Site Level Flood Risk Assessment
Hrushikesh Sandhe, PE, LEED AP
Principal & Infrastructure Head

Hrushikesh Sandhe is a Head-Infrastructures with more than 21 years of experience in water resources engineering. His experience includes flood and water supply planning, feasibility studies and Detail Design. He has extensive experience with complex water resources projects across the globe (India, United States, Saudi Arabia, Oman, and the United Kingdom).
Walter P Moore is an international company of engineers, innovators, and creative people who solve some of the world’s most complex structural and infrastructural challenges. We design solutions that are cost and resource-efficient, forward-thinking, and help support and shape communities worldwide.
Practice Areas

Walter P Moore Services

- Infrastructure
  - Civil Engineering
  - Water Resources Engineering
  - Transportation Engineering
  - Traffic Engineering/ITS

- Structures
  - Structural Engineering
  - Façade Engineering
  - Secure Design
  - Parking Services
  - Construction Engineering

- Diagnostics
  - Building Enclosure
  - Forensic Analysis
  - Parking Restoration
  - Restoration/Renovation

- Technology Consulting
  - BIM Project Coordination
  - IT Infrastructure Consulting
Agenda

• Flood Risk concept
• Lifecycle of flood risk process
• Application of Spatial data for risk assessment
• Challenges / summary
Flood - a large amount of water covering an area that is usually dry

A flood risk assessment (FRA) is
• an assessment of flood risk from all flooding mechanisms,
• the identification of flood mitigation measures and
• should provide recommendations on actions to be taken before and during a flood.
Floods are the most frequent disaster in India
1,058 climate-related events by disaster type (1995-2020)

- Floods: 33%
- Heatwaves: 24%
- Cold waves: 22%
- Cyclones: 5%
- Droughts: 16%

Source: India National Institute of Disaster Management
2022 Year So Far
- Bangalore Flood
- Rainfall in Indore breaks 39 year record
- Rain submerges Kochi
- Heavy Rain in Pune

Source: News agencies
River Flooding
Coastal Flooding
Internal Drainage Flooding
Flood Risk Lifecycle

- Protection / Prevention
- Learnings
- Trainings
- Updates
- Risk reduction Modelling
- Civil design
- Awareness
- Forecasting
- O&M
- Assessment
- Options
- Strategies
- Understanding
- Protection scheme review
- Updates
- Protection / Prevention
- Learnings
- Trainings

Assessment / Planning

Mitigation

Evaluation

Flood Event

Flood Risk Lifecycle

Assessment / Planning

Mitigation

Evaluation

Flood Event

- Protection scheme review
- Updates
- Protection / Prevention
- Learnings
- Trainings
# Data Checklist

## Economics of Green Infrastructure

### Assessment Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Intended Goal</th>
<th>Required Items</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Synthetic Habitat Baseline</td>
<td>Identify and Complement the Habitat Fragmentation Strategy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>Rainwater Harvesting Potential Baseline</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>Managed Stormwater Treatment Baseline</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>Economic Benefits and Costs Analysis</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Land Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Baseline</th>
<th>Impact</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use Current</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Land Unit Features</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Land Cover Current</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Land Cover, Historical</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Digital Elevation Models (DEMs)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Weather and Climate Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Baseline</th>
<th>Impact</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation Current</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Precipitation Future</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Climate Data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Hydrology Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Baseline</th>
<th>Impact</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflow Flow Locations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Watershed Delineations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Stream Networks</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Stream Points</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flood Regulatory Maps</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>FEMA Digital Flood Insurance Maps (DFIRM)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>FEMA Flood Insurance Rate (FIR)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>USGS Regression Equations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flood Storage ft</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Runoff Discharge Factor</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Water Quality</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rural Water Discharges</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Infiltration Grids</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flow Direction Grids</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flow Accumulation Grids</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Social and Economic Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Baseline</th>
<th>Impact</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Vulnerability Rates</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Labor Specialization (Bureau of Labor Statistics)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Infrastructure Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Baseline</th>
<th>Impact</th>
<th>Additional Items</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Parcellation Assistance Database</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ecosystem Health Score</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Building Structure</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Green Infrastructure Sites, Current</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Green Infrastructure Sites, Future</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Impervious Surface %</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Citywide Flood Vulnerability
Site Specific Flood Vulnerability
Site Vicinity

Project Location

Small drain flowing in the South

Kilometers
## Public Data Used

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>IMD and NOAA</td>
<td>Intensity-Duration-Frequency</td>
</tr>
<tr>
<td>Topographic</td>
<td>BHUVAN - ISRO</td>
<td>Catchment delineation</td>
</tr>
<tr>
<td>Survey</td>
<td>Client</td>
<td>Site topographic</td>
</tr>
<tr>
<td>Satellite Imagery</td>
<td>Google Earth Pro</td>
<td>Site vicinity</td>
</tr>
</tbody>
</table>
Topographic Data
Field Data Collection

- Collector for ArcGIS
  - iOS or Android

- WebMaps from ArcGIS Online

- Explorer for ArcGIS
  - iOS or Android
Existing Condition of Project Site
Drainage Area
Site Flow Path (Spatial Data Challenges)
Offsite Drain Analysis in GIS
Goal

- Velocities
- Culvert/nalla crossing back water
- Site Entrance
- Road Elevation
- Compound wall/flood defence height
- Critical Infrastructure
- Any inundation zones
Challenges/ Summary

• Participation of Flood risk process from beginning
• Local Spatial data Availability (topography, rainfall, flooding, inundation issues etc)
• Local drainage information in Spatial format
• Offsite topographic data and Survey are different
Opportunities

• Better late than never
• Data Gaps and accessibility to data
• Opportunity for Spatial Data Integration
• Understanding and awareness of flood risk to the site
• Environmental impact due to mitigation
• Offsite impact due to mitigation (Holistic Approach)
Thank You

Hrushikesh Sandhe, PE LEED AP
Principal/ Head of Infrastructure Group
hsandhe@walterpmoore.com