Spatial Models for ***Slum Area*** Mapping

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Flowminder Foundation
WorldPop, University of Southampton

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UN-GGIM, Nairobi

Expert slum mapping meeting

Bellagio

Surveys for Urban Equity Project

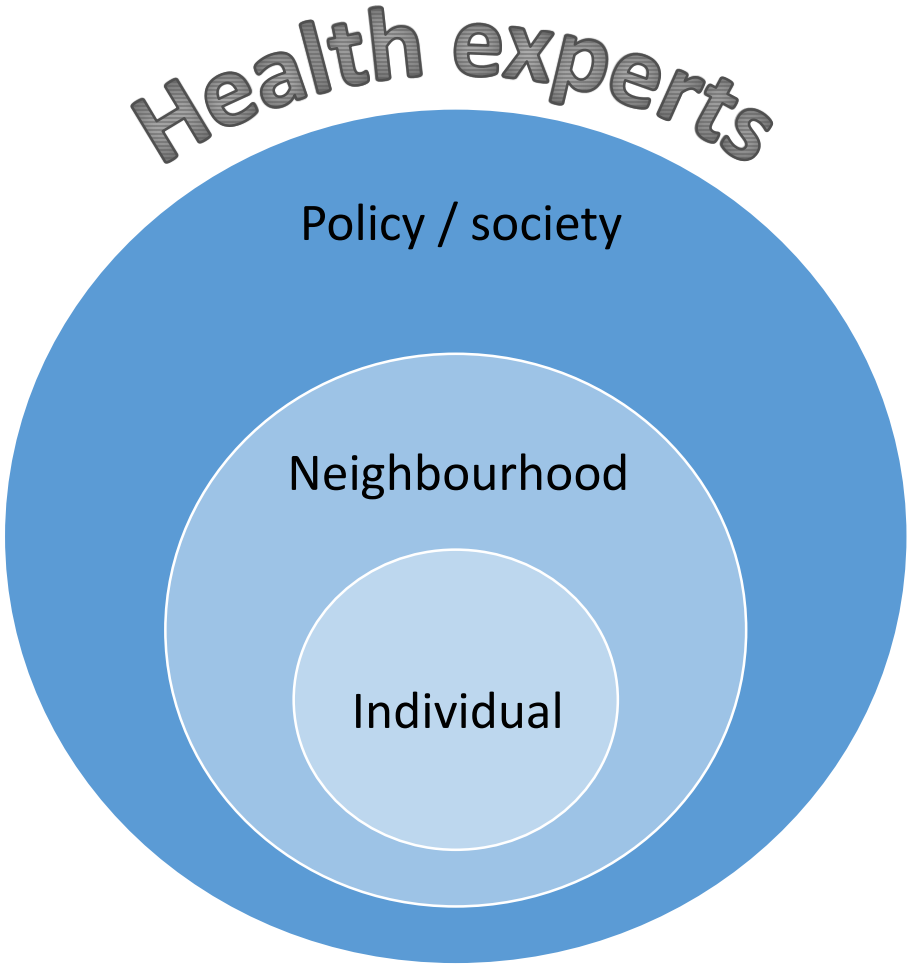
