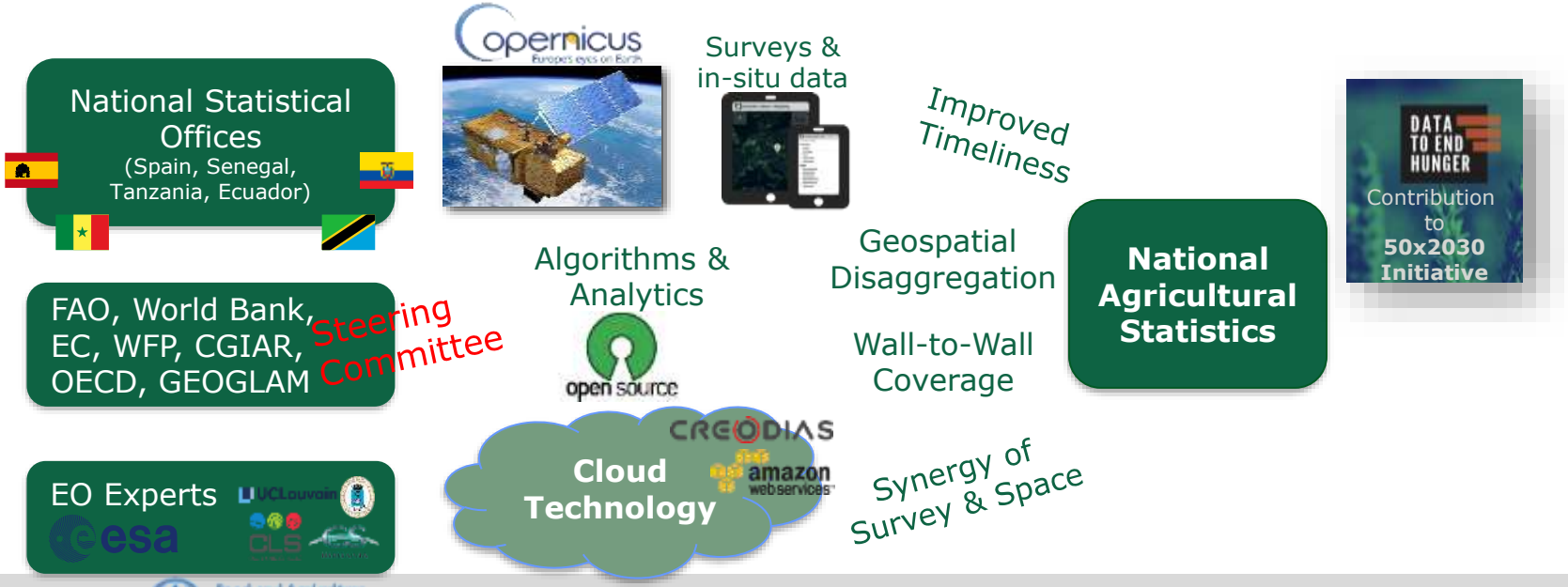
Lorenzo De Simone, FAO
prepared by S. Bontemps (UCL) and Z. Szantoi

Earth Observation to support official agricultural statistics

- Engage **National Statistical Offices (NSOs)** to demonstrate the **benefit of EO information** within their operational workflows for agriculture
- **Provide and demonstrate validated algorithms**, open-source **tools, products** and **best practices facilitating the uptake of EO information** by them



NSO requirements defining different use cases

COST EFFICIENCY — Using EO data in the statistical framework to maximize the statistics accuracy (i.e. low variance) or/and to reduce cost (thanks to free data, « simple » methods)

Current sampling often designed for national level => use EO data to allow statistical disaggregation at smaller administrative areas (province, county) — **STAT. GRANULARITY**

STAT. TIMELINESS — Statistics often available late after the end of the campaign and once a year => use EO data to forecast statistics and provide seasonal estimates

Use EO data to support the building of an area sampling frame (moving from LIST/POINT) and to find the optimal samples size and segments size — **SAMPLING DESIGN**

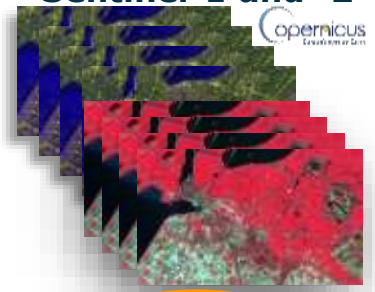
DATA QUALITY CONTROL — Improving the quality of the [ground] database (data collection protocol and quality control procedure)

