→ EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Water Resources Management

Asian Water Forum | Oct. 5th 2018 | Asian Development Bank | Manila, Philippines

Applications of Earth Observations for Water Resource Management and SDG Monitoring

Christian Tottrup, DHI GRAS

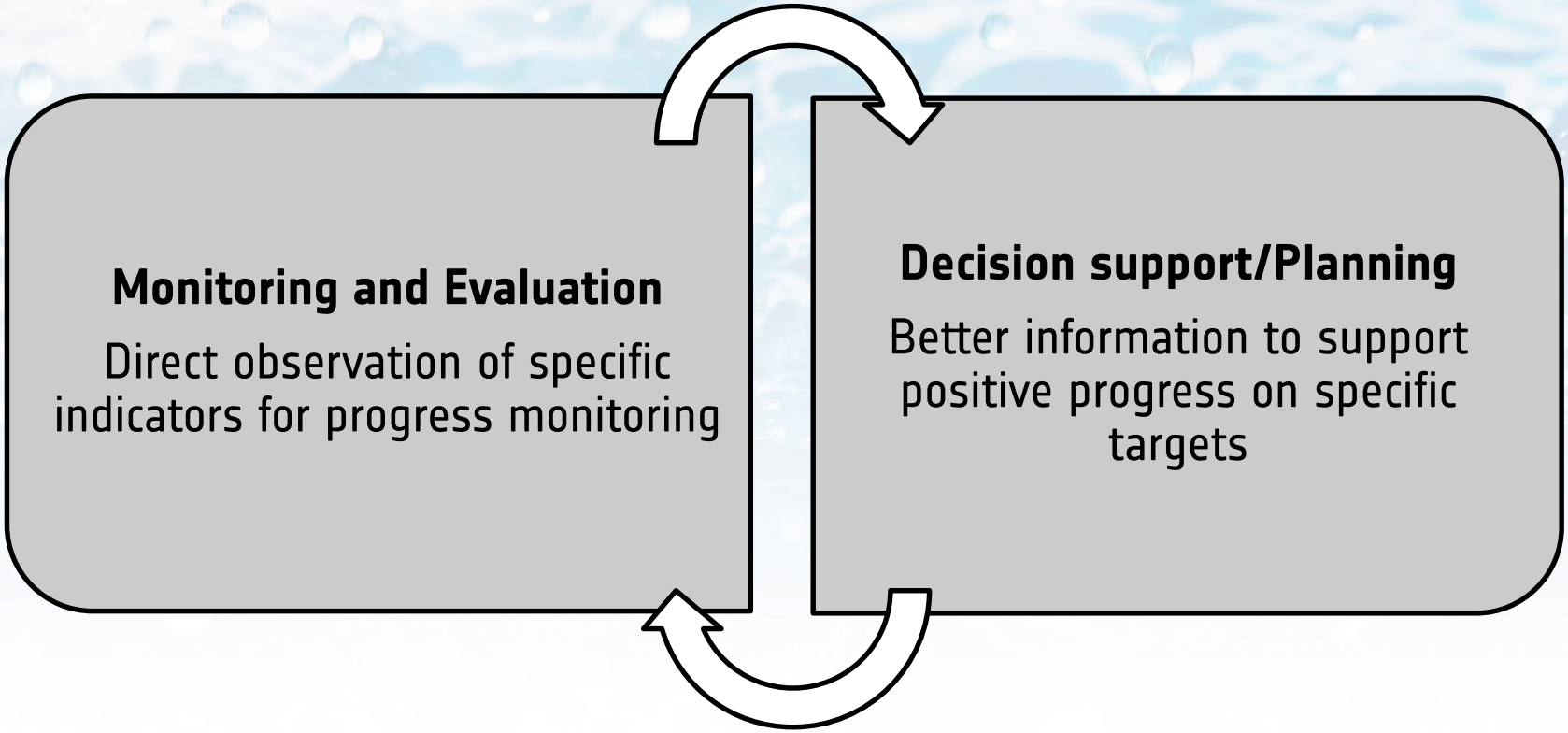
SDG 6 context

- The SDGs require a global indicator framework needed to measure, monitor and report progress
- Require use of multiple types of data, including traditional national accounts, household surveys and routine administrative data as well as Earth Observation data
- There is a growing awareness that EO data has the potential to provide robust monitoring for several of SDG indicators because of their consistency, accessibility, repeatability, and global coverage

→ the Water goal

http://ceos.org/document_management/Ad_Hoc_Teams/UNSDGs/SDG_General%20doc/EO-for-2030-Agenda-for-SD_21Mar2017.pdf

The dual role of EO for implementing the 2030 Agenda



- Many water related issues/indicators not easy to assess at basin/national level with traditional survey data → EO can provide harmonized transboundary/national information

The SDG Water targets

Earth Observation for Target 6.3: Water Quality

esa

Target 6.3

"Water quality and wastewater"

Indicator 6.3.2

Proportion of bodies of water with good ambient water quality

EO support

EO can support the delineation of surface water bodies and partly the monitoring requirememts for a limited number of parameters

Water quality mapping

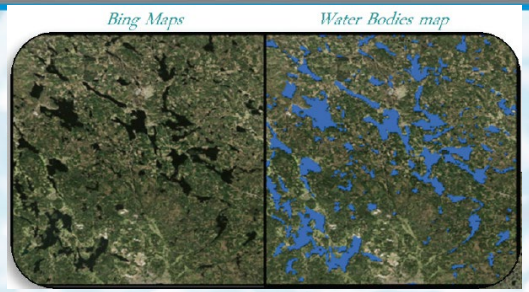
Previously restricted to coastal waters and large lakes but now feasible also for inland water bodies and river systems

Relevant parameters:

- Chlorophyll concentration
- Turbidity
- Water surface temperature

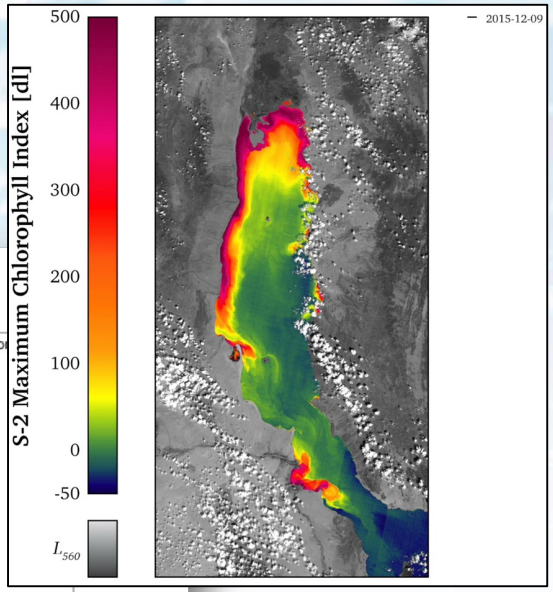
+ Water surface delineation

EO can also be used to monitor pollution sources and points of discharge into water bodies (cf. Indicator 6.3.1)



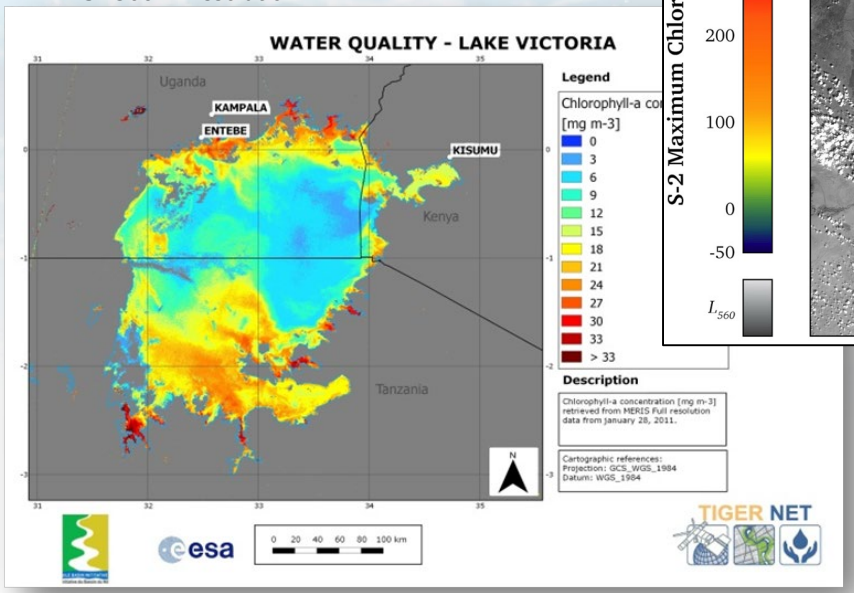
Source: ESA CCI

Sentinel-2: 10 m resolution



Source: ESA Sponge

MERIS: 300 m resolution



Source: DHI GRAS

Earth Observation for Target 6.4: Water Use Efficiency

Target 6.4	Indicator 6.4.1	EO support
"Water use and scarcity"	Indicator: 6.4.1 Change in water-use efficiency over time	EO partly support the indicator by providing operational capacity for mapping irrigated water use efficiency

Water use efficiency in irrigation

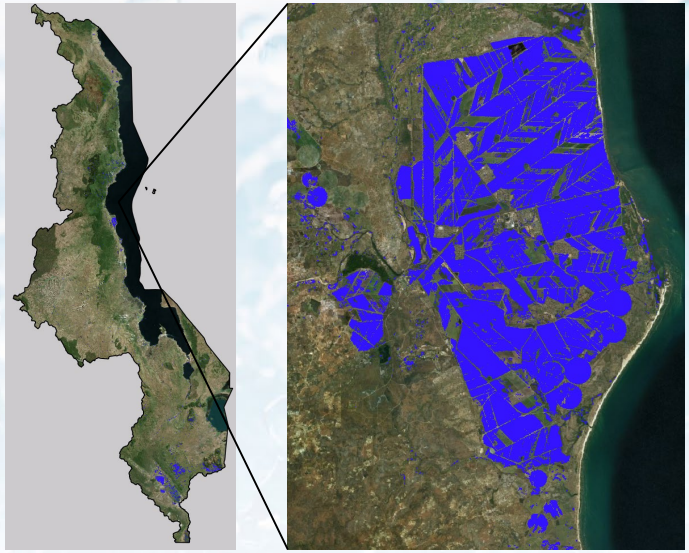
$$WE = A_{we} + I_{we} + S_{we}$$

Where

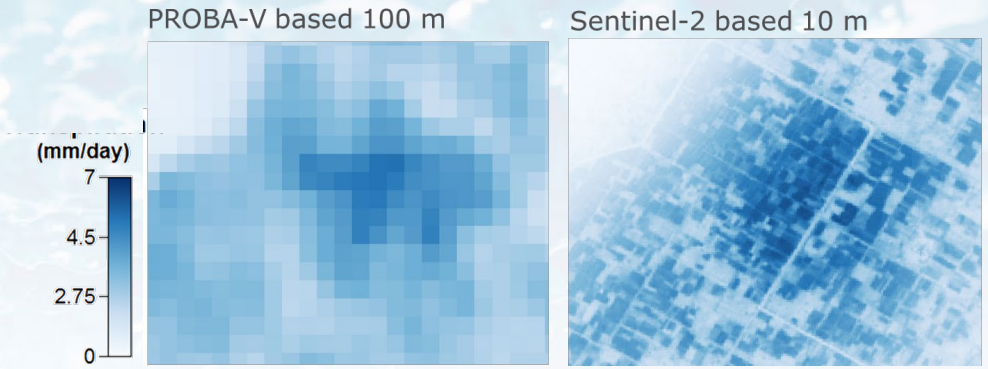
WE	=	*Water efficiency*
A_{we}	=	*Irrigated agriculture water efficiency [USD/m³]*
I_{we}	=	*Industrial water efficiency [USD/m³]*
S_{we}	=	*Services water efficiency [USD/m³]*

