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AFRICA REGIONAL
DATA CUBE

How Africa Regional Data Cubes is supporting
the delivery of Sustainable Development in
Africa

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Introduction

- The Africa Regional Data Cube, formally launched at a high-level event in Nairobi, Kenya in 2018, is a new tool that harnesses the latest Earth observation and satellite technology to help Kenya, Senegal, Sierra Leone, Ghana, and Tanzania and addresses food security as well as issues relating to agriculture, deforestation, and water access

- Strathmore University set a landmark precedent by becoming the only University in Africa to be hosting Data for over 5 Countries going back 17 years under the Africa Regional Data Cubes;

- The African Regional Data Cube (ARDC) is based on the Open Data Cube (ODC) infrastructure (http://opendatacube.org), which has been successfully demonstrated in Australia, Switzerland, and Colombia and is under development or evaluation by more than 30 other countries;

- The ODC allows analysis-ready satellite data (e.g. Landsat, Sentinel) to be spatially and temporally aligned in "cubes" of pixels. These data cubes, hosted in the cloud, allow efficient time series analyses (e.g. land change, water extent and quality, agriculture extent, and health), permit the use of diverse data sets via interoperable methods, and support connections to common analysis tools while reducing the data preparation and management burden on users;

- In addition, the ODC community allows engagement of other global users to develop new core code, share algorithms, and provide support for the resolution of problems.

ABOUT THE AFRICA REGIONAL DATA CUBES

- While satellite data is not new, it has traditionally been difficult to access and use, limiting its potential to help governments meet key development challenges.

- The Africa Regional Data Cube provides layers satellite imagery in an analysis-ready format that allows users to more easily see and understand changes– such as urbanization, deforestation, and crop formation –over time.

- This new tool helps governments, farmers, and consumers has access to vast quantities of freely available satellite data offer real opportunity to improve agricultural production, food security, and access to water.

- The Data Cube provides important solutions to government ministries, national statistical agencies, geographic institutes, research scientists, civil society, and beyond.