SDG'S REPORTING — SDG's 2 "Zero Hunger" and 6 "Clean Water and Sanitation"

Early warning systems, water body map, soil suitability, comparing yield statistic estimates — **OTHER**

An open-source system to couple EO and statistical surveys for improved statistics

Sentinel-1 and -2

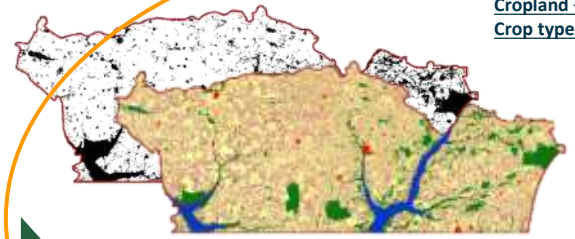


Agri. surveys

EO cloud

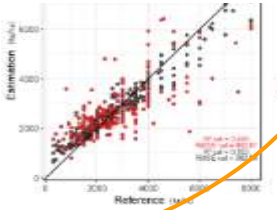
Sen4stat

EO products



SENEGAL – NIORO DU RIP
Cropland – non cropland map
Crop type map
OA: 88,2 %
F-Score Groundnut : 95,2%
F-Score Mil : 83,8 %
F-Score Maize : 54,8%

SPAIN – CASTILLA Y LEON
Soft wheat yield estimation



SENEGAL
Crop growing metrics evolution

COST EFFICIENCY

STAT. GRANULARITY

STAT. TIMELINESS

SAMPLING DESIGN

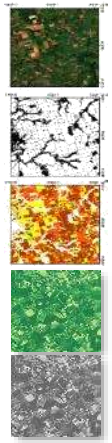
DATA QUALITY CONTROL

SDG'S REPORTING

Toolbox for operational crop mapping and agricultural statistics at national scale

Processes Sentinel-1, Sentinel-2 and Landsat-8 and -9 time-series including advanced SAR products (coherence, gamma naught,…)

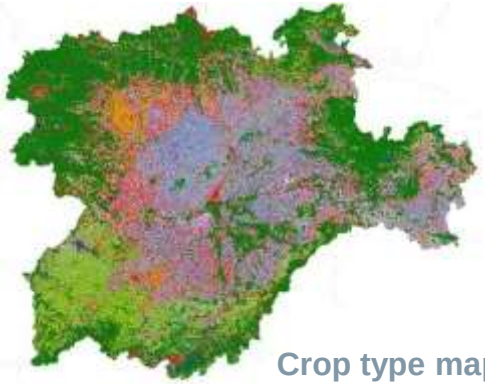
Delivers automatically or on request **five types of products** (*processors*) in near real time or off-line:



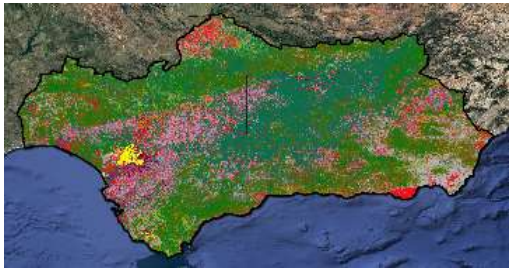
- **10m optical cloud free temporal synthesis and SAR temporal synthesis**
- **time series of spectral indices** (NDVI, coherence,…) and **biophysical variables** (LAI, fCover, fAPAR)
- **10m crop type maps** throughout the season, based on in-situ data and stratification
- **a large set of crop growth conditions metrics** (including meteorological data)
- **crop yield estimation** at various aggregation levels (national, regional, …)

Sen4Stat in Spain – EO to improve acreage estimates

- High quality in-situ data, explicit request from the NSO
- Andalusia and Castilla y Leon



