

# Using Earth Observation Data to Support the Achievement of the Sustainability Agenda

## Monitoring Land Degradation (SDG 15.3.1)

When: Thursday October 10, 2019 at 4 pm (1 hour and 20 min)  
Where: Embajadores Hall

Mariano Gonzalez-Roglich, Conservation International  
[mgonzalez-roglich@conservation.org](mailto:mgonzalez-roglich@conservation.org)  
Argyro Kavvada, NASA & GEO EO4SDG  
[Argyro.Kavvada@nasa.gov](mailto:Argyro.Kavvada@nasa.gov)

# TRENDS.EARTH - WHAT IS LAND DEGRADATION



*“Land degradation is defined as the reduction or loss of the biological or economic productivity and complexity of rain fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from a combination of pressures, including land use and management practices”*

## SDG Indicator 15.3.1

“Proportion of land degraded over total land area”



## SDG Indicator 15.3.1

“Proportion of land degraded over total land area”

## SDG Indicator 15.3.1



Land Productivity



Land Cover



Carbon Stocks

# TRENDS.EARTH - MONITORING LAND CONDITION



Tier 1: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.

**Tier 2: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.**

Tier 3: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.

# TRENDS.EARTH - MONITORING LAND CONDITION



- Identification of degraded lands
- Can set baselines, and track progress
- Best global datasets
- Allows use of best-available local information

Supports all three components of SDG Indicator 15.3.1



Land Productivity



Land Cover



Carbon Stocks

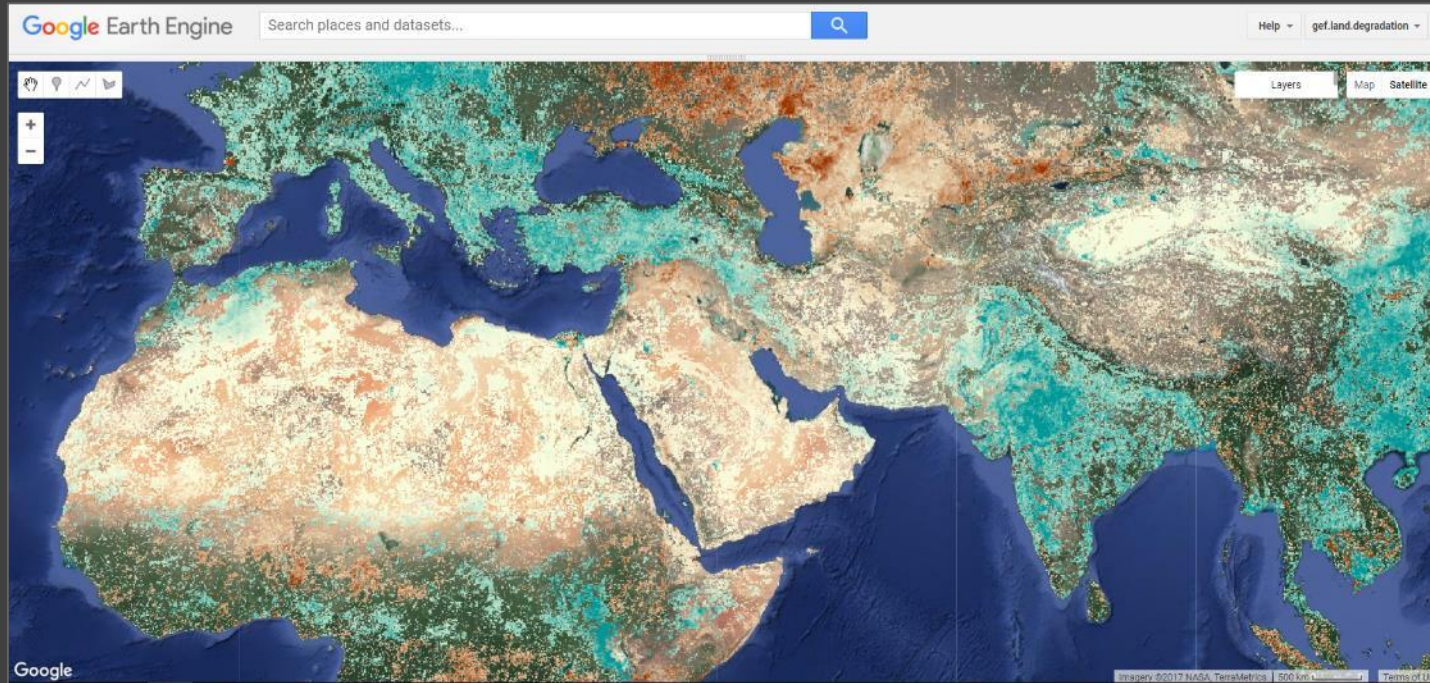


# TRENDS.EARTH - WHAT IS IT?

TARGET 15.3



END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND



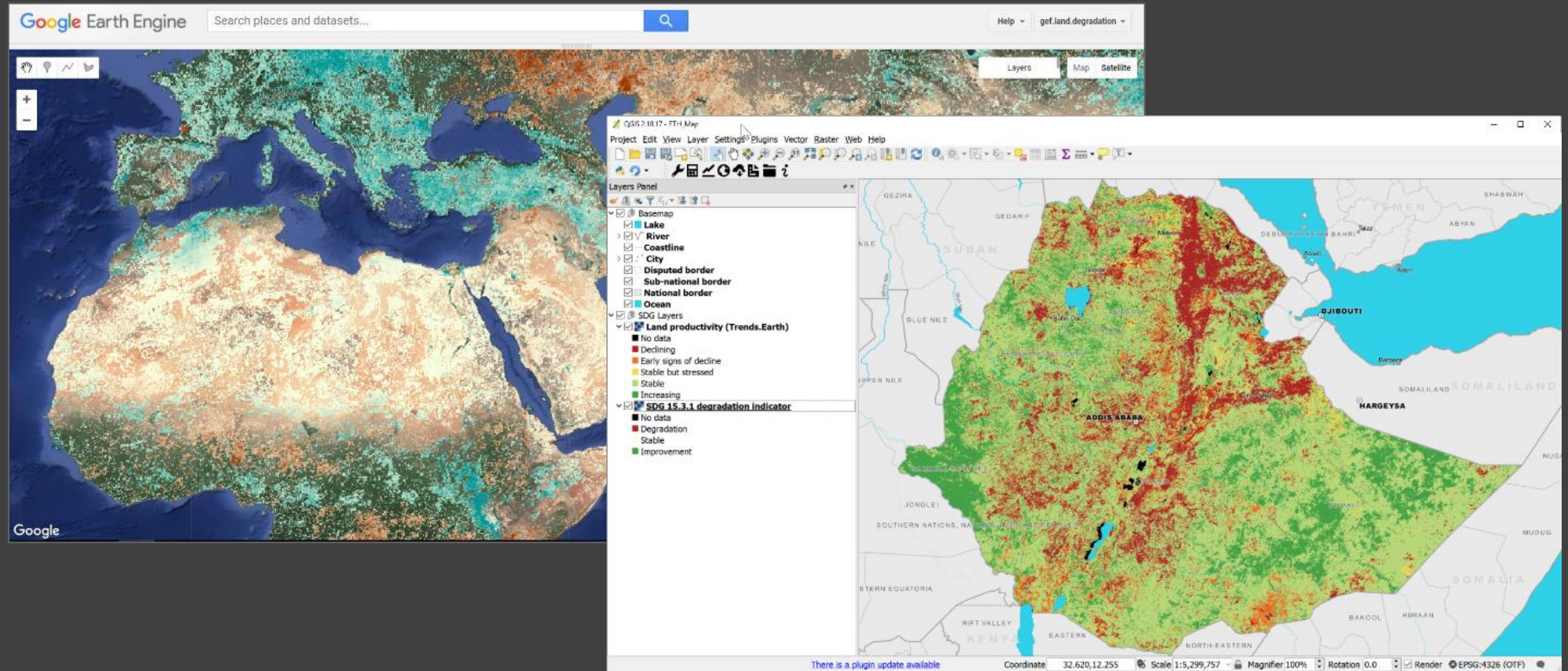


# TRENDS.EARTH - WHAT IS IT?

TARGET 15.3



END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND



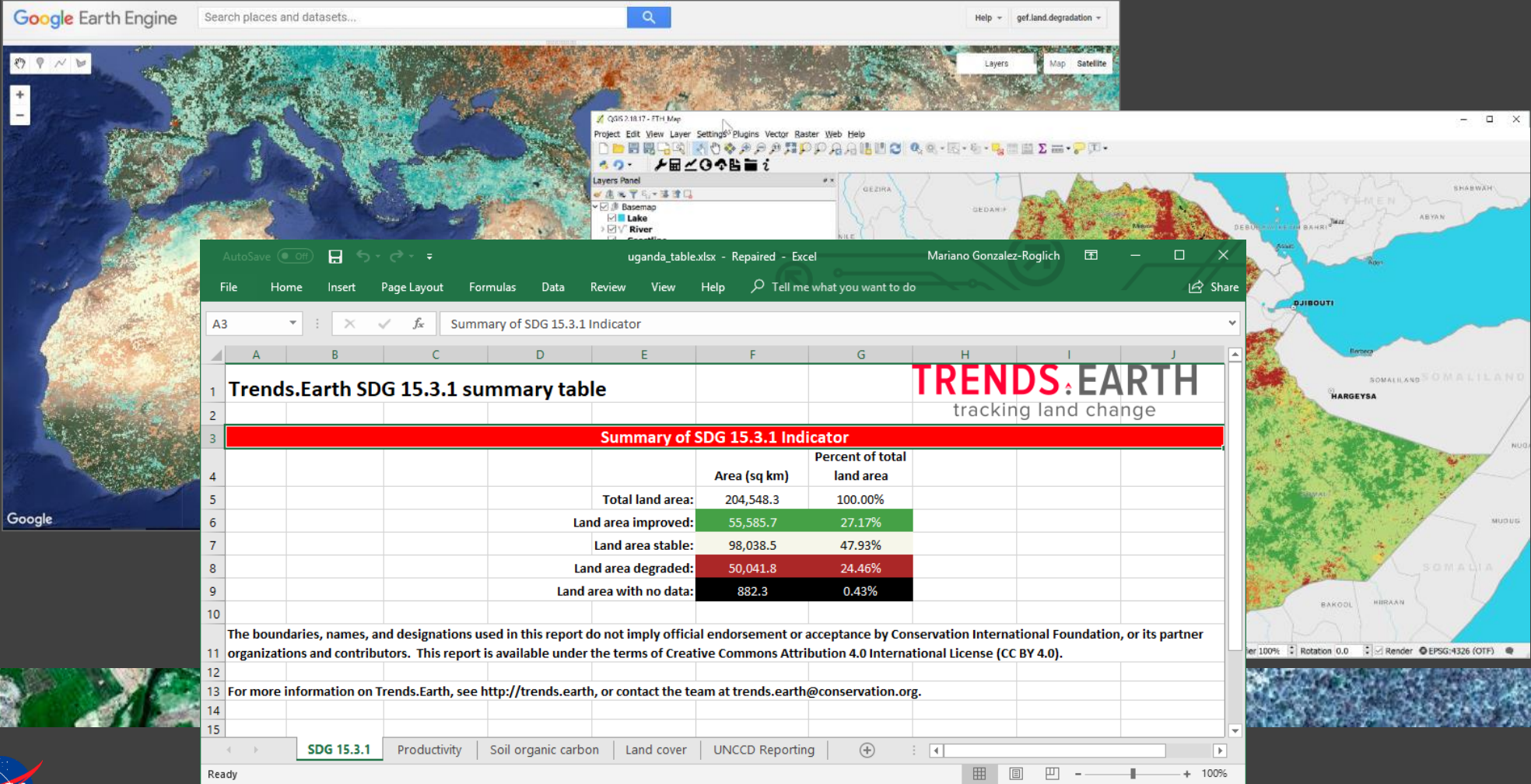


# TRENDS.EARTH - WHAT IS IT?

TARGET15•3



END DESERTIFICATION AND RESTORE DEGRADED LAND



Proportion of land that is degraded over a total area



1. Land Productivity

Net Primary Productivity



2. Land Cover

Land Cover Change



3. Above and Below Ground C

Soil Organic Carbon



# TRENDS.EARTH - PRODUCTIVITY

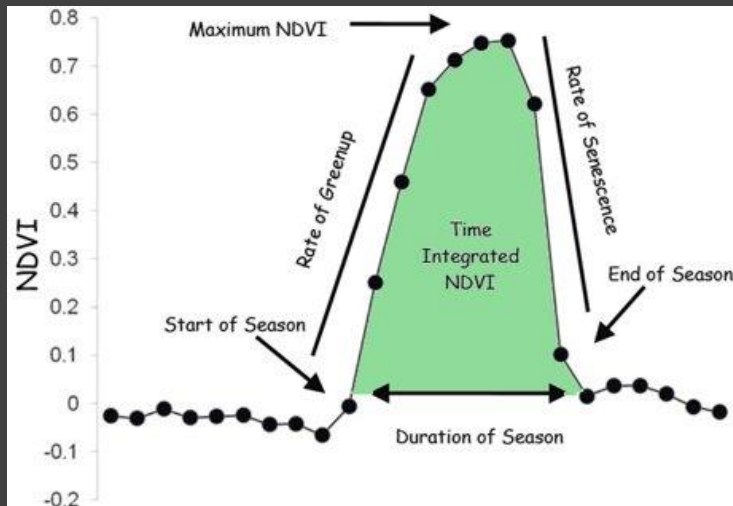


- **Land productivity** is the biological productive capacity of the land, the source of all the food, fiber and fuel that sustains humans (United Nations Statistical Commission 2016).