Kathmandu, Dhaka, Hanoi

GRID3

DRC, Nigeria, S. Sudan, Mozambique, Zambia

Area-level health determinant indicators paper

LMICs

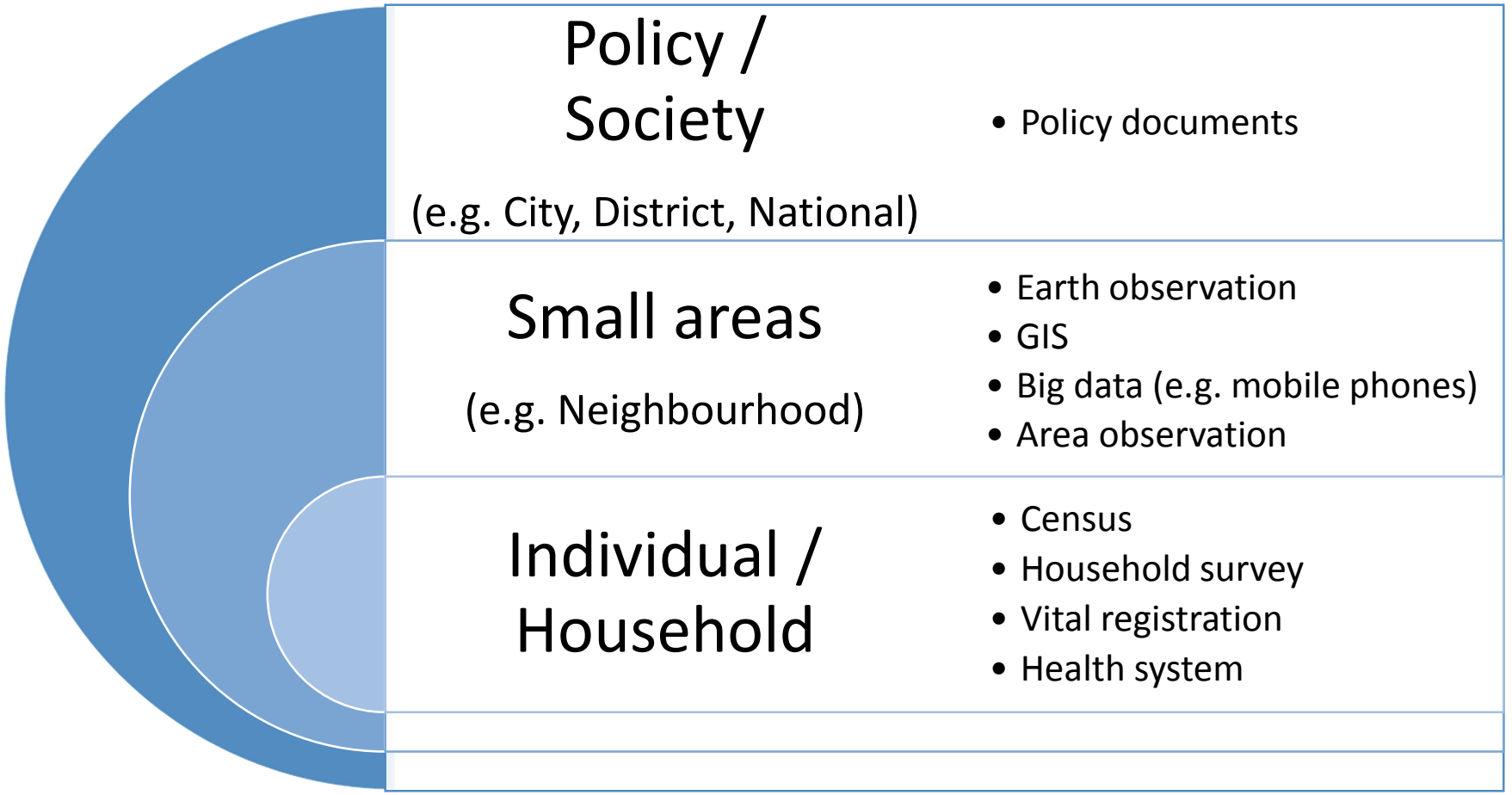


Credit: Public domain pictures

Data users

Data producers

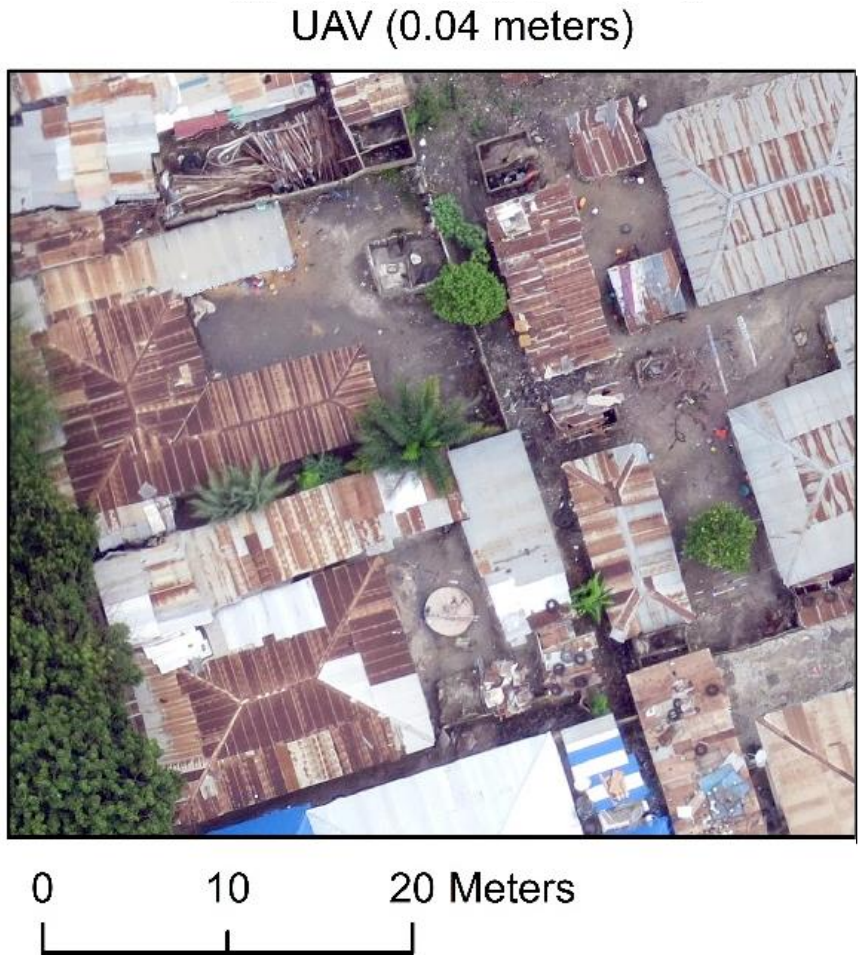
Joint framework



Slum areas
Safe recreational spaces
Open, blocked drainage

