URBANE FERNERKUNDUNG ALS INSTRUMENT ZUR RISIKOBEWERTUNG

Prof. Dr. Thomas Esch

Deutsches Zentrum für Luft- und Raumfahrt (DLR) | Deutsches Fernerkundungsdatenzentrum (DFD)
Dynamik der Landoberfläche (LAX) | Smart Cities und Raumentwicklung

DLR

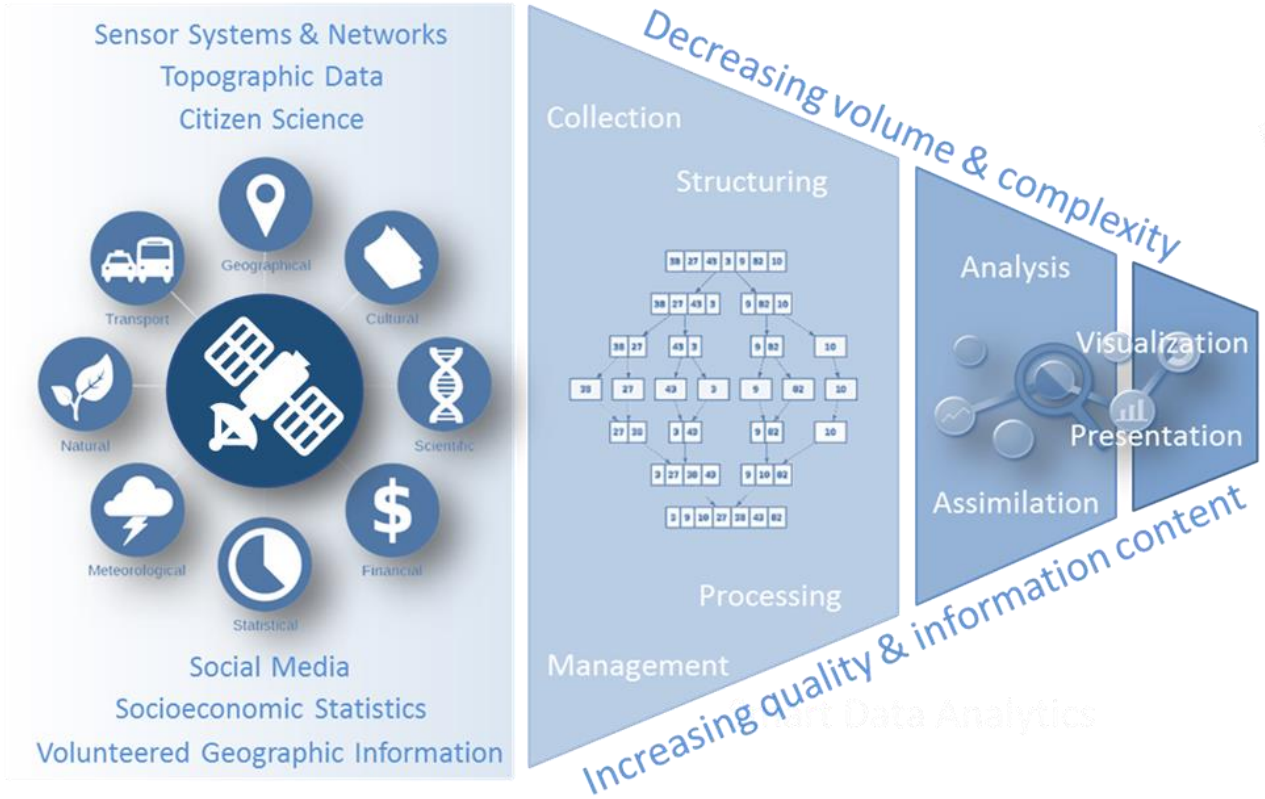

Urbanisation is among the major
global challenges of our time...

Urbanisation is among the major **global challenges** of our time...


Urbanisation is among the major
global challenges of our time...

Global Urbanization meets Climate Crisis: Increased Risks

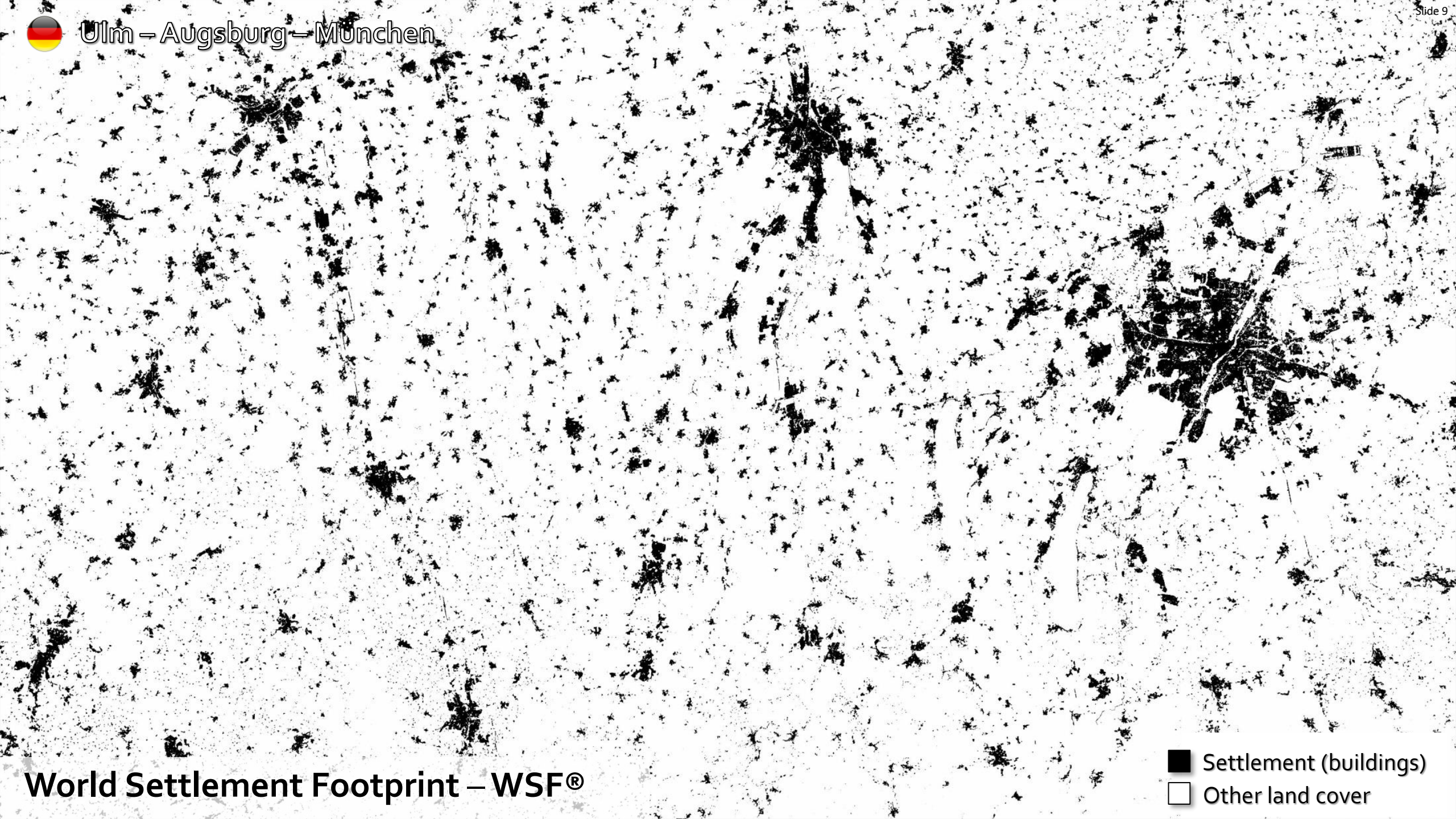
With Big Data from Space to Risk Informed Urban Planning



Knowledge and Technology Transfer

Evidence-based Policy Advice and Decision Support

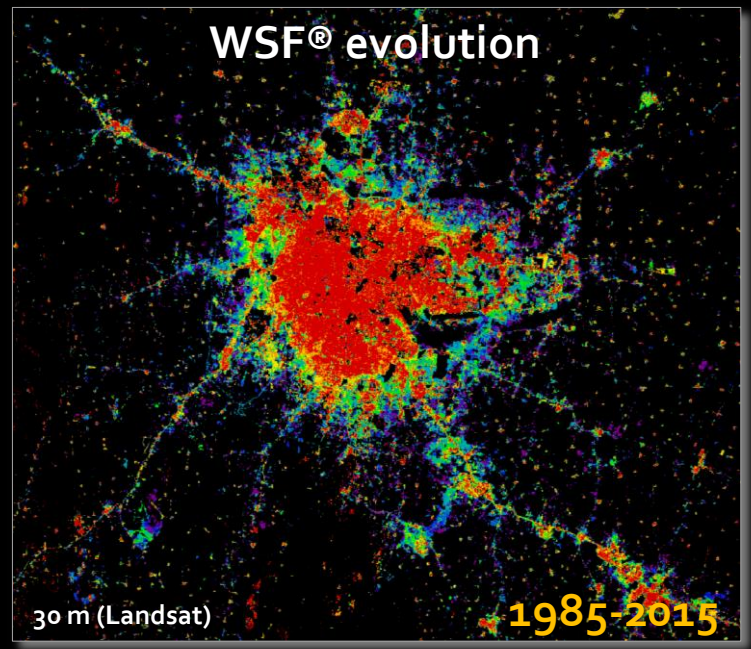
Ulm – Augsburg – München



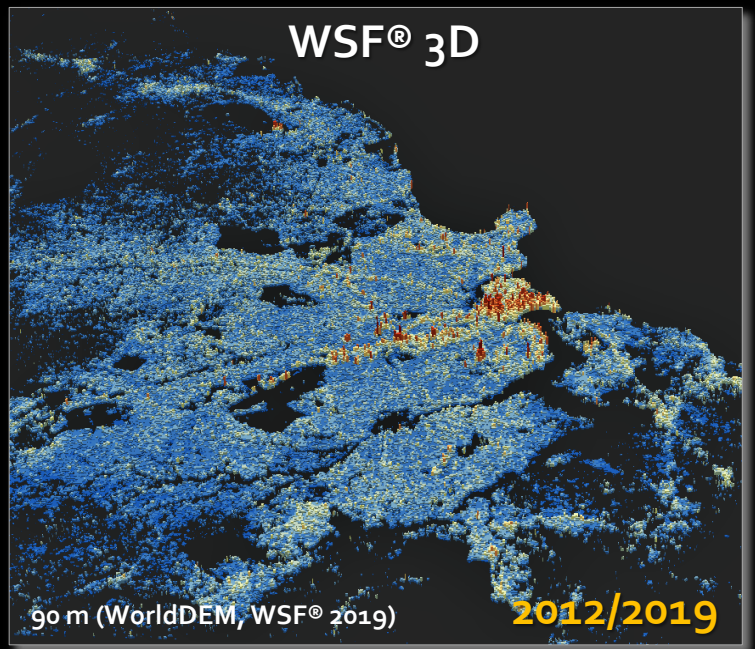
World Settlement Footprint – WSF®

World Settlement Footprint
WSF®

Download: https://geoservice.dlr.de/web/maps/eoc:wsf2019



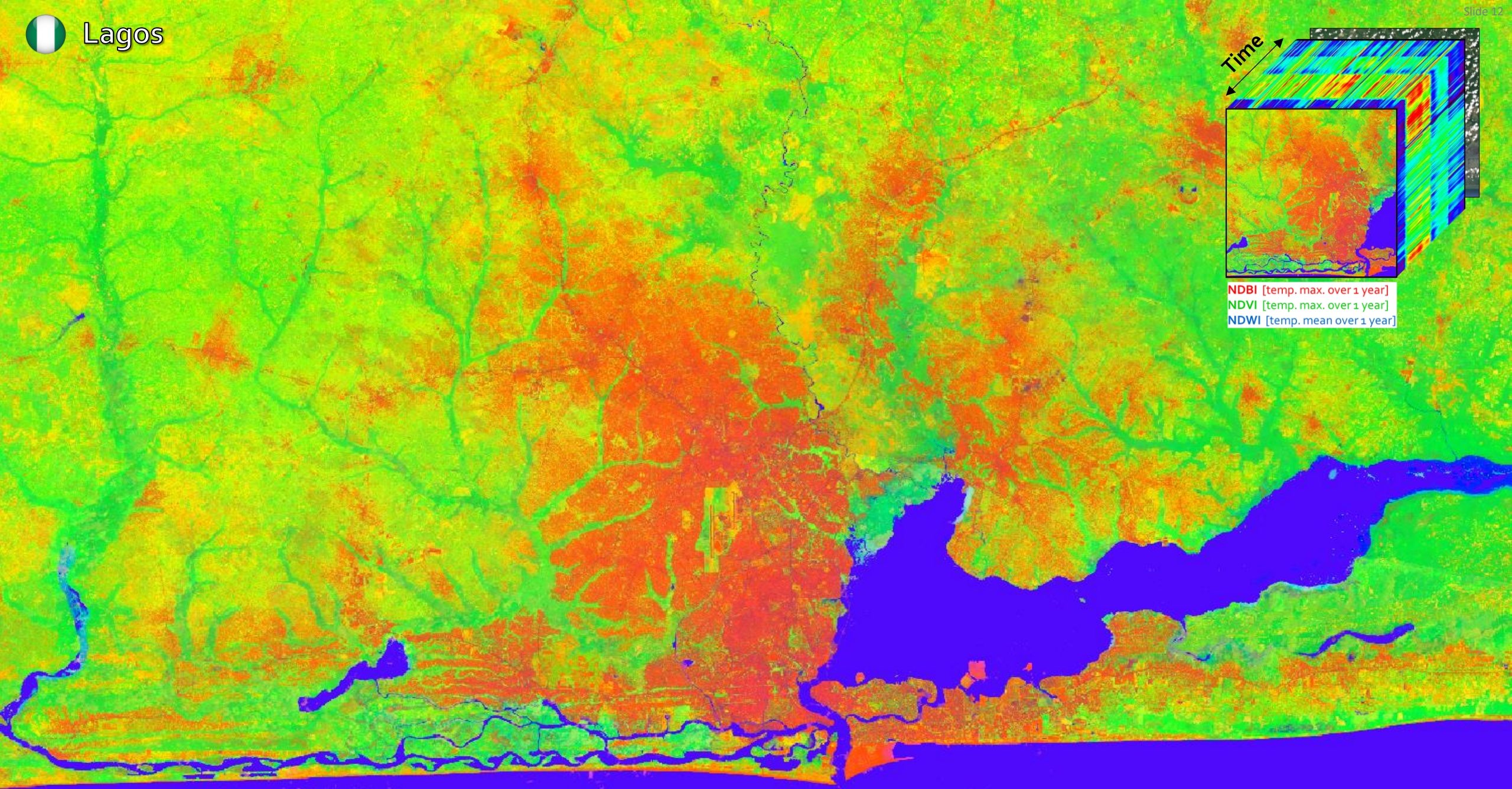
Download: https://geoservice.dlr.de/web/maps/eoc:wsfevolution



