Mapping access to safe water and sanitation in LMICs: Implications for Disease Control

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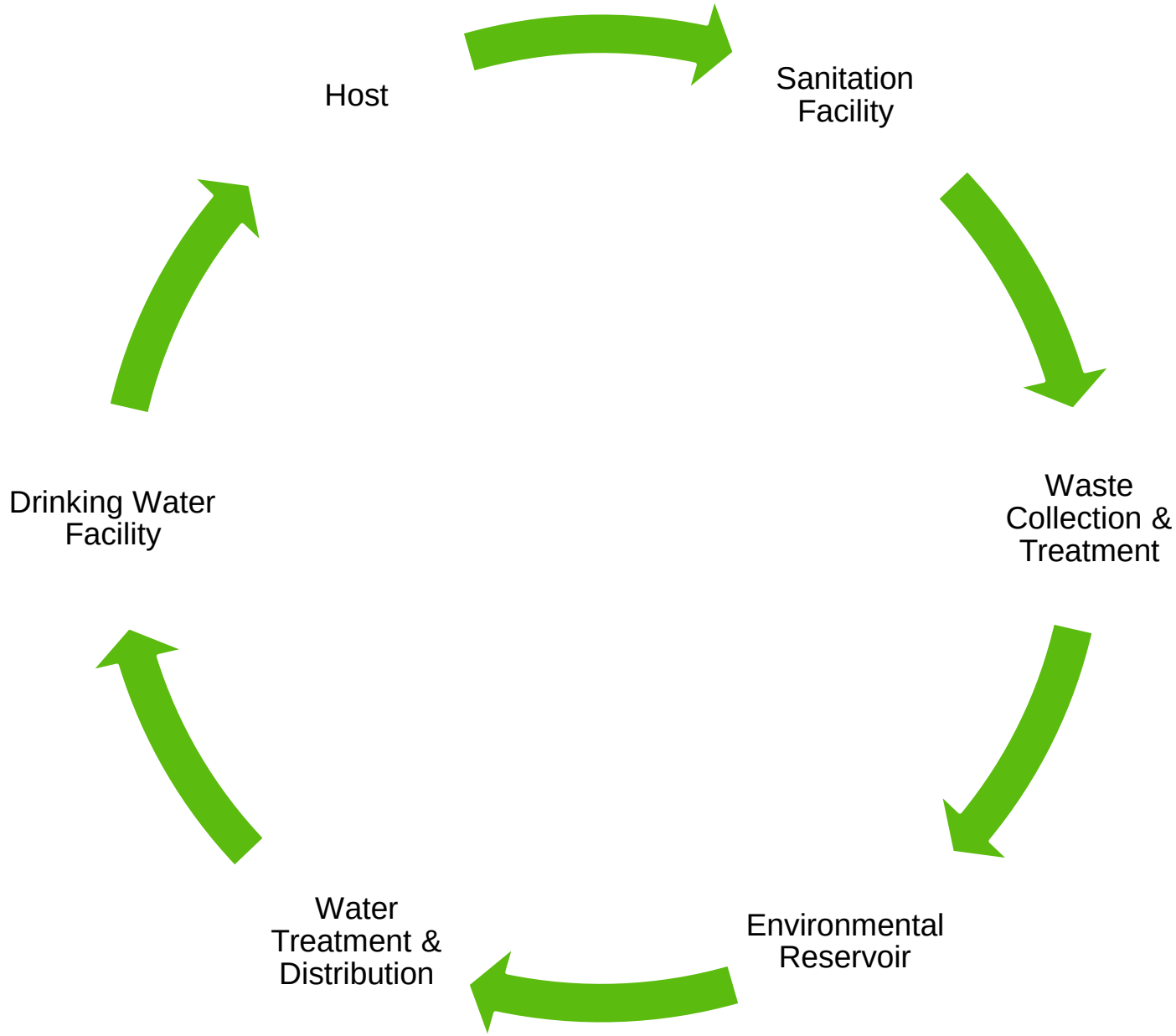
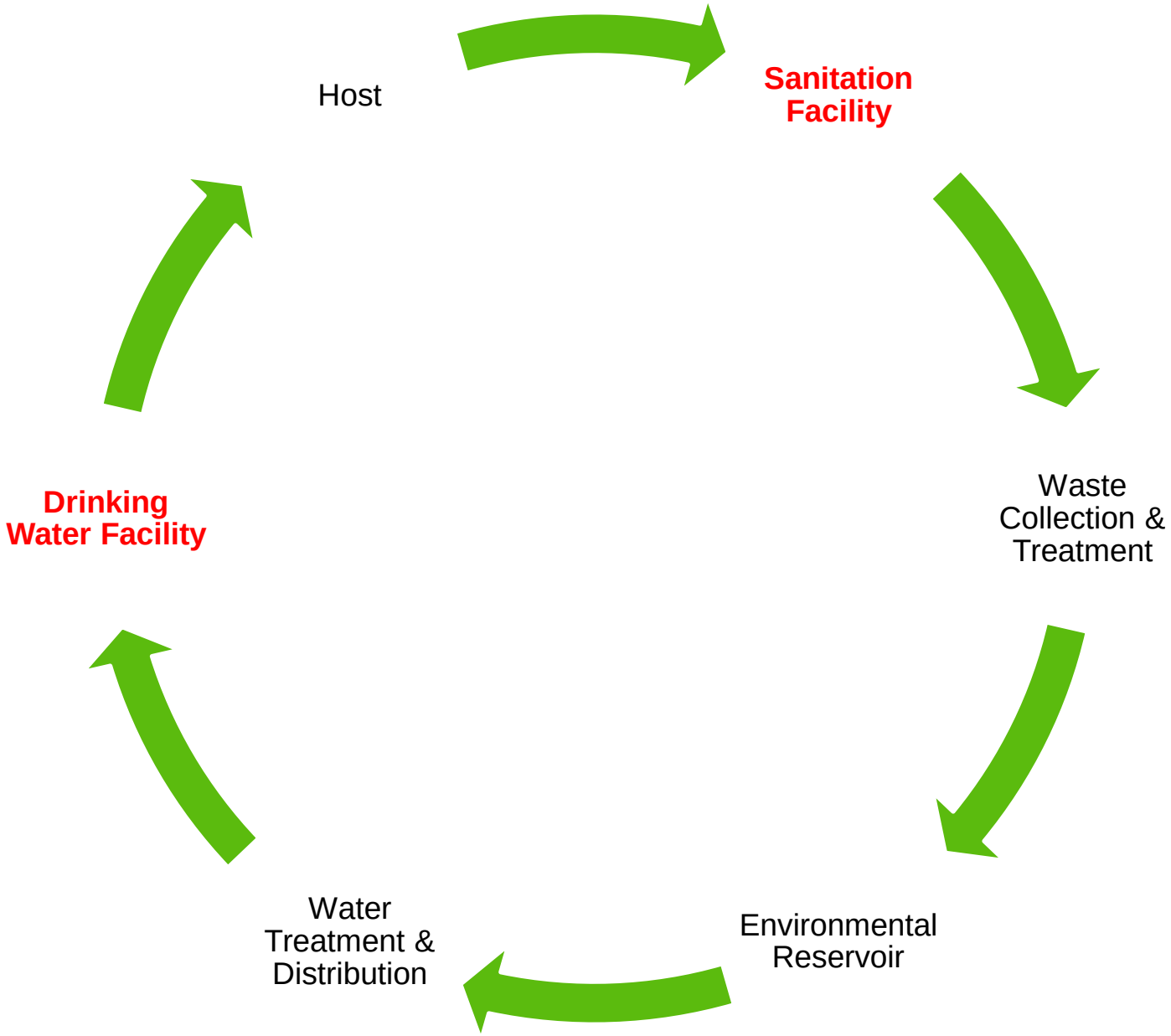
Motivation

