<table>
<thead>
<tr>
<th>HOUSEHOLD CAPITAL/ASSET</th>
<th>RURAL LIVELIHOOD</th>
<th>GOVERNMENT SCHEMES</th>
<th>SOCIO-ECONOMIC CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human capital</td>
<td>Nature of Employment and Earnings</td>
<td>PDS</td>
<td>Education</td>
</tr>
<tr>
<td>Social Capital</td>
<td>Production Based Activities</td>
<td>MGNREGA</td>
<td>Healthcare</td>
</tr>
<tr>
<td>Physical Capital</td>
<td>Use of Common Property</td>
<td>NRLM</td>
<td>Standard of Living</td>
</tr>
<tr>
<td>Financial Capital</td>
<td>Resources (CPR)</td>
<td>SGSY and SHGs</td>
<td>Status of Food Security</td>
</tr>
<tr>
<td>Natural Capital</td>
<td>Livelihood Shock</td>
<td>Others (BRGF, JFM)</td>
<td>and Poverty</td>
</tr>
</tbody>
</table>

SK Ghosh, CSE, IIT Kharagpur
Few Facts and Figures

**Land use pattern in the selected blocks**

<table>
<thead>
<tr>
<th>Block</th>
<th>Net Cropped Area</th>
<th>Area under Pasture &amp; Orchard</th>
<th>Current Fallow Land</th>
<th>Forest land</th>
<th>Area under More than Once</th>
<th>Gross Cropped area</th>
<th>Cropping Intensity (%)</th>
<th>Geographical Area (in hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sankrail</td>
<td>21153</td>
<td>446</td>
<td>420</td>
<td>1620</td>
<td>11275</td>
<td>32428</td>
<td>153</td>
<td>27610</td>
</tr>
<tr>
<td>Keshiary</td>
<td>20720</td>
<td>585</td>
<td>400</td>
<td>2314</td>
<td>11827</td>
<td>32547</td>
<td>157</td>
<td>29352</td>
</tr>
<tr>
<td>Sabang</td>
<td>21083</td>
<td>372</td>
<td>-</td>
<td>-</td>
<td>20526</td>
<td>41609</td>
<td>197</td>
<td>30075</td>
</tr>
<tr>
<td>Daspur-II</td>
<td>13000</td>
<td>462</td>
<td>-</td>
<td>-</td>
<td>12127</td>
<td>25127</td>
<td>193</td>
<td>16614</td>
</tr>
</tbody>
</table>

*Source: District Census Handbook of Paschim Medinipur, 2011*
LULC Maps of a Keshiary Block (2022 vs 2020)
NDVI Maps of a Keshiary Block (2022 vs 2020)
Enabling Interoperability - Schema Integration [SDI to IGIF]

Spatial Data Repository
- Household Field Survey
- Secondary Data
- Village/Block/District

Domain Specific Schema
- Road
- Rail
- Block
- HQ
- Domain Specific Schema 1
- Block
- Income
- Domain Specific Schema 2
- LULC
- Canal
- Lake
- NH
- Domain Specific Schema 3

Common Integrated Infrastructure
- Geo-Ref
- With or Without Geo-Ref
- Application Schema

Spatial Data Infrastructure
GeoSpatial Data Model
Sustainable Livelihoods Framework (SLF)

- **Sustainable livelihoods** can be seen as a way of thinking about the objectives, scope and priorities for development, in order to **enhance progress in poverty elimination** (Roe, 1998).
- A livelihood comprises various type of assets required for a means of living.
- A livelihood is sustainable when it will be available for next generation.

The assets that are generally recognized within sustainable livelihoods theory, as summarized by McLeod (2001a) are:

- **Human Capital**: Education/Skill
- **Social Capital**: Access/SHGs
- **Physical Capital**: Equipment of production/ Trade
- **Financial Capital**: Saving/Credit facility
- **Natural Capital**: Forest/Water
Livelihood Security - Multi-criteria Decision-Making based Sustainability Analysis

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variable name</th>
<th>Variable description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCI</td>
<td>Monthly Per Capita Income (PCI)</td>
</tr>
<tr>
<td>2</td>
<td>POV</td>
<td>% BPL people</td>
</tr>
<tr>
<td>3</td>
<td>DIV</td>
<td>% Diversification</td>
</tr>
<tr>
<td>4</td>
<td>MIG</td>
<td>% Migration</td>
</tr>
<tr>
<td>5</td>
<td>PHC</td>
<td>% Benefited Primary Health Care</td>
</tr>
<tr>
<td>6</td>
<td>MGA</td>
<td>% Benefited MGNREGA</td>
</tr>
<tr>
<td>7</td>
<td>SHG</td>
<td>% Benefited Self Help Group</td>
</tr>
<tr>
<td>8</td>
<td>PEN</td>
<td>% Benefited Old age pension</td>
</tr>
<tr>
<td>9</td>
<td>ILT</td>
<td>% Illiterate</td>
</tr>
<tr>
<td>10</td>
<td>LIT</td>
<td>% Literate</td>
</tr>
<tr>
<td>11</td>
<td>SKL</td>
<td>% Skill (excluding learner)</td>
</tr>
</tbody>
</table>

