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Social, Urban, Rural & Resilience

Spatial Disaggregation of Gross Domestic Product

An innovative method for producing high resolution economic activity information for Disaster Risk Management

Paul Baptiste Blanchard, Brian Blankespoor, Johanan Rivera-Fuentes, Rashmin Gunasekera, Oscar Ishizawa, Luis Felipe Jiménez (working paper in preparation)

DISASTER RISK MANAGEMENT AND RESILIENCE
Global Solutions Group

CAPRA
Probabilistic Risk Assessment Program

Australian Aid

Summary

1) Context and motivations

2) Methodology

3) Visualizing disaggregated GDP

4) Strengths and limitations

5) Applications in Disaster Risk Management

6) Q&A

Context and Motivations

- Spatial component of disaster risk assessment
- Economic risk analysis → Gross Domestic Product (GDP)
- Spatial mismatch hazard-exposure
- Poor statistical capacity in developing countries + informal activities
- Non-agricultural component of GDP : different spatial structure.

→ *Objectives*:

1) Model a measure of economic activity at a fine resolution
2) Scalability

- Why GDP?

  - "Monetary value of all goods and services produced in a country in a given period of time" (IMF)

  - Economic performance

  - GDP : refers to location (≠GNI) = spatial measure

- Accounting VS Spatial measure:

  - National accounts measure: Production, Income, Expenditure

  - Spatial: Production AND Consumption

  → workers, built-up areas, infrastructures… (non-agricultural)

  ⚠ Scale considered !

Methodology

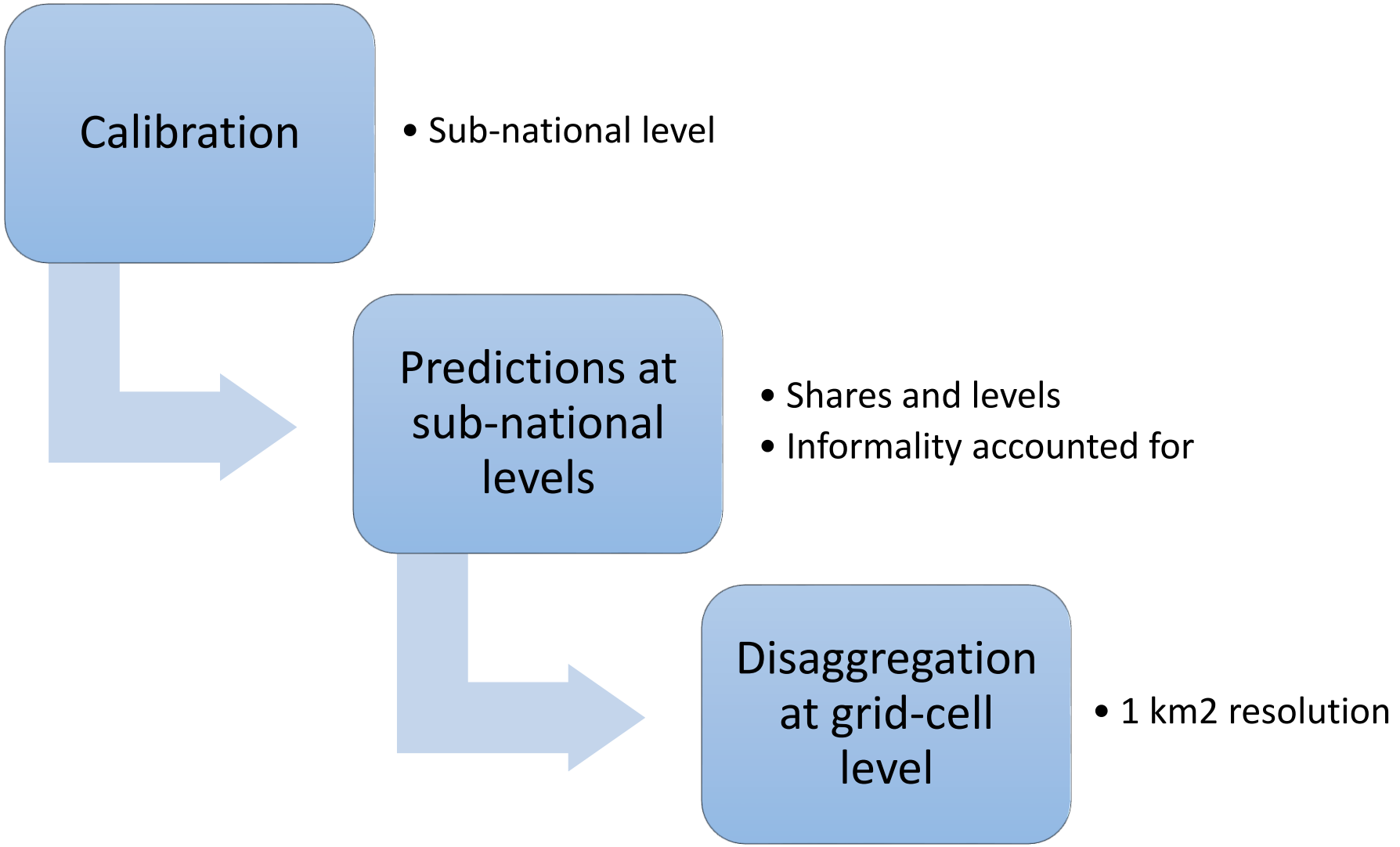
- *Challenges*:

  - Predict GDP at a scale different than GDP data observations

  - Limited number of relevant indicators at cell level

  - Measurement errors (including informality)

  - Comparability of GDP values from country to country


Calibration
• Sub-national level
Predictions at sub-national levels
• Shares and levels
• Informality accounted for
Disaggregation at grid-cell level
• 1 km2 resolution

- *Use of OECD GDP data*

  - more reliable data

  - lower informal shares

  - larger sample size

→ Consistency

- *Calibration of a distribution model at the sub-national level*

  - ~~conversion issues~~

  - gets rid of some country fixed effects

- *Assumptions:*

  - External validity assumption → correct specification, same underlying "true model"

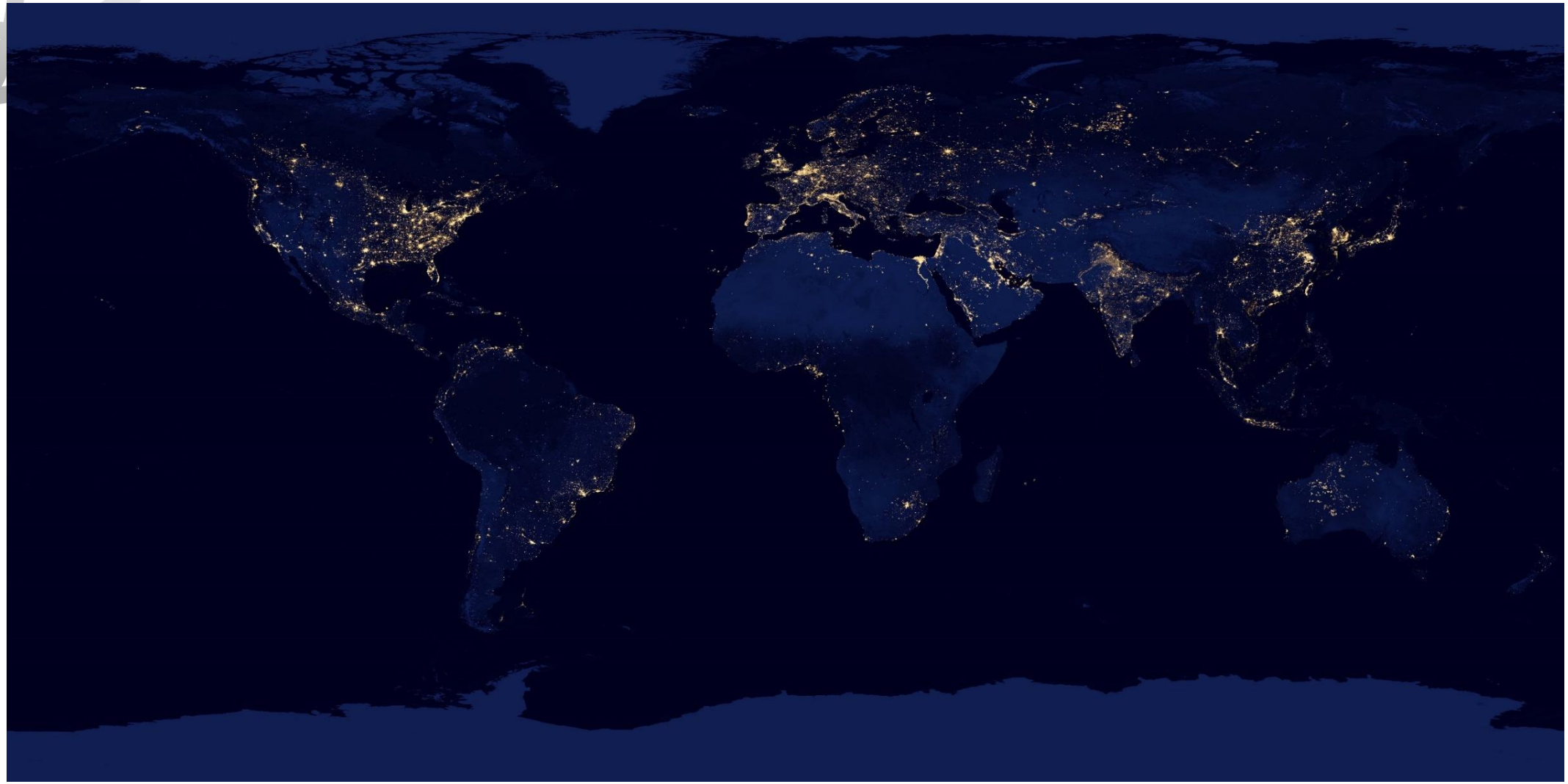
  - Model "blind" to the nature of the production (formal VS informal)