- And allows users in the region to apply satellite-based Earth observation data to address local and national needs and development strategies, meet international initiatives such as the 2030 Agenda for Sustainable Development, and support the upcoming 2020 round of censuses in African countries — the most significant data collection exercise for a decade
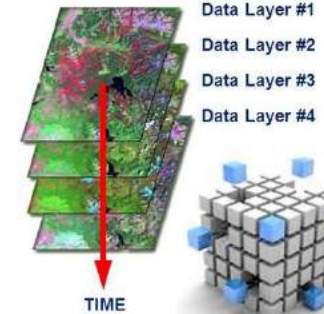
AFRICA DATA CUBES PILOT COUNTRIES
Ghana, Kenya, Senegal, Sierra Leone, Tanzania
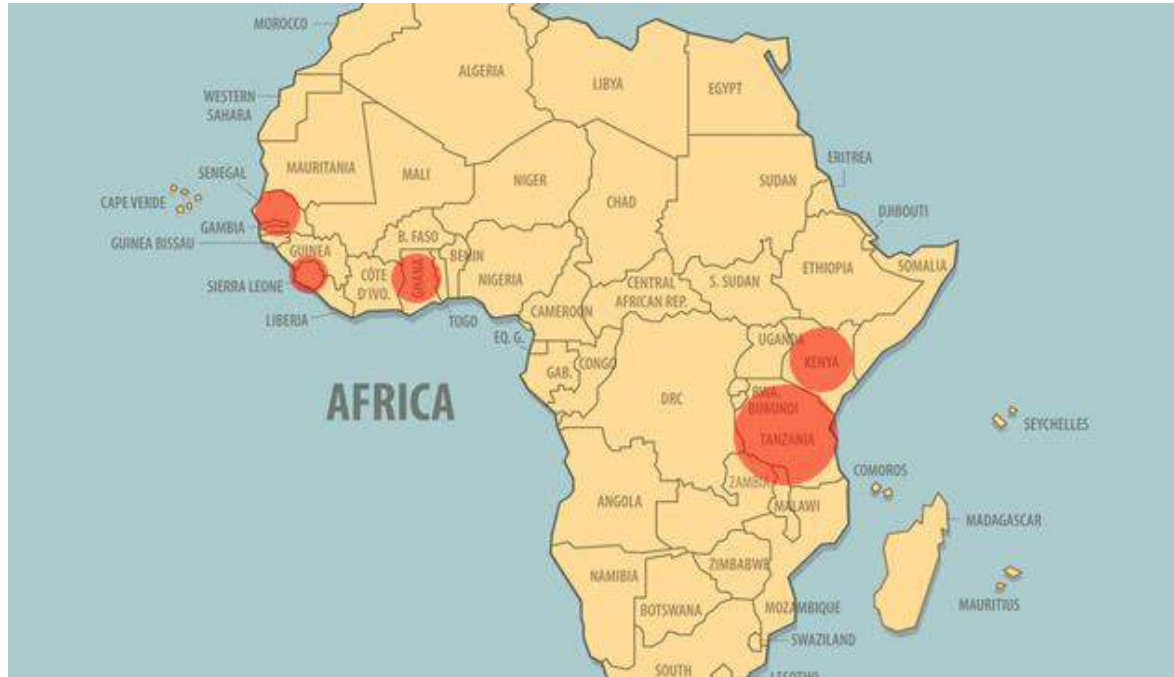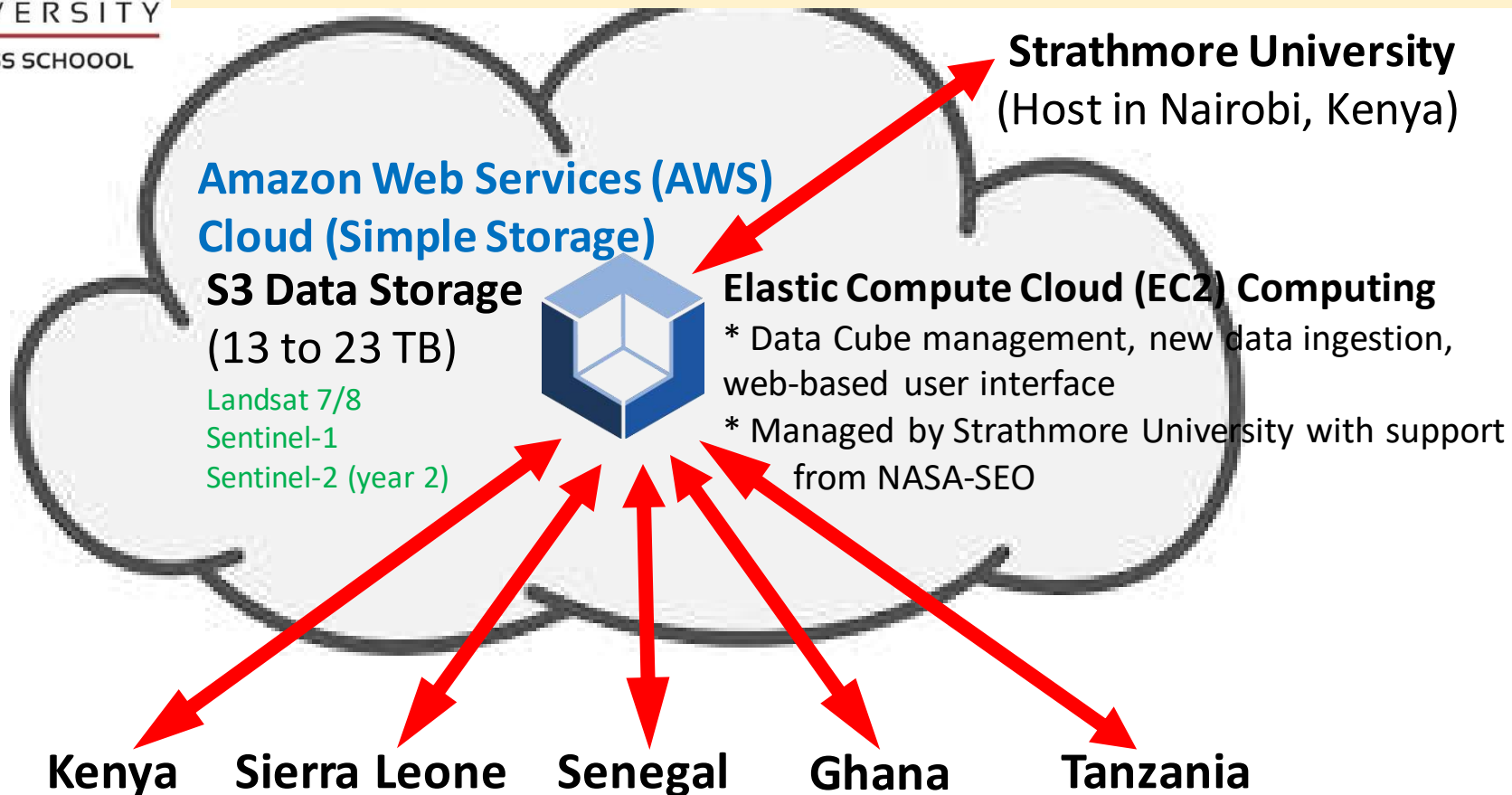
HOW ARDC WAS DEVELOPED

