



INTEGRATING MULTI-DIMENSIONAL DATA FOR INCLUSIVE AND SUSTAINABLE DEVELOPMENT OF URBAN SLUMS

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XVIII MEEW workshop, 26 of June 2020

OUTLINE

- BACKGROUND & GOAL
- METHODS & RESULTS
- OTHER LESSONS LEARNED:
 1. Research projects with multiple remote partners
 2. New paradigm for a social scientists: big data and ML approaches
 3. In pursuit of “open (social) science”...

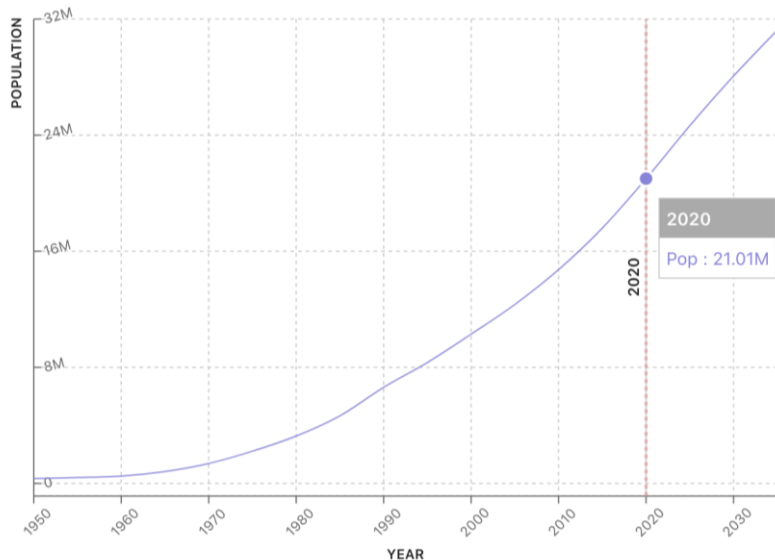
DHAKA: URBAN & INFRASTRUCTURE PLANNING HARDLY KEEPING UP WITH A FAST GROWING MEGACITY



- Fast growing population (21 mln) led to:
 - overcrowding
 - high rates of poverty
 - pollution
 - congestion
 - frequent flooding and water-logging (poor drainage)
 - vulnerability to cyclones

- Ranked among “least liveable cities” (*Economist*)

