Global Monitoring for Environment and Security and Africa (GMES & Africa)

OSS_North_Africa_ Land & Water

Earth Observation for Sustainable Land and Water Management in North Africa

TERMS OF REFERENCE FOR THE RECRUITMENT OF AN INDIVIDUAL CONSULTANT / CONSULTING FIRM FOR THE DEVELOPMENT OF OPERATIONAL EARTH OBSERVATION SERVICES FOR NATURAL RESOURCES MONITORING

This call of tenders targets the African private sector

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List of acronyms

ASAL	Agence Spatiale ALgérienne / Algerian Space Agency
AU	African Union
AUC	African Union Commission
CNCT	Centre National de Cartographie et de Télédétection /National Centre of Mapping and Remote Sensing
CRASTE-LF	Centre Régional Africain des Sciences et Technologies de l 'Espace en Langue Français / African Regional Centre for Space Science and Technology Education in French Language
CRTEAN	Centre Régional de Télédétection pour les Etats de l'Afrique du Nord / Regional Centre for Remote Sensing of North Africa States
CRTS	Royal Centre for Remote Sensing / Centre Royal de Télédétection Spatiale
DRC	Desert Research Centre
EO	Earth Observation
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
LCRSSS	Libyan Centre for Remote Sensing and Space Sciences
LULC	Land Use / Land Cover
OSS	Observatoire du Sahara et du Sahel / Sahara and Sahel Observatory
RS	Remote Sensing
SLM	Sustainable Land Management
SLWM	Sustainable Land and Water Management
UNA	Al-Asriya University of Nouakchott

1. Introduction

"Earth Observation for Sustainable Land and Water Management in North Africa is a project implemented by the OSS in collaboration with regional and national partners, specialized in remote sensing: ASAL (Algeria), DRC (Egypt), LCRSSS (Libya), CRTS (Morocco), AL-Aasriya University of Nouakchott (Mauritania) and CNCT (Tunisia) for the national level and CRTEAN and CRASTE-LF for the regional level.

The **overall objective** of this project is to support decision-making in sustainable natural resources and water management through the provision of products and services based on Earth Observation (EO) data and techniques.

Figure 1: Action zone of GMES North Africa Land and Water consortium

The following specific objectives will be achieved through:

- Developing and sustaining decision support services for natural resources and water managers;
- Boosting regional cooperation and promoting the know-how exchange on natural resources and water management in North Africa;
- Capacity-building and awareness-raising among all partners and end users on the potential and better consideration of technical data and Earth Observation applications.

Three services will be developed by the OSS consortium:

- Water Abstraction Surveillance, Monitoring and Assessment in Irrigated Areas
- Land Degradation Monitoring and Assessment
- Agriculture Seasonal Monitoring, Early Warning and Assessment

These ToRs are elaborated for the development of a multi-scale Decision Support System (DSS) for the three services at the regional level (North Africa) as well as at the pilot sites level. The DSS technical specifications are detailed in the annexes.

2. DSS Objectives

The main objective of this DSS is to strengthen North-African policy-makers', environment and agriculture and water resources manager's, planners', scientists' and citizens' capacities to assess and monitor land degradation, agriculture and water use for irrigation using geospatial technologies whilst promoting sustainable natural resources management through the use of Earth Observation data and related information.

The DSS will represent a platform to assess and analyse EO data to support monitoring and decision making, to deliver information in a used-friendly way whilst leveraging awareness raising among decision makers, water and natural resources managers and the general public. The DSS should be used operationally by technical staffs in charge of environment monitoring and agriculture and water resources managers for monitoring agriculture activities, water use for agriculture and land degradation assessment.

The ultimate water abstraction monitoring service objective is to provide insights on irrigated areas and water abstractions for agriculture purpose over the aquifer that can be compared to the recharge and the aquifer ability in order to better plan actions and direct decision making.

The land degradation monitoring service focus on the provision of evidence-based proofs on land degradation and its spatiotemporal distribution and therefore on the hotspots where priority action should be conducted or awareness-raising campaign should be planned.

The agriculture monitoring service targets the regular delivery of a timely information on crop monitoring and the agriculture campaign. This will allow the assessment of crop conditions and yield forecast, produce early warnings alerts of drought.

The consultant is expected to apply to each service independently, (one technical offer and one financial offer per service). It's possible to apply to the three services together, but the offers should be presented separately. In other words, for each service, an application including a detailed technical offer and a financial offer should be presented.

It is better for the DSS to be developed in open source license, so that it can be made available for the OSS and its GMES&Africa North Africa partners.

2.1. Design and Development

The DSS will provide a dashboard for interactive visualization of EO-related products in the three topics for different sets of users, ranging from decision makers (where summary information is displayed) to technical managers (who will analyse the georeferenced products). It will have two components:

- **Webservice**: allowing the time-series EO data collection, processing and analysis in order to produce, analyse and visualize interactively the products, in a user-friendly way, with a download and maps creation on the fly functionalities. The maps creation will be carried out intuitively with a predefined symbology for the different products
- **GIS plugin**: allowing the same functionalities as the web service, in a desktop environment allowing end-users wishing to undertake more advanced analysis to use their own data in GIS environment, without having to share them on the web.

Both solutions will include the same kit of functionalities. The Desktop-GIS option will allow technical staff to use the service for more advanced analysis without sharing their ancillary data.

The users can undertake interactive maps creation, including the products display with the predefined symbology and layout preparation for map generation. The default layout will take into consideration the GMES&Africa graphic chart (mainly the logos of the OSS, GMES&Africa, and AUC & EC). The service will also allow the maps exports (for their future use in reports and bulletins for example)

In order to guarantee the operational service delivery, the consultant will guarantee the delivery of the DSS, its deployment and maintenance, the development of technical guides and reports, the capacity building materials that will be used as supports for training the end-users on the service use.

The call will include also capacity building sessions for end-users in the six countries. The OSS and its partners will support in terms of logistics preparation and organization at the national level. The training plan and session contents will be developed in a collaborative approach

2.2. Service ownership

The developed tool is the property of the OSS and its partners and meant to be used at a larger scale by the partners and end-users in the framework of GMES&Africa and beyond. The system and its components will be fully used, maintained and upgraded by the GMES consortium, without requiring any additional rights requests or payment of any extra rights.

The OSS and its partners have the right to copy or distribute the system components to third parties, to upgrade it and to implement new algorithms and functionalities, without any prior permission or request.

2.3. Service feedback collections

The service is meant to evolve according to the growing end-users needs and to be interactive in a user-friendly way. If the service is malfunctioning or the products do not correspond to the end-user's expectations, the service users should have the possibility to contact the admin team and to provide their feedback.

The service must include a feedback collection and the technical offer must include a section describing how the consultant will handle the feedback collection and management... The Frequently Asked Questions (FAQs) section should be taken into consideration. The moderation service should be also described in the technical offer.

2.4. Service versioning

Based on the first prototype results and the growing end-users needs, the need for new functionalities, the processing customization and some pilot-sites specificities are expected to be raised. Therefore, the service is called to evolve. The versioning must be taken into consideration in the service development cycle.

In other words, the first prototype of the service will be tested by the GMES partners and presented to the end-users. Hence, the feedback collection will be carried out in order to reflect the needs in terms of functionalities, options and customization that will be handled to release the new version of the service.

2.5. Capacity building

Two types of capacity building will be provided in the framework of this call:

- Capacity building on the DSS administration / maintenance
- Capacity building on the DSS use in the 06 countries (see the countries member list above)

Since the DSS is the property of the OSS and its partners, their technical team should be able to secure its administration and maintenance. Therefore, the consultant should secure the full technological transfer of the DSS and its components to the OSS team.

The capacity building materials that will be used as supports for training the end-users on the service use will be developed in the framework of this consultancy, which includes also the organization of capacity building sessions for end-users in the six countries where the trainings on the service use will be conducted.

The OSS will support the trainings in terms of logistics preparation and organization at the national level. The training plan and session contents will be developed in a participatory approach.

3. Qualifications and experiences required

The consultant can be an individual consultant or a consulting firm.

The consultant and the Key staff to be mobilized by the consulting firm must have the qualifications following:

- PhD or postgraduate degree in computer science, geomatics, environment, agriculture, remote sensing, natural resource management and other related and relevant fields;
- At least 10 years of experience in remote sensing / environment.
- Solid experience in EO-derived application development, in Python for geospatial development, web interfaces design, EO data and products processing and analysis.

They shall also possess the following skills:

- Ability to work closely with a group of national and international experts, meet strict deadlines and plan work according to priorities;
- Excellent initiative, good analytical and synthesis skills, ethics and honesty;
- Good communication skills and the ability to interact productively in a teamwork environment.
- Fluency in French and/or English, knowledge of Arabic is a plus;

It’s worth noting that a regular meeting (face-to-face or through remote calls) should be undertaken regularly, during the development process of the service.

4.1. Deliverables and deadlines

The deliverables can be summarized in the following points:

- **Datacenter**: delivered and set at the OSS premises
- **Three WNR services (water abstraction monitoring service, agriculture monitoring service and land degradation monitoring services)**: up and running, with different components for data acquisition, processing and analysis, interpretation and exports.
- **Service maintenance**, feedback collections mechanism and capacity building materials
- **Technical documents** (service use, scientific background…)
- Capacity building materials
- Technical reports and service's related documentation: detailed and summary format
- Trainings on service use in 06 countries.
- Training on DSS administration and maintenance

It's worth noting that:

- The first prototype is expected to be delivered before **September 30th, 2020**;
- The first official public release up and running, integrating the end-user's feedbacks, is expected by **November 30th, 2020**;
- The technical documents as well as the capacity building materials are expected to be delivered by **September 30th, 2020**;
- The training of the IT team in charge of the DSS administration and maintenance is expected before **November 15th ,2020**;
- The end-user's capacity building training sessions are expected to be undertaken as soon as the first public prototype released and end before **February 28th, 2021**;
- The final release, integrating the first round of user's feedbacks, must be up and running before **February 28th ,2021.**

The development will be made with the full involvement a restricted committee including the OSS team and GMES North Africa partners. Regular virtual meetings are planned to monitor the overall progress, to provide feedbacks and recommendations based on the past experiences and national studies

4.2. Remuneration and payment procedure

For the whole package described in this present document (ToRs), the financial offer will be proposed by the consultant. The financial offer will be negotiated with the OSS according to the offer consistency and the technical specifications in the ToRs. The technical offer will be also discussed with the OSS according to the technical consistency and feasibility of the different tasks and components.

Accordingly, a contract will be prepared by the OSS and the consultant.

The payment will be made by the OSS to the bank account specified by the consultant, upon validation by the OSS of the tasks requested. It will be carried out in several instalments, which will be defined, by mutual agreement with the consultant, in the contract. A first proposal can be presented as follow:

- **30 %** of the overall amount of the cost will be provided once the datacentre delivered and correctly established at the OSS premises.

- **30%** of the overall amount will be paid once the first prototype of the service up and running and the capacity building materials, including the technical documents, delivered

- **40 %** of the total amount will be paid once the final release of the DSS received and validated, the reviews reflecting the end-users feedbacks integrated and the capacity building sessions achieved.

The payment can be negotiated if requested and a mutual agreement with the consultant will be reached accordingly.

4.3. Content of the offer

Applicants are invited to apply by sending their offers by e-mail to: **procurement@oss.org.tn**

Mentioned in the subject line for each service:

- "GMES&Africa - Notice of call for applications for the development of GMES-EO services – Water abstraction service **[AO/OSS/GMES-WATER/120620-18]**".

- "GMES&Africa - Notice of call for applications for the development of GMES-EO services – Agriculture monitoring service **[AO/OSS/GMES-AGRICULTURE/120620-19]**".

- "GMES&Africa - Notice of call for applications for the development of GMES-EO services – Land degradation monitoring service **[AO/OSS/GMES-LAND/120620-20]**".

The consultant is free to apply for one service or multiple services, provided that he/she observes the one application containing (the technical offer and the financial offer) per service provision. The technical offer and the financial offer must be provided separately

The deadline for receiving offers is **Sunday 05th, July 2020** at 3 p.m. (Tunis time).

The file must contain a technical and a financial offer:

a) Technical offer

- A 3-page methodological note for carrying out the mission, which details the expert's field of competence;
- A **detailed technical** offer describing how the technical aspects are handled: water balance / energy balance, service processing …. This will include the literature to be used as well as a detailed chronogram (prototype development, versioning …);
- A detailed curriculum vitae of the consultant; (use the standard OSS CV template available for download at the following link: [**OSS CV Template**];
- Other references deemed useful.

b) Financial offer

In order to better compare the applicants' offers, it is recommended that applicants provide a breakdown of their financial offer. In addition, applicants should take note that payments can only be made based on the products delivered i.e. on presentation of the result of the services specified in the ToRs and after validation of these deliverables **by the monitoring committee (composed by OSS and GMES North African partners)**.

The offer should be valid for three months, starting from the day following the deadline submission.

4.4. Offer evaluation

Offers will be evaluated based on the weighted rating method:

- Weight of technical criteria: 70%
- Weight of financial criteria: 30%

Contract award should be made based on the evaluation of offers determined as follows:

- Compatibility / acceptability and
- Obtaining the best score on a predetermined set of criteria weights specific technical and financial.

Only applications having obtained a minimum of 70 points would be considered for the evaluation financial.

The application is rated according to the following grid:

Table 1: Evaluation grid of the technical offers

	Water abstractions monitoring service	Land Degradation monitoring service	Agriculture seasonal monitoring service
Qualifications & Experiences (50 pts)	**Diploma *(10pts)***	**Diploma *(10pts)***	**Diploma *(10pts)***
	References in the field of study: Scientific releases, ... *(10pts)* - Estimation of evapotranspiration; - Modelling of theoretical crop water requirements; - Mapping of irrigated perimeters and estimation of agricultural water withdrawals -Remote Sensing / Geo-spatial Science and Technology; -Agriculture, Water and Forestry	**References in the field of study: Scientific releases, ... *(10pts):*** - Land degradation monitoring through remote sensing; - Modelling of vulnerability to degradation (desertification, erosion, ...); - Mapping of degradation hotspots -Remote Sensing / Geo-spatial Science and Technology; -Agriculture, Water and Forestry	**References in the field of study: Scientific releases, ... *(10pts):*** - Crop mapping through remote sensing; - Crop growth modelling; - Use of Sentinel data and/or vegetation indicators for crops characterization and agricultural campaign monitoring -Remote Sensing / Geo-spatial Science and Technology; -Agriculture, Water and Forestry
	References in the field of study: Design, Development, ... *(20pts):* - Development of web services, geoportal and map viewing interfaces; - Development of geospatial processing chains; - Design / Development of platforms for monitoring natural resources through remote sensing	**References in the field of study: Design, Development, ... *(20pts):*** - Development of web services, geoportal and map viewing interfaces; - Development of geospatial processing chains; - Design / Development of platforms for monitoring natural resources through remote sensing	**References in the field of study: Design, Development, ... *(20pts):*** - Development of web services, geoportal and map viewing interfaces; - Development of geospatial processing chains; - Design / Development of platforms for monitoring natural resources through remote sensing
	Language *(10pts)*	**Language *(10pts)***	**Language *(10pts)***
Methodology (50 pts)	**Methodology *(50 pts)***	**Methodology *(50 pts)***	**Methodology *(50 pts)***
	ToRs compliane *(20 pts)*	**ToRs compliane *(20 pts)***	**ToRs compliane *(20 pts)***
	Organization, planning and comments *(20 pts)*	**Organization, planning and comments *(20 pts)***	**Organization, planning and comments *(20 pts)***
	Proposals *(10 pts)*	**Proposals *(10 pts)***	**Proposals *(10 pts)***

Annex 1 - Technical specifications

1. Services presentation

1.1. Water abstraction monitoring service

Sustainable water resources management requires reliable information on the resources as well as on socio-economic developments for assessing the scarce groundwater resources, their management and allocation in order to secure the future livelihoods. Decision makers' awareness needs to be raised through evidence-based proofs.

Groundwater monitoring is expensive, time consuming and requires high technical expertise. When technical staff has to cover hundreds of kilometers to monitoring wells in remote areas, remote sensing data and techniques appear to be a reliable system. Therefore, mapping irrigated perimeters and estimate the groundwater abstractions for agriculture use based on crop mapping from multi-spectral remote sensing can be considered as a suitable cost-effective solution in support to technical departments in charge of groundwater resources management. The field is required mainly for the calibration of the models and the validation of the results, since minimum of in-situ data are required.

For that, the water abstraction service aims to provide insights on water abstractions over the aquifer that can be compared to the recharge and the aquifer ability in order to better plan actions and direct decision making. This kind of evidence-based proofs derived from EO data and techniques supports the definition of water manager's roadmap towards a more sustainable water resources managements and more resilient agriculture to climate change. It supports also the stakeholders' awareness-raising on the critical situation of our aquifers and the irrigation management.

At the regional level, the service provides decision makers and stakeholders with global information on climate and vegetation covering the North Africa region. This may include estimated rainfall trends and abnormalities, evapotranspiration, water deficit (ET-Rainfall) … The consultant(s) is called to propose relevant topics and datasets at the regional level.

At the local level, the core-service provides two products at the 6 pilot sites level distributed in 06 countries with different contexts and environments (soil types, climate, crop types, …):

- **Maps of irrigated areas** at the pilot sites level, derived from time-series Sentinel-2 imagery, in GIS format (Tiff, SHP, … GeoPDF). This information is used to provide an overview of the spatial distribution of irrigation perimeters at the pilot site level, to do advanced analysis on water productivity, to undertake an analysis of historical data to quantify the changes over years and determine the evolution and trends of irrigation activities at the pilot sites level.

- **Water abstraction volumes** for each parcel at the pilot sites level, estimated through evapotranspiration. This information will be used for analyzing the actual situation, to assess the water consumption for agriculture purpose and have it compared with the abstraction thresholds allowing a sustainable water resource management and to identify non-authorized abstraction by overlaying the official water point's database on the map of irrigated areas and analyzing the irrigated areas where no water-point is counted.
- **Summary information** of the actual abstractions compared to the aquifers recharge, as well as the trends. This information is provided through simplified and intuitive dashboard, resulting from the aggregation of the products at the parcel level. This aims to simplifying the decision makers analysis and interpretation.