- The data cube was developed by the Committee on Earth Observation Satellites (CEOS) in partnership with the Group on Earth Observations, Amazon Web Services, Office of the Deputy President – Kenya, Strathmore University in Kenya, and the Global Partnership for Sustainable Development Data. https://www.youtube.com/watch?v=tEeT5VH7qVc&app=desktop
- Initial focus for the data cube currently is on algorithms that addresses priorities identified by GPSDD partners across the member states

5 countries: **Ghana | Kenya | Senegal I Sierra Leone | Tanzania**

Kenya Government

Strathmore UNIVERSITY

NASA

CEOS Committee on Earth Observation Satellites

esa

GEO GROUP ON EARTH OBSERVATIONS

Harnessing the Power of Satellite Data
ONE PIXEL AT A TIME
Learn More >>

The Open Data Cube (ODC) initiative seeks to increase the value and impact of global Earth observation satellite data by providing an open and freely accessible exploitation architecture and to foster a community to develop, sustain, and grow the technology and the breadth and depth of its applications for societal benefit.

Data Layer #1
Data Layer #2
Data Layer #3
Data Layer #4

TIME

WHY THE AFRICA REGIONAL DATA CUBES

- The data cube provides analytically ready data across decades allowing for easily accessible geospatial analysis on priority thematic sectors.

- This new tool is aimed at harnessing the latest earth observation and satellite technology and it is now helping the pilot countries- Kenya, Senegal, Sierra Leone, Ghana, and Tanzania to address food security as well as issues relating to agriculture, deforestation, and water access;

- The data cube is now helping the various governments to understand crop distribution, changing seasons, and use of agricultural land in rural areas; as well as better protect its forests and water towers;

- The Vast quantities of freely available satellite data is offering real opportunity to improve agricultural production, food security, and access to water and also helping the governments, farmers, and consumers to manage the complex challenges they face.

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African Regional Data Cube (ARDC) Operational Model

Strathmore University (Host in Nairobi, Kenya)

Amazon Web Services (AWS) Cloud (Simple Storage)

S3 Data Storage (13 to 23 TB)
Landsat 7/8
Sentinel-1
Sentinel-2 (year 2)

Elastic Compute Cloud (EC2) Computing
* Data Cube management, new data ingestion, web-based user interface
* Managed by Strathmore University with support from NASA-SEO

Kenya   **Sierra Leone**   **Senegal**   **Ghana**   **Tanzania**

Each country has its own EC2 Computing "instance" for analysis purposes (User Interface and Jupyter Notebooks), but S3 data storage is shared among countries in the AWS cloud

How ARDC is helping Africa in Harnessing the Data Revolution
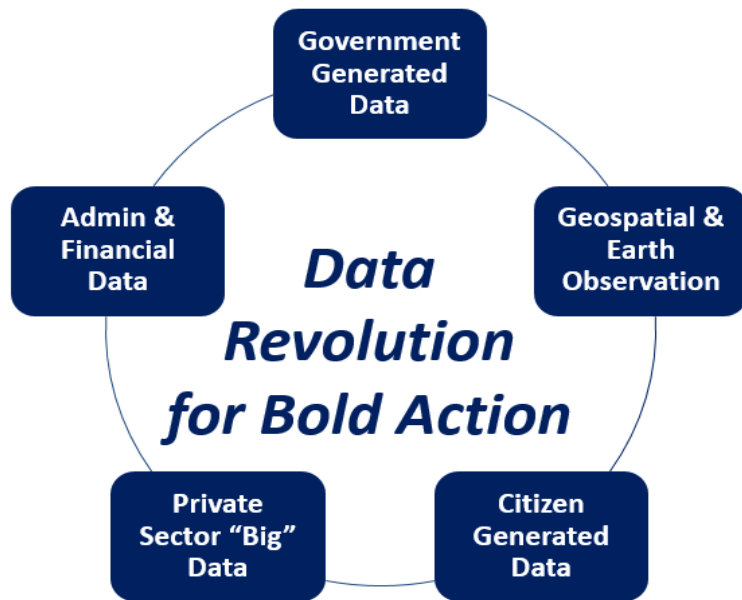
- Supporting and complementing government and civil society efforts to generate data for statistics for the formal SDG monitoring framework
- Unleashing innovation in production, accessibility and use of real-time, dynamic, disaggregated data from multiple sources