- Unsafe water & sanitation (WatSan) is the third leading risk factor for under-5 mortality, largely caused by enteric diseases according to the Global Burden of Diseases, Risk Factors, & Injuries Study (GBD 2017)
- WatSan interventions can be targeted to prevent exposure to enteric pathogens and reduce disease burden and outbreak vulnerability
- WatSan access is a measure of environmental risk exposure to populations and provides insight into transmission dynamics of fecal-oral pathogens


Host
Sanitation Facility
Waste Collection & Treatment
Environmental Reservoir
Water Treatment & Distribution
Drinking Water Facility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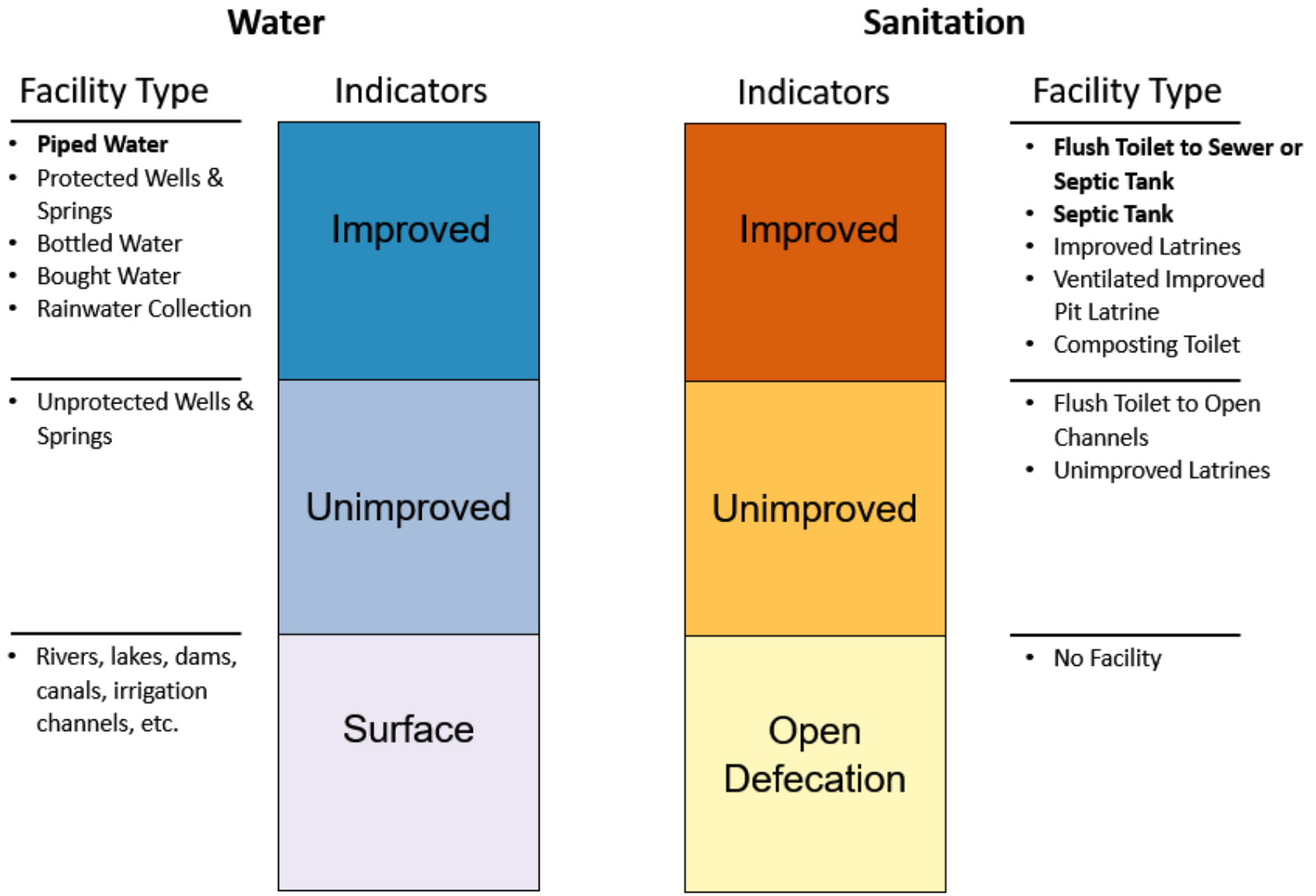
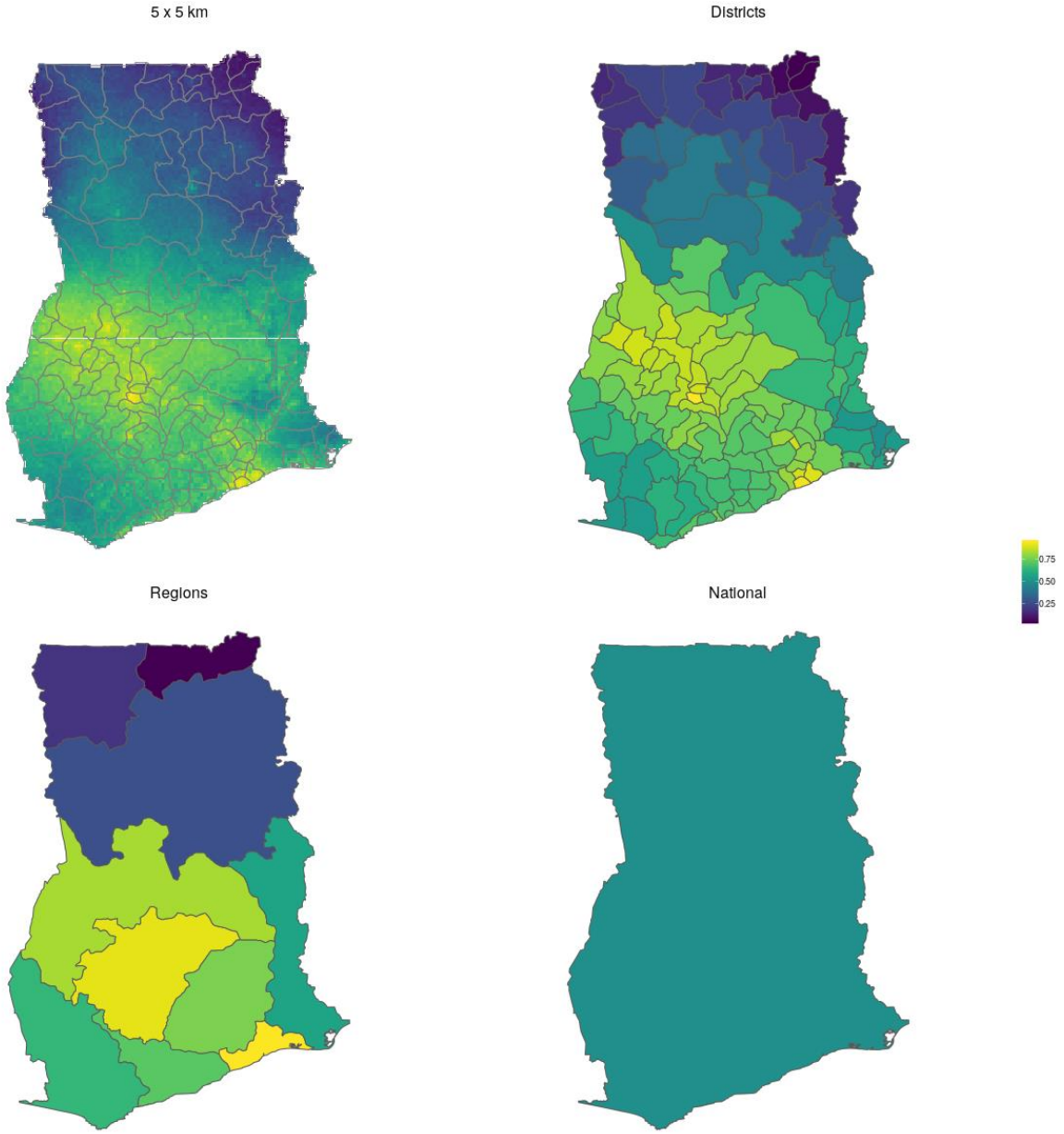
Facility Types



