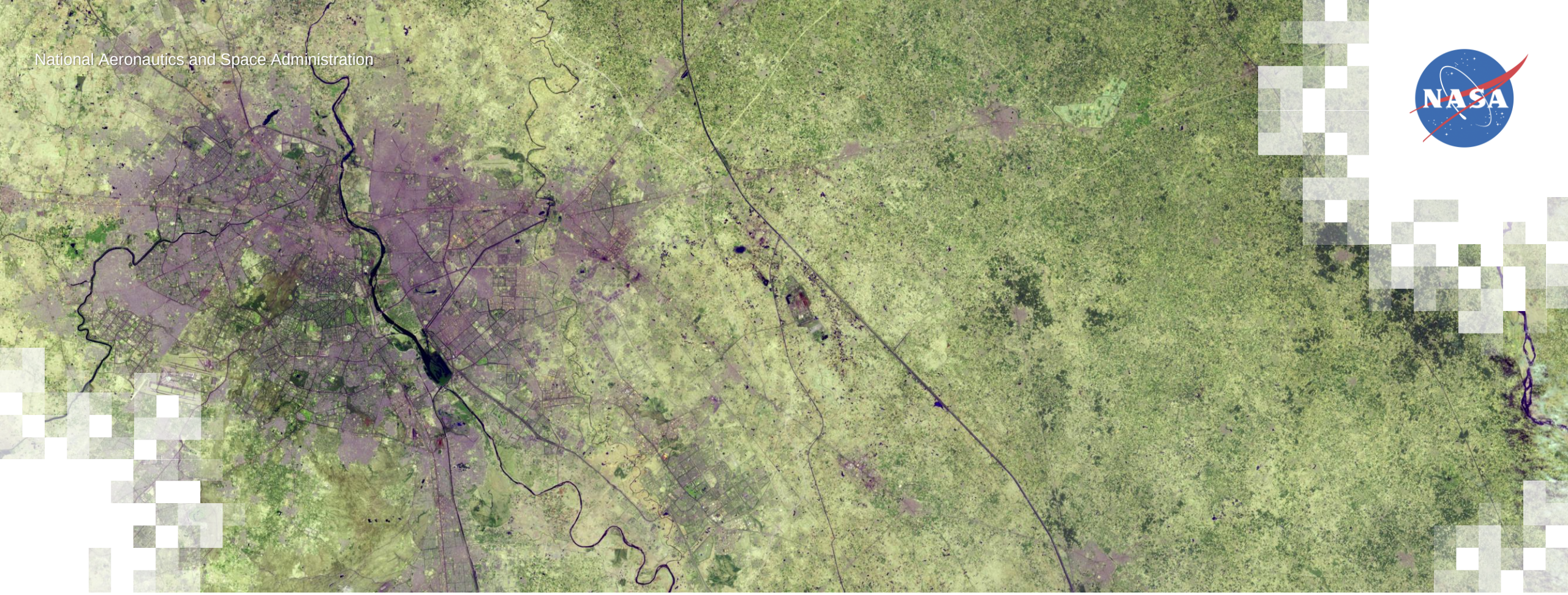


Remote Sensing for Land Degradation and Consumption SDGs

Speakers: Amber McCullum, Dennis Mwaniki, Dr. Alexander Zvoleff, Monica Noon, Dr. Mariano Gonzalez-Roglich

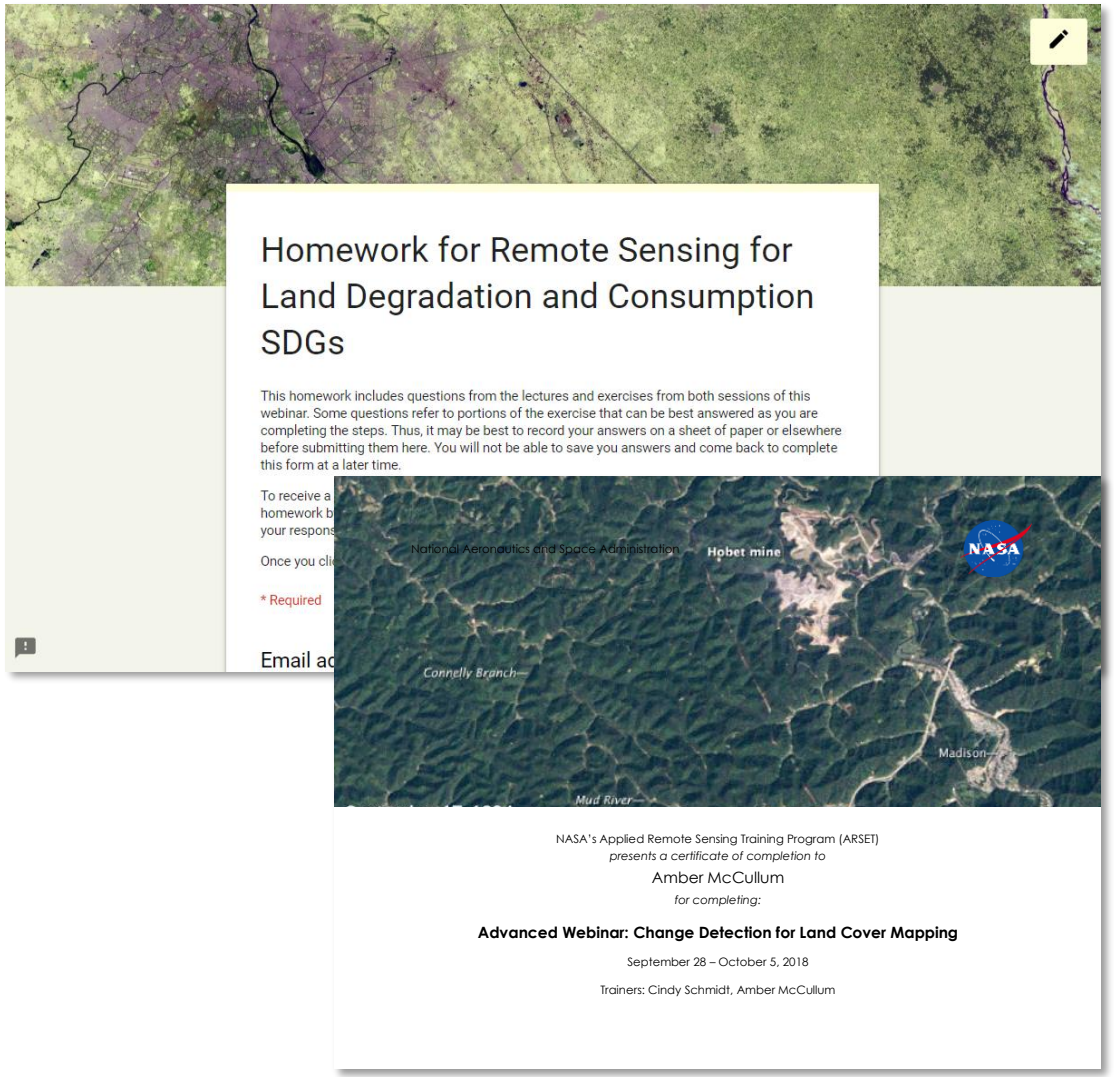
July 23, 2019

Course Structure

- Three, 1.5 hour sessions on July 9, 16, and 23, 2019
- The same content will be presented at two different times each day:
  - Session A: 10:00-11:30 EST (UTC-4)
  - Session B: 18:00-19:30 EST (UTC-4)
  - **Please only sign up for and attend one session per day**
- Webinar recordings, PowerPoint presentations, and the homework assignment can be found after each session at:
  - https://arset.gsfc.nasa.gov/land/webinars/land-degradation-SDGs19
- Q&A: Following each lecture and/or by email
    - amberjean.mccullum@nasa.gov
    - juan.l.torresperez@nasa.gov

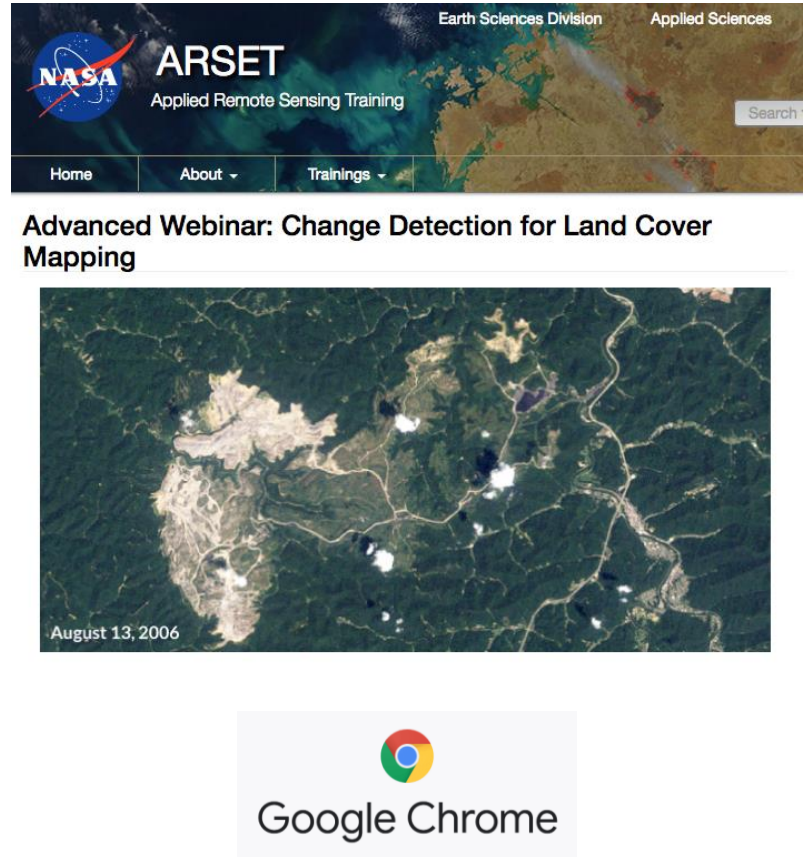
Homework and Certificates

- Homework
  - One homework assignment
  - Answers must be submitted via Google Forms
- Certificate of Completion:
  - Attend both live webinars
  - Complete the homework assignment by the deadline (access from ARSET website)
    - HW Deadline: Tuesday August 6th
  - You will receive certificates approximately two months after the completion of the course from: marines.martins@ssaihq.com



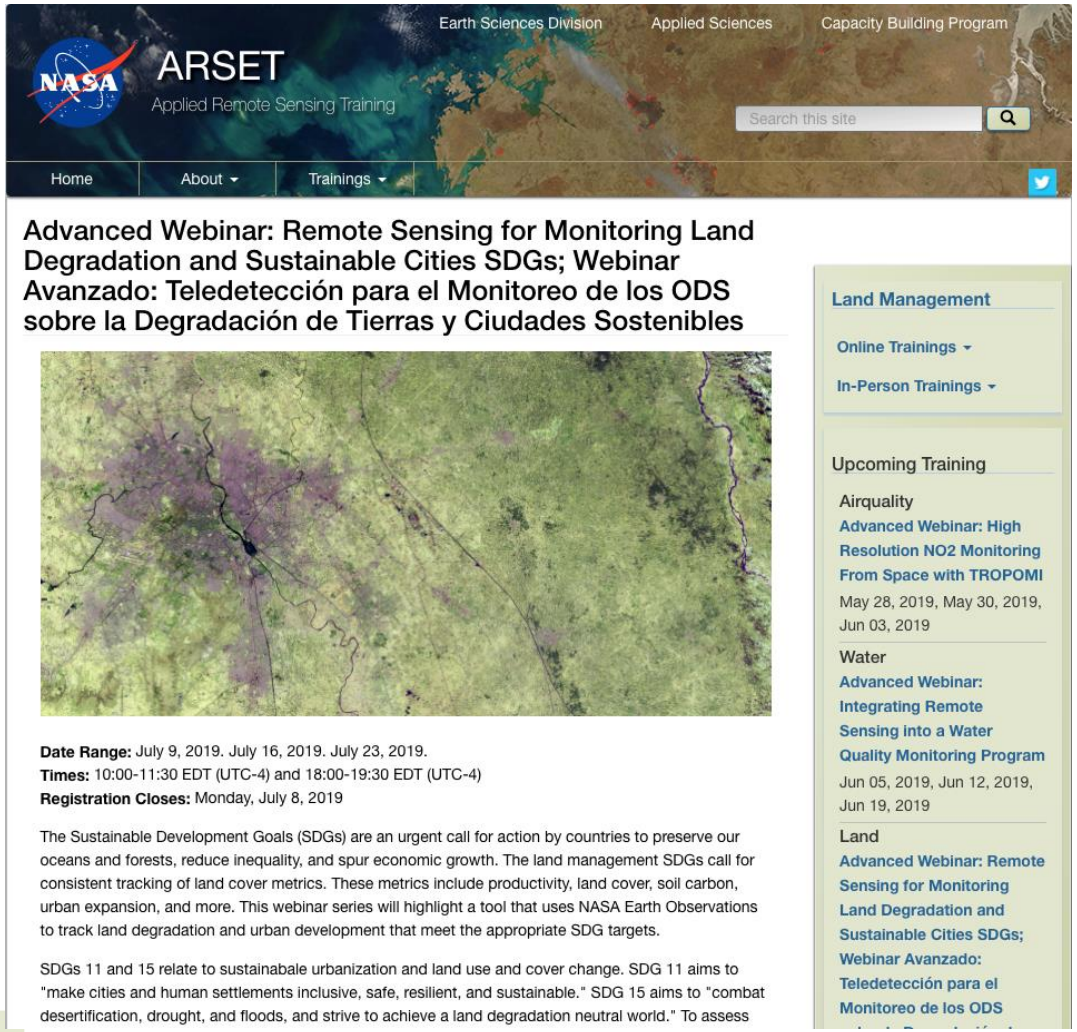
Prerequisites

- Complete Sessions 1 & 2A of Fundamentals of Remote Sensing, or equivalent experience
- Download and install QGIS. QGIS version 2.18.15
  - Use this exercise for help: Downloading and Installing QGIS
- Download, install, and register the Trends.Earth software. This is a QGIS plugin that only currently works with the Version 2 iterations of QGIS (not version 3 or higher).
  - Be sure to read the Before Installing the toolbox page prior to Installing the toolbox.