Download: https://geoservice.dlr.de/web/maps/eoc:wsf3d

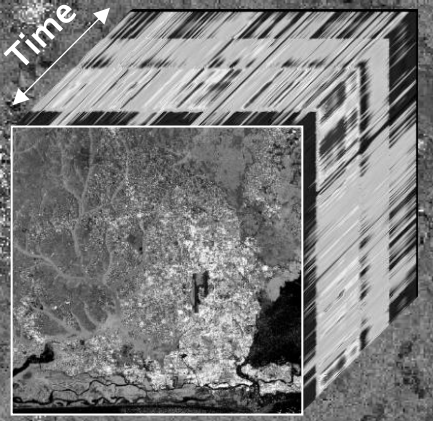
Sentinel 2 (multispectral) – single scene

Lagos



Sentinel 2 (multispectral) – multitemporal composite

Lagos



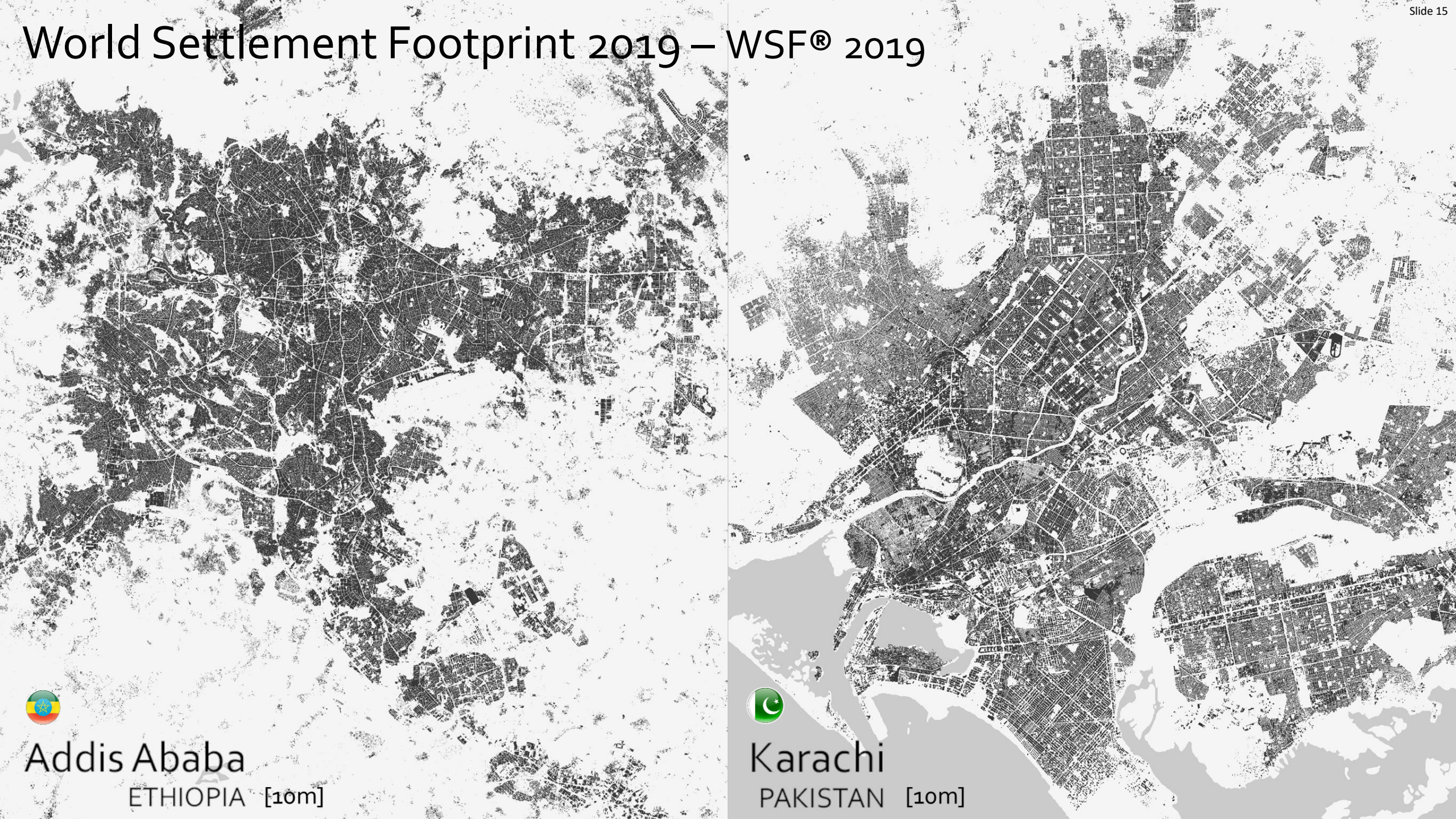
S1A IW GRDH VV
temporal mean

Sentinel 1 (Radar) – multitemporal composite

Lagos

World Settlement Footprint – WSF®

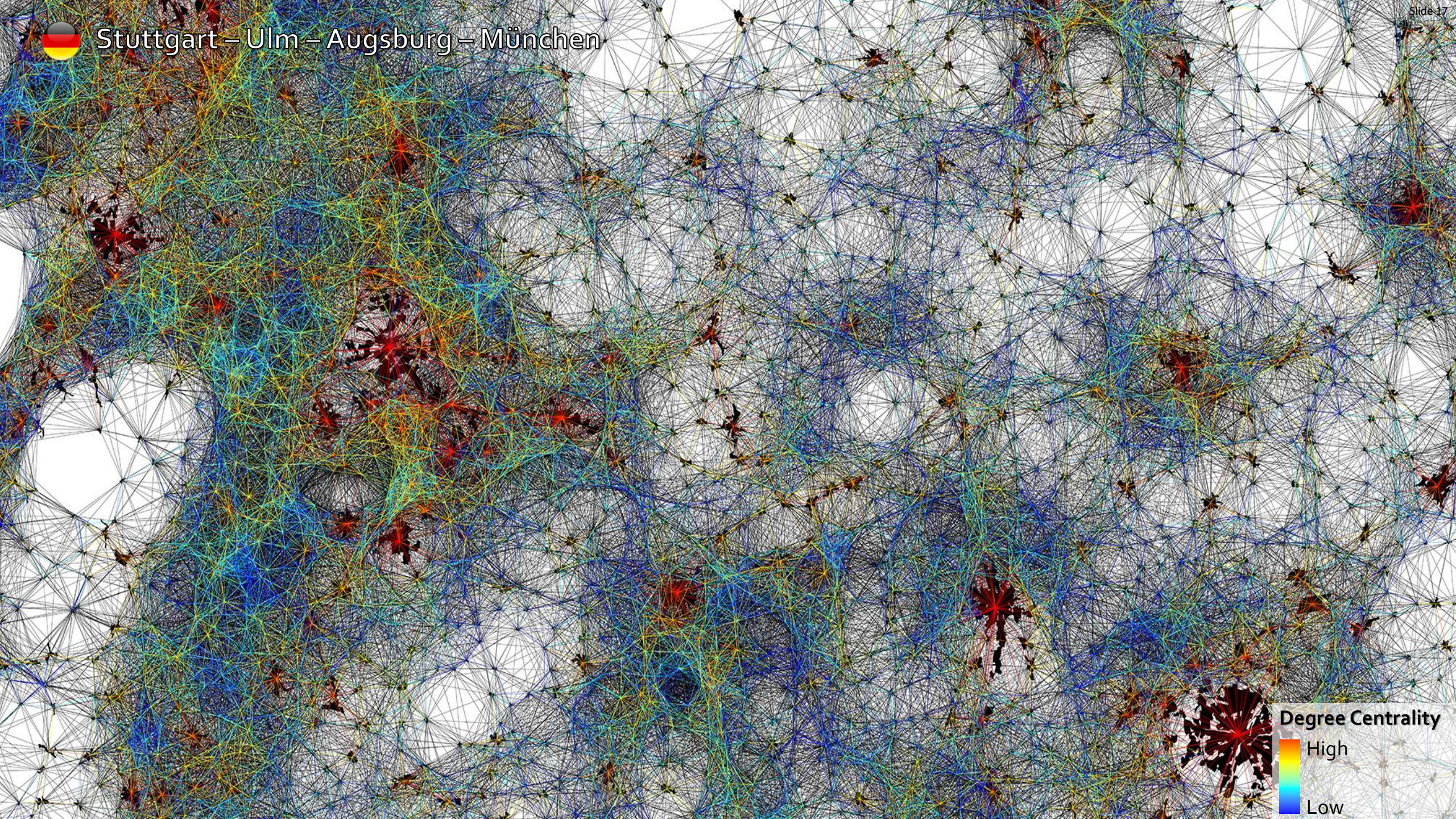
World Settlement Footprint 2019 – WSF® 2019