Why use a geospatial approach?

- Use all available information in a single cohesive analytical framework (data at all spatial scales)
- Leverage inherent spatial and temporal trends not accounted for in alternative approaches
- Measure geographic equity and target interventions at local scales
- Produce results that can be aggregates to the area of interest
  - Disease transmission isn't confined to politically defined boundaries
  - Environmental reservoirs can span irregular areas

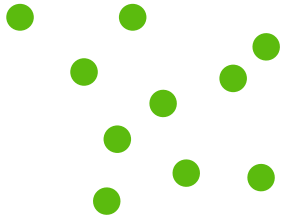

5 x 5 km
Districts
Regions
National
0.75
0.50
0.25

Data sources

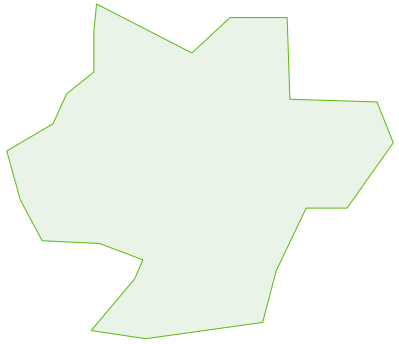
- **Environmental data**
- **National and subnational surveys**
- **Census information**
- **Program information**
- **Scientific literature**