- EO support mapping of:
  - Irrigated crop area
  - Evapotranspiration
  - Biomass or crop yield

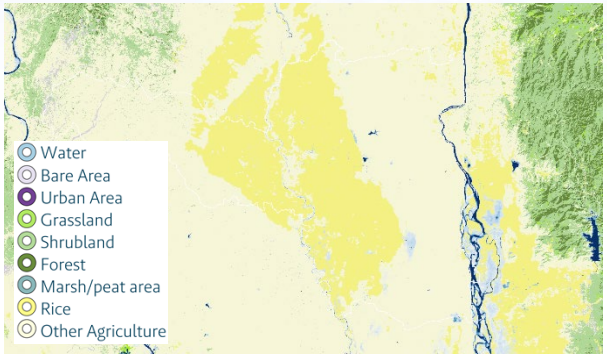
Water use efficiency in irrigation



EO can be used to map Ai at national scale
(© DHI GRAS / EO4SD)



– Evapotranspiration can be estimated with EO at regional and field scales (© eLeaf / WaPOR/ EO4SD)



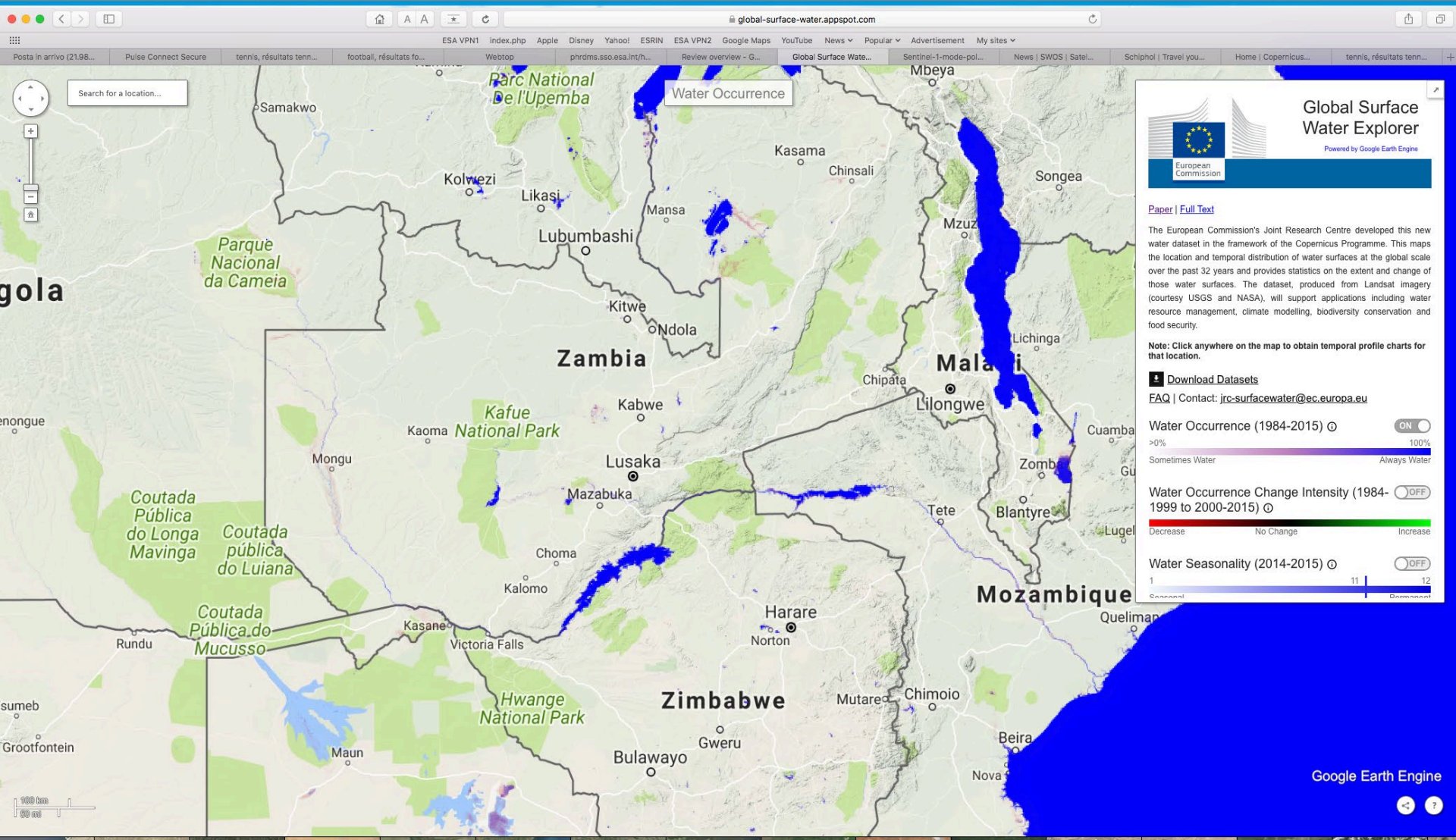
Gross value added by agriculture depends on crop type and yield – both can be estimated with EO (@ Satelligence / EO4SD)

Earth Observation for Target 6.6: Water-related Ecosystems

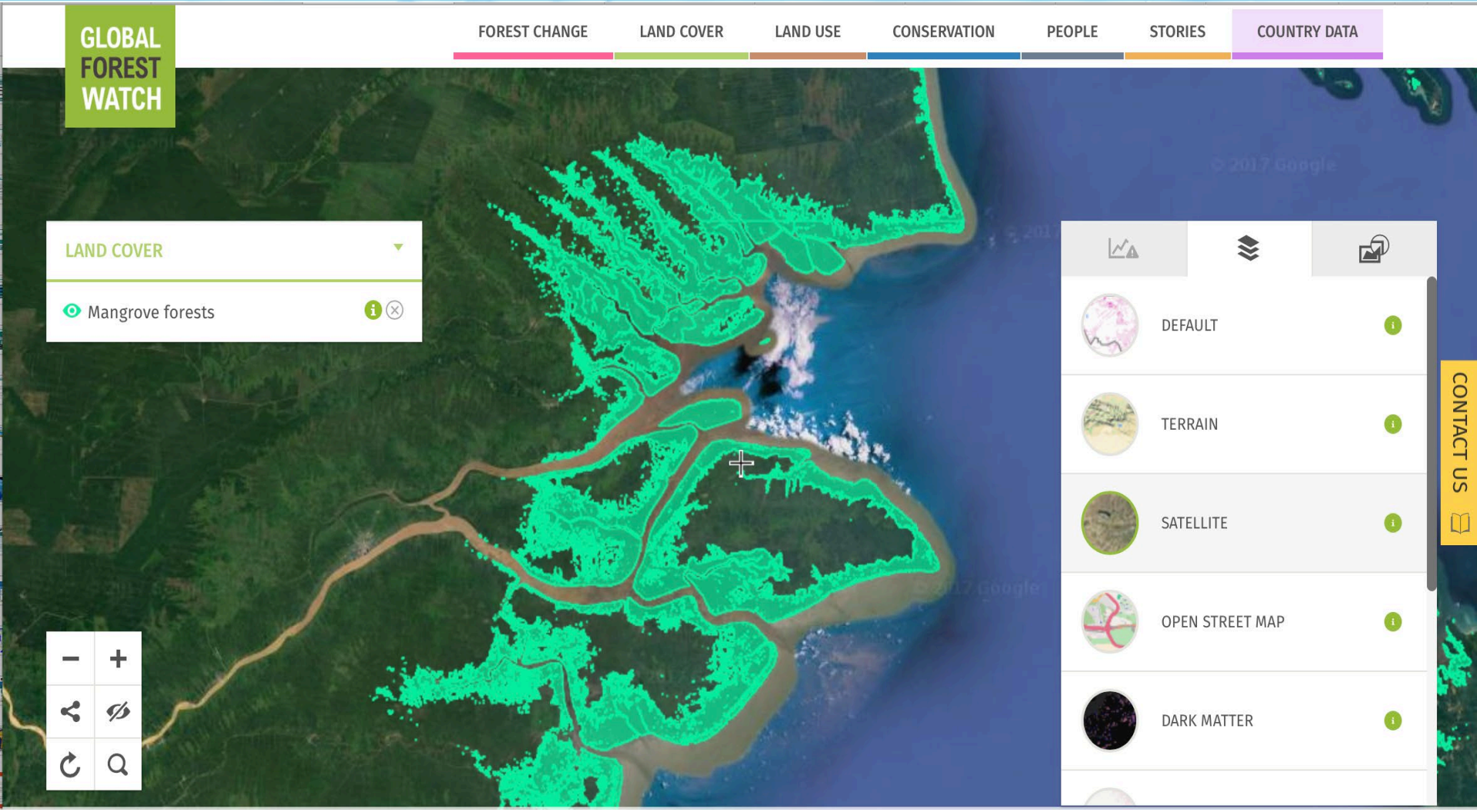
Target 6.6	Indicator 6.6.1	EO support
"Water-related ecosystems"	Indicator: 6.6.1 Change in the extent of water-related ecosystems over time	Water-related ecosystems that are most amenable to EO include the spatial extent of wetlands as well as open water surfaces*

** Forest and drylands are also suitable to EO but being considered under Goal 15: Life on Land (cf. Indicator 15.1.1 and 15.3.1)*