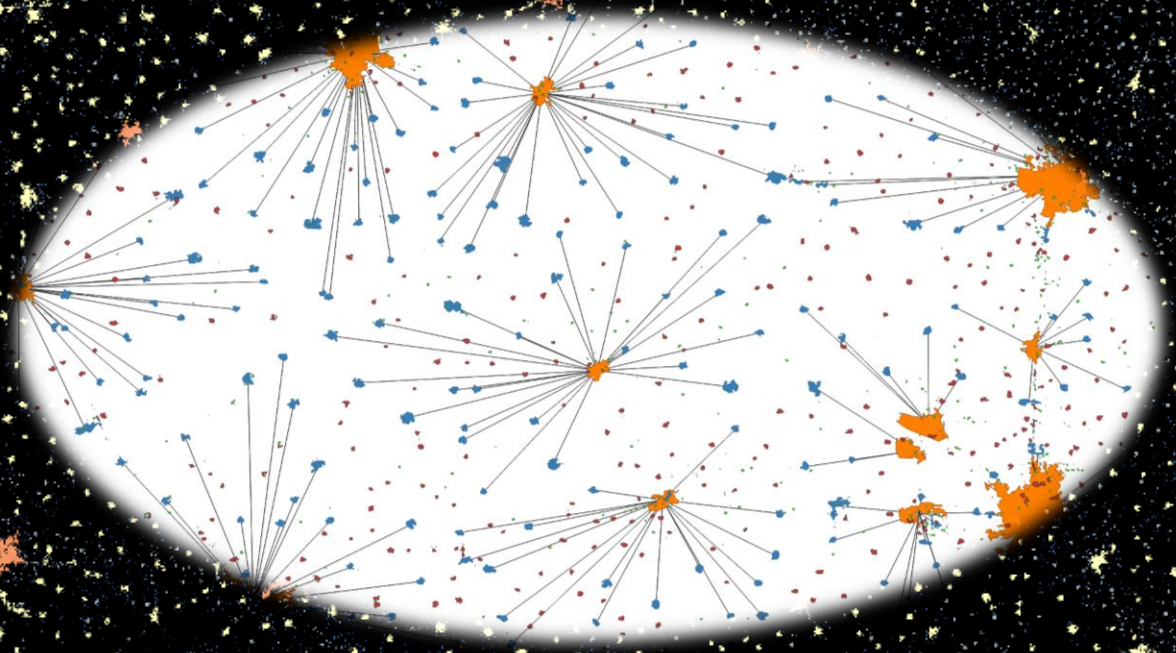
Temuco

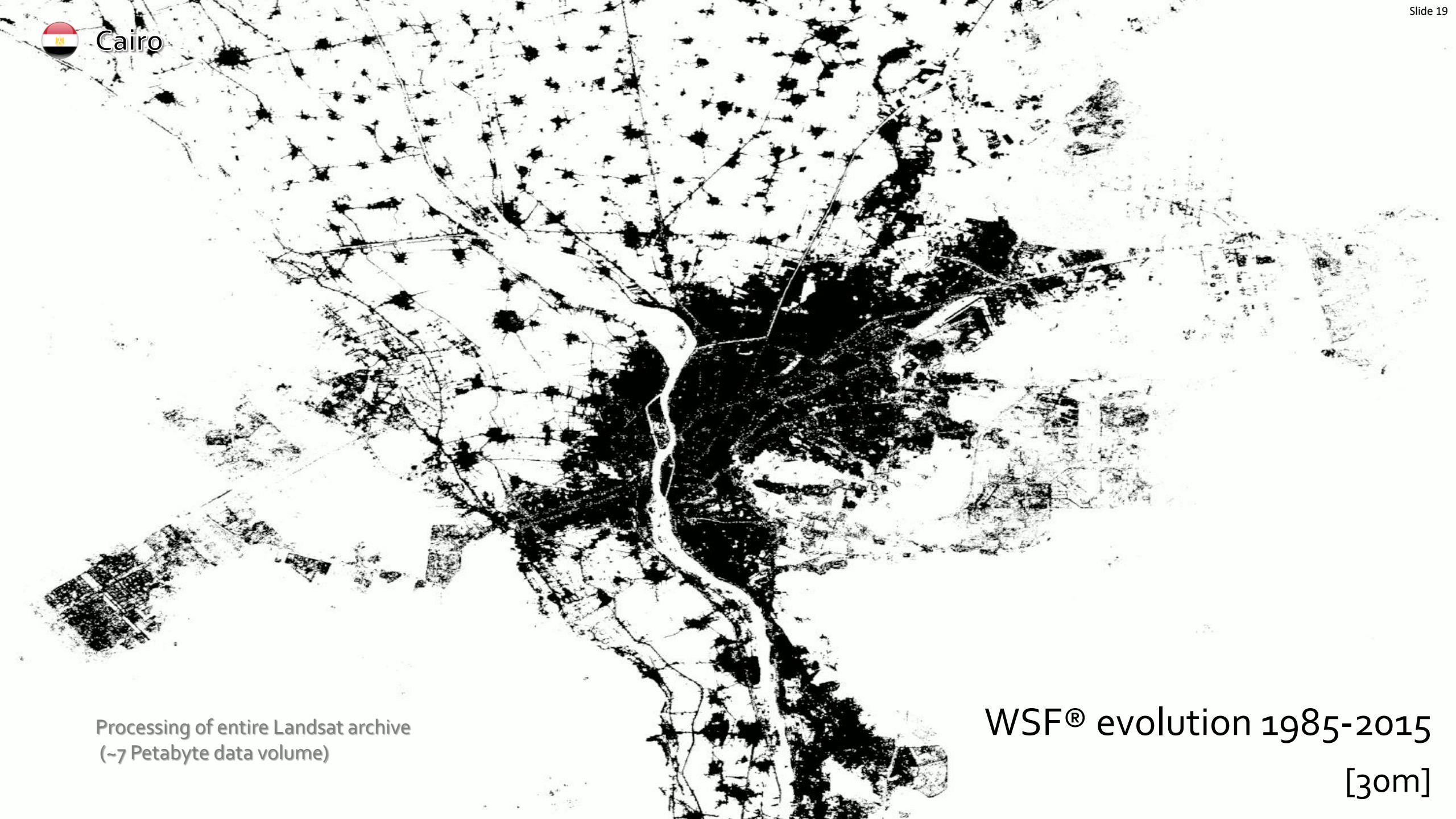
WSF® 2019

Stuttgart – Ulm – Augsburg – München

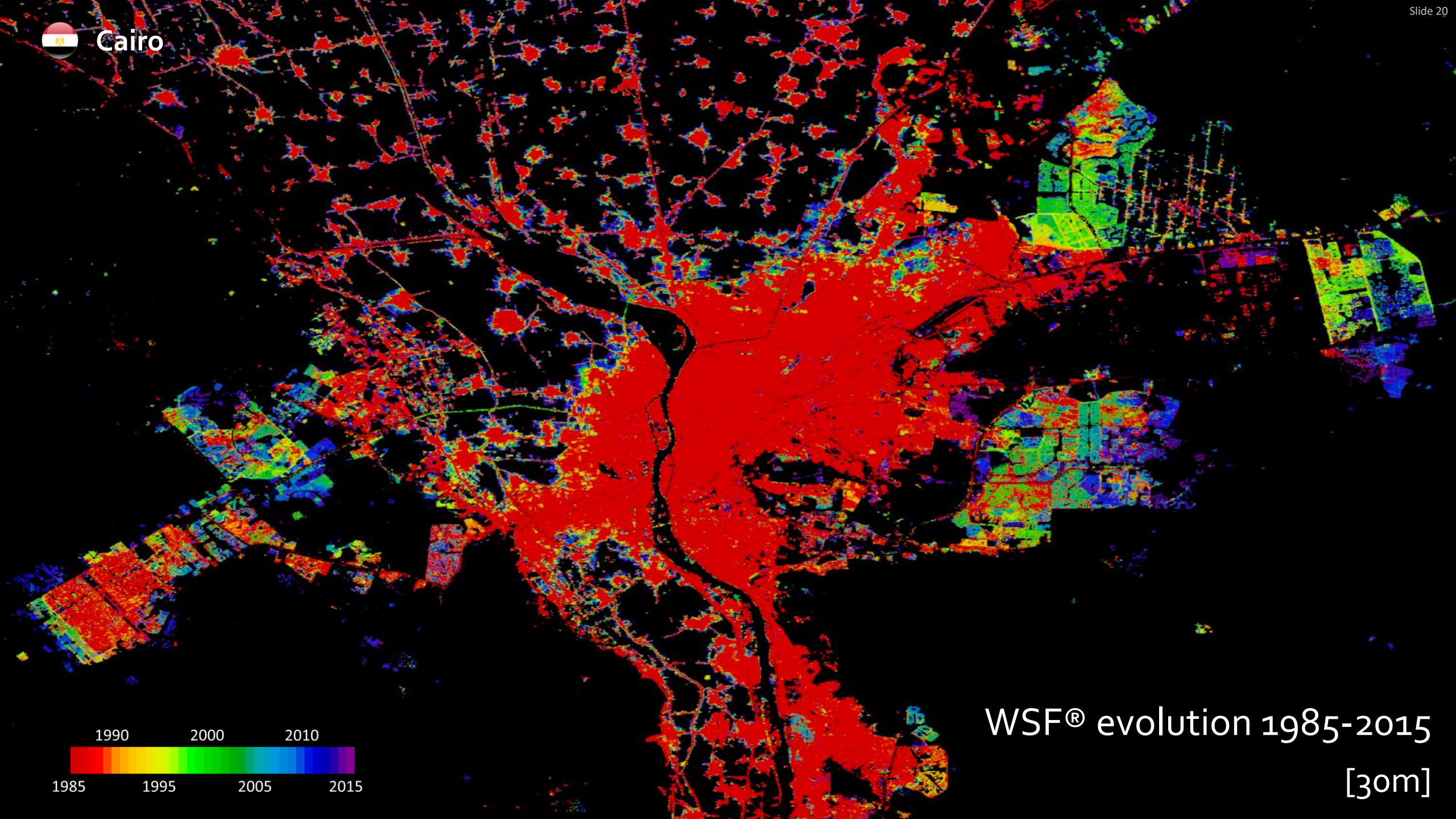


Ludhiana – Chandigarh



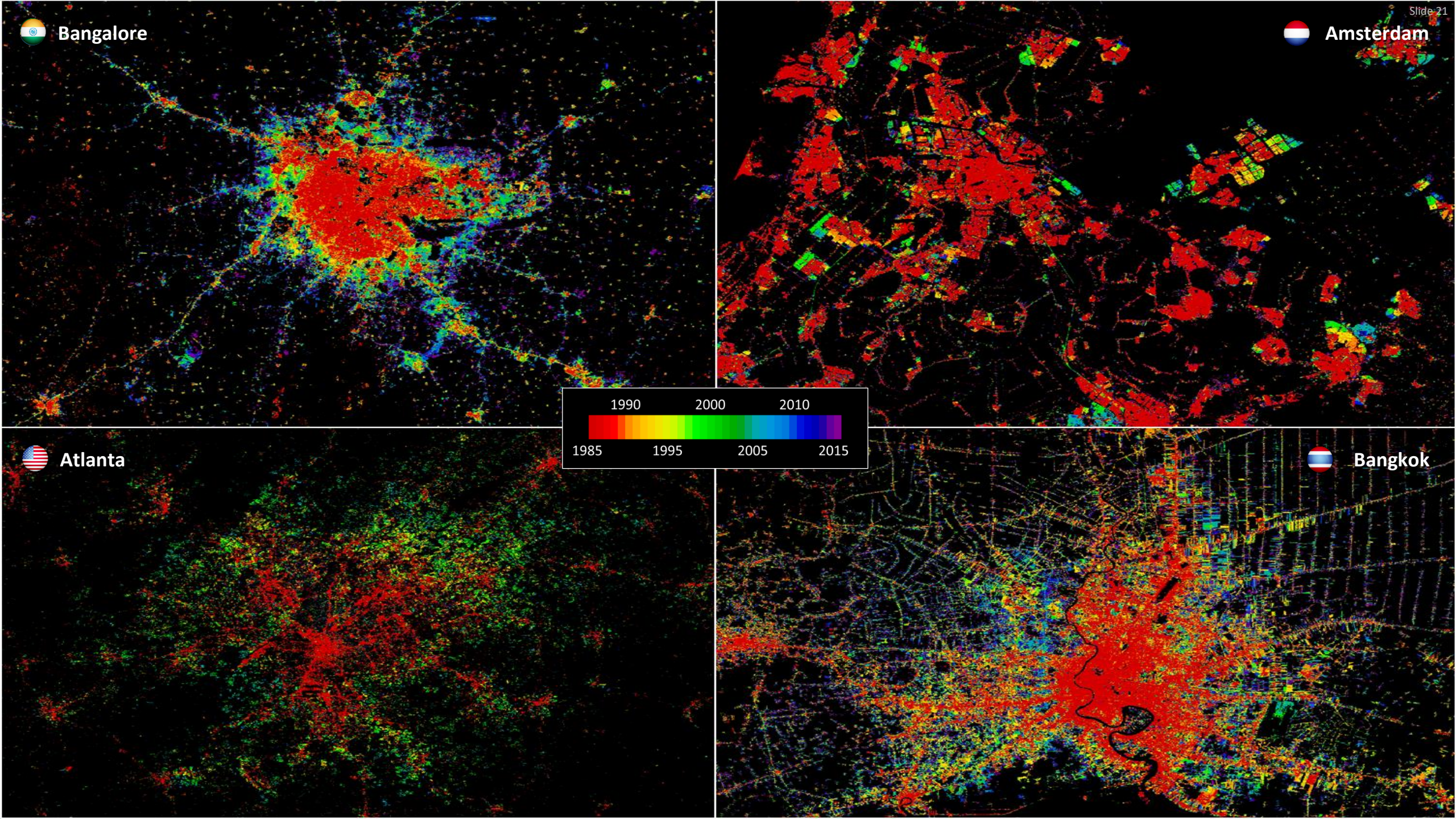

Cairo
Processing of entire Landsat archive
(~7 Petabyte data volume)
WSF® evolution 1985-2015
[30m]

Cairo



WSF® evolution 1985-2015

[30m]