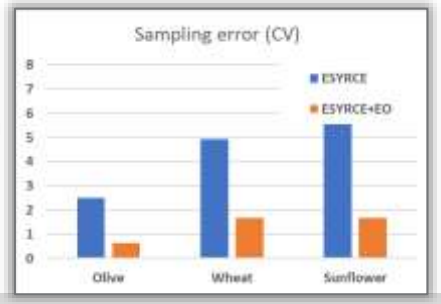
Crop type maps
OA >85%



Regional barley acreage estimates in Castilla y Leon

Data	Barley acreage (Hectares) in the study area. Spain. 2018	Uncertainty			
		95% Confidence Interval (Hectares)		Sampling Error (CV%)	Relative efficiency
		Limits	Amplitude		
Ground (ESYRCE)	236165.4	Lw: 215951.7 Up: 256379	40427.24	4.37	------
Ground+EO	228550.1	Lw: 219699.8 Up: 237400.3	17700.51	1.98	5.2

Sampling Error in Andalusia



COST EFFICIENCY

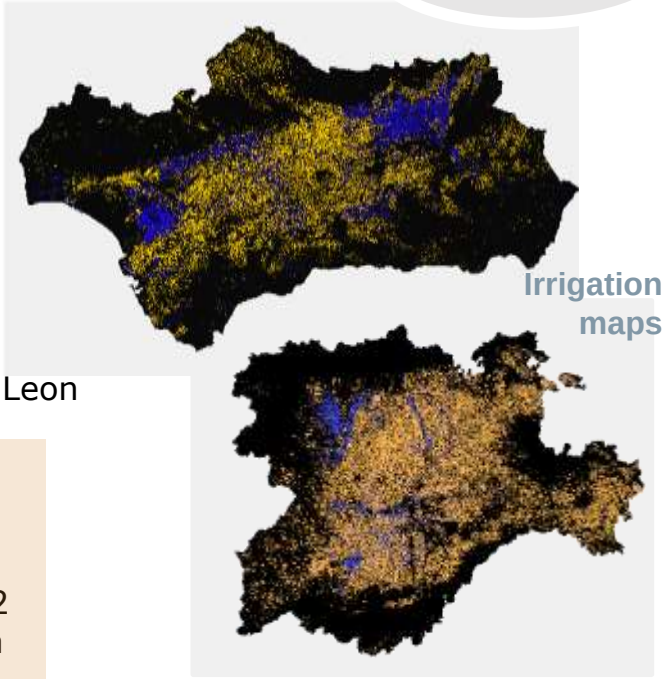
EO to improve granularity and timeliness, and to support new sampling frame

REGION	ESYRCE		ESYRCE+EO		Relative Efficiency
	Acreage (has.)	Error (CV%)	Acreage (has.)	Error (CV%)	
León	6853.2	24.15	6834.5	16.20	2.3
Palencia	88602.0	7.36	90535.3	3.33	4.7
Valladolid	128209.5	5.57	119707.4	2.66	5.1
Zamora	12324.2	17.71	10948.2	8.16	6.4
TOTAL AREA	235989.1	4.37	228028.5	1.98	5.2