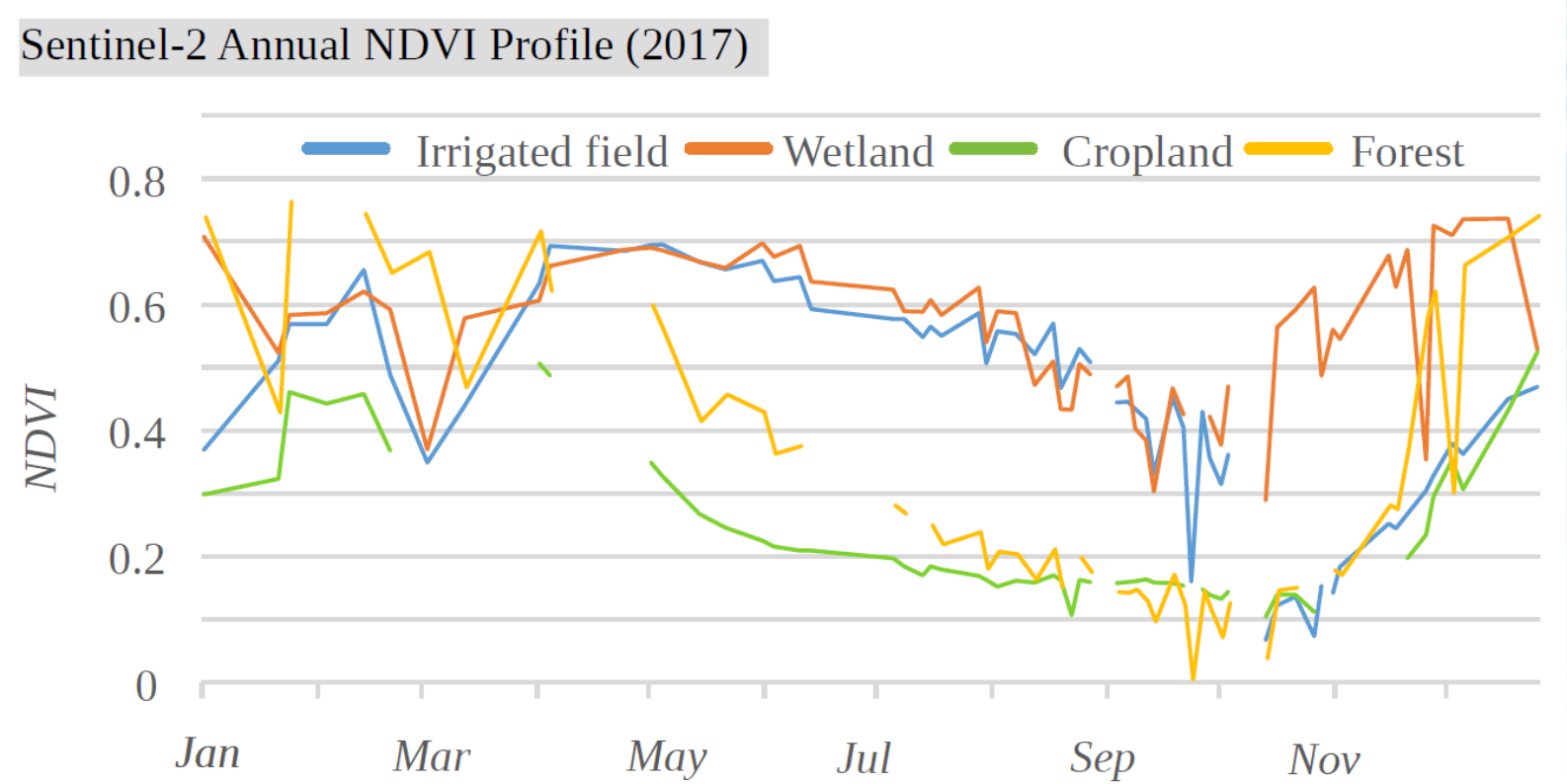
Towards high quality Global Data Sets at high resolution (10-30m)



Towards high quality Global Data Sets at high resolution (10-30m)

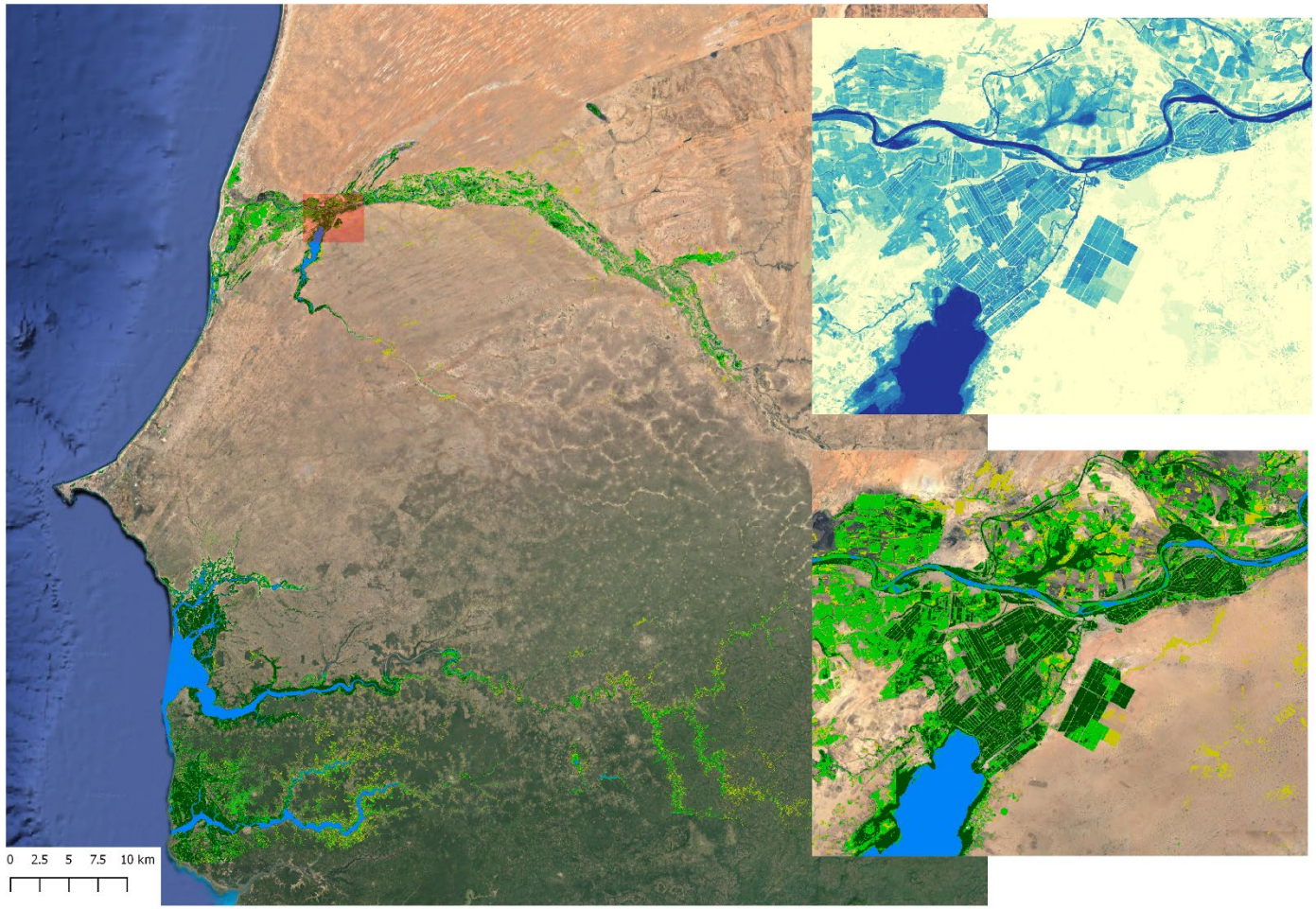


The value of high temporal information



+ Sentinel-1 for its weather-independent information on soil moisture and surface water

Senegal wetlands



(© GeoVille / GlobWetland Africa)

Earth Observation for Target 6.5: IWRM

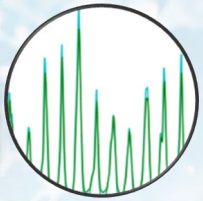
Target 6.5	Indicator 6.5.1	EO support
"Water resources management"	Indicator: 6.5.1 Degree of integrated water resources management implementation (0-100)	EO does not increase the degree of IWRM but can provide indirect support by providing operational capacity to establish harmonized transboundary water related information for IWRM

EO services overview

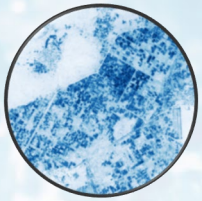
EO services for water resources management

Surface water monitoring

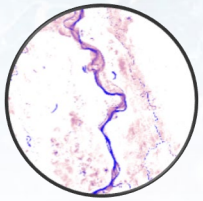
Water Quality and availability of reservoirs and lakes



Hydrological modelling and monitoring

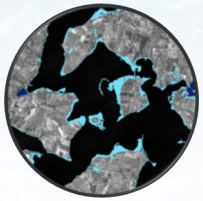


Modelling of crop water needs



Hydrological Network Mapping

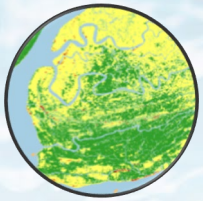
Industrial Activity Assessment



Natural Risk Management

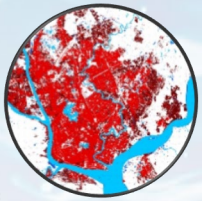
Groundwater mapping and exploitation

Supporting EO services

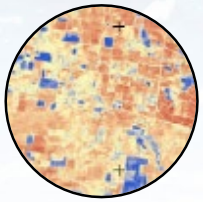


Land Use and Land Cover mapping and change mapping

Thematic mapping



Settlement characterization and change assessment



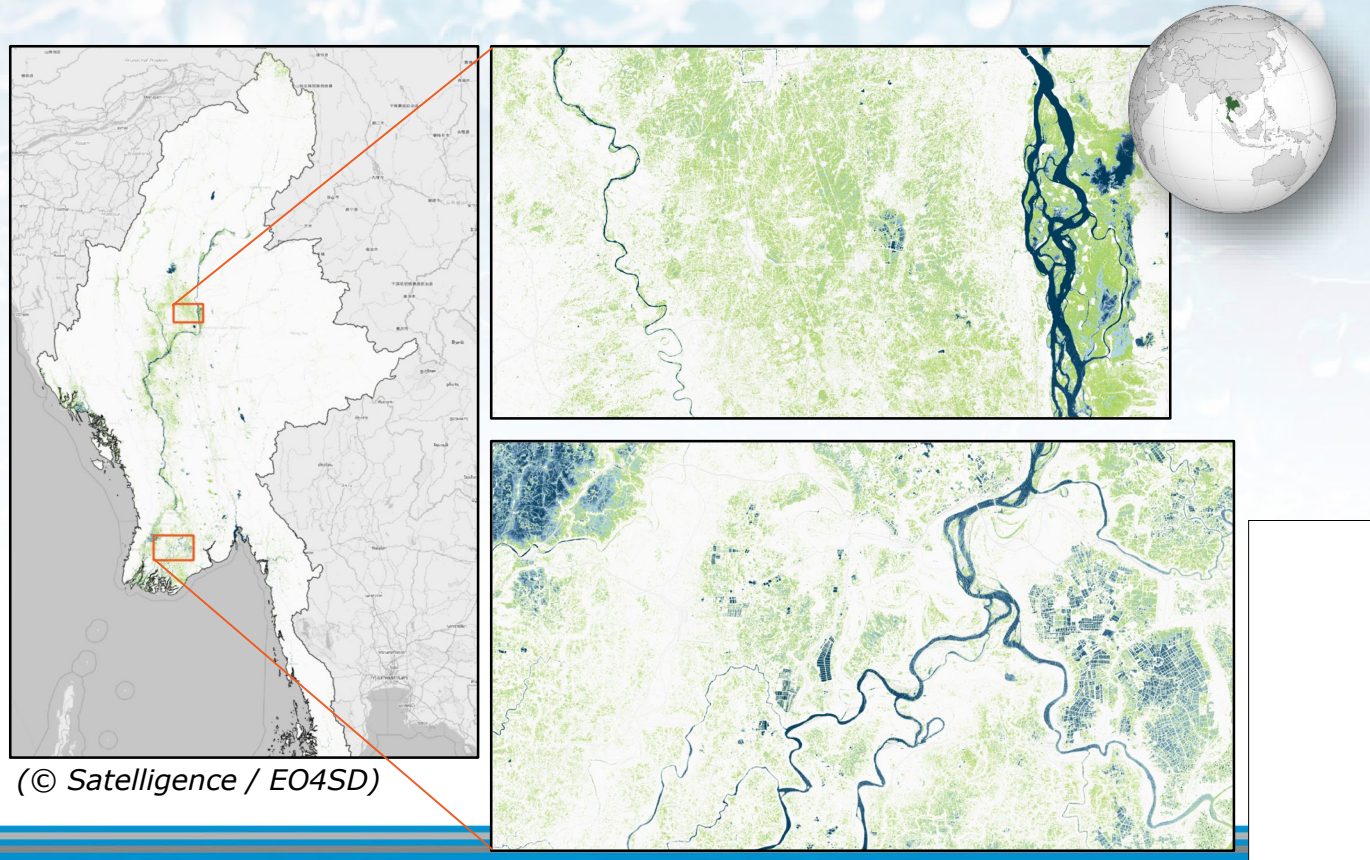
Mapping of actually irrigated land versus irrigable land