SK Ghosh, CSE, IIT Kharagpur
Towards IGIF

Integrated Geospatial Information Framework (IGIF)

Data-driven Approach for Extracting Cause and Impact Relation
ML-enabled module to append heterogeneous data instances

Governance
- Strategy for socio-economic Data Acquisition, Use
- Country Level Implementation Plan

Policy
- Rules and regulation for socio-economic data use, storage
- Easily adaptable geospatial information management

Financial
- Funding and Investment region-wise strategy
- Evaluation and measurement of plan completion

Data
- Data storage, indexing, management
- Knowledge-graph implementation

Innovations
- Data-driven methods to identify cause and impact of socio-economic condition
- Association-rule based mechanism to find out interconnection

Standards
- Standardization of data collection and storage
- Flexible schema
- Interoperability and orchestration

Partnership
- Interdisciplinary cooperation to understand the interconnection between attributes
- Collaborative approach from domain experts and ML expert

Capacity and Education
- Training and Awareness among stakeholders
- Training of new skill among users
- Launching new business venture

Communication And Engagement
- User Engagement
- Sharing information [VGI]
- Feedback and refinement

Prediction of Impact of different causes and strategy outcomes

Socio-economical Revival Strategy post-COVID era
Integrated Geospatial Information Framework (IGIF)
Realizing IGIF (1 of 3)

Data:
• Primary data of 400 households of 16 villages from 4 blocks.
• Secondary sources - Government report, Satellite data etc.
• Create interlinkage between the secondary and primary data sources.
• Data curation is done by using various statistical tools.

Innovation
• Developing SDI for harvesting Spatial and Socio-economic data
• Developing models (Statistical/ AI/ ML) to analyze the geo-spatial and socio-economic data
• SDI / IGIF framework may help in minimize the digital divide

Standards
• SDI is developed based on OGC complaint services
• Promotes interoperability of Data and Services
Partnerships
• Community participation in every village has been encouraged during survey.
• Village level qualitative data (e.g. health infrastructure) is collected through community participation method.
• Local government bodies of the villages and blocks have participated and cooperated with us to get proper information of the villages.

Capacity and Education
• During the field survey the investigators tried to develop the awareness of the households about the relevant government schemes.
• Tried to create awareness about market, modern machines and loan availability.

Communication and Engagement
• Block level planning and stake holder identification are very important to improve the livelihood of the households.
• Integrated engagement strategies of various stakeholders with continuous monitoring and evaluation of the villages are required for better resource management and sustainable livelihood.
Governance and Institutions

- Each of the four blocks have different characteristics in terms of geo-spatial and socio-economic characters.
- Need a proper governance model to promote proper resource management techniques and to ensure sustainable rural livelihood.
- To promote government schemes more accurately at the ground level and to make village resources sustainable we have to define leadership properly.

Legal and Policy

- The backend SDI harvest vast dataset related to study villages.
- Legal protection policy of primary data should be framed to protect the data privacy.
- Legal policies are also required for better implementation and also to increase the accountability.

Financial

- Proper financial model may help to increase the livelihood status of the households of the blocks.
- There are partnership opportunities of the small entrepreneurs with other established organizations for better financial returns.
Socio-economic Impact of Migration during COVID-19 Crisis in the Sundarbans Region: A Study of Sustainable Solutions using Geo-spatial Analytics

Objective of the Project:
I. To create a knowledge base on socio-economic status of local people and impact of migration due to COVID 19 pandemic in selected areas of Sundarbans region;

II. To understand the underlying dynamics and influence of different factors on migration of workforce following COVID 19 pandemic and its socio-economic-ecological implications;

III. To create of an interactive resource map from the survey data, satellite images and interviews, and secondary data sources;

IV. To carry out hotspot analysis and develop multi-hazard cascade model for the areas affected by the pandemic and natural disasters; and

V. To design intervention strategies for creating sustainable livelihood opportunities at local level.

Source: Google Map
Uniqueness of Our Project

Why focus on Sundarbans?

Natural resource conservation, biodiversity, vulnerability (land erosion, cyclone)

High migration (at least one in 75% hh) rate due to lack of job opportunities (73%), out of state (64%)

Requirement of community mobilization

Operational Experience of NGO partner in the area >40 years

Applicability, feasibility and implementability of intervention Model
Overall Methodology

Livelihood Asset Index

265 households surveyed in 12 villages, situated in 4 blocks of the South 24-Parganas district of West Bengal, viz., Patharpratima, Mathurapur II, Sagar and Gosaba

LAI is a function of working capacity, education, Cultivated land, land holding, physical equipment, Livestock, house type, cash income and access to Loan indices (Yan et al., 2010; Shee and Maiti, 2022)
Resource Map helps visualize the demographic and migration data of villages in Sundarbans.