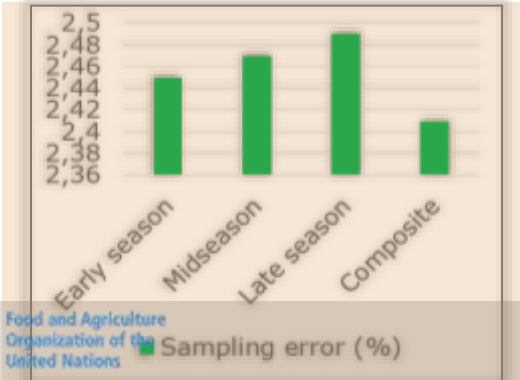
STAT. GRANULARITY

Regional barley acreage estimates in Castilla y Leon

SAMPLING DESIGN



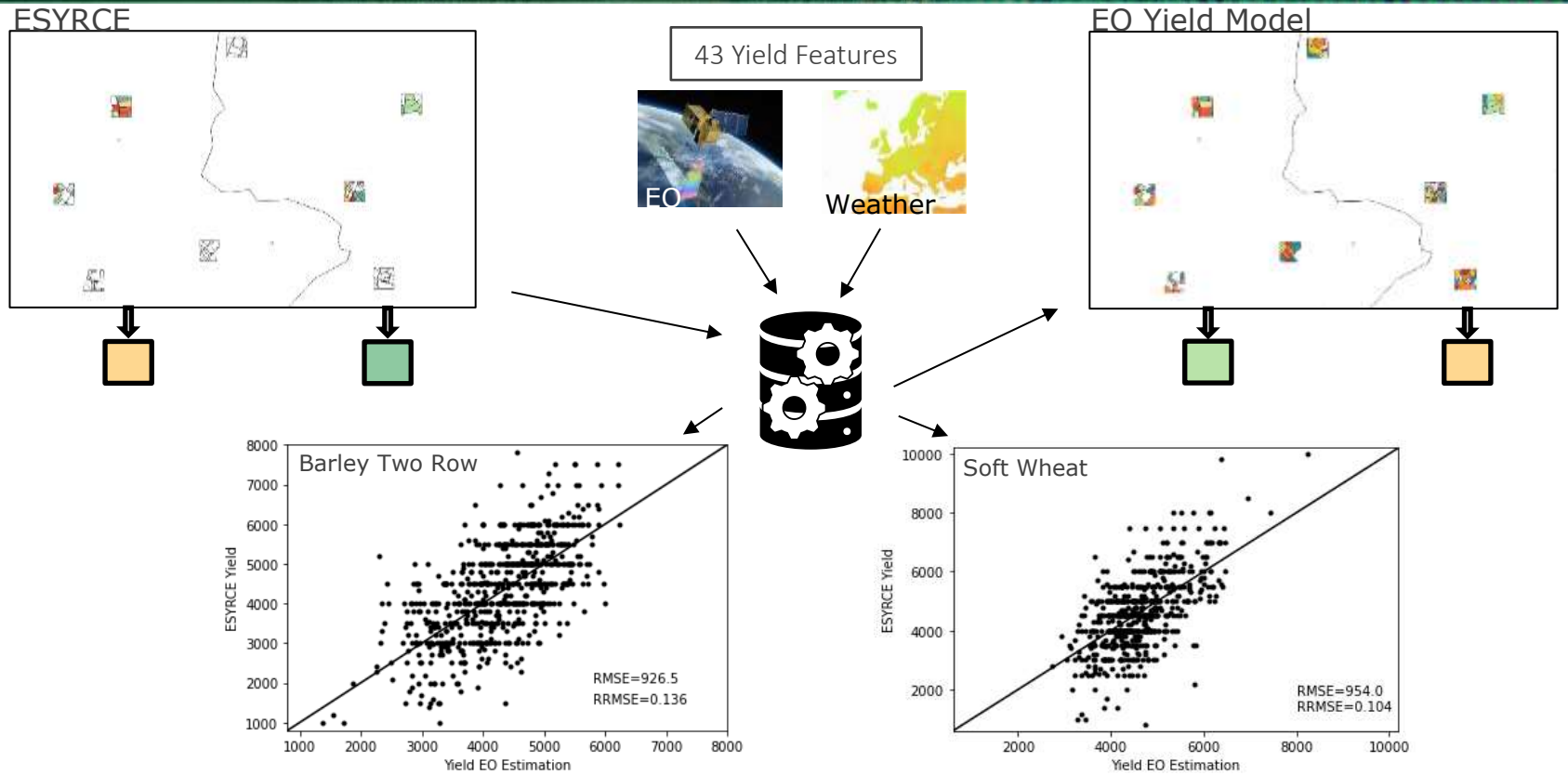
Irrigation maps



Barley yield forecast and composite estimate (4 S2 tiles in Castilla y Leon)

STAT. TIMELINESS

Sen4Stat in Spain: sub-national yield estimation for cereals



EOSTAT – FAO's support to countries

EOSTAT was launched by FAO in 2019. In collaboration with ESA and the University of Louvain we support countries using Sen4STAT tool box and we deliver a series of technical capacity building services.

Actively implemented in 21 countries:

- Latin America and Caribbeans (6)
- Western, Eastern and Southern Africa (12)
- Eastern Europe - Middle East (1)
- Asia and the Pacific (2)

Capacity building main activities:

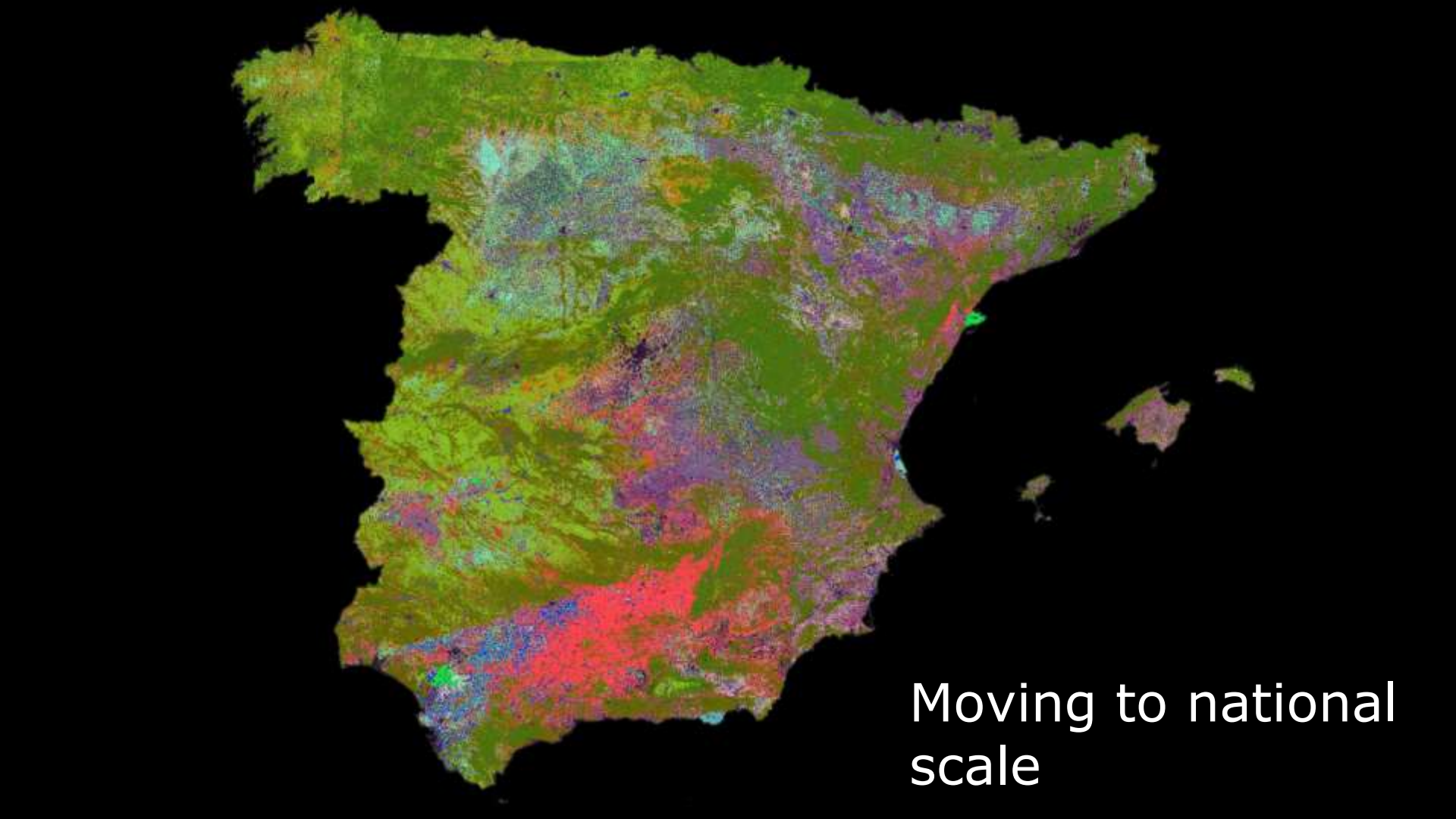
- ❑Opimization of survey design and best practices in georeferencing
- ❑Crop type mapping and estimation of acreage
- ❑Crop yield mapping and estimation of yield and procuction
- ❑Automatic field boundary delineation

COUNTRIES SUPPORTED

- **Angola**
- **Burkina Faso**
- **Cameroon**
- **Chile**
- **Colombia**
- **Ecuador**
- **El Salvador**
- **Eswatini**
- **Gabon**
- **Guatemala**
- **Kenya**
- **Lesotho**
- **Mali**
- **Peru**
- **Senegal**
- **Tajikistan**
- **Timor Lest**
- **Uganda**
- **Ukraine**
- **Zimbabwe**

