United Nations

Statistical Commission

56th Session

ECONOMY • ENVIRONMENT • POPULATION • SOCIETY • TRADE

UNSC56 SIDE EVENT

OPERATIONAL APPLICATION OF EO DATA FOR AGRICULTURAL STATISTICS

FROM CROP CLASSIFICATION AND PARCEL SEGMENTATION TO EARLY-SEASON YIELD FORECASTING AND PADDY CROP PHENOLOGY IDENTIFICATION

Monday, 3 February 2025
09:10–10:15 New York Time
15.10–16.15 Rome Time
Online

Food and Agriculture Organization of the United Nations

INEGI

Operational application of EO data for agricultural statistics

UN Task Team on Earth Observation for Agricultural Statistics

Lorenzo De Simone – *FAO, Co-Chair*
Eduardo Vazquez – *INEGI, Co-Chair*
Valerie Bizier – *FAO, Secretariat*

UNBigData

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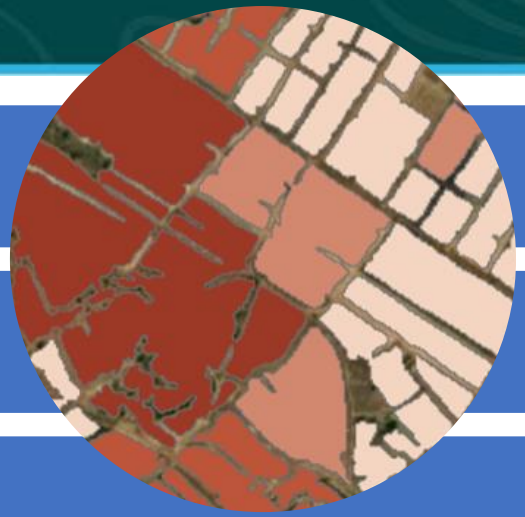
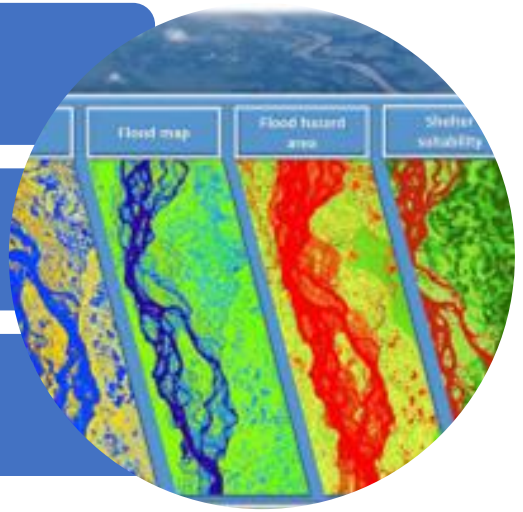
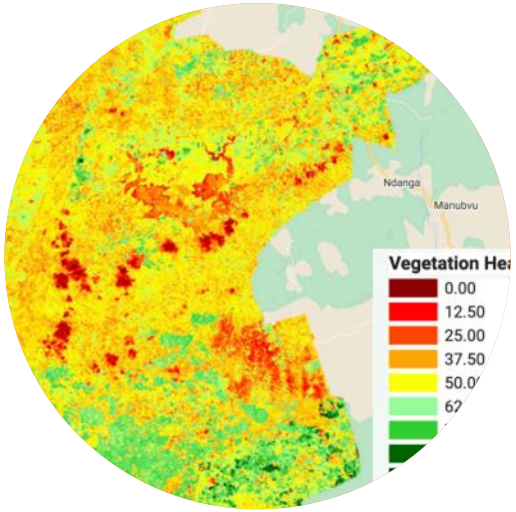






History and Mandate of the Task Team

EO Integration for Modern Statistics: Recognized by the UN Statistical Commission as a **cost-effective**, **granular alternative** to **traditional surveys** and **censuses**, especially for **monitoring agriculture** and **SDGs**.

Origins in Big Data Transformation: Sparked by the **2014** Statistical Commission decision, leading to the **establishment of UN-CEBD** to explore Big Data applications and address quality and confidentiality.

Formation & Evolution of the Task Team: Initial Focus: Began as the Task Team on Satellite Imagery under the Global Working Group on Big Data for Official Statistics, targeting **crop yield prediction** through representative training data.

Expanded Scope: Renamed to the Task Team on Earth Observation Data for Agricultural Statistics to encompass a broader range of EO applications.

Key Milestones:

- **2017**: Published foundational guidance on EO data use ("**Satellite Imagery and Geospatial Data Task Team Report**").
- **2020**: Restructuring led to the **Joint Task Team** (UN-CEBD/UN-CEAG) aligning EO applications with broader food security and agricultural statistics priorities.

