Decision Support Tool for Inclusive Sanitation Intervention

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Problem Statement

Hypothesis

• Let’s plan and implement sanitation interventions in our city
  • Everyone should get benefits of this interventions

Implications

• Troubled with sewerage system
• Troubled with my toilet containment system
• Municipality huge investment in sanitation has not yield the desired results

City Wide Inclusive Sanitation (access to all) – A myth or reality?
Decision Support Tool for Sanitation Intervention

What it is?

*Geo-spatial tool* to support in decision making for range of sanitation intervention in cityscape

What it does?

Spatially *demarcate area* at settlement level and recommend on the suitable sanitation intervention options to decision makers
To o l  P r o g r e s s i o n

Timeline

2017
Rajasthan (India)
- Conceptualized Idea and developed analysis framework
- Binary interventions i.e. FSM and SS
- Pilot city Identified and GIS based sanitation interventions suitability undertaken
- Disseminations at various platform including FSM 4, Chennai and BMGF Partner meet, Senegal

2019
Khulna (Bangladesh)
- Regrouping and brain-storming on assessment framework
- Geo spatial model with interventions (DST) at three level i.e. FSM, SS and DWT
- Stakeholder consultations and city-wide workshops
- Critical inputs in modifying phase 1 sewerage planning and core foundation for phase II plan.

2021
Madhya Pradesh (India)
- Developed advance framework on adequate data generations for DST
- Tested the model applicability in varying scale of town with range of performance parameters
- Developed DST based sanitation intervention in 8 Towns of MP
- Pipeline for many more cities in MP
- DST based sanitation interventions are being taken up for implementation in 8 towns

Findings shaping the DWT interventions in Khulna city
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sub - Parameters</th>
<th>Highly suitable for</th>
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</thead>
<tbody>
<tr>
<td>Settlement Typology</td>
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<tr>
<td>Residential</td>
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<tr>
<td>Planned</td>
<td>Planned</td>
<td>Sewerage/DEWATS</td>
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<tr>
<td>Planned</td>
<td>▲ Pop density &amp; ▼ built up density</td>
<td>Sewerage/FSM</td>
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<tr>
<td>Planned</td>
<td>▲ Pop density &amp; ▼ built up density</td>
<td>FSM/DEWATS</td>
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<td>Planned</td>
<td>▲ Pop density &amp; ▼ built up density</td>
<td>FSM/Sewerage</td>
</tr>
<tr>
<td>Planned</td>
<td>▲ Pop density &amp; ▼ built up density</td>
<td>FSM</td>
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<tr>
<td>Planned</td>
<td>Slums (sewerage #)</td>
<td>FSM</td>
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<tr>
<td>Others</td>
<td>Education centre, Offices, Commercials etc.</td>
<td>Sewerage/DEWATS</td>
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<tr>
<td>Economic Vulnerability</td>
<td></td>
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<tr>
<td>Planned</td>
<td>Employment and Income - Critical</td>
<td>FSM</td>
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<tr>
<td>Planned</td>
<td>Employment and Income - Non critical</td>
<td>Sewerage</td>
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<tr>
<td>Planned</td>
<td>Insecured land tenure *</td>
<td>FSM</td>
</tr>
<tr>
<td>Drainage Coverage and Typology</td>
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<tr>
<td>Planned</td>
<td>Pucca drain and uncovered</td>
<td>Sewerage/FSM</td>
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<tr>
<td>Planned</td>
<td>Katcha drain</td>
<td>DEWATS</td>
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<tr>
<td>Planned</td>
<td>Covered pucca drain</td>
<td>FSM</td>
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<tr>
<td>Planned</td>
<td>Unserved area</td>
<td>DEWATS</td>
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<tr>
<td>Ground Water Vulnerability</td>
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<tr>
<td>Planned</td>
<td>High risk</td>
<td>Sewerage/DEWATS</td>
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<tr>
<td>Planned</td>
<td>Moderate risk</td>
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<tr>
<td>Planned</td>
<td>Low risk</td>
<td>FSM</td>
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<td>Accessibility Level</td>
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<tr>
<td>Planned</td>
<td>Abutting road width more than 7 m (2 lane carriage way)*</td>
<td>Sewerage</td>
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<tr>
<td>Planned</td>
<td>Abutting road width within range of 3.5 to 7 m</td>
<td>Sewerage/FSM</td>
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<tr>
<td>Planned</td>
<td>Abutting road width within range of 3.5 m to 2 m</td>
<td>FSM</td>
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<tr>
<td>Planned</td>
<td>Less than 2 m road width and beyond the 100 feet accessibility buffer*</td>
<td>DEWATS</td>
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<tr>
<td>Water Sensitive Area</td>
<td></td>
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<tr>
<td>Planned</td>
<td>Water ponding area/depreciation area/Low lying areas</td>
<td>Sewerage/DEWATS</td>
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<tr>
<td>Planned</td>
<td>Flood prone area</td>
<td>Sewerage/DEWATS</td>
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<tr>
<td>Planned</td>
<td>Settlements with higher concentration of nearby ponds</td>
<td>Sewerage/DEWATS</td>
</tr>
<tr>
<td>Topography</td>
<td></td>
<td></td>
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<tr>
<td>Planned</td>
<td>Flat terrain</td>
<td>Sewerage/FSM</td>
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<tr>
<td>Planned</td>
<td>Undulating terrain</td>
<td>FSM</td>
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<tr>
<td>Planned</td>
<td>Consistent slope terrain</td>
<td>Sewerage</td>
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<tr>
<td>Planned</td>
<td>Piped water supply coverage to HH</td>
<td>FSM</td>
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<tr>
<td>Water Supply Coverage</td>
<td></td>
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<tr>
<td>Planned</td>
<td>Stand post coverage to locality (sewerage #)</td>
<td>FSM</td>
</tr>
<tr>
<td>Planned</td>
<td>No piped water supply coverage (sewerage #)</td>
<td>FSM</td>
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</tbody>
</table>
Delivered Results
Output Illustration: Khulna City – Proposed Sanitation Intervention at City and Ward Level
“Low built-up/population density and flood prone area. Located remotely from main-settlements. More suitable to be covered by NSS. Houses should have improved containment system to function in water-logging/flooding situations.”