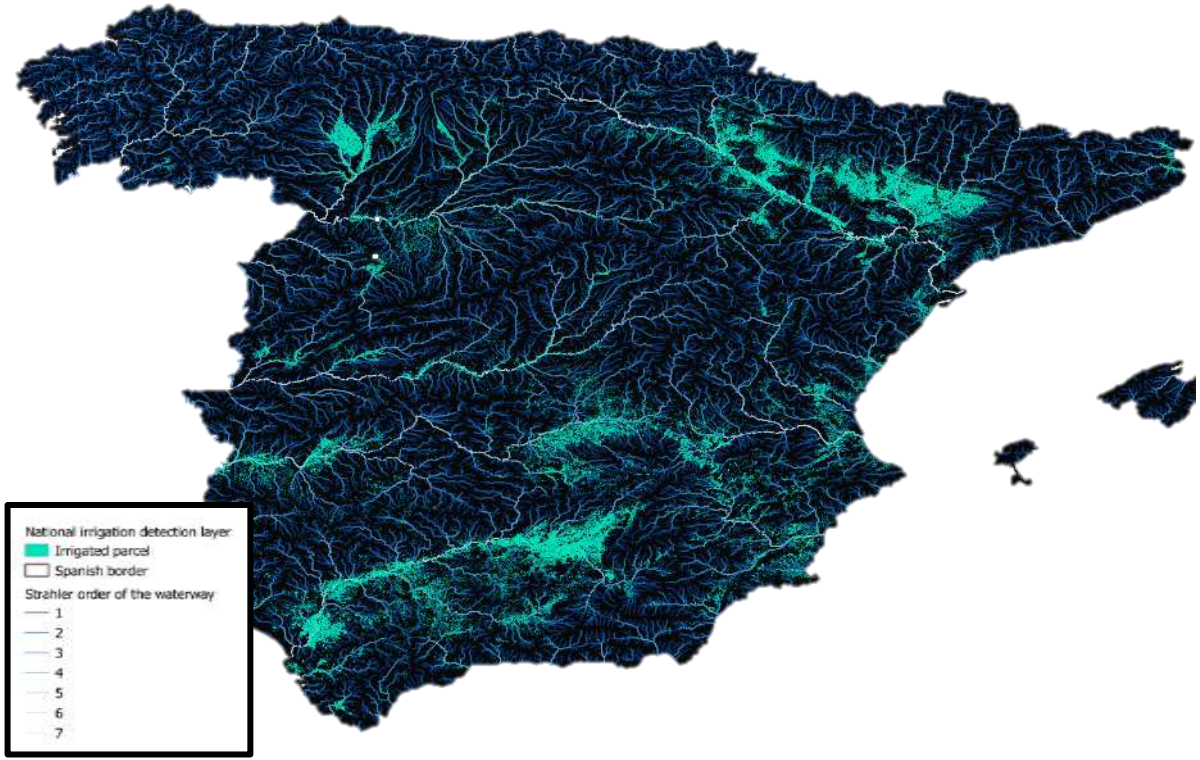
UCLouvain

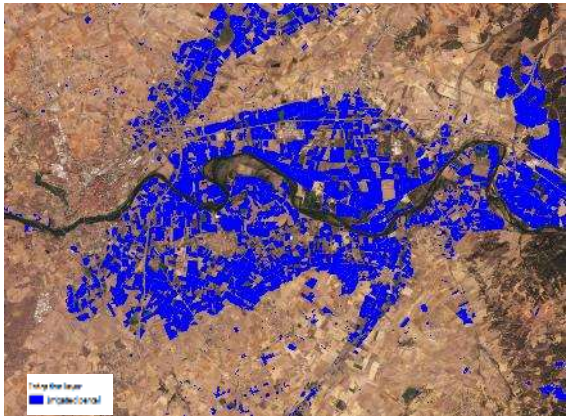
Food and Agriculture Organization of the United Nations


Moving to national scale

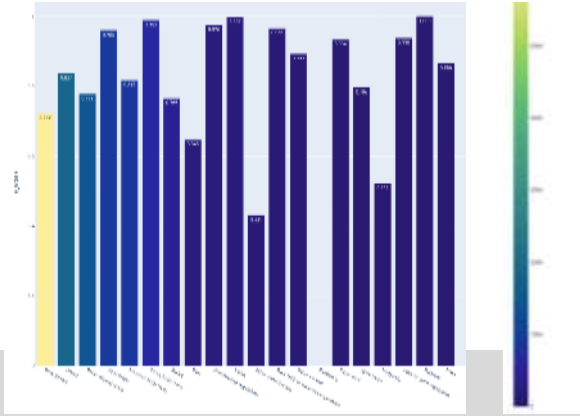
Sen4Stat in Spain: mapping irrigated crops to support and improve sampling design