- *Comparison OECD/LAC : expected results.*

  - comparable estimates

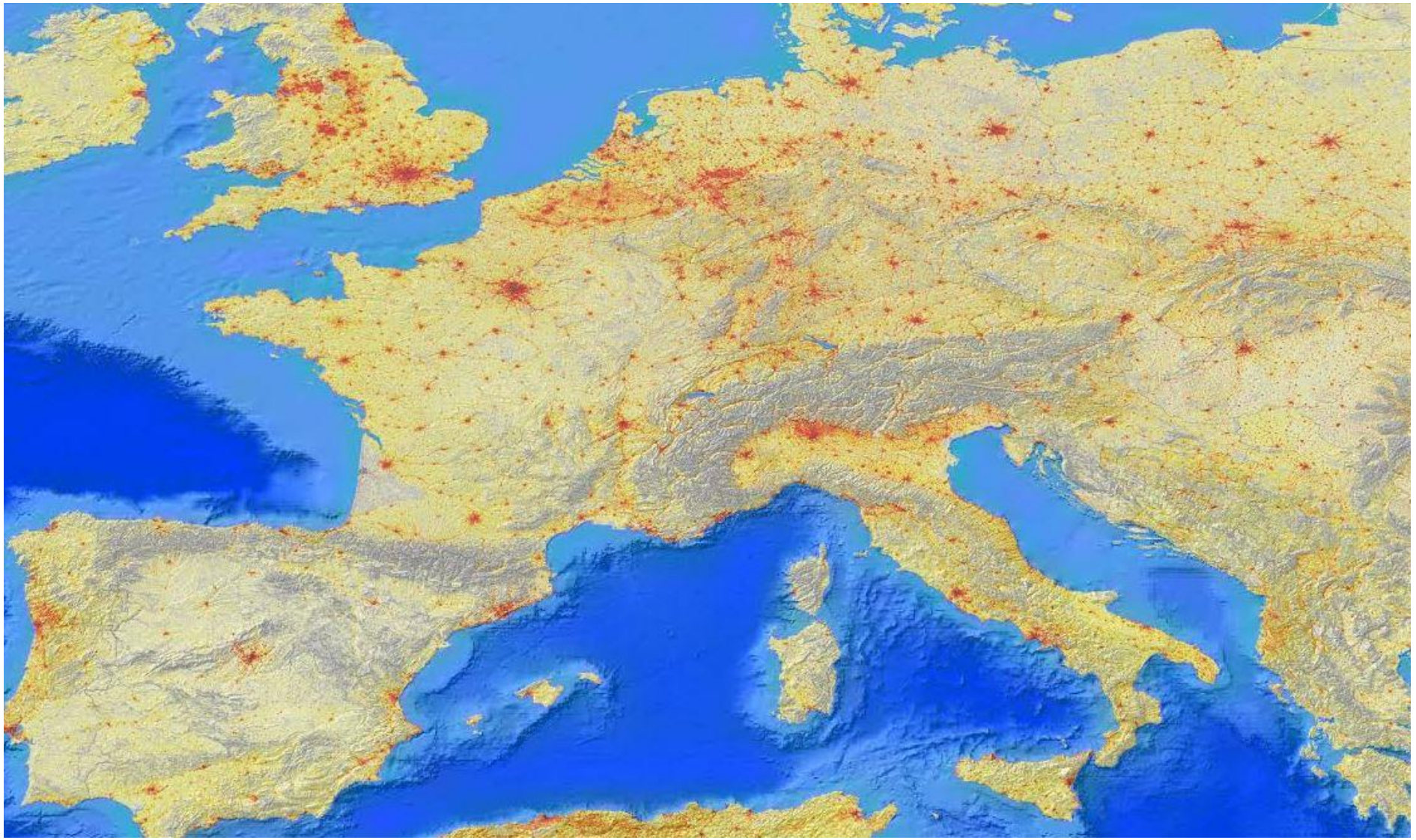
  - higher standard errors

  - lower goodness-of-fit



Night time lights global map, 2014 (NOAA).

Night time lights Western Europe map, 2014 (NOAA).



Population Western Europe , 2014 (LandScan).

Data sources and compilation

Variable	Source	Observations
GDP	National Statistical Institutes WDI	OECD+LAC countries
Population	LandScan	Global
Nighttime lights (radiance calibrated)	NOAA	Global

- GDP data matched with GADM boundaries
- Gridded data aggregated up at corresponding administrative levels
- Urban shares from WDI
- Urban categories by population density

Specification

- *Set of specifications*:

  - calibrated on both LAC & OECD data sets

  - pooled OLS

  - combination of different urban categories, quadratic terms, interaction terms, various functional forms

- *Main findings*:

  - Core urban centres unambiguously highly productive

  - Rural areas less productive (non-agricultural)

  - Lights/Population weakly correlated in secondary cities/sub-urban areas → lights=control for productivity

- *Final specification* :

  - share of core urban centres population

  - interaction between share of population in less dense areas and corresponding share of night lights