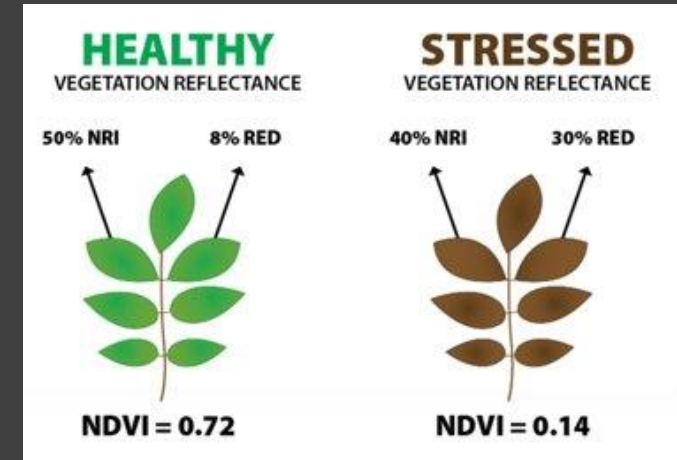
# TRENDS.EARTH - PRODUCTIVITY → PRIMARY PRODUCTIVITY



- **Net primary productivity (NPP)** is the net amount of carbon assimilated after photosynthesis and autotrophic respiration over a given period of time (Clark et al. 2001) and is typically represented in units such as kg/ha/yr.



$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}}$$





# TRENDS.EARTH - PRODUCTIVITY INDICATORS



**Trajectory:** • Measures the rate of change in primary productivity over time.

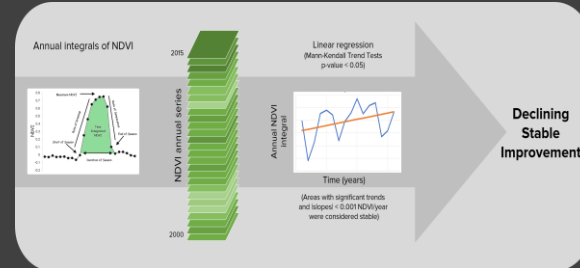
**State:** • Compares the current productivity level in a given area to historical observations of productivity in that same area.

**Performance:** • Measures local productivity relative to other similar vegetation types in similar land cover types or bioclimatic regions throughout the study area.

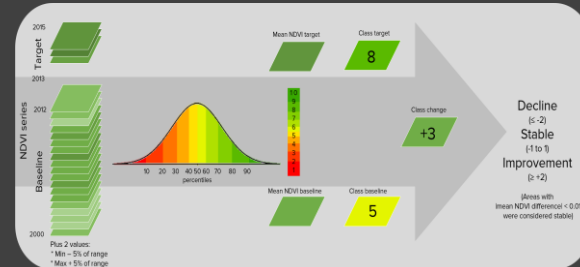
# TRENDS.EARTH - PRODUCTIVITY INDICATORS



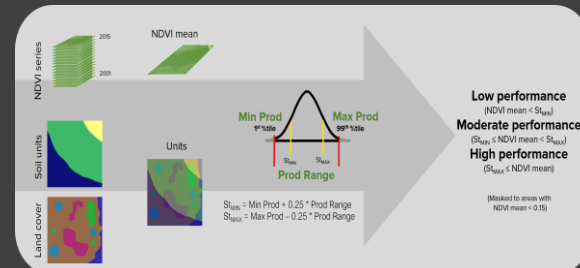
## Trajectory:



## State:



## Performance:



For details, check:

<http://trends.earth/docs/en/index.html>

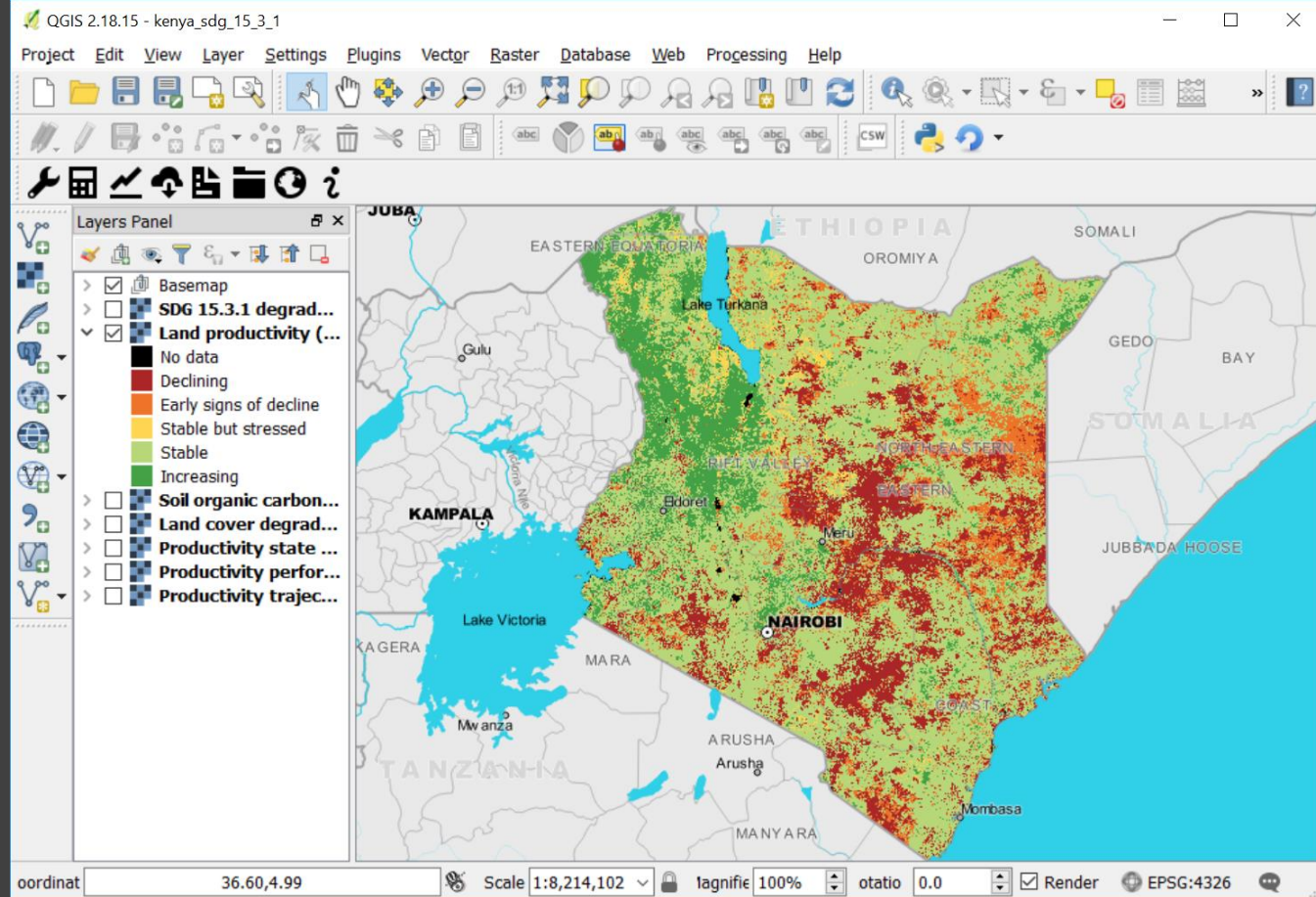


# TRENDS.EARTH - LAND PRODUCTIVITY

TARGET 15.3



END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND



Proportion of land that is degraded over a total area



1. Land Productivity

Net Primary Productivity



2. Land Cover

Land Cover Change



3. Above and Below Ground C

Soil Organic Carbon



# TRENDS.EARTH - LAND COVER CHANGE



- ...describes changes in the observed biophysical character of the earth's surface to help identify areas that may be subject to change. A transition from one land cover type to another may be considered an improvement, a neutral change or degradation, depending on the perspective of the country in question.

# TRENDS.EARTH - LAND COVER CHANGE

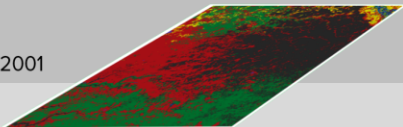
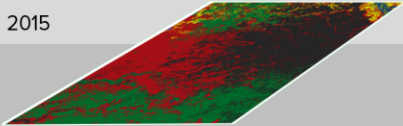
TARGET15•3



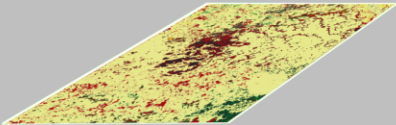
END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND



Land cover for baseline and target years



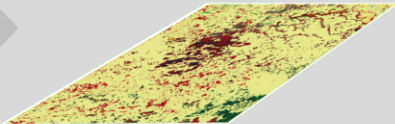
Transition map



+

Transition criteria

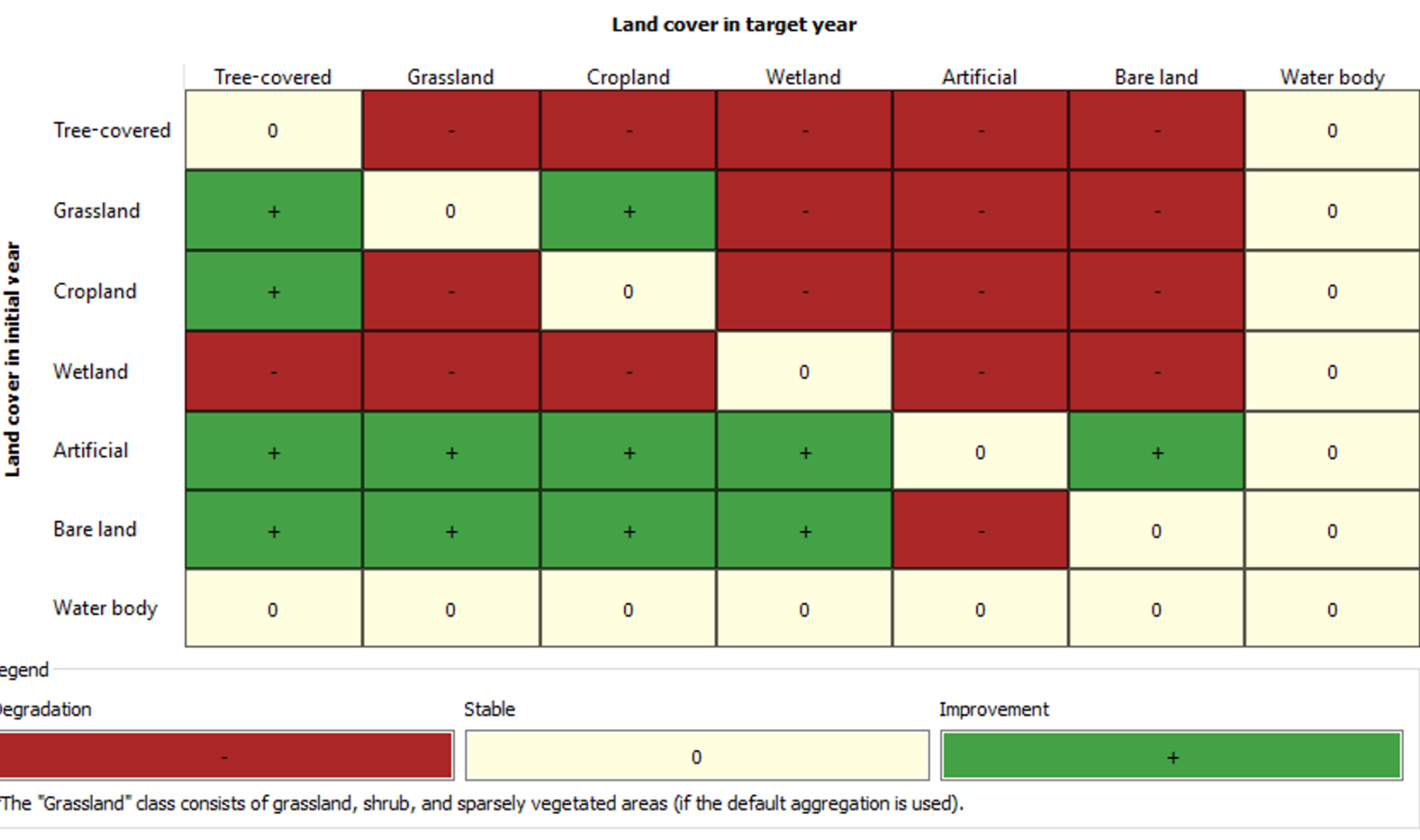

Potential land  
degradation



# TRENDS.EARTH - LAND COVER CHANGE

TARGET 15•3

END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND





Proportion of land that is degraded over a total area



1. Land Productivity

Net Primary Productivity



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Land Cover Change



3. Above and Below Ground C

Soil Organic Carbon

# TRENDS.EARTH - SOIL ORGANIC CARBON



- Carbon stocks reflect the integration of multiple processes affecting plant growth and the gains and losses from terrestrial organic matter pools. The metric used to assess carbon stocks adopted for Indicator 15.3.1 is soil organic carbon (SOC).



$$\text{SOC}_{\text{final}} = \text{SOC}_{\text{ref}} \times \text{FLU} \times \text{FMG} \times \text{FI}$$

- **FLU**: land-use factor that reflects carbon stock changes associated with type of land use,
- **FMG**: management factor representing the main management practice specific to the land-use sector (e.g., different tillage practices in croplands)
- **FI**: input factor representing different levels of carbon input to soil.

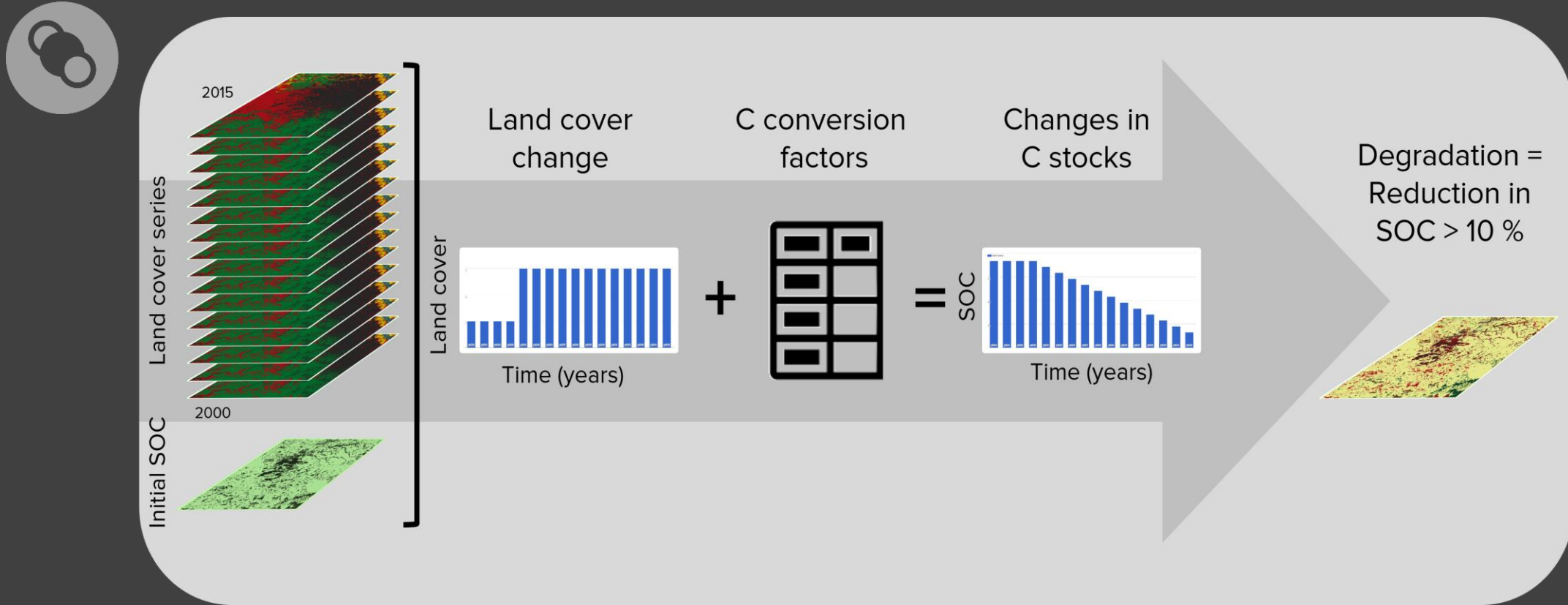




$$\text{SOC}_{\text{final}} = \text{SOC}_{\text{ref}} \times \text{FLU} \times \text{FMG} \times \text{FI}$$

- **FLU**: land-use factor that reflects carbon stock changes associated with type of land use,
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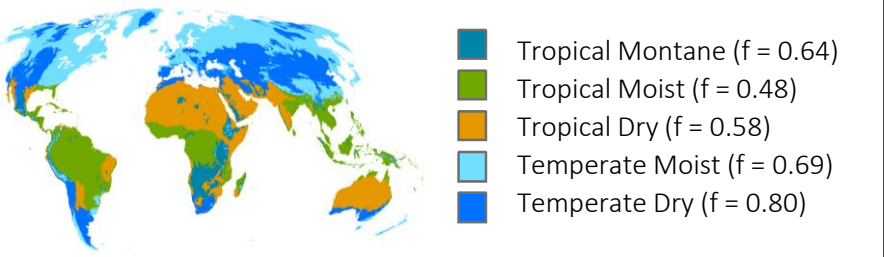
# TRENDS.EARTH - SOIL ORGANIC CARBON



# TRENDS.EARTH - SOIL ORGANIC CARBON



Land use factors		Final land cover						
		Forest	Grassland	Croplands	Wetlands	Artificial	Bare lands	Water
Initial land cover	Forest	1	1	f	1	0.1	0.1	1
	Grassland	1	1	f	1	0.1	0.1	1
	Croplands	1/f	1/f	1	1/0.71	0.1	0.1	1
	Wetlands	1	1	0.71	1	0.1	0.1	1
	Artificial	2	2	2	2	1	1	1
	Bare lands	2	2	2	2	1	1	1
	Water	1	1	1	1	1	1	1





# TRENDS.EARTH - SDG 15.3.1 one out-all out



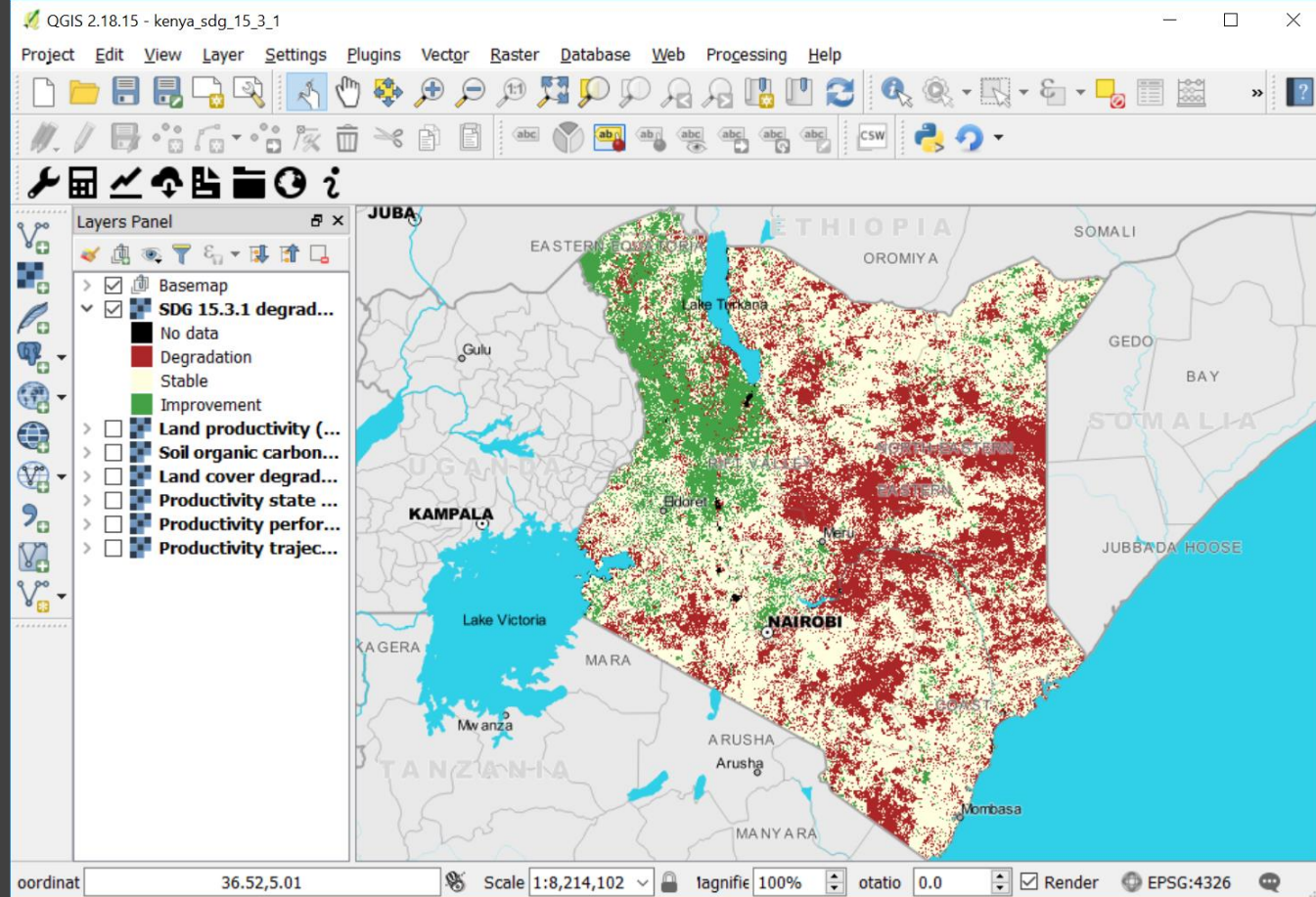
Productivity	Land Cover	SOC	SDG 15.3.1
Improving	Improving	Improving	Improving
Improving	Improving	Stable	Improving
Improving	Improving	Declining	Declining
Improving	Stable	Improving	Improving
Improving	Stable	Stable	Improving
Improving	Stable	Declining	Declining
Improving	Declining	Improving	Declining
Improving	Declining	Stable	Declining
Improving	Declining	Declining	Declining
Stable	Improving	Improving	Improving
Stable	Improving	Stable	Improving
Stable	Improving	Declining	Declining
Stable	Stable	Improving	Improving
Stable	Stable	Stable	Stable
Stable	Stable	Declining	Declining
Stable	Declining	Improving	Declining
Stable	Declining	Stable	Declining
Stable	Declining	Declining	Declining
Declining	Improving	Improving	Declining
Declining	Improving	Stable	Declining
Declining	Improving	Declining	Declining
Declining	Stable	Improving	Declining
Declining	Stable	Stable	Declining
Declining	Stable	Declining	Declining
Declining	Declining	Improving	Declining