Therefore, one can enter a dataset with geometry fields and assess the data better using the tools.

This would significantly help in analyzing various kinds of information, distributions from the data.

Thus, the tool can be used to cluster villages/households, find optimal locations for resource centers etc.
Secondary Data - Census 2011

| NAME_1 text | Rural | No_HH | geometry
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tona</td>
<td>Rural</td>
<td>1316</td>
<td>0103000020847F000000</td>
</tr>
<tr>
<td>2 Uttar Swarup Nagar</td>
<td>Rural</td>
<td>201</td>
<td>0103000020847F000000</td>
</tr>
<tr>
<td>3 Uttar Gazipur</td>
<td>Rural</td>
<td>547</td>
<td>0103000020847F000000</td>
</tr>
<tr>
<td>4 Shyamnagar</td>
<td>Rural</td>
<td>769</td>
<td>0103000020847F000000</td>
</tr>
<tr>
<td>5 Dakshin Swarup Nagar</td>
<td>Rural</td>
<td>294</td>
<td>0103000020847F000000</td>
</tr>
</tbody>
</table>

Figure 3: INPUTS

Primary Data - Household Survey 2022

Figure 4: OUTPUT - Interactive Resource Map

The following map shows the resources collected from the primary survey data and secondary village-level data for the Sundarbans Region collected from Census 2001, on an interactive map.

**Secondary Data - Census 2011**

- Choropleth Map Field: Number of Households
- Village Information 1: Female Population
- Village Information 2: Literate Population
- Village Information 3: Number of Registered Private Medical Practitioners
- Village Information 4: Number of Agricultural Credit Societies
- Village Information 5: Navigable water way including River, Canal etc.

**Primary Data - Household Survey 2022**

- Household Detail 1: Respondent’s Name
- Household Detail 2: Village
- Household Detail 3: Respondent’s Age
- Household Detail 4: Respondent’s Gender
- Household Detail 5: Total Annual Income (INR)
## Data Sources

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Source</th>
<th>Date</th>
<th>Data type</th>
<th>Purpose of uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall data</td>
<td>DSMW <a href="https://crudata.uea.ac.uk">https://crudata.uea.ac.uk</a></td>
<td>2000–2020</td>
<td>Vector</td>
<td>Rainfall map</td>
</tr>
<tr>
<td>River buffers</td>
<td>Google Earth Pro and Landsat 8 image</td>
<td>2020</td>
<td>Vector</td>
<td>For proximity analysis</td>
</tr>
</tbody>
</table>
Land Use Land Cover Analysis: Sagar Block
Land Use Land Cover Analysis: Mathurapur II Block
Land Use Land Cover Analysis: Pathar Pratima
Land Use Land Cover Analysis: Gosaba
Resource Maps
Key Findings

- Natural calamities causing destruction of property, infrastructure, crop loss, soil and water salinization, drinking water crisis
- Remoteness
- Both long-term and seasonal migration
- Daily wage labourers in informal sectors
- Better coordination required between government agencies, NGOs, local administration, research institutes and private sectors for:
  - Sustainable agricultural solutions
  - Livelihood diversification opportunities
Supporting the SDGs

1. NO POVERTY
2. ZERO HUNGER
3. GOOD HEALTH AND WELL-BEING
4. QUALITY EDUCATION
5. GENDER EQUALITY
6. CLEAN WATER AND SANITATION
7. AFFORDABLE AND CLEAN ENERGY
8. DECENT WORK AND ECONOMIC GROWTH
9. INDUSTRY, INNOVATION AND INFRASTRUCTURE
10. REDUCED INEQUALITIES
11. SUSTAINABLE CITIES AND COMMUNITIES
12. RESPONSIBLE CONSUMPTION AND PRODUCTION
13. CLIMATE ACTION
14. LIFE BELOW WATER
15. LIFE ON LAND
16. PEACE, JUSTICE AND STRONG INSTITUTIONS
17. PARTNERSHIPS FOR THE GOALS
Conclusion

- Applications of geospatial information management system at the micro level would play a crucial role in creation of human and social capitals and linking them effectively with the markets, policies and institutions.

- Management of natural, physical and financial capitals for enabling and maintaining a sustainable livelihood framework in the rural areas.

- Adopting Integrated Geospatial Information Framework (IGIF) with backend SDI will help in Sustainable and Scalable development.
Thank You!

Soumya K. Ghosh
Professor Department of Computer Science and Engineering
IIT Kharagpur, India
skg@cse.iitkgp.ac.in