  - share of rural nighttime lights

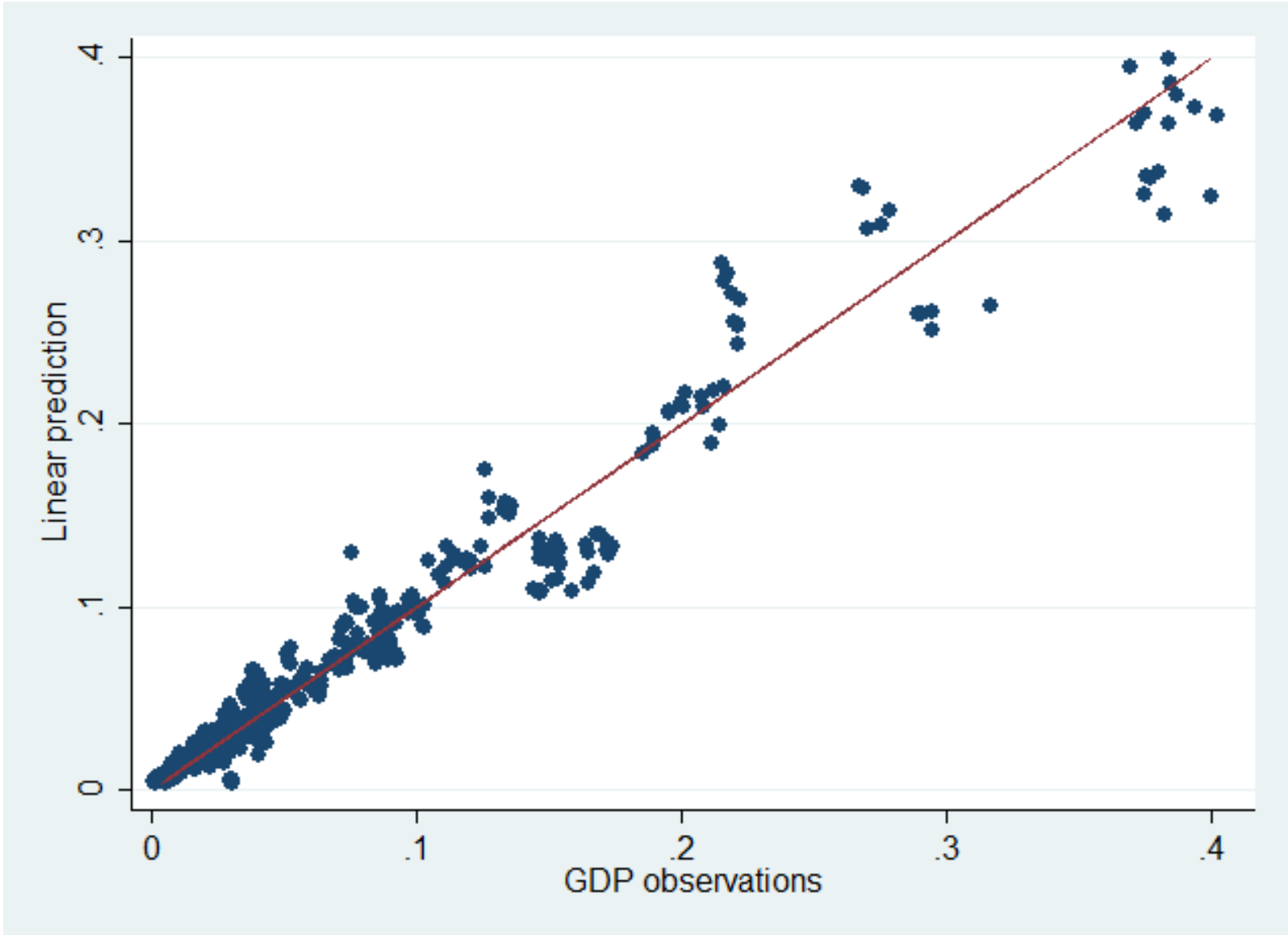
  - trade-off explaining power VS risk of overfitting

- *Results* :

