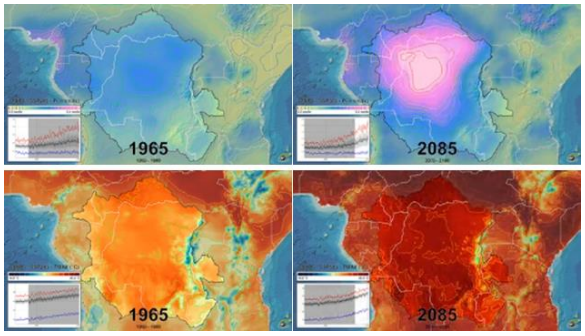
Space-based solutions for Disaster management: Climate Monitoring, Modelling and Adaptation

Newspace 2024, Luanda (Angola)
Thursday 4th April 2024

1. Please provide an overview of the company's offerings and how they leverage satellite data and remote sensing technologies to support climate monitoring, disaster risk reduction, and environmental management in Africa.

Climate model data - AfEOS and VisioTerra have gathered data from the 6th phase of CMIP6 managed by IPCC of precipitation (PR), night temperatures (TMIN), day temperatures (TMAX) according to two scenarios SSP245 and SSP585 calculated between 1950 and 2100 at the global level (see world or *monde*).

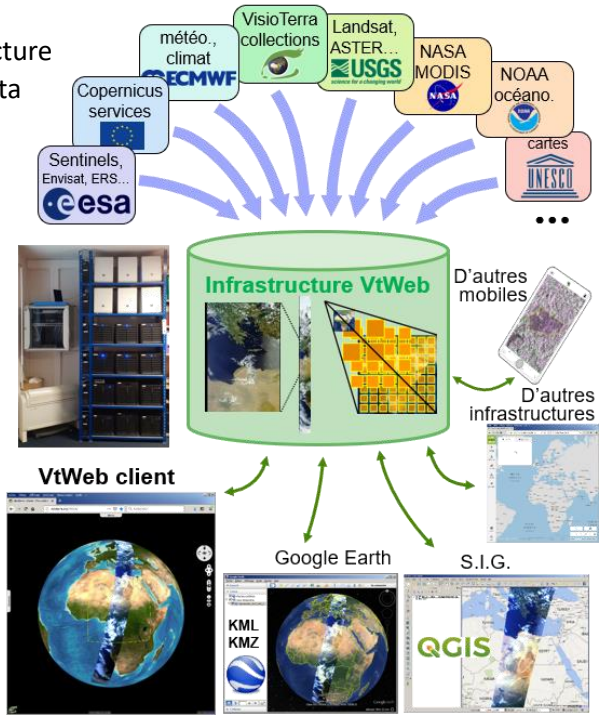


Artificial Intelligence (AI) processing has made it possible to increase the spatial resolution to analyse climate change at the level of a country, a province or a sub-region. The study carried out in the Congo Basin (see the attached figure showing the precipitation and diurnal temperatures from 1965 to 2085 available on video in English or *French*) shows that the **impact of climate change is and will be much more severe on the African continent than in the rest of the world!**

Data access - With VisioTerra, AfEOS has developed the VtWeb infrastructure allowing access to a wide variety of archive and near real-time (NRT) data:

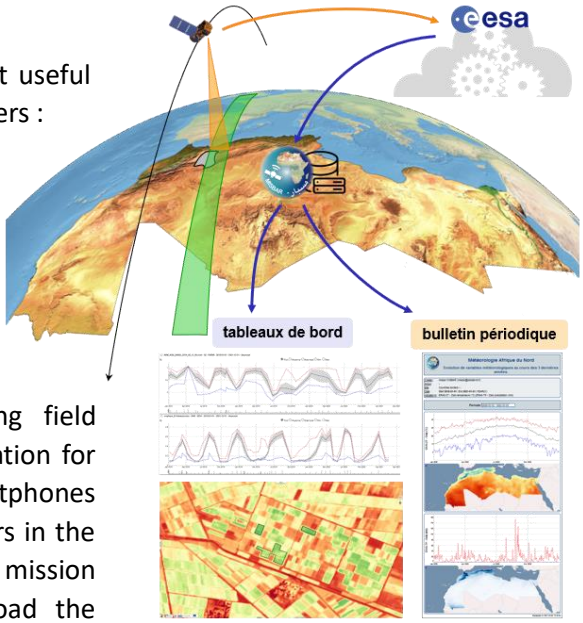
- **Earth observations** - Earth observations - Copernicus Sentinels (radar, optical, thermal, altimeter, atmospheric chemistry... from ESA, Landsat (Nasa/USGS), ALOS (Jaxa), SPOT...
- **Models** - Copernicus services (CMEMS, CAMS, C3S, CLMS, CEMS), Digital Elevation Models, hydrology, toponymy, meteorology, climatology, geology, pedologic, LU/LC (land use and occupation) ...

Infrastructure - To combat the **digital divide**, our VtWeb infrastructure is a **Data Processing Relay** that processes terabytes of heavy data from data providers and **processes it on the fly using POF-ML scripts** (Processing On-the-Fly Macro Language) to return lightweight data (tiles, vectors, statistical values) to HTTP clients. The hardware infrastructure has 1 petabyte (PB) of disks and a 1 gigabit per second (1 Gb/s) fiber optic link. **It is this type of infrastructure that was delivered as part of our three GMES&Africa projects: MISBAR, CAFWS and GERNAC.**



In future versions currently under development, we will introduce **DaMiNo** (Data Mining Nodes) which will run geoservices in data providers' edge virtual machines. This new type of data access will save the product downloading phase, and therefore be faster in the event of emergency management

during disasters: geoservices usable in real time by a "**crisis unit**".

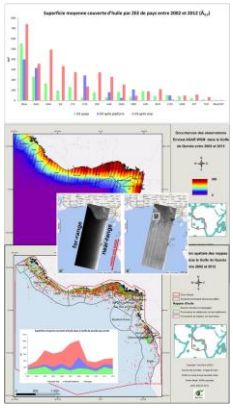


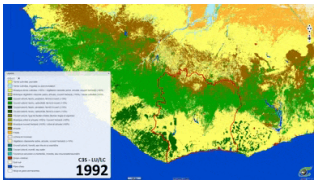
Géoservices - Geoservices are intended not to provide data but useful **information** in **areas of interest** and the **domain of interest** of users : agriculture, irrigation, active fires, burned areas, ¬deforestation, ¬floods, marine pollution... These Information is delivered in the form of **dashboards**, **periodic bulletins** and **alerts**. Areas of interest can be defined **at all scales** ranging from plot, province, nation, sub-region to continent.

Smartphone solutions - For several applications, AfEOS and VisioTerra have developed **smartphone applications** allowing field missions to be carried out without Internet coverage (deforestation for CAFWS or navigation assistance for GERNAC). These smartphones prepare the mission by synchronizing with the server, guide users in the field and allow **in-situ observations** to be brought back from the mission in a collaborative manner. On return, the applications upload the observations and allow you to edit a **mission report**.

Trainings - AfEOS and its partner VisioTerra offer videoconference or in-situ training which can include **field missions**.

Communication - VisioTerra and AfEOS publish a **newsletter** which reports on collaborations in the academic fields, research, platform development, cartographic studies... See one of the 2023 editions.