Accessing Course Materials

https://arset.gsfc.nasa.gov/land/webinars/land-degradation-SDGs19



Course Agenda:

Agenda

Part One

In this webinar, attendees will learn about the SDG framework and global agency coordination; become familiar with SDG 15, Target 15.3, and Indicator 15.3.1; learn about the concept of net primary productivity and how to monitor that metric with remote sensing data; and will learn to view and interpret remote sensing data associated with SDG 15 within a QGIS tool developed by Conservation International called Trends.Earth as a hands-on activity.

- Presentation Slides »
- Exercise 1 »
- Exercise 2 »

Prima Parte

En esta sesión aprenderán acerca del marco de los ODS y la coordinación entre agencias a nivel mundial; se familiarizarán con el ODS 15, Meta 15.3 e Indicador 15.3.1; aprenderán sobre el concepto de la productividad primaria neta y cómo monitorear esa métrica con datos por teledetección; también aprenderemos cómo visualizar e interpretar datos por teledetección asociados con el ODS 15 dentro de una herramienta para QGIS desarrollada por Conservation International llamada Trends.Earth como un ejercicio práctico.

- Diapositivas de la Presentación »
- Ejercicio 1 »
- Ejercicio 2 »

Part Two

In this webinar, attendees will learn about land cover change and soil organic carbon and how to monitor those metrics with remote sensing; learn about country reporting requirements for SDG 15; and view and interpret local remote sensing data associated with SDG 15 within Trends.Earth.

- Presentation Slides »
- Exercise 1 »

Segunda Parte

En esta sesión, aprenderán acerca de los cambios en la cobertura terrestre y el carbono orgánico del suelo y cómo monitorear esas métricas mediante la teledetección; aprenderán acerca de los requisitos en cuanto a la presentación de informes para el ODS 15; además,visualizarán e interpretarán datos por teledetección locales asociados con el ODS dentro de Trends.Earth.

- Diapositivas de la Presentación »
- Ejercicio 1 »

Course Outline

Session 1: SDG 15

- ARSET and the SDGs
- SDG 15 Overview
- Trends/Earth for 15.3.1
- Exercise (default data)

Session 2: SDG 15

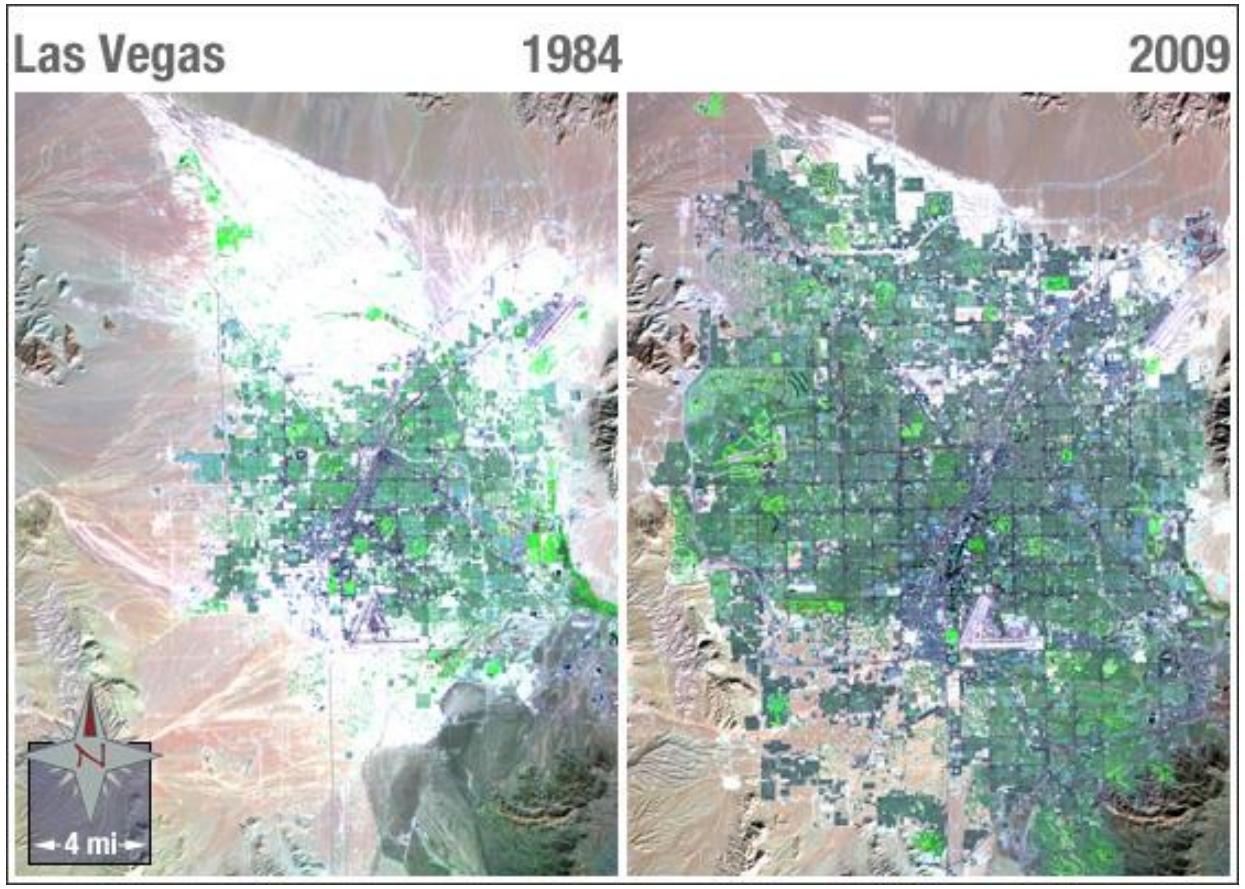
- Global Datasets
- Country/local data example
- Exercise (local data)

Session 3: SDG 11

- SDG 11 Overview
- Trends/Earth for 11.3.1
- Exercise (urban mapping)

Session 3 Agenda

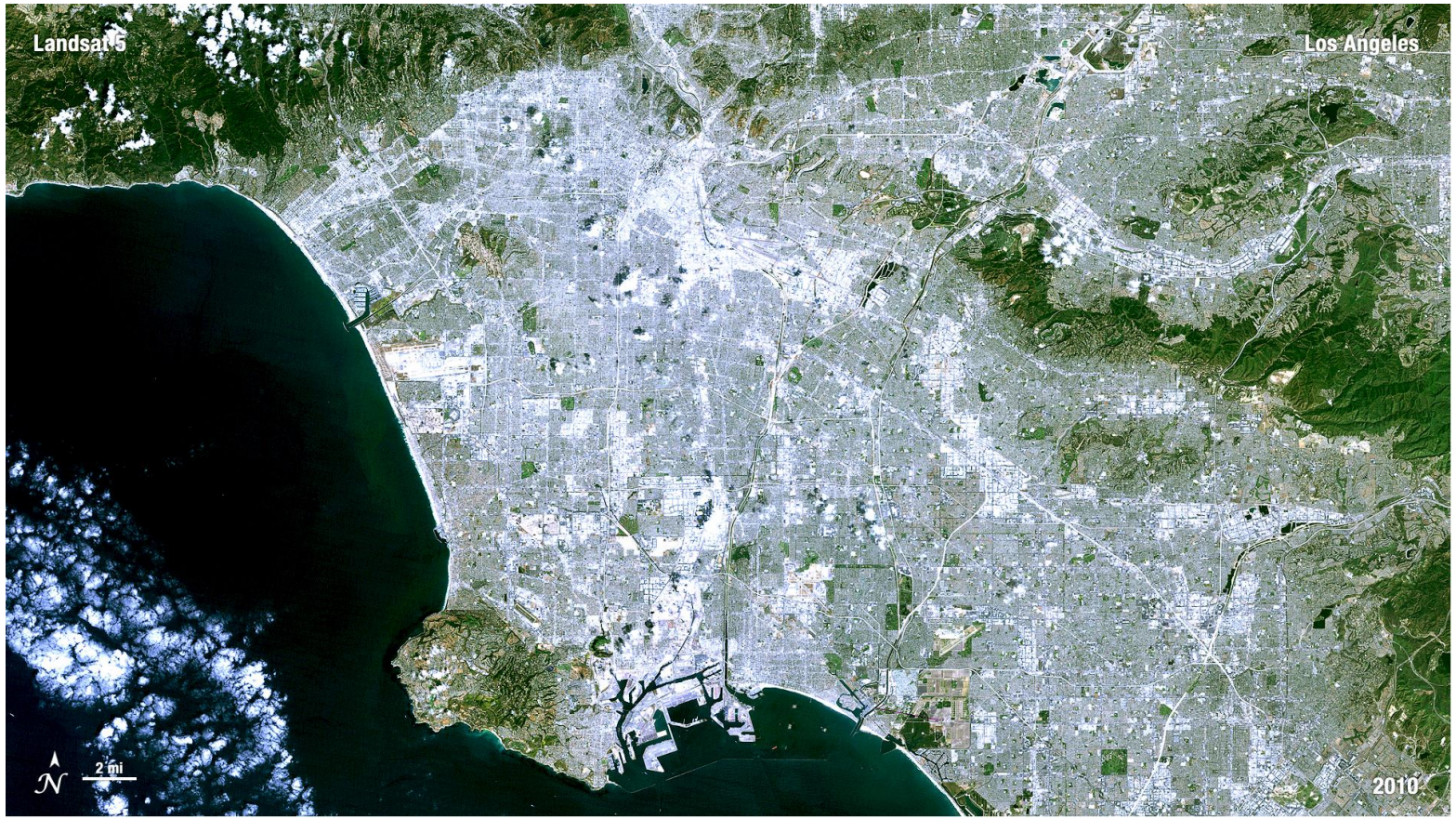
- NASA - Overview of SDG 11
- UN Habitat – Indicator 11.3.1 and data needs
- CI - Presentation on the Trends.Earth tool for SDG 11.3.1
- CI - Exercise using Trends.Earth for urban mapping



Landsat Images of Las Vegas. Image Credit: NASA

SDG 11: Sustainable Cities and Communities

- Make cities and human settlements inclusive, safe, resilient and sustainable

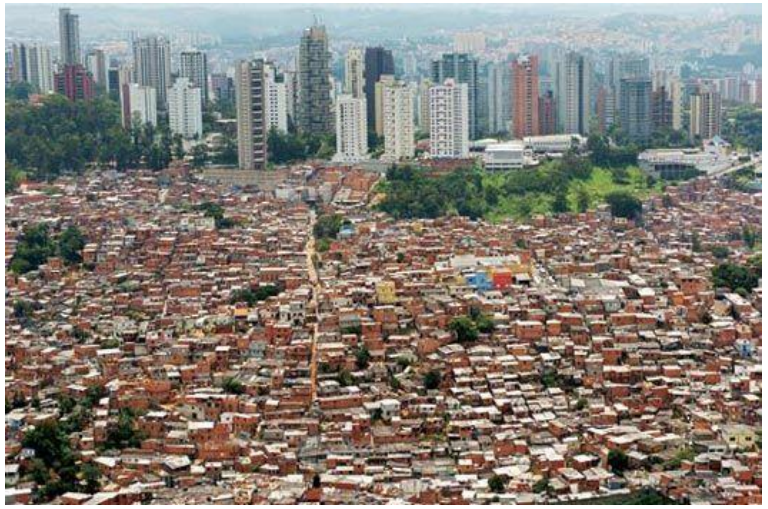


Los Angeles from Landsat. Image Credit: Earth Observatory

SDG: Target 11.3

Supporting Sustainable Cities

- By 2030 enhance inclusive and sustainable urbanization and capacities for participatory, integrated and sustainable human settlement planning and management in all countries
- This target has many aspects, but portions of the indicator 11.3.1 can be monitored via remote sensing