Breaking New Barriers

- A regional, demand-driven data solution
- Availing satellite **data free and open source** to countries
- Implementation is in the cloud with a wide-range of applications
- Facilitating data and analytics (algorithms)-sharing among users
- Increasing regional and global capacity to use satellite data
- Supporting the delivery of the SDGs & other development goals
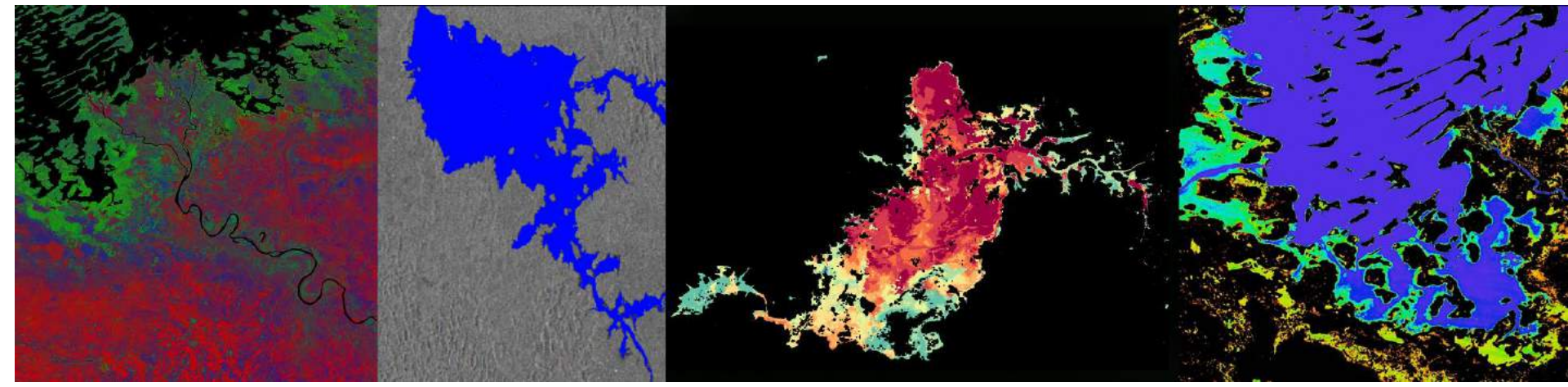
Examples how ARDC has been used -Illegal Mining on the Ankobra River in Ghana
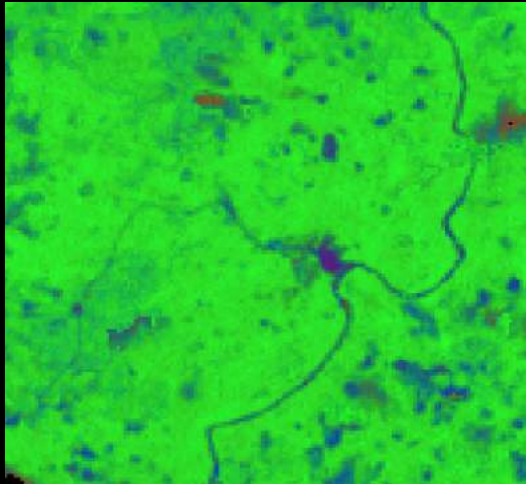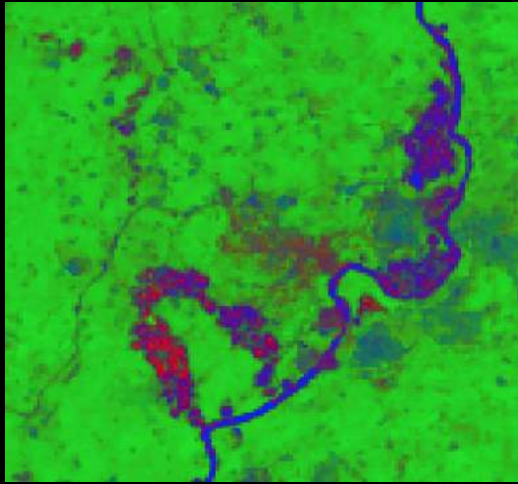