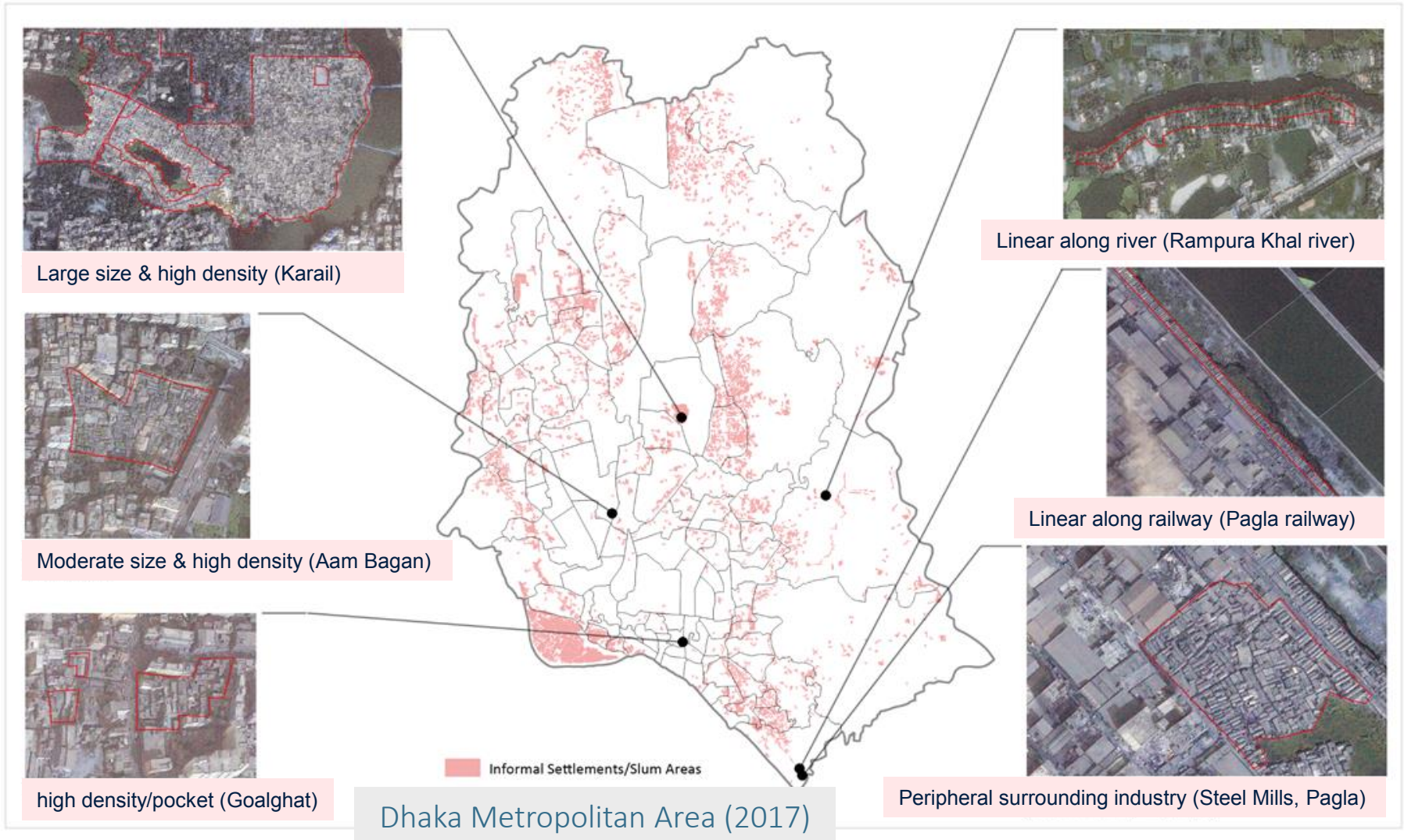
- **About 3,500 slums** where **30-40% of Dhaka's population lives**



Greater
Dhaka
Population
over time

ALL SLUMS ARE NOT “CREATED EQUAL”:

≠ Age, Size, Location, Morphological And Geological Context →
representativity issue with small surveys

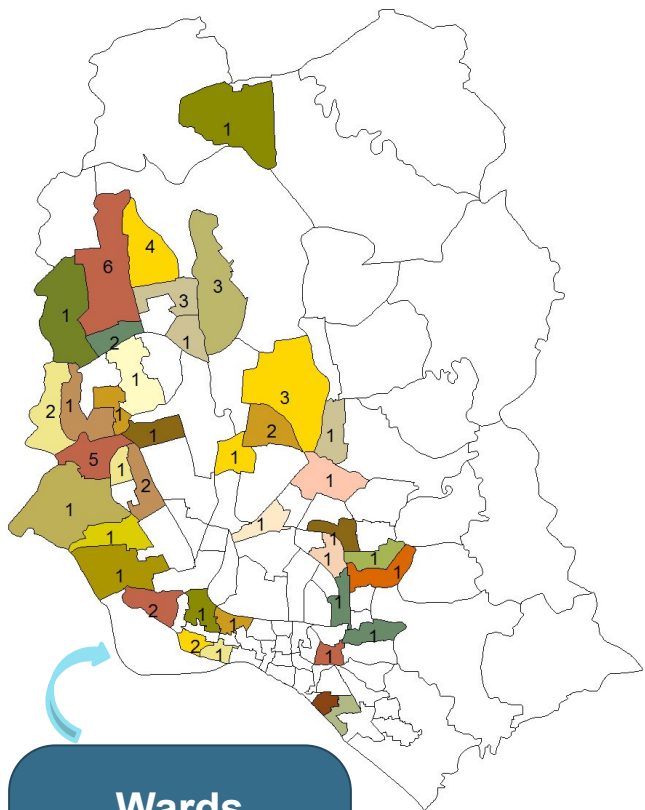


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1ST DATA SOURCE: SURVEY OF DHAKA SLUMS (FROM WASH-POVERTY DIAGNOSTIC)



Wards
covered by
2016 **BUISBS**
slum survey

DATA FROM: 2 SUBSEQUENT REPRESENTATIVE SURVEYS CONDUCTED BY ANOTHER WBG TEAM:

- 1) **MAY 2016 ON 588 HH IN 63 SLUMS**
 - * Slum locations mapped
- 2) **JUNE 2016 ON 600 HH IN 6 SLUMS**
 - * Shorter, more focused on sanitation
 - * Households' GPS location collected

KEY INDICATORS:

- households composition and characteristics
- access and quality of water and sanitation services,
- adequate living space,
- type of housing structure,
- security of tenure,
- access to electricity.