National irrigation map of Spain, waterways highlighted



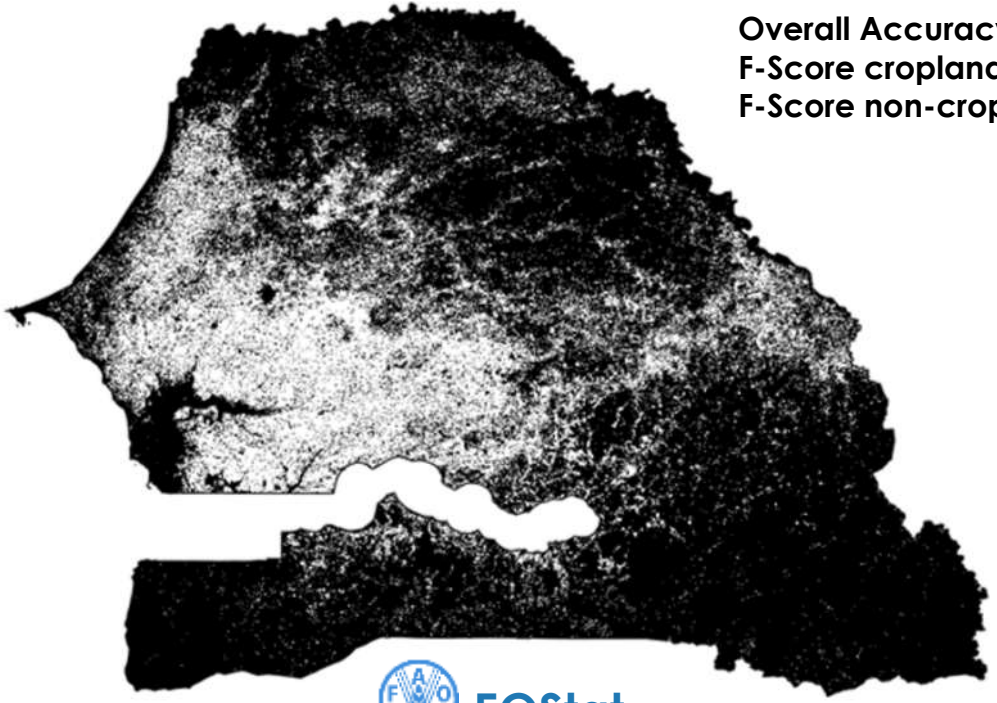


F-scores of irrigation detection model



Sen4Stat in Senegal: national cropland mask at 10-m resolution

Random Forest classification based from S2 and L8 time series only



Overall Accuracy : **96%**
F-Score cropland: **0,97**
F-Score non-cropland: **0,88**

EOStat

Sen4Stat in Senegal: adjustment of agricultural survey protocol to facilitate the EO integration

More information needed for the powerful use of EO data supporting agricultural statistics

Pilot field campaign ongoing in Nioro du Rip Department:

1) Record fields area and field boundaries
2) Collect non-cropland geographical information (mandatory to discriminate between crop and non crop classes)
3) Collect additional information about mixed crops, field heterogeneity and presence of adventices
4) Take GPS coordinates of the crop-cutting plot for yield estimation