Crop mapping for agricultural water demand assessment

High-resolution digital elevation models

Surface water monitoring
Identifying flood prone areas in Myanmar

- Official measurements of water resources is limited to major dams and river flow stations yet this only represent a small portion of the overall water
- Regular and systematic EO data acquisitions provides an efficient tool for monitoring the status of all surface water resources for storage capacity assessment, planning and management

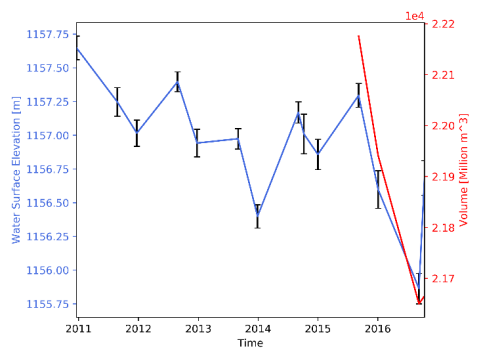


(© Satelligence / EO4SD)

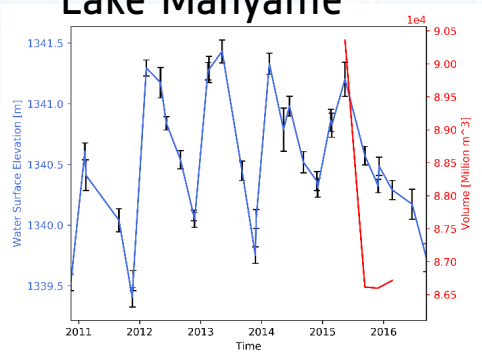
➢ Seasonal information on inundation patterns are of high importance for planning- and management purposes in Myanmar

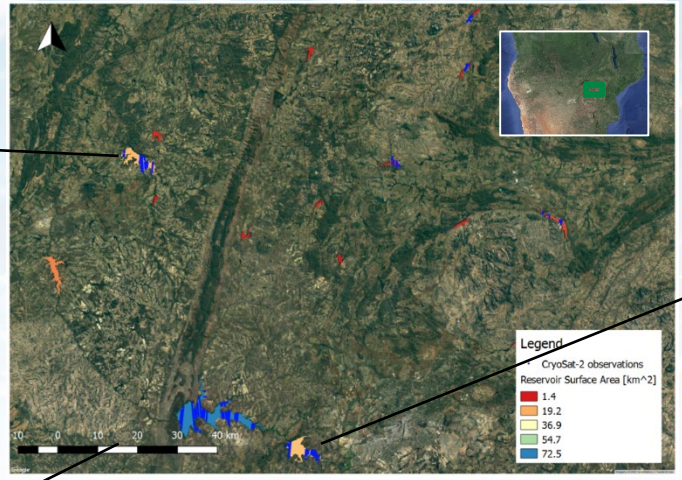
Water levels
Reservoirs in a subset of the Kariba-Tete

Mazvikadei



Lake Manyame





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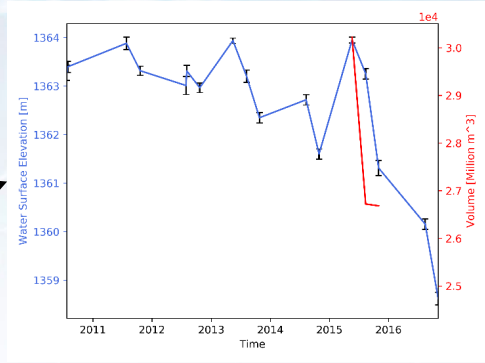
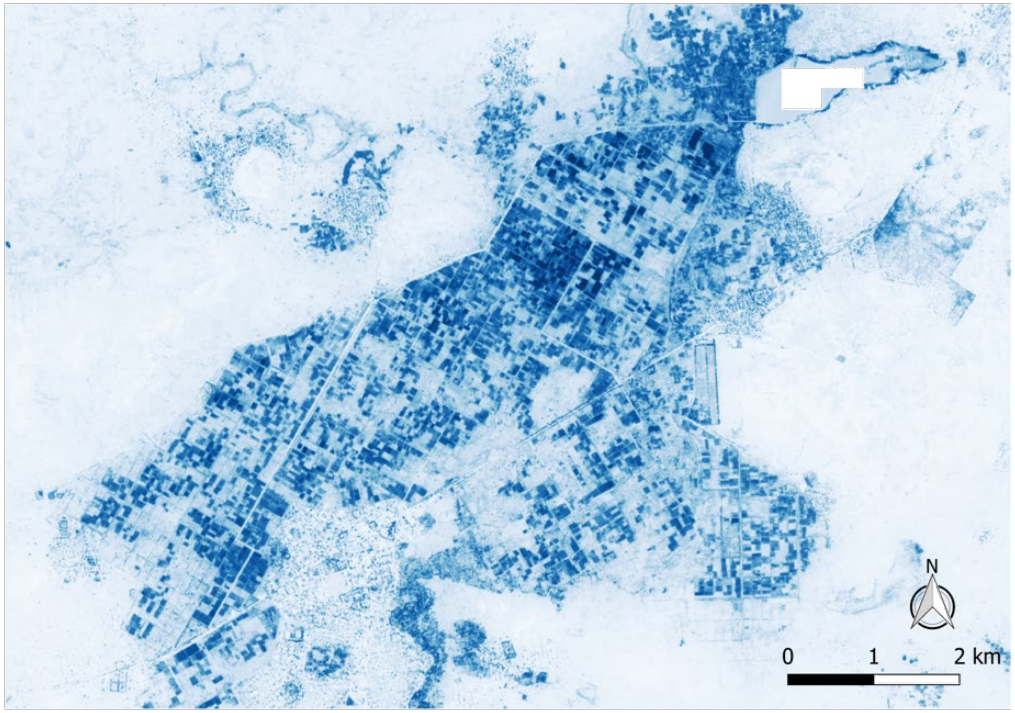
Lake Chivero



Irrigation management

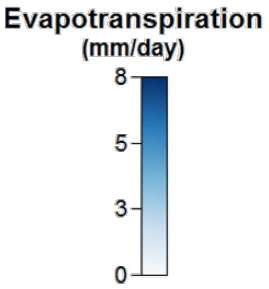
EO tools for assessing irrigation performance

- EO-based estimations of evapotranspiration (ET) is key to understand agricultural water use; provided at two levels to look at water consumption between irrigation schemes (regional level) and within irrigation schemes



Provide updated crop water and productivity information in order to evaluate:

- the water use efficiency (crop water use vs pumped water)
- productivity (crop water use vs production)
- Crop water deficit



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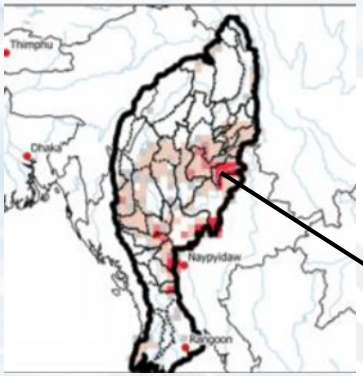
Natural Risk Management - Droughts