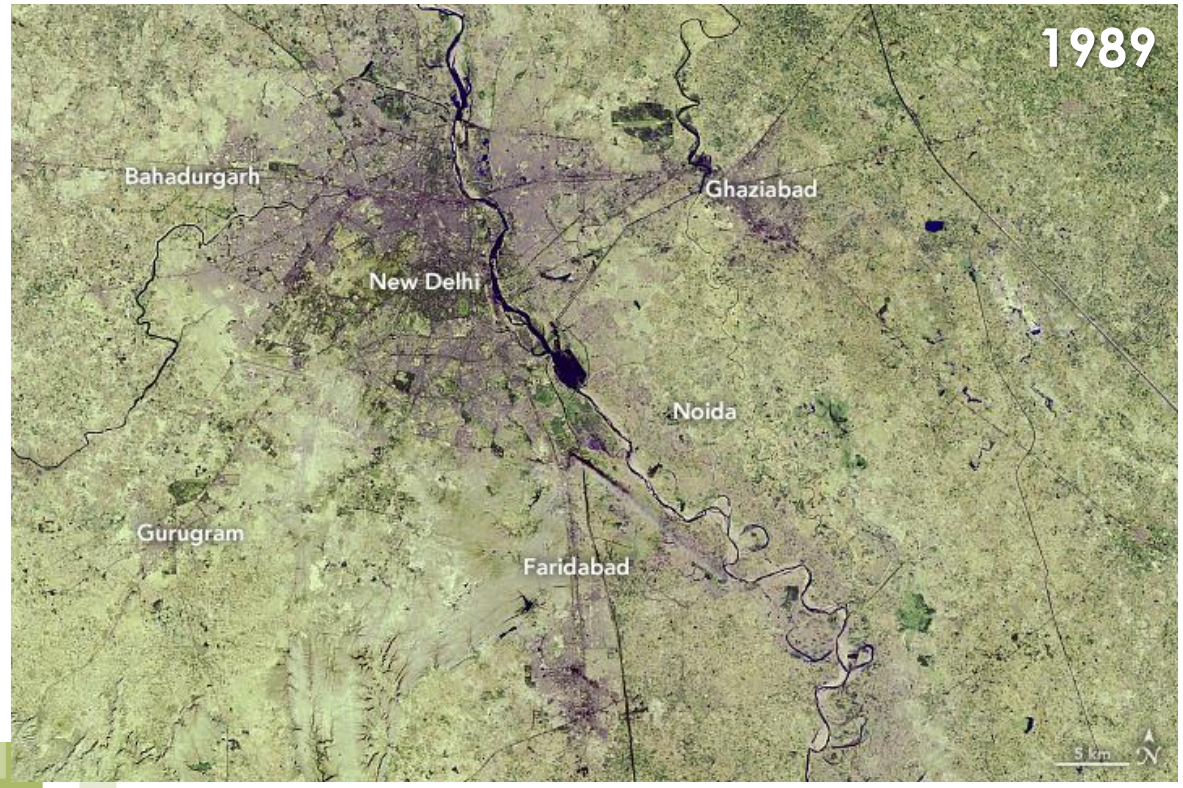


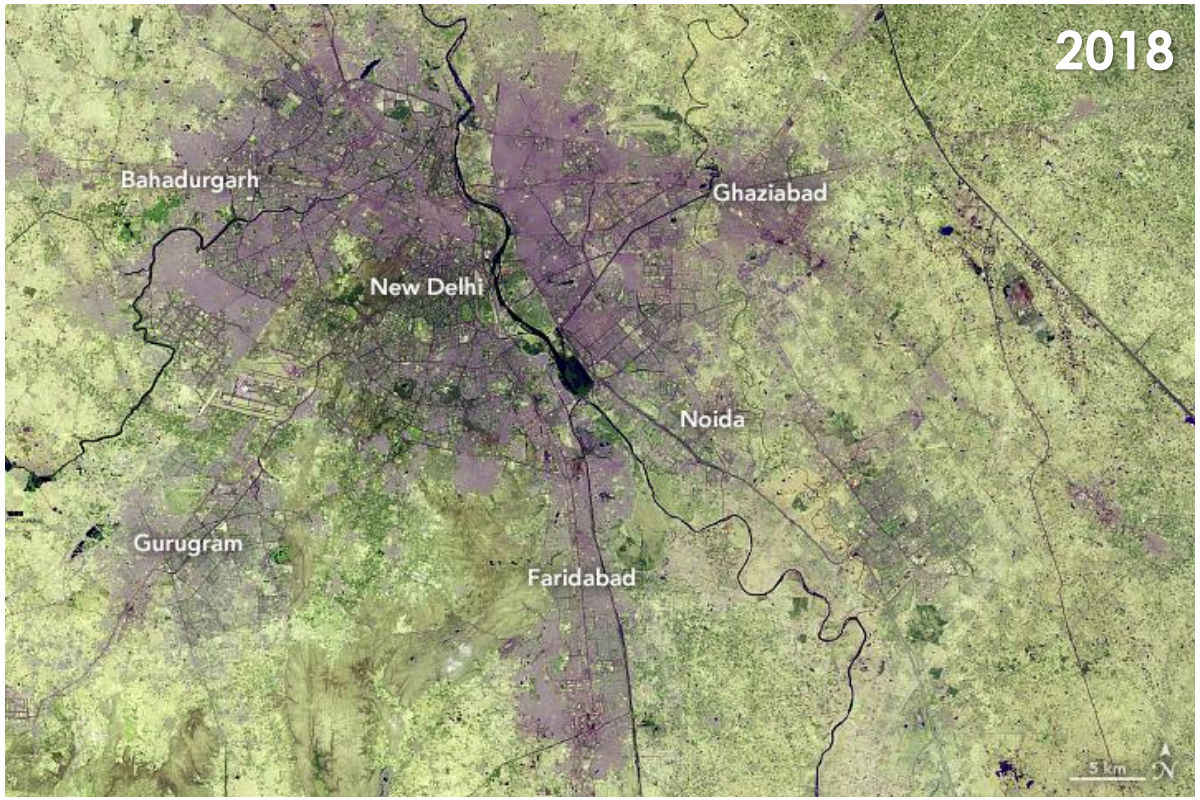
Images: (left) Bombay, India, Image Credit: shilpi siwach; (right) Bombay India from Landsat. Image Credit: Earth Observatory; Credit: Alex Zvoleff

SDG Indicator 11.3.1

Supporting Sustainable Cities

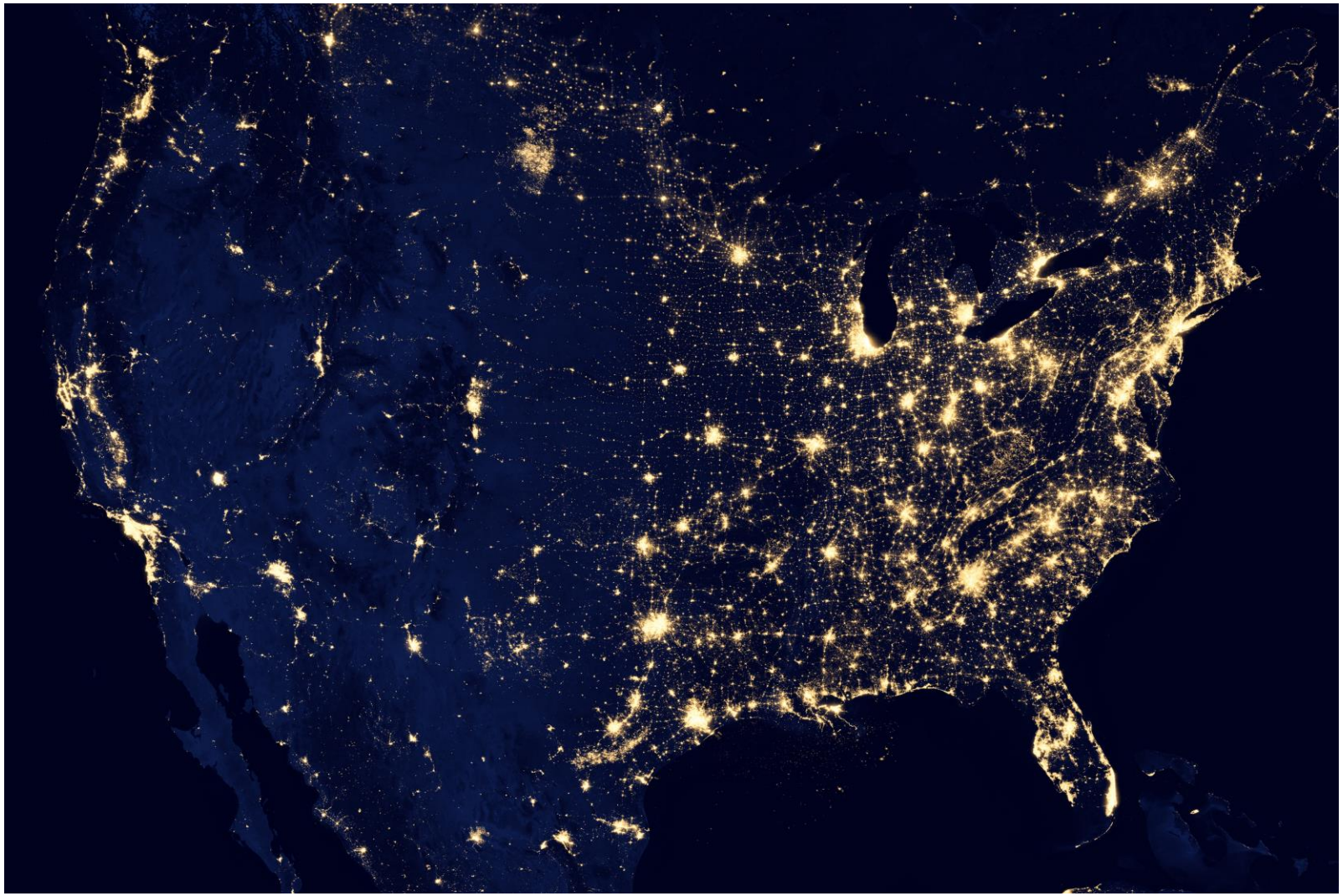
- **Ratio of land consumption rate to population growth rate**
- Landsat data can be used to determine "built up area" over multiple years





SDG 11.3 Data Needs

- Satellite images
  - Impervious index
  - Built up area
  - City extent
- City population
- **Good Practice Guidelines**
- **Country reporting**



United Nations Development Programme

https://www.undp.org

- Focus on many SDGs including target 11.3 in effort for maintaining and increasing the sustainability of cities

4.2 billion

In 2018, 4.2 billion people, 55 percent of the world's population, lived in cities. By 2050, the urban population is expected to reach 6.5 billion.

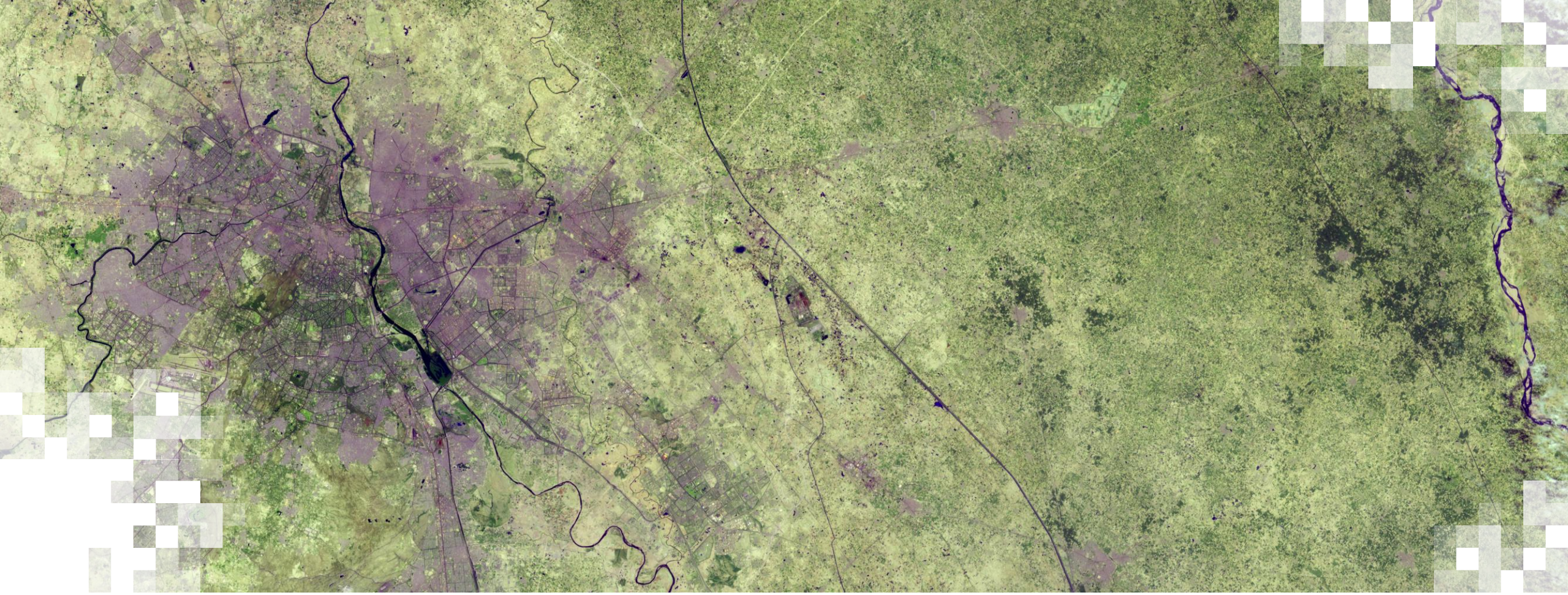
3%

Cities occupy just 3 percent of the Earth's land but account for 60 to 80 percent of energy consumption and at least 70 percent of carbon emissions.

828 million

828 million people are estimated to live in slums, and the number is rising.