Bangalore
Amsterdam
1990
2000
2010
1985
1995
2005
2015
Atlanta
Bangkok

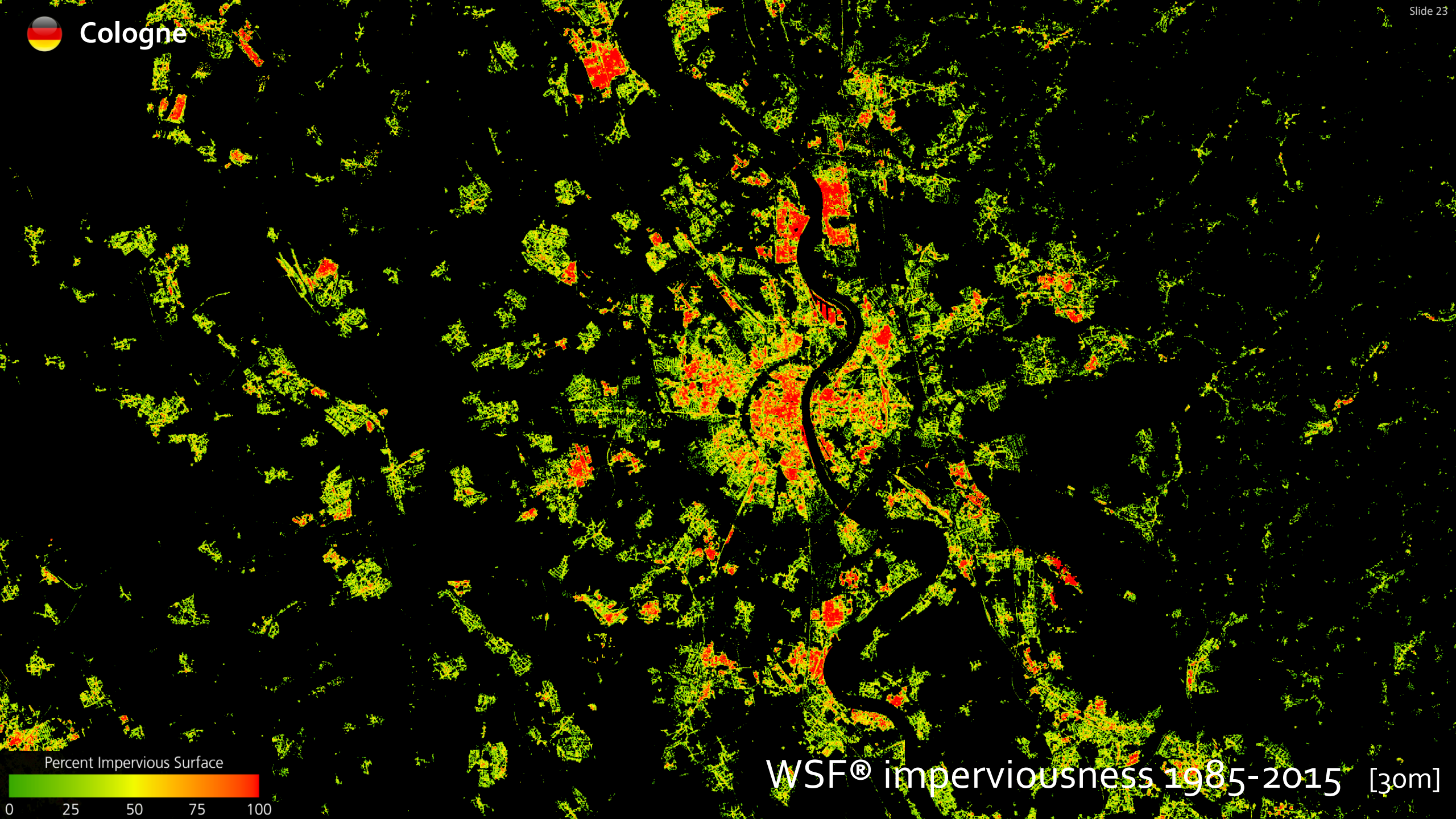
Bangalore

Amsterdam

Atlanta

Bangkok

Cologne



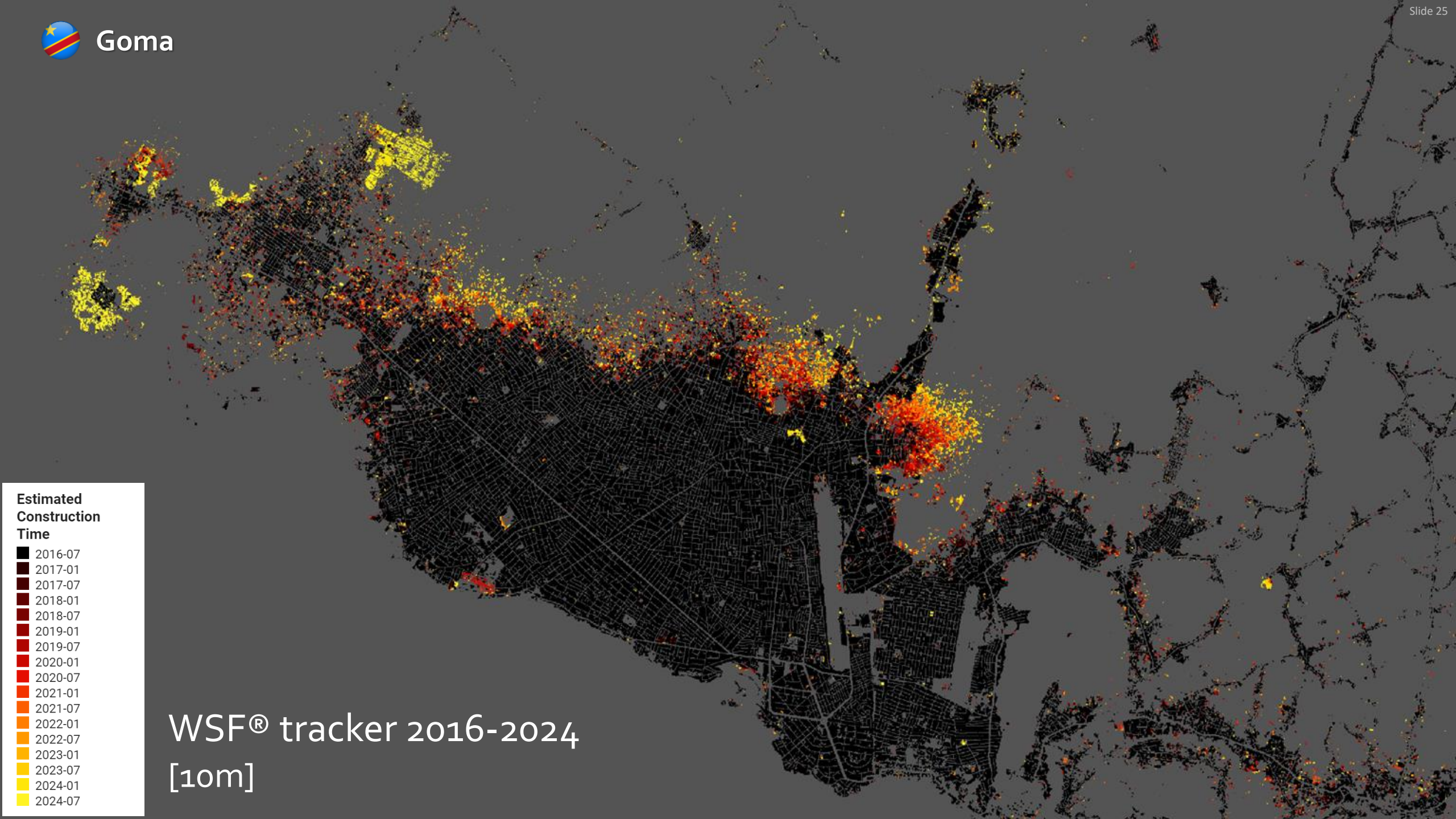
WSF® imperviousness 1985-2015 [30m]

New Cairo

WSF® tracker 2016-2024

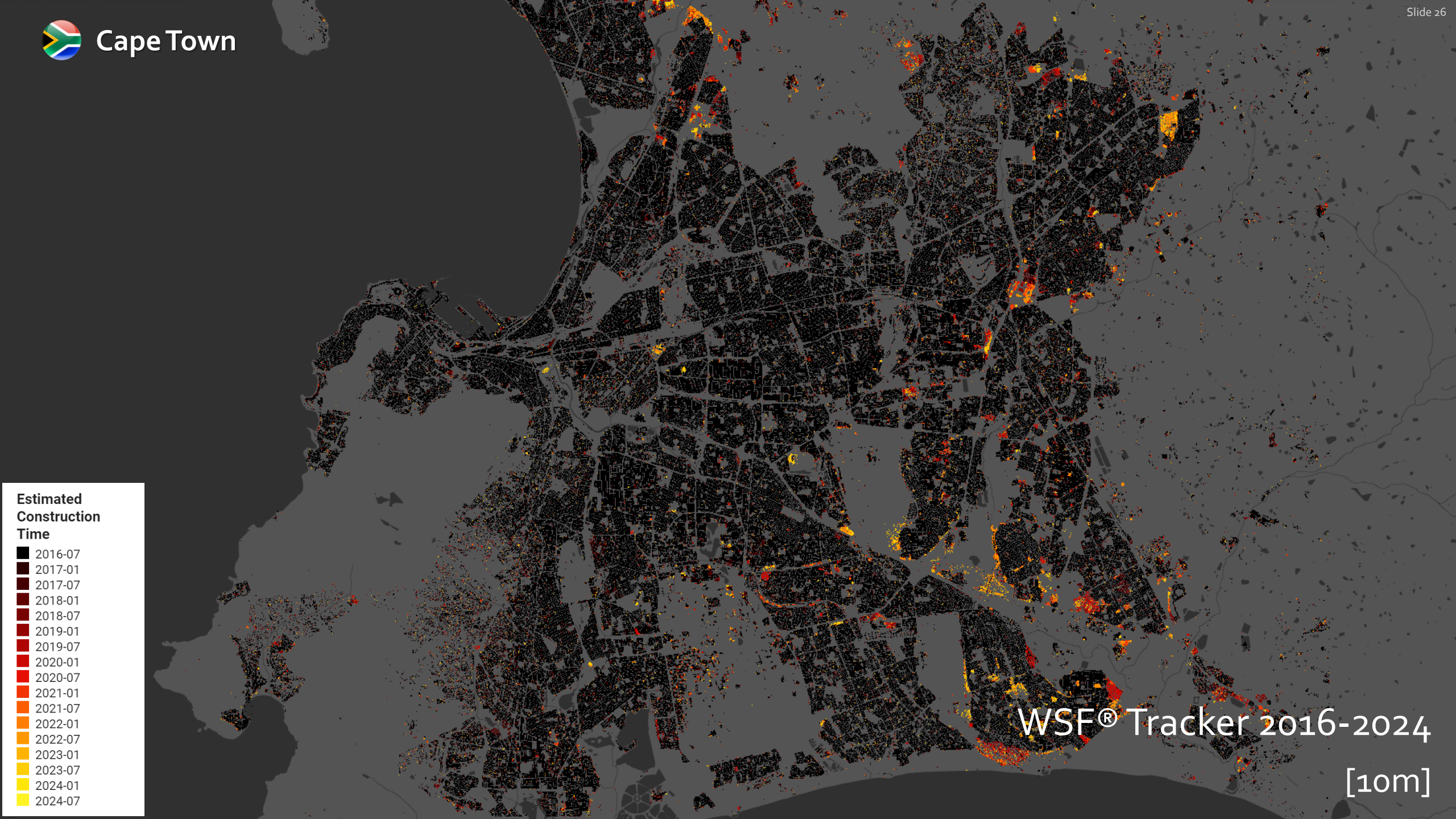
[10m]

Goma



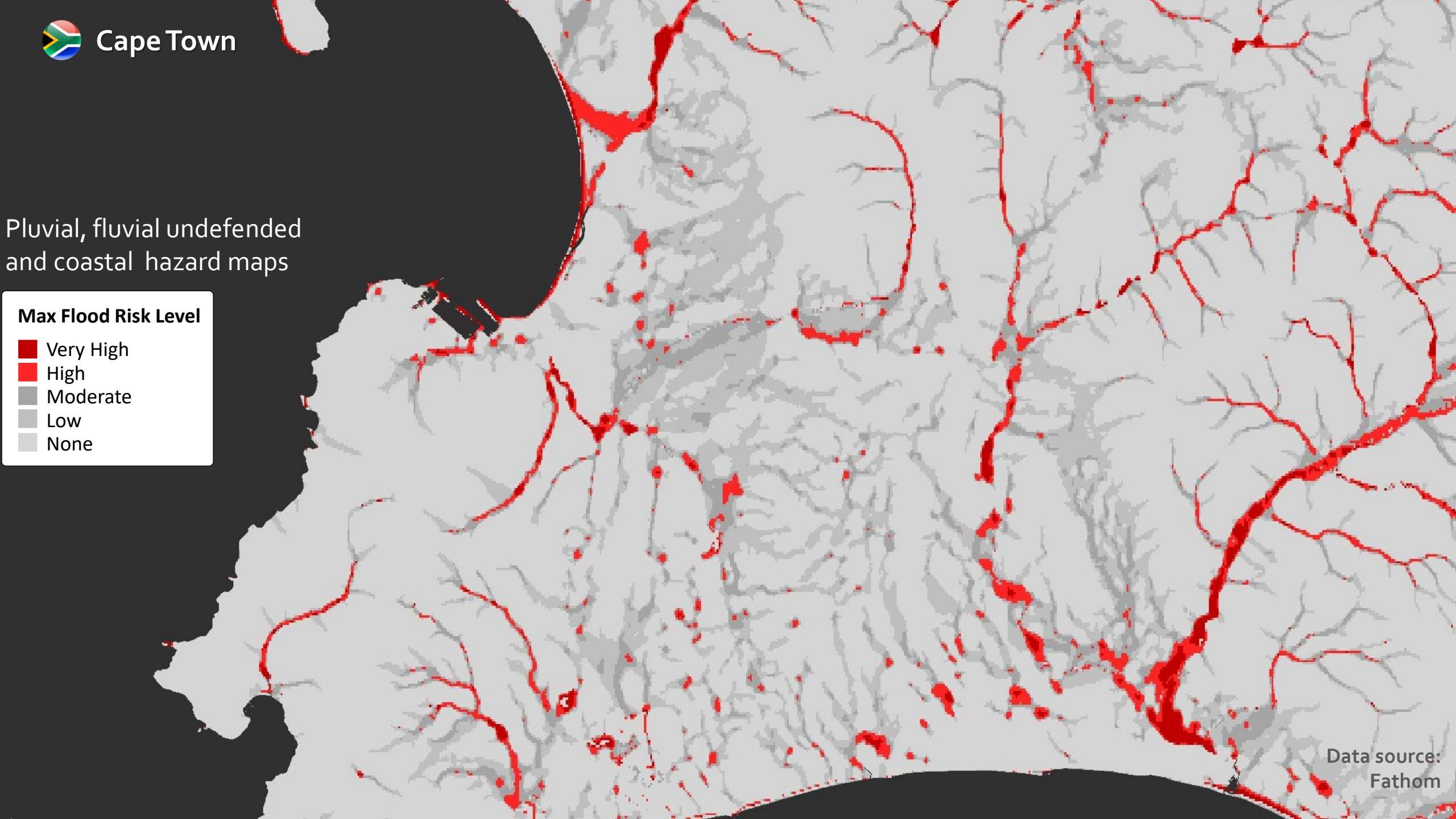
WSF® tracker 2016-2024
[10m]