“Low built-up/population density with depression area. Settlement separated from canal and have relatively lesser scope of development in future. Will have more cost in case of SS with involved pumping components.”

“Low built-up/population density and isolated settlements from main-town development.”

“Low built-up/population density and isolated settlements from other developed settlements of town.”

“Low built-up/population density and with organic settlement growth of town, may be covered with SS during 2nd phase of interventions.”

Illustration: Nagda City – Proposed Sanitation Intervention and Conflict Areas
Output Illustration: Tonk City – Sanitation Intervention Suitability for NSS
Tool Configuration
Geospatial Database

Settlement Typology

- Predict and identify settlement typology such as planned, unplanned, slums etc from SI

Population and Built-up Density

- Building footprints and heights from multi-spectral high-resolution imagery

Accessibility Level

- Satellite data and Open Street maps

Ground Water Vulnerability

- Soil – National Remote Sensing Agency
- Groundwater Level – CGWB (Central ground water board)

Water Sensitive Areas

- Landsat multispectral data

Topography

- SRTM Digital Elevation Model

Economic Vulnerability

- Census/ Economic survey

Containment Coverage

- Secondary Sources

Drainage Coverage and Types

- Secondary Sources

Water Supply Coverage

- Secondary Sources

Geospatial Data – Open Sources

- Artificial Intelligence and Deep Learning Techniques
  - Object Detection
  - Pattern Detection
  - Prediction

GIS and Remote Sensing Tools

- Raster Overlay Analysis
- Suitability Analysis

Geospatial Database

- Suitable Sanitation Interventions
  - Sewerage
  - FSM
  - DEWATS

Secondary Sources

- Field Observations

DST Tool in ArcGIS Platform

Interactive GIS web portal

- Linking with spatial data
Building Footprints Extraction using GIS and Deep Learning Models

• AI and Deep learning automates the process of feature extraction from large satellite imageries
• ArcGIS API for Python to be used.
• Train a Model with sample data
• Deploy the model and Extract Footprints
Building Height extraction from satellite imagery

- Shadow of the structure can be used to capture its height.
- Shadow depends on sun elevation angle at time of image acquisition.
- Building height along with building footprint helps in estimating the population density.
Identification of Settlement typology using Deep Learning techniques

- Determine settlement typology based on building layouts, setbacks and road networks.
- Planned/Unplanned and informal settlements to be identified using deep learning techniques.
Road Network Generated using Deep Learning Models and Open Street Maps (OSM)

- Road Network can be either extracted from satellite imagery using deep learning techniques or from Open Series Maps
Extraction of Elevation Data from open-source DEM

- Elevation and contour can be extracted from open source DEM such as SRTM, Aster GDEM etc.
- Elevation data can be used to identify depression zones within each settlements.
Water Sensitive Areas and Flood Vulnerability assessment

- Water Sensitive areas to be extracted from Landsat satellite imagery
- Water sensitive areas and elevation profile can be overlaid to identify the flood prone regions
DST as a Geospatial Tool in ArcGIS platform

- DST can be added as a tool in ESRI ArcGIS platform.
- All datasets needs to be filtered and formatted before executing the tool.
Tool Benefits

Support in **rational decision making** and design sustainable sanitation interventions at city scale.

Understanding on **implementation phasing** and assist in future planning to ULB on range of sanitation interventions.

Help in **dialogue building with relevant stakeholders** and developing city sanitation interventions road map with collective consensus.

Key role in providing contextual **inputs in developing city sanitation regulations**.

Function as effective **rapid assessment tool** and form the main body of feasibility report for city sanitation interventions.
Eight towns of Madhya Pradesh (India) have finalized the sanitation interventions using DST and rolling out the work tenders for implementations (under MPUDC Phase II ADB Funded & BMGF Supported)

Two towns in Phase III towns of Rajasthan (India) have implemented the sanitation interventions (both SS & NSS) involving DST under RUIDP program (ADB Funded)

Khulna city (Bangladesh) have finalized the priority list of DEWATs interventions and currently implementing in priority city parcel based on findings derived from DST (SNV & BMGF Supported)
Way Forward

• Tool Integration for Technology selection and Investment Estimations
• Developing Web-Portal for ease of system handling
• More aligned towards AI and Deep Learning
• Further reduce the primary data dependency
• More pilot testing in different context and geography
Thank You