# TRENDS.EARTH - THE OUTPUTS

TARGET 15.3

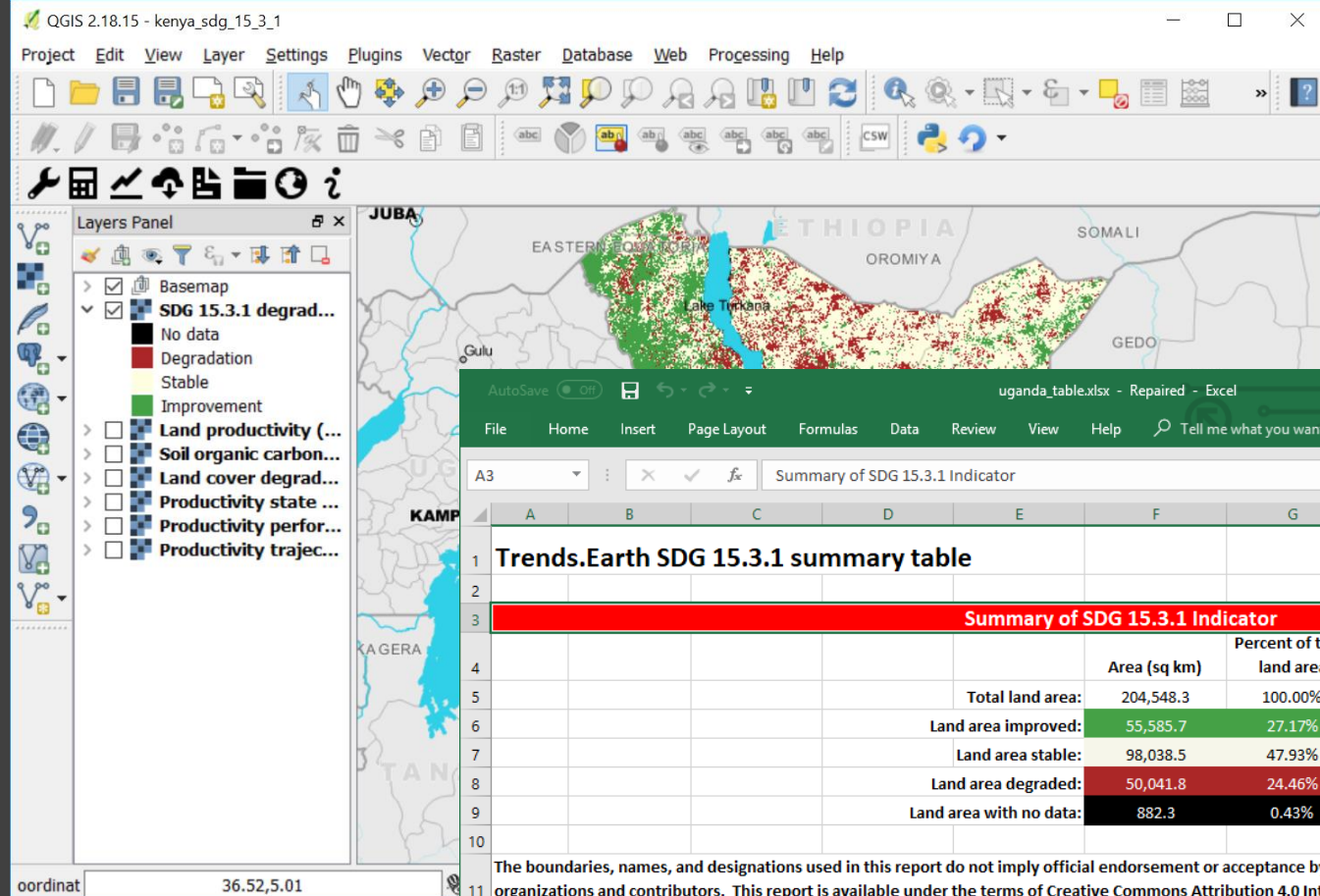


END DESERTIFICATION  
AND RESTORE  
DEGRADED LAND





# TRENDS.EARTH - THE OUTPUTS



AutoSave On | uganda\_table.xlsx - Repaired - Excel | Mariano Gonzalez-Roglich

File Home Insert Page Layout Formulas Data Review View Help Tell me what you want to do Share

A3 | Summary of SDG 15.3.1 Indicator

TRENDS.EARTH tracking land change									
Summary of SDG 15.3.1 Indicator									
						Area (sq km)	Percent of total land area		
Total land area:						204,548.3	100.00%		
Land area improved:						55,585.7	27.17%		
Land area stable:						98,038.5	47.93%		
Land area degraded:						50,041.8	24.46%		
Land area with no data:						882.3	0.43%		
The boundaries, names, and designations used in this report do not imply official endorsement or acceptance by Conservation International Foundation, or its partner organizations and contributors. This report is available under the terms of Creative Commons Attribution 4.0 International License (CC BY 4.0).									
For more information on Trends.Earth, see <a href="http://trends.earth">http://trends.earth</a> , or contact the team at <a href="mailto:trends.earth@conservation.org">trends.earth@conservation.org</a> .									



More than **2500 users** from over **170 countries** are using Trends.Earth for assessing land condition and planning for LDN

- Increases spatial resolution datasets
- Update to QGIS 3
- We on integration with **WOCA**T and **LandPKS** (and other tools) to support decision makers from field to national scale.
- Decision support tool, not just for monitoring, but for planning.

# Using Earth Observation Data to Support the Achievement of the Sustainability Agenda

## Monitoring Sustainable Cities (SDG 11.3.1)

When: Thursday October 10, 2019 at 5:30 pm (1 hour and 20 min)  
Where: Embajadores Hall

Mariano Gonzalez-Roglich, Conservation International  
[mgonzalez-roglich@conservation.org](mailto:mgonzalez-roglich@conservation.org)  
Argyro Kavvada, NASA & GEO EO4SDG  
[Argyro.Kavvada@nasa.gov](mailto:Argyro.Kavvada@nasa.gov)

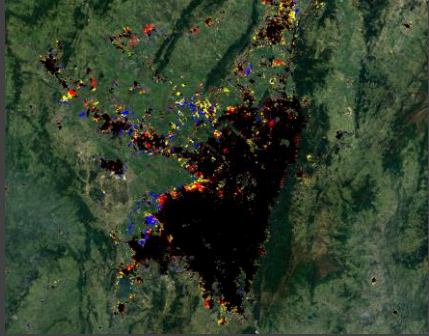


- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
  - Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
    - Indicator 11.3.1: Ratio of land consumption rate to population growth rate
- Data needs:
  - Urban extent
  - Population data

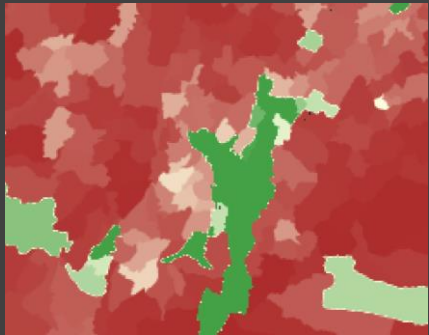
# TRENDS.EARTH - SDG 11.3.1



Trends.Earth urban extent series



Gridded Population of the World V4



- Part 1: Estimating the population growth rate
- Part 2: Estimating the land use consumption rate
- Part 3: Estimating SDG 11.3.1

$$PGR = \frac{(\text{LN}(\text{Pop}_{(t+n)} / \text{Pop}_t))}{(y)}$$

$$LCR = \frac{(\text{LN}(\text{Urb}_{(t+n)} / \text{Urb}_t))}{(y)}$$

$$LCRPGR = \frac{(\text{Annual Land Consumption rate})}{(\text{Annual Population growth rate})}$$

# TRENDS.EARTH - MONITORING CITIES



Tier 1: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.

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# TRENDS.EARTH - COMPUTE SDG 11.3.1