**Year 2000**   **Year 2017**   **Google Earth 2017**

- A Fractional Cover (FC) analysis (GREEN images) showed a 13% loss in dense vegetation along the river & when it started
- A Google Earth image in 2017 (far right) shows the known locations of illegal mining, provided by the Ghana Government
- Pin-pointing potential hotspots to warrant further investigations saves both time and money - and enhances efficiency

Examples how ARDC has been used Deforestation and Settlements along the East Chenene Forest Reserve in Tanzania

Africa Regional Data Cube
Land Change 2012-2016
(orange and red)
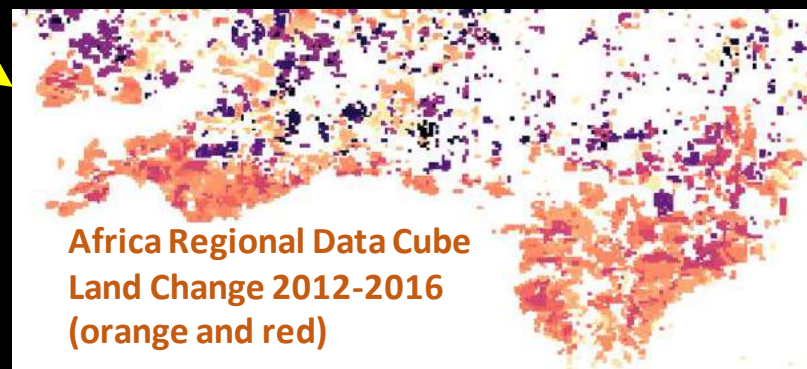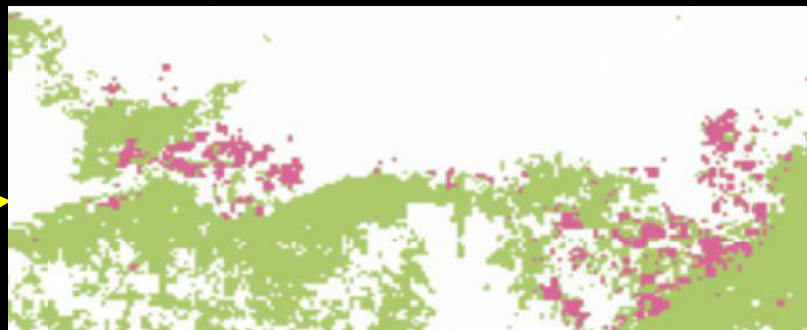
The PyCCD Land Change Algorithm (orange/red – bottom figure) compares well with the Global Forest Watch results (pink – top figure) for deforestation detection