Cape Town


Estimated Construction Time
2016-07
2017-01
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
2023-07
2024-01
2024-07
WSF® Tracker 2016-2024
[10m]

Cape Town

Pluvial, fluvial undefended and coastal hazard maps




Cape Town
Max Flood Risk Level
Very High
High
Moderate
Low
None
Estimated Construction Time
2016-07
2017-01
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
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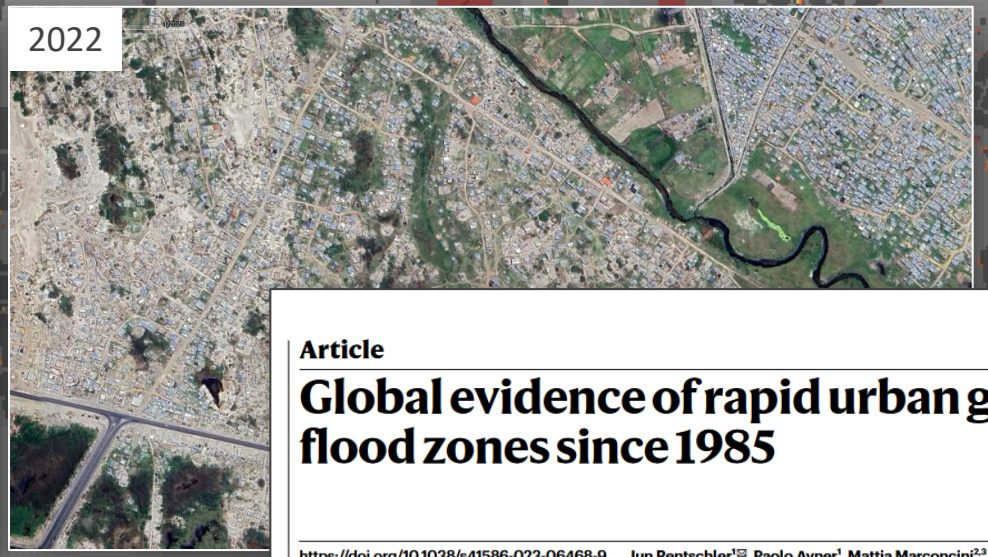
2022-07
2023-01
2023-07
2024-01
2024-07



Max Flood Risk Level

- Very High
- High
- Moderate
- Low
- None

Estimated Year of Construction

- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022

122 % increase in **settlement extent** exposed to the **highest flood hazard** from 1985 to 2015

nature

Article

Global evidence of rapid urban growth in flood zones since 1985

https://doi.org/10.1038/s41586-023-06468-9

Received: 17 March 2022

Accepted: 21 July 2023

Published online: 4 October 2023

Check for updates

Jun Rentschler[1], Paolo Avner[1], Mattia Marconcini[2,3], Rui Su[1], Emanuele Strano[3], Michalis Vousdoukas[4] & Stéphane Hallegatte[1]

Disaster losses are increasing and evidence is mounting that climate change is driving up the probability of extreme natural shocks[1–3]. Yet it has also proved politically expedient to invoke climate change as an exogenous force that supposedly places disasters beyond the influence of local and national authorities[4,5]. However, locally determined patterns of urbanization and spatial development are key factors to the exposure and vulnerability of people to climatic shocks[6]. Using high-resolution annual data, this study shows that, since 1985, human settlements around the world—from villages to megacities—have expanded continuously and rapidly into present-day flood zones. In many regions, growth in the most hazardous flood zones is outpacing growth in non-exposed zones by a large margin, particularly in East Asia, where high-hazard settlements have expanded 60% faster than flood-safe settlements. These results provide systematic evidence of a divergence in the exposure of countries to flood hazards. Instead of adapting their exposure, many countries continue to actively amplify their exposure to increasingly frequent climatic shocks.

The world's cities are growing rapidly as people from peripheral regions move in search of economic opportunities[7]. Urbanization and economic development have traditionally gone hand in hand as cities enable agglomeration economies[8], for instance, by matching employers and job seekers, sellers and buyers, and capital and projects, and supporting productive infrastructure such as public transport systems[9,10].

However, rapid urban growth can also cause congestion effects; for instance, by increasing exposure to natural hazards and pressure on public services and infrastructure. This is particularly relevant in low-income and middle-income countries that lack the capacity for risk-informed urban and infrastructure planning and the resources to invest in transport and protection infrastructure. Moreover, spaces that are safe from floods are increasingly occupied and the resulting land scarcity can drive new developments disproportionately into previously avoided areas, including riverbeds and floodplains (Fig. 1).

Despite the increasing interplay between rapid urbanization trends and flood disasters, the lack of high-resolution flood-hazard maps and annual settlement footprint data has been a key factor limiting systematic analysis of global flood-exposure trends[11]. By using historical records of flood events, such as EM-DAT, studies have estimated expo-

Owing to data limitations, past studies also focus on certain types of flood, rather than assessing the combined hazards from all flood types (that is, fluvial, pluvial and coastal flooding)[11,14,16–18]. Others assess hazards for a subset of countries, falling short of full global coverage[19,20]. Similarly, studies using relatively coarse spatial resolution flood-hazard data tend to inaccurately represent principal floodplains, thus underestimating exposure[19,21–25].

This study makes several contributions. First, by considering flood-exposure trends with annual frequency, it demonstrates the value of continuous monitoring of evolving flood exposure. Second, it distinguishes the growth dynamics of flood-exposed versus flood-safe spatial development to document a divergence in flood exposure—regions that are either increasing or decreasing exposure as they urbanize. Third, rather than focusing on a certain flood type, it combines different flood types and assesses overall exposure. Fourth, by using high-resolution global datasets, it documents trends with complete global coverage and within one consistent methodology. Last, by estimating spatially disaggregated trends of urbanization and flood exposure, it offers concrete evidence to policymakers for prioritizing measures in risk prevention, reduction and preparedness

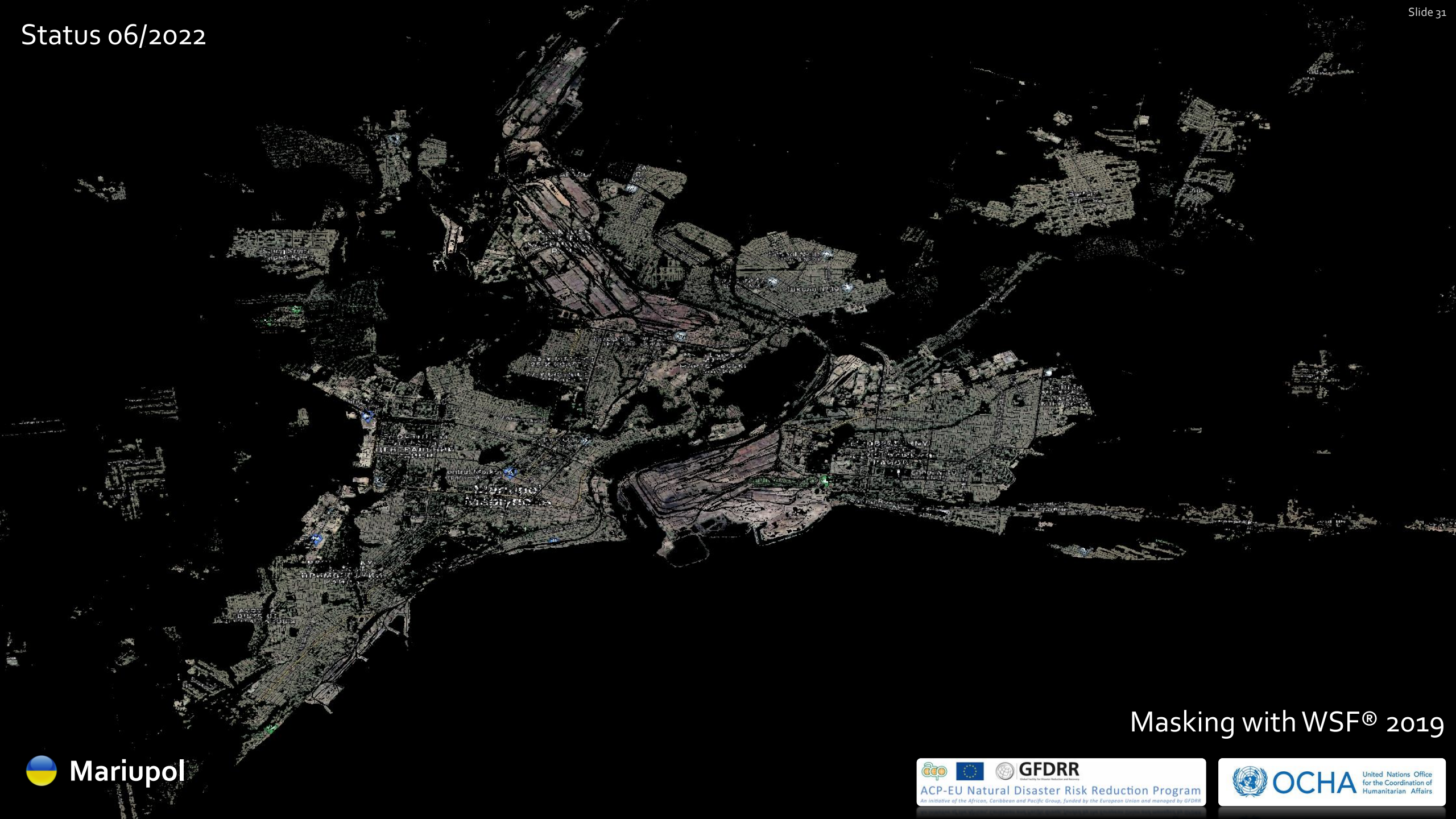
Damage mapping in the event of natural disasters or conflicts

Ukraine conflict (status 06/2022)

Mariupol

ACP-EU Natural Disaster Risk Reduction Program
An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR
GFDRR
OCHA United Nations Office for the Coordination of Humanitarian Affairs

Status 06/2022



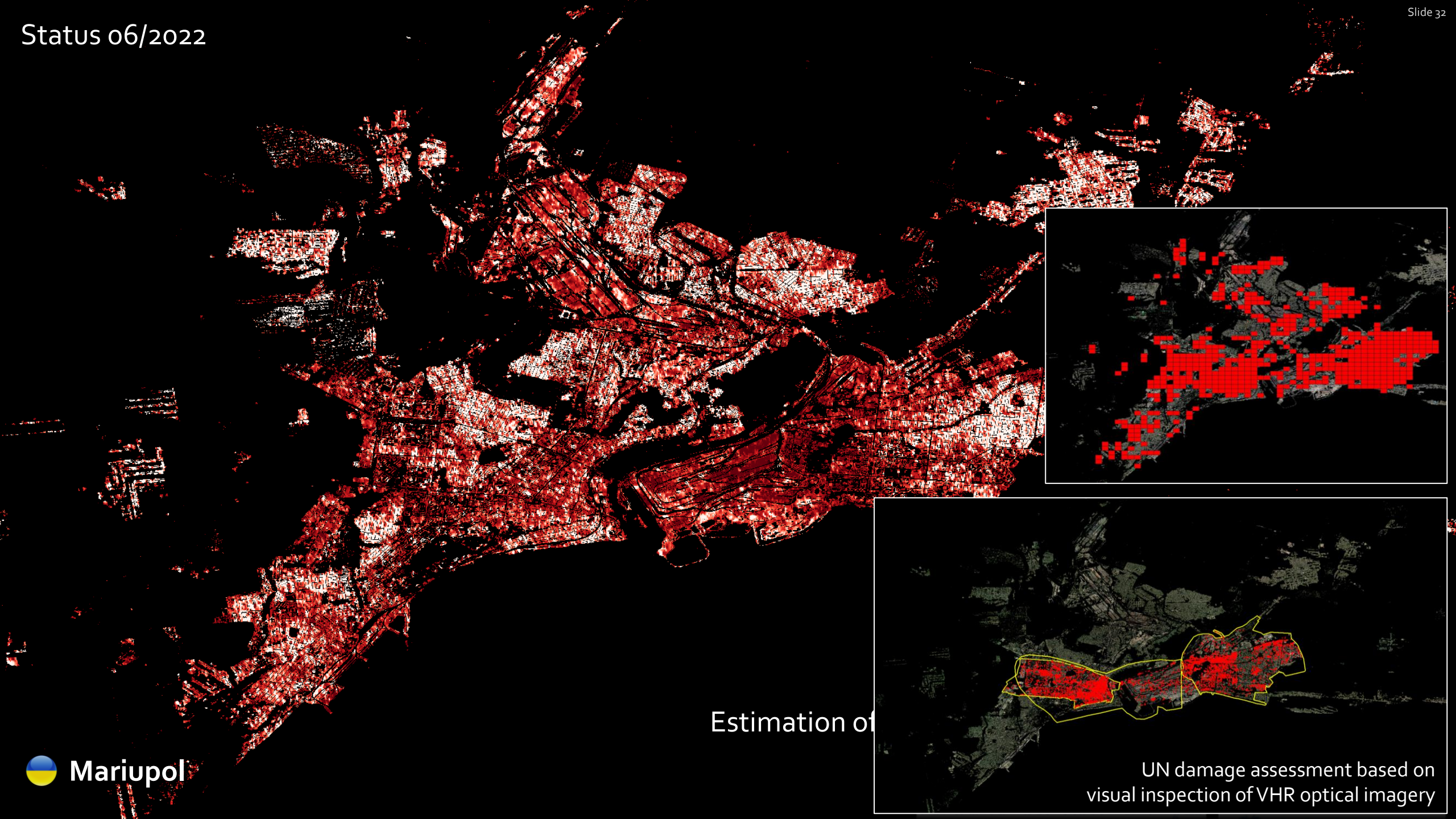
Masking with WSF® 2019

Mariupol

ACP-EU Natural Disaster Risk Reduction Program
An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR

OCHA United Nations Office for the Coordination of Humanitarian Affairs

Status 06/2022

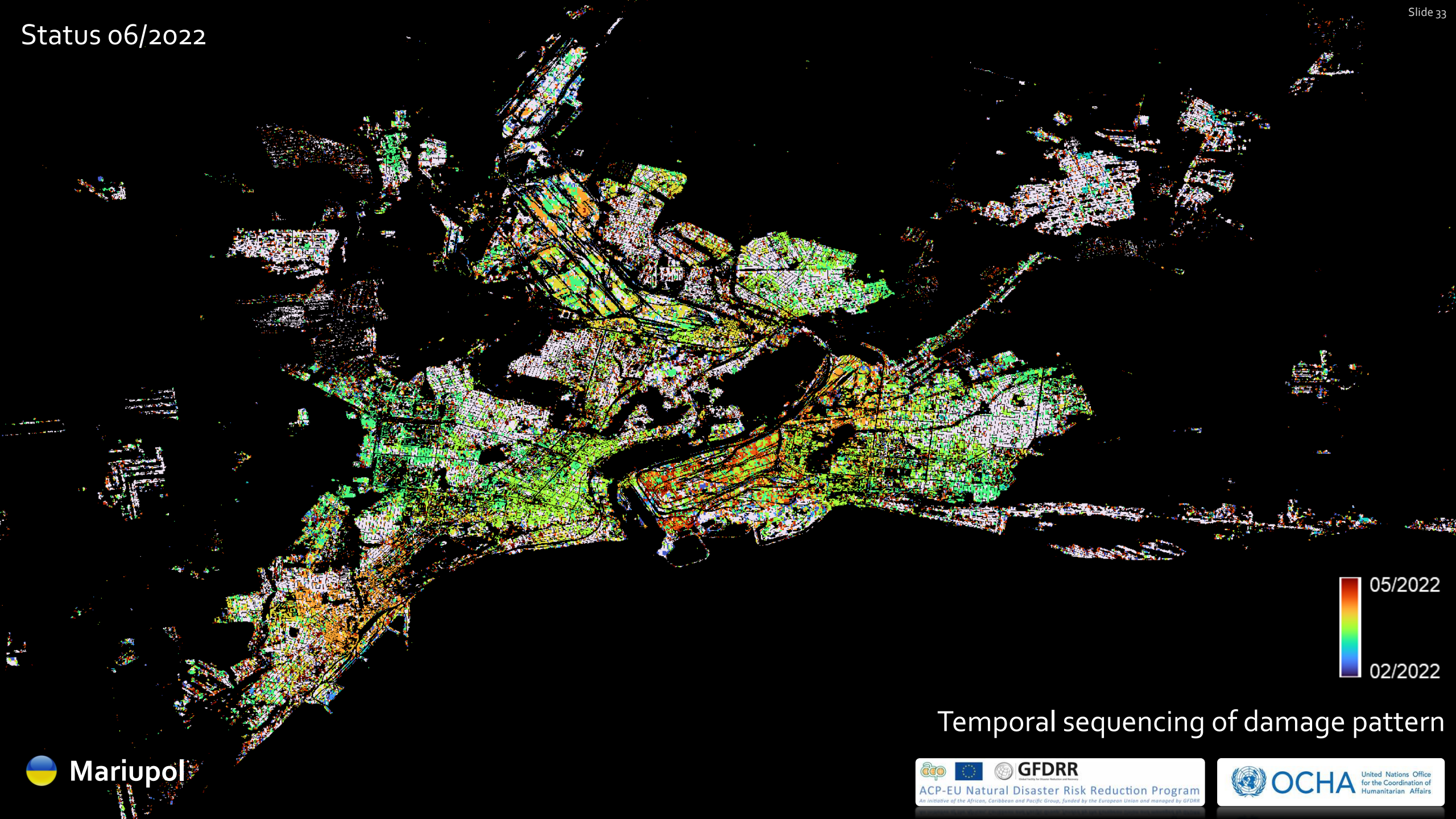


Estimation of

UN damage assessment based on visual inspection of VHR optical imagery

Mariupol

Status 06/2022



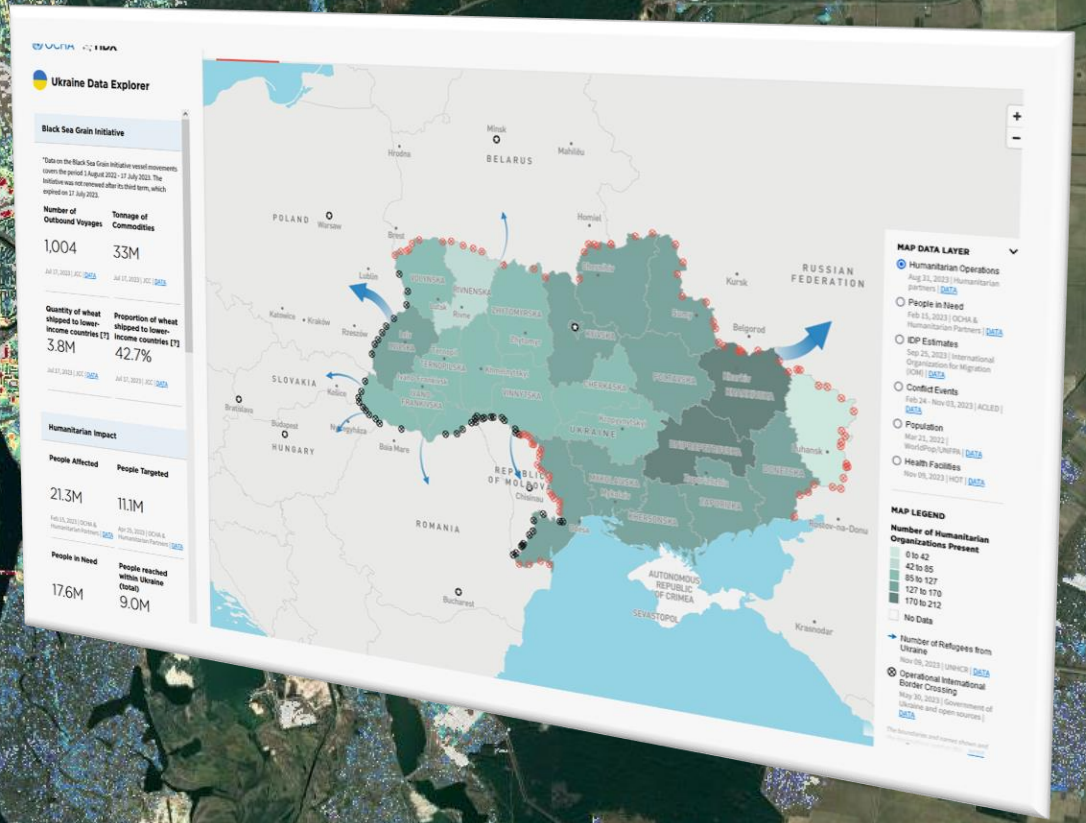
Temporal sequencing of damage pattern

Mariupol

GFDRR
ACP-EU Natural Disaster Risk Reduction Program
An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR
OCHA United Nations Office for the Coordination of Humanitarian Affairs

Status 06/2022

WSF® population 2022 [10m]



Kyiv

Persons per pixel (10m x 10m)

0 >0 <6

ACP-EU Natural Disaster Risk Reduction Program

An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR

GFDRR

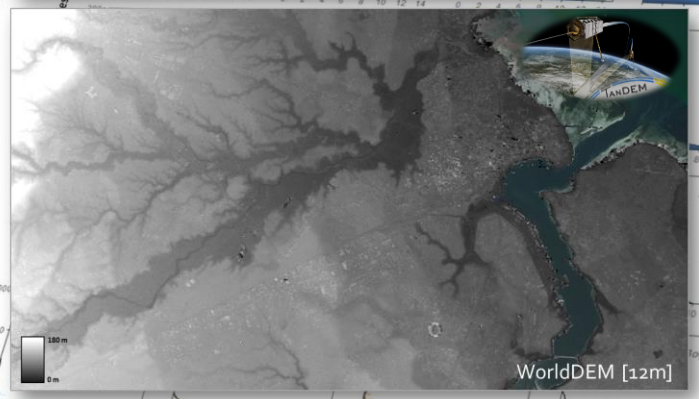
OCHA United Nations Office for the Coordination of Humanitarian Affairs

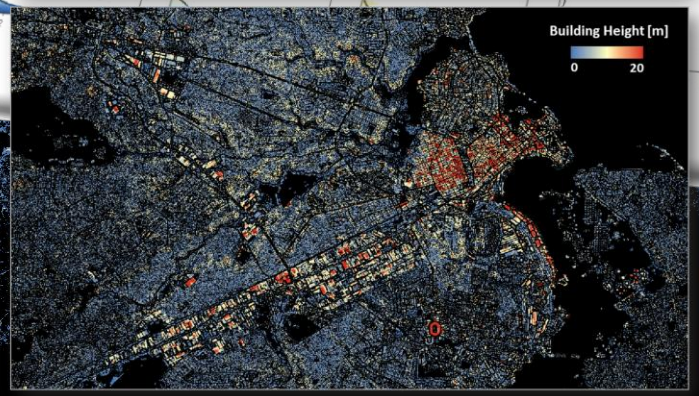
World Settlement Footprint 3D – WSF® 3D

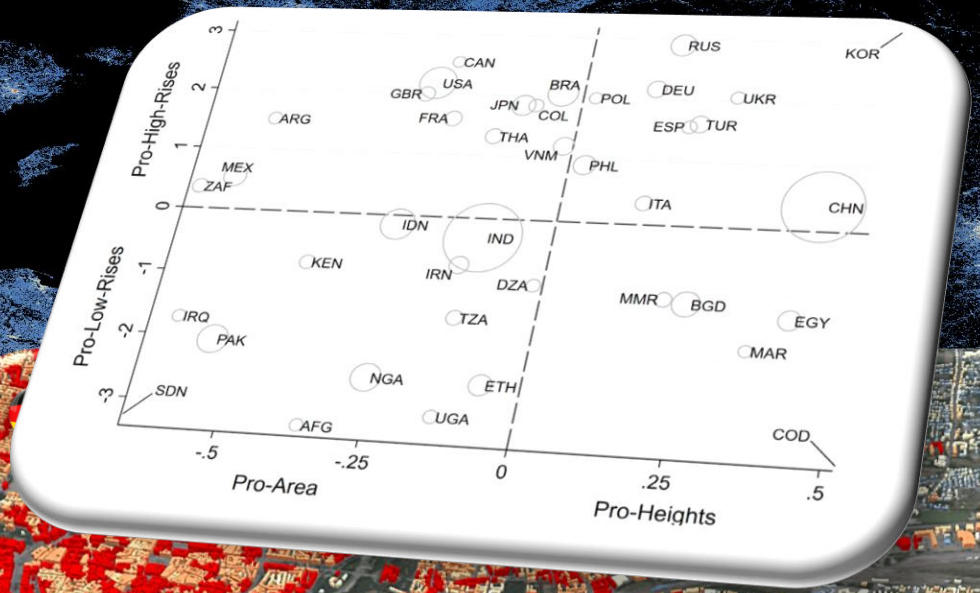
[90m]

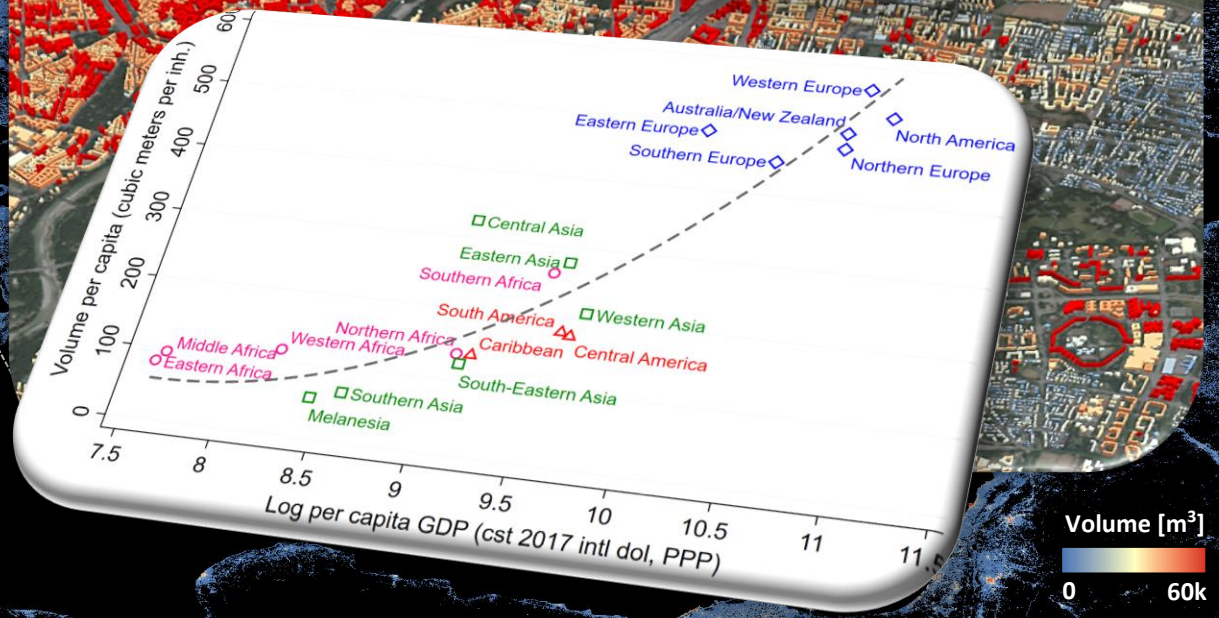
First worldwide 3D mapping of entire built environment