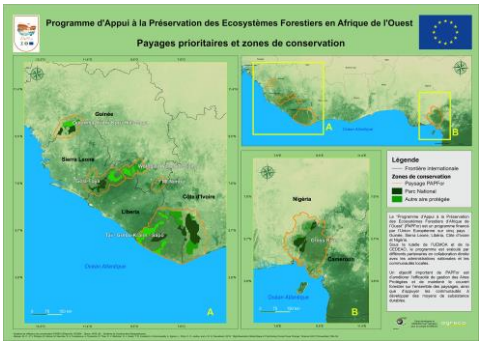


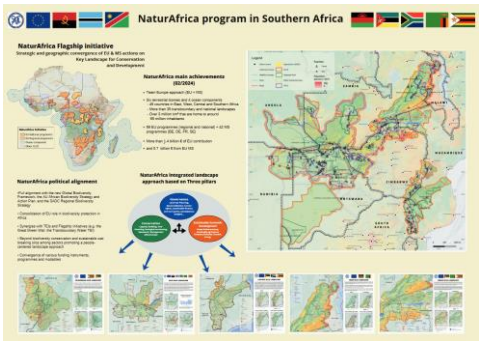
As part of the Sentinel Vision project for ESA, more than 1,300 stories were produced, many of which recount events occurring in Africa.

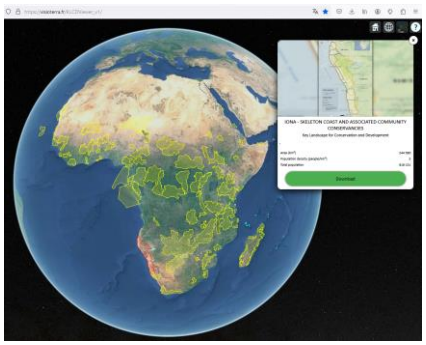
Studies and cartography - We have also carried out several studies for NGOs, institutes, private companies, the European Union, UNEP... by reanalysing **archive** data over the long term: -coffee plantations seen from the space, -deforestation due to gold panning, -changes in land use in and around protected areas, -monitoring of oil slicks in the Gulf of Guinea... For several of these projects,

we collaborated with academics African and European countries and welcomed African students as part of internships.

See for example PAPFor (Support Program for the Preservation of Forest Ecosystems in West Africa), the mapping of KLCD (Key Landscape Conservation and Development) as part of the **Green Deal**



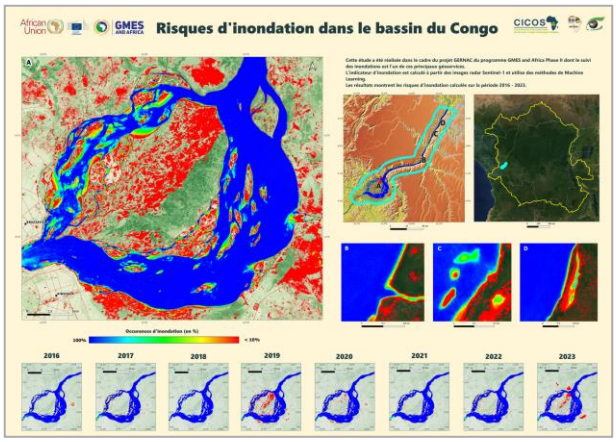


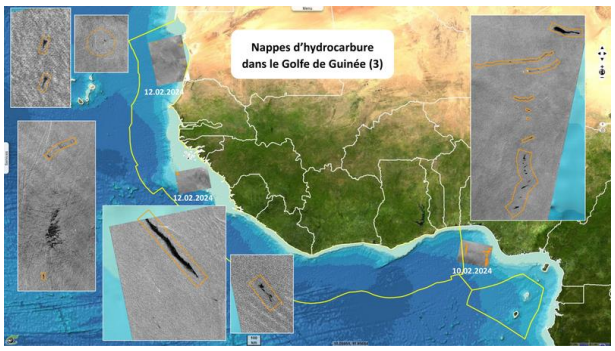


program and its **NaturAfrica** component of the Union European.

2. Effective disaster response and recovery efforts rely heavily on timely and accurate information. How is Africa EO Services utilising satellite data and geospatial analysis to support emergency response operations, damage assessment, and post-disaster recovery efforts in Africa?