Sources:

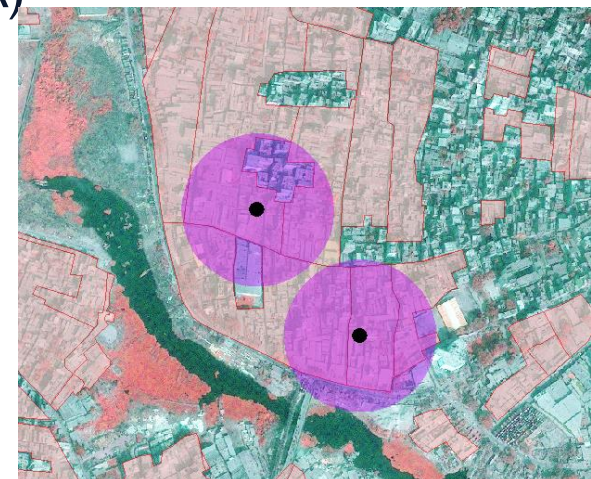
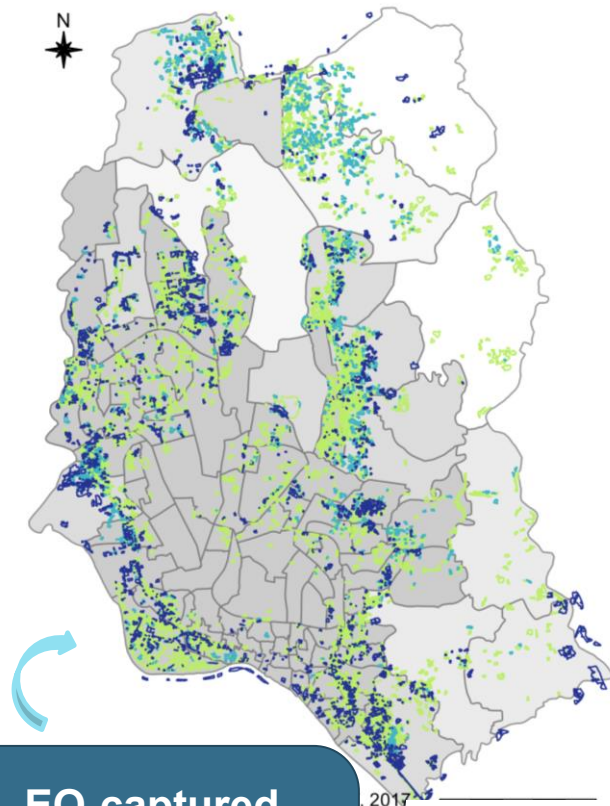
- 1) Bangladesh Urban Informal Settlements Baseline Survey (**BUISBS**) survey: 63 slums over 39 Wards



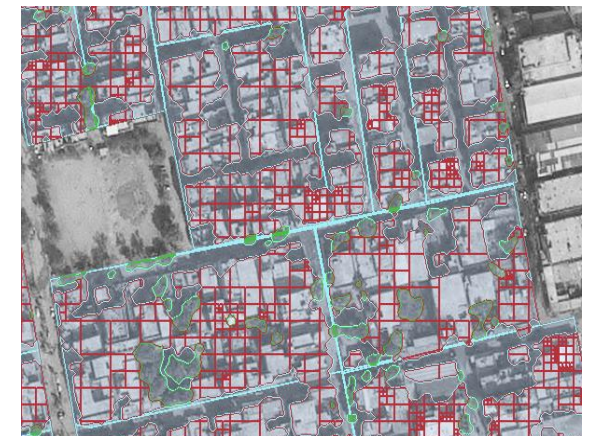
2ND DATA SOURCE: GEOSPATIAL DATA (FROM ESA-WB COLLABORATION AND OTHER OPEN GIS DATA)

