→ EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Urban Development

City Academy: Geospatial Data Applications for Urban Development, Sao Paulo 16.-17.09.2019

What can Earth Observation provide for Urban Applications?

Amelie Broszeit, GAF AG

urban development
eo4sd

GAFAG SIRS gisat

DLR egis JOANNEUM RESEARCH NEO GISBOX

Agenda and Speaker

Speaker

Amelie Broszeit
Remote Sensing Specialist
GAF AG Munich, Germany

Agenda

What can Earth Observation provide for Urban Applications?

1) EO products for Urban Development
2) EO based Solutions for Urban Planning
3) EO products and application fields
4) Value of EO products

EO Products for Urban Development

Satellite Data: HR, VHR

Preprocessing:
- Geometric Validation
- Atmosphere Correction
- Cloud Masking
- ...

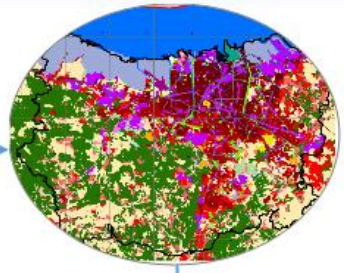
Ancillary Data:
- OSM Data
- User Data

Semi-Automatic/ Automatic Classification

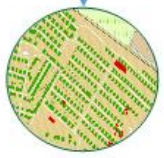
Transport Network

Land Use / Land Cover

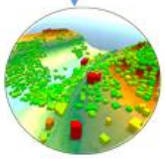
With **VHR Data:**	With **HR Data:**
- Up to 30 classes	- Up to 10 classes
- Accuracy > 85%	- Accuracy > 85%
- MMU = 0.25 ha	- MMU = 0.5 to 1 ha



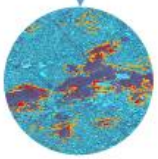
Urban Extent, Imperviousness and Change



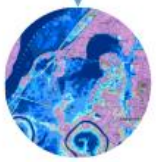
Building Footprint and Heights



Elevation Models

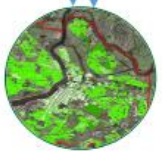


Landslide Risk



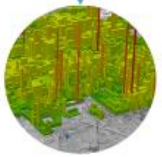
Flood Risk

Terrain Motion



Urban Green Areas

Informal Settlements



Population Distribution

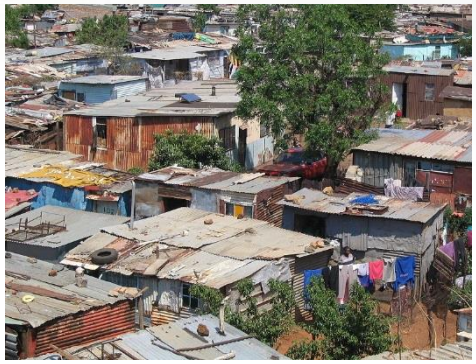
Advanced Spatial Analytics
Indicators of Sustainable Development Goal 11, Urban Planning Metrics

EO Based Solutions for Urban Planning

- Analysis of the effectiveness of Urban Master Plans
- Urban Growth Analyses

- Infrastructure Planning (e.g. Road Network Analysis, Accessibility Analysis)

- Assessment and monitoring of slums areas and informal settlements (e.g. EO-Monitoring of unplanned urban sprawl)



EO Based Solutions for Urban Planning

- Urban green areas planning

- Population distribution and density estimations
- Building heights data for tax estimation

- Risk / Disaster assessment
  e.g. Flood risk, land subsidence monitoring
- Monitoring of urban indicators
  e.g. SDG Goal 11 indicators

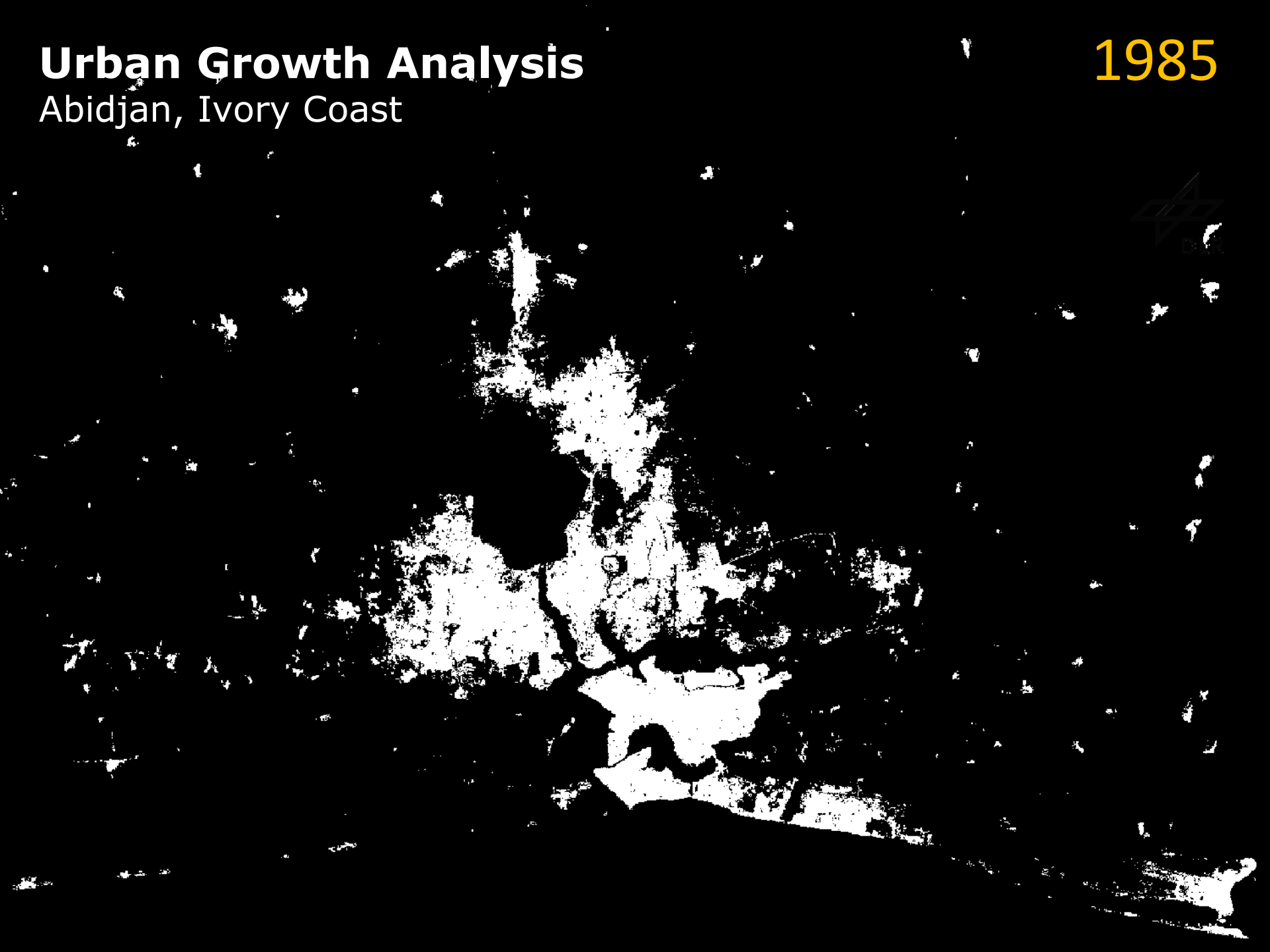
Urban Growth Analysis

Abidjan, Ivory Coast

Urban Growth Analysis

Abidjan, Ivory Coast

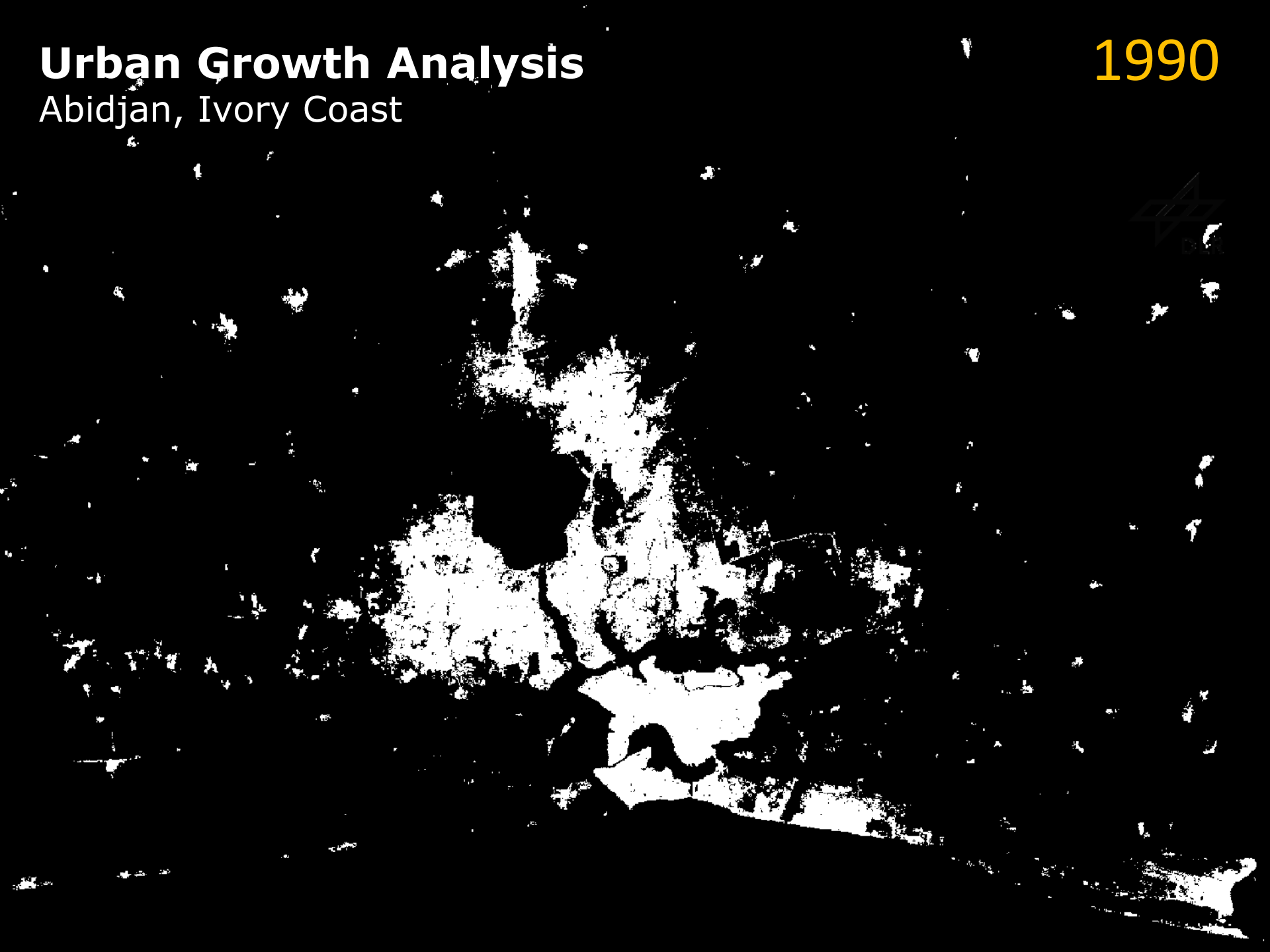
1985



Urban Growth Analysis

Abidjan, Ivory Coast

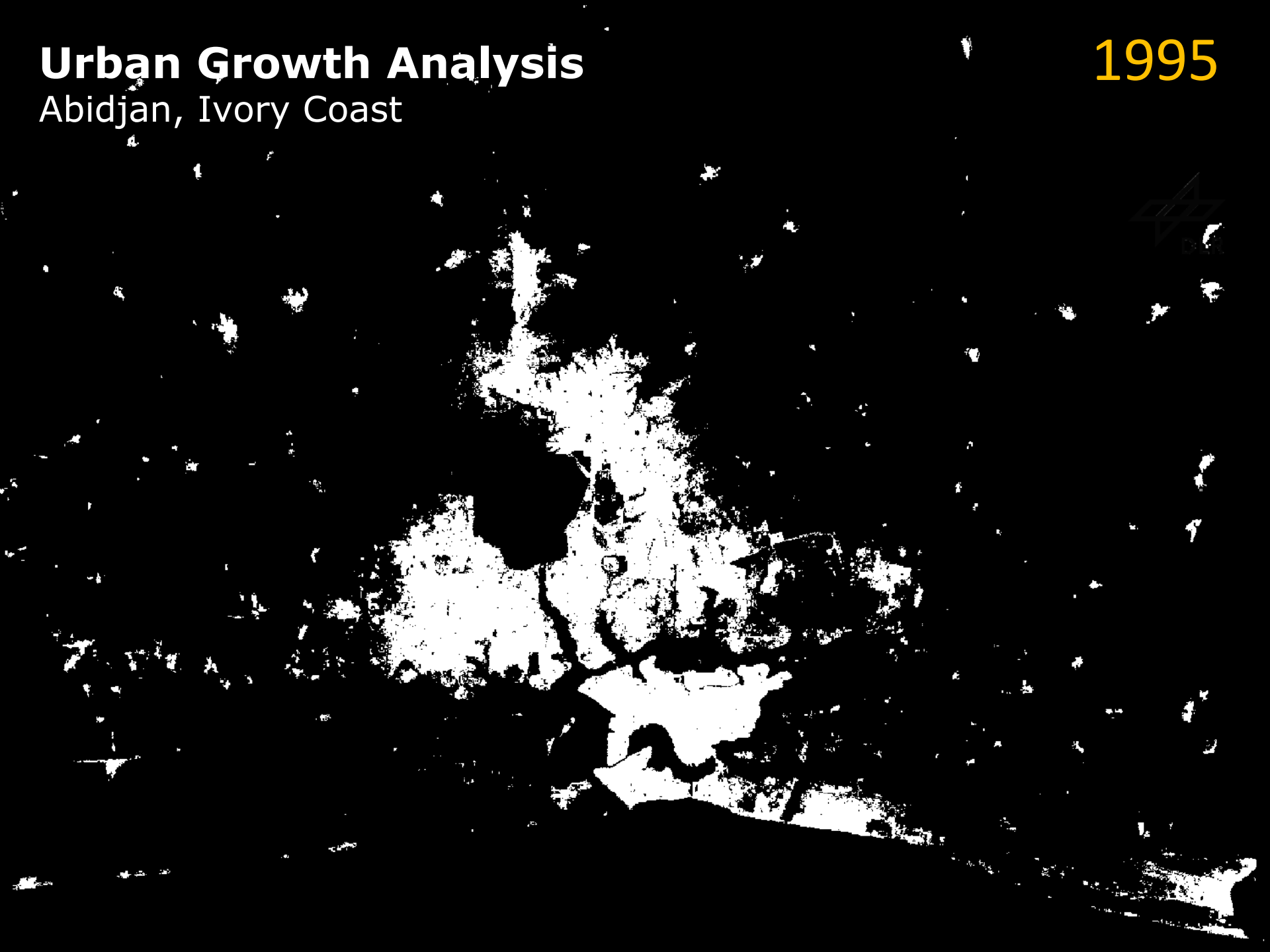
1990



Urban Growth Analysis

Abidjan, Ivory Coast

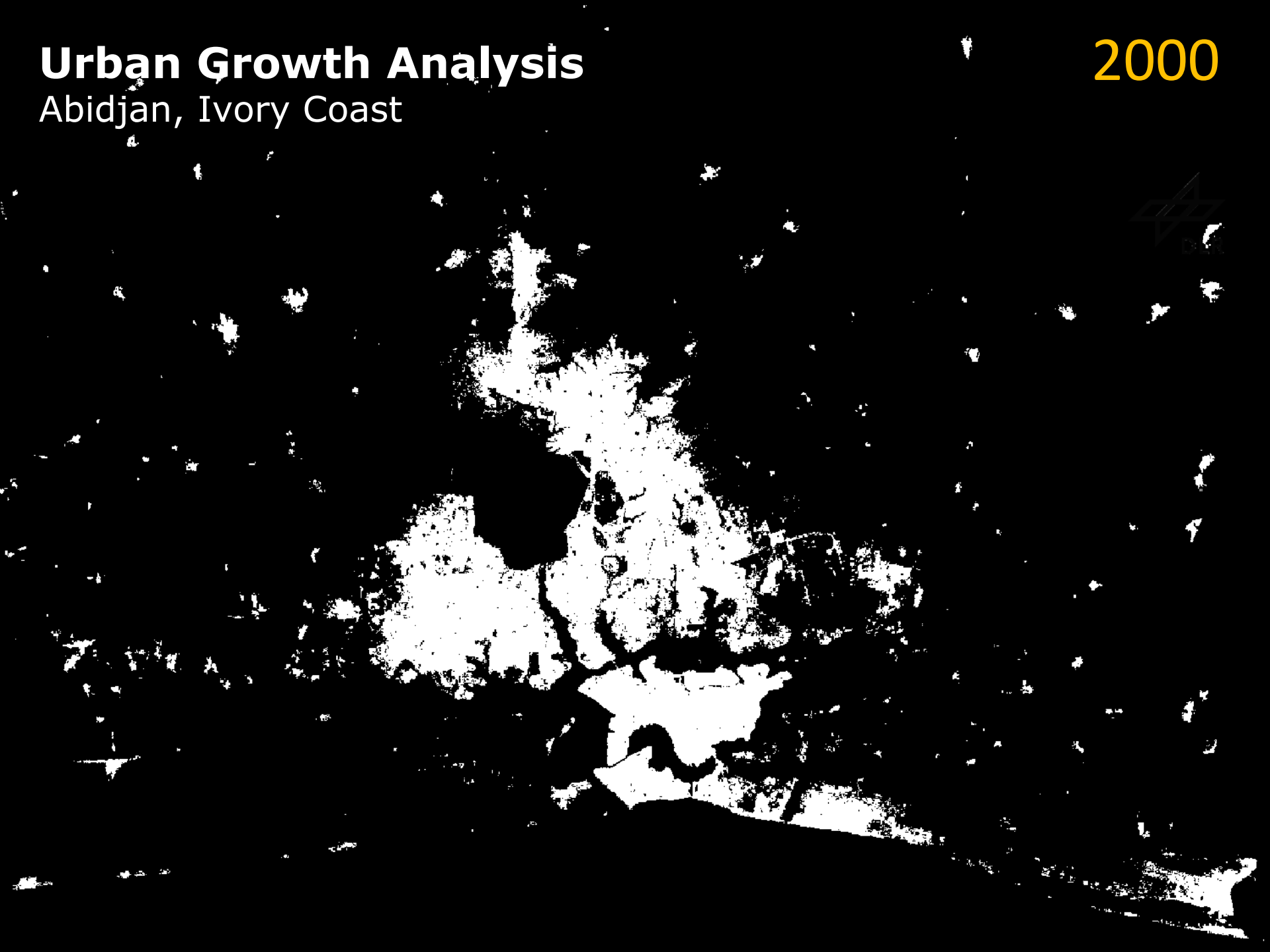
1995



Urban Growth Analysis

Abidjan, Ivory Coast

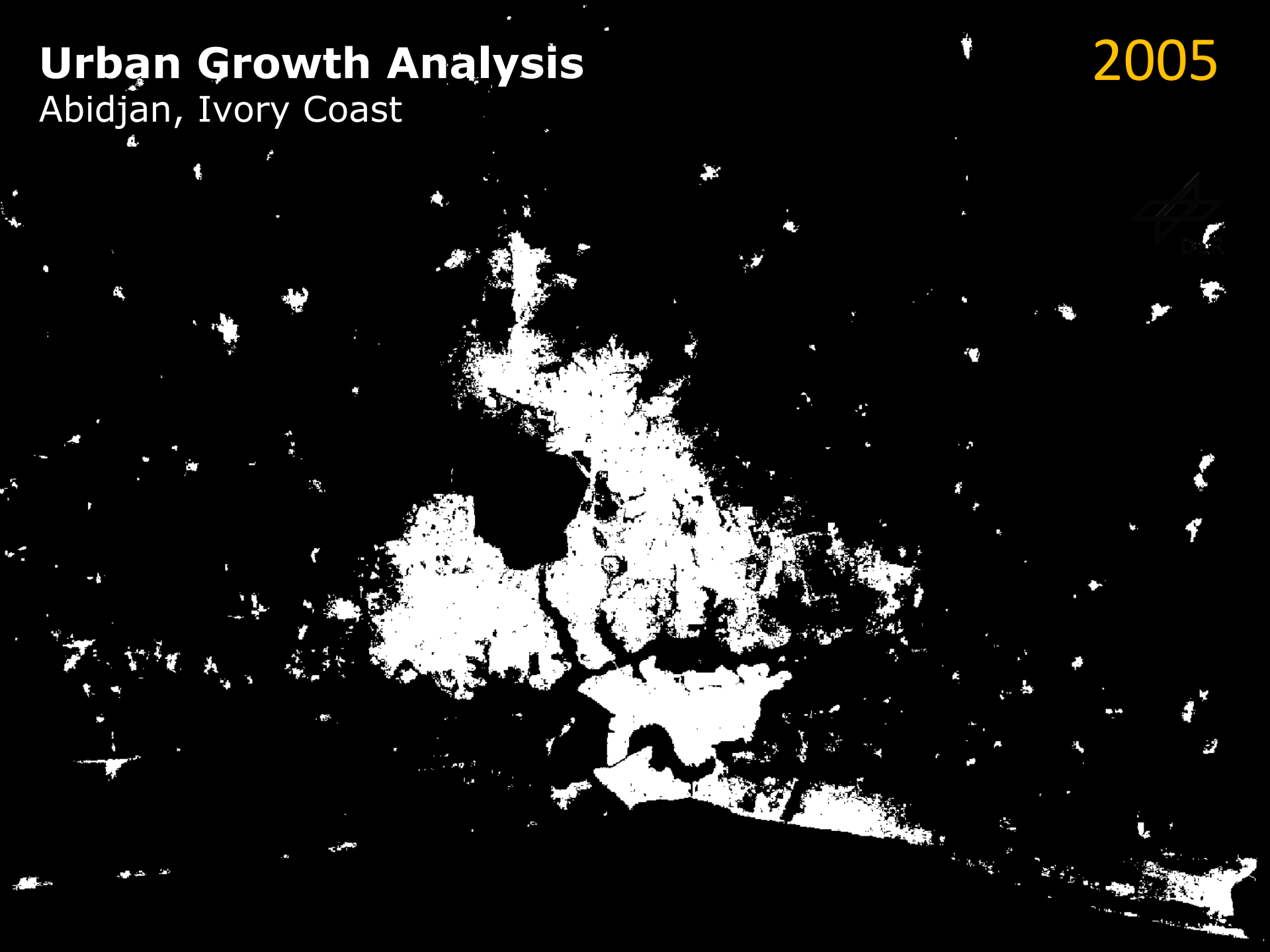
2000



Urban Growth Analysis

Abidjan, Ivory Coast

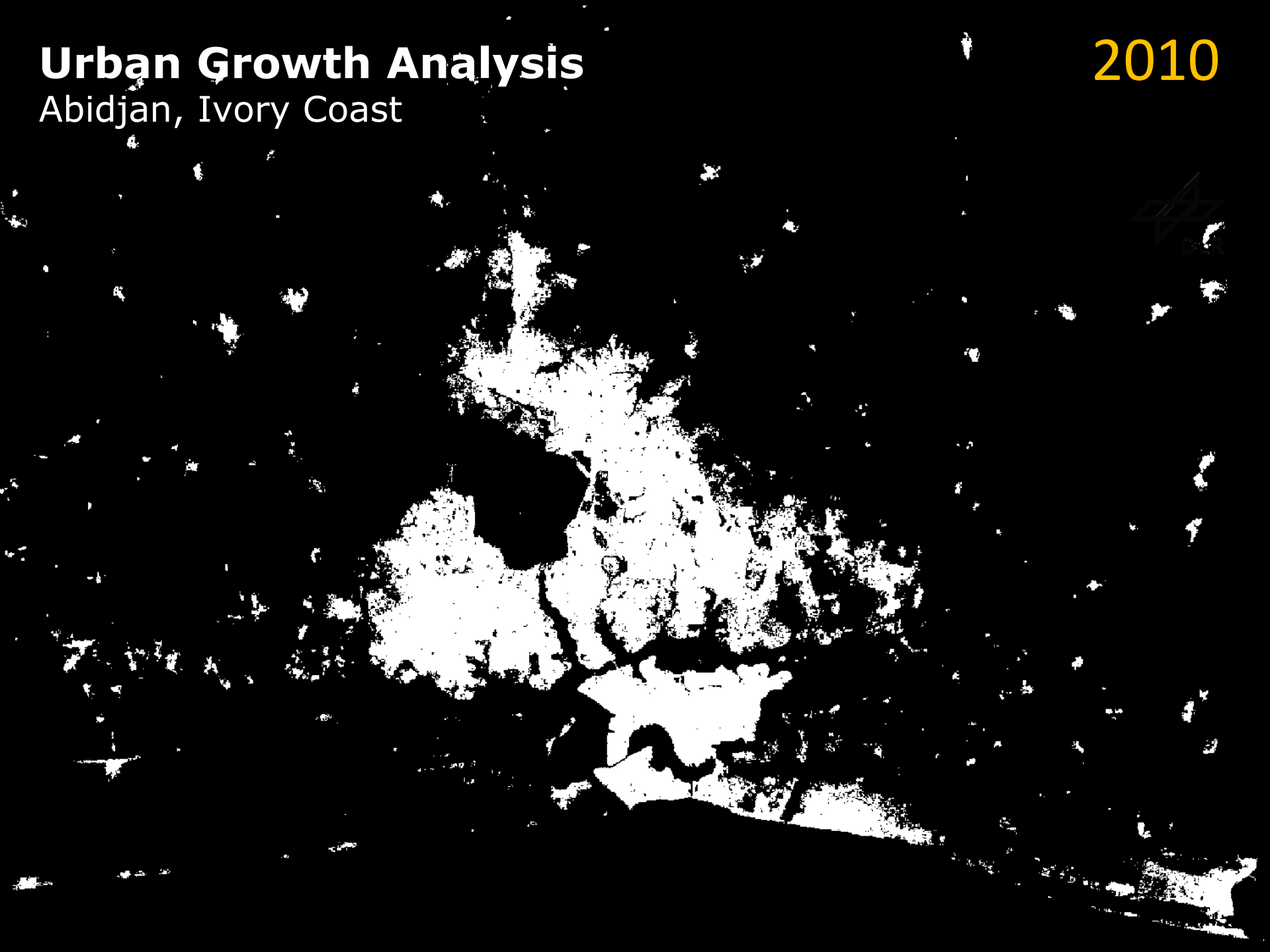
2005



Urban Growth Analysis

Abidjan, Ivory Coast

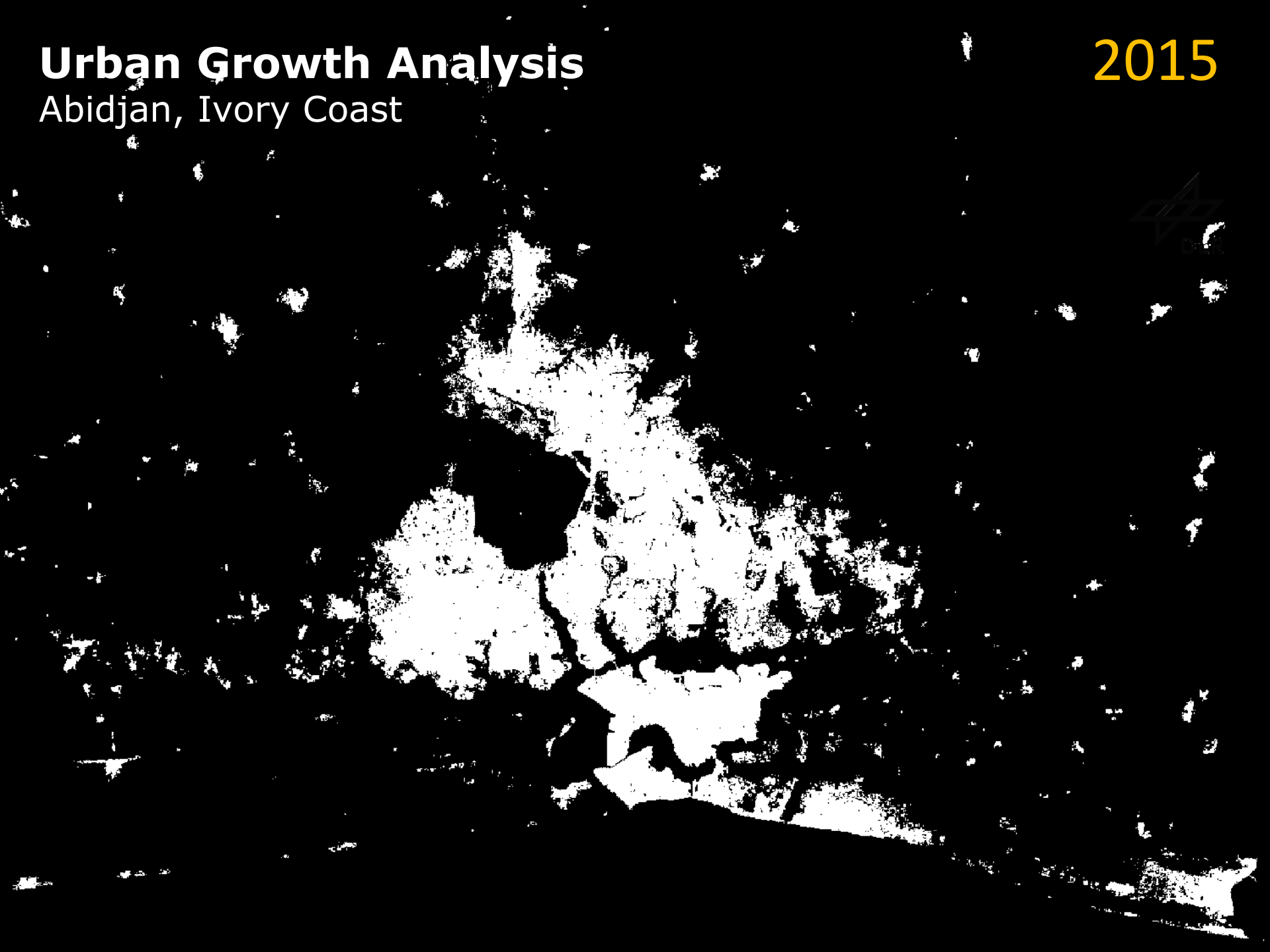
2010



Urban Growth Analysis

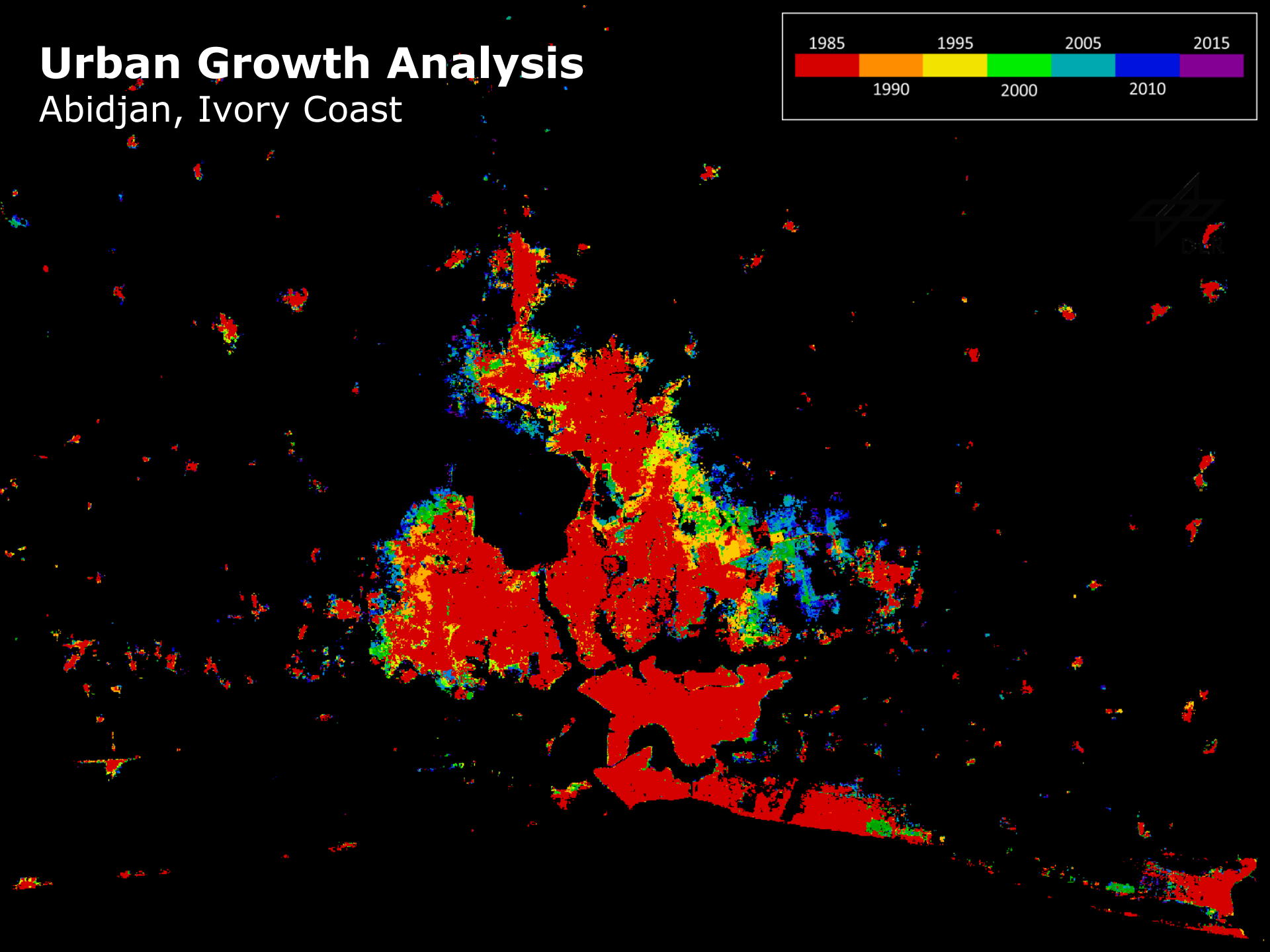
Abidjan, Ivory Coast

2015



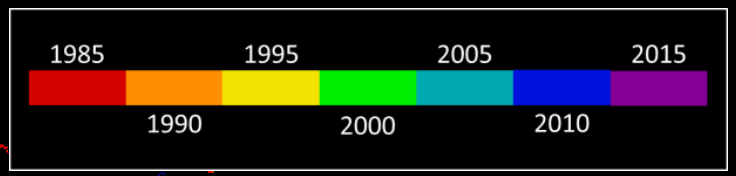
Urban Growth Analysis

Abidjan, Ivory Coast



Urban Growth Analysis

Bhopal, India

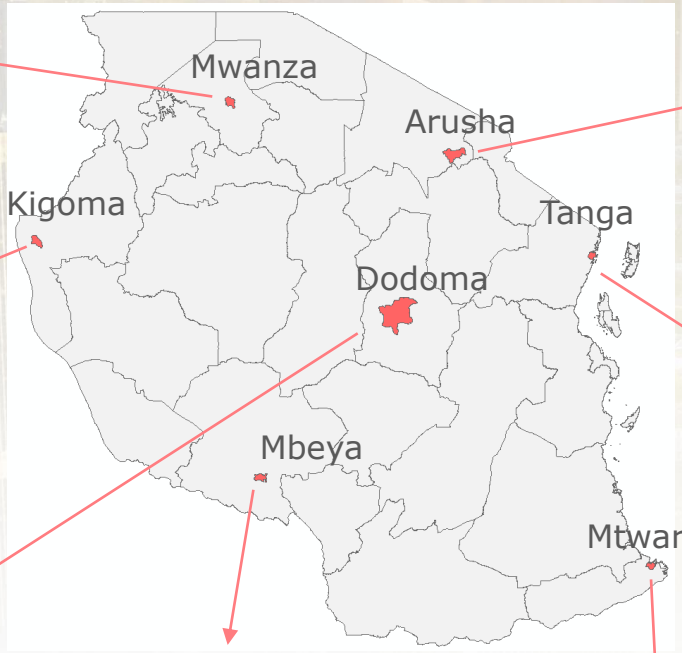


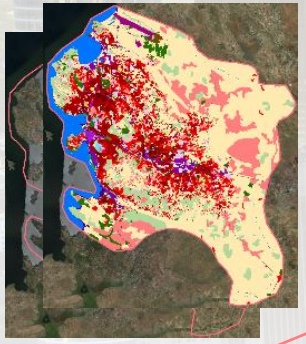
Urban Growth Analysis

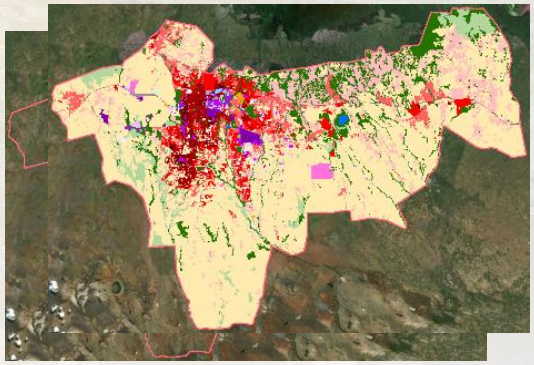
Dar Es Salaam, Tanzania

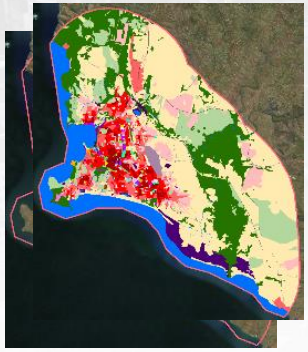
Urban Planning

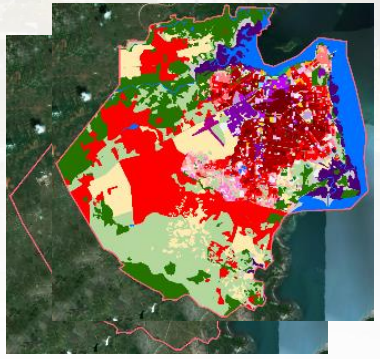
Land Use / Land Cover Maps of Tanzanian Cities

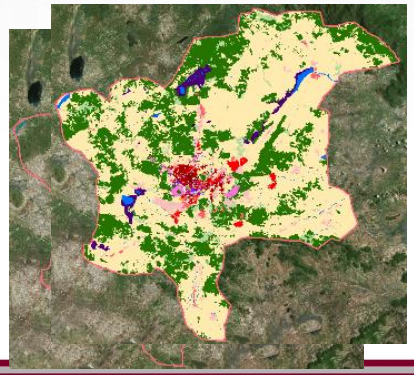


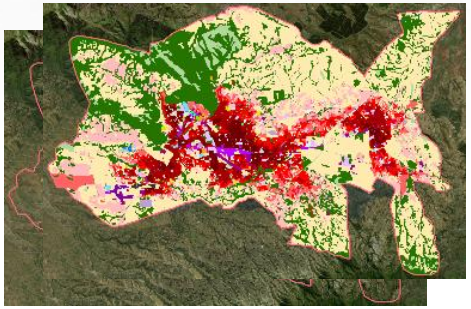


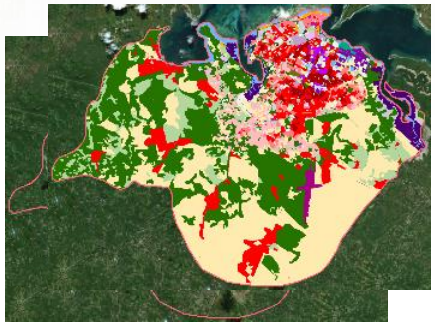












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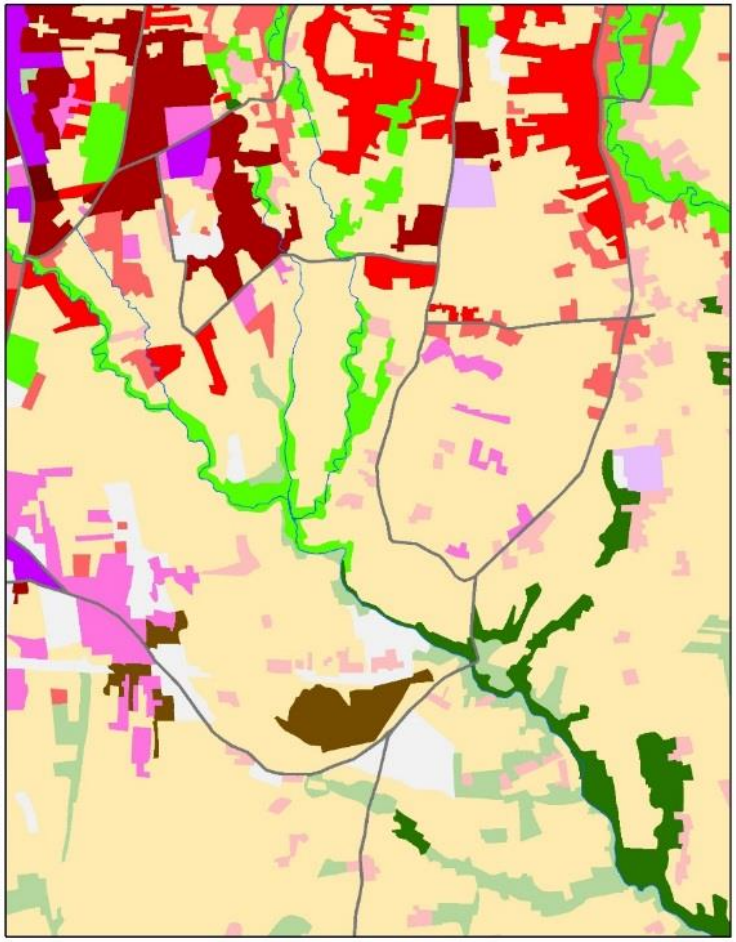
Urban Planning

Arusha – Tanzania: Land Use/Land Cover 2005



N

0 0,75 1,5 km

N

0 0,75 1,5 km

Subset

- Agricultural Area
- Airport
- Arterial Line
- Bare Soil
- Cemeteries
- Collector Line
- Commercial Area,
- Construction Site
- Forest and Shrublands
- Government
- Hospitals
- Industrial Area
- Land Without Current Use
- Military
- Mining/Quarry Areas/DumpSites
- Natural areas (non-forested)
- Public Buildings
- Railway
- Recreation Facilities
- Residential, 0 - 10% Sealed
- Residential, 10 - 30% Sealed
- Residential, 30 - 50% Sealed
- Residential, 50 - 80% Sealed
- Residential, 80 - 100% Sealed
- Schools
- University
- Urban Parks
- Water
- Wetlands

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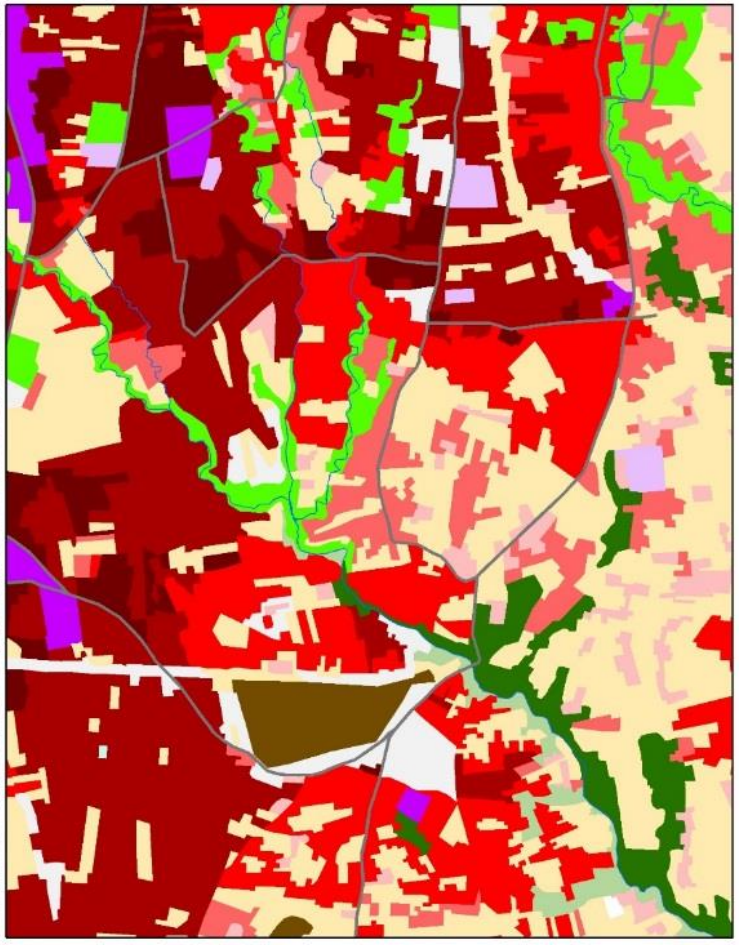
Urban Planning

Arusha – Tanzania: Land Use/Land Cover 2015



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- Wetlands

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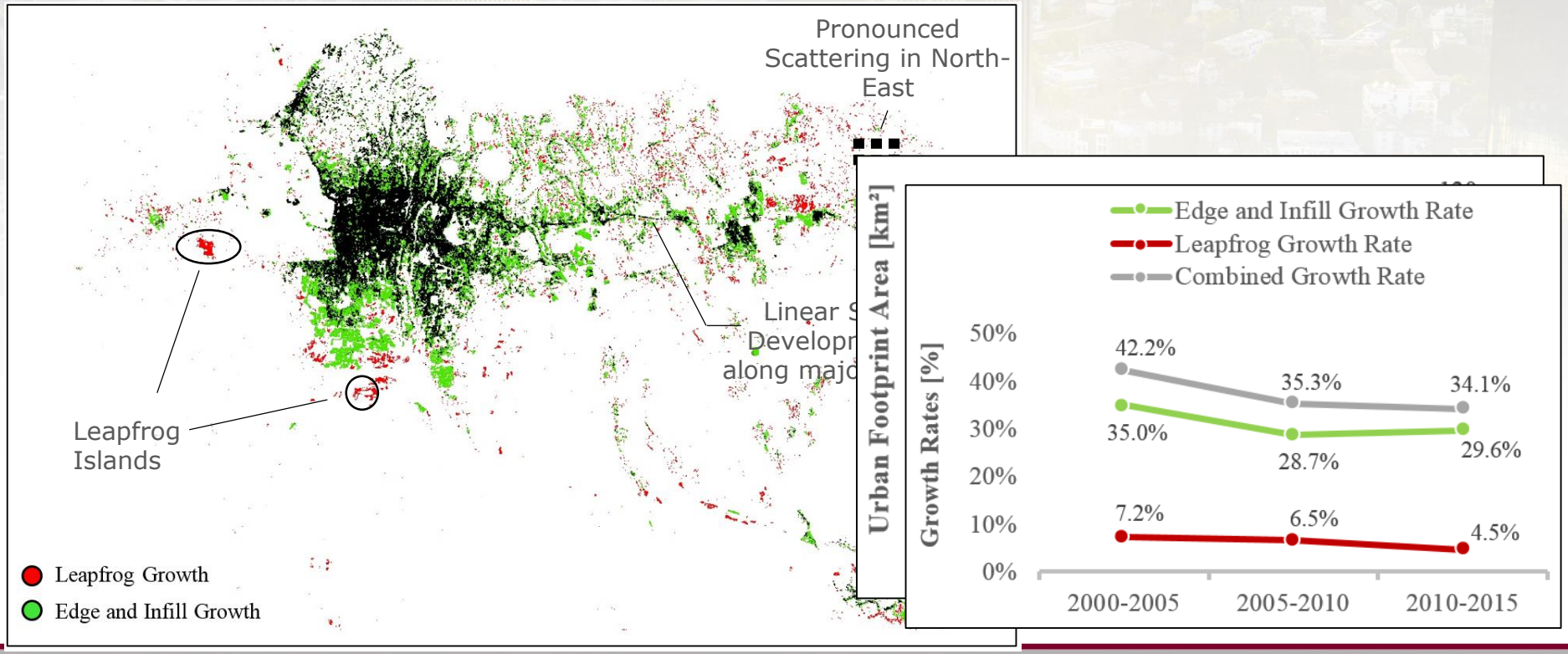
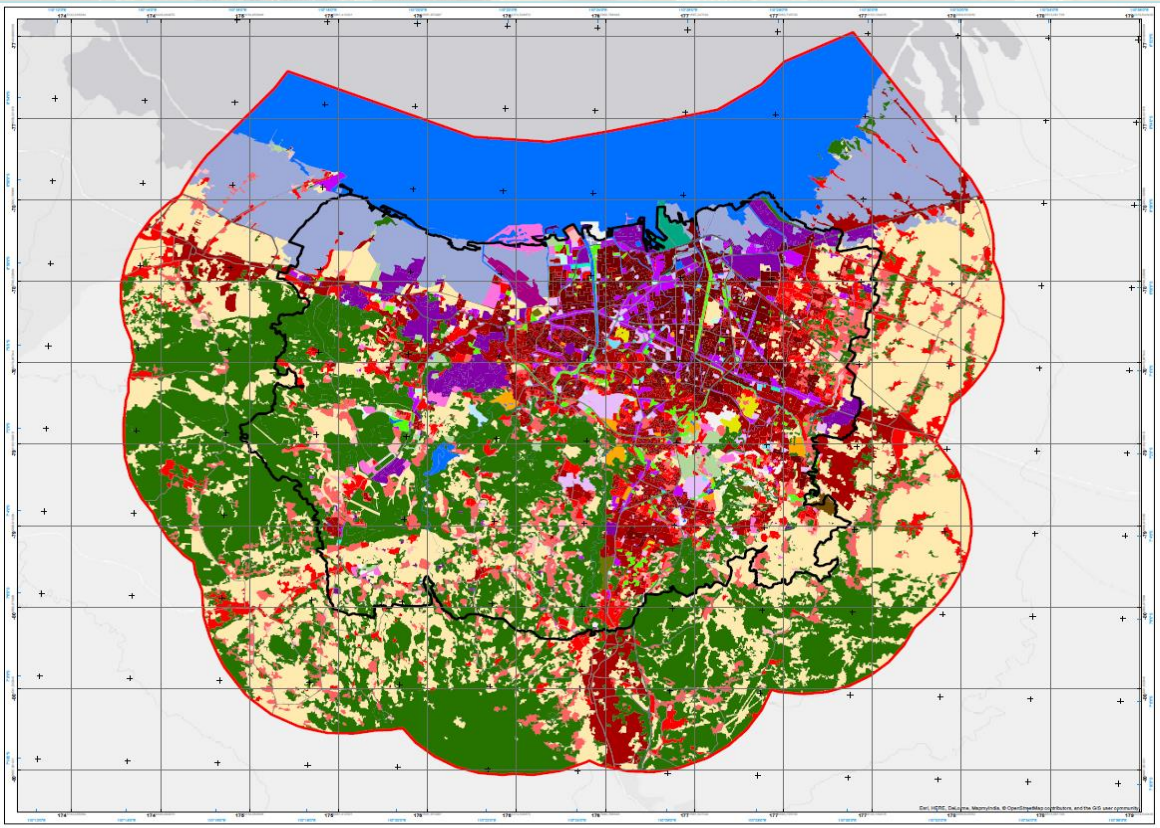
Urban Planning
Spatial Analytics for Urban Planning

Urban Size and Expansion	Understand and visualise different patterns of urban footprint growth including a visualisation of edge, infill and leapfrog developments. Statistical evaluation that quantifies the relative importance of each of the two categories, in terms of area increase.

Results:



Urban Planning
Land Use / Land Cover Map of Semarang



EO4SD-Urban:
Earth Observation for Su
Map Producer: GAF AG
Interpretation:
The map displays precise
(delivered in vector format
contains spatial explicit info
the year 2015.
The LULC information with
High Resolution (VHR) EO
the peri-urban area was ma
aggregated nomenclature.
Image Data:
Pleiades-1B © CNES (2015
08/09/2015 03:04 UTC, GSI
Sentinel-2A (2016) (acquire
provided by the European S
Vector Data: © OSM (2015
Background Map: © 2017
Land Use / Land C
Artificial areas
Very High Density Discontinuous Urba
High Density Discontinuous Urban Fal
Medium Density Discontinuous Urban
Low Density Discontinuous Urban Fal
Very Low Density Discontinuous Urba
Isolated Structures, Density n.a.
Commercial Area
Industrial Area
Business District (Government, Office
Education Facilities
Military
Health Facilities
Public Buildings
Arterial Line
Toll Line
Collector Line
Railway and Associated Area
Port and Associated Area
Airport and Associated Area
Mining Area
EO4SD-Urban is an ESA pr
products from Earth Observa
programmes.
More information available u
Map produced for:

Improvement for Master Plans and NUPS:

- EO4SD-Urban provided additional LU / LC classes, improved overall accuracy and higher granularity over existing Master Plans.
- Additionally the geo-spatial data provided a major input for urban growth analytics.

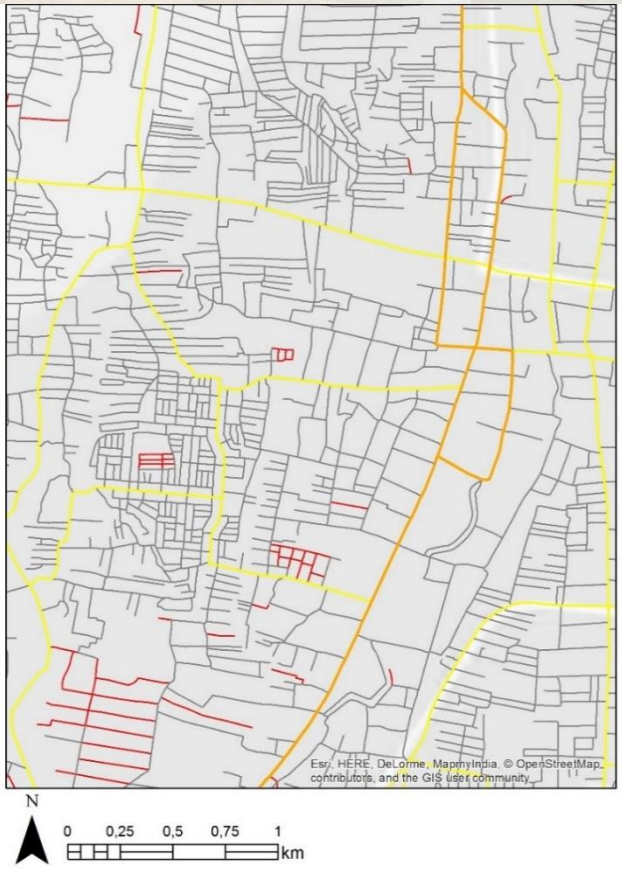
Infrastructure Planning

Indonesia: Transport Network in Denpasar (2006 – 2016)

2006

2016

Change Layer 2006 - 2016



Arterial Roads

Collector Roads

Local Roads

Changes between 2006 and 2016

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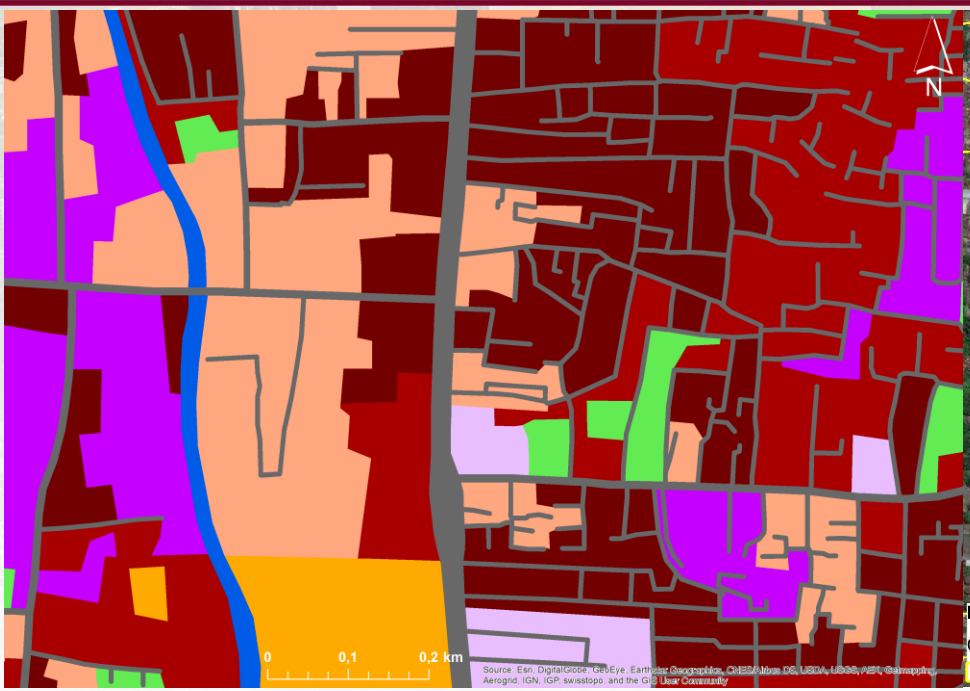
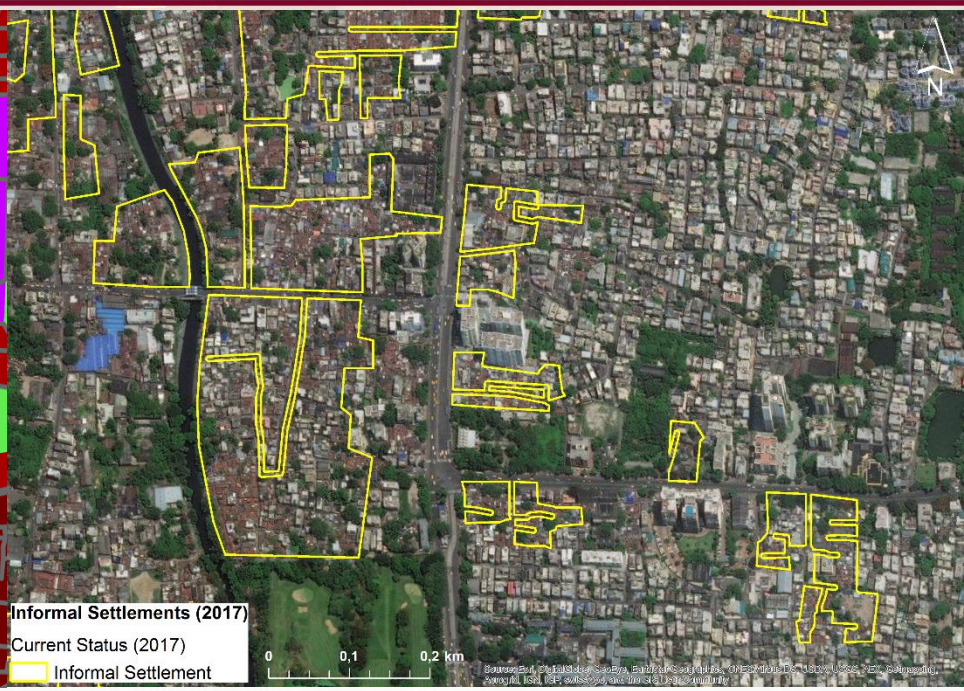
Delineation of Informal Settlements

Kolkata, India: Informal Settlements in 2017





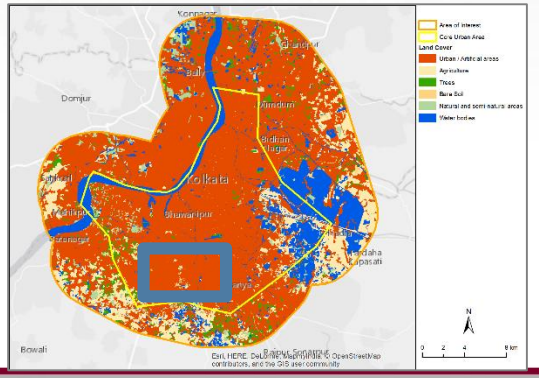
Artificial areas

- Urban / artificial areas
- Formal very high density residential (Sealing level > 80%)
- Formal high density residential (Sealing level: 50% - 80%)
- Formal low density residential (Sealing level: 10% - 50%)
- Informal settlement (Sealing level > 80%)
- Village settlement (Sealing level < 10%)
- Commercial and industrial units
- Non-residential urban fabric
- Roads and associated land
- Railways and associated land
- Port areas
- Airports
- Waste sites
- Construction sites
- Vacant land not obviously being prepared for construction
- Urban greenery
- Sports and leisure facilities

Other types

- Agriculture
- Trees
- Other natural and semi-natural areas incl. Wetlands
- Bare land
- Water bodies

SIRS
A CLS GROUP COMPANY



Urban Green Area Planning

Bangladesh: Dhaka – Green Areas and Open Spaces 2017

Transportation connectivity nodes

- 3
- 4 relative importance by number of streets/roads
- 5

Transportation network

- Motorway
- Primary
- Secondary
- Local
- railway

Open / Green areas typology

- Square - Central
- Square - Neighbourhood
- Market - Open sky
- Street
- Waterfront
- Waterfront - Beach
- Waterfront - Park
- Watefront - Berthing & Boardwalk
- Green - Central / Downtown
- Green - Neighbourhood
- Green - Minipocket
- Green - City woodland
- Green - Sub-urban forest
- Green - Alley
- Green - Sport & Leisure
- Green - Unrecognized green area
- Cemetery
- Water

Square - Central

Square - Neighourhood

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Risk and Disaster Assessment

Indonesia: City of Semarang – Terrain and Infrastructure Motion

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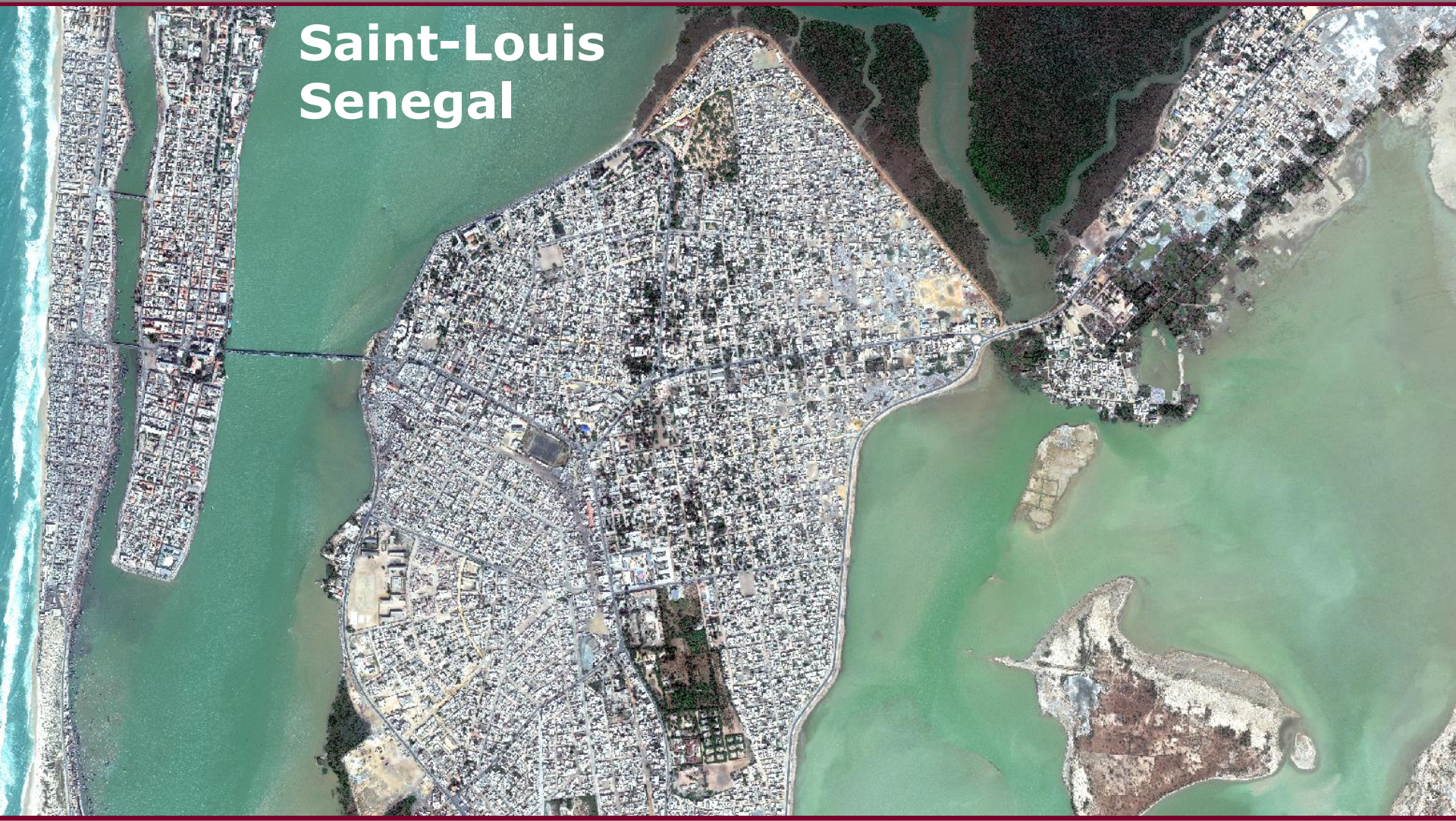
Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment



Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment

3 Main Flood Scenarios:

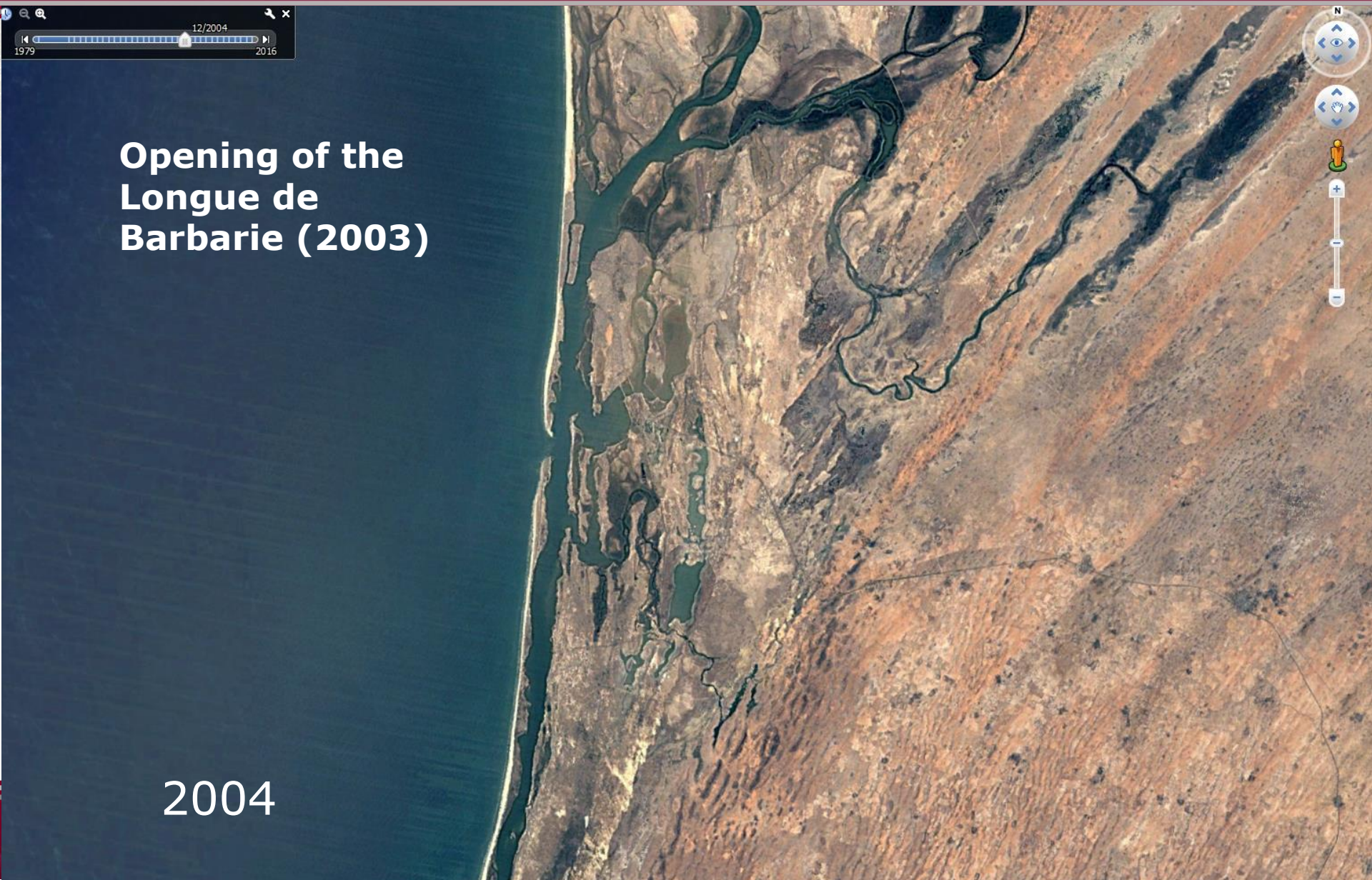
- Fluvial floods of Senegal river after heavy rainfall in the upper part of the catchment area (typically August – November)
- Local floods from direct heavy rainfall – often connected to blocked drainage systems
- Coastal floods (tidal waves, coastal erosion)

Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment

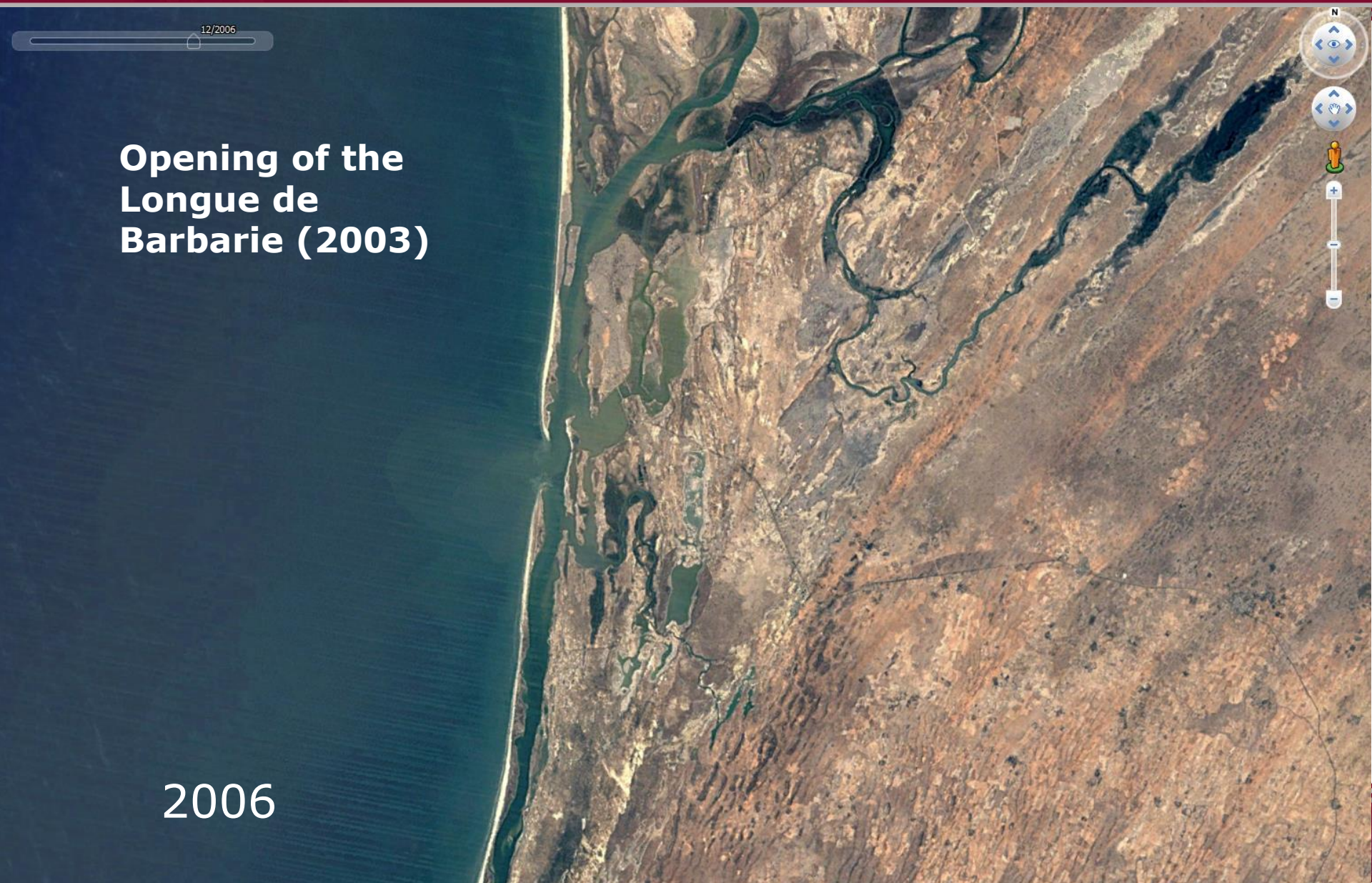
Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment



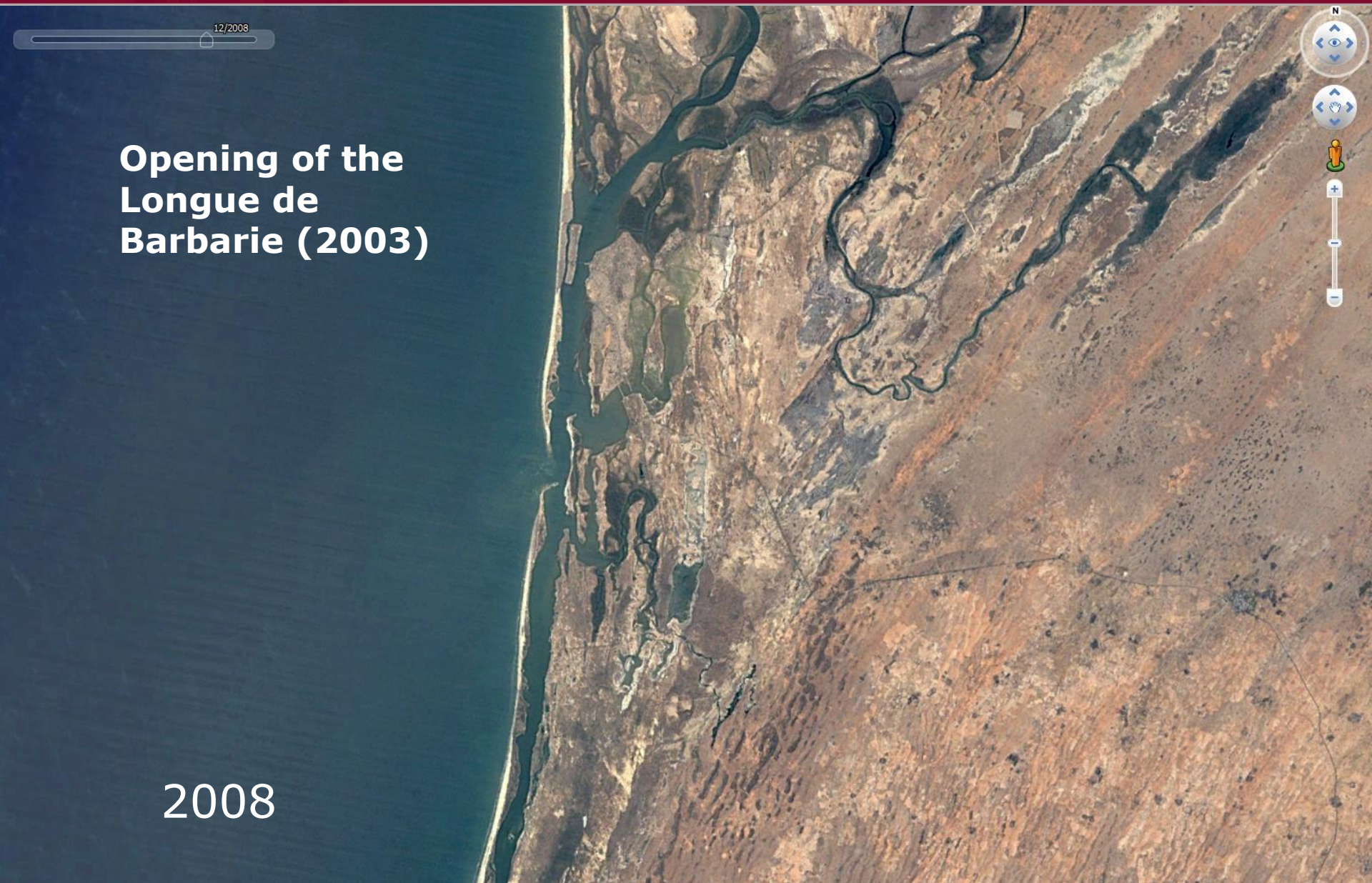
Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment



Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment



Risk and Disaster Assessment

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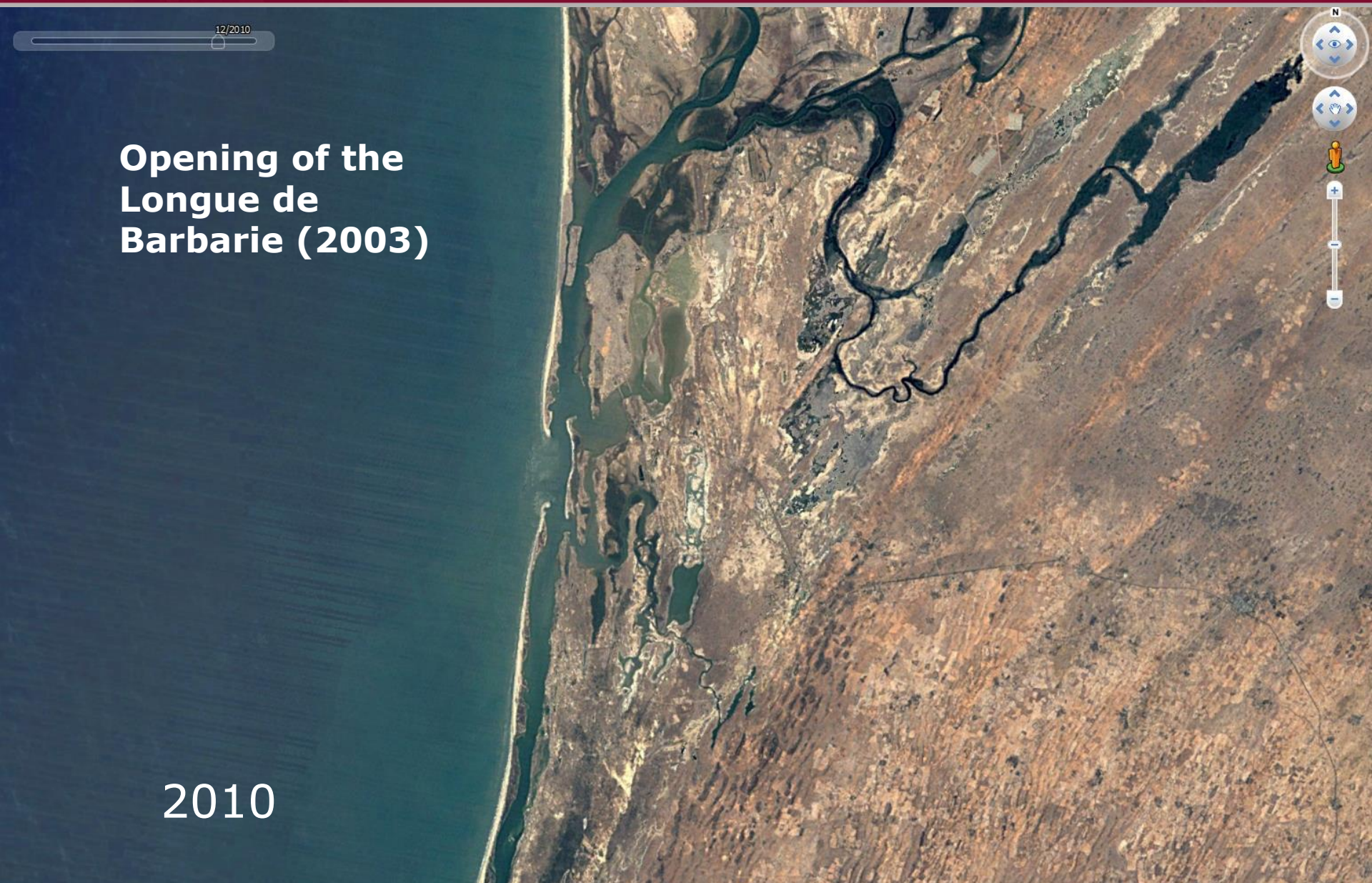

Risk and Disaster Assessment

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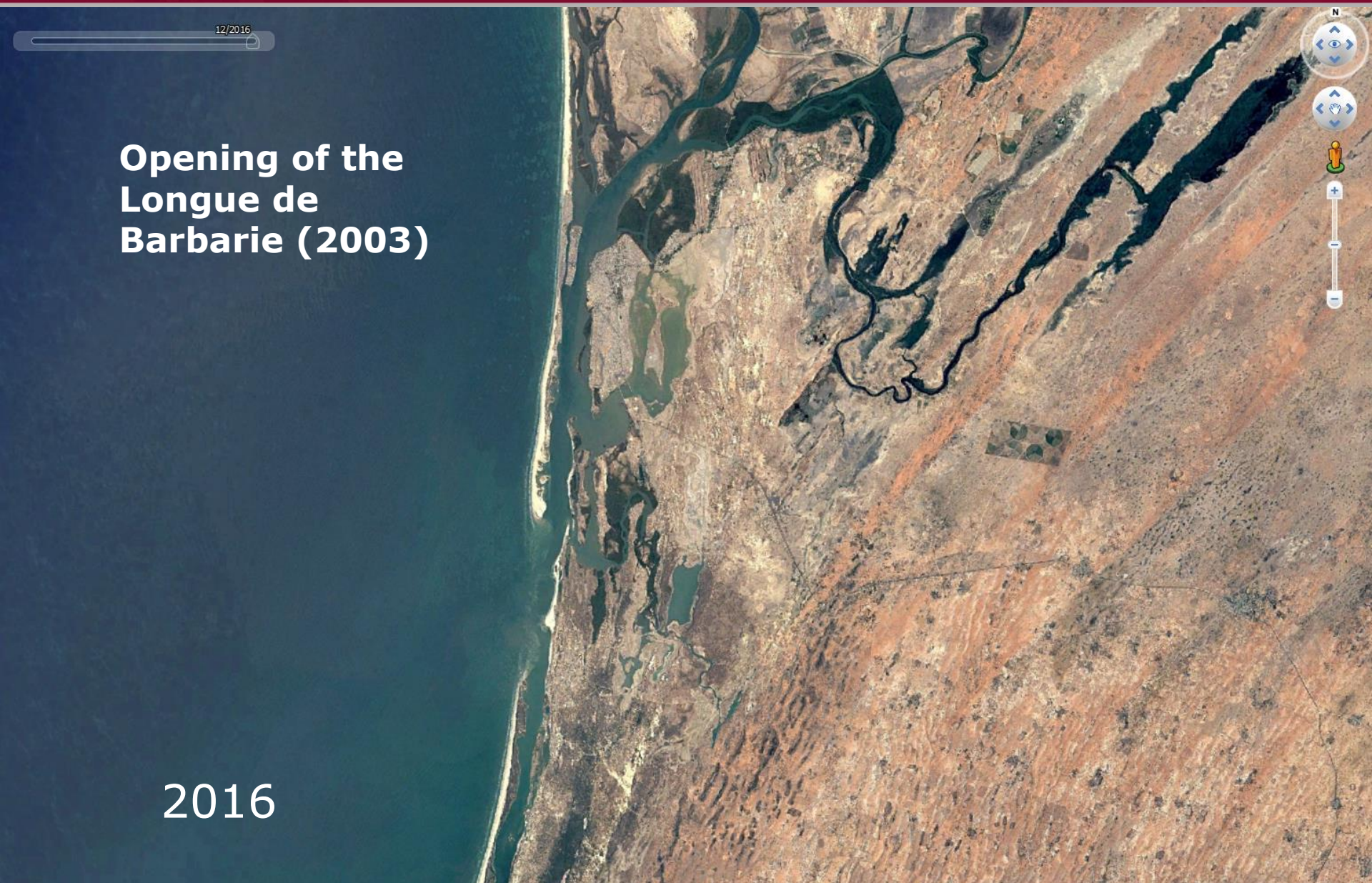
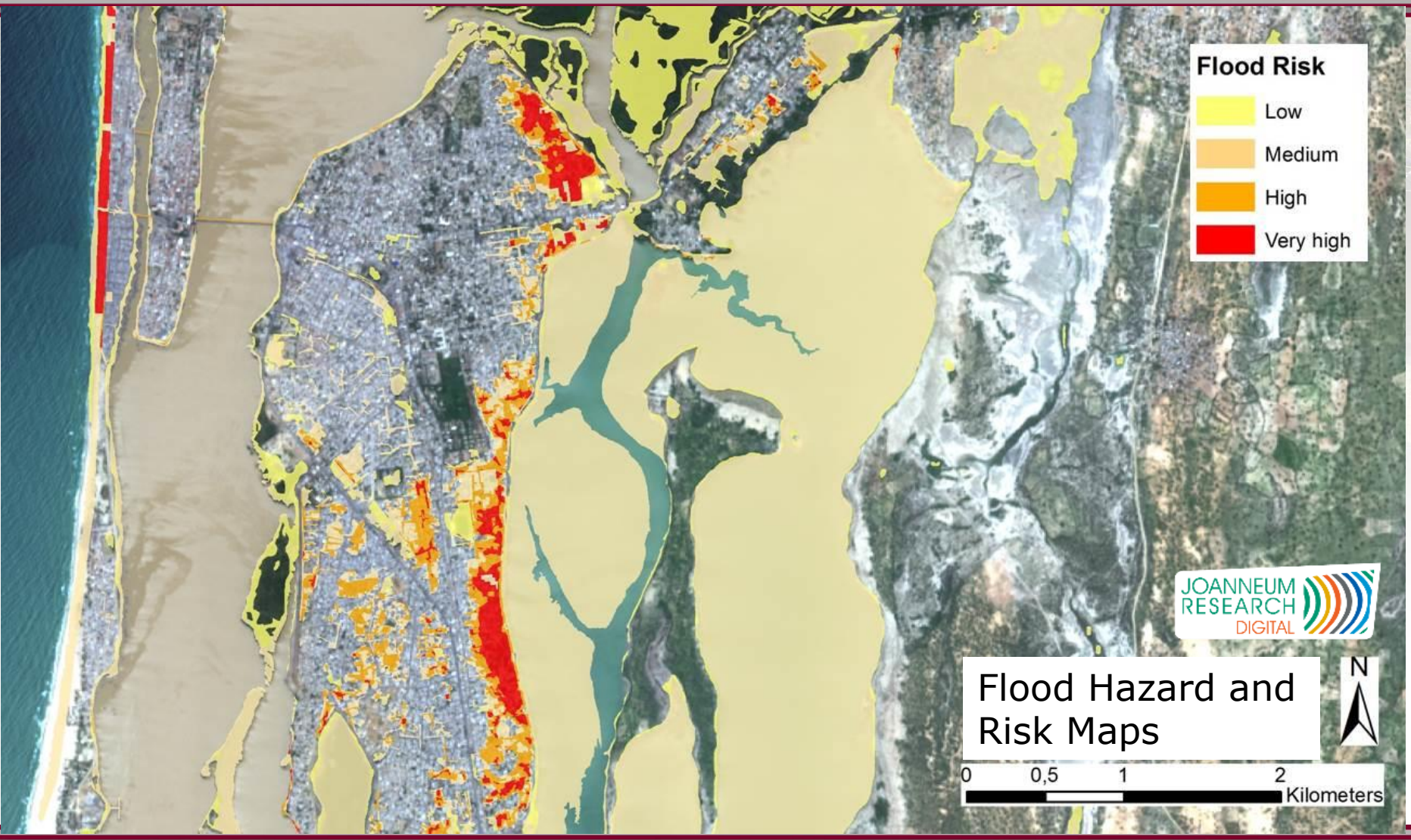
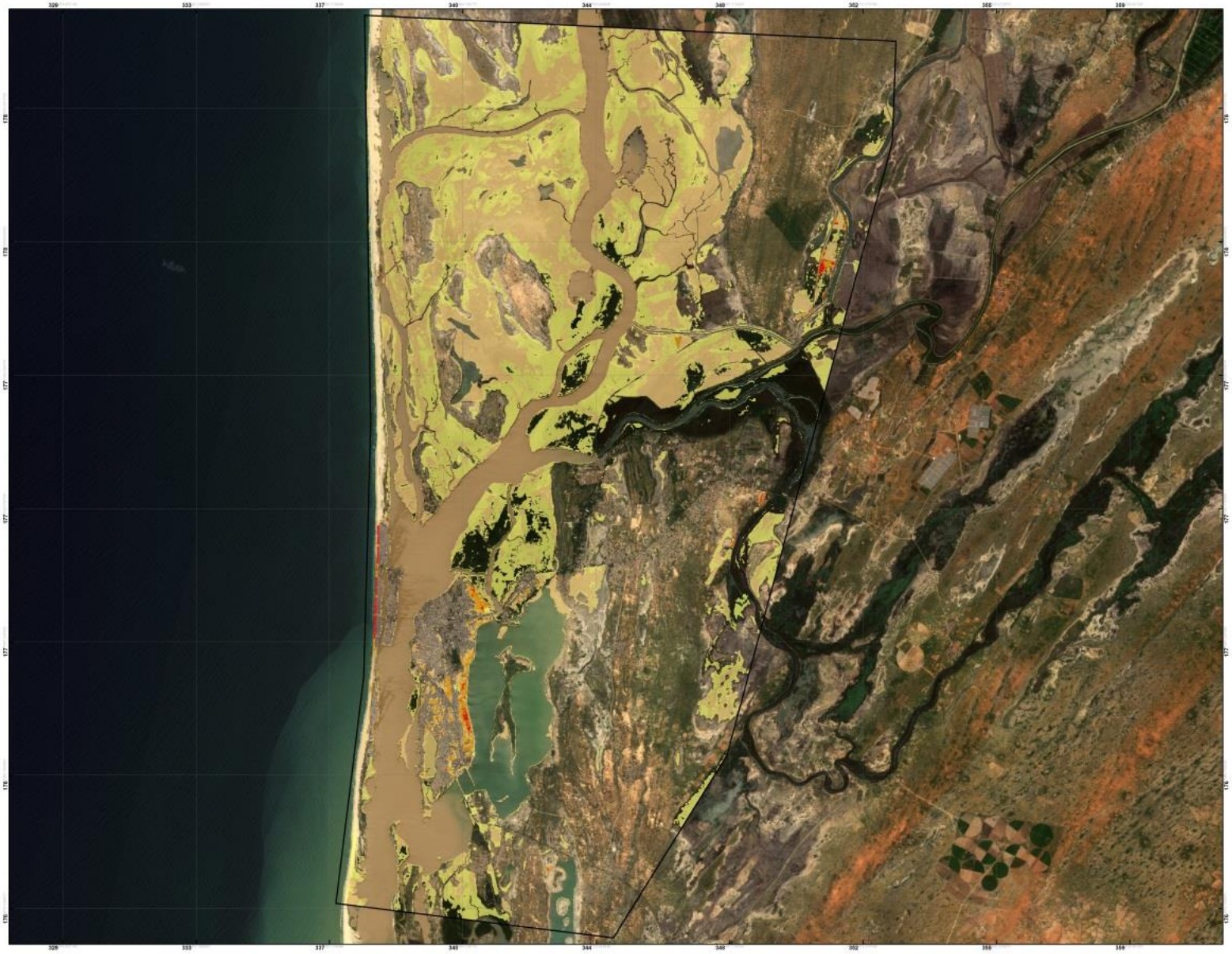


Risk and Disaster Assessment

Senegal: Saint-Louis – Flood Risk Assessment





EO4SD-Urban:
Earth Observation for Sustainable Development -

Map Producer: JOANNEUM Research

Interpretation:
The map displays flood risk information (delivered in vec
Louis (SENEGAL). This data is based on the occurrer
past 10 years combined with information of the land us
NEO B.V. of this project area. It takes into account bot
and potential damages, based on different land uses.
assessed on 4 aspects: economic, social, physical and fl

Based on:
Landsat 5 (2009, 2011), Landsat 8 (2013, 2015, 2016,
the US Geological Survey
Sentinel-2 (2015-2018), provided by the European Space
Sentinel-1 (2016-2018), provided by the European Space

Image Data:
Sentinel-2 (2017) (acquired on 10/09/2017, GSD 10n
European Space Agency)

Background Map: © 2018 Esri

Flood Risk

- Low
- Medium
- High
- Very high

Overview Map

Area of Interest for EO Data Acquisition and Ma

EO4SD-Urban is an ESA project aimed at deriving key g
products from Earth Observation data in support of urbar
programmes.

More information available under: http://www.eo4sd-urba

Map produced by:

Map produced for: WORLD BANK GROUP

Project implemented by a Consortium lead by:

Project fu

GAFAG

Coordinate System: WGS 1984 UTM Zone 28N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500000.0
False Northing:10000000.0
Central Meridian: 117.000
Scale Factor: 0.9996
Latitude of Origin: 0.00
Units: Meter

Printed on: 24.06.2019
Version: 1.0

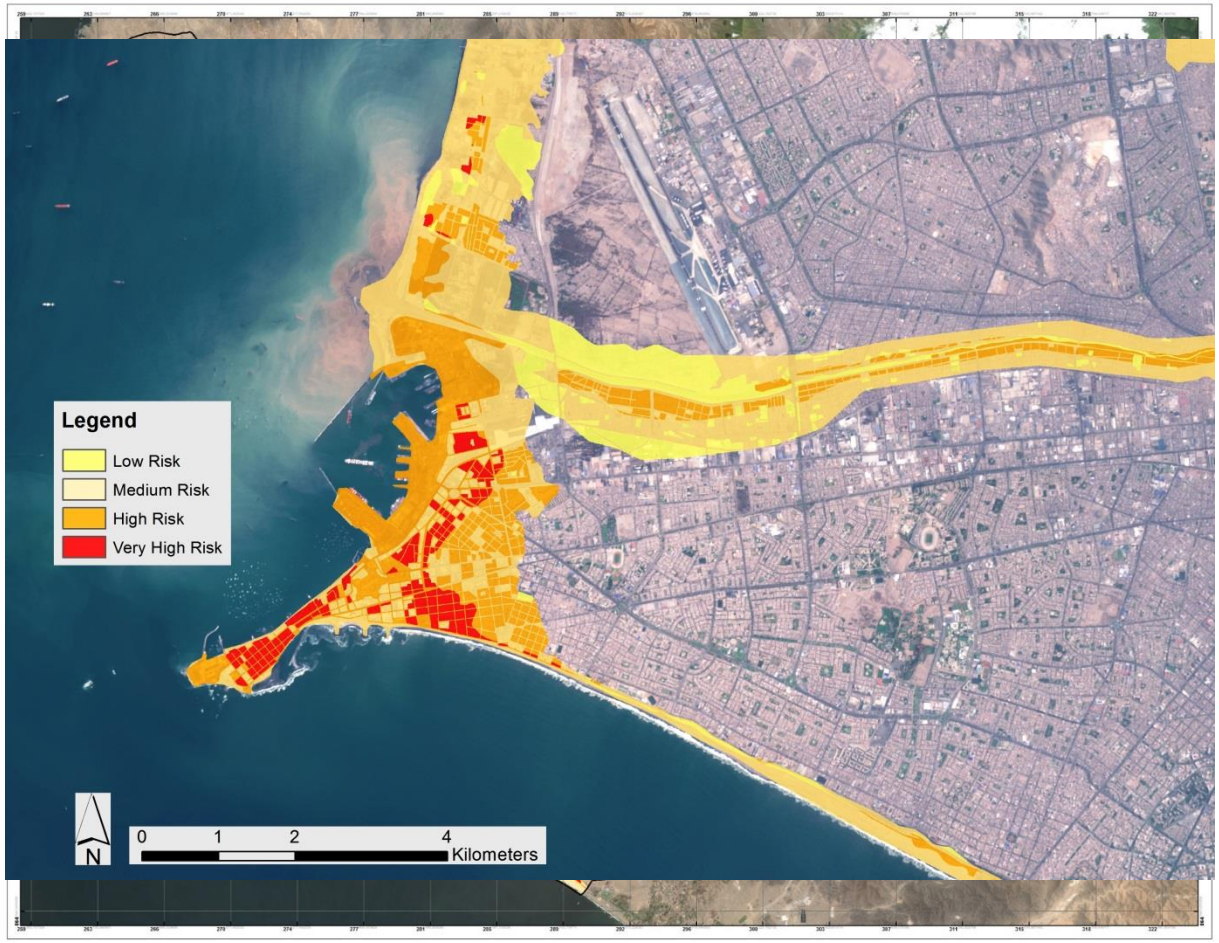
FLOOD RISK MAP OF SAINT LOUIS, SENEGAL

Combined Core City and Peri-Urban Area

0 0,5 1 2 3 4 5 6 7 8 9 10 km

urban development eo4sd

Risk and Disaster Assessment
Peru: City of Lima – Flood Risk Assessment



EO4SD-Urban:
Earth Observation for Sustainable Development - Urban Project

Map Producer: JOANNEUM RESEARCH

Interpretation:
The map displays flood risk information (delivered in vector format) in Metropolitan Lima (PERU). It takes into account both, the risk from tsunamis in costal areas as well as from short-term river and flash floods after heavy rainstorms. Tsunam risk assessment is based on existing modelling results, River and flash flood risk assessment is based on the occurence of floods of the past 20 years.
This data is combined with information of the land use map based on analysis of Pleiades imagery (2016) and provided by SIRS and land use data from the EOWORLD project delivered by IABG. It takes into account both, the hazard level and potential damages, based on different land uses. The damages are assessed on 4 aspects: economic, social, physical and flood duration

Based on:
Sentinel-1 and Sentinel-2 provided by the European Space Agency
WorldView-2 (2015, 2016, 2017), as available on Google Earth
Pleiades (2016) provided by SIRS
ALOS World 3D - 30m, version 2.1, provided by Japan Aerospace Exploration Agency
Local reports and press releases
Tsunami Hazard Maps of Dirección de Hidrografía y Navegación

Background Image: Sentinel-2 (acquired on 20/02/2017, GSD 10m) provided by the European Space Agency

Background Map: © 2017 Esri

Flood Risk Level
- low
- medium
- high
- very high
- Area of Interest for EO Data Acquisition and Mapping

Overview Map
- Area of Interest for EO Data Acquisition and Mapping

EO4SD-Urban is an ESA project aimed at deriving key geo-information products from Earth Observation data in support of urban development programmes.

More information available under: http://www.eo4sd-urban.info/

Map produced by: JOANNEUM RESEARCH

Map produced for: IDB

Project implemented by a Consortium lead by: SIRS

Project funded by: esa

WGS_1984_UTM_Zone_18S
WKID: 32718 Authority: EPSG
Projection: Transverse_Mercator
False_Easting: 500000,0
False_Northing: 10000000,0
Central_Meridian: -75,0
Scale_Factor: 0,9996
Latitude_Of_Origin: 0,0
Linear Unit: Meter (1,0)

Printed on: 05.03.2019
Version: 1.0

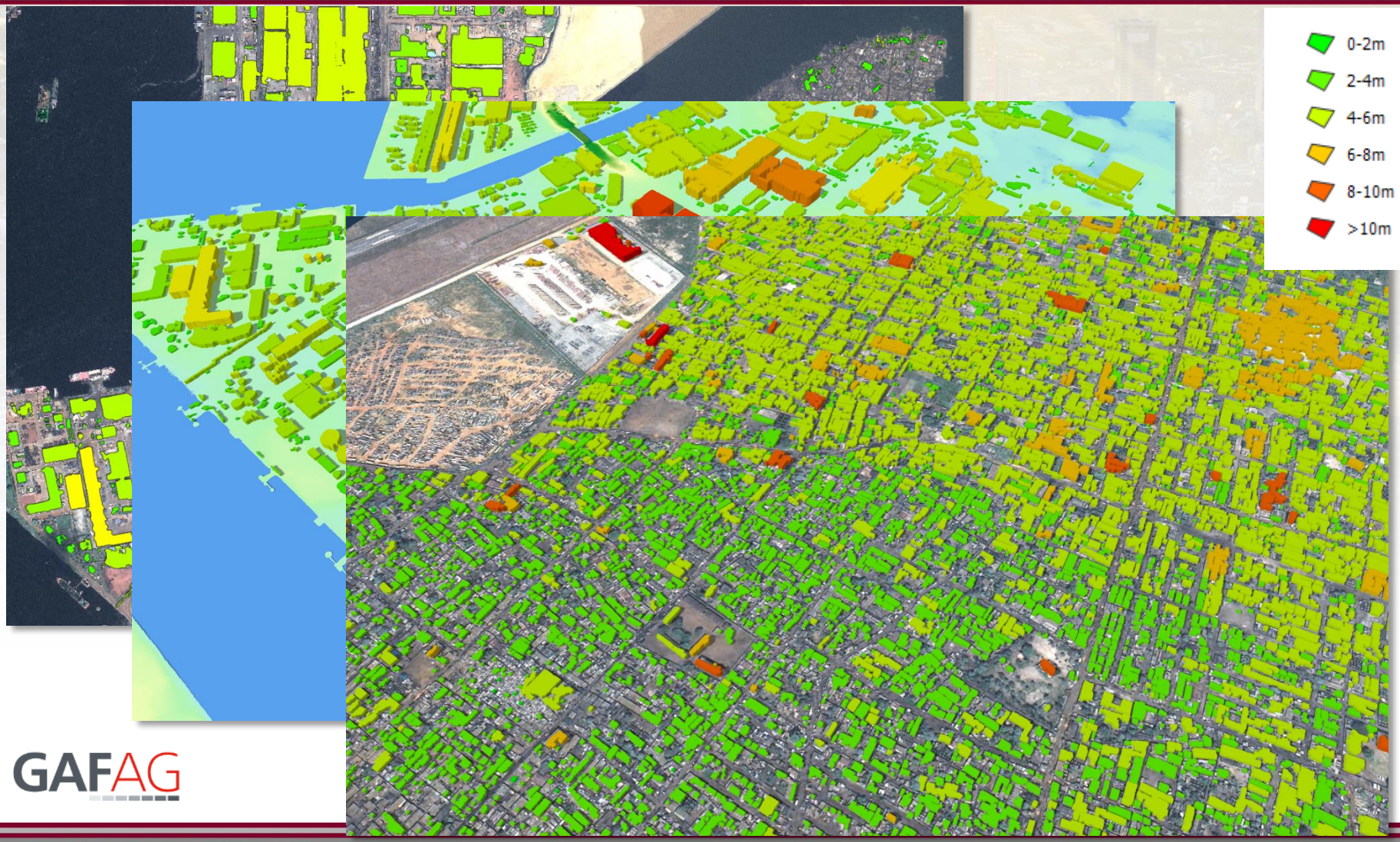
FLOOD RISK MAP OF LIMA, PERU

Status 2017

N
0 5 10 15 20 km

urban development eo4sd

Building Footprints and Heights
Abidjan, Ivory Coast

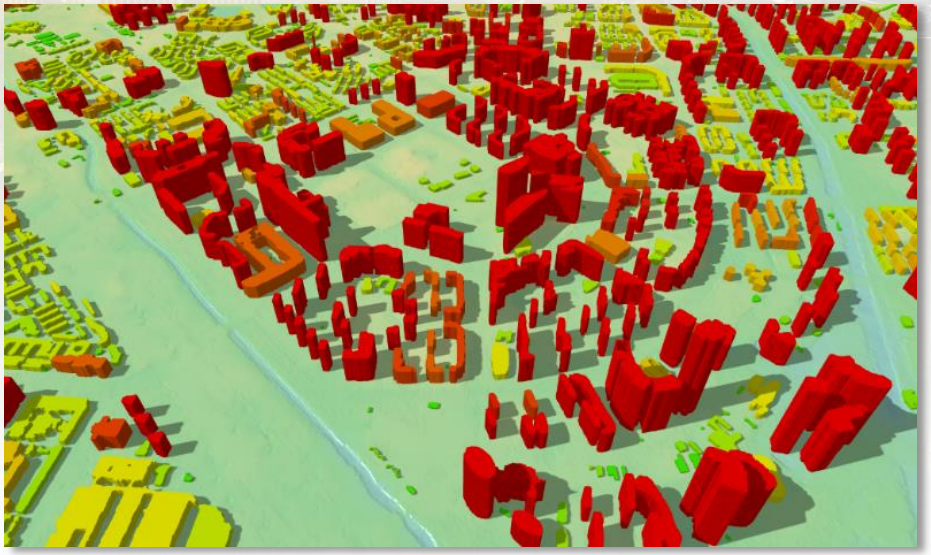


GAFAG

Terrain DSM Abidjan Côte d'Ivoire © 2016, GAF AG, © CNES (2016) Distribution AIRBUS DS – visualized in GAFmap

Building Footprints and Heights (Beijing)

- 0-2m
- 2-4m
- 4-6m
- 6-8m
- 8-10m
- 10-15m
- 15-20m
- 20-25m
- 25-30m
- 30-35m
- 35-40m
- 40-45m
- 45-50m
- 50-55m
- >55m



Tri-Stereo DSM Beijing, China © 2017, GAF AG, © CNES (2017) Distribution AIRBUS DS visualized in GAFmap

Value of the EO Products

EO-products are based on:

- Verified user requirements
- Harmonised and standardised state-of-the-art methodologies
- Comprehensive and transparent documentation
- Application of statistically sound accuracy assessment
- Stringent Quality Control to ensure:
  - transparency
  - repeatability
  - completeness
  - validity
- User feedback needed (and some already given) to improve the services

Thank you for your attention!

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