2000

Satellite  
images

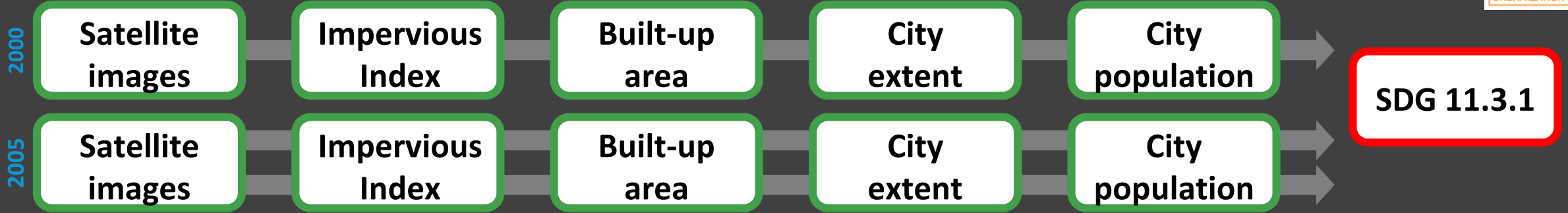
Impervious  
Index

Built-up  
area

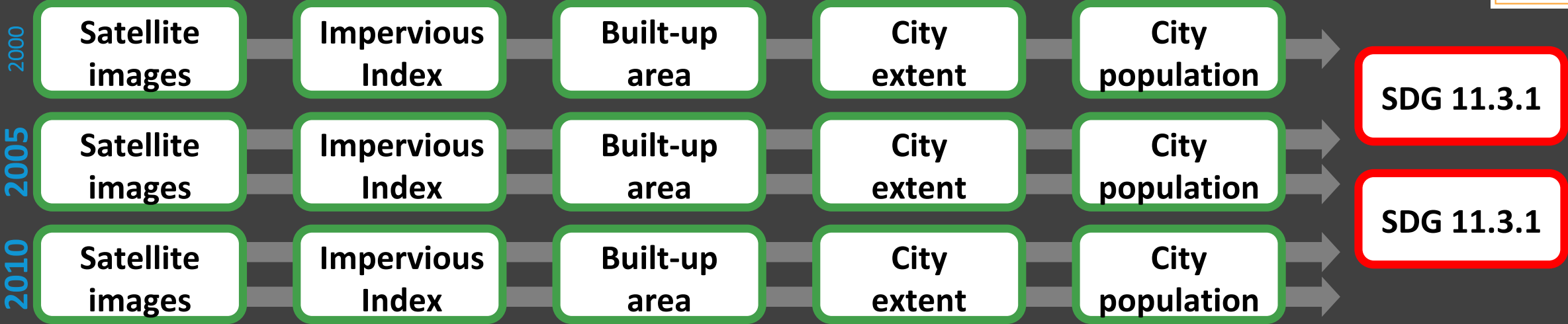
City  
extent

City  
population

# TRENDS.EARTH - COMPUTE SDG 11.3.1

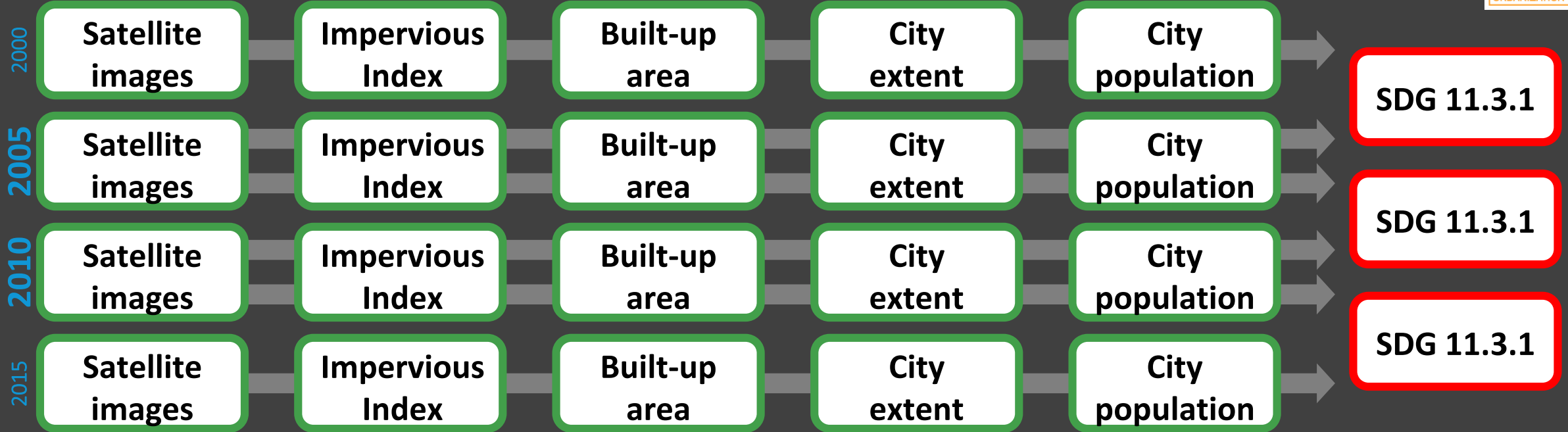


# TRENDS.EARTH - COMPUTE SDG 11.3.1

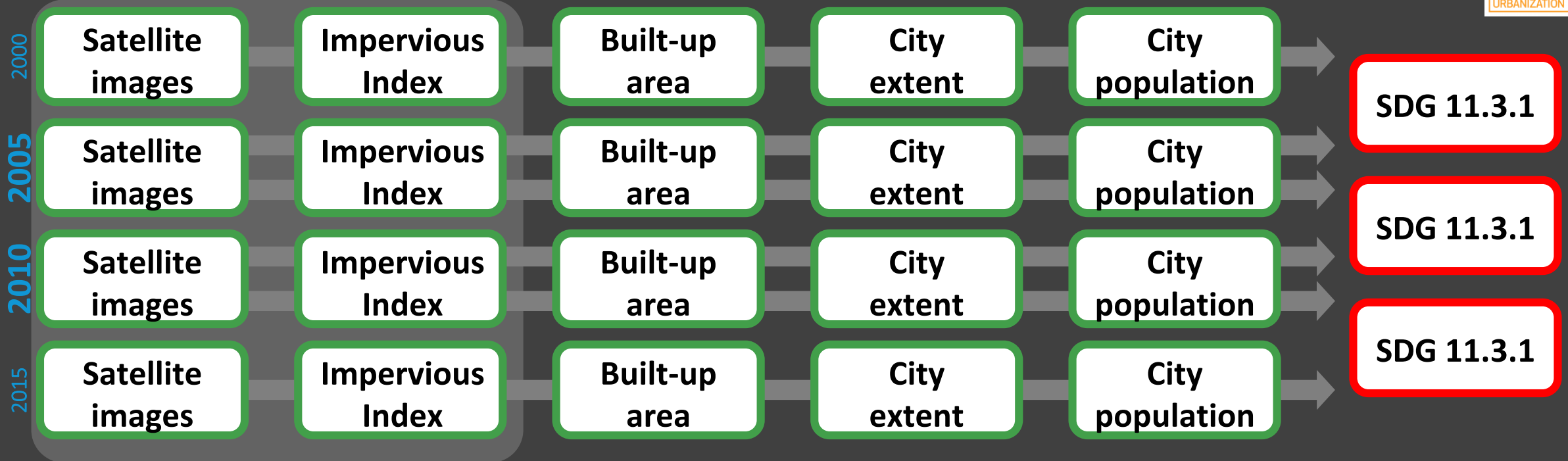




# TRENDS.EARTH - COMPUTE SDG 11.3.1

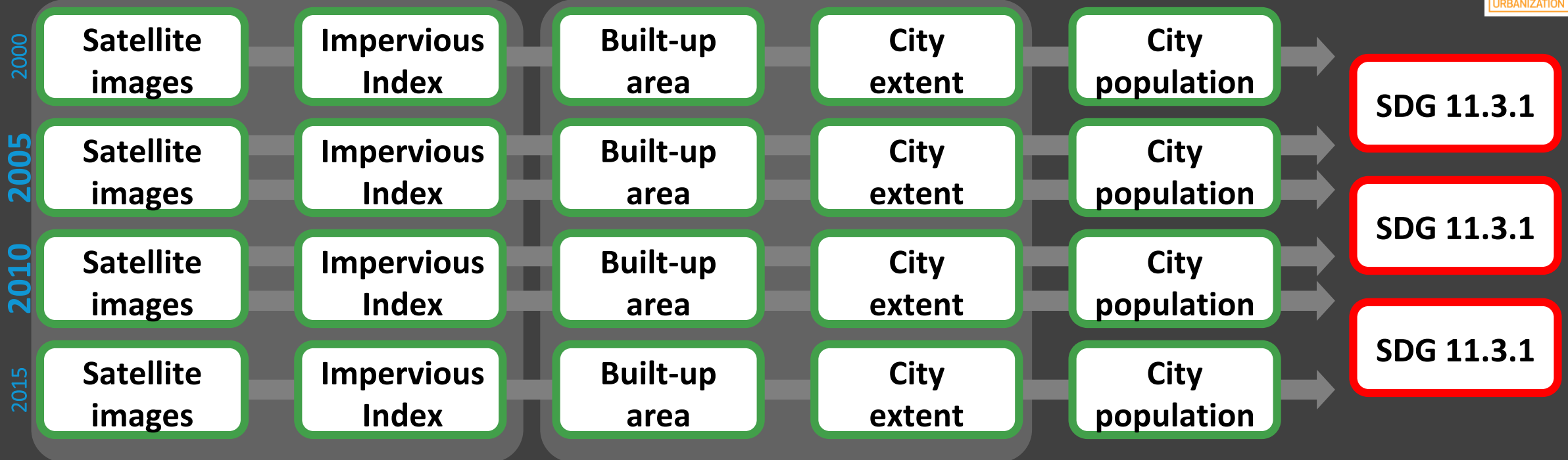


# TRENDS.EARTH - COMPUTE SDG 11.3.1



**Pre-Computed**  
(2.3 M Landsat scenes  
1.15 Petabytes of data)

# TRENDS.EARTH - COMPUTE SDG 11.3.1

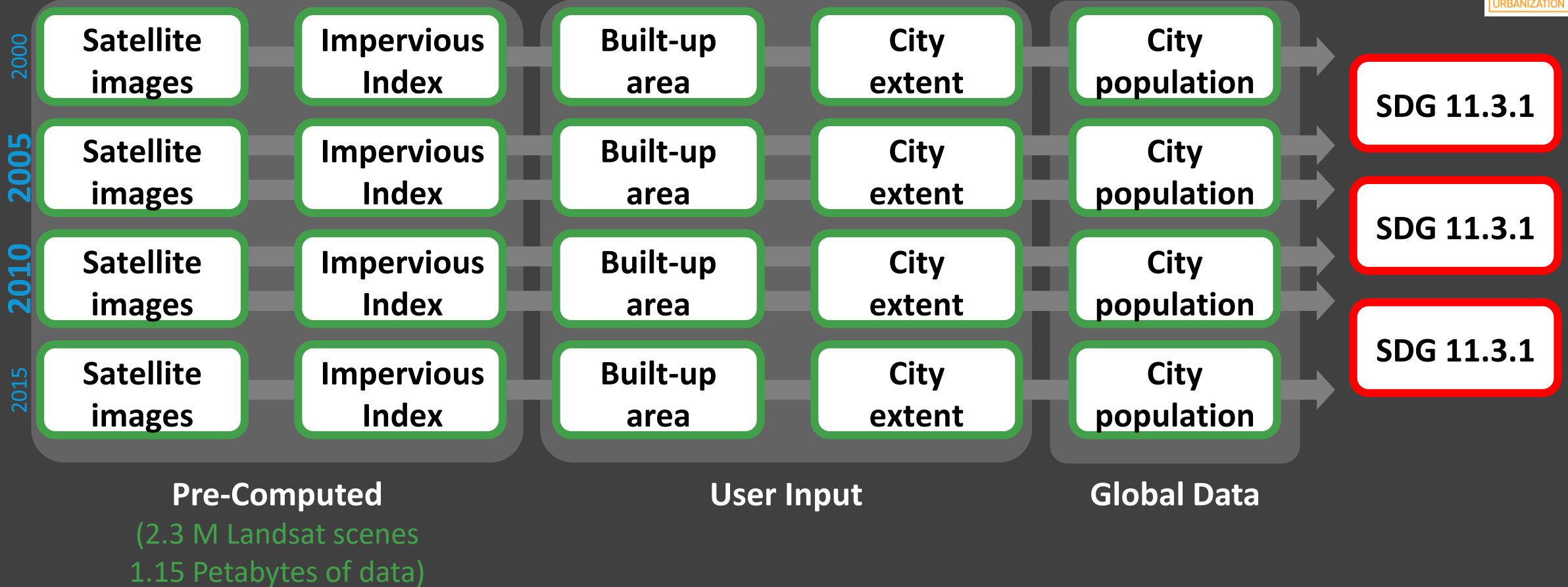


**Pre-Computed**  
(2.3 M Landsat scenes  
1.15 Petabytes of data)

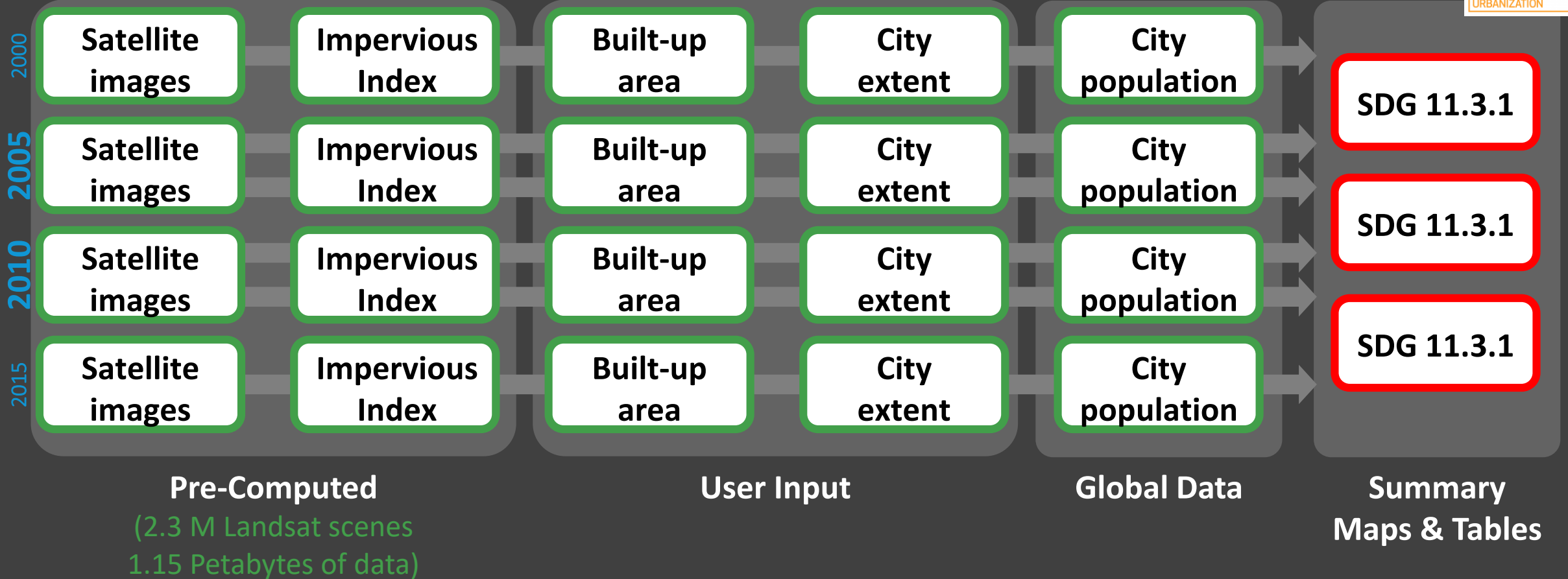
**User Input**



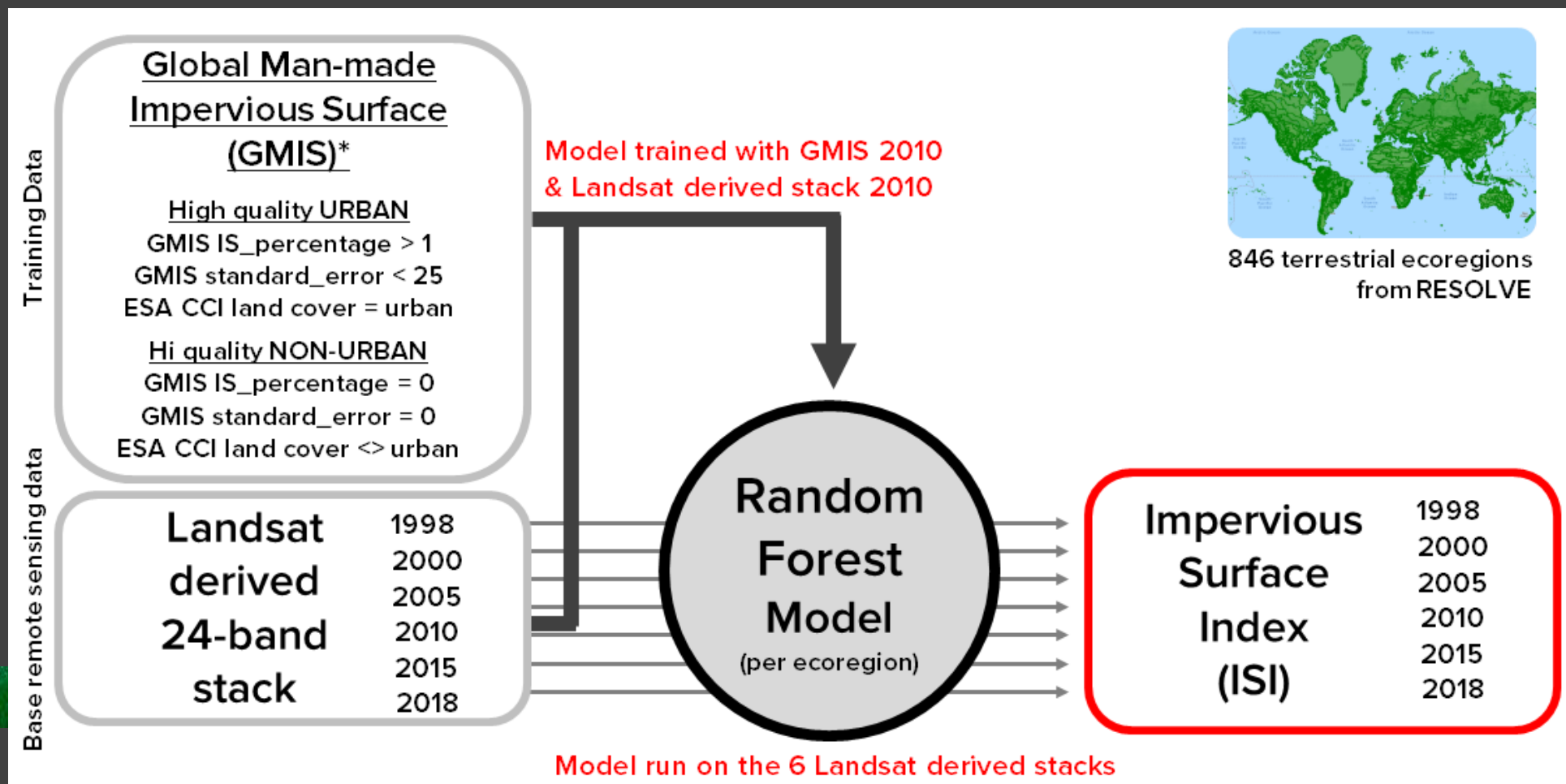
# TRENDS.EARTH - COMPUTE SDG 11.3.1



# TRENDS.EARTH - COMPUTE SDG 11.3.1



# TRENDS.EARTH - COMPUTE SDG 11.3.1

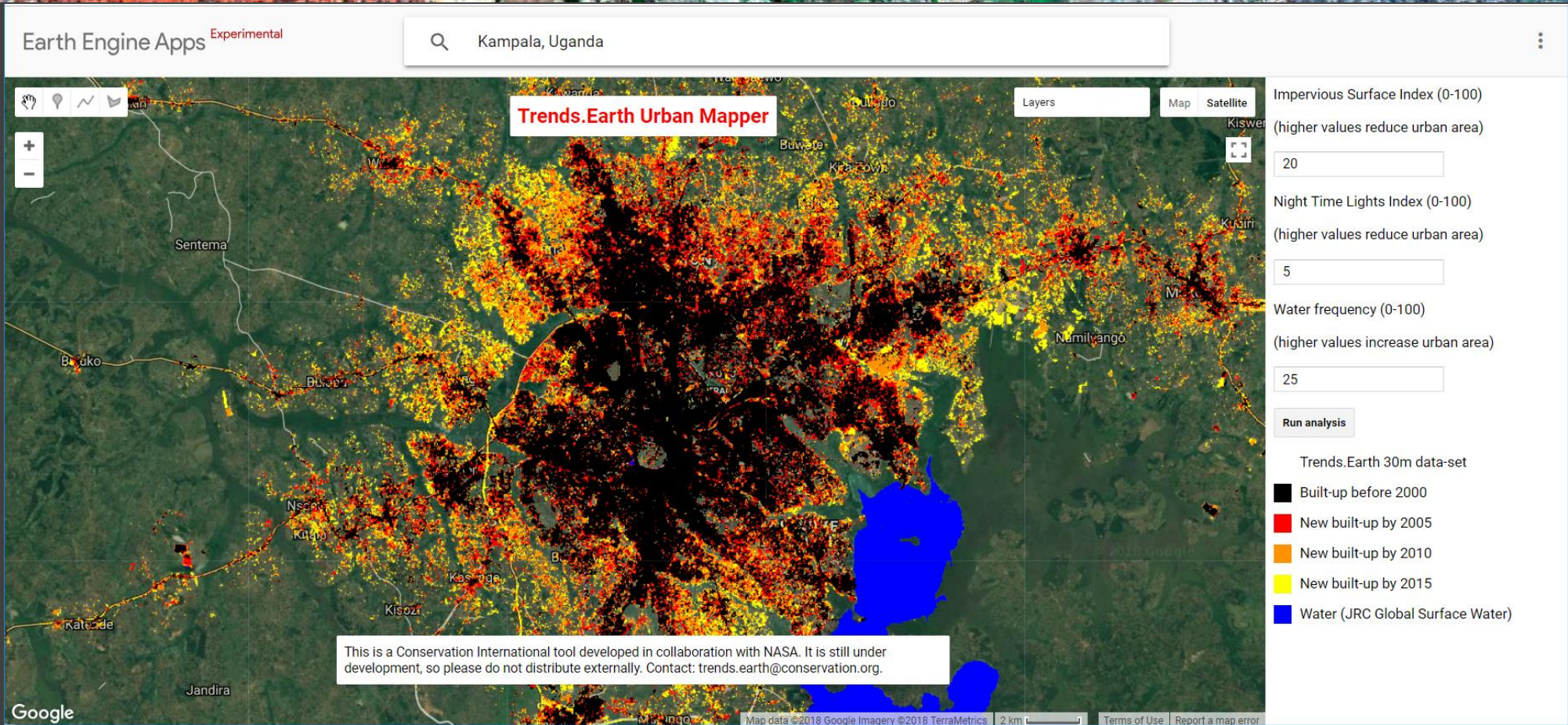




# TRENDS.EARTH - URBAN MAPPER

TARGET 11.3

INCLUSIVE AND SUSTAINABLE URBANIZATION



# TRENDS.EARTH - QGIS

Define built-up area

Calculate Urban Area Change Metrics

Settings

Advanced

Area

Options

Thresholds

See the [Urban Mapper page](#) for assistance choosing these values.

**Impervious Surface Index (0-100)**  
(higher values reduce urban area)

20

**Night Time Lights Index (0-100)**  
(higher values reduce urban area)

10

**Water Frequency (0-100)**  
(higher values increase urban area)

25

Previous

Next

Calculate





## Define urban areas (zonation)

Calculate Urban Area Change Metrics

Settings

Advanced

Area

Options

Urban definition

Percentage built-up considered suburban  
(values below this will be considered rural)

25%

Percentage built-up considered urban  
(values below this will be considered suburban)

50%

Open space definition

Area of largest captured open space (hectares)  
(contiguous captured open space larger than this area will be considered rural)

200

Population definition (Gridded Population of the World, v4)

☒ Population density consistent with national census and population registers


☐ Population density adjusted to match official UN population estimates

Previous

Next

Calculate

TARGET11.3



INCLUSIVE AND SUSTAINABLE URBANIZATION

CONSERVATION  
INTERNATIONAL

NASA



## Define area of analysis

Calculate Urban Area Change Metrics

Settings

Advanced

Area

Options

Area to run calculations for

☒ Country / Region

First level

Uganda

Second level

☐ Region: All regions

☒ City: Kampala (Kampala)

Disclaimer: The provided boundaries are from [Natural Earth](#), and are in the [public domain](#). The boundaries and names used, and the designations used, in Trends.Earth do not imply official endorsement or acceptance by Conservation International Foundation, or by its partner organizations and contributors.

☐ Area from file

Click "Browse" to choose a file...