Geospatial Data

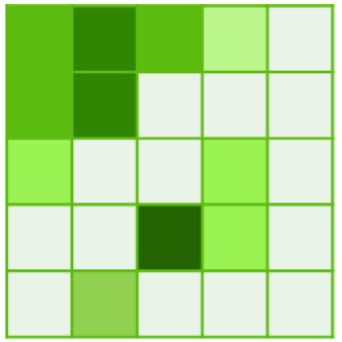
- **Point**
  - GPS coordinates
  - Infinitesimal representation



- **Polygon**
  - Aerial representation. Typically mean over a region.
  - Typically via data matched to admin shape files



- **Raster**
  - Data discretized over continuous space, represented by pixel values in a bitmap
  - Covariates and outputs

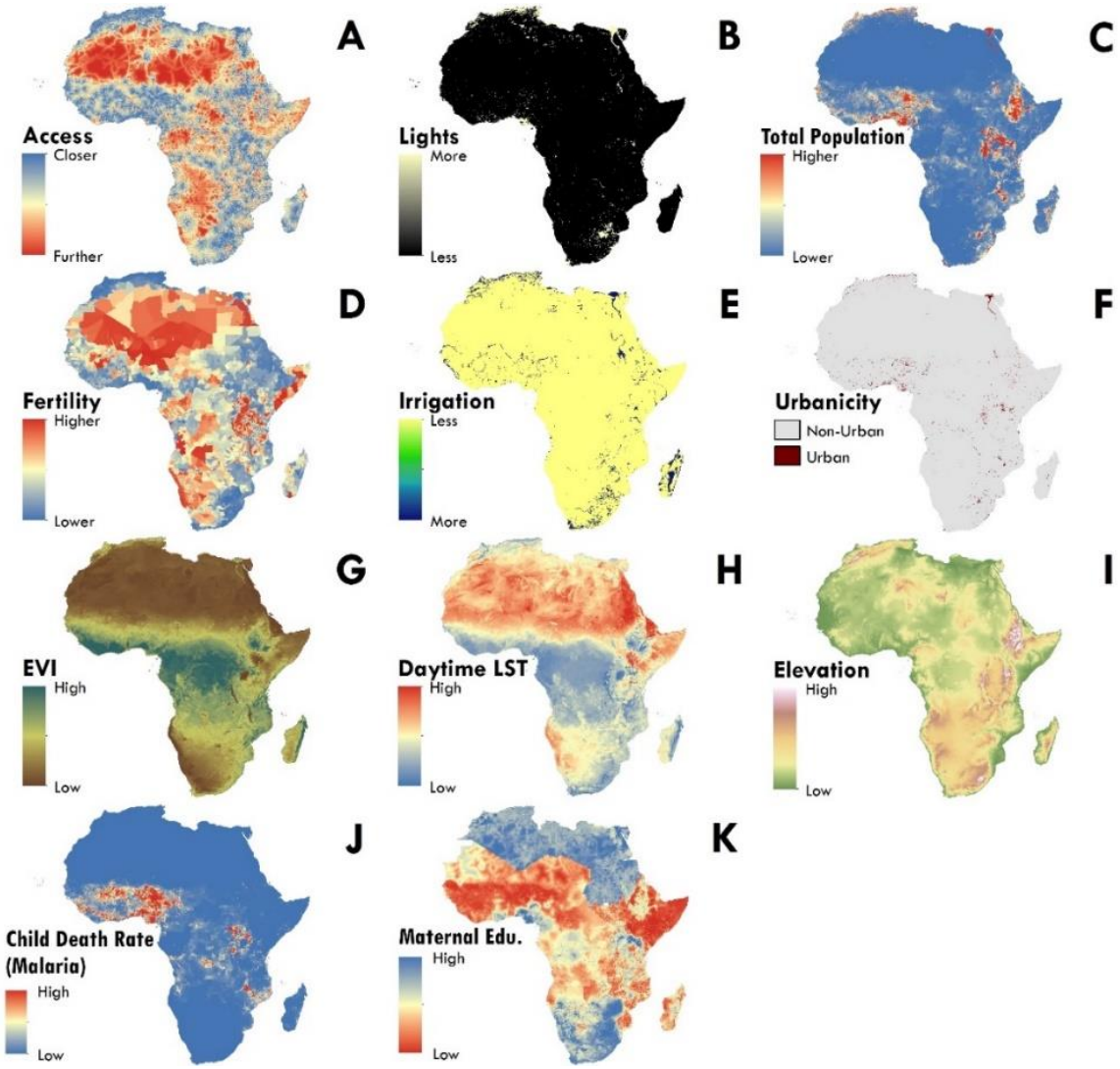


Model-based geostatistics

Covariates

- The Local Burden of Disease project is home to a continually growing **spatial covariate repository**