Recent Contributions & Initiatives:

2022: Released "Lessons Learned and Recommendations from Select Earth Observation Applications on Agriculture.“
2023: Launched an EO methodology knowledge assessment application to support capacity building.

Ongoing Focus Areas: Enhancing crop classification, integrating Big Data, addressing governance, and exploring new EO applications for emerging challenges.

Identity Card of the Task Team

E-Stat

Chair and Secretariat

Lorenzo De Simone — **FAO-HQ (Co-Chair)**

Eduardo Vazquez — **INEGI-Mexico (Co-Chair)**

Valérie Bizier — **FAO-HQ (Secretariat)**

Ronald Jansen — **UNSD (Secretariat)**

International partnership

Food and Agriculture Organization of the United Nations

United Nations Statistics Division

WORLD METEOROLOGICAL ORGANIZATION

THE WORLD BANK

USDA United States Department of Agriculture

ADB ASIAN DEVELOPMENT BANK

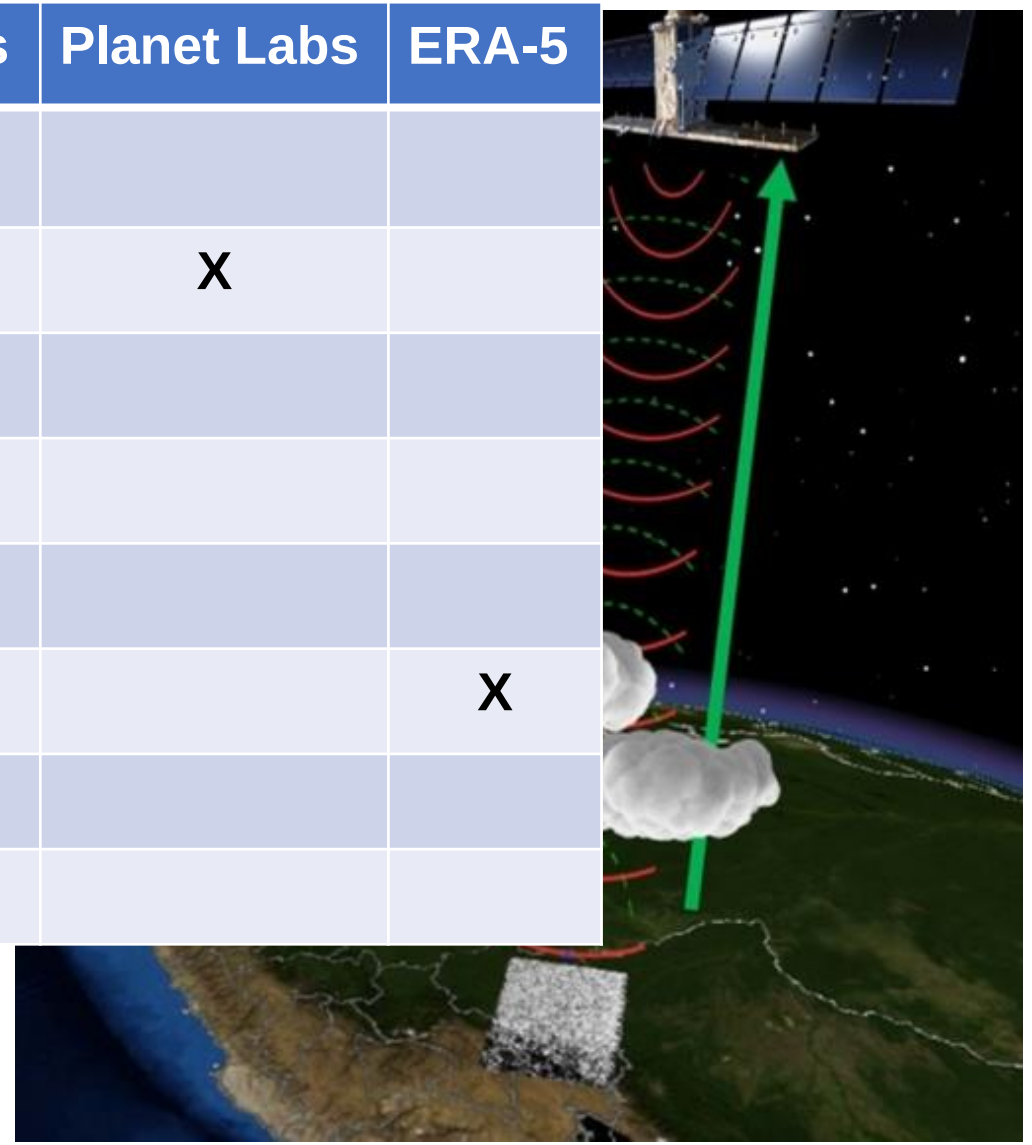
Digital Earth AFRICA

Evolving Trends in Earth Observation for Agriculture

- **Trend 1:** Fusion of multiple EO sensors, both Optical and Radar Data, VHR, and agroclimatic data
- **Trend 2:** Advanced Machine Learning and Artificial Intelligence
- **Trend 3:** Introduction of EO Data Cubes
- **Trend 4:** Expansion of Crop Yield Forecasting Models