Images from UNDP



Guest Speakers:
Dennis Mwaniki (UN Habitat),Dr. Mariano Gonzalez-Roglich (CI), Dr. Alexander Zvoleff (CI), Monica Noon (CI)

TRENDS.EARTH - SDG 11.3.1 and DATA NEEDS

UN-HABITAT

- **Like living organisms**, cities evolve, transform, adapt, innovate and change with emerging trends
- Four broad ways cities grow: ***Infill , Extension, Leapfrogging, and Inclusion***

Indicator 11.3.1 measures rate at which cities are expanding spatially versus the rate of their population is growing

– **Five year measurement intervals recommended**

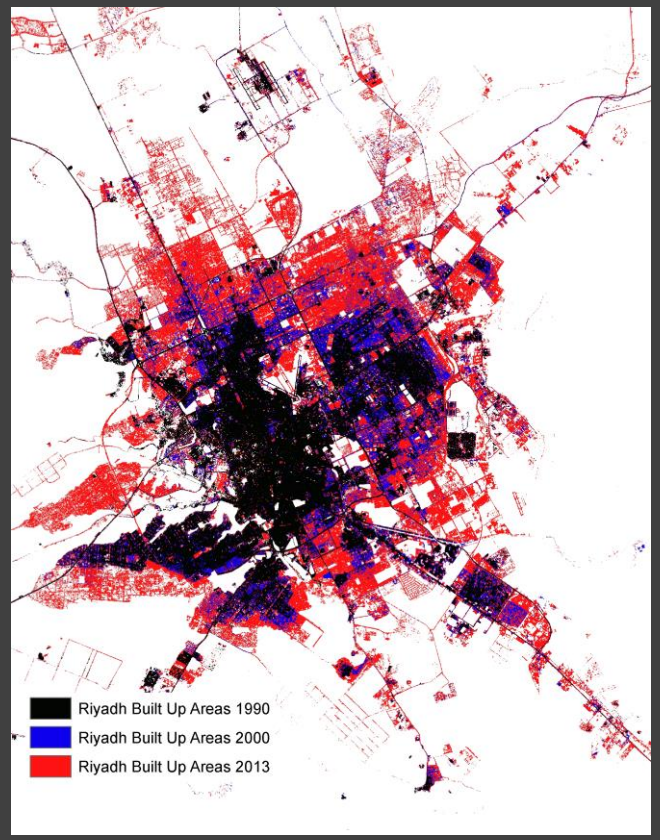
CONSERVATION INTERNATIONAL TRENDS.EARTH

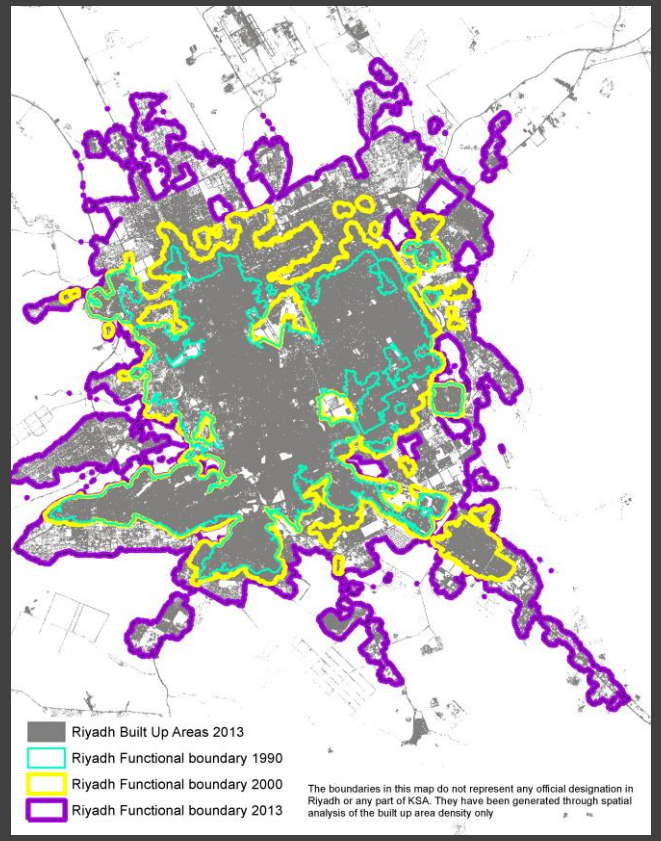
TRENDS.EARTH - SDG 11.3.1 and DATA NEEDS

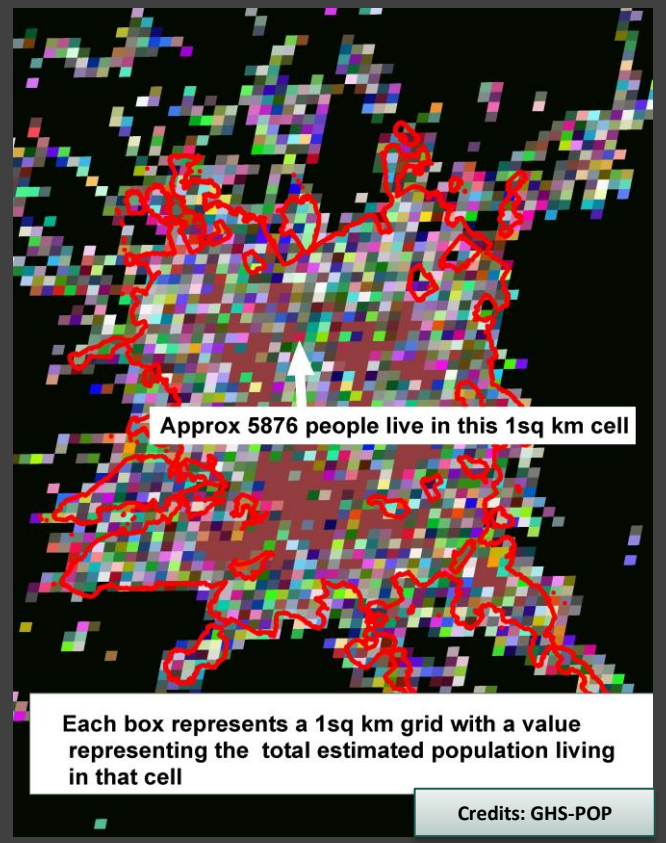
UN-HABITAT

Concepts

- Land Consumption Rate
- Population Growth Rate







Data needs/ Indicator inputs → Built up layer → Dynamic & functional city boundaries → Disaggregate population data

CONSERVATION INTERNATIONAL TRENDS.EARTH

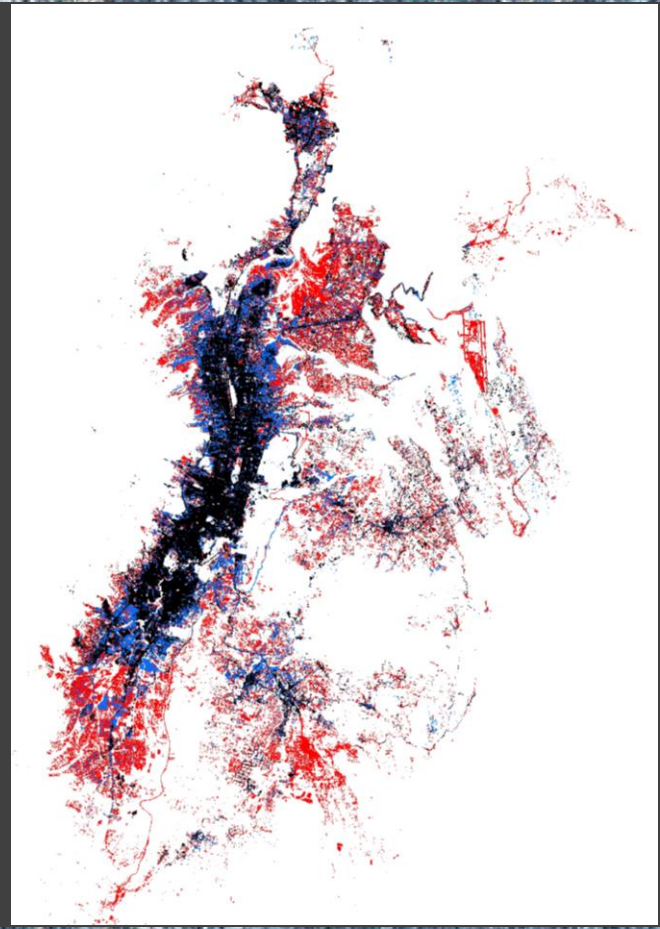
TRENDS.EARTH - SDG 11.3.1 AND DATA NEEDS

UN-HABITAT

Why measure land consumption rate to population growth rate?

- To understand urban transition dynamics
  - Speed of growth for different settlements
  - Direction of growth
  - Type of growth

- Understanding growth can:
  - Help estimate demand for services, direct investments
  - Support development of policies for sustainable urbanization
  - Support vulnerability assessment & disaster preparedness/response



Remote Sensing for monitoring Land Degradation and Sustainable Cities SDGs

Session 3

Presenters: Mariano Gonzalez-Roglich, Alexander Zvoleff, Monica Noon
Conservation International, trends.earth@conservation.org

CONSERVATION INTERNATIONAL

TRENDS.EARTH
tracking land change

NASA

United Nations
Convention to Combat Desertification

gef

Updated May 9, 2019

TRENDS.EARTH

SUPPORTING SUSTAINABLE CITIES

CONSERVATION INTERNATIONAL

gef

Google Earth Engine

UN-HABITAT

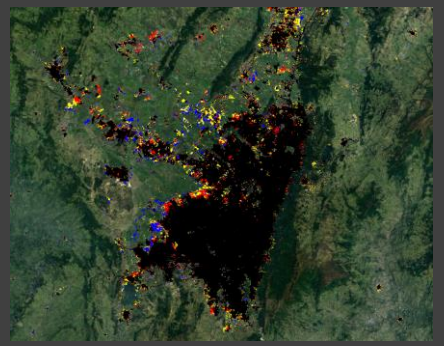
NASA

TRENDS.EARTH - SDG 11.3.1

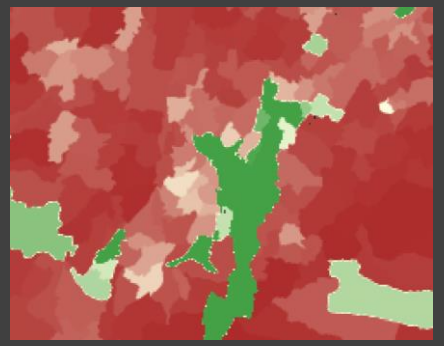
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
  - Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
    - Indicator 11.3.1: 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

$$PGR = \frac{(LN(Pop_{(t+n)}/Pop_t)}{(y)}$$

$$LCR = \frac{(LN(Urb_{(t+n)}/Urb_t)}{(y)}$$

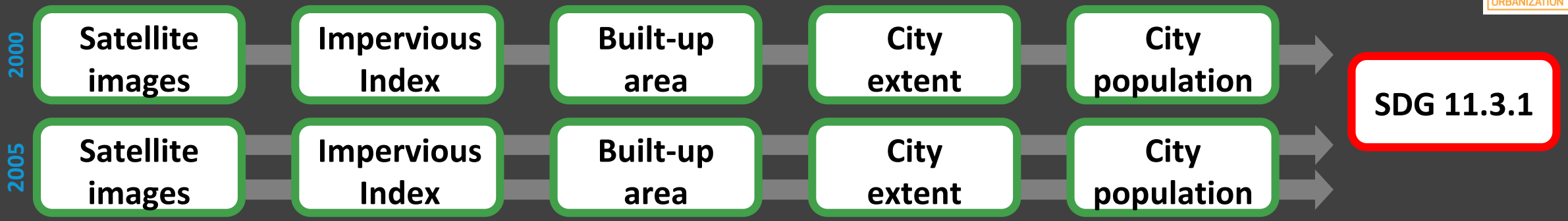
$$LCRPGR = \frac{(\text{Annual Land Consumption rate})}{(\text{Annual Population growth rate})}$$

UN HABITAT
FOR A BETTER URBAN FUTURE

Metadata on SDGs Indicator 11.3.1
Indicator category: Tier II

TRENDS.EARTH - COMPUTE SDG 11.3.1

TRENDS.EARTH - COMPUTE SDG 11.3.1



CONSERVATION INTERNATIONAL TRENDS.EARTH

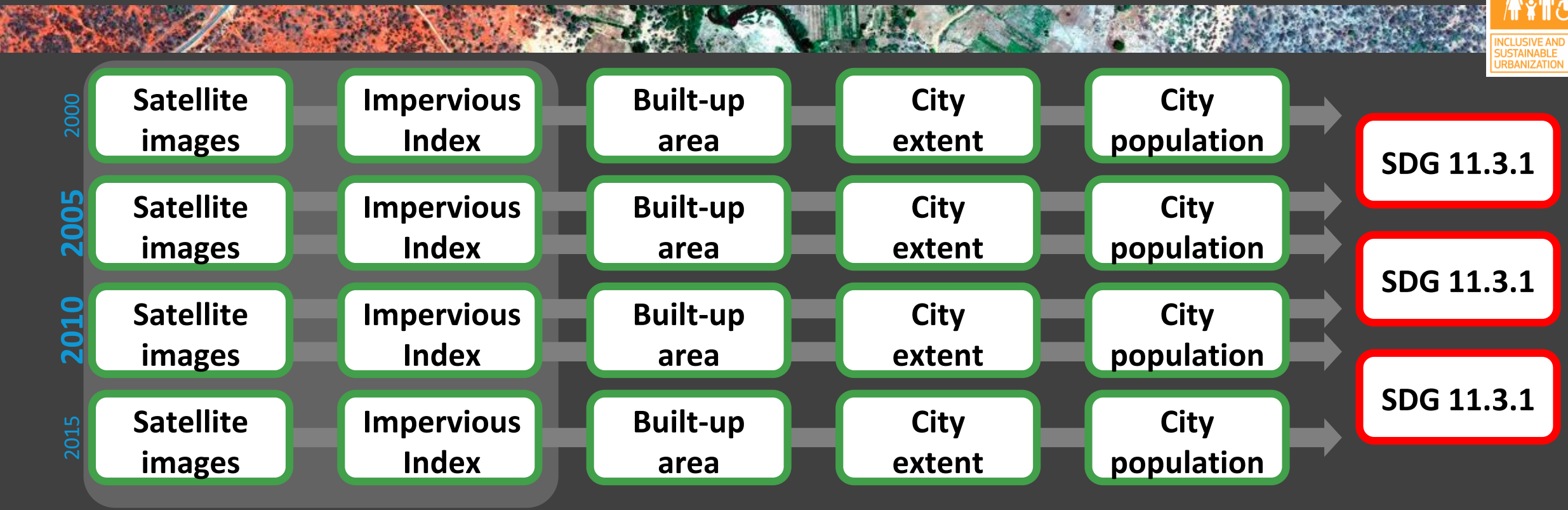
TRENDS.EARTH - COMPUTE SDG 11.3.1

2000	Satellite images	Impervious Index	Built-up area	City extent	City population	SDG 11.3.1
2005	Satellite images	Impervious Index	Built-up area	City extent	City population	SDG 11.3.1
2010	Satellite images	Impervious Index	Built-up area	City extent	City population	

TRENDS.EARTH - COMPUTE SDG 11.3.1

2000	Satellite images	Impervious Index	Built-up area	City extent	City population	SDG 11.3.1
2005	Satellite images	Impervious Index	Built-up area	City extent	City population	SDG 11.3.1
2010	Satellite images	Impervious Index	Built-up area	City extent	City population	SDG 11.3.1
2015	Satellite images	Impervious Index	Built-up area	City extent	City population	