World Settlement Footprint 3D [90m]



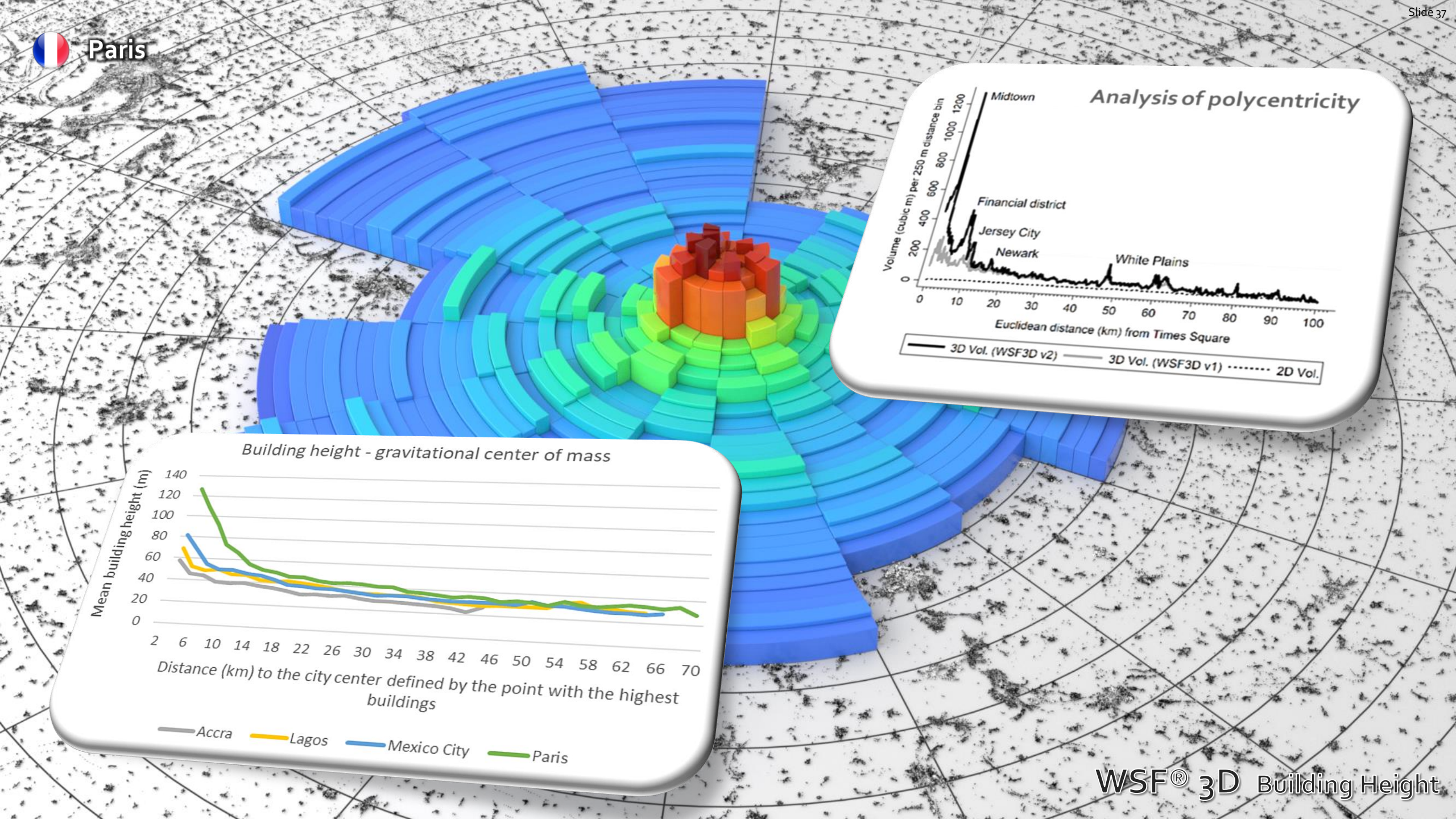






First worldwide 3D mapping of entire built environment

Paris


Analysis of polycentricity
Midtown
Financial district
Jersey City
Newark
White Plains
Volume (cubic m) per 250 m distance bin
0
200
400
600
800
1000
1200
0
10
20
30
40
50
60
70
80
90
100
Euclidean distance (km) from Times Square
3D Vol. (WSF3D v2)
3D Vol. (WSF3D v1)
2D Vol.
Building height - gravitational center of mass
Mean building height (m)
0
20
40
60
80
100
120
140
2
6
10
14
18
22
26
30
34
38
42
46
50
54
58
62
66
70
Distance (km) to the city center defined by the point with the highest buildings
Accra
Lagos
Mexico City
Paris

Climate change mitigation and adaptation

Bundesinstitut für Bau-, Stadt- und Raumforschung

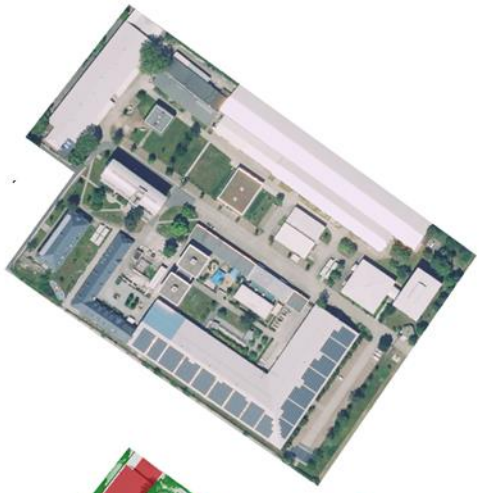
Federal property

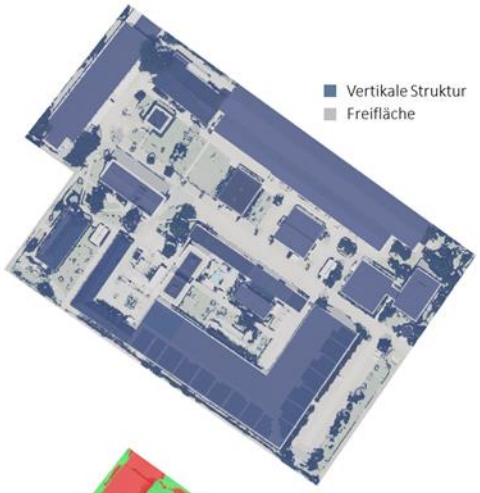
Vertical structure

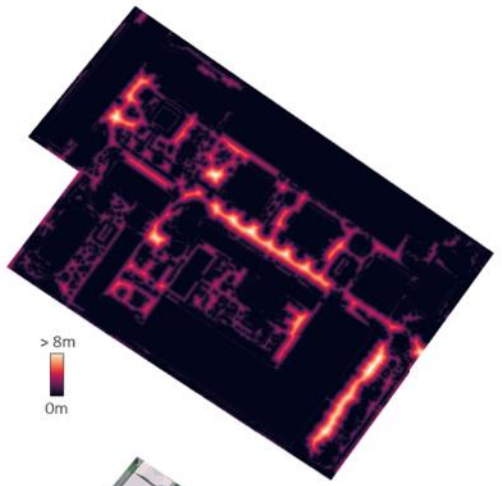
Open space

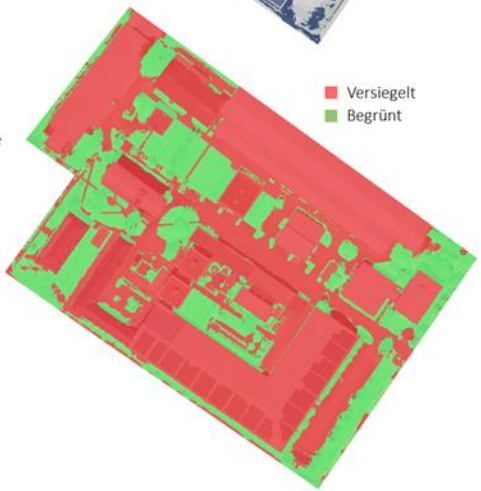
Climate change mitigation and adaptation

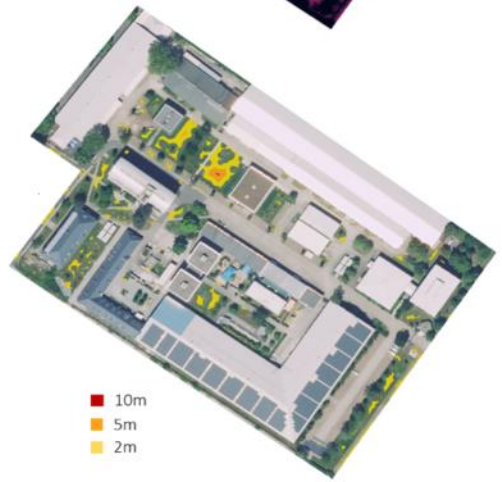
Bundesinstitut für
Bau-, Stadt- und Raumforschung











Orthophoto
(DOP20 – RGB)

Informationen aus Geobasisdaten
- Flurstück
- Bundesgebäude
- Sonstiges Gebäude

KI-basierte Auswertung von DOP20 Luftbildern
- Gebäude mit Gründach
- Gebäude mit PV-Anlage

Informationen aus Geobasisdaten
- Flurstück mit Bundesgebäude
- Gebäude

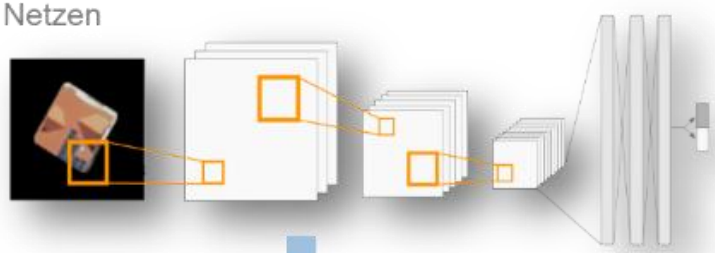
Auswertung von Luftbilddaten und digitalem Oberflächenmodell mittels machinellem Lernen
- Höhe der Vegetation
- Vegetationslose Freifläche

Green open space | Impervious surface | Trees, hedges | Building

Climate change mitigation and adaptation

Erstellung von Trainigsdaten
- Manuelle Erhebung auf Basis von Luftbildern
- Automatisierte Stichprobennahme über Adressen aus öffentlichen Registern (Bundesnetzagentur)

Künstliche Intelligenz - Modelltraining und Qualitätsbewertung mit Faltungsneuronalen Netzen



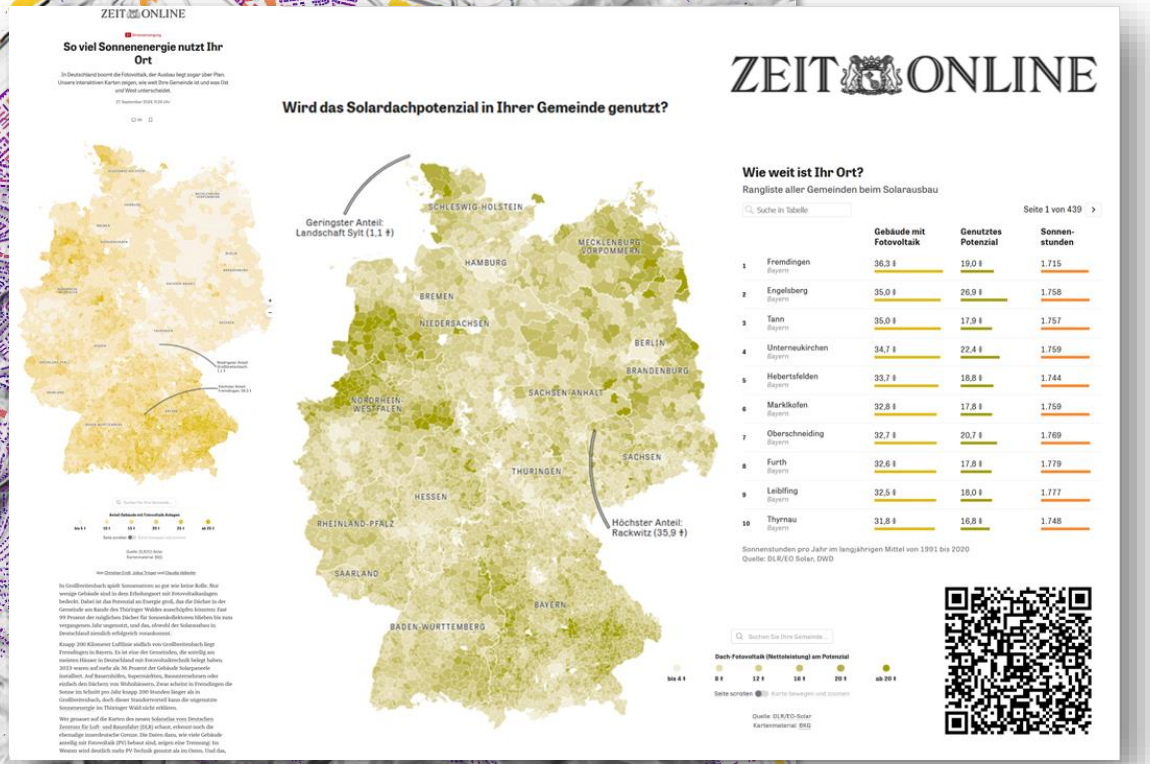
Fernerkundung

Deutschlandweite, sehr hochauflösende Luftbilder (RGB-NIR)

Modell-Erstellung
Erfassung von Solaranlagen für jedes Gebäude in Deutschland

Climate change mitigation and adaptation

DOM1 © GeoBasis-DE / BKG (2023)



Stuttgart

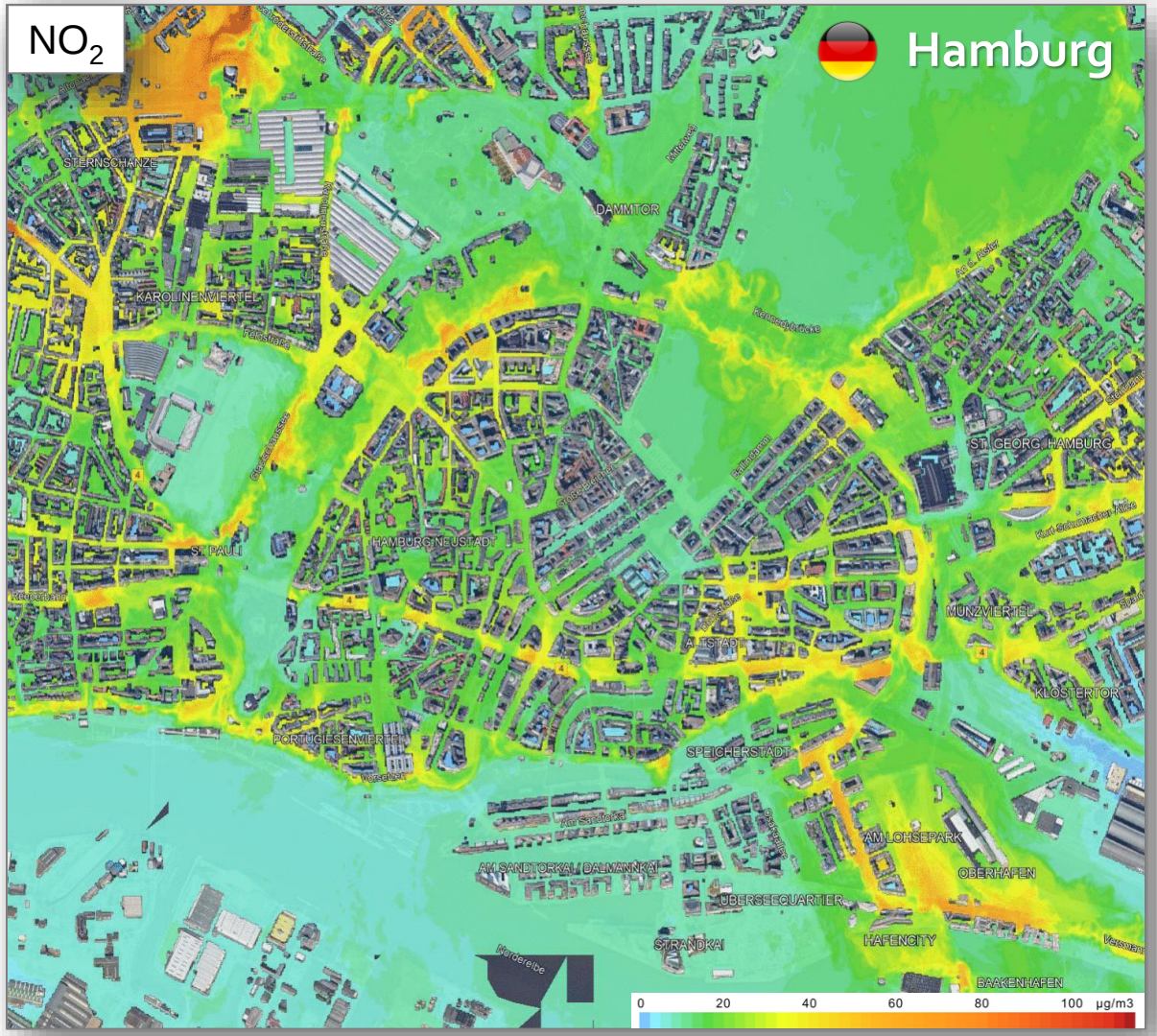
eosolar.dlr.de

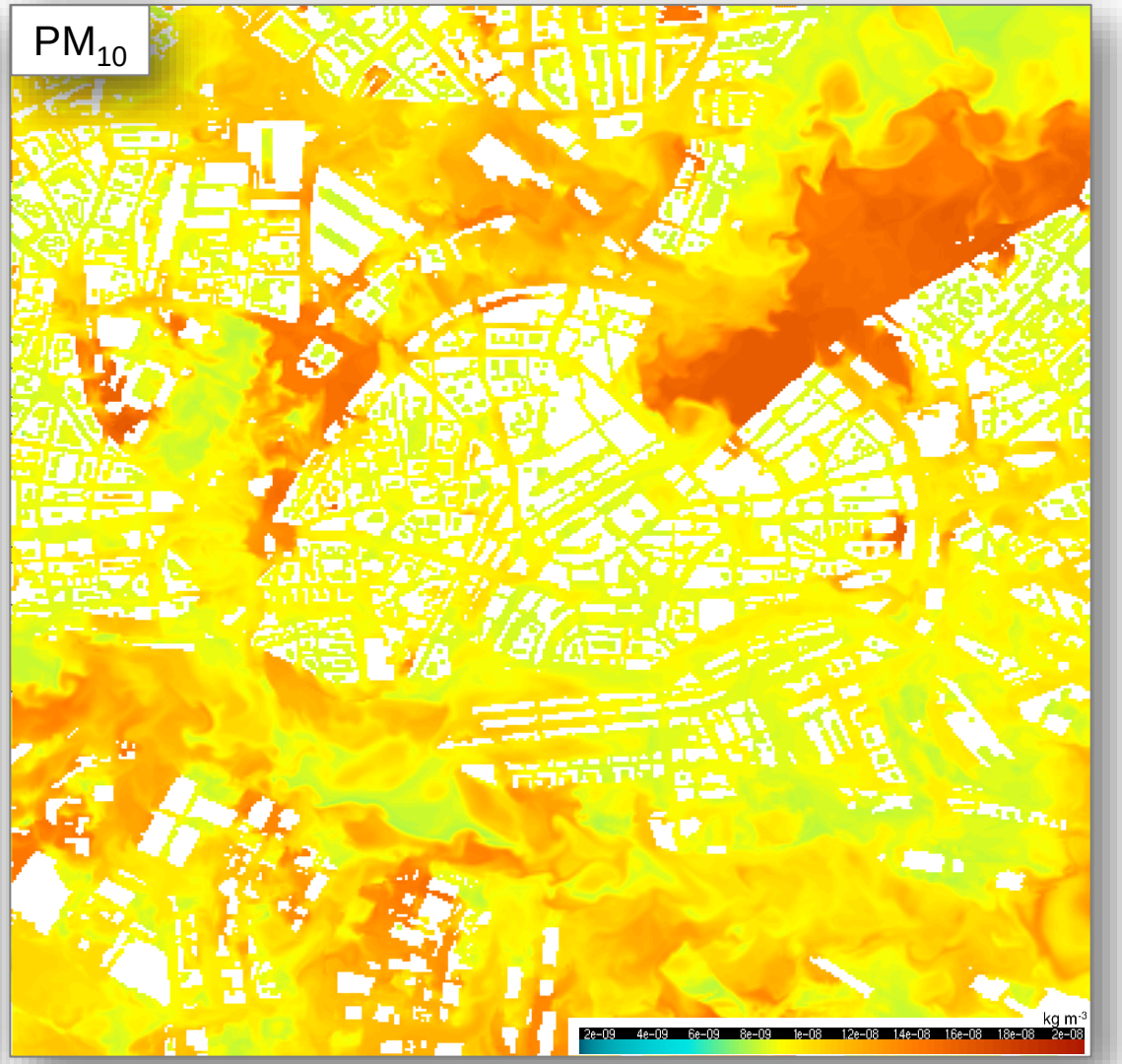
>0 10 35 150 500 >750

Solar Potential [MWh/Jahr]

Climate change mitigation and adaptation

Bundesministerium für Bildung und Forschung
FONA Forschung für Nachhaltigkeit
DLR
[UC]² Urban Climate Under Change Stadtklima im Wandel

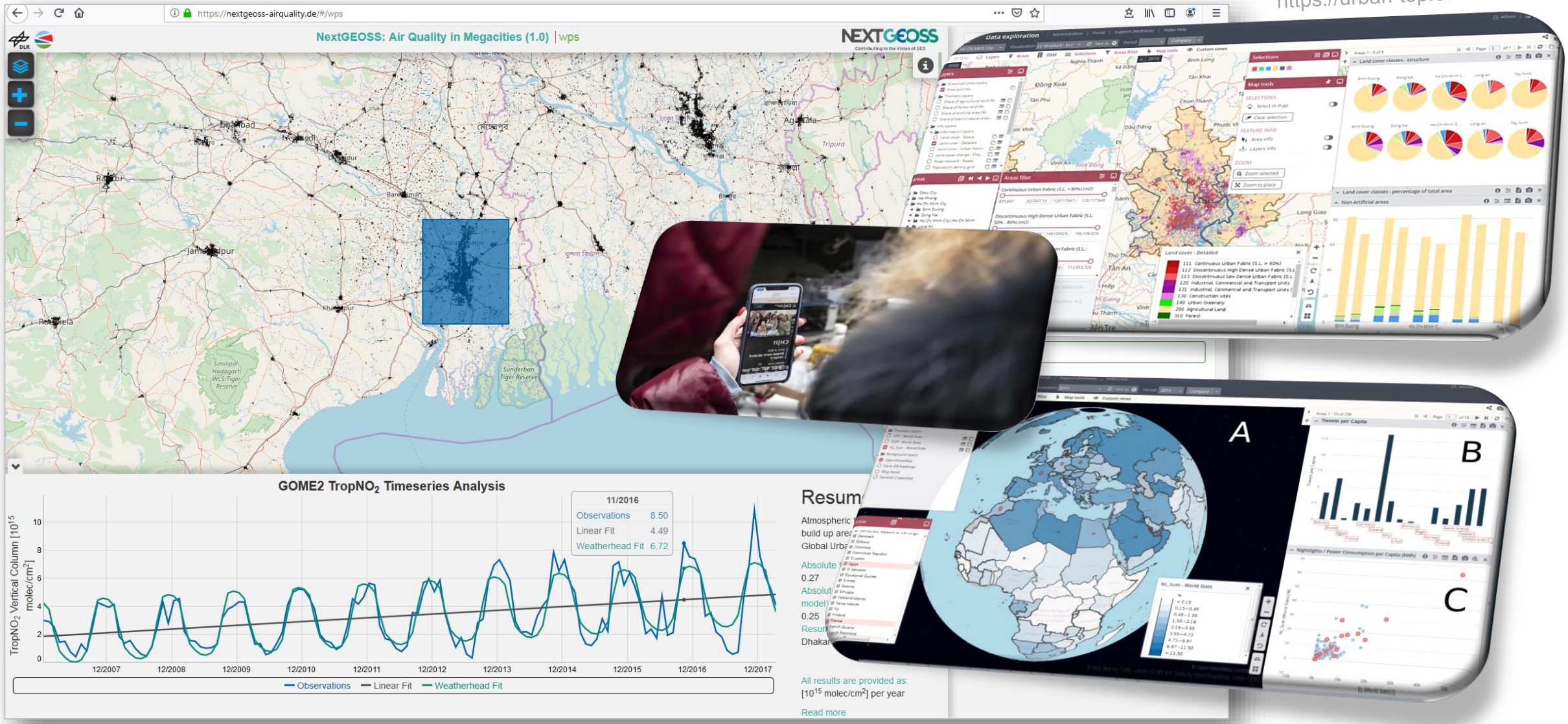




PALM-4U urban climate model (Hamburg city centre, 15 March 2022, 7:00 to 9:00 am, 5 m x 5 m spatial resolution)

Enabling Technologies and Decision Support

https://urban-tep.eu



Enabling Technologies and Decision Support

Evidence-based policy advice and decision support

Knowledge and technology transfer

Vielen Dank
für Ihre Aufmerksamkeit!

Email: Thomas.Esch@dlr.de | Telefon: +49 8153 28-3721

Team Smart Cities und Raumentwicklung:
Thomas Esch – Martin Habermeyer – Devanshi Kacholia – Mattia Marconcini – Annekatrin Metz-Marconcini – Julian Zeidler – Cornelia Zygar

Zugang zu WSF® Daten: https://geoservice.dlr.de/web