Myanmar drought and crop water portal



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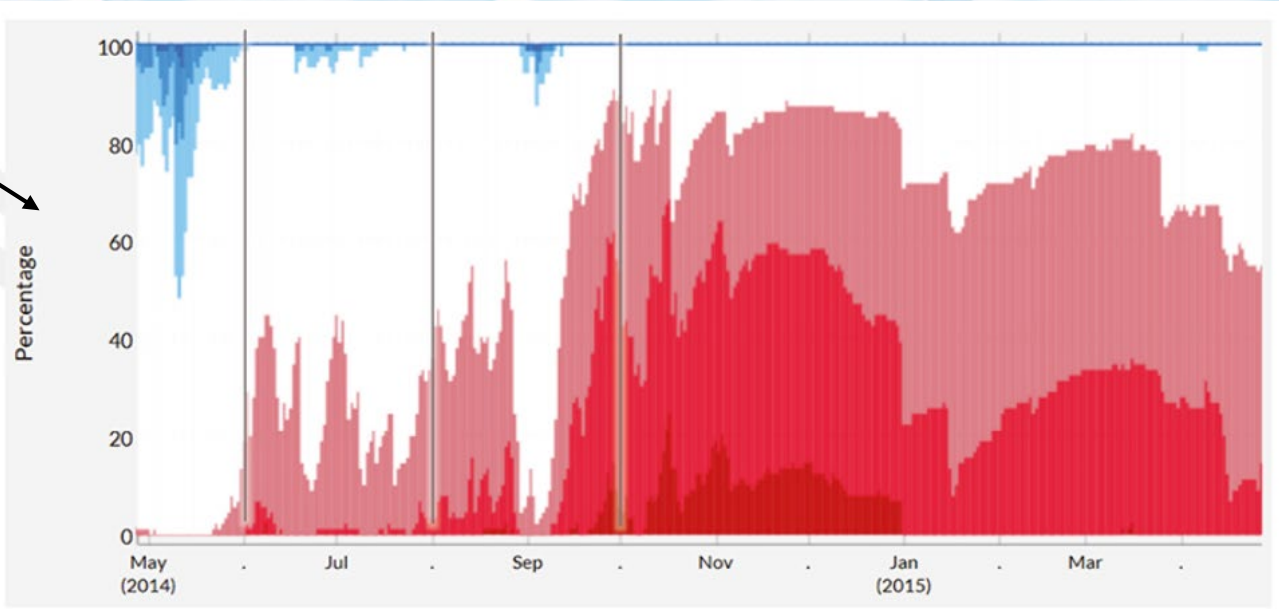
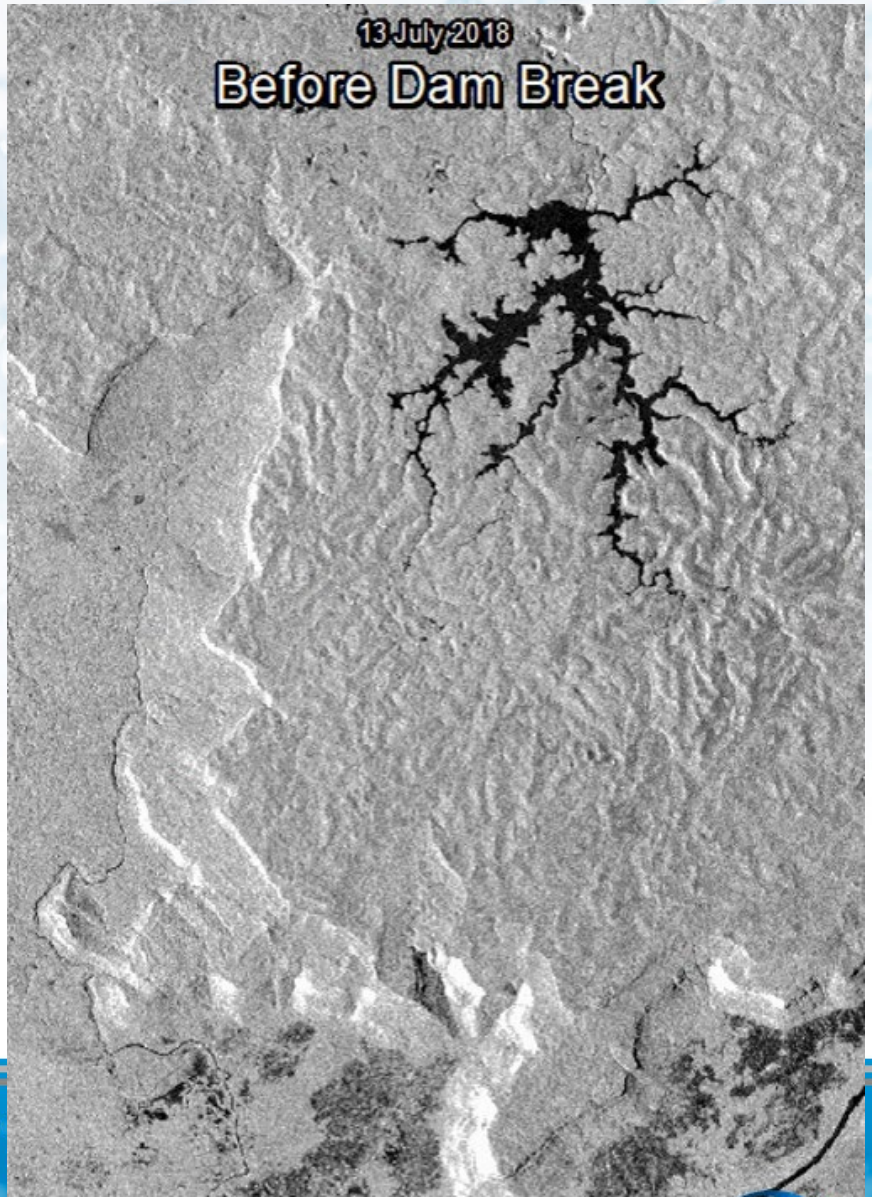
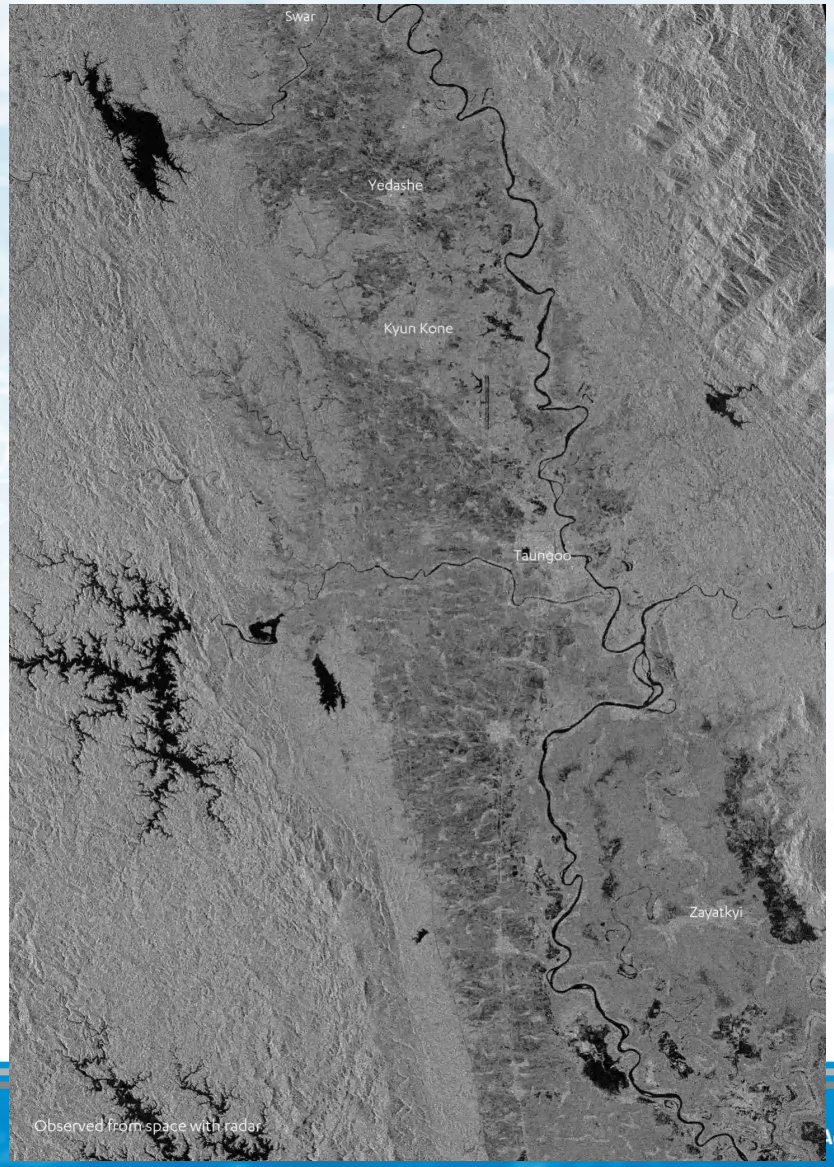


	Extreme dry		Very dry		Moderate dry		Normal	
	%	km²	%	km²	%	km²	%	km²
June 2014	0	0	2	900	26	11 700	72	32 400
Aug 2014	0	0	3	1 350	32	14 400	64	28 800
Octo 2014	6	2 700	48	21 600	36	16 200	10	4 500