One distinguishes four types of activities in anticipation, in the short, medium and long terms:

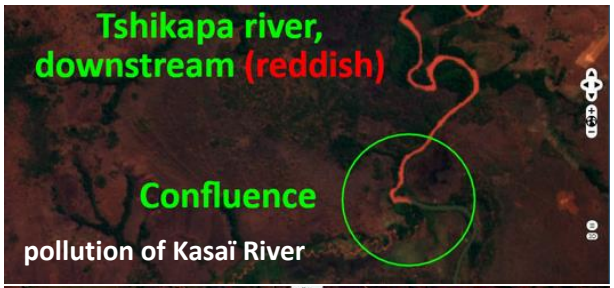


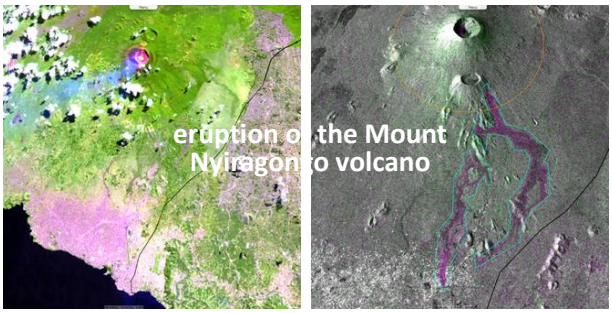


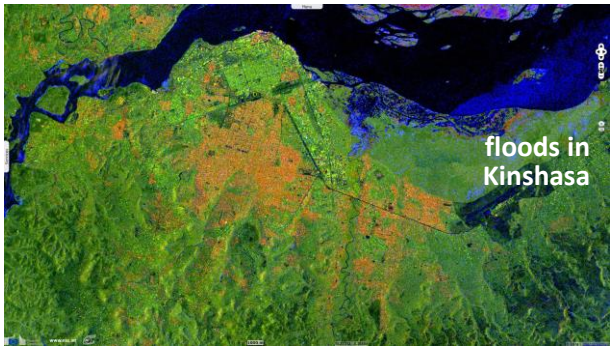
1. **Early warnings** - Observational data combined with models make it possible to anticipate risks. These models can rely on past observations; see for example the flood risk map along the Congo River produced as part of the GMES&Africa GERNAC project. In the future, **flood risk alerts** will be issued by analysing precipitation observed in upstream watersheds according to hydrodynamic models taking into account land use (LU/LC), density and nature of trees, slopes, soil porosity, etc. Other examples concern -**landslides** depending on the nature of the soil, slopes, accumulation of precipitations…, -**bush fires** being triggered depending on the temperature of the ground. surface, soil humidity, species present, population density, transhumance activity, poaching... -**drift of oil spills** released by oil platforms or deballasting and whose trajectory is conditioned by ocean surface currents, wind fields...
2. **Support for crisis units** - As with the International Charter Space and Major Disasters, a Crisis Unit is set up by the authorities (generally the Civil Protection) which will centralize multi-source data in real-time. The CEMS (Copernicus Emergency Management Service) service is another way to find data relating to a disaster. The **VtWeb** platform provides access to Copernicus Sentinel satellite data in **Near Real Time** (**NRT**), i.e. within minutes when data are made available by ESA, which employs a few tens of minutes to several hours to prepare the products from satellite observation. In addition to observation data, VtWeb brings together maps to access

the site(s), DEMs and land use maps to evaluate accessibility, past or future precipitation data...

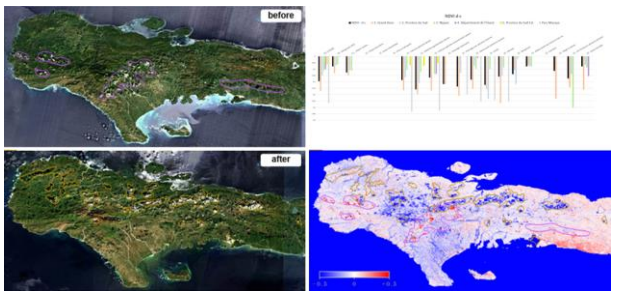
AfEOS and VisioTerra used VtWeb in several circumstances at the request of national institutes:
-**CRREBaC** in DRC for monitoring **pollution of the Kasaï river** due to the collapse of a heavy metal basin in a diamond mine in Angola and which caused several dozen deaths (see opposite and the story EVT-919 which demonstrates the responsibility of this mine),
-**ERAIFT** in DRC for **monitoring floods of the Congo River** which submerged a large part of the capital Kinshasa (see the attached figure and the story SED-565)...
Other disasters were followed by VisioTerra & AfEOS:
-**Eruption of the Mount Nyiragongo volcano** threatening the city of Goma in the DRC (see the attached optical and radar images extracted from the story EVT-875),
-**Landslides** around Lake Kivu (DRC, Uganda, Rwanda) which caused several deaths (see story SED-1284)...