Trend 1: Fusion of multiple EO sensors

Country	Sentinel-2	Sentinel-1	Sentinel-3	Modis	Planet Labs	ERA-5
Austria	X	X				
Brazil	X	X			X	
Finland	X					
Indonesia	X	X		X		
Mexico	X	X				
Poland	X	X	X			X
Senegal	X	X				
Zimbabwe	X					

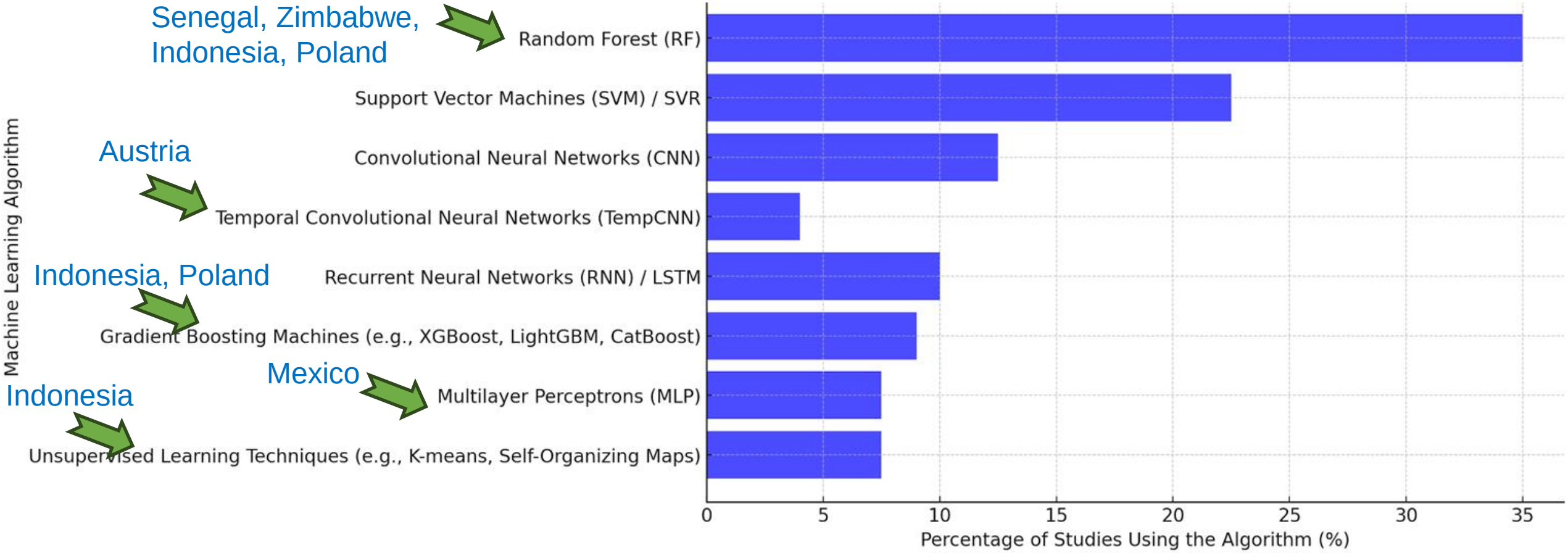


Trend 2: Advanced Machine Learning and Artificial Intelligence

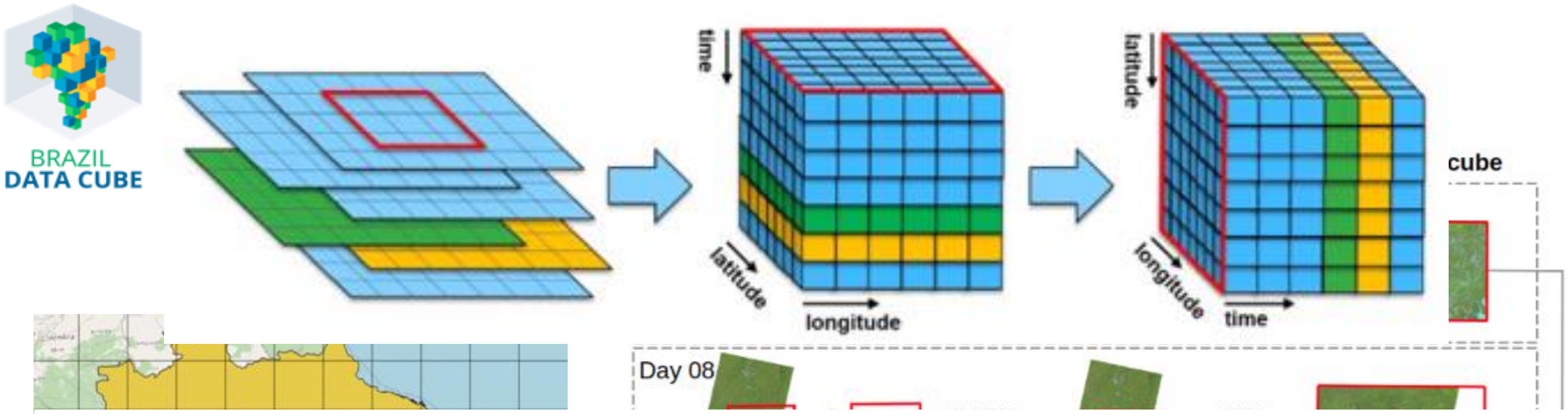
- *Effective Temporal Feature Extraction*
- *Enhanced Classification Accuracy*
- *Robustness to Noise and Variability*
- *Computational Efficiency*
- *End-to-End Learning Capability*
- *Improved Generalization*
- *Versatile Application*

Trend 2: Advanced Machine Learning and Artificial Intelligence