Unimproved toilet
High BMI
HH poverty

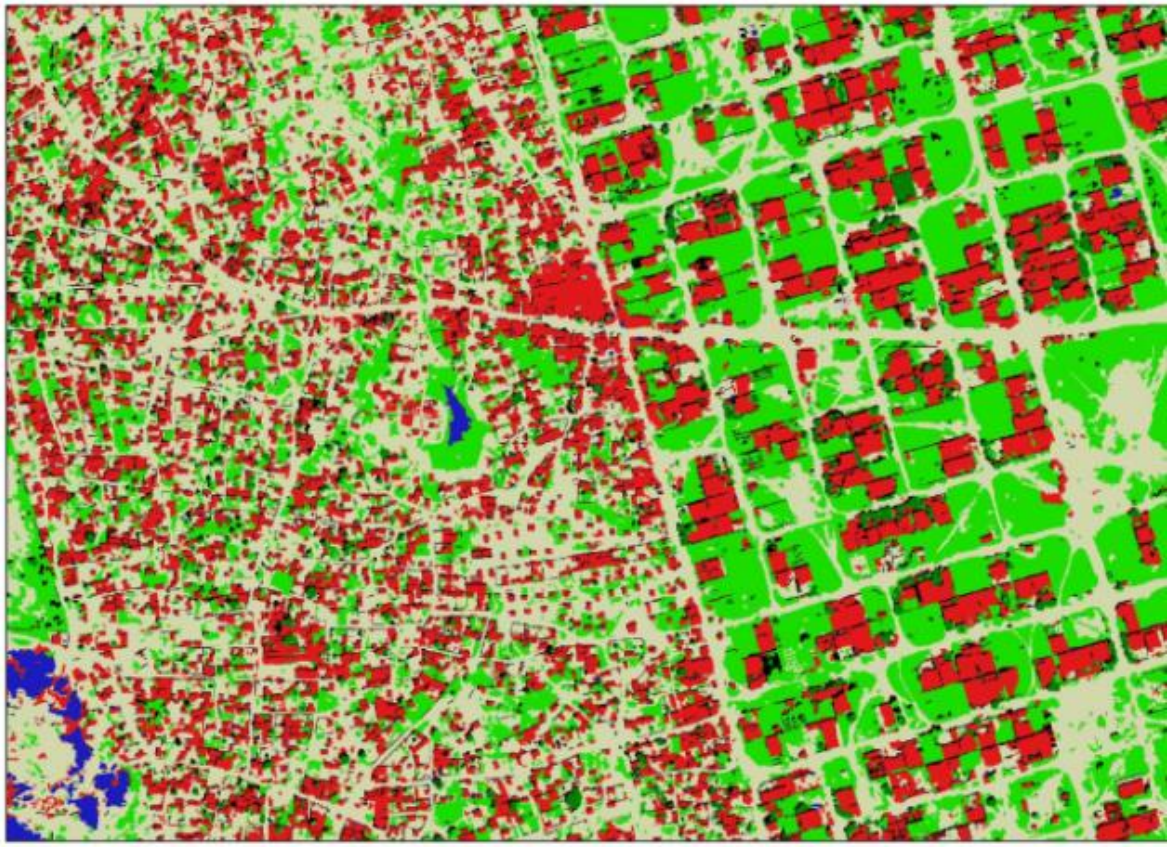
Area-level data: Earth Observation



- High Resolution imagery
- Very High Resolution imagery
- Aerial photographs
- Unmanned Aerial Vehicle (“drones”)
- Sensors

Credit: Digital Globe, Royal Museum of Central Africa, Tanzania Open Data Initiative