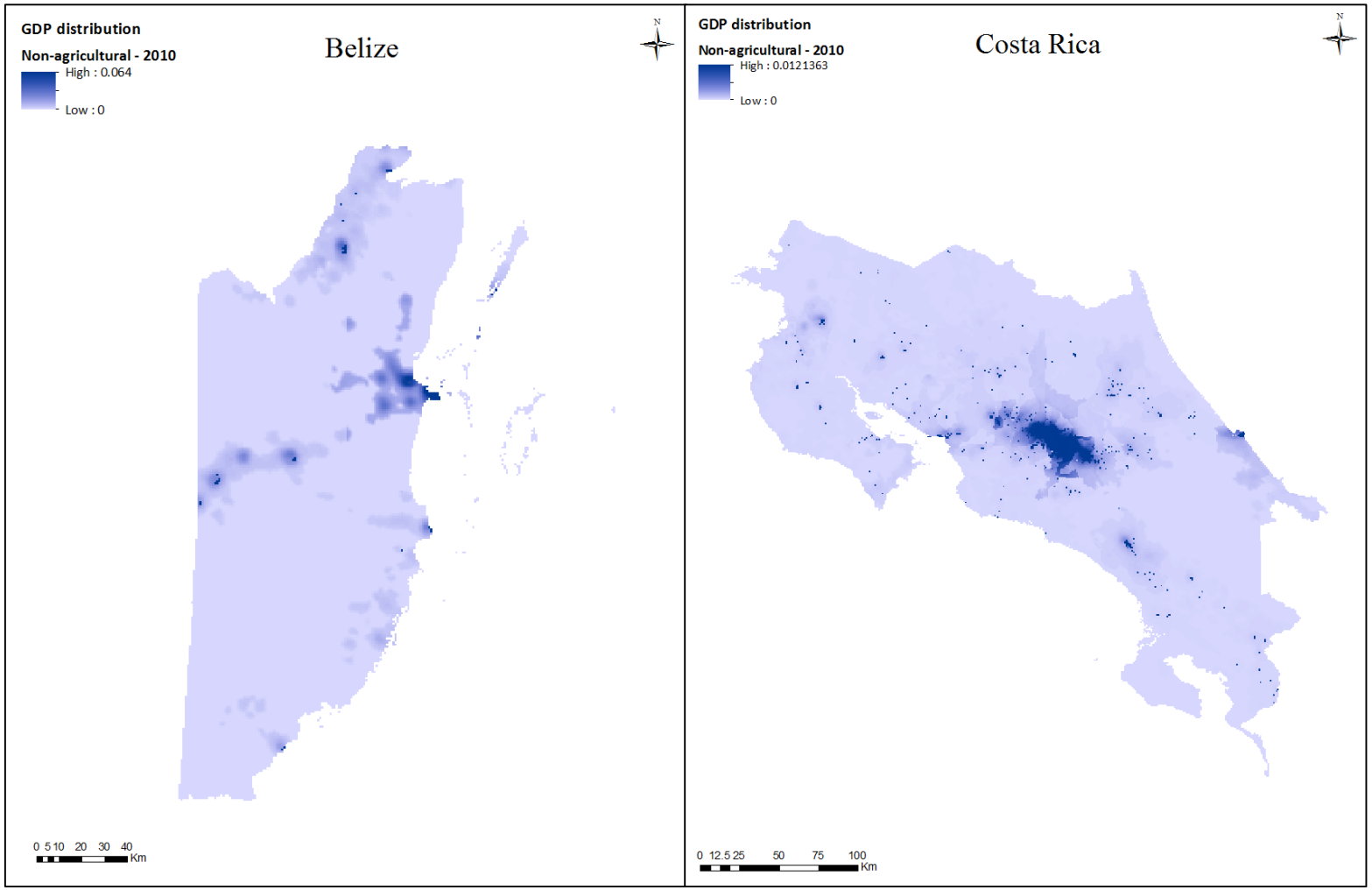
  - (adj.)$R^2 \approx 0.96$ for OECD and lower for LAC