- Both **external** (e.g. satellite data) and **internal** (i.e. model outputs) covariates available, in a standardized format

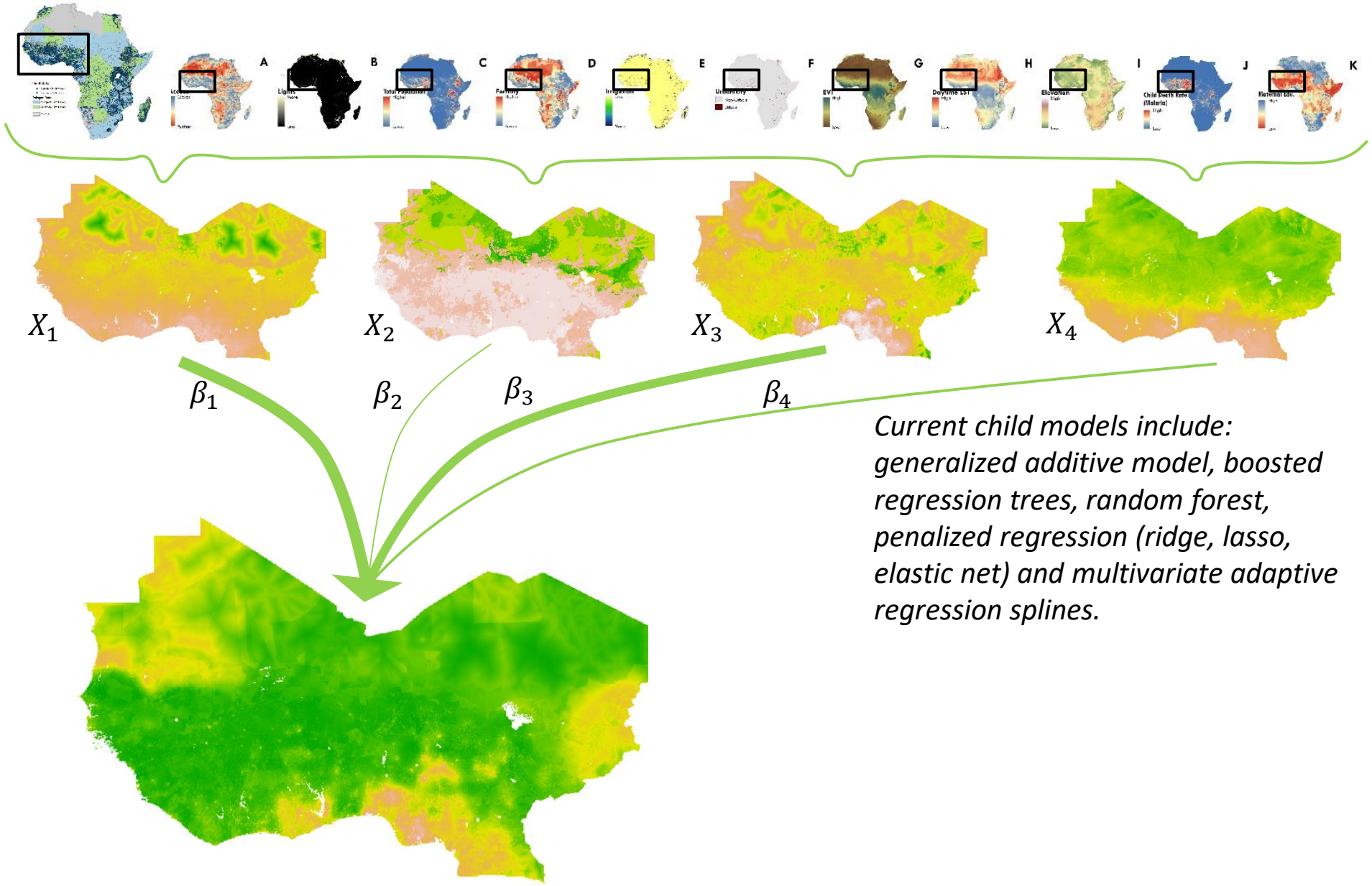


Data + Suite of covariates

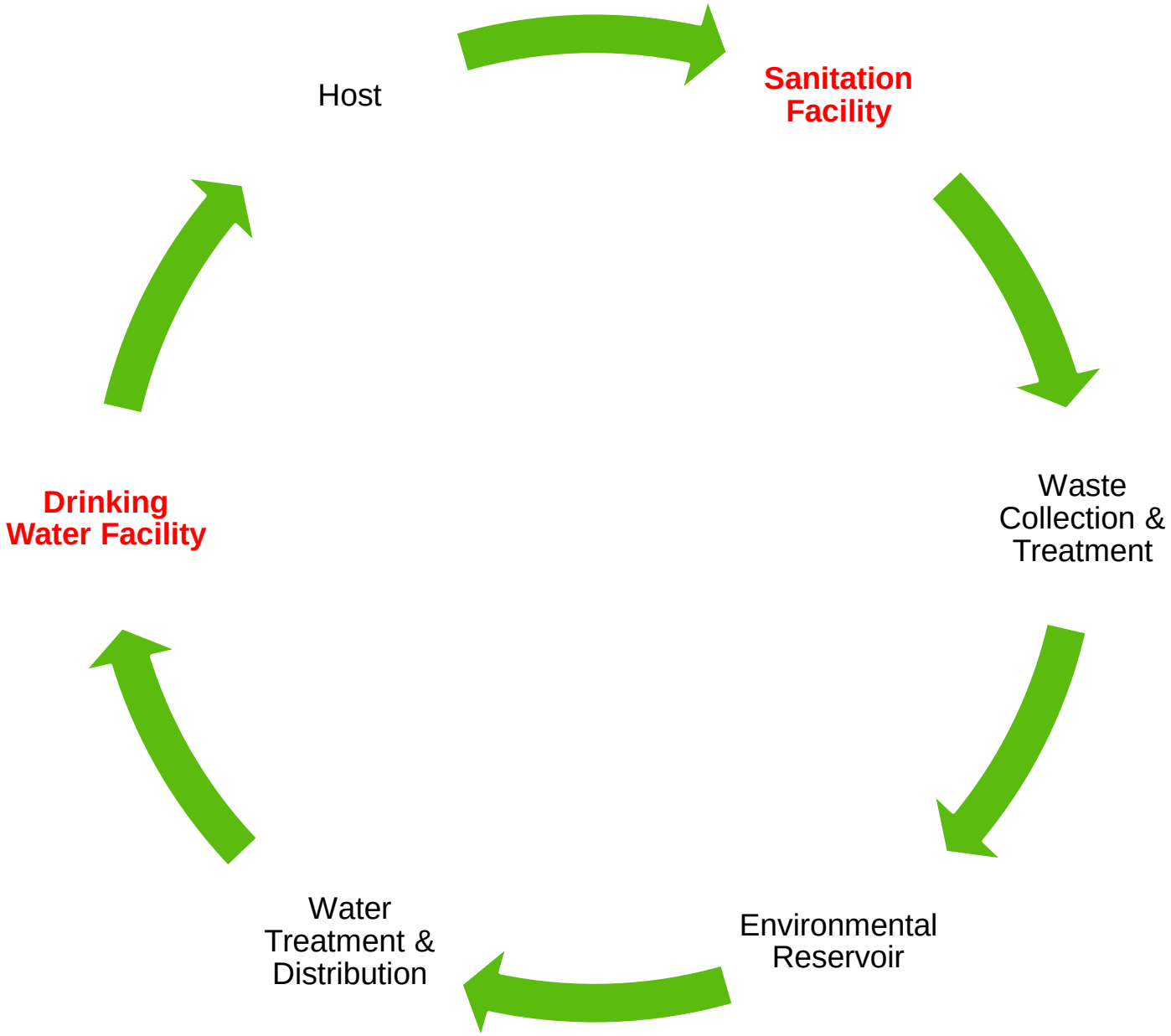
Fit many ‘child’ models to data

Fit a new model to the data, using child models as covariates

Repeated for every age bin, region, year



Current child models include: generalized additive model, boosted regression trees, random forest, penalized regression (ridge, lasso, elastic net) and multivariate adaptive regression splines.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Applications of WASH Mapping

- Monitoring progress towards SDG 6 for universal access
- Identifying locations for targeting interventions of infrastructure development or risk mitigation
- Assessing vulnerability to enteric disease outbreaks and the burden of endemic diarrheal diseases

BILL & MELINDA GATES foundation

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