GISAT provided:

1. **Extent and Type of Informal Settlements/Slum Areas**
2. **Ad hoc, (spatially-driven) factors and patterns as potential predictors of slum severity:**
 - neighborhood locational,
 - neighborhood accessibility,
 - morphological characteristics,
 - LULC proportional characteristics,
 - internal structure and dwelling characteristics
3. **Ancillary GIS, or OpenStreetMap indicators**



Test slum areas locations derived from WASH-POV



- Sources:**
- 1) Dhaka Slum mapping from EO in 2006 & 2010 (GIS Available - Copyright © 2014 Oliver Gruebner et al.)
 - 2) GISAT Slum detection from VHR EO data in 2017 (Pleiades, QuickBird 2016/17)

USING EO DATA AS INPUT AND SURVEY DATA AS “LABELS”, WE BUILT A PREDICTIVE MODEL ESTIMATING THE **SLUM SEVERITY INDEX (SSI)**

INPUT DATA = VHR multispectral satellite images obtained + Ancillary GIS data from other (open) sources



RESPONSE VARIABLES = data from WASH-POV slum survey
 -At community level
 -At household level

EO imagery combined with field surveys

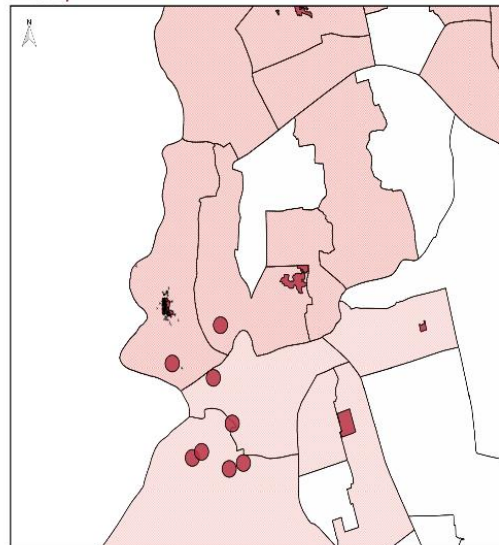
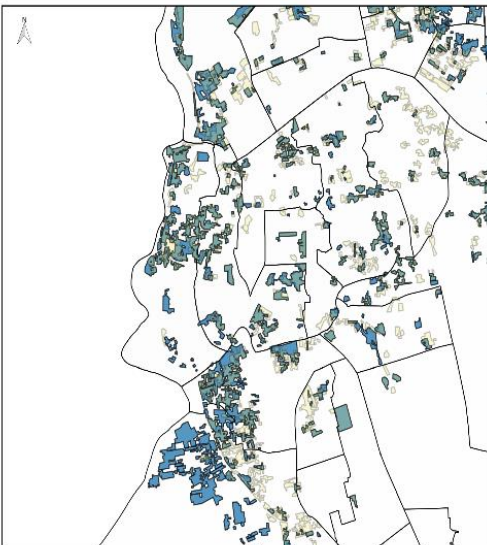


"Slum-like" areas in Dhaka identified via VHR EO

- Yellow = slums detected in 2006 (Gruebner et al. 2014)
- Blue = slums detected in 2017 (Gisat, 2017)

WASH-Pov diagnostic surveys

- Maroon polygons = 2016 survey (GPS reconstructed)
- Black stars = 2017 follow-up survey (household-level GPS)