# Examples how ARDC has been used -Urbanization in Freetown, Sierra Leone

Year 2000

Year 2017
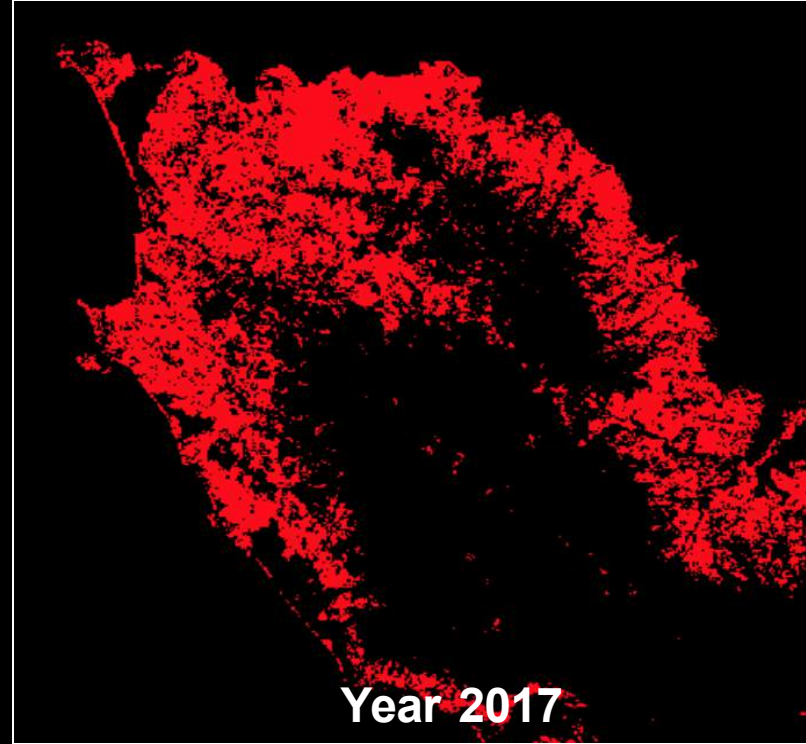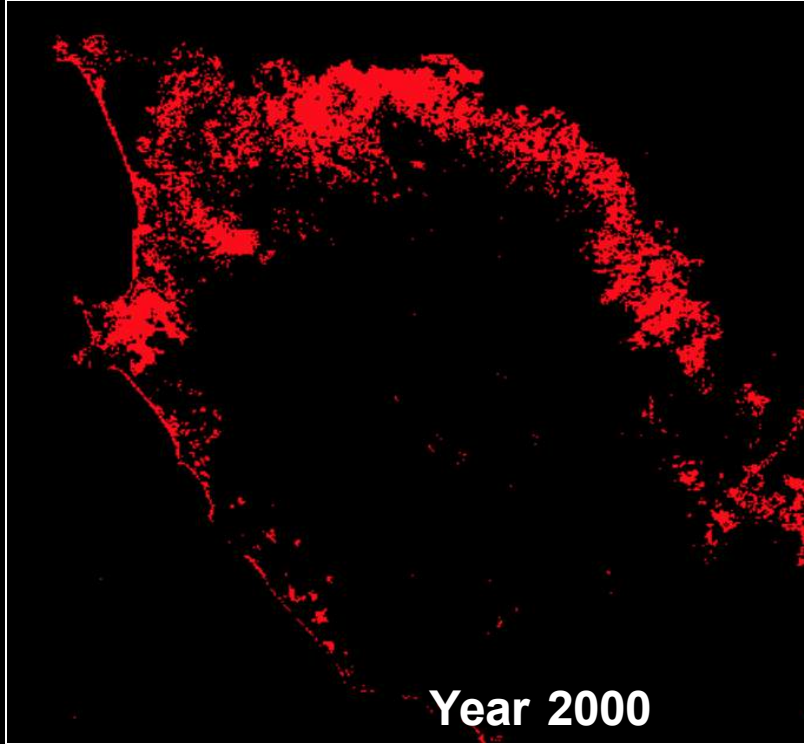
Urban extent has grown 11.4% over 10 years

* Analyses based on the NDBI index using the Africa Regional Data Cube

Application Products

20+ algorithms & 17+ years of data;

- A cloud-free mosaic (geo-median) for each country using Landsat-8 data from 2016.

- Use of mosaic product (above) to develop a K-Means or Random Forest clustering product to support land classification (one for each country). Identify one known land type in each country product.

- Develop a water extent product (Australian WOFS algorithm) using Landsat-7 time series data from 2000 to 2017. Create one for each country, including a time series animation. Compare with JRC water product results.