Browse

☒ Apply a buffer to the chosen area


Buffer size (kilometers): 20.0

Previous

Next

Calculate

TARGET 11.3



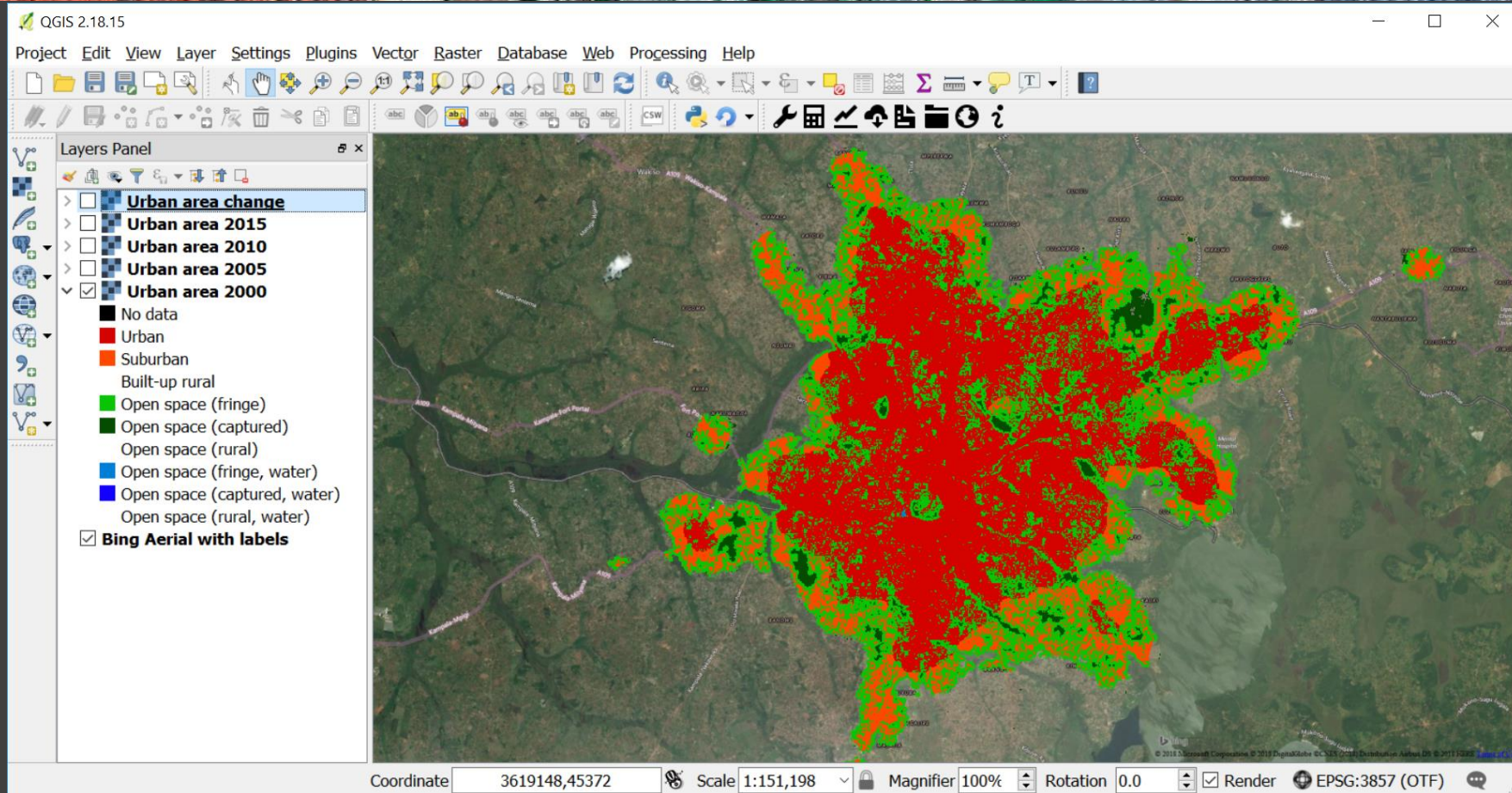
INCLUSIVE AND SUSTAINABLE URBANIZATION

CONSERVATION  
INTERNATIONAL

NASA

# TRENDS.EARTH - QGIS

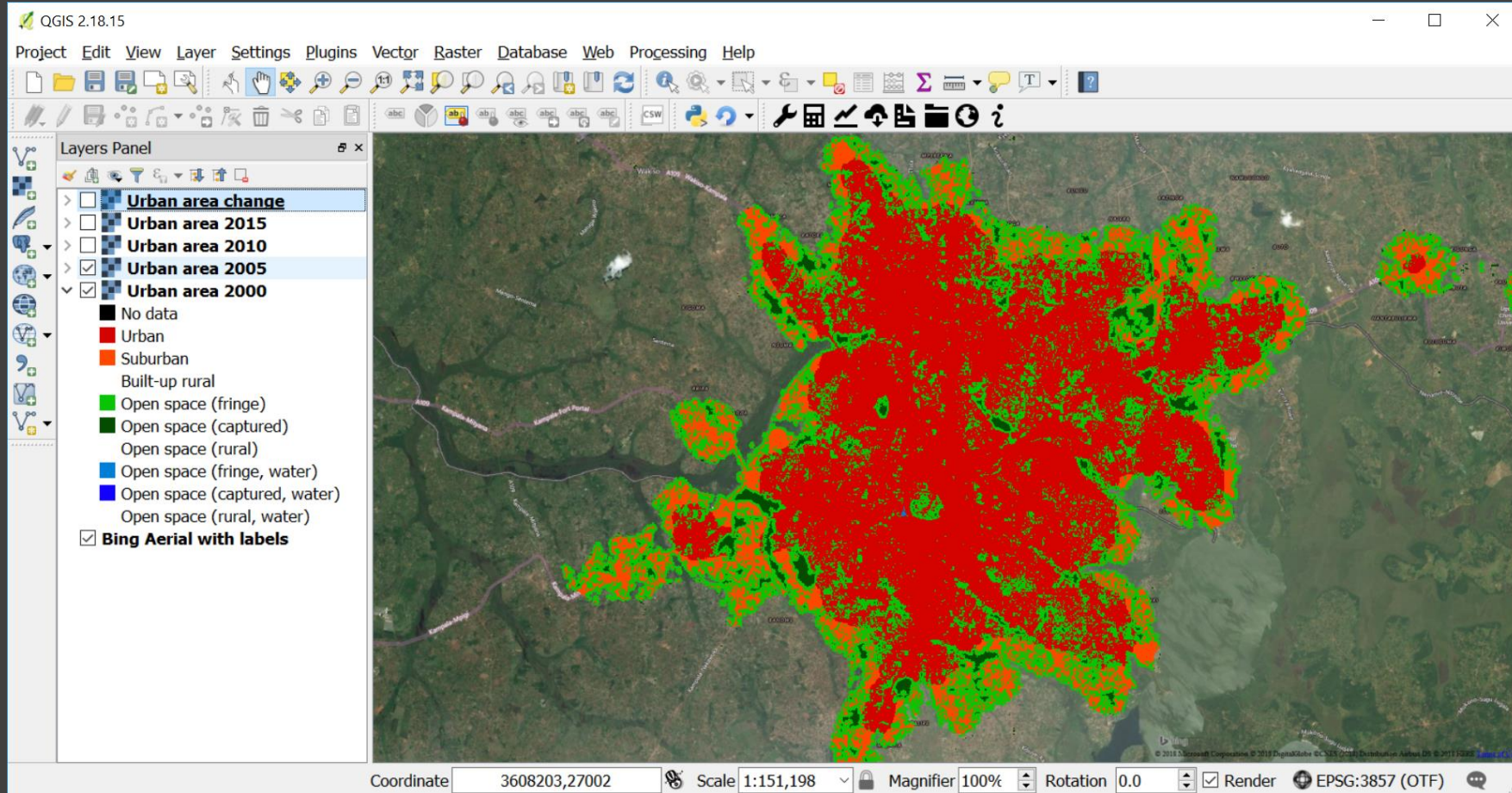
Kampala,  
Uganda –  
2000





# TRENDS.EARTH - QGIS

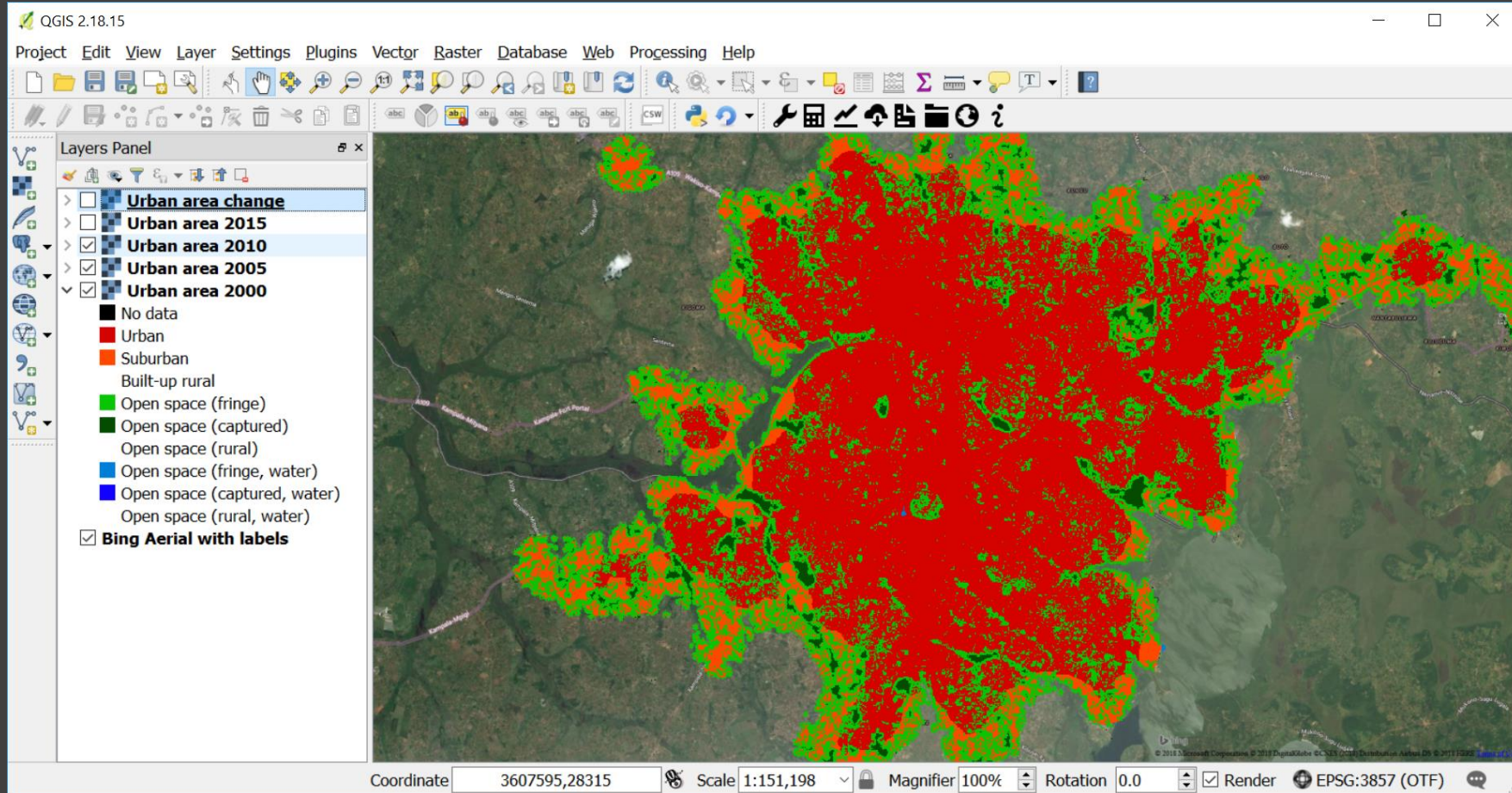
Kampala,  
Uganda –  
2005





# TRENDS.EARTH - QGIS

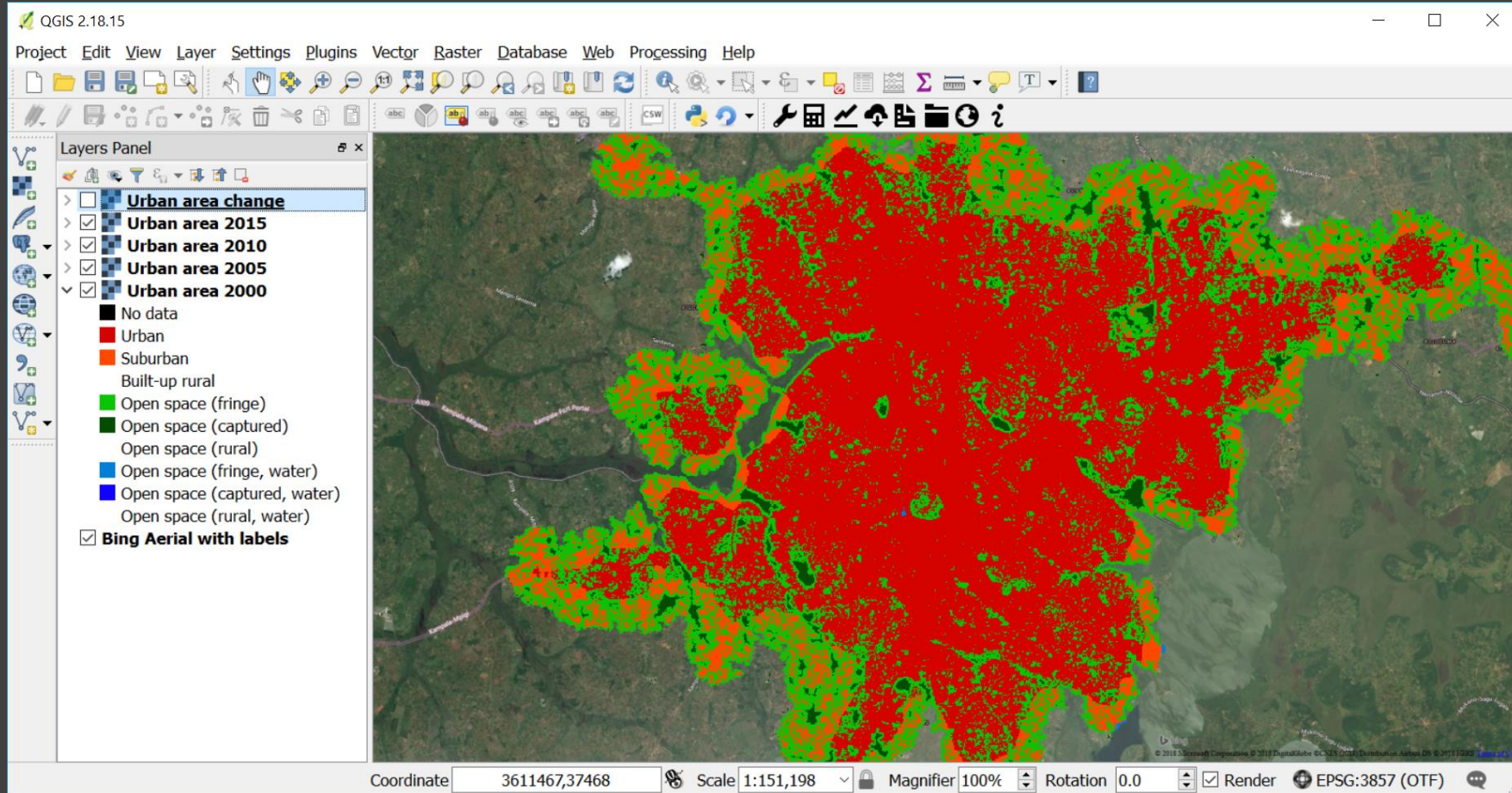
Kampala,  
Uganda –  
2010





# TRENDS.EARTH - QGIS

Kampala,  
Uganda –  
2015





# TRENDS.EARTH - QGIS

Kampala,  
Uganda –  
Time series

QGIS 2.18.15

Project Edit View Layer Settings Plugins Vector Raster Database Web P

Layers Panel

- ☐ Urban area change
- ☒ Urban area 2015
- ☒ Urban area 2010
- ☒ Urban area 2005
- ☒ Urban area 2000
- ☐ No data
- ☐ Urban
- ☐ Suburban
- ☐ Built-up rural
- ☐ Open space (fringe)
- ☐ Open space (captured)
- ☐ Open space (rural)
- ☐ Open space (fringe, water)
- ☐ Open space (captured, water)
- ☐ Open space (rural, water)
- ☒ Bing Aerial with labels

Coordinate 3611467,37468

AutoSave Off kampala\_table.xlsx - Rep... Mariano Gonzalez-Roglich

File Home Insert Page Layout Formulas Data Review View Help Tell me Share

A3 Summary of population growth rate and land consumption

**Trends.Earth SDG 11.3.1 summary table**

**Summary of population growth rate and land consumption**

Period	City population change	City population growth rate	City area change (sq km)	Land consumption rate	SDG 11.3.1