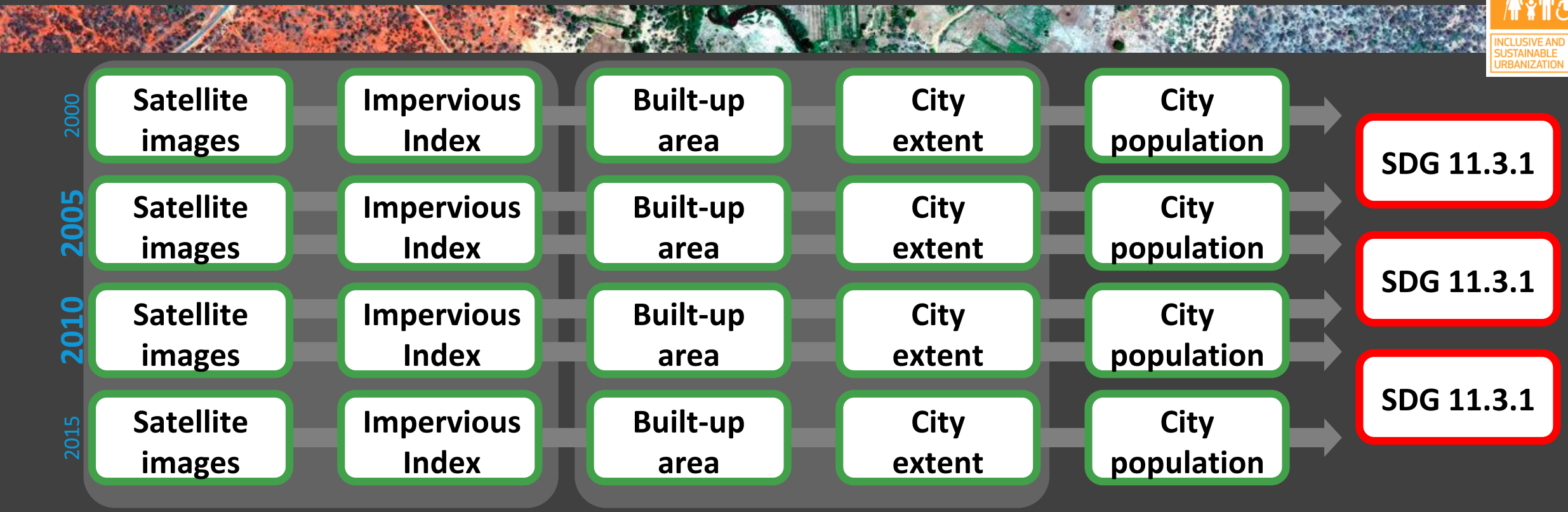
TRENDS.EARTH - COMPUTE SDG 11.3.1



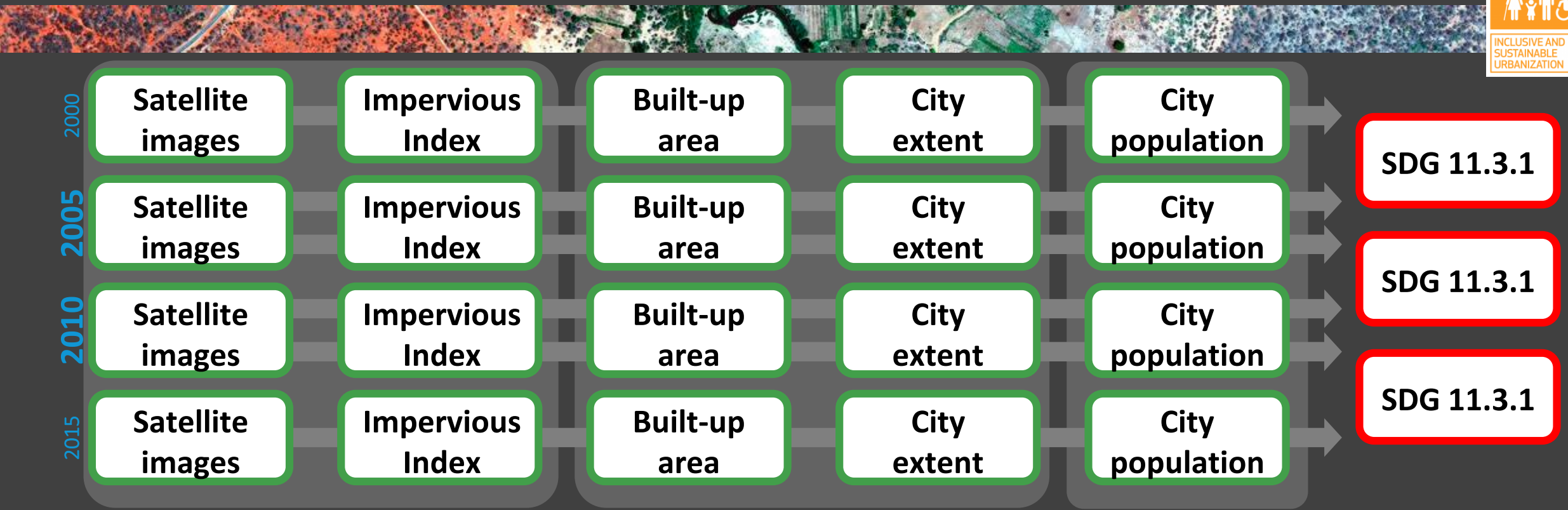
Pre-Computed

(2.3 M Landsat scenes
1.15 Petabytes of data)

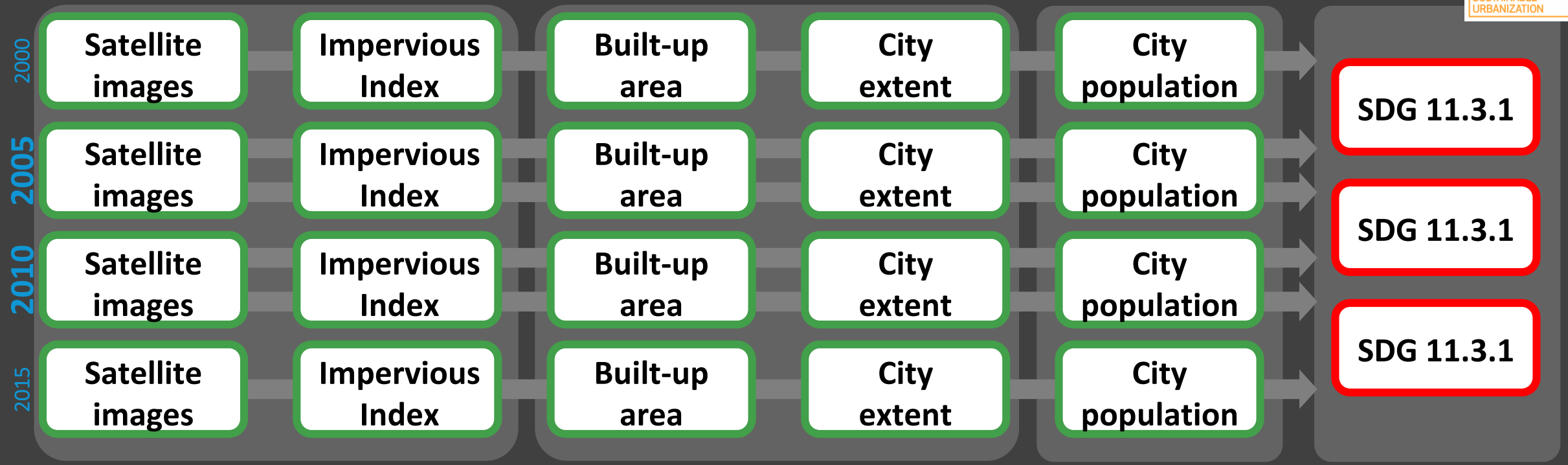
TRENDS.EARTH - COMPUTE SDG 11.3.1



TRENDS.EARTH - COMPUTE SDG 11.3.1



TRENDS.EARTH - COMPUTE SDG 11.3.1



TRENDS.EARTH - COMPUTE SDG 11.3.1

Processing Workflow

Global Man-made Impervious Surface (GMIS)

High quality URBAN
GMIS IS_percentage > 1
GMIS standard_error < 25
ESA CCI land cover = urban

Hi quality NON-URBAN
GMIS IS_percentage = 0
GMIS standard_error = 0
ESA CCI land cover <> urban

Model trained with GMIS 2010 & Landsat derived stack 2010

Models were trained per terrestrial ecoregion (4000 for urban & 4000 for non-urban)

- 1998 Landsat derived 24-band stack
- 2000 Landsat derived 24-band stack
- 2005 Landsat derived 24-band stack
- 2010 Landsat derived 24-band stack
- 2015 Landsat derived 24-band stack
- 2018 Landsat derived 24-band stack

Random Forest (Regression trees)

- 2000 impervious surface index
- 2005 impervious surface index
- 2010 impervious surface index
- 2015 impervious surface index

846 terrestrial ecoregions
https://doi.org/10.1093/biosci/bix014

CONSERVATION INTERNATIONAL TRENDS.EARTH

Brown de Colstoun, E. C., C. Huang, P. Wang, J. C. Tilton, B. Tan, J. Phillips, S. Niemczura, P.-Y. Ling, and R. E. Wolfe. 2017. Global Man-made Impervious Surface (GMIS) Dataset From Landsat. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4P55KKF.

TRENDS.EARTH - IMPERVIOUS SURFACE INDEX TO BUILT-UP AREA

Three parameters influence how a map of built-up area is produced from the map of impervious surface index:

Impervious surface index (ISI): higher values reduce built-up area

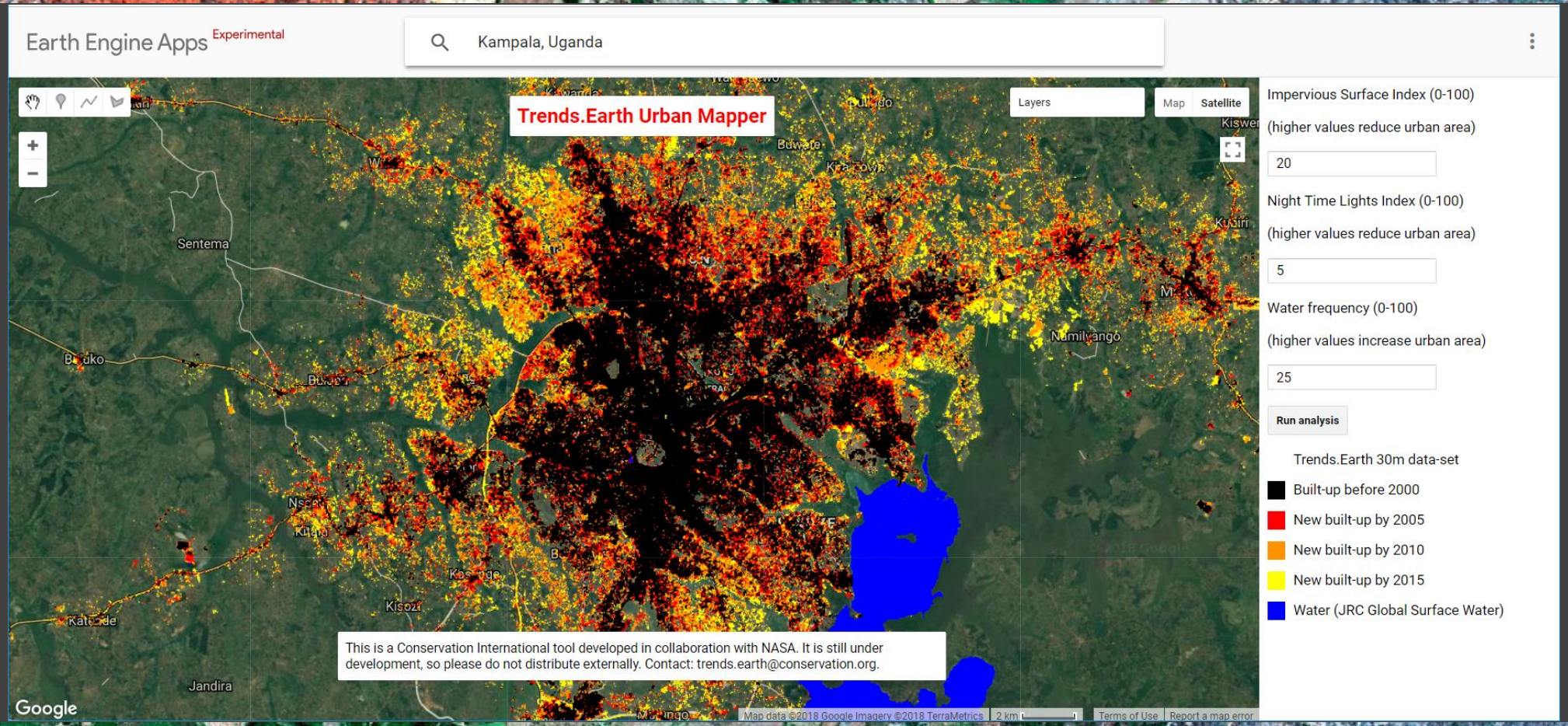
Night time lights index (NTLI): higher values mean darker areas are excluded form built-up

Water frequency: higher values allow areas with more frequent occurrence of water to be included in the built-up area

TRENDS.EARTH - URBAN MAPPER

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION



CONSERVATION INTERNATIONAL TRENDS.EARTH

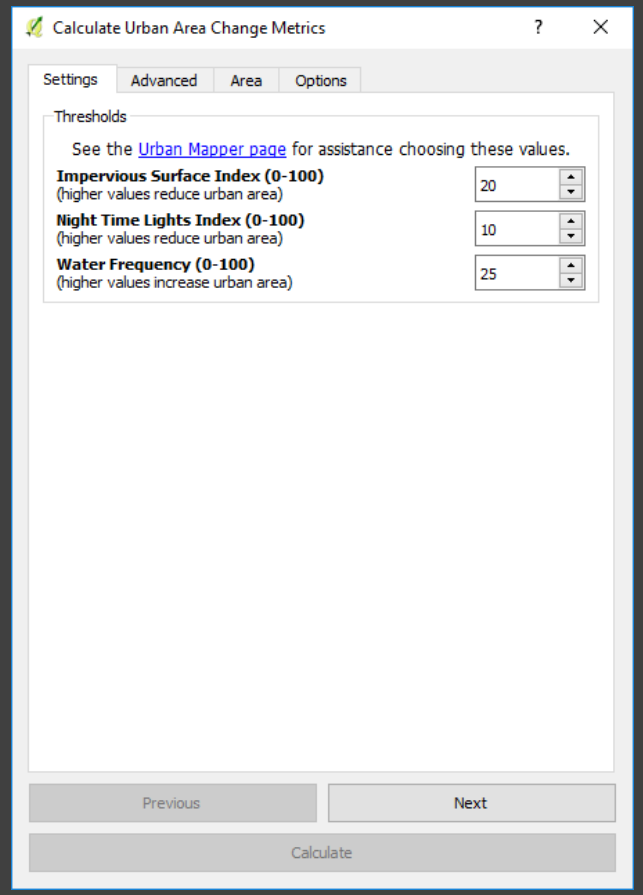
https://geflanddegradation.users.earthengine.app/view/trendsearth-urban-mapper

TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Define built-up area



TRENDS.EARTH - CONVERTING BUILT-UP AREA TO URBAN EXTENT

TARGET 11·3

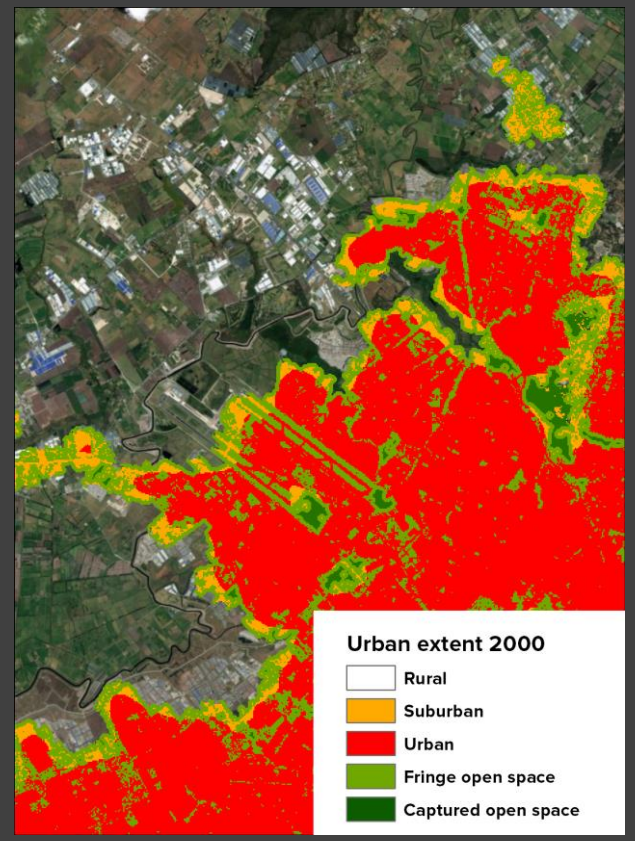
INCLUSIVE AND SUSTAINABLE URBANIZATION

Built-up density within a 500 m radius:

1) Urban → > 50%
2) Suburban → 25-50%
3) Rural → < 25 %

Open space (OS):

4) Fringe OS → OS < 100 m from urban and suburban
5) Captured OS → OS fully surrounded by fringe OS
6) Rural OS → All other OS

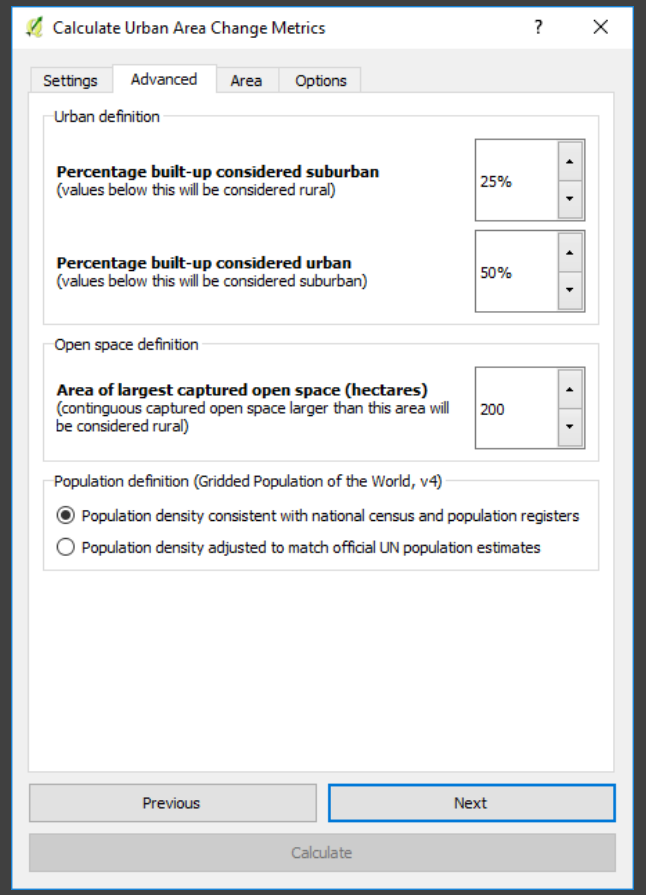


TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Define urban areas (zonation)