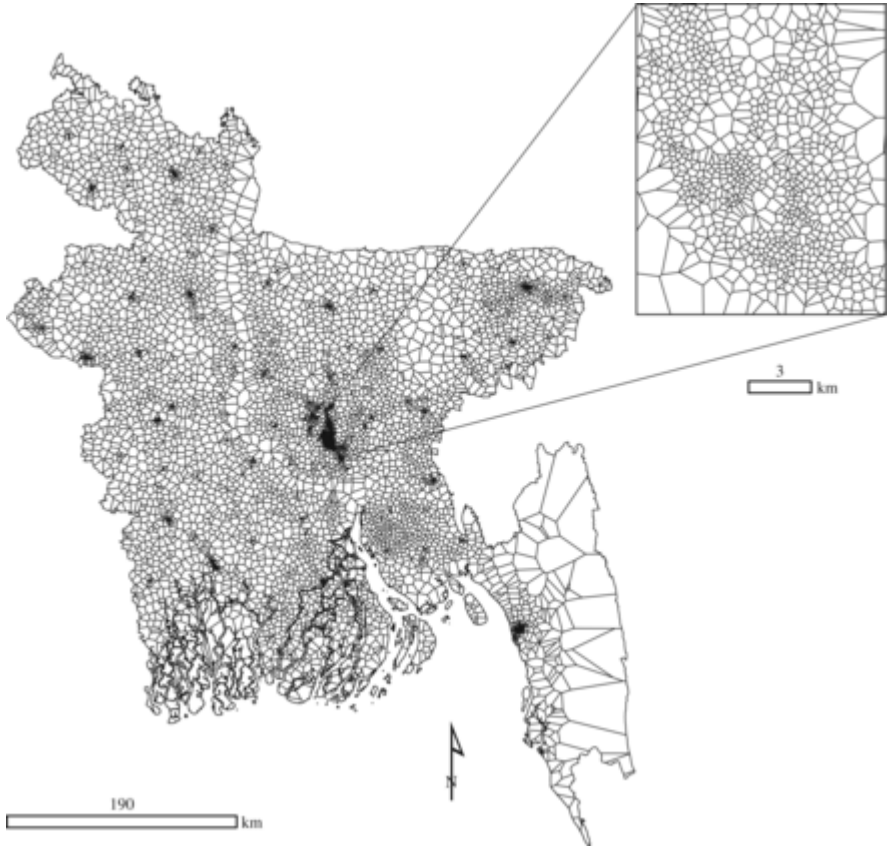
Area-level data: GIS



Credit: Wikimedia Commons, OpenStreetMap, Tais Grippa

- GPS points / traces
- Manually digitize imagery (e.g. OpenStreetMap)
- Automated feature extraction from satellite imagery

Area-level data: Big Data



- Geo-tagged tweets
- Geo-tagged Flickr images
- Aggregated, anonymized mobile phone call detail records (CDRs)

Credit: Wikimedia Commons, Jessica Steele

Area-level data: Field Observation

Credit: HERD International

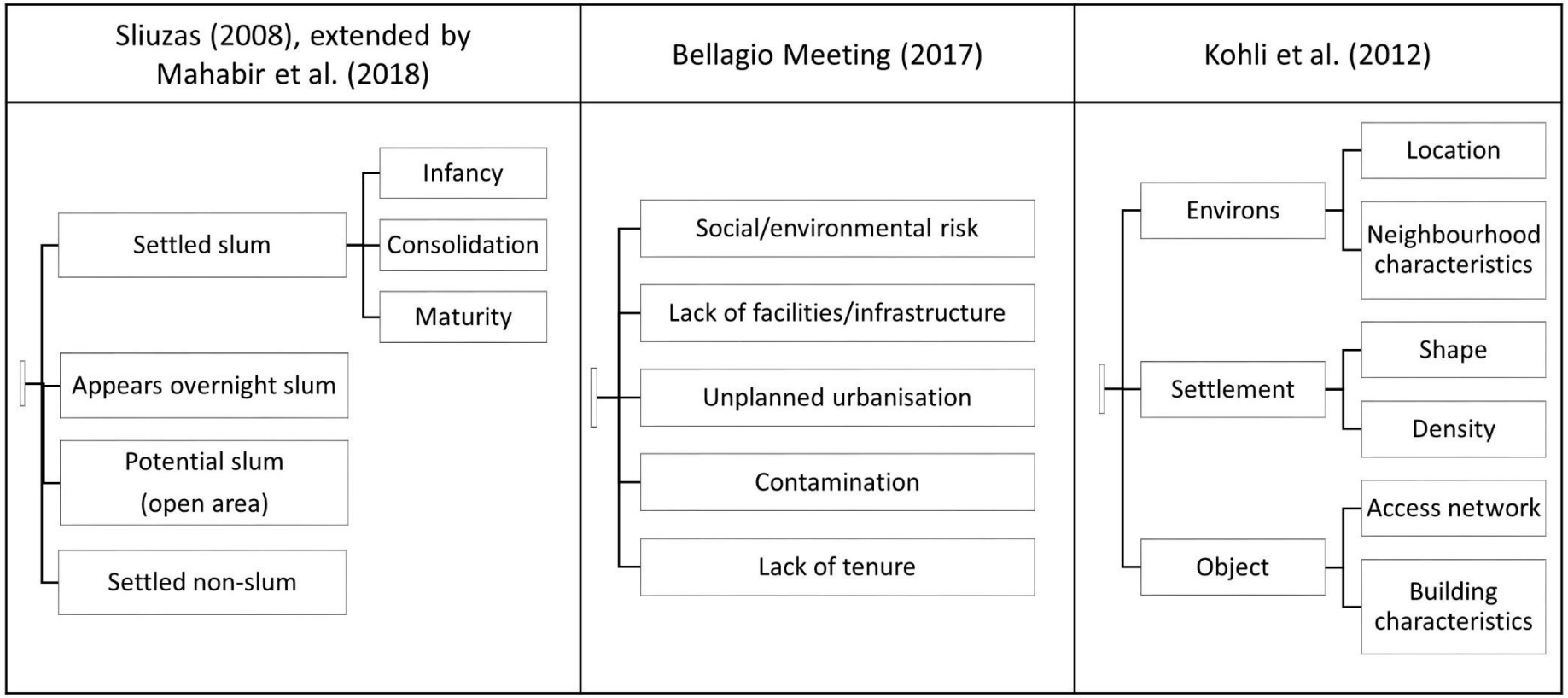
- Gold standard, laborious, expensive
- Most examples
  - Small scale studies
  - Participatory mapping exercises
- Urban health experts suggest rural, urban slum, urban non-slum
  - Classify survey clusters
  - Classify census EAs
  - Area observation form (Urban Inequities Survey & Surveys for Urban Equity)