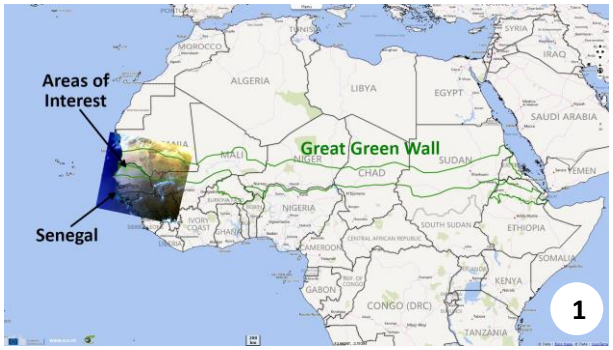




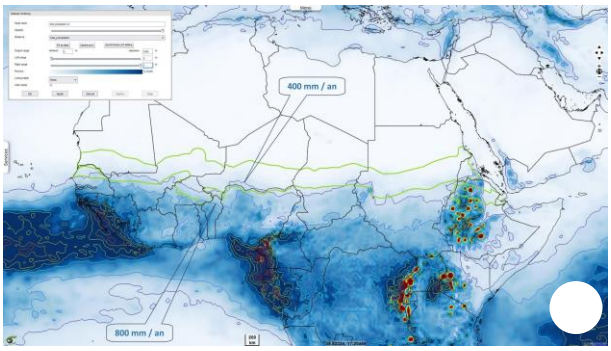
3. **Damage assessment** - In the weeks following the disaster, it is necessary to assess the damage and losses in order to plan restoration actions and compensate the victims (requests from insurance companies and international support organisations). The example opposite shows an assessment of crop and vegetation losses following Hurricane Matthew in Haiti. This assessment was carried out at the request of UNEP. The situation observed by the satellites **before and after the disaster** is used to calculate vegetation loss **statistics** within user-defined areas (provinces, communes…).

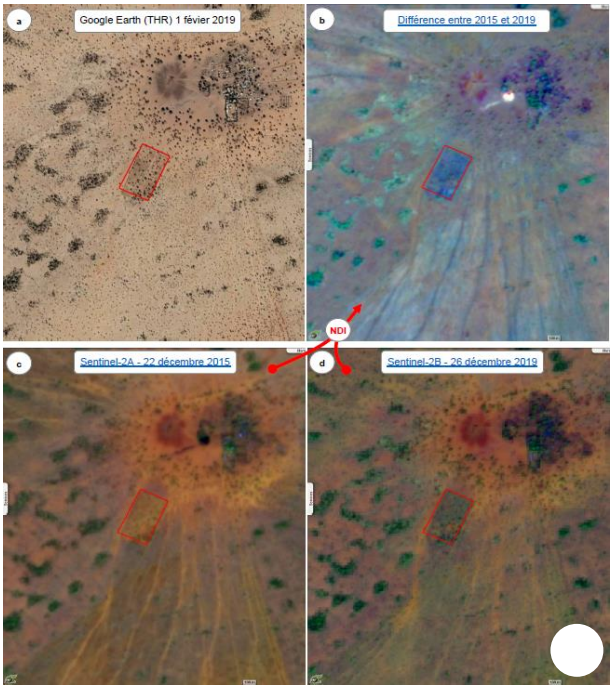


4. **Ecosystem recovery** - The restoration of ecosystems degraded by a disaster can be observed by satellites. Restoration efforts carried out by humans can be quantified by measuring the evolution over time of **biogeophysical variables** (vegetation indicators, humidity, leaf area index, biomass, open water, change in land use...) observed from space.

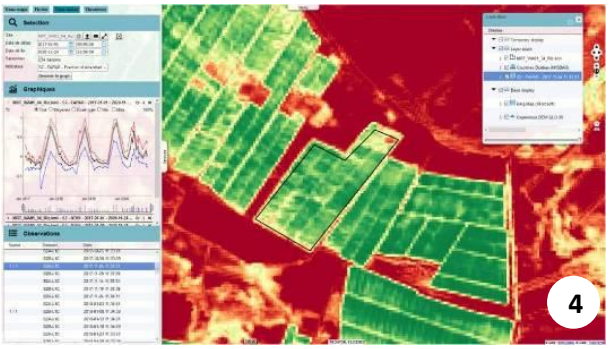


VisioTerra and AfEOS support, for example, the efforts made by the 13 countries of the **Great Green Wall** to fight against the advance of the desert through reforestation/afforestation practices, the maintenance of reforestation plots, multi-purpose gardens, the implementation plot protections... Several studies such as "Senegal: the Great Green Wall seen by Sentinel-2", "Monitoring of the Tankouri bocage perimeter in Burkina Faso", "MISBAR Platform - Sustainable land and water management in North Africa" as well as stories were produced (EVT 739, EVT 891 and EVT 1071) which demonstrate the performance of a future monitoring platform such as SIOBAP planned with the APGMV





The images opposite were extracted from the documents mentioned above and are produced by the VtWeb platform: (**1**) Limits of the Great Green Wall (GMV) as well as a Sentinel-3/OLCI scene observed on 03.19.2018. (**2**) Map of isohyets (isovalue curves of annual precipitation) whose value 400 mm/year determines the plot of the GMV. (**3**) Widou multipurpose garden in Senegal showing a- the Sentinel-2 image on 12/22/2015 then b on 12/26/2019 with c the difference showing the variation in vegetation. (**4**) Monitoring of irrigated agriculture in arid zones.



3. Climate change adaptation strategies require informed decision-making and long-term planning. Could you share Africa EO Services' approach to developing climate risk assessment tools and decision support systems that enable stakeholders and policymakers to analyse climate impacts and plan adaptation measures?

During COP15 in 2009 in Copenhagen, developed countries committed to mobilizing **$100 billion dollars** for developing countries to finance their actions to combat climate change. At least on the occasion of each UNFCCC COP, each country must therefore assess the cost of reducing their greenhouse gas emissions and adapting to climate change.

The **ClimAsset** application offered by VisioTerra and AfEOS aims to help the governments of each African country to:

- **Evaluate the evolution of essential climatic variables** (past and future in the short/medium/long term) such as temperatures, precipitation, drought, land use, water height, coastline, water quality, water quality. 'air...
- **Propose alternative solutions** such as changing crops, selecting other more resilient plant species in forests and savannahs, selecting other animal species, urban planning, developing tourism...
- **Present the implications of these alternatives** in terms of energy, development (roads, rail, navigation, ports, etc.), labour, infrastructure (schools, dispensaries, sanitation, etc.), needs in water / inputs / fodder / grasses...
- **Evaluate the cost of each alternative solution** at the country or region level by giving the user the possibility of selecting the chosen alternative.
- **Produce an "Adaptation Report"** including a description of the state of essential climate variables, the choices made, their implication, details of associated costs...

Expertise - This ambitious project would be developed in several phases by involving a number of global experts in adaptation to climate change but also experts from African countries to share experience of types of crops / livestock / development...

Technical solution - With the advent of Artificial Intelligence, solutions exist for multi-agent dynamic models of increasing complexity and which would correspond to the different versions of ClimAsset.

The ClimAsset application would be a **digital twin** which could be co-financed by the European Union as part of the Destination Earth (DestinE) program implemented by the European Space Agency.