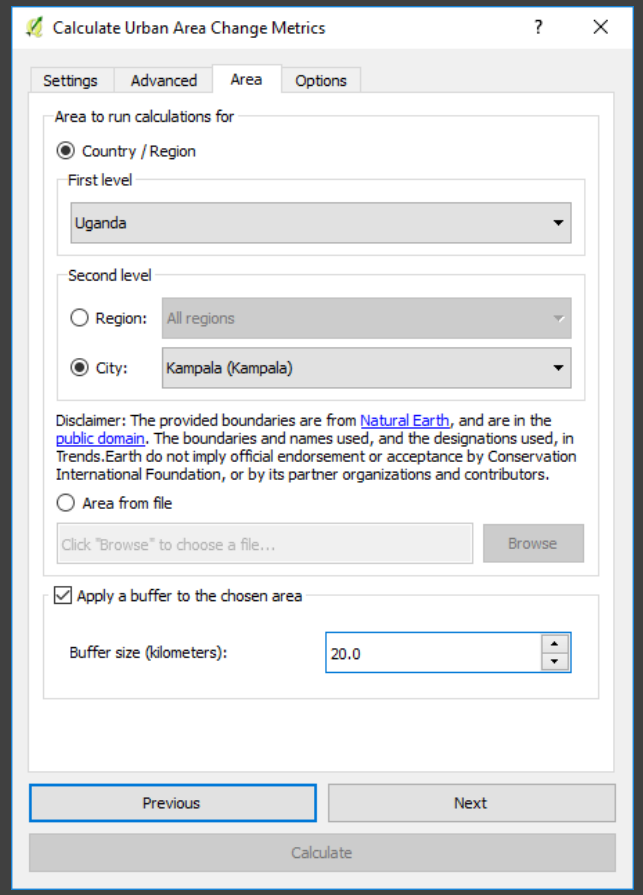


TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Define area of analysis

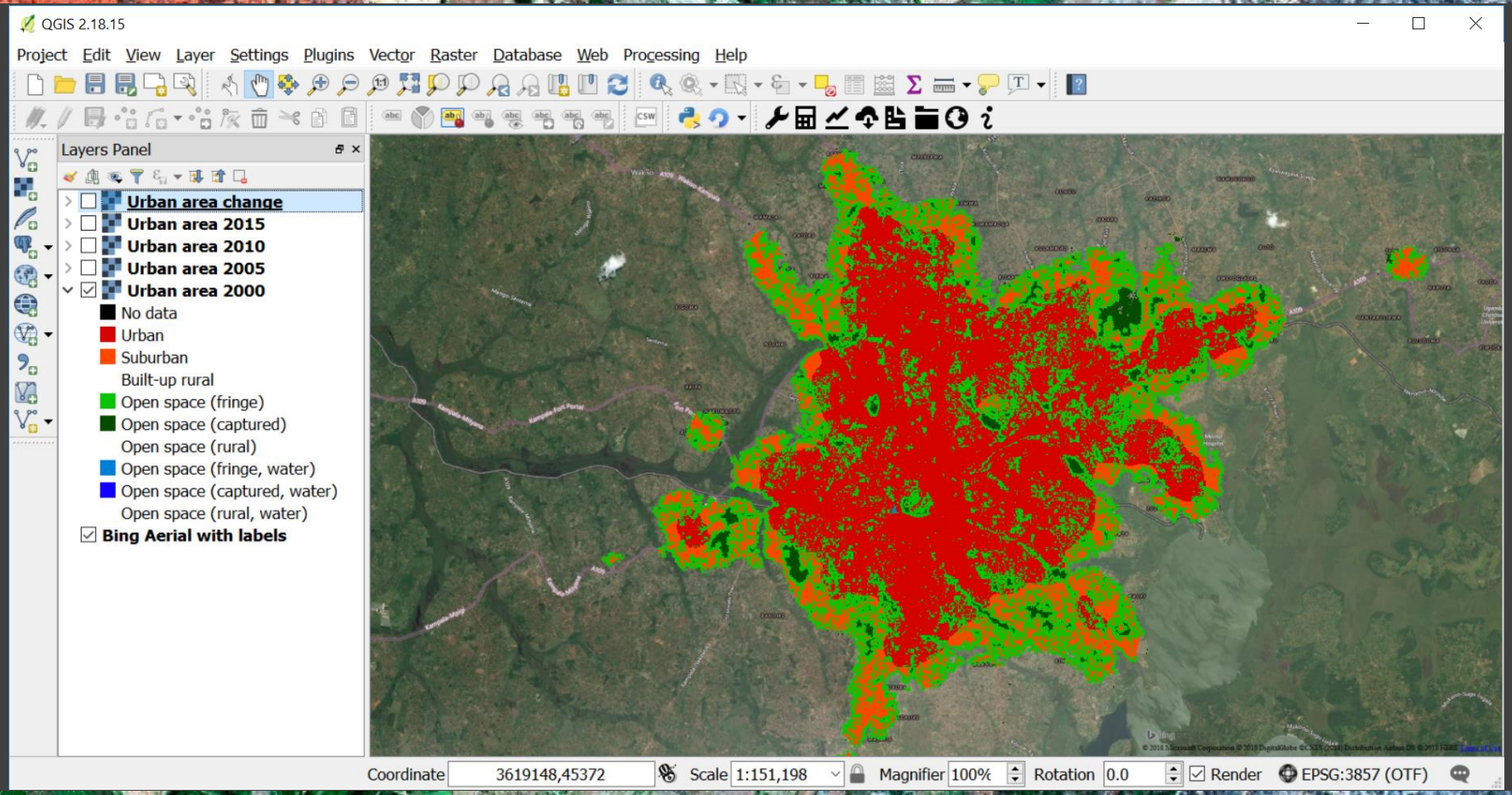


TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Kampala, Uganda – 2000



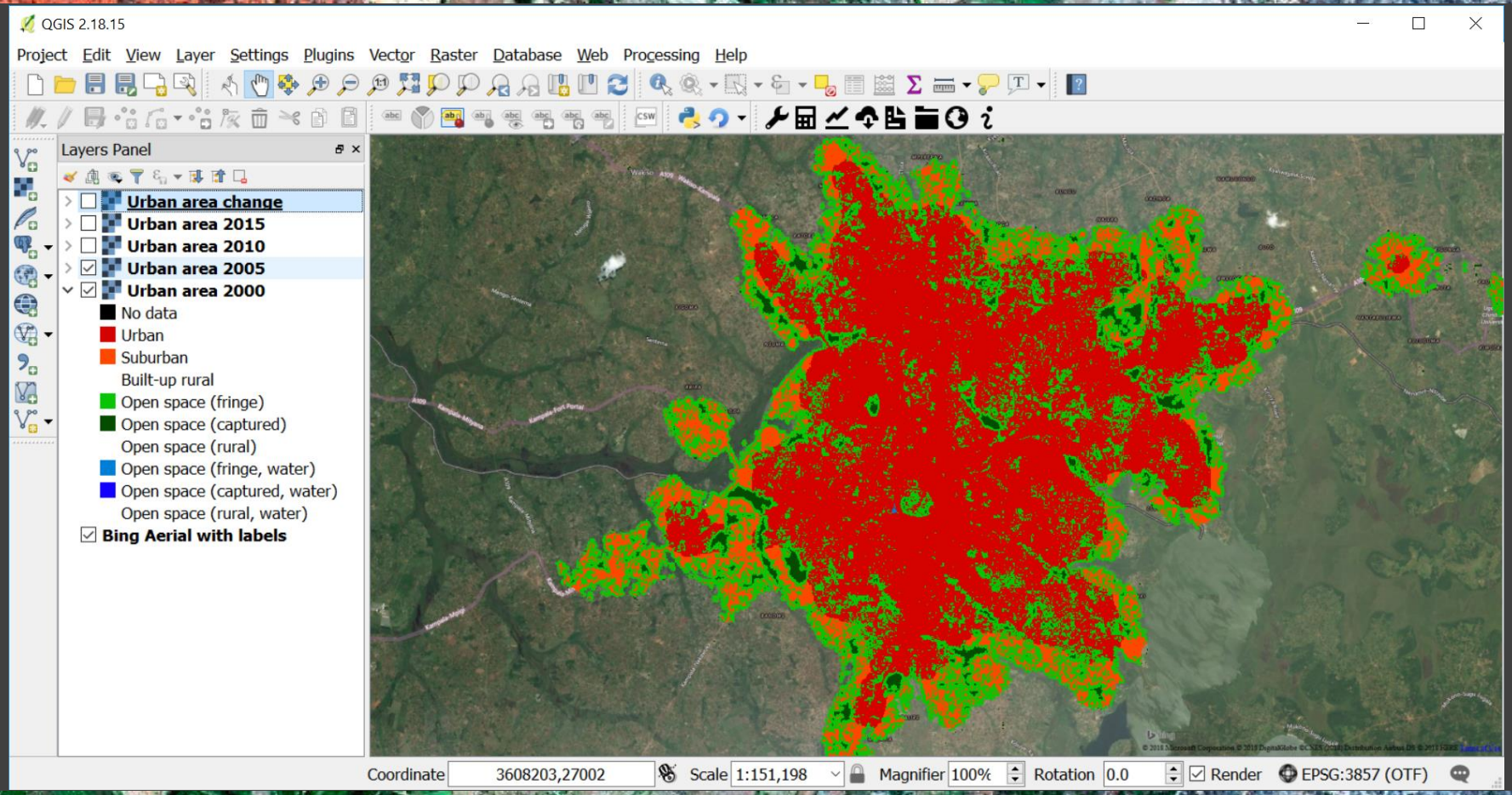
CONSERVATION INTERNATIONAL TRENDS.EARTH

TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Kampala, Uganda – 2005



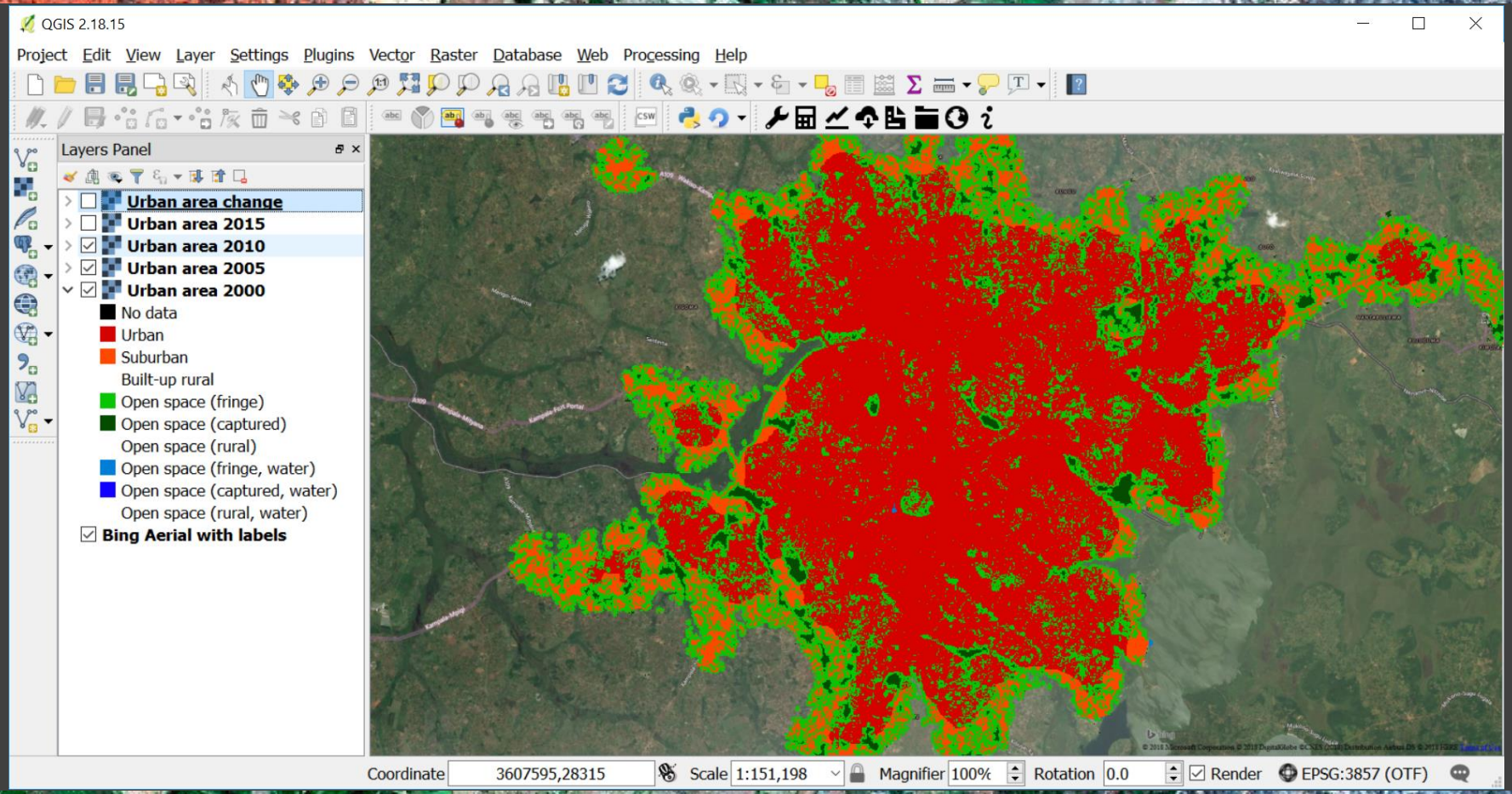
CONSERVATION INTERNATIONAL TRENDS.EARTH

TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Kampala, Uganda – 2010



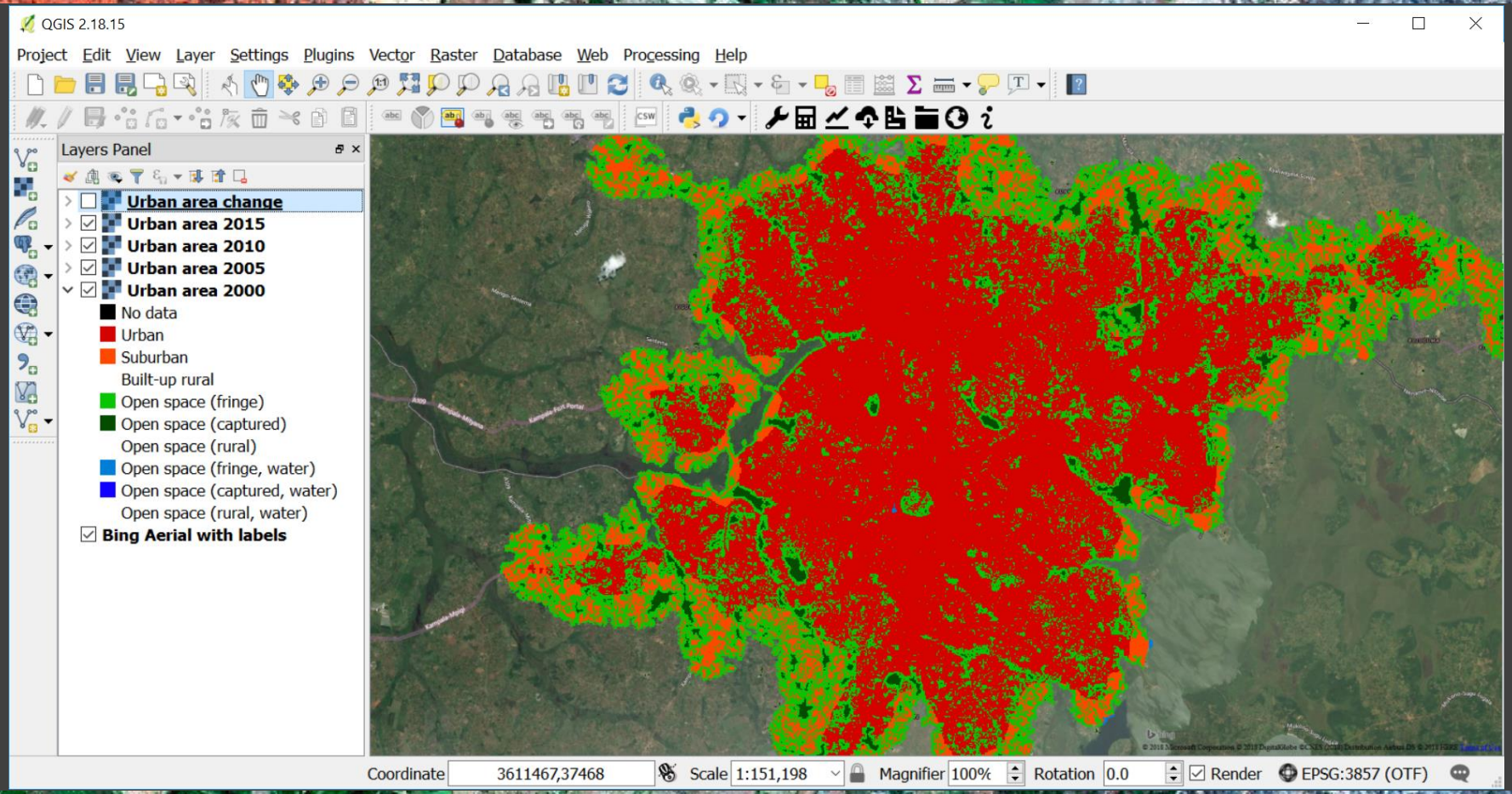
CONSERVATION INTERNATIONAL TRENDS.EARTH

TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Kampala, Uganda – 2015



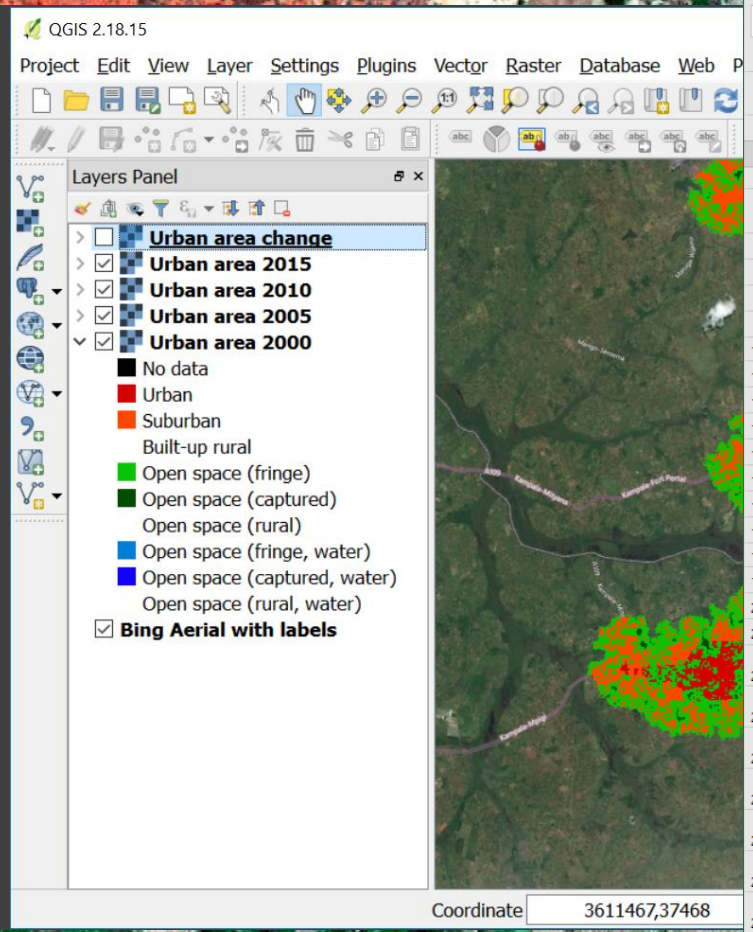
CONSERVATION INTERNATIONAL TRENDS.EARTH

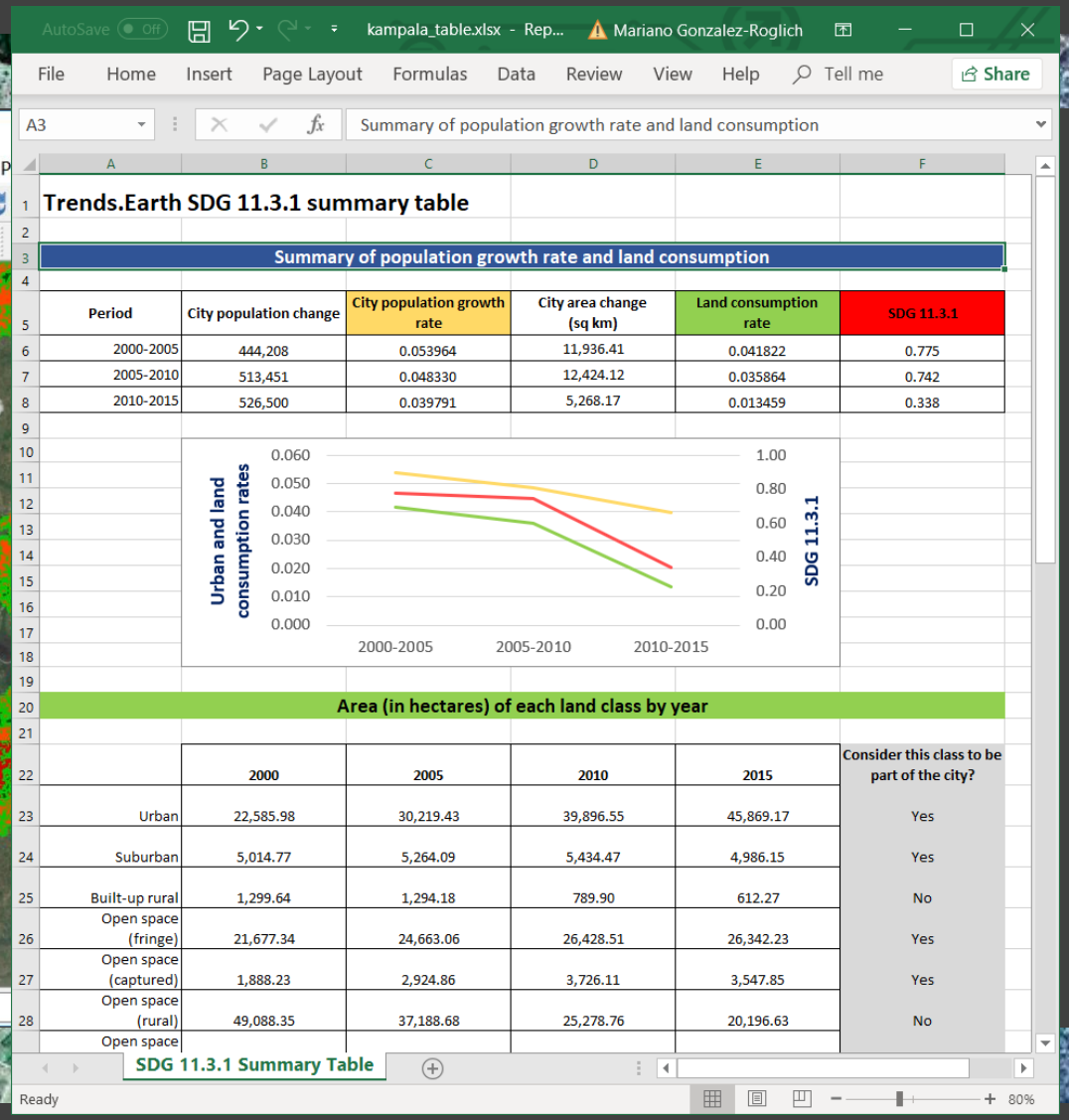
TRENDS.EARTH - QGIS

TARGET 11·3

INCLUSIVE AND SUSTAINABLE URBANIZATION

Kampala, Uganda – Time series





CONSERVATION INTERNATIONAL TRENDS.EARTH

TRENDS.EARTH - REGIONAL TESTING

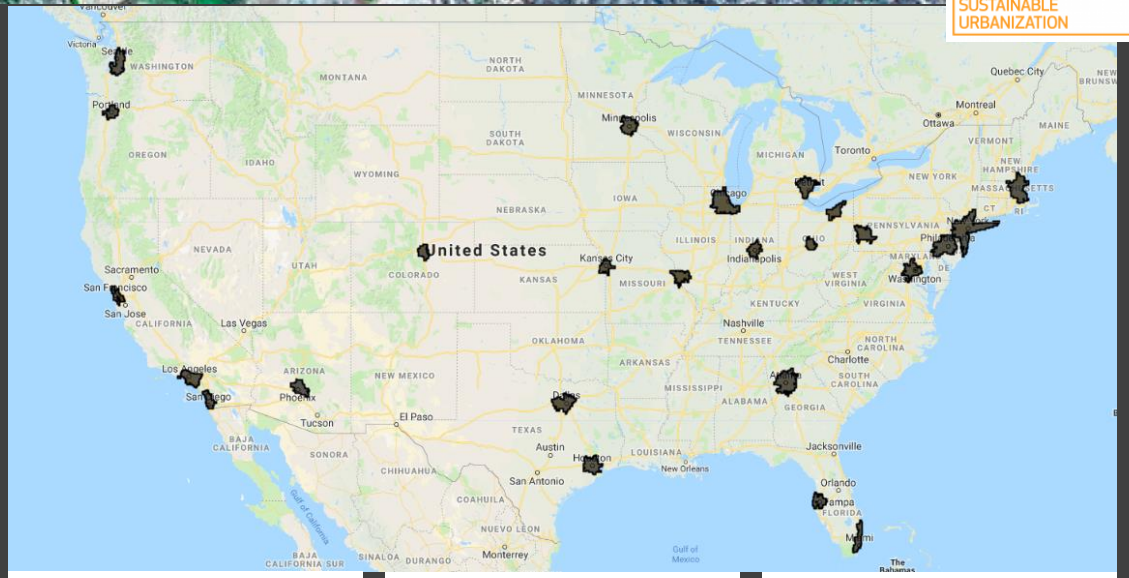
- NASA
- UN-Habitat
- Mexico
- Peru
- Colombia
- USA

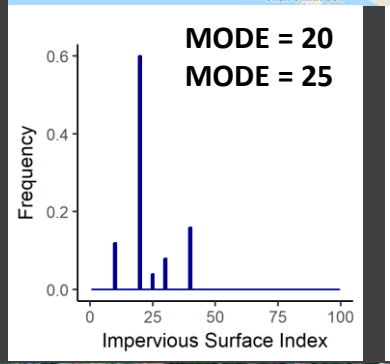
TRENDS.EARTH - REGIONAL TESTING