Natural Risk Management - Floods

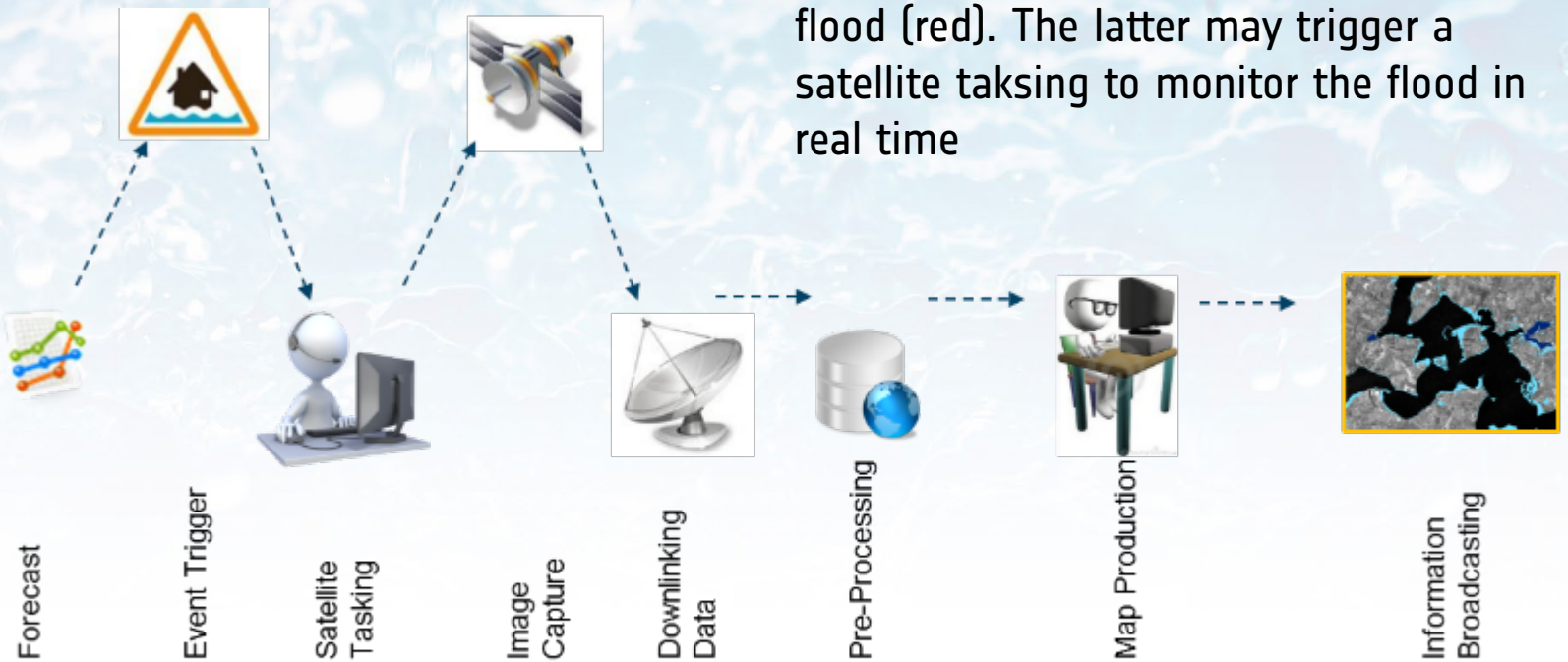
Recent Dam breaks in Lao and Myanmar



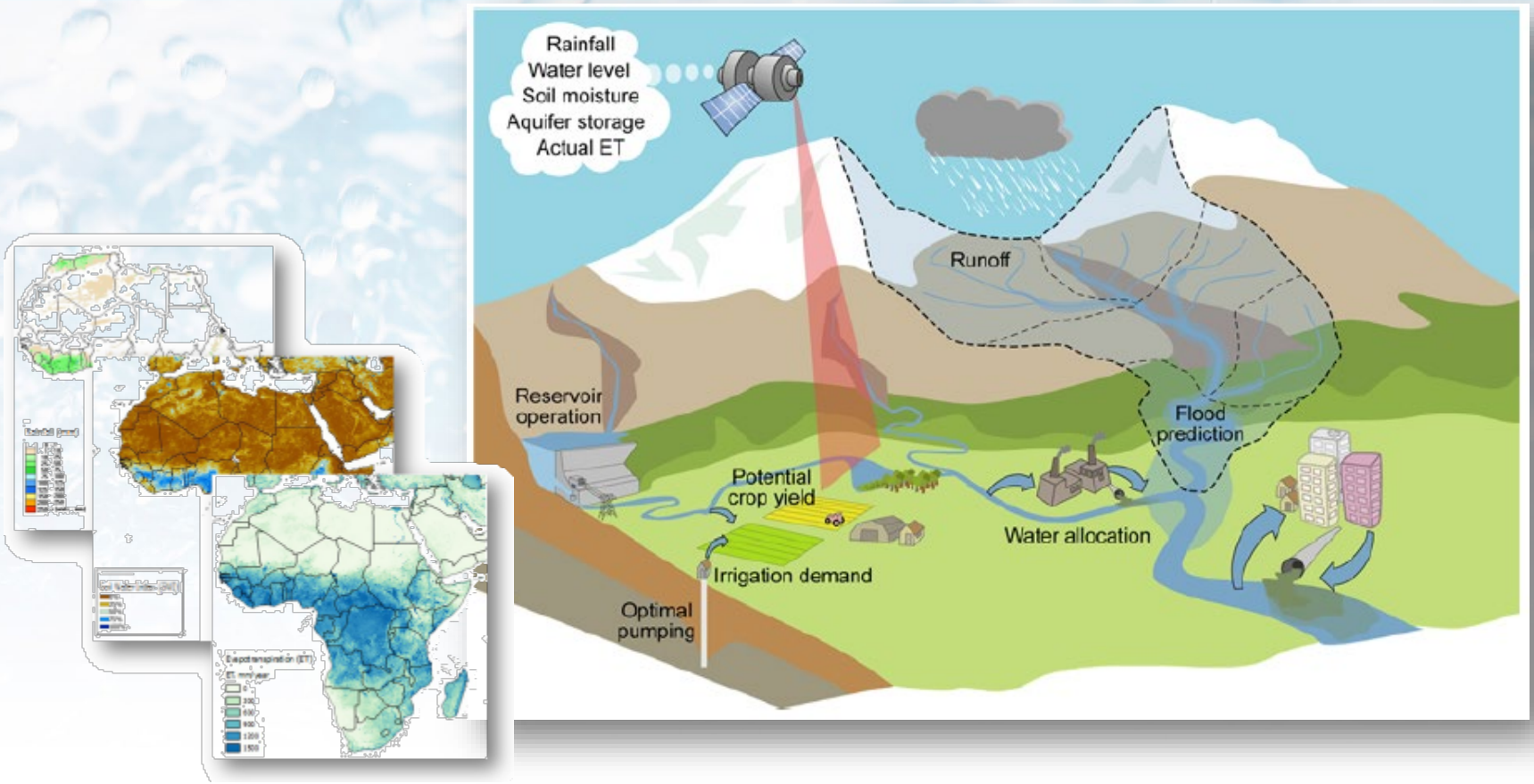


Link to forecast system

- implemented with traffic like notifiction i.e. no flood (green), some likelihood for flood (yellow) and high likelihood for flood (red). The latter may trigger a satellite taksing to monitor the flood in real time

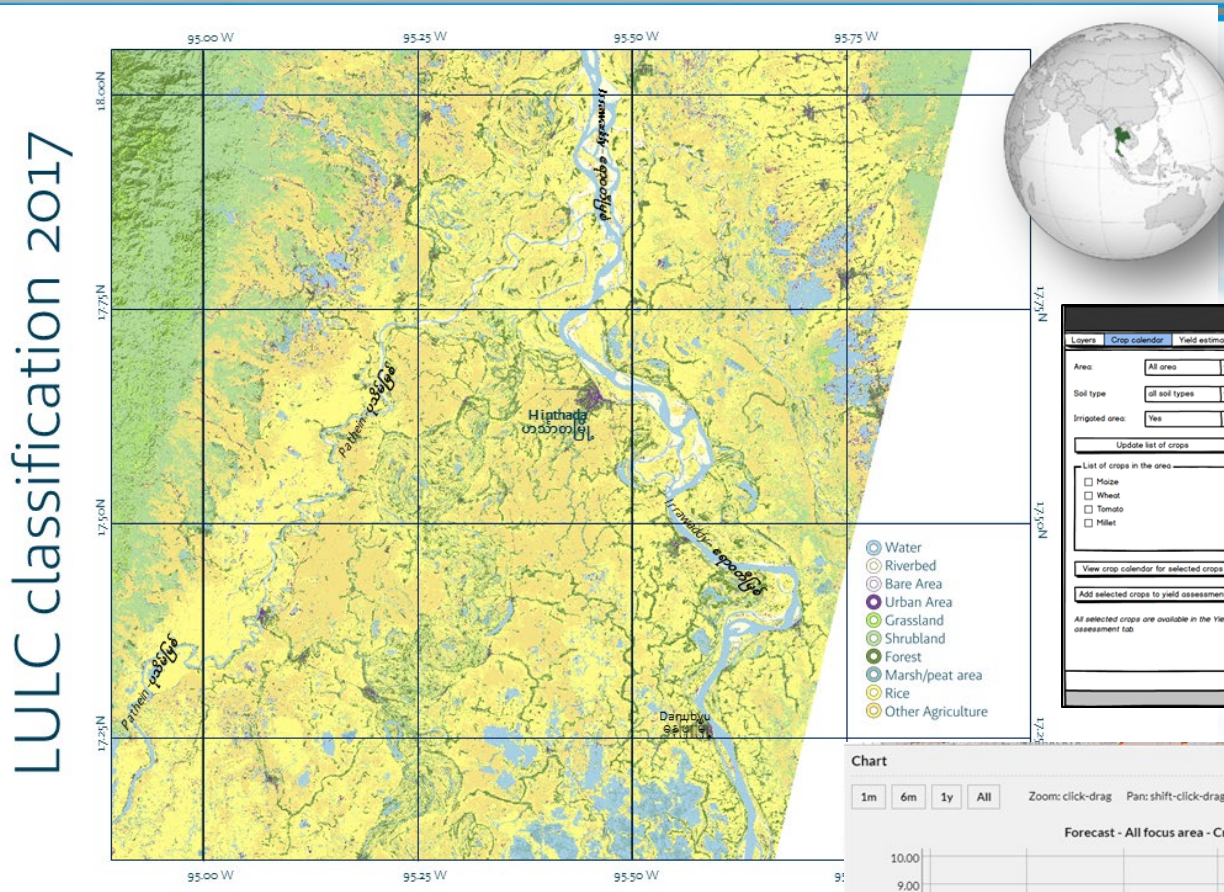


Hydrological modelling for improved water ressource management



- *Earth Observation (EO) is recognized as a reliable and cost-effective technique for provision of timely observations and information products that support water resources management in large and poorly gauged river basins. Such data are also extremely valuable for the calibration and validation of hydrologic simulation models.*

Application #1: Crop water demand and yield prediction



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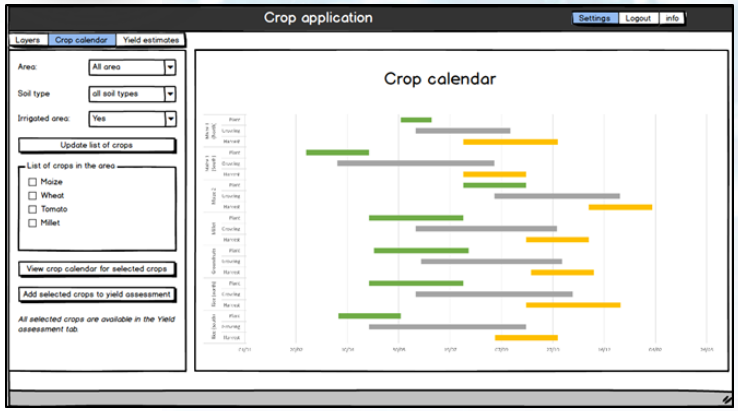
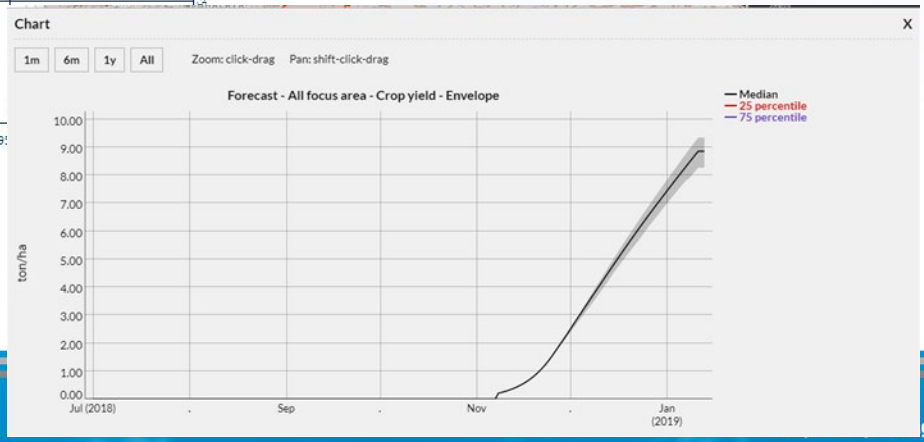
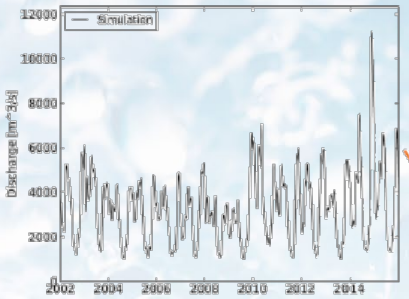
- **EO input**
  - Crop map
  - Climate data