- Develop an NDVI trend product (new Vogelmann algorithm) using Landsat-7 time series data from 2000 to 2017. Create one for each country with a focus on deforestation or agriculture changes. Compare with deforestation / reforestation trends in GFW results
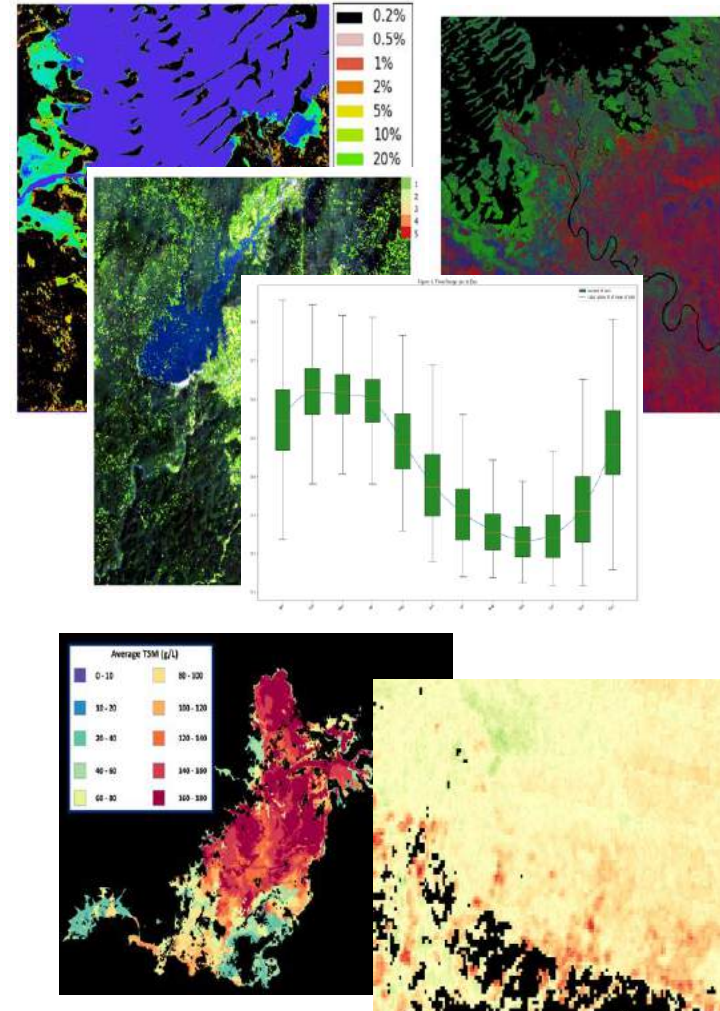
WHAT ARE THE ROLES AND RESPONSIBILITIES OF STRATHMORE UNIVERSITY?

- We are at the centre of ARDC core data, algorithms, and user interface management;

- After the launch we did an in-depth training for government representatives of participating countries, so that they can immediately make use of this cutting-edge technology.

- Enhance skills in the region on Earth observations and Geo-spatial information through training and carrying out modular courses for Government leaders, students and other stakeholders;

- Adding new satellite data to the ARDC (moving toward automation)

- Training for local users

- Managing ARDC accessibility for researchers and students

- Building an educational degree centered on the use of the ARDC

- Branding and advertisement of the ARDC throughout Africa

- Evaluation of long-term operational options including cloud-based deployment (e.g. Amazon), local deployment (e.g. Strathmore computing systems), and network enhancement (e.g. Liquid Telecom).

Collaboration and partnership

- To create the Demand and supply side of Geo Spatial information to create a social, environmental and economic impact economic by creating an increasing technical skills to help governments, farmers, and consumers manage the complex challenges they face in trying to navigate the economic, social, and environmental systems;

- We are having a collaborative project JGI- University of Bristol on "Sharing expertise in data science to address challenges relevant to the African context"

- Government ministries, national statistical agencies, geographic institutes, research scientists, and civil society all stand to benefit from this new technology and training and capacity building which will soon commence across countries to help national representatives utilize, contribute to, and ultimately benefit from the data cube.
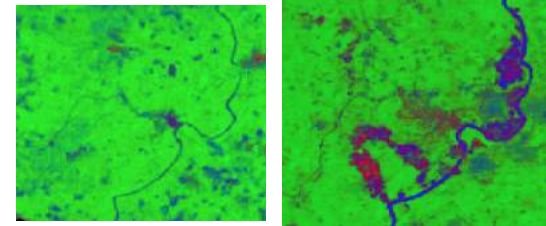
Impact

- National coordinating mechanisms established in 4 out of 5 countries;
- Did the initial training for policy leaders from each country and developed a training manual in partnership with NASA;
- Recent web-based remote training for Ghana (July 31), Tanzania (August 16), and Sierra Leone (Aug 24). More training planned for late 2018;
- Enhancements to the infrastructure based on user experience;
- Initial support has been focused on algorithms to support desired use-cases in:

Kenya: Dadaab Refugee Camp expansion, deforestation and vegetation extent, livestock rangelands

Tanzania: Chenene Forest Reserve deforestation and agriculture phenology

Ghana: Illegal mining (on right)

Sierra Leone: Flooding and urbanization (below)

