Future resilience of cities relies on today's management of human settlements

Preparing for operational monitoring of human settlements

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Resilient cities & human settlements

- “A resilient system or society is able to face shocks and persistent structural changes in such a way that it keeps on delivering societal well-being without compromising that of future generations” (Manca et al., 2017)*
- Today, cities and city inhabitants are facing increasing challenges:
  - uncontrolled urbanization
  - climate change
  - political instability, and others

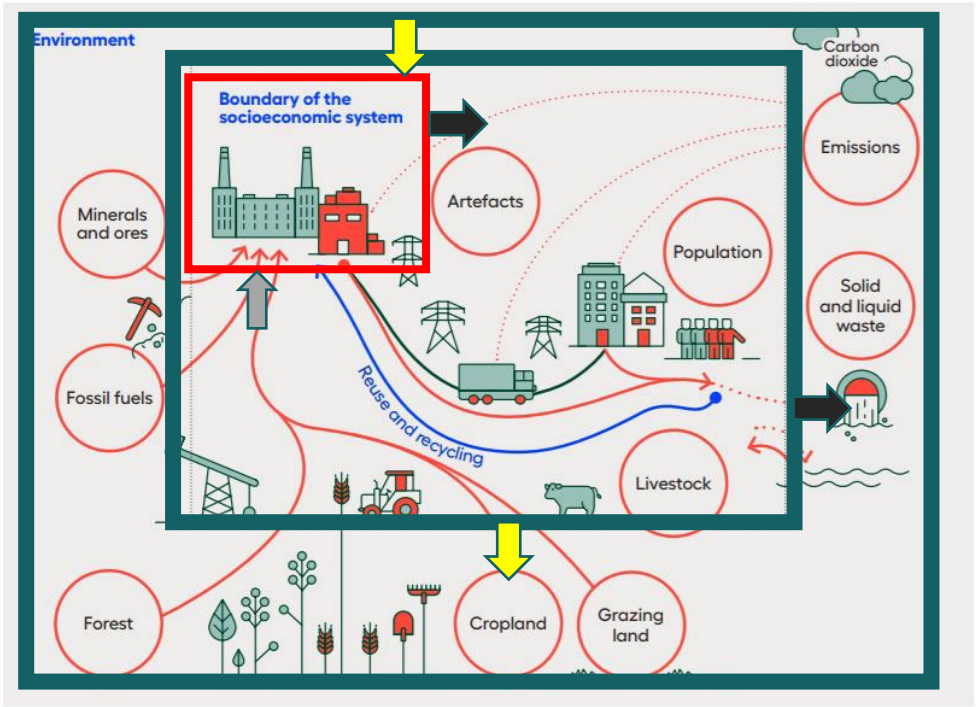
*https://urban.jrc.ec.europa.eu/thefutureofcities/the-resilien-city#the-chapter

https://www.oecd.org/cfe/resilient-cities.htm

Human systems are centered on settlements

Measuring and understanding **human settlements, societal demands and impact** across scales is essential for resilience and for staying within the planetary boundaries

Figure 1.5 Human societies are imbedded in the biosphere: Energy and biophysical resources are used to build stocks and provide benefits for humans while generating waste and emissions



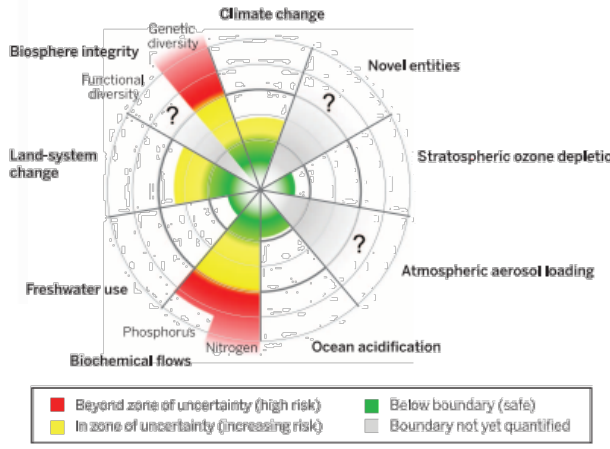
Source: Haberl and others 2019.