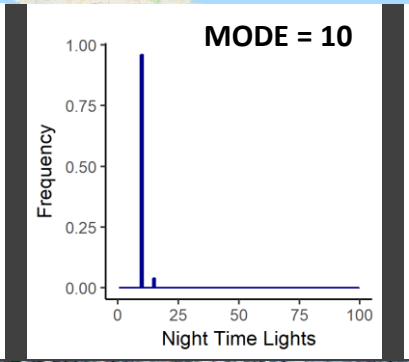
TARGET 11·3

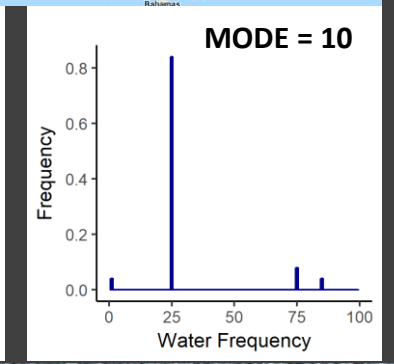
INCLUSIVE AND SUSTAINABLE URBANIZATION

1. Atlanta, GA
2. Boston, MA
3. Chicago, IL
4. Cleveland, OH
5. Columbus, OH
6. Dallas, TX
7. Denver, CO
8. Detroit, MI
9. Houston, TX
10. Indianapolis, IN
11. Kansas City, MO
12. Los Angeles, CA
13. Miami, FL
14. Minneapolis, MN
15. New York, NY
16. Philadelphia, PA
17. Phoenix, AZ
18. Pittsburgh, PA
19. Portland, OR
20. San Diego, CA
21. San Francisco, CA
22. Seattle, WA
23. St. Louis, MO
24. Tampa, FL
25. Washington, DC





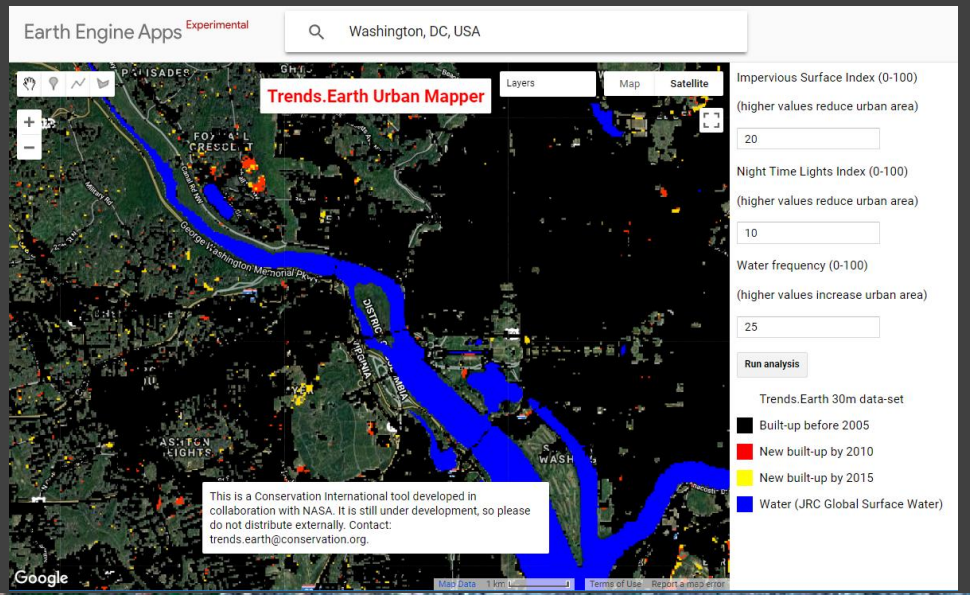




CONSERVATION INTERNATIONAL TRENDS.EARTH

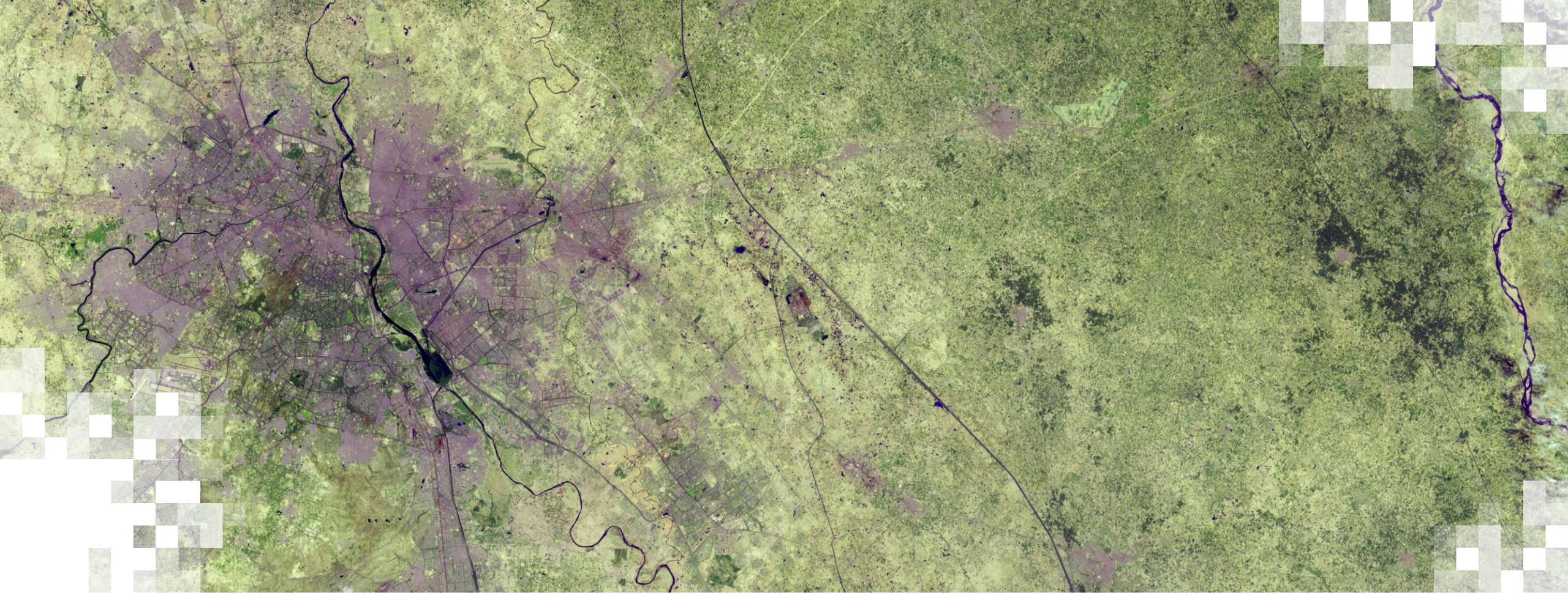
TRENDS.EARTH - NEXT STEPS

- 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)



TRENDS.EARTH - DEMO

- QGIS Plug in: Trends.Earth
- Website: **http://trends.earth**
- Urban Mapper: https://geflanddegradation.users.earthengine.app/view/trendsearth-urban-mapper



Trends.Earth Exercise

Contacts

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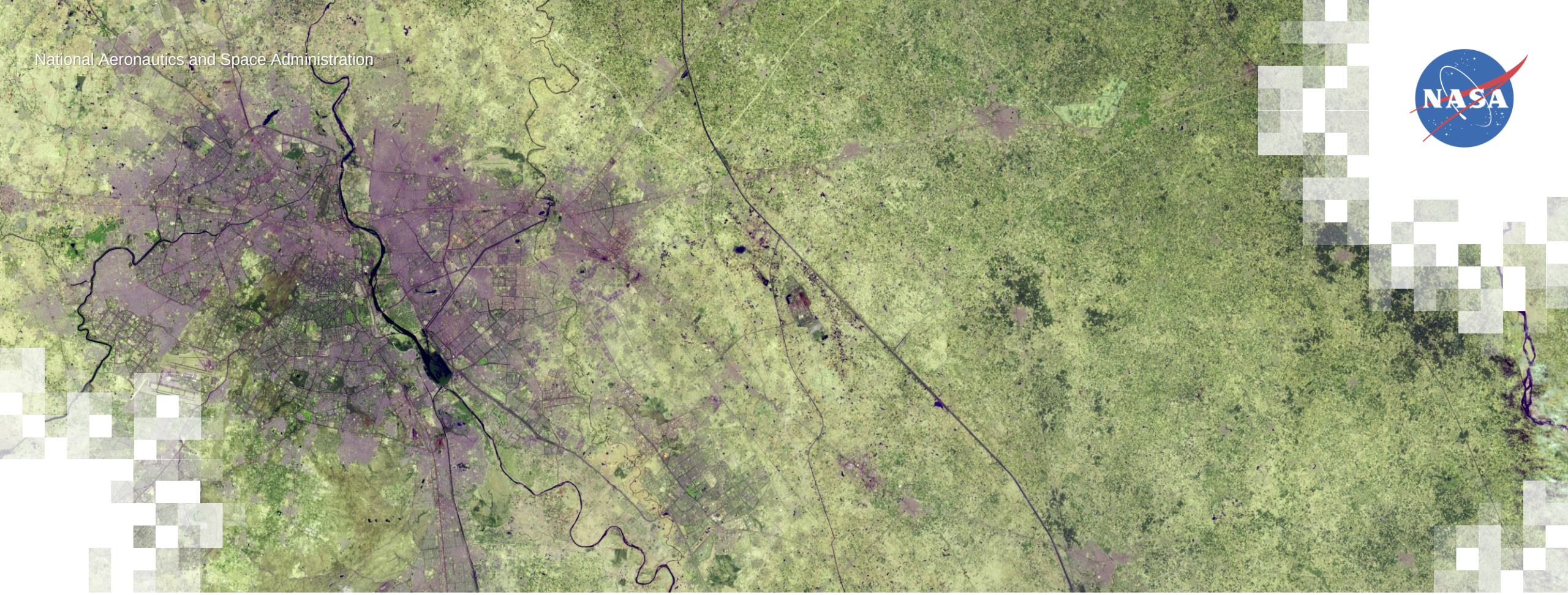
- ARSET Website:
  - http://arset.gsfc.nasa.gov



Thank You

Please complete the homework by August 6th, 2019

7/23/2019