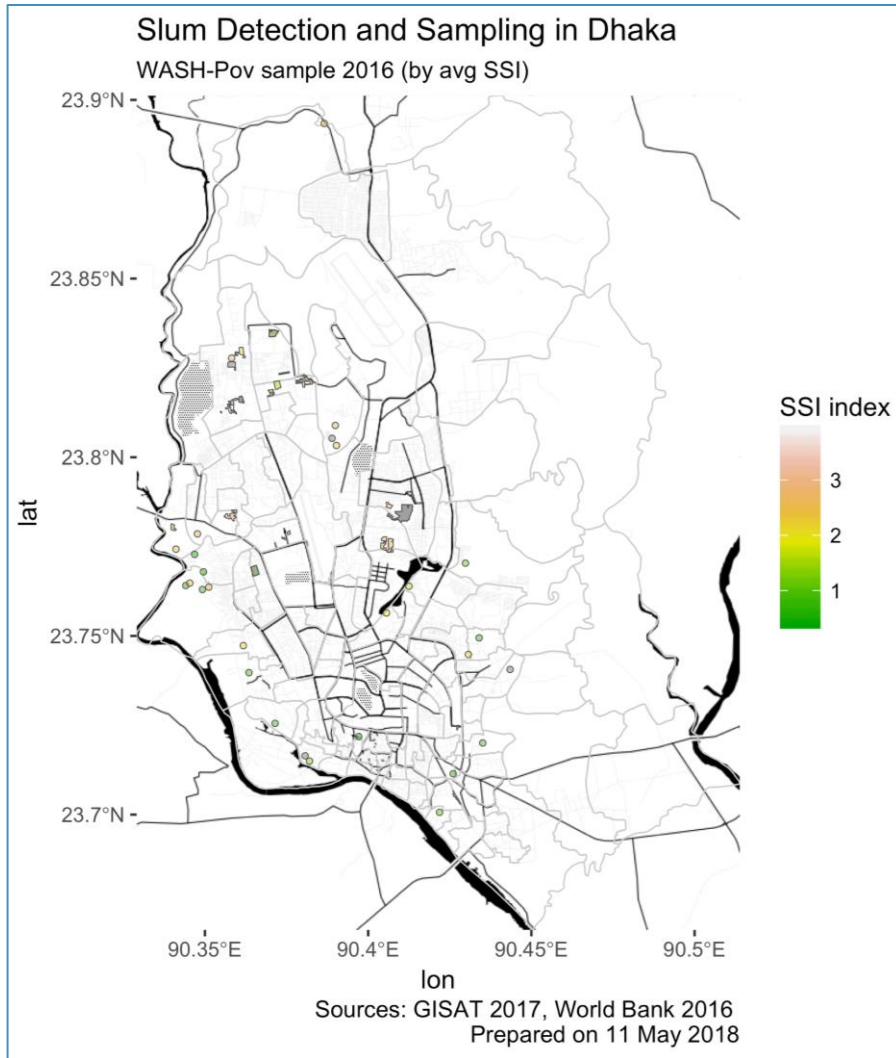
$$SSI = \sum_{i=0}^6 S_i$$



From 0 (Non-slum) to 6 (Most Deprived)

- S_1 : Lack of Access to improved water (Binary)
- S_2 : Lack of Access to improved sanitation (Binary)
- S_3 : Lack of Sufficient living space (Binary)
- S_4 : Lack of Durable structure (Binary)
- S_5 : Lack of Secured Tenure (Binary)
- S_6 : Lack of Access to Electricity (Binary)

PILOT RESULTS: EO PREDICTORS OF HOUSING AND BASIC SERVICES DEPRIVATION IN SLUMS



Most interesting **geospatial predictors** of slum **relative risk of overall deprivation**:

- distance to the central business district (↑), arterial roads (↑), major road junctions (↑), railroads, (↑)
- building density (↑),
- winding index for informal streets (↑)
- low-level node connectivity ratio (↑)
- proximity to heavy industry and shoreline (↓),
- average dwelling size (↓),
- proximity to various social amenities (~ ↓)



Predictive model was validated on testing dataset
(sample of 2nd survey round)