Source: Lorenzo De Simone, Metanalysis of literature: (Cheng, Han, & Guo (2016/2017); Zhu et al. (2017); X et al. (2017); Banerjee (2018); Chen et al. (2018); Ma et al. (2019); Ban et al. (2019); Li et al. (2019); Ball & Helber;



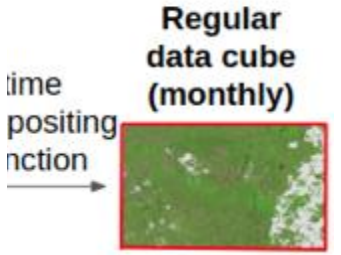
Trend 3: adoption of EO Data Cube



A regular, dense raster data cube is a four-dimensional array with dimensions x (longitude or easting), y (latitude or northing), time, and bands with the following properties:

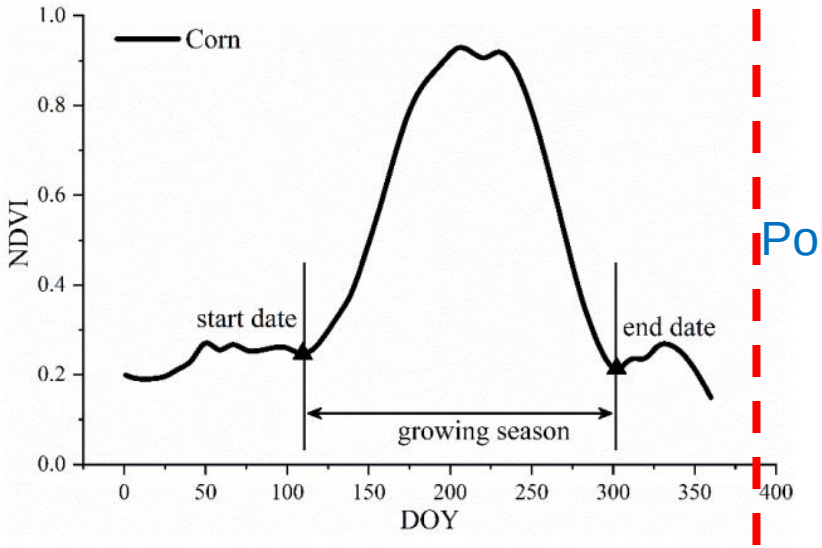
1. Spatial dimensions refer to a spatial reference system (SRS);
2. Cells of a data cube have a constant spatial size;
3. The cube axes are aligned with the SRS axes;
4. The temporal reference is a known set of temporal intervals;
5. For every combination of dimensions, a cell has a single (real) attribute value.