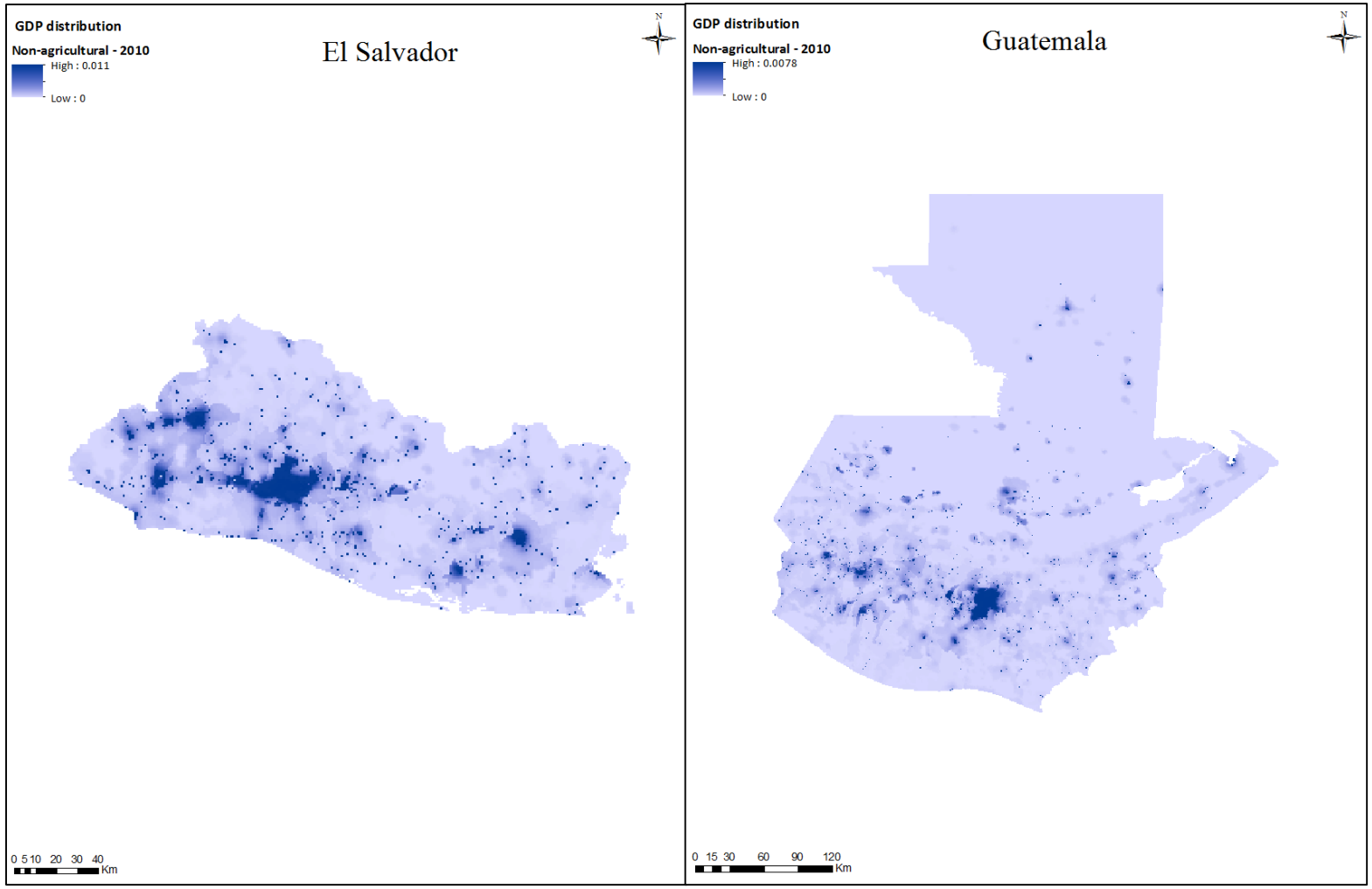
  - comparable estimates

  - higher standard errors


Linear prediction
0
.1
.2
.3
.4
GDP observations
0
.1
.2
.3
.4

Visualizing disaggregated GDP


GDP distribution
Non-agricultural - 2010
High : 0.064
Low : 0
Belize
N
0 5 10 20 30 40
Km
GDP distribution
Non-agricultural - 2010
High : 0.0121363
Low : 0
Costa Rica
N
0 12.5 25 50 75 100
Km


GDP distribution
Non-agricultural - 2010
High : 0.011
Low : 0
El Salvador
N
0 5 10 20 30 40
Km
GDP distribution
Non-agricultural - 2010
High : 0.0078
Low : 0
Guatemala
N
0 15 30 60 90 120
Km

- *Disaggregated GDP package*:

  - non-agricultural GDP grids (0.83’ ≈ 1 km^2)

  - sub-national GDP tables (regional, municipal)

  - distribution (%) + different metrics (constant, current, LCU, $...)

  - Informality adjustments (Schneider et al.,2010)

Strengths and Considerations

- Distribution model → External validity assumption → Reproducibility
- External validity tested for on LAC data set
- Finer distinction urban/rural with urban categories
- Nighttime lights (≈electricity consumption) to control for productivity
- Informal activities included
- Accurate sub-national estimations

- GDP : refers to location (≠GNI) → spatial measure ?
- "Economic activity" : byproduct consumption-production
- Scale at which it is used:
  - regional/municipal : accurate macroeconomic measure
  - cell-level : ?
- Seasonality

- What it does not do :

  - distinguish consumption/production at low scales

  - characterize economic activities

- Room for improvement :