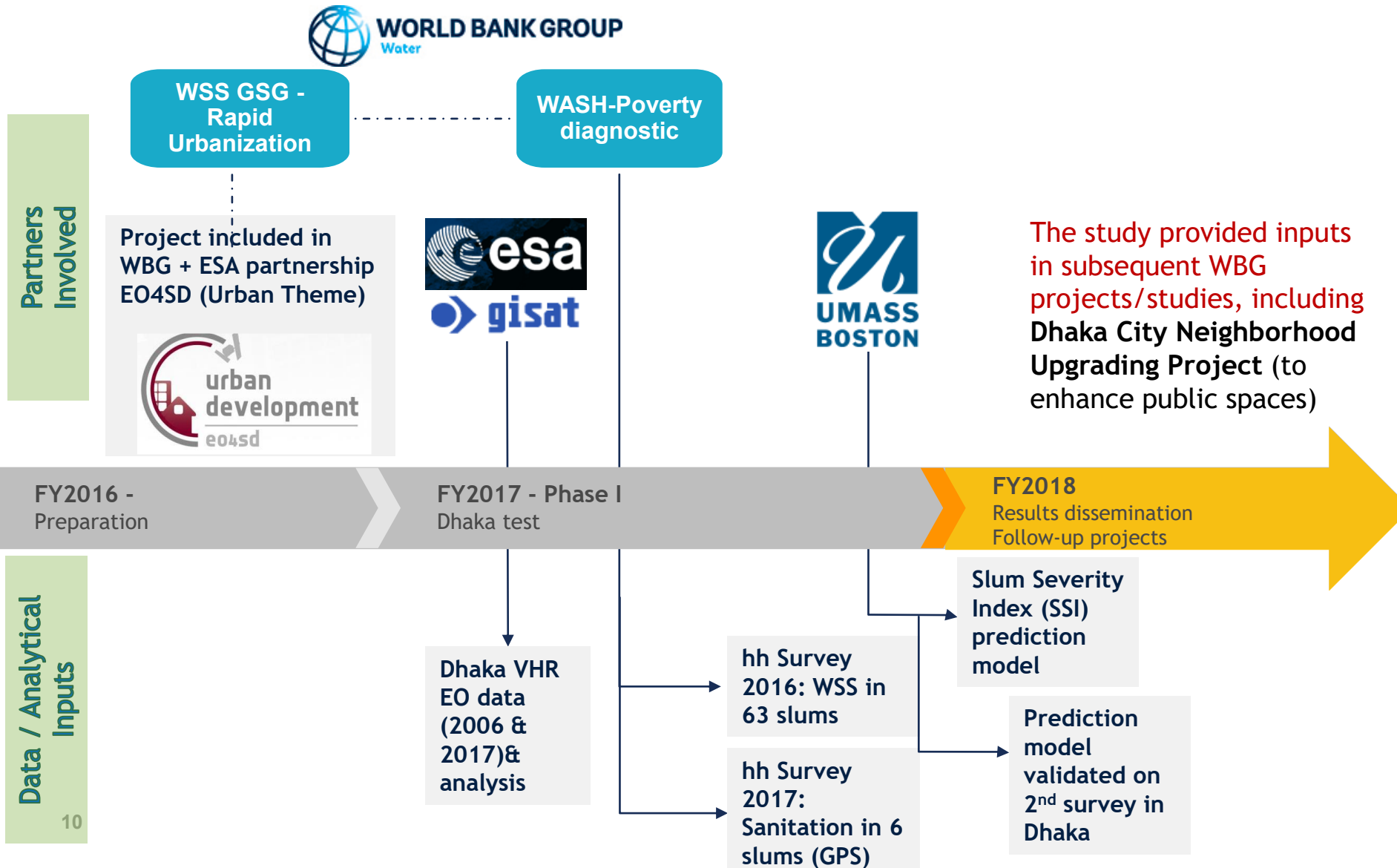


Predictive model could be applied to entire city

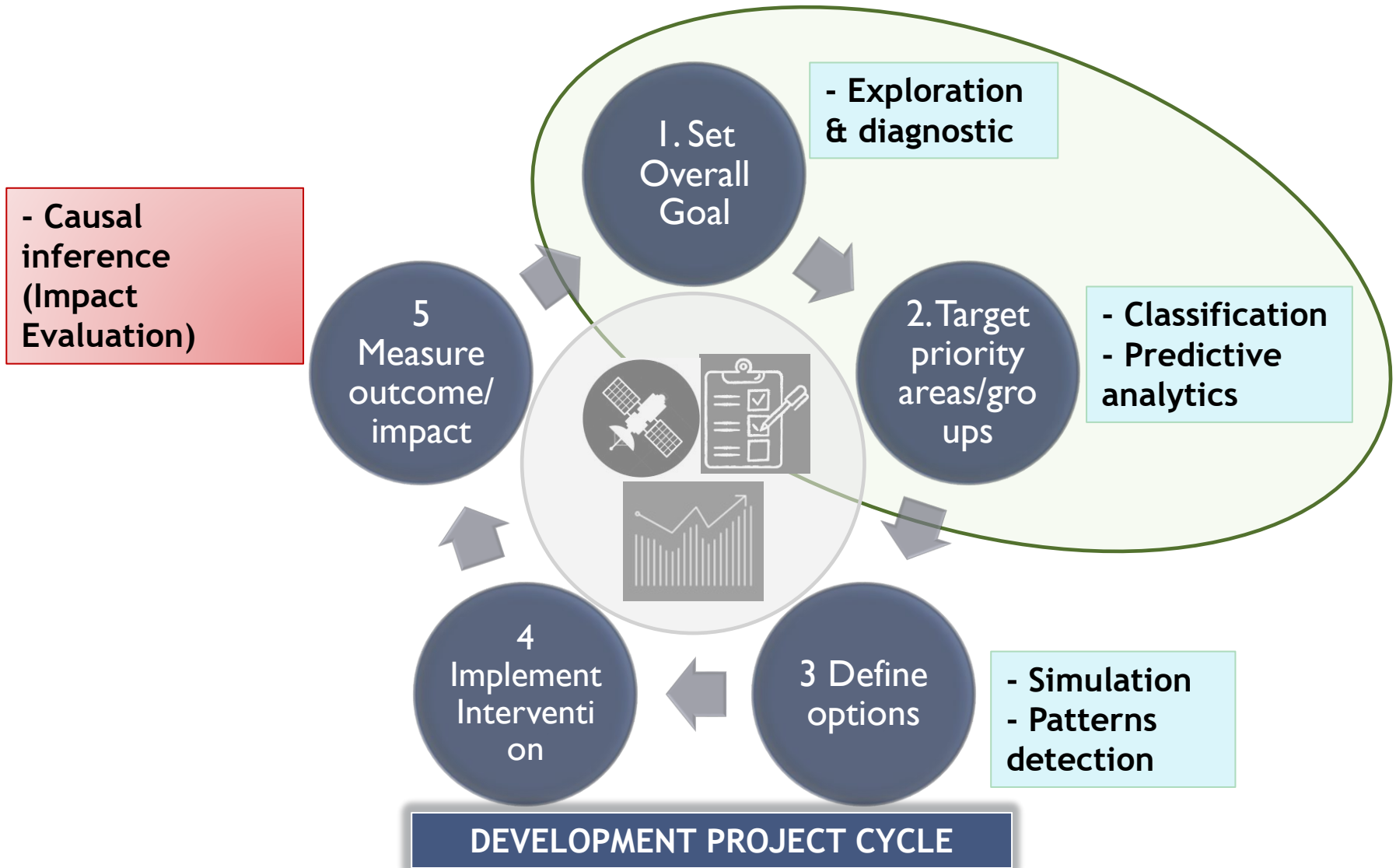
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A COLLABORATION AMONG MULTIPLE PARTNERS



SHIFTING ANALYTICAL FOCUS FOR SOCIAL SCIENTISTS



OPEN SCIENCE: EASIER SAID THAN DONE!

CHALLENGES

Data collection

- “Off the map” poor areas
- Survey Confidentiality
 - Anonymization? / Pseudonymization?



Data Analysis

- Reproducibility of research
- ≠ Data types from ≠ domains



Data - Code - Results Dissemination

- Defining Ownership
- Proper repository
- Data size / computing power

TOOLS / PLATFORMS

Crowd-sourcing

Data Collaboratives

Engaging local universities



Open Science Framework



Berkeley Initiative for Transparency in the Social Sciences

Deeper engagement at the city level



Project's contributors

CORE TEAM

- Luisa M. Mimmi – **World Bank Group**
- Christian Borja-Vega – **World Bank Group**
- Tomas Soukup – **GISAT (ESA EO4SD Urban)**
- Jan Kolomaznik – **GISAT (ESA EO4SD Urban)**
- Amit Patel – **University of Massachusetts Boston**
- Tanushree Bhan – **University of Massachusetts Boston**
- Hyun Jung Lee – **University of Massachusetts Boston**

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Thank you!

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Presented study: [link to pre-print](#)

EO4SD Dhaka initiatives review: [link to WB portal](#)

(The views and opinions expressed in this presentation are solely those of the presenter and not necessarily those of her current and former employers.)