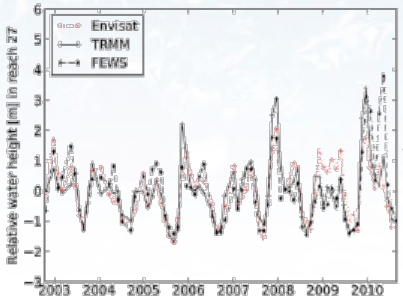


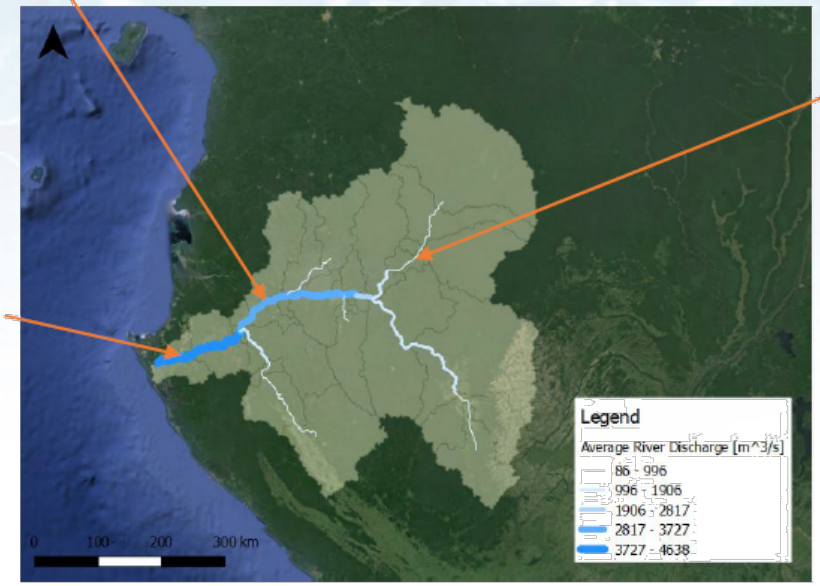


Application #2: Predition of river flow

- Spatio-temporal characterisation of discharge and water height







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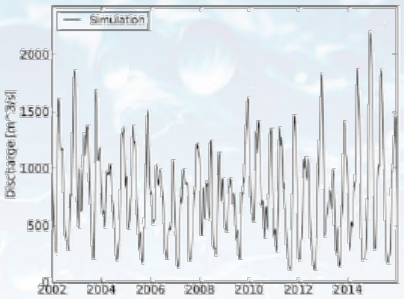
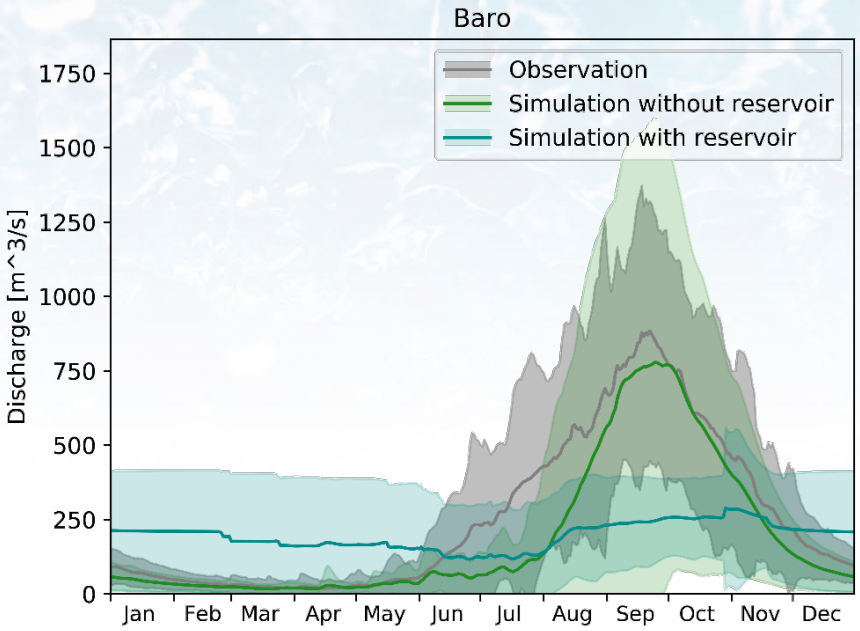


- **EO input**
  - Climate data
  - DEM
  - Water levels
  - Water mask
  - GRACE

Application #3: Scenarios

- Hydrological models allow for scenario analysis of changes in response to e.g. climate change and hydropower development.



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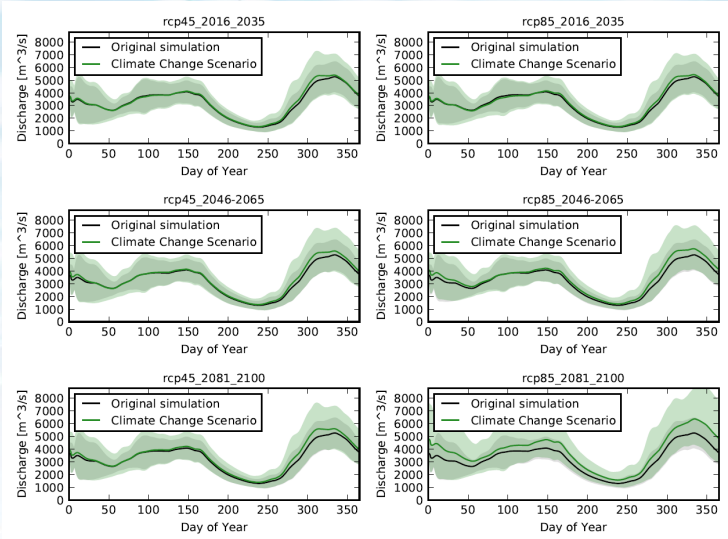
Climate change scenarios for Ogooué river



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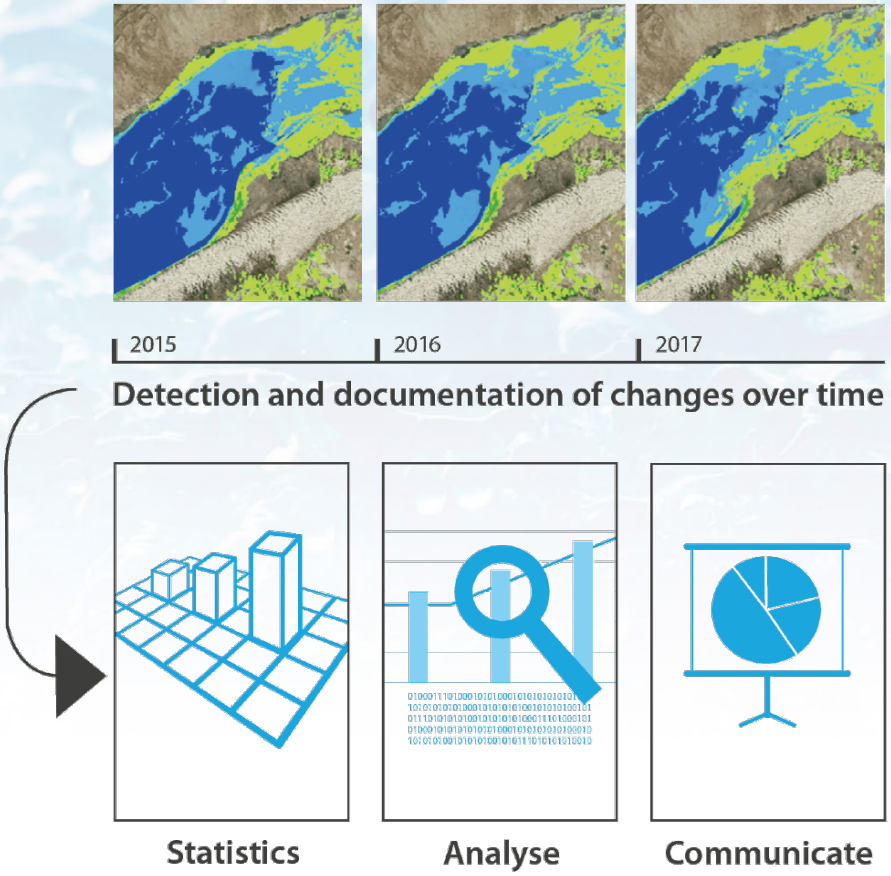
Simulation of new hydraulic infrastructure on the inner Niger delta the largest inland wetland in West Africa

Summary

- The ability to observe the dynamics of water resources over time is essential to support activities such drought mitigation, irrigation management and planning of infrastructure investment (e.g. dam constructions)
- Regular and systematic EO data acquisitions (combined with modelling tools) provides an efficient tool for statistical reporting, analysis and communication on the status of surface water resources



Enabling EO based national monitoring

- Member States own SDG monitoring and reporting but lack of data, appropriate information and challenges in human and institutional capacity put a serious constraint on effective monitoring and tracking of progress for SDGs in many low- and lower-middle income countries
- There is a need to recognize the critical importance of supporting developing countries in strengthening the capacity of national statistical offices and data systems to ensure access to high quality, timely and reliable and data
- Flexible methodologies for Member States to enter monitoring in line with national capacity and resource availability i.e. start simple and advance progressively as capacity and resources increase
  (cf. progressive monitoring)

Capacity Building

Sustainability through Free data & Open Source

- The main goal of the capacity building efforts will be to ensure the development of the required human, technical and institutional capacity needed to empower stakeholders with the ability to utilize the developed services in an independent and sustainable manner.
  - User workshops
  - Training courses
  - Awareness events
  - Webinars/online learning

- Powerful and user friendly Open Source GIS QGIS provides capabilities for data viewing, editing, analysis and presentation

- A common architecture for Sentinel processing and analysis

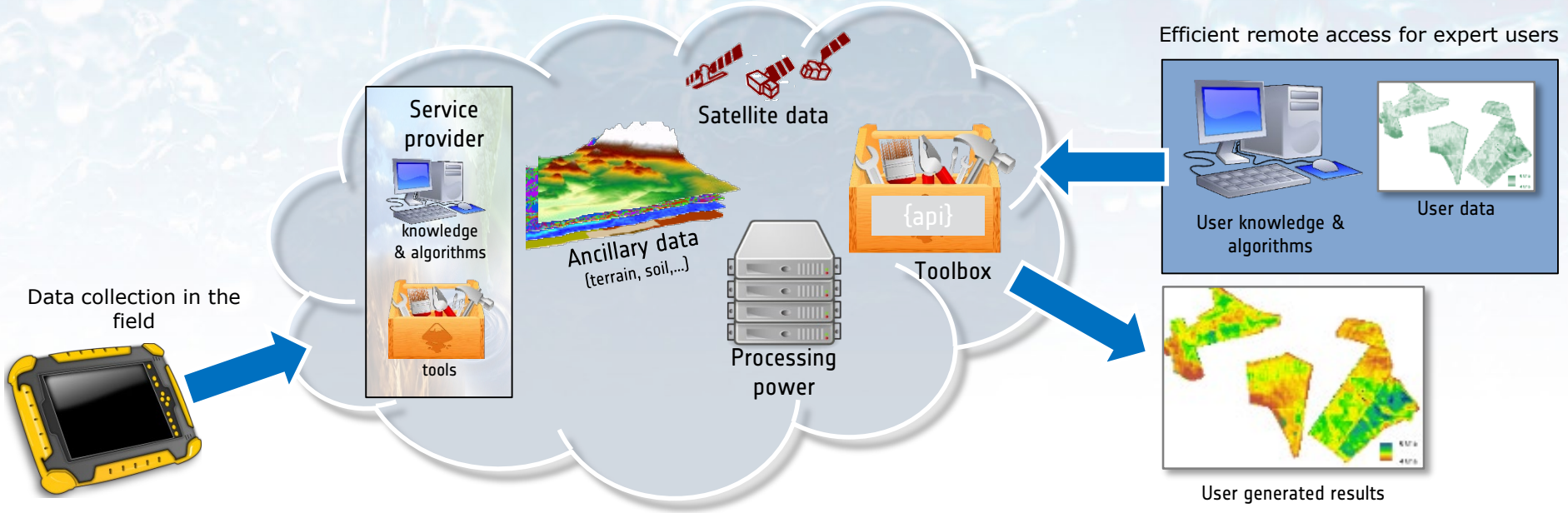
- For the exploitation of Sentinel-2 for local to national operational agricultural monitoring