Slum definitions

- Slum “household”: UN-Habitat
  - Lack any: durable housing, sufficient space, safe water, adequate sanitation, security of tenure
  - Measurement: household survey, census
- Slum area: NONE
  - Area physical characteristics
  - Area social characteristics
  - Context dependent, local knowledge is essential
  - Comparable across cities and countries

Credit: Wikimedia Commons

Slum area mapping taxonomies



(Slum) settlement type and time

Indicator domains

Select measurable indicators

Cox’s Bazar, Bangladesh

Infancy: few dwellings have been built on the land

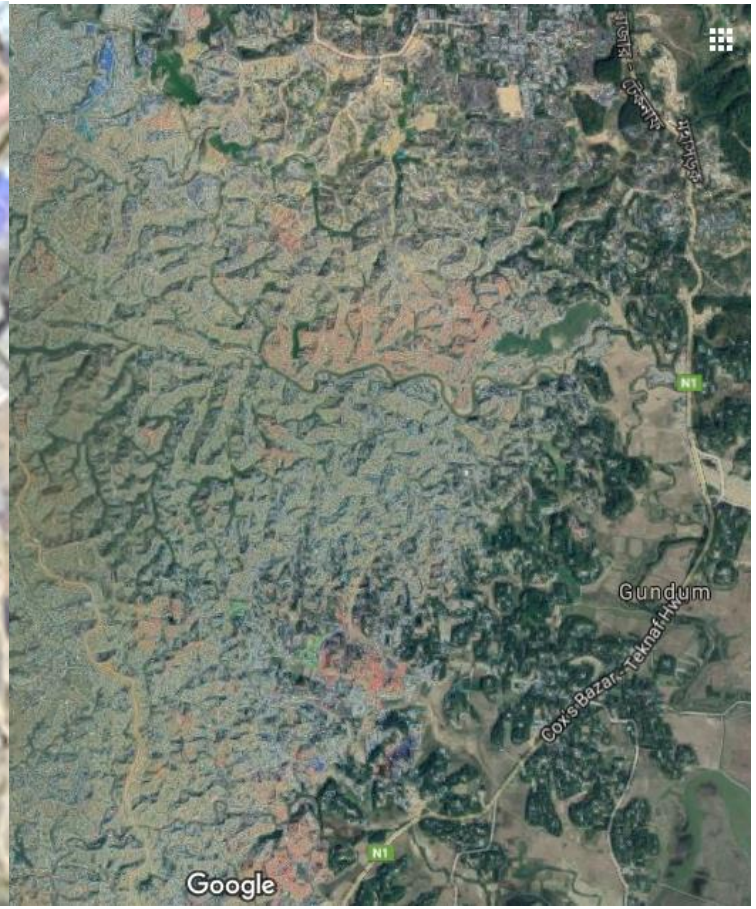
Ouagadougou, Burkina Faso

Consolidation: dwellings grow in number, settlement boundary takes shape, more services are introduced, improvements to dwelling conditions

Kuala Bandar, Mumbi, India

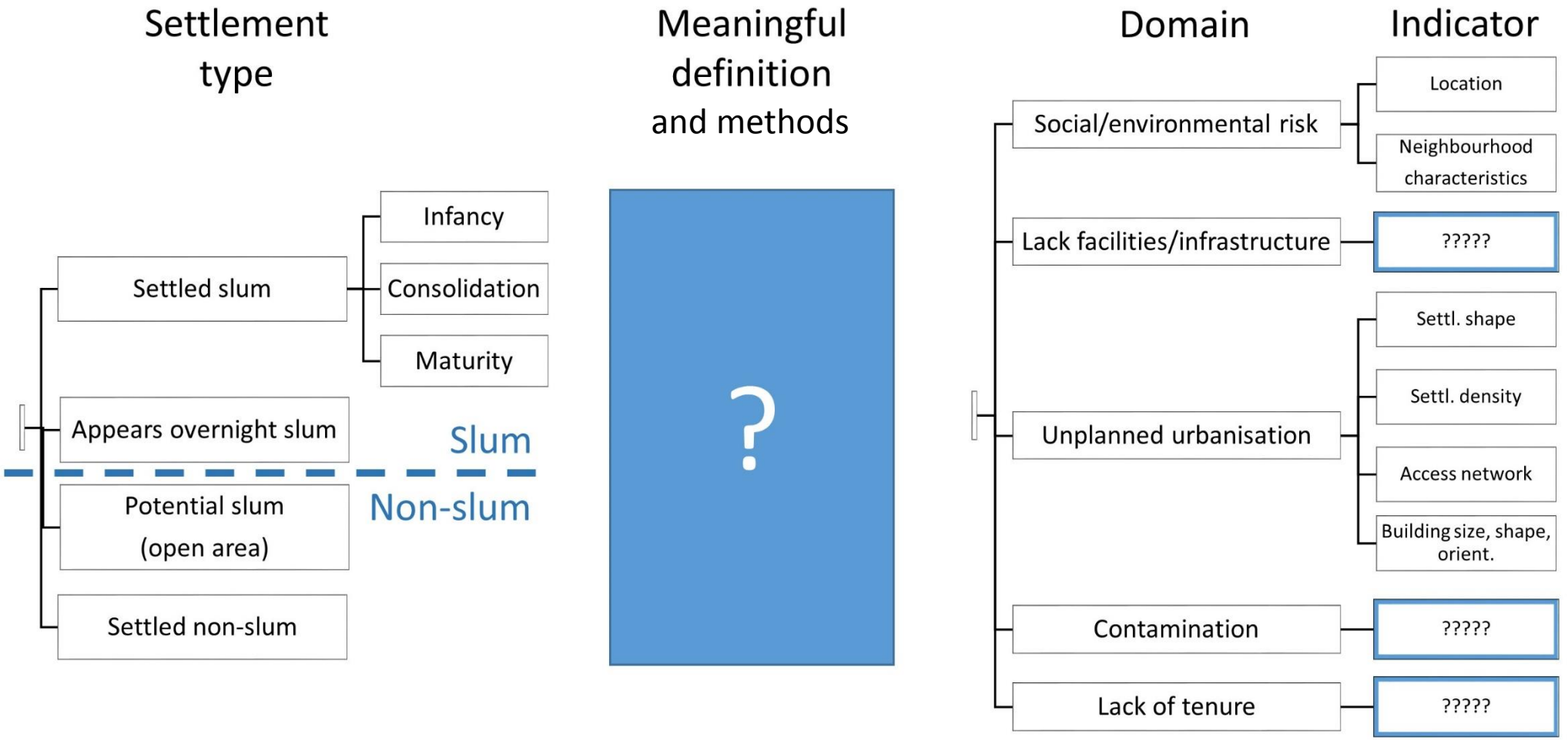
Maturity: vertical densification and demolition of dwellings may occur