Key areas ARDC is having impacts

- Some Kenyan Researchers & Conservationists are using Earth-observing Satellites to Locate Invasive Species Threatening Livestock, Livelihoods and Landscapes
- Piloted a project in partnership with Kenya Tea Development on Geodata for small sale farmers where they can use Africa Regional Data Cubes for satellite information and accessing it through Shamba Intel,
- In Embu planning to pilot work with scale-scale farmers in potato sector on geodata driven value chain approach

Partnership impacts

RESEARCH

- We have done the first ever inter-University Research on Hotspot analyses of earth observations and community mapping for Kenya's County Spatial Development Planning & national agenda in 3 Counties (Vihiga, Narok, Elgeyo- Marakwet)

- The Team Leader: Prof.r Jacquie McGlade-Director of Maasai Mara University Green Growth Development Research and Training Centre,

- Others: (1) Ms. Rosemary Okello-Orlale- Director AMH- Strathmore University (2) Samson Mabwoga (Lecturer), (3) Anil Kumar (Lecturer), Maasai Mara University; (4) Community: Solomon Ntaiyia, Patrick Letura, Emanuel Karia

Hotspots Analysis

Impacts of increasing land temperature & unpredictable rainfall

- Crop failure, food contamination and starvation

- Increases in mosquito-borne diseases (malaria, dengue, Rift Valley Fever and chikungunya) and bacterial infections (e.g. cholera)

- Greater air pollution from chemicals, pollen and dust

- **Hotspot analyses can help government agencies**

- Determine ways of anticipating and responding to short-term crises

- Mobilise resources more effectively to tackle the human and livestock health impacts and agricultural productivity

- Work with communities to co-create longer term solutions

Challenges

- Since the initial training in May 2018, there has been little progress in expanding the satellite data in the ARDC.

- We need strengthen GIS technical support and add new datasets

- From May to July 2018 there was limited interaction with country users. July to August 2018 showed a significant increase in interactions with several remote training sessions and identification of use-cases

- Limited capacity of partners means much training is needed to impart skills – especially face-face

- Whereas remote training is possible, internet connectivity has hampered this in some instances – effective use hinged on good internet connectivity

- Analytical products are always technical and need to be packaged better to communicate to broader audiences

- Many African countries do not have Data Policy or framework to enhance the eco-system to work better for an ordinary citizen.

Learning

- Having infrastructure, easy access to data, and necessary tools can be great, but the most critical is leadership buy-in, a proper coordination mechanisms, country buy-in and ownership;
- Significant and sustained capacity development is needed to impart skills
- EO and satellite data are great but depending on what you have available it may not be applicable across the board
- Combining satellite data and other data sources yields optimum results.
- It takes time, you need patience and resources. More sustained training is needed to impart skills – especially face-face
- Demand exists. Other data communities are needed to foster innovation and effectively respond to demand

Key Questions that keep coming up

- Tackling policy and legal barriers - what are the challenges, priorities and solutions?

- What are the key capacity gaps or needs – how can these be met?

- Governments sustainable investments in Earth Observations and satellite data - what approaches should be adopted and by who?

- Exploring practical use and innovation around Earth Observations and satellite data - what are the priority sectors?

- Government coordinating mechanisms and building data communities around Earth Observations and satellite data - how can this be effectively achieved and communicated?

VIEWS FROM LEADERS ABOUT THE AFRICA DATA CUBES

- Ghana's Vice President, Dr. Mahamudu Bawumia, said *"Over half of our labor force is made up of agricultural labor. This innovation has the potential to boost our economy, help enhance agricultural production and our efforts to tackle malnutrition in Ghana*."

- The Deputy President of Kenya, H.E. William Ruto: '' *The Kenyan Government will use the data cube to underpin the success of food security, a pillar of its 'Big Four' priorities alongside manufacturing, universal healthcare, and affordable housing. The data cube will allow the government to understand crop distribution, changing seasons, and use of agricultural land in rural areas; as well as better protect its forests and water towers. This technology will also help us to understand month by month how our land is being used so that we can target interventions aimed at improving our actions against climate change, help smallholder farmers, and secure sustainable food and water for our citizens.''*

- Claire Melamed, CEO of the Global Partnership for Sustainable Development Data said: ''*These five countries are in the vanguard of data for sustainable development. With their example, we hope that we can broaden access to the data cube across the continent so more countries can benefit from this fantastic solution. The sky really is the limit when it comes to how data from satellites can help drive sustainable development.''*

THANKS
ANY QUESTIONS

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