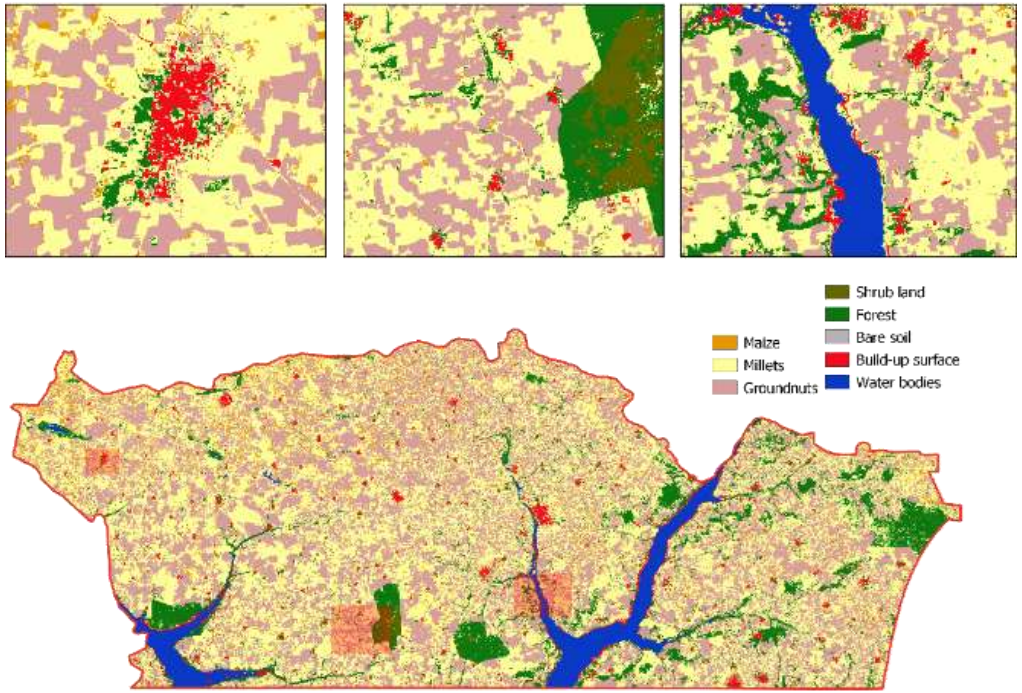
Dakar, April 2022

GPS Tablet (ODK)

GPS Garmin

New pilot protocol in Nioro in 2021, extended to 6 departments in 2023 (also targeting crop yield)

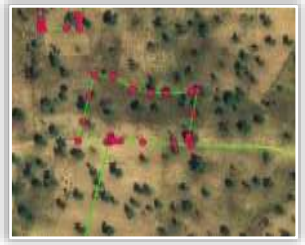
Sen4Stat in Senegal: improved acreage estimates in Nioro (2021)



COST EFFICIENCY

Crop type	Acreage (hectare)	Uncertainty	
		Standard error	Coefficient of variation (%)
Millet	89215	3661.103	4.11
Groundnut	78815	2923.94	3.71

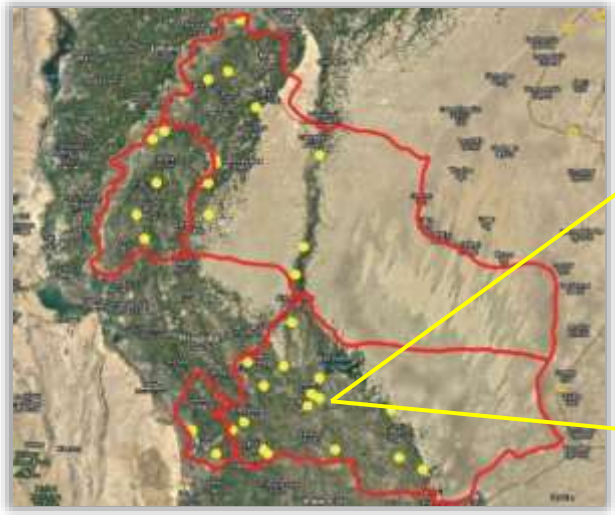
DATA QUALITY CONTROL



Sen4Stat extension aiming at system improvement and better user uptake

- System demonstration:
  - Spain, Senegal, Pakistan, Angola, Ethiopia, Mali
  - Additional countries supported by FAO (EOStat programme): Rwanda, El Salvador, Uganda, Tajikistan, Timor Leste (Kenya TBC)
  - Use cases executation with pilot countries (on their own premises or on the cloud – NoR support)
- System improvement and maintenance
  - Adding AWS datasource, moving from CentOS7, update for Sentinel-1C, improving IT performance
- User community federation and capacity building: forum, trainings, improved documentation
- Scientific publications

Field campaing in Pakistan – Sindh province
Acreage estimates for irrigated wheat (Rhabi season)



- 33 segments over 4 districts: Matiari, Sanghar, Nahshehro Feroze and Khairpur
- 2 km² segments; 15 points / segment
- Figures obtained to minimize the error on the acreage estimation
- 2-week field campagne (March 24)

Application of Sen4STAT in Zimbabwe

Thank you

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