Cox’s Bazar, Bangladesh



Overnight: land is occupied by residents rapidly, legally or illegally

Combined slum area mapping taxonomies



Slum area mapping methods

Aggregated census slum households

Fink et al (2014), Patel et al (2014), Snyder et al (2014)

✗ Area physical characteristics

? Area social characteristics

✗ Context dependent

✓ Comparable across cities / countries

Slum area mapping methods

Apriori satellite imagery classification

Kohli et al (2012), Kuffer et al (2016)

✓ Area physical characteristics

✗ Area social characteristics

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Slum area mapping methods

Field classification

Urban Inequities Surveys (2006), Surveys for Urban Equity (2018)

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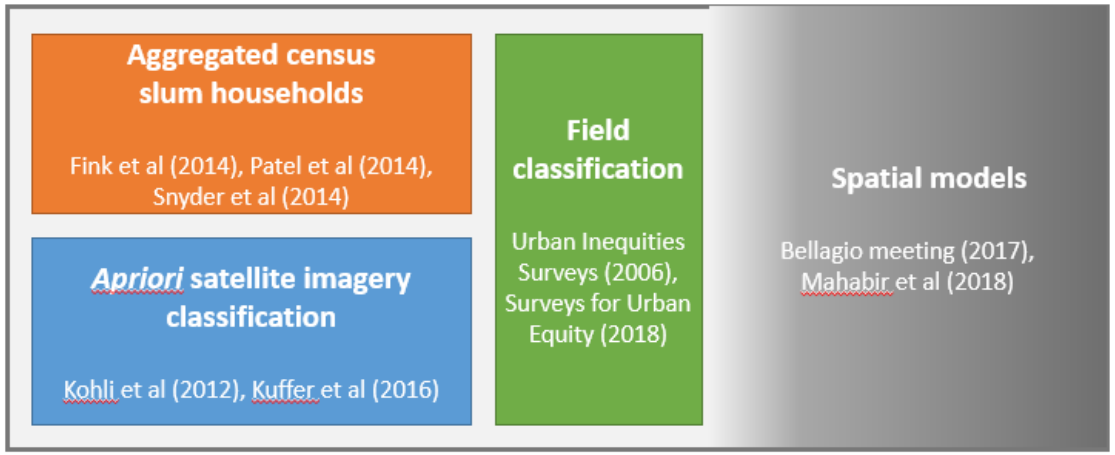
Urban Inequities Surveys (2006), Surveys for Urban Equity (2018)

Spatial models

Bellagio meeting (2017), Mahabir et al (2018)