- Enable water authorities to improve IWRM by exploiting EO technology
  - Transboundary Observation Capacity
  - Transparent tool for Reporting & IWRM

Towards efficient “big data” exploitation platforms

The power of the Cloud
“Bringing the users to the data”

The massive size of EO data generated by today´s sensors, in the order of daily Terabytes, means that cost-effective procurement of the computing infrastructure for archiving and processing is needed

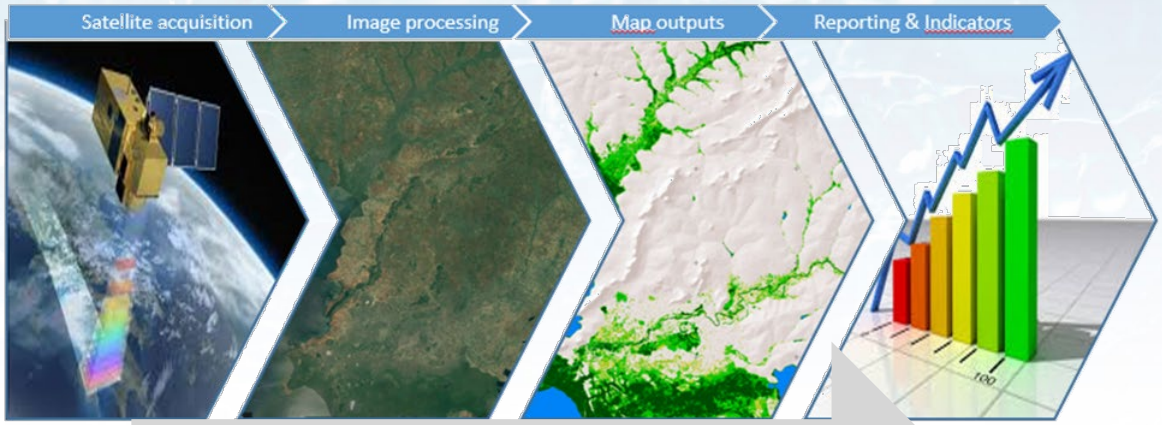


Demonstration: SDG support Uganda

Wetlands Monitoring with Earth Observation Data

SDG reporting on indicator 6.6.1

- Full national wetland inventory for Uganda based on Sentinel data
- Development of a user-friendly digital system for Ugandan authorities to monitor and report on national wetland resources

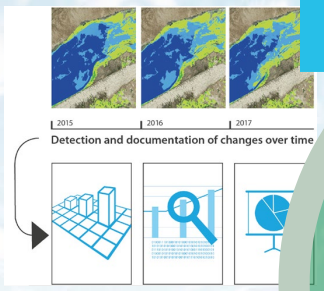


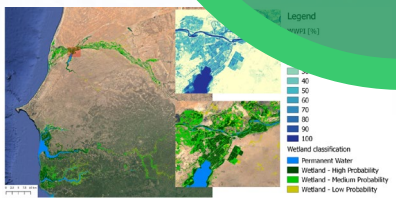
GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT DATA

Bringing it all together!

Front-end:
Visualization and reporting

Indicator 6.6.1





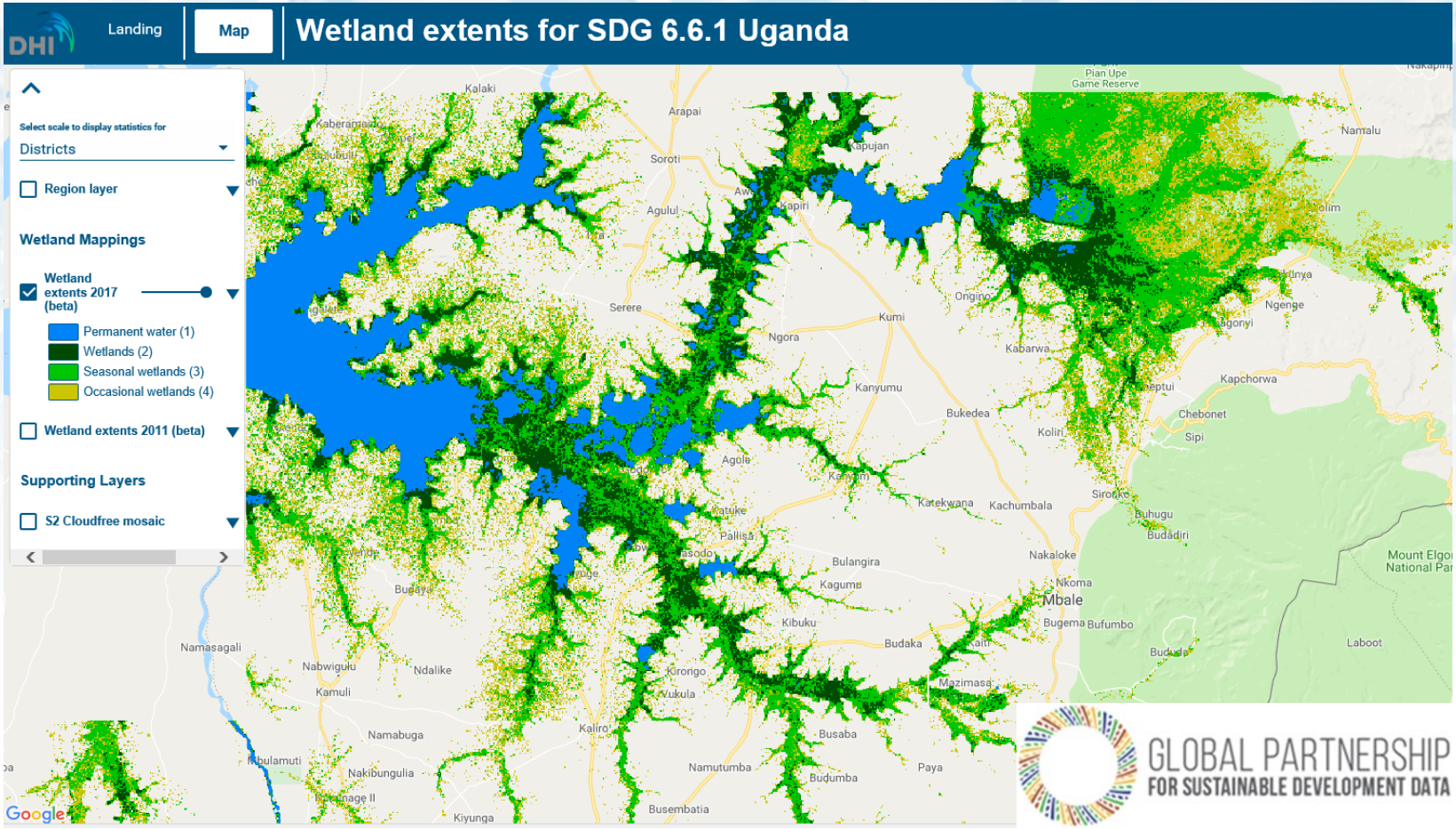
Back-end:
Image processing and statistics

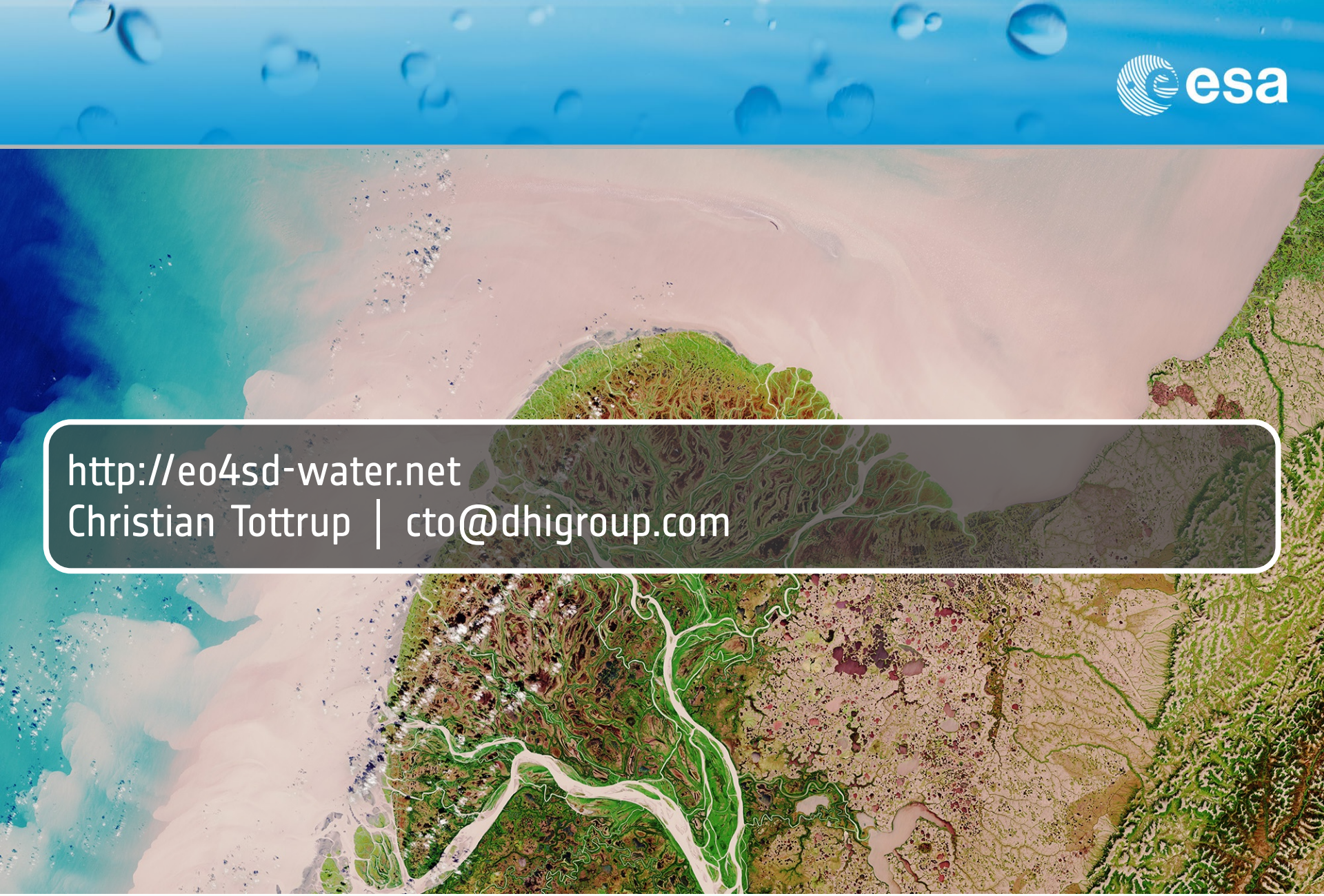
GLOBAL PARTNERSHIP
FOR SUSTAINABLE DEVELOPMENT DATA

Wetlands Monitoring with Earth Observation Data

SDG reporting on indicator 6.6.1

http://uganda-wetlands.dhigroup.com/





http://eo4sd-water.net
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