  - more recent NTL data

  - GHSL human settlement data

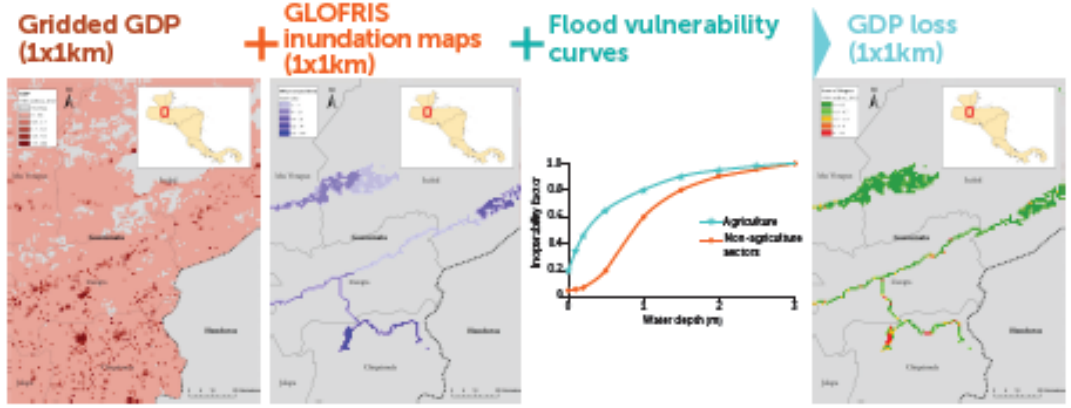
  - level model using more inputs

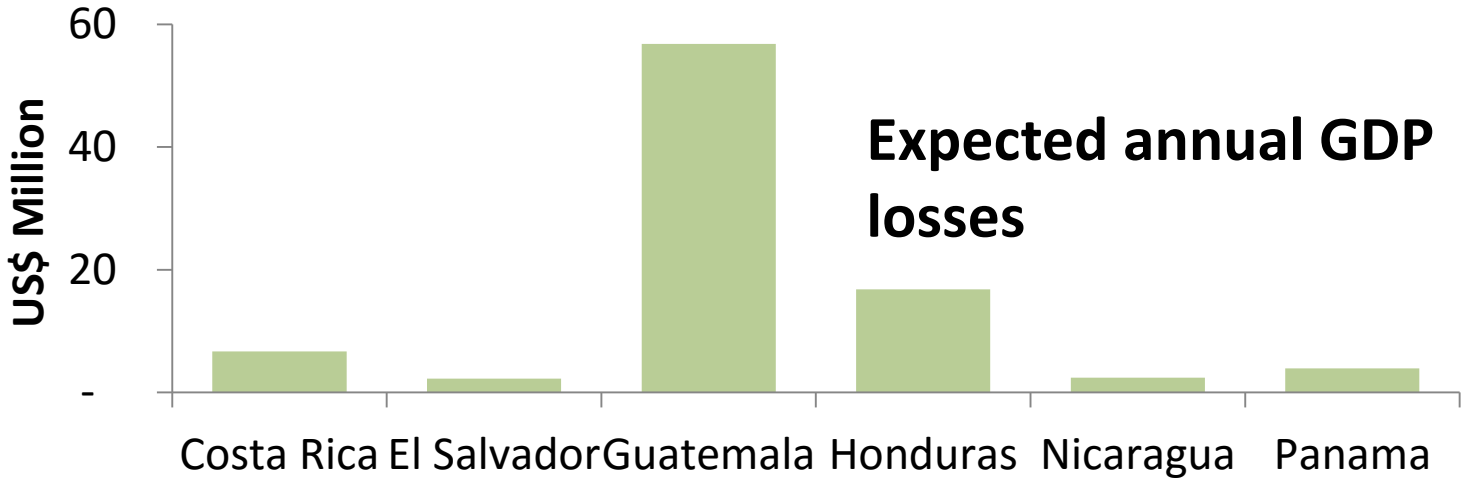
Applications in DRM

- Economic exposure proxy
- Risk mitigation/quantification, preparedness…
- Economic vulnerability assessment
- Combined with other data to characterize GDP :

  - structure of the economy
  - interdependence of economic activities (non-structural losses)
  - economic vulnerability (firms sizes, business interruption…)

Flood Risk Profiles in Central America





- Results presented are part of the *ongoing* Country Disaster Risk Profile (CDRP) study and The Disaster Risk & Resilience Analytics and Solutions (D-RAS) Knowledge Silo Breakers. Therefore, presented estimations and results should be considered as preliminary.
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Questions