Slum area mapping methods



- ✓ Area physical characteristics
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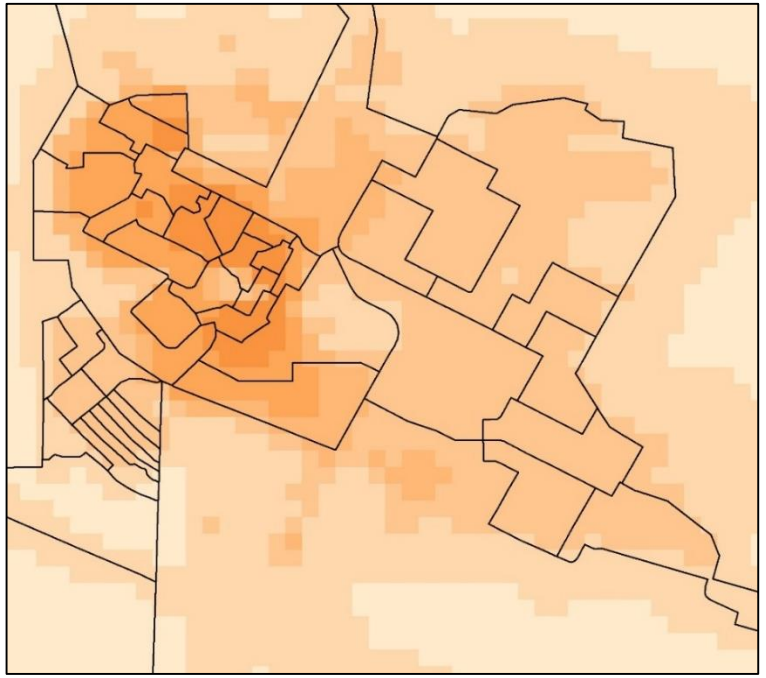
Spatial models



- Methods
  - Decision trees (e.g. Random Forest)
  - Deep learning (e.g. pattern recognition)
  - Geostatistical modelling
- Strengths
  - Accommodate multiple covariates with different resolutions and formats
  - Models trained with ground-referenced input data reflecting local context
  - Possible to extrapolate into unmeasured similar cities, countries, years
  - Leverage each of our strengths
    - Health experts – define model inputs and outputs
    - Data scientists – apply specialized data infrastructure, methods

Considerations

- Requires sizable funding and complex collaborations – e.g. Gates / DIFD
- Slum area outputs may need to be further “packaged” for users
- NSA involvement end-to-end is key for accuracy and usability
- Address VERY common concern among users: privacy in EO & big data
  - Transparency in methods
  - Caution mapping vulnerable areas (e.g. resolution, vector vs raster boundaries)

Thank-you!

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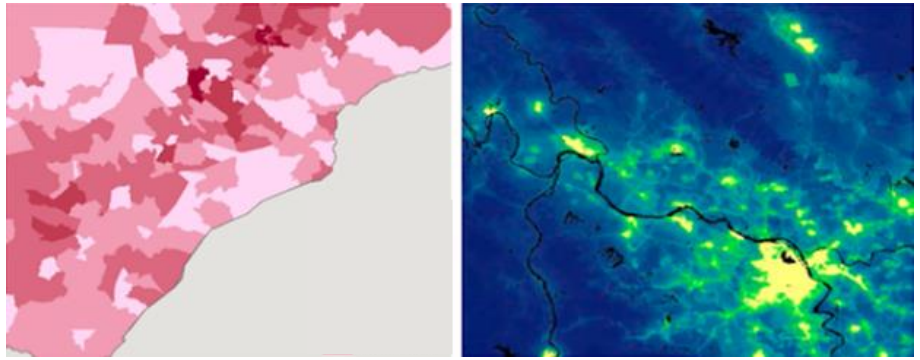
GRID3

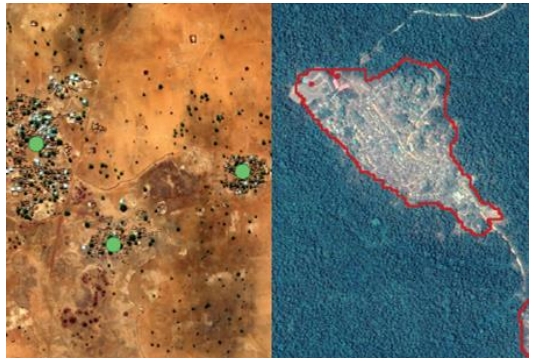
GEO-REFERENCED INFRASTRUCTURE AND DEMOGRAPHIC DATA FOR DEVELOPMENT

GRID3 provides support to low- and medium-income countries to collect, analyse, integrate, disseminate, and utilise high-resolution geo-referenced data for development and humanitarian decision making.

High-Resolution Population Maps



Settlement Locations



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Center for International Earth Science Information Network
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Acknowledgement

Making People Who Live in Slums Count
Bellagio, Italy | 20-23 November 2017

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Area-Level Indicators for Urban Health