Adapted from Appel and Pebesma (2018)



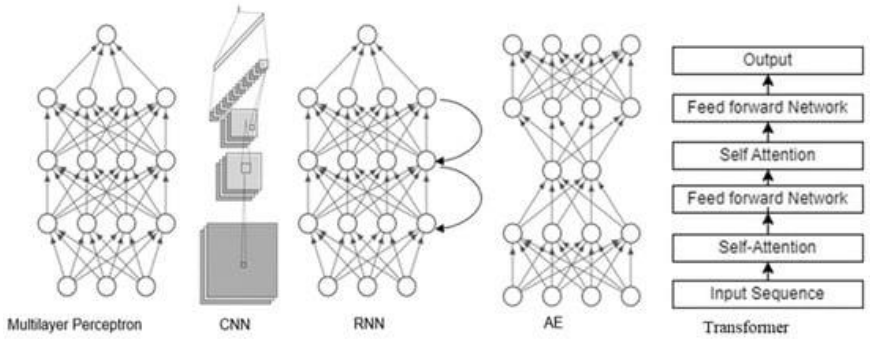
Trend 4: expansion of crop yield forecasting models

Statistical regressions

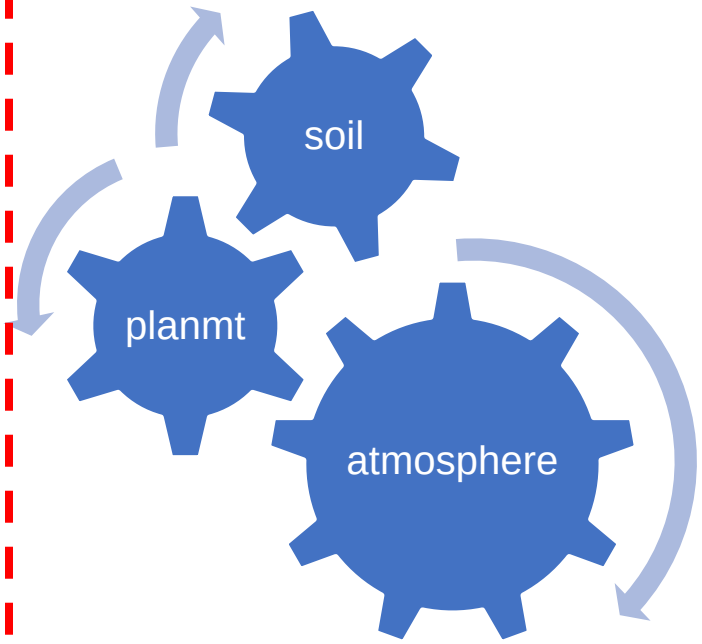


Poland

Machine learning



Process based models



Task Team's expanded scope

The Task Team has expanded its scope **4 NEW thematic areas**:

1) **Disaster Risk Reduction**
   - Drought monitoring
   - Flood forecasting and mapping

2) **Biodiversity**

3) **Data Governance**

4) **Collaboration** with the **Regional and Global Big Data Hubs**
   - Regional workshops
   - Webinars
   - Technical support to projects

Key Takeaways

Increased Sophistication: EO applications have become more sophisticated, incorporating advanced techniques like radar data and machine learning.

Broader Application: The scope has expanded beyond simple mapping to include yield forecasting and addressing environmental and disaster-related issues.

Enhanced Scalability: The use of data cubes and cloud computing has made these methods more scalable and efficient.

Focus on Global Impact: The Task Team is now more focused on addressing challenges in developing countries, with an emphasis on capacity building and in-situ data collection.

Highlights Report 2024

Use Cases from NSOs:

Austria: Crop type classification using Temporal Convolutional Networks and Sentinel-1 and Sentinel-2 imagery, complementing the Land Parcel Identification System (LPIS).
Brazil: Parcel segmentation for agricultural census planning using HRNet models and radar imagery, improving field boundary mapping and data collection.
Finland: Early-season crop yield estimation for major and minor crops, integrating Sentinel-2 data with neural networks and survey data.
Indonesia: Rapid rice phenology prediction using Sentinel-1 imagery and Area Sampling Frame surveys, enabling timely and accurate rice statistics.
Mexico: Open-source crop classification leveraging Sentinel-1 and Sentinel-2 data with machine learning algorithms, providing replicable methodologies.
Poland: Development of a Crop Monitoring System and yield forecasting models using Sentinel 3 data, MODIS vegetation indices, and ERA-5 agrometeorological indicators.

Capacity-building projects:

Zimbabwe: Leveraging FAO and African Development Bank support to evaluate classification approaches for winter wheat crop type mapping, as well as to optimize field survey design, and finally increase accuracy of acreage statistics
Senegal: Generating crop type maps under conditions of limited in situ data using Sentinel imagery and annual agricultural surveys.

Thank you