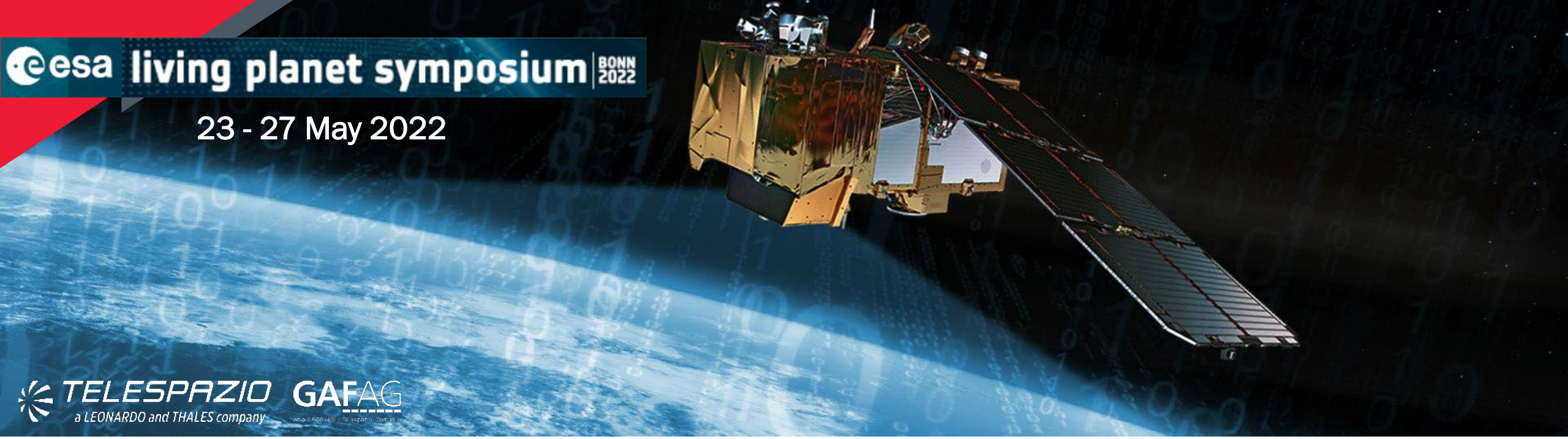


EO Applications and Innovations in Urban Planning/Development in the Global South

Thomas Häusler, Sharon Gomez, Andreas Uttenthaler, Fabian Enssle-GAF AG

Session: D2.01 Resilient Cities

Presentation Objectives

- Provide examples of EO data and applications for Urban Development programmes in Global South
- Provide an overview of ESA's **Earth Observation for Sustainable Development (EO4SD) – Urban Project** (2016-2020).
- Highlight major technology evolutions which increased the efficiency of product generation, provided cost-savings, and enhanced utility in work practices.
- Introduce ESA's **GDA Urban Sustainability Progamme** (2022-2023), as the logical consequence to facilitate the integration of EO into the International Finance Institutes (IFIs) work practices.

The National Urban Planning Process (NUP)

- .... is comprised of several stages:

- To implement these steps **evidence-based approaches** for decision making are needed.

- The NUPs should address three main themes:
  - urban legislation,
  - urban economy and
  - urban planning and design.

- urban planning and design is a key requirement at local and national level.

- Geo-spatial data play a major role in evidence based urban planning.

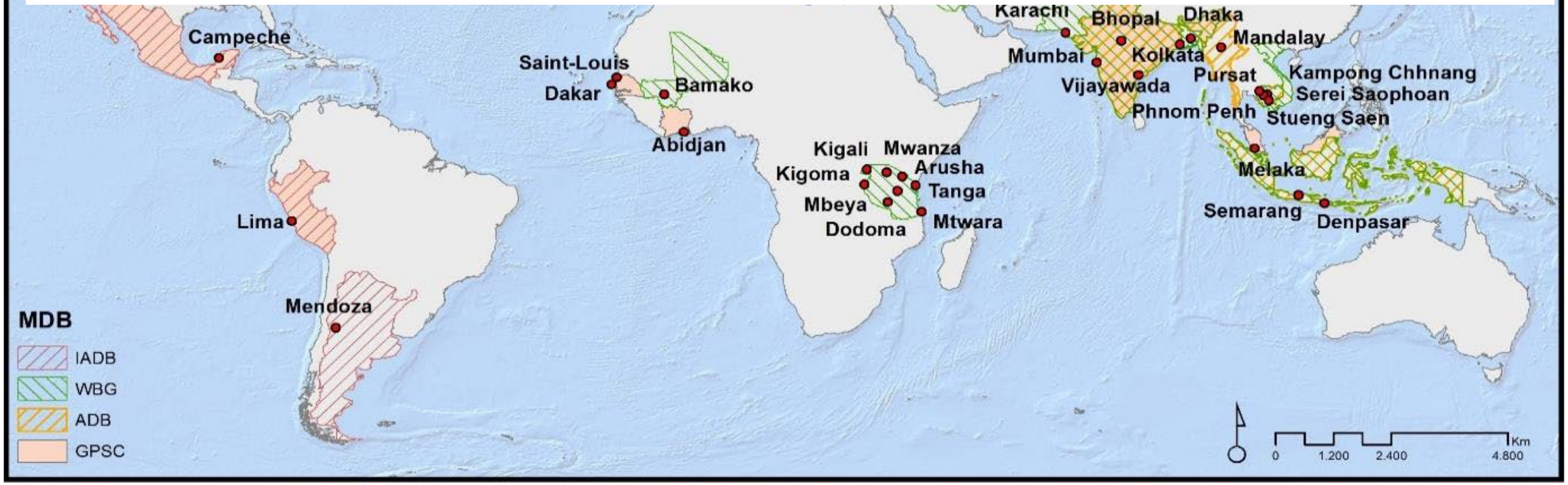
Poorly planned urbanisation leads to environmental destruction, increased carbon emissions, transport congestion, poor air quality, and urban sprawl.

EO4SD-Urban Project – Improving Urban Planning

www.eo4sd-urban.info

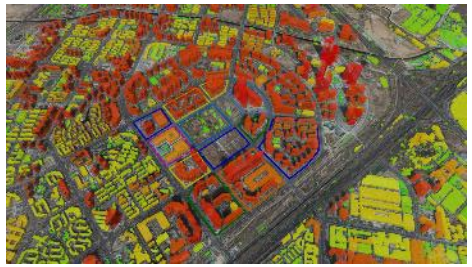
2016-2020

- The project provided 32 Cities with more than 500 products for which the overall accuracies ranged from 85-95%.
- In collaboration with International Financial Institutions (IFIs), like the World Bank Group (WBG), the Interamerican Development Banks (IADB), and the Asian Development Bank (ADB), as well as the GEF funded Global Platform for Sustainable Cities (GPSC).
- **Project Lead: GAF AG**, Partners: GISAT, DLR, CLS, EGIS, NEO, Joanneum Research, GISBOX, Caribou Space

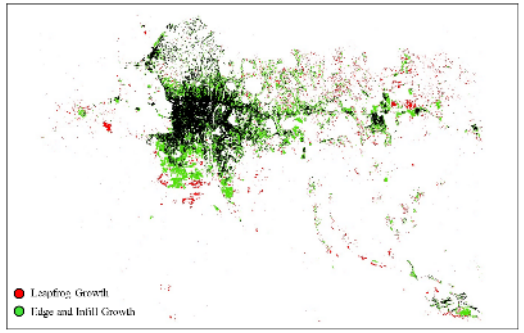


Examples of Analytical Work included: …

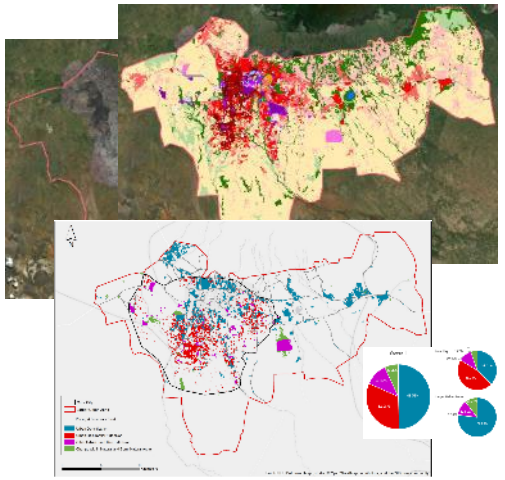
Building Heights and Footprints



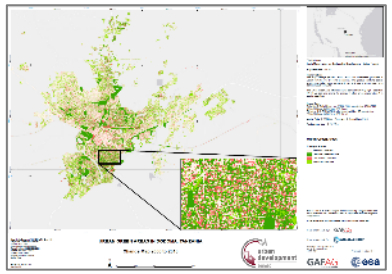
Urban Growth Over Time



LU/LC Change Over Time

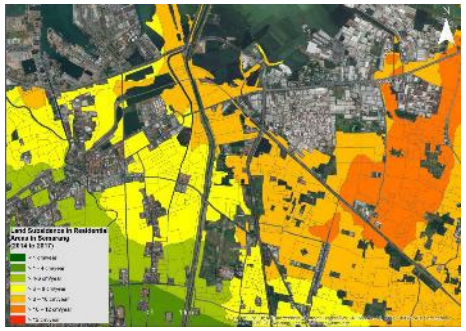


Green Areas and Open Spaces

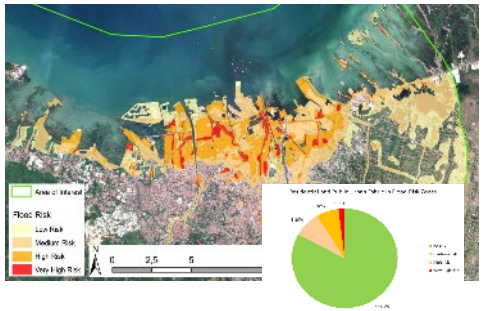


Population Distribution and Change

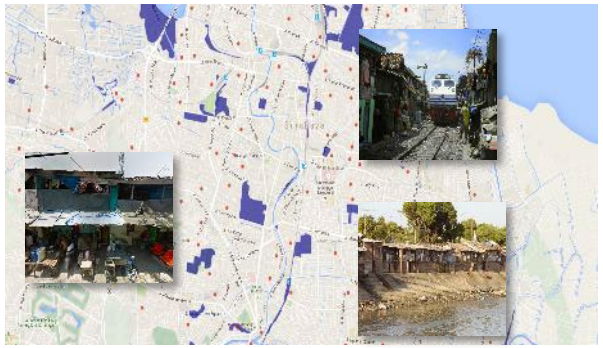
Terrain Motion in Residential Areas



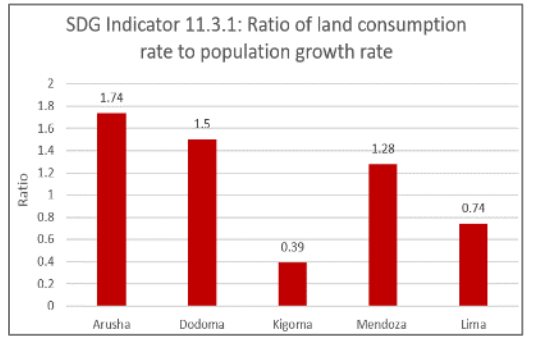
Assessment of Flood Prone/Flood Risk Areas



Informal Settlements



Support to SDG Goal 11 and Related Indicators



Kigali City Case Study: Assessing Property Tax Potential

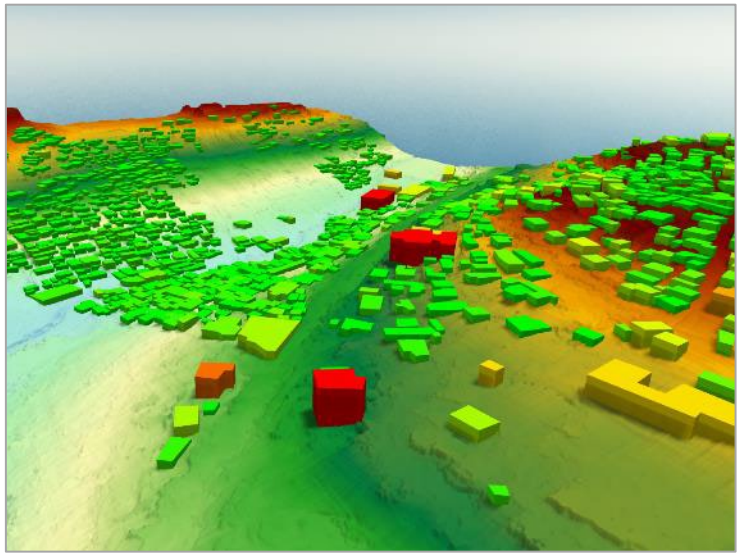
Pilot with **World Bank Development Economics Research Group** to simulate different property values and related tax rates to assist with improving the total revenues captured.

Using:

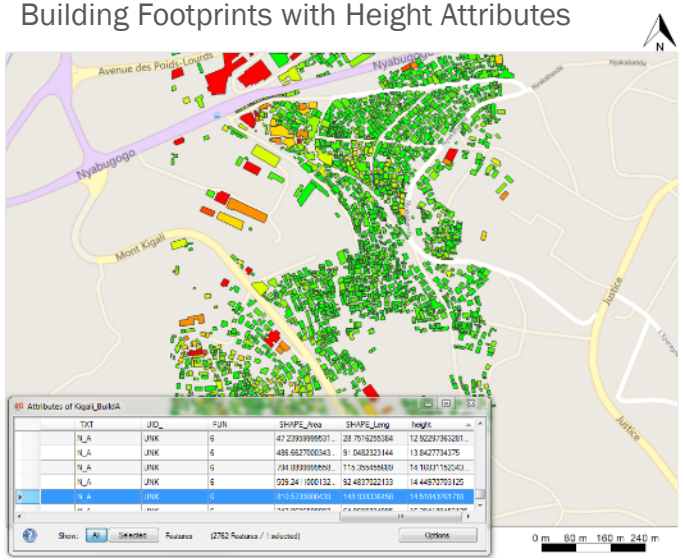
- existing land transaction data,
- land cadastral map,
- building footprints and building height data [based on 3D VHR data],

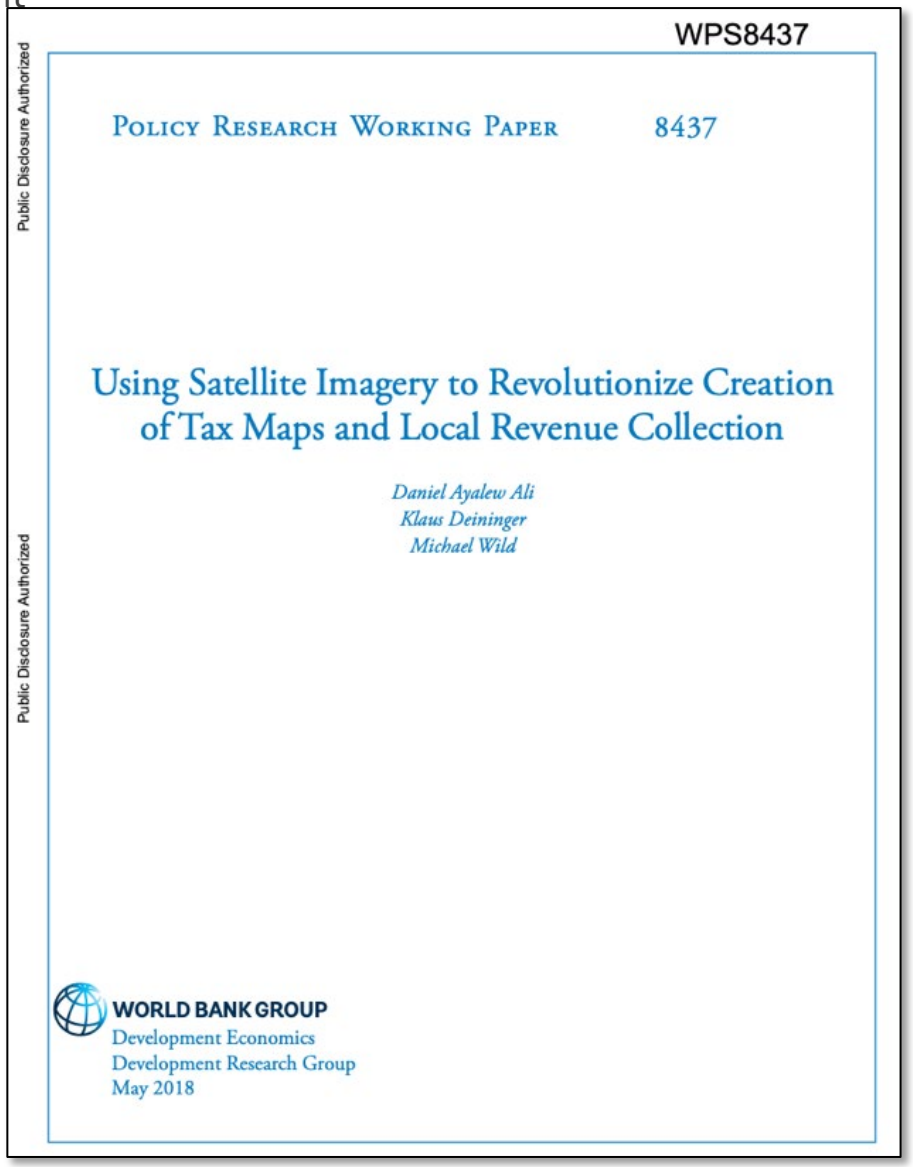
The new improved data showed that the tax revenues could increase to almost 10 times what was collected previously.

Innovation need: workflows for Building Footprints need to be faster and cheaper.



Building Footprints with Height Attributes





Major Technology Evolution using Deep Learning Networks

Building Footprints

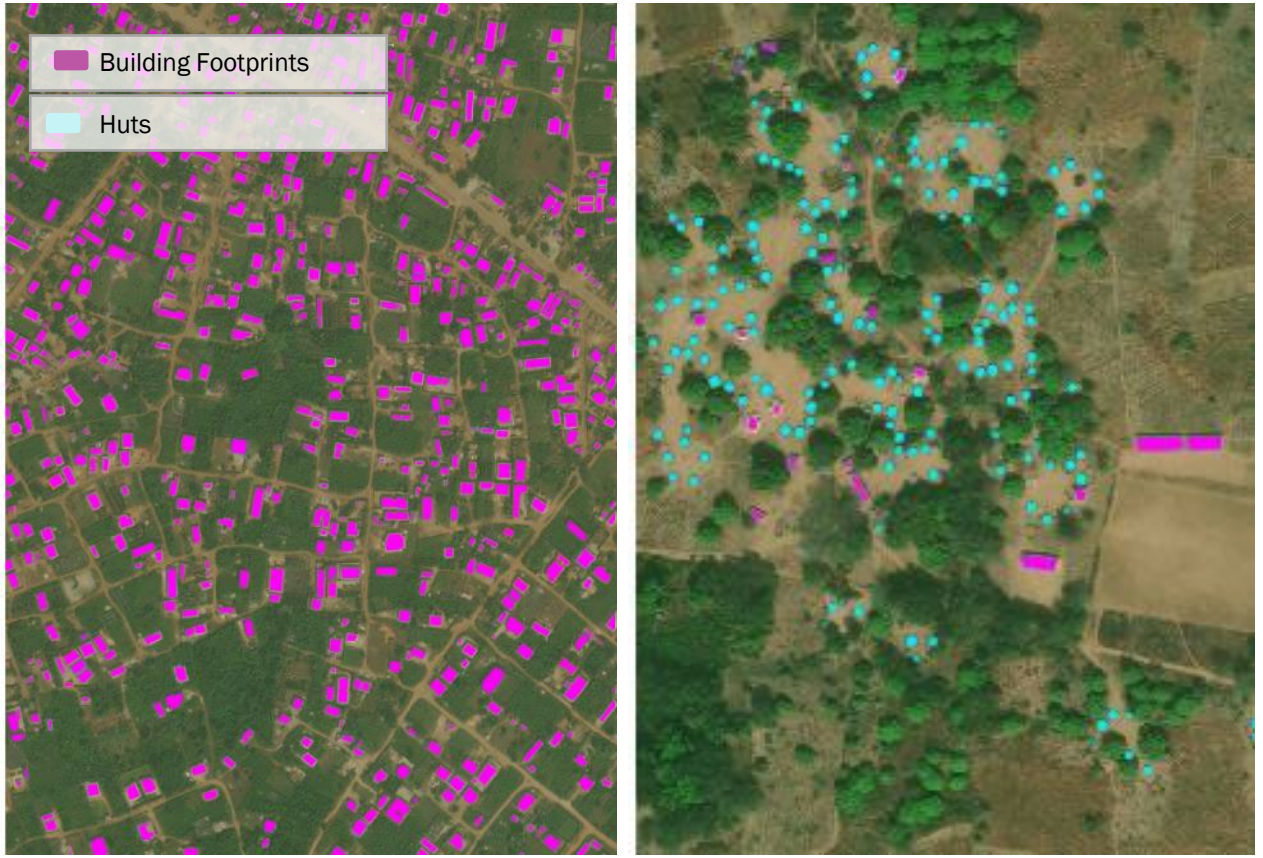
- Automated extraction of Building Footprints and Huts in rural areas from VHR data (0,3 m to 0,5 m) using **Deep Learning technologies increased cost efficiency**.

- Ideally suited for small cities and/or rural areas

Limitations

- Capturing individual Building Footprints in highly dense building agglomerations is challenging,

- Tall buildings in off-nadir images cause distortions.



0,5m Worldview, © Maxar (2020)

Major Technology Evolution using Deep Learning Networks

Digital Surface Models

The generation of Digital Surface Models based on various VHR data has become a standard for many years:

- 0.3 m: Worldview.3/-4
- 0.5 m: Pleiades, Wordview-1/-2, GeoEye-1
- 2 m SPOT-6/-7 Tri-stereo
- 5 m IRS-P5 Cartosat-1

Automated Generation of 3D Building Footprints based on DL

- Innovations with VHR and 3D modelling for Building Height and Footprint data have moved into the Deep Learning domain.
- The Hybrid-cGAN fully convolutional neural network architecture [Bittner et al., 2019b] fuses the depth information of the digital surface model (DSM) with the multispectral information of optical VHR data to delineate building footprints.

This gain of efficiency and utility has allowed EO service industry to address better IFI tenders, which require these products for many cities over many countries in a very short time.

Gain in Efficiency Resulted in WB Procurement: Building Footprints for All of Nigeria

World Bank Programme: States Fiscal Transparency, Accountability & Sustainability (SFTAS) Programme for Nigeria

Timeline: 6 months

Size of data production AoI: approx. 902,576 sqkm

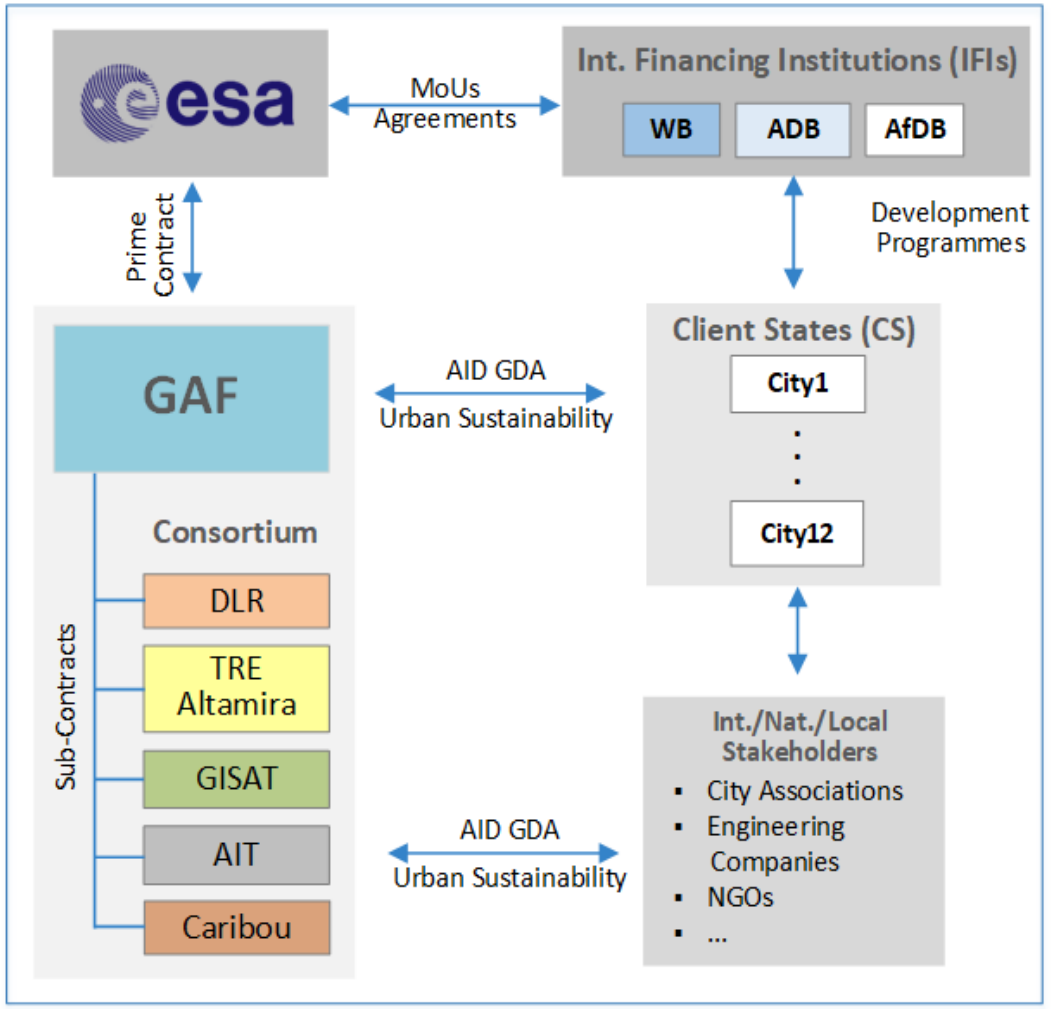
Products: True Ortho, DSM, DTM and 3D building footprints for urban areas, 2D building footprints for rural areas

Interactive user interface developed by GAF AG using similar technology

ESA's GDA Urban Sustainability: Objectives and Team

2022-2023

"....to respond rapidly to the geo-information requirements of several Bank teams by developing **enhanced EO thematic information products that go beyond what is routinely available today**, and to test & evaluate these developments together with the Bank teams in the framework of their operational activities."

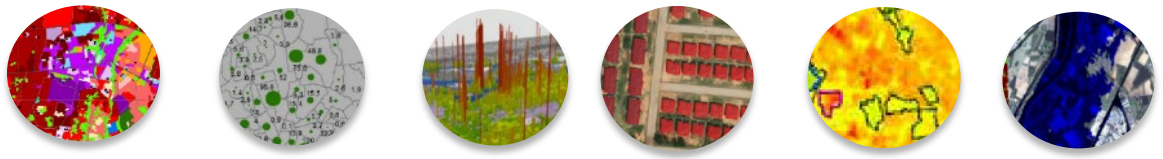


GDA Urban Sustainability: From Use Case to Innovation

Use Cases

- Land and Growth
- Buildings
- Deprivation
- NBS
- Liveability
- Transport
- Master Planning
- Socio-economic

EO-Derived Input Data



- LULC/Imper-viousness/ Transport
- Open Green Areas
- Population/ Informal Settlements
- Buildings
- Waste/ Air / UHI
- Hazards

Non-EO Input Data

- Census Data
- Adminis-trative
- Municipal Dashboards
- Attractors/ PoIs
- Sensor Data
- Economic Projections
- ...

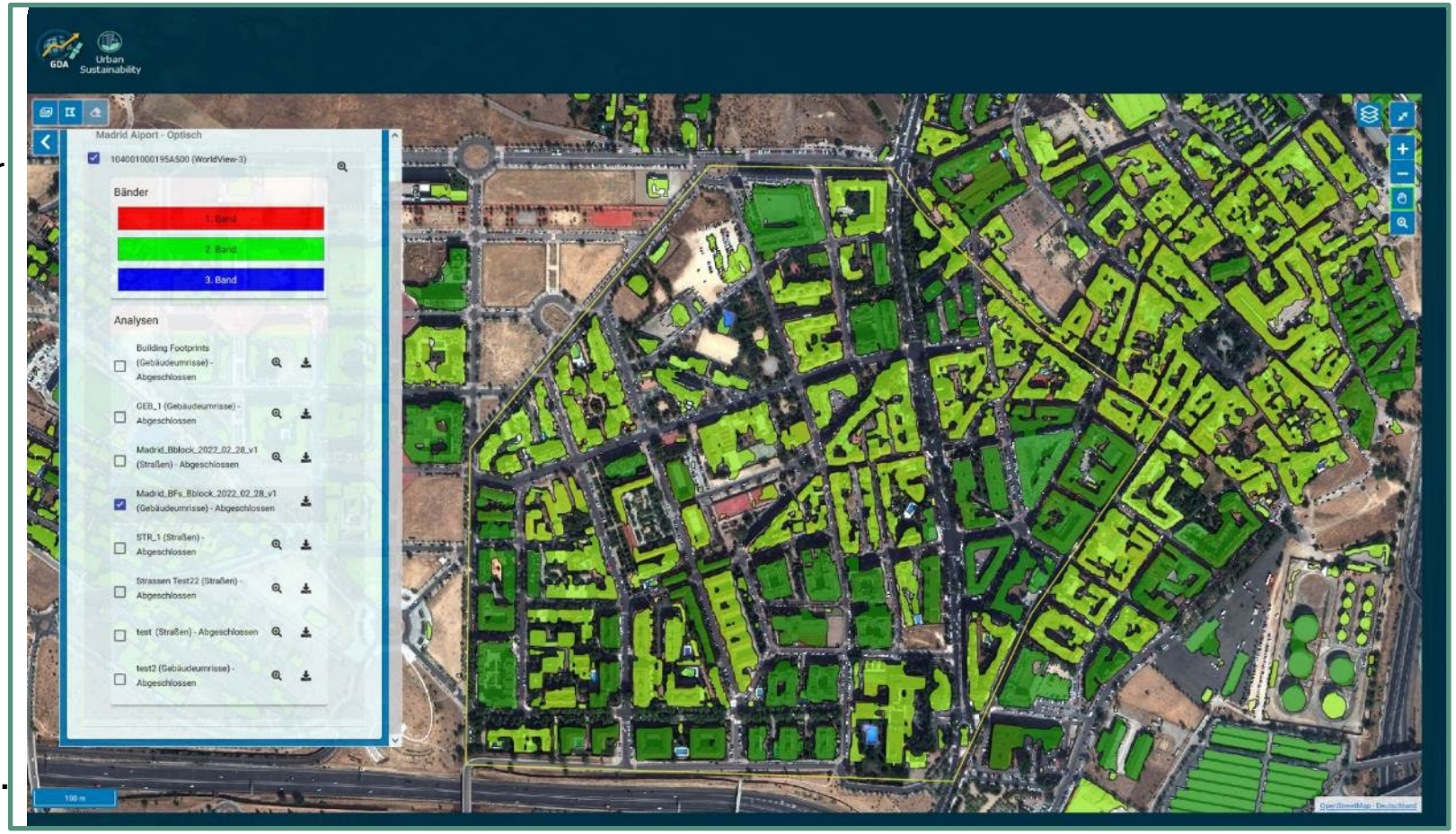
Types of Innovations / „Innovation Clusters“ (early ideas)

New datasets (WSF update, new geo-products)	Enhanced Production and Service Modality (automa./cloud/AI/PaaS..)	User-Focused Analytics (GIS, interactive, indices, audience conscious)	Backcasting->Now-casting-> Forecasting/ Modeling	Project-specific (e.g. city-scale -> quadrant/neighb.)	.....

Innovation Example: GAF AG | The User in the Driving Seat

Completely in the Cloud – little GIS / remote sensing expertise required

1. Zoom to an area of interest
2. Draw or upload an AoI
3. Drop-down **select** a sensor and find your image to analyse
4. Drop-down **select** the type of feature to AI-detect:
    - Transport Networks
    - Building Footprints (BF) and Heights
    - ….
5. Have the AI **detect** features in seconds or a few minutes/scene
6. Complement and annotate features (e.g. attribution of BFs)
7. Download vector data



Conclusions

- Comprehensive geoinformation for urban planning can optimally be achieved by combining HR and VHR EO data.
- The gain in efficiency by applying DL technology allows the production of high quality building footprints and building heights for large areas, which can be produced quickly at affordable costs.
- This enables a digital urban model which is based on the smallest object, i.e. buildings, instead of land use classes.
- E-numeration of more precise objects can be implemented by Surveyor counterparts, fostering a participatory approach.

Thank you for your attention!

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