International Conference on Urban Health 2018

Dana R. Thomson

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Acknowledgement

Surveys for Urban Equity Project
2017-2019 Kathmandu, Dhaka, Hanoi

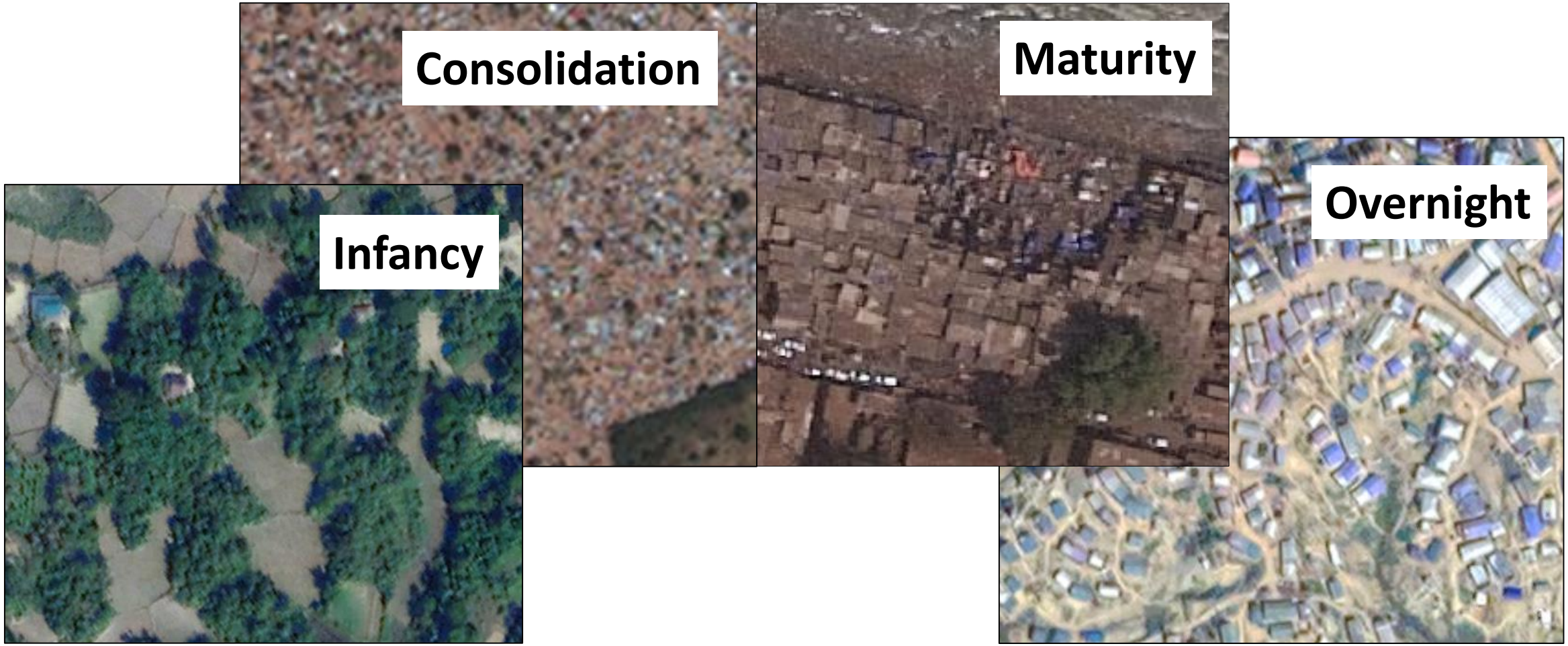
Development & Evaluation of Novel Survey Methods

To more accurately sample poor and vulnerable households in complex urban settings

Dana R. Thomson, Sushil Baral, Mashreky Saidur, Hoang Van Minh, Helen Elsey, Radheshyam Bhattarai, Rajeev Dhungel, Subash Gajurel, Sushil Singh, Shraddha Manandhar, Sudeepa Khanal, Silvia Junnatul Ferdoush, Tarana Ferdous, Duong Minh Duc, Nguyen Bao Ngoc, Ak Narayan Poudel

Acknowledgement

Discussion 1: Can we train an algorithm to distinguish these slum settlement types? If not, why?



Discussion 2: Which prominent slum area feature datasets exist, or could be created?

Social / environmental risk

- No green/open recreational spaces
- Standing grey-water
- Opened and/or blocked drains
- Evidence of flooding or landslides

Lack facilities / infrastructure

- Few school and health facilities
- Lack functioning street lights

Unplanned urbanisation

- Non-permanent building materials
- Small, disorganized buildings
- Close proximity of buildings
- Narrow paths with no vehicle access

Contamination

- Faecal matter in drains, roadside
- Open dumping of garbage
- Smokey, dusty air

Lack of tenure

- Area not zoned for residence

Discussion 3: What minimum area (eg 100m X 100m) & minimum population (eg 50 ppl) define a slum area?

E.G. National Housing Authority of Thailand:
minimum of 30 housings units per 1,600 square meters

Discussion 4: For what purpose do users need slum area maps?

National Statistical Agency	*Disaggregate census/survey*
Ministries	*Planning, policy-making, evaluation*
Municipal Governments	*Planning, policy-making, evaluation*
Civil society	*Local advocacy*
International organizations	*Global advocacy*
NGOs / private / other providers	*Target interventions, evaluation*
Academia / research institutions	*Research*

References

Urban indicators

- Cities Alliance (2002)
- Habitat Agenda (2006)
- Urban HEART (2010)
- SDGs (2018)
- Surveys for Urban Equity (2018)
- Pineo et al. (2018)
- Hoornweg & Bhada-Tata (2012)

Slum mapping

- Expert meeting (2002)
- Expert meeting (2008)
- Expert meeting (2017)
- Fink et al (2014)
- Patel et al. (2014)
- Snyder et al. (2014)
- Kohli et al. (2012)
- Kuffer et al. (2016)
- Ezeh et al. (2017)
- Steele et al. (2017)
- Mahabir et al. (2018)