Local scale

Regional/ National

Global Scale

Planetary Boundaries



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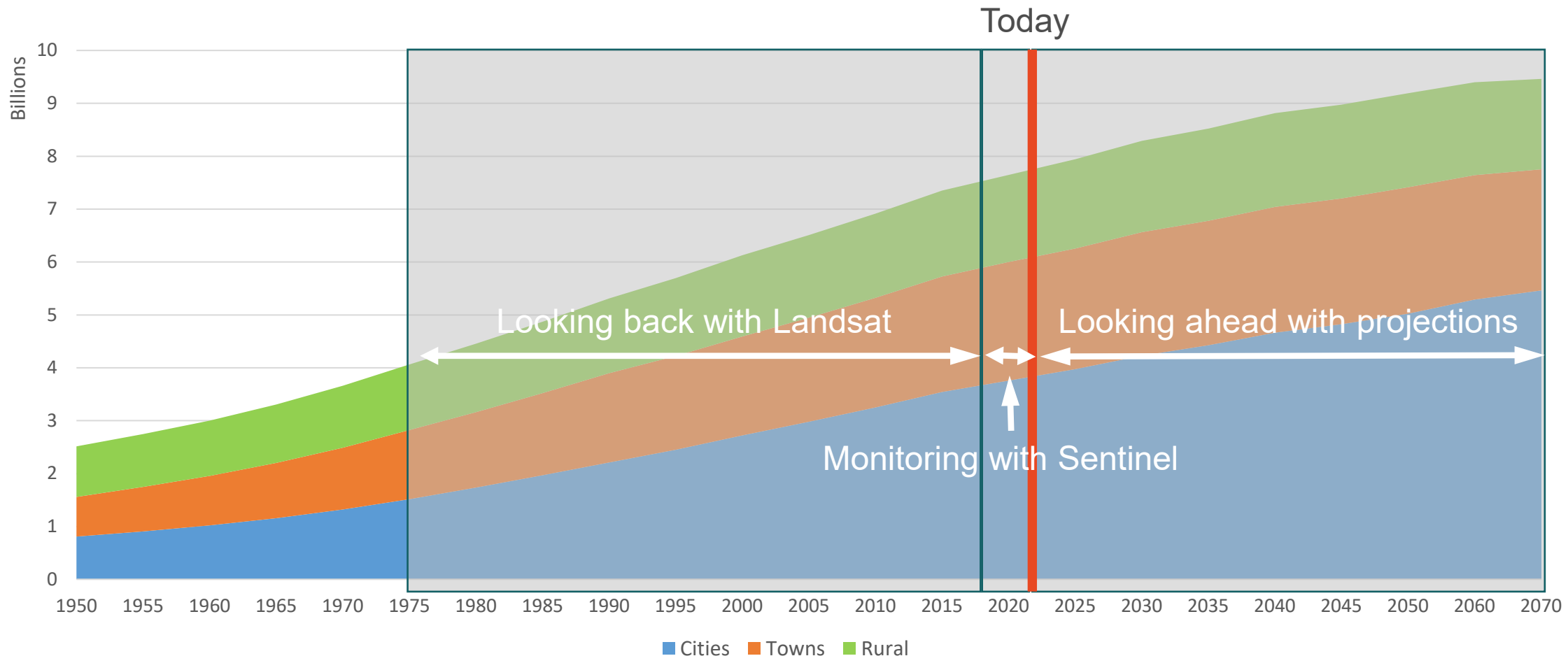
Measuring & understanding human settlements: past, presence & future



Global Population by Degree of Urbanisation, 1950-2070

Source: doi:10.2760/693381

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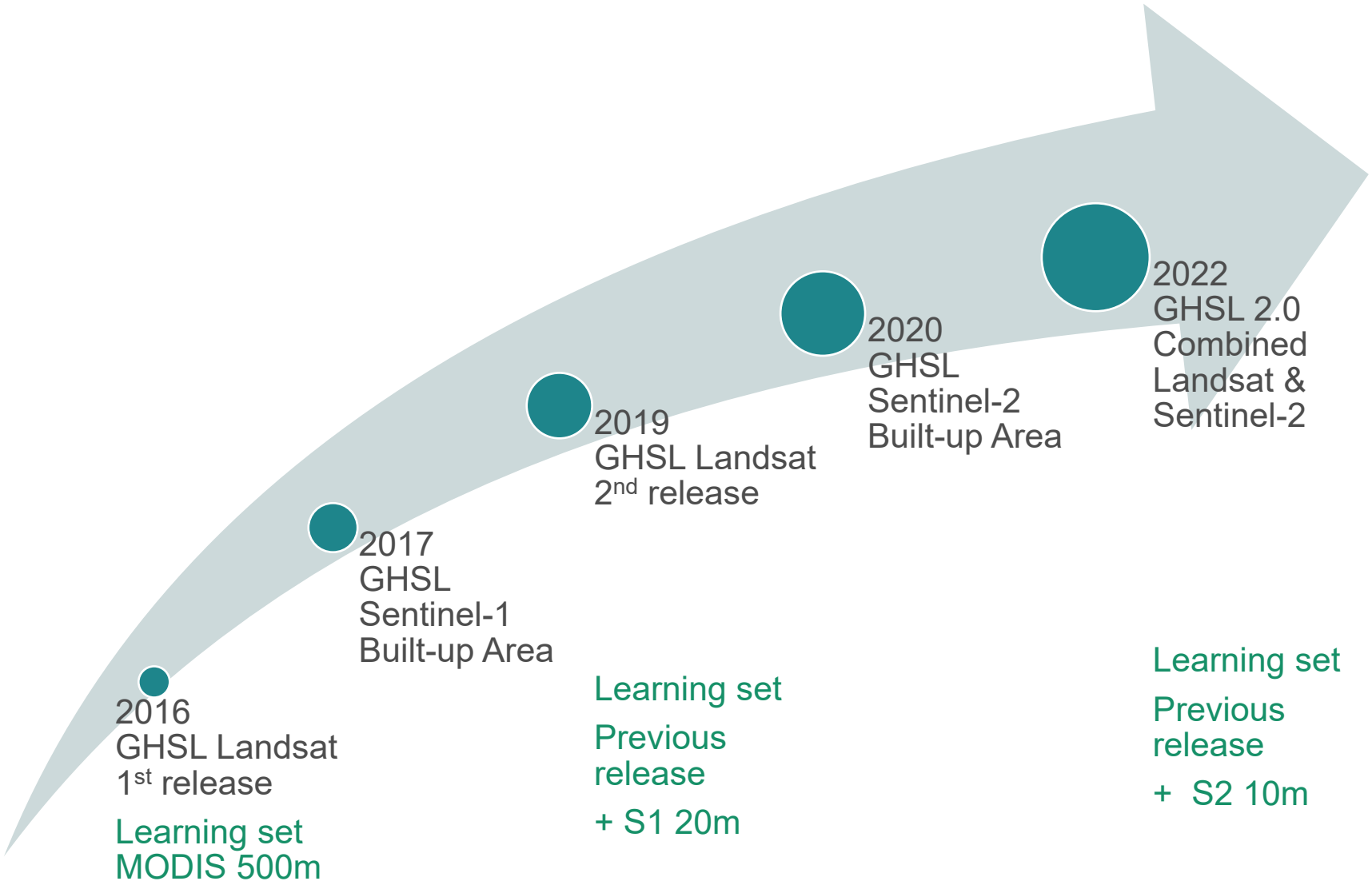
GHSL Evolution



2023

Operational Production in CEMS with regular updates of built-up area and population

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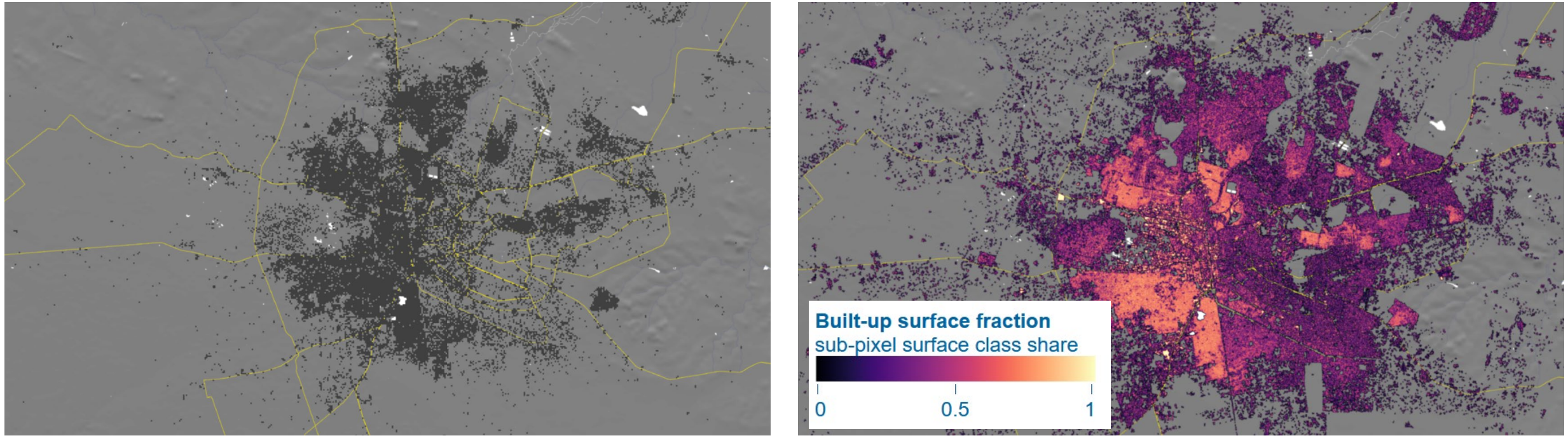
GHSL Built-up Surface

GHSL R2019, 30 m

GHSL R2022, 10 m

Lusaka, Zambia



Processing of S2 composite data 2018 using SML and mathematical morphology (DMP) and a composite of S2CNN predictions, OSM, and other VHR reference data as training set

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GHSL 2.0 preliminary quality assessments

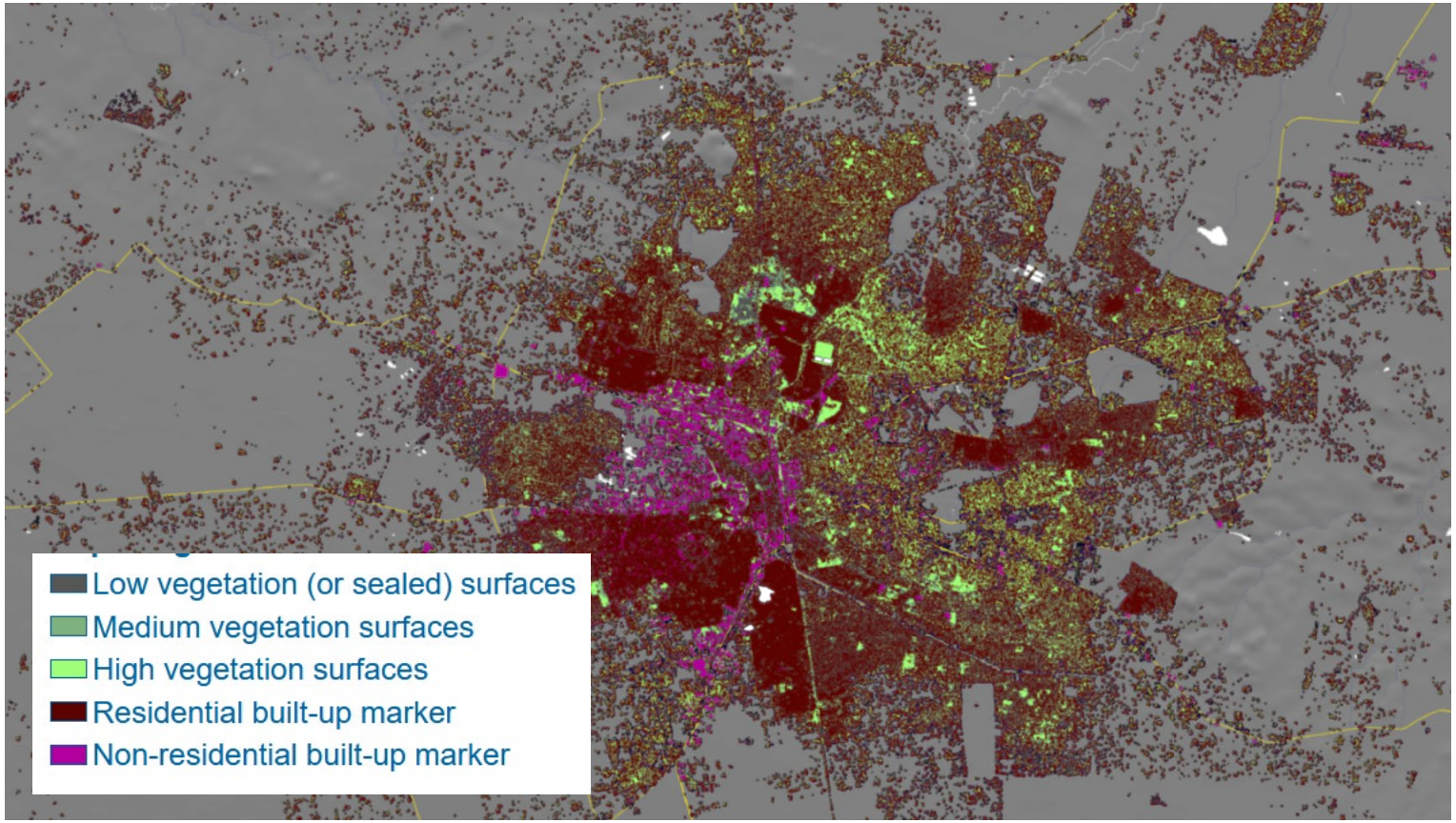
- Preliminary results
- 500 test areas with vector building footprints, rasterization 1m-resolution

	Mean Absolute Error (MAE)			
	MODEL output	MAE 10m	MAE 100m	Relative 100m-res error change vs. the previous GHSL
GHSL2.0	BUfracPRO (10m)	0.0576	0.0348	-76.14%
Copernicus GLC	BASELINE GLC100_URBAN (100m)	n.a.	0.1438	-1.33%
GHSL1.0	BASELINE GHSL_LANDSAT (30m)	n.a.	0.1457	0.00%
	Number of Valid Samples	6,688,272,182	66,378,749	

GHSL Residential/Non-Residential

- Classification model based on image segmentation using radiometric, textural, and morphological characteristics of the NRES domain
- global set of expert-driven rules, and a locally adaptive set of rules trained by OSM data

GHSL R2022 Lusaka, Zambia



Validation in preparation by Copernicus EMS

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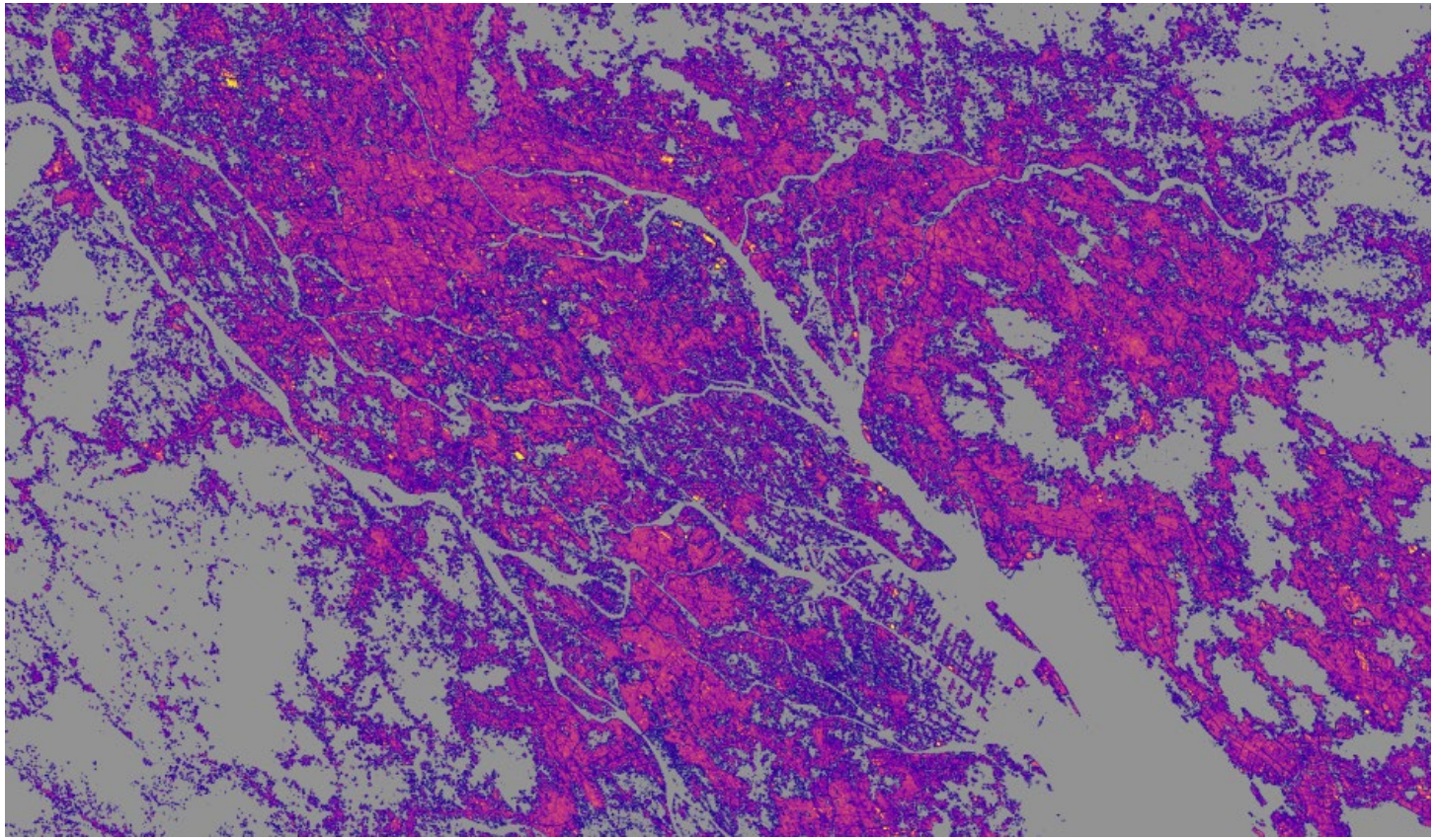
GHSL 2.0 Population

Data Characteristic	R2019	NEW R2022
Ref tot. pop.	UNWPP 2015	UNWPP 2019
Spatial resolution (max)	250m	100m (5 mapped epochs)
Temporal coverage	1975-2015	1975-2018 -> 2020-2030
Temporal resolution	4 epochs	5-yr grids (1 km)
Attributes	Tot. pop	+Sex, Age (WorldPop)
IN BU data	generic BU	RES/NRES BU
Methods		Improved population estimates
Methods	Validation in EU	Validation in all Regions

GHSL 2.0 Data Cube

- data cubes at 5 year time interval from 1975-2030 interpolated and extrapolated in the spatio-temporal domains using spatial rank-optimization techniques at 100m
- Instead of arbitrary image data collections 1975-1990-2000-2014-2018



Guangzhou : BU surface 1975, 2020, 20230

100m-res, grey : zero , yellow : 10,000 square meters

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Emergency Management

New Service Component: Exposure Mapping

Exposure information is fundamental for disaster risk and crisis management:

- Users need impact information
- All CEMS components are using population and/or built-up area information already
- Global, harmonised and regularly updated information is required to complement national datasets

New CEMS component:

Information on population and settlements is relevant for many other application domains, international frameworks and other Copernicus services:

UN World Conference on Disaster Risk Reduction 2015 Sendai Japan

SUSTAINABLE DEVELOPMENT GOALS

TOGETHER TOWARDS HABITAT III

11 SUSTAINABLE CITIES AND COMMUNITIES

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

The European Green Deal

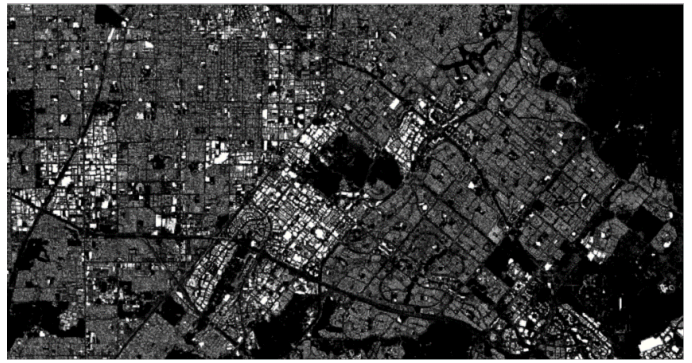
Land Monitoring

Climate Change

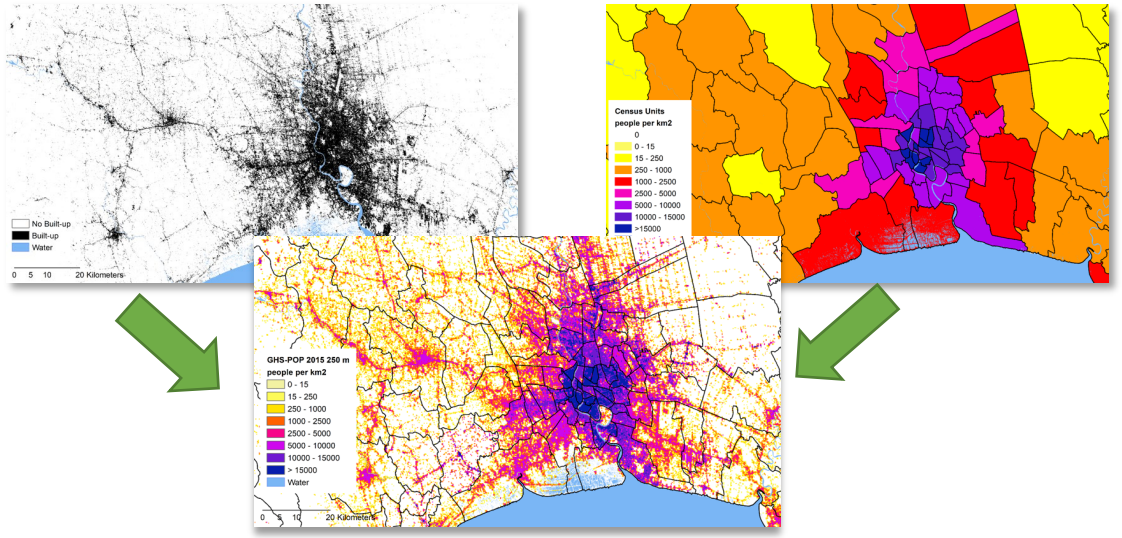
Security

Emergency Management

Examples of CEMS evolution: Exposure Mapping



- Based on the Global Human Settlement Layer concept
- First reference production year: 2022
- Biannual updates



Exposure Mapping in CEMS:

- Input:
  - Sentinel-2 (and Sentinel-1)
  - Population census data
- Output:
  - Built-up surface grids at 10 m resolution
  - Population density grids at 100 m resolution
  - Degree of Urbanisation at 1000 m

Conclusions

- Through measuring and monitoring of human settlements, Earth Observation can significantly contribute to the resilience of societies
- With the new exposure mapping component, the European Commission proposes an operational framework for the global monitoring of human settlements and population
- Thematic and geometric improvements of the GHSL data allow a better characterisation of human settlements and opens opportunities for new applications

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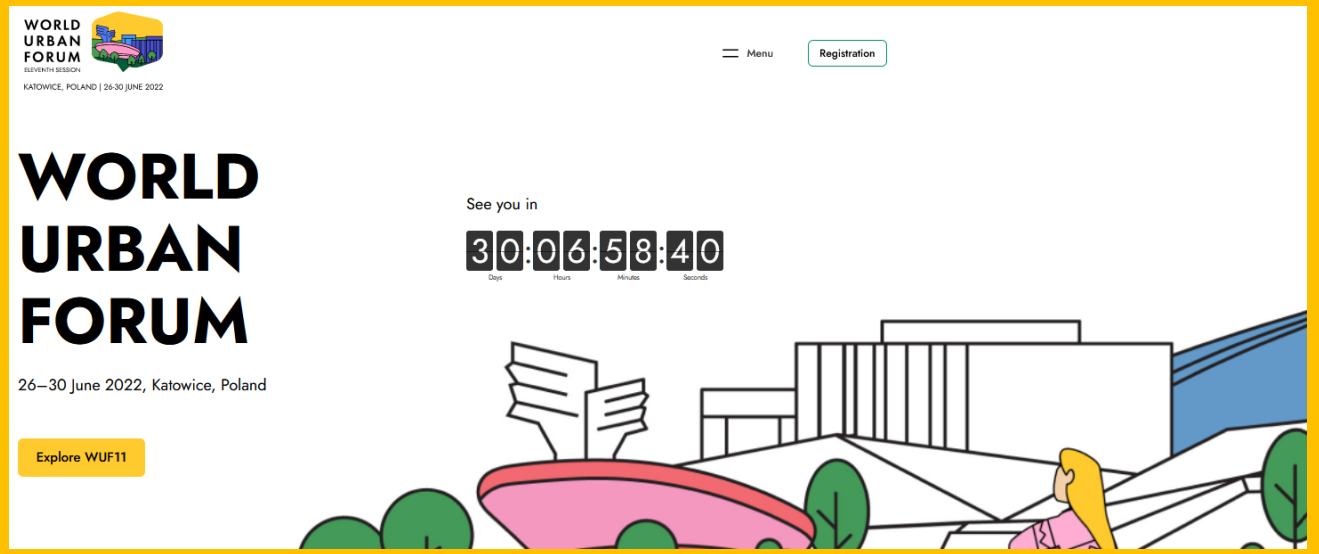

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https://ghsl.jrc.ec.europa.eu

Slide 2: Measuring City Resilience OECD, 2018

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