2000-2005	444,208	0.053964	11,936.41	0.041822	0.775
2005-2010	513,451	0.048330	12,424.12	0.035864	0.742
2010-2015	526,500	0.039791	5,268.17	0.013459	0.338

Urban and land consumption rates

**Area (in hectares) of each land class by year**

	2000	2005	2010	2015	Consider this class to be part of the city?
Urban	22,585.98	30,219.43	39,896.55	45,869.17	Yes
Suburban	5,014.77	5,264.09	5,434.47	4,986.15	Yes
Built-up rural	1,299.64	1,294.18	789.90	612.27	No
Open space (fringe)	21,677.34	24,663.06	26,428.51	26,342.23	Yes
Open space (captured)	1,888.23	2,924.86	3,726.11	3,547.85	Yes
Open space (rural)	49,088.35	37,188.68	25,278.76	20,196.63	No
Open space					

**SDG 11.3.1 Summary Table**

Ready 80%



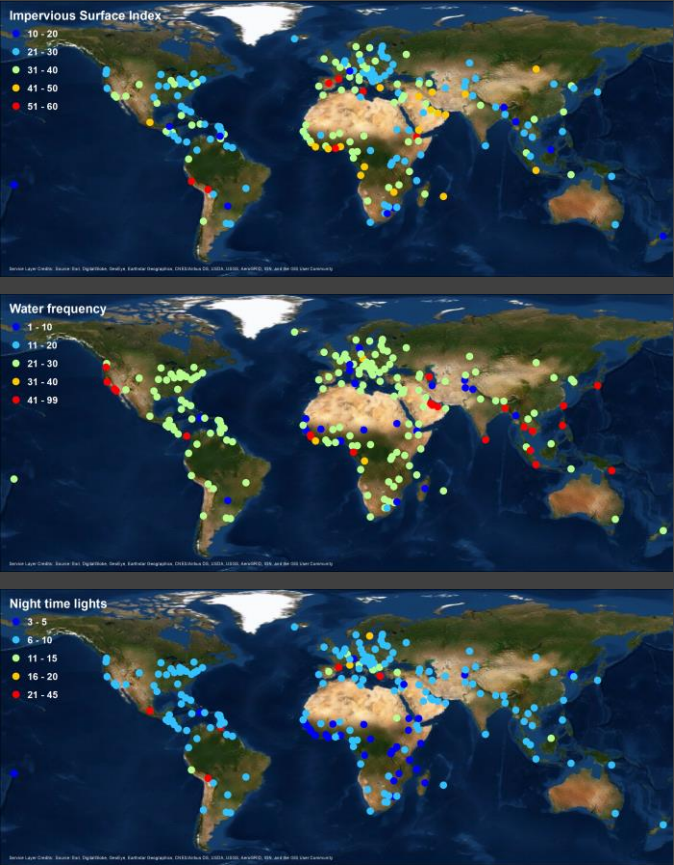
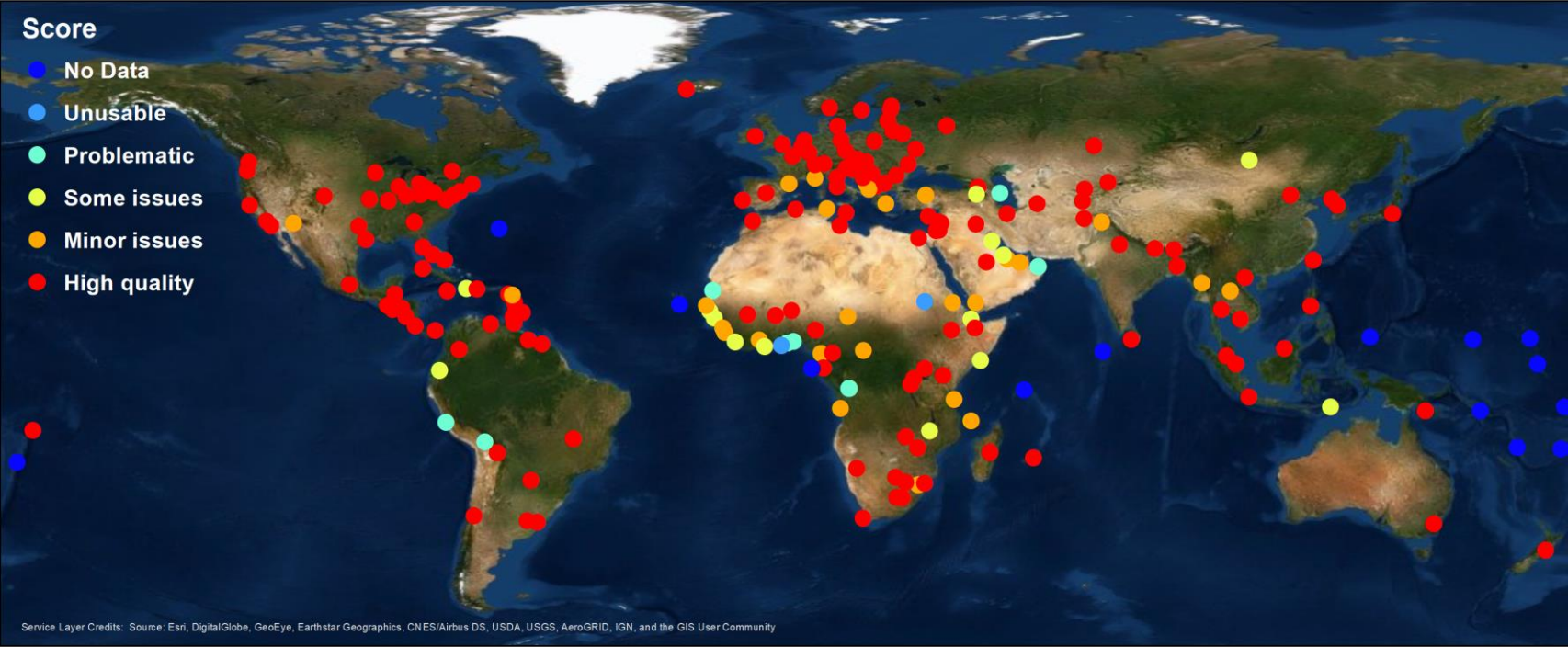


# TRENDS.EARTH - TESTING

TARGET 11-3



INCLUSIVE AND SUSTAINABLE URBANIZATION

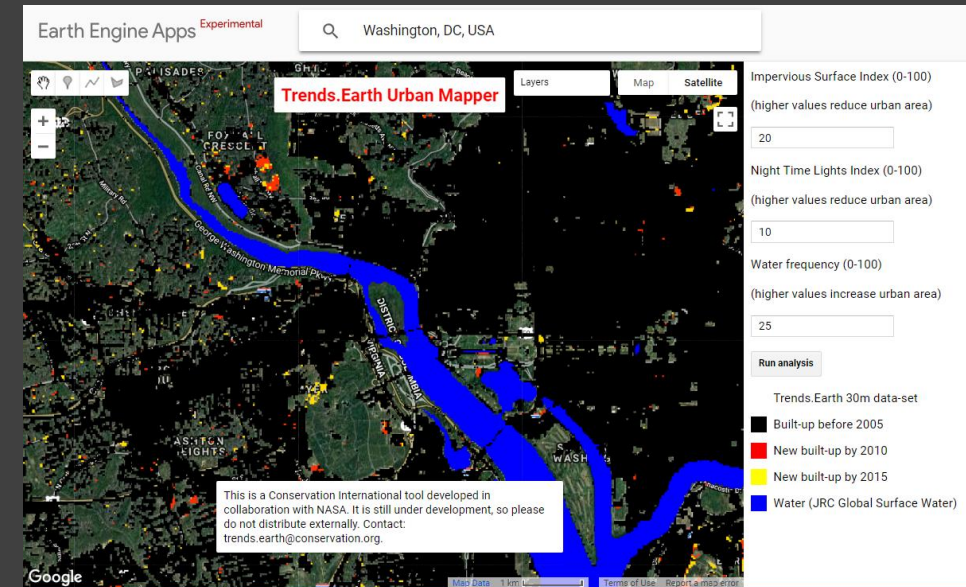




# TRENDS.EARTH - NEXT STEPS



- Continue the verification process to provide regional guidelines.
- Address limitation on hyper arid regions
- Work with gridded population data providers to improve relevance of population data at city level.
- Continue capacity building efforts
  - (ARSET webinar & in person)





## Muchas Gracias! Preguntas?

- QGIS Plug-in: Trends.Earth
- Website: <http://trends.earth/>
- Outputs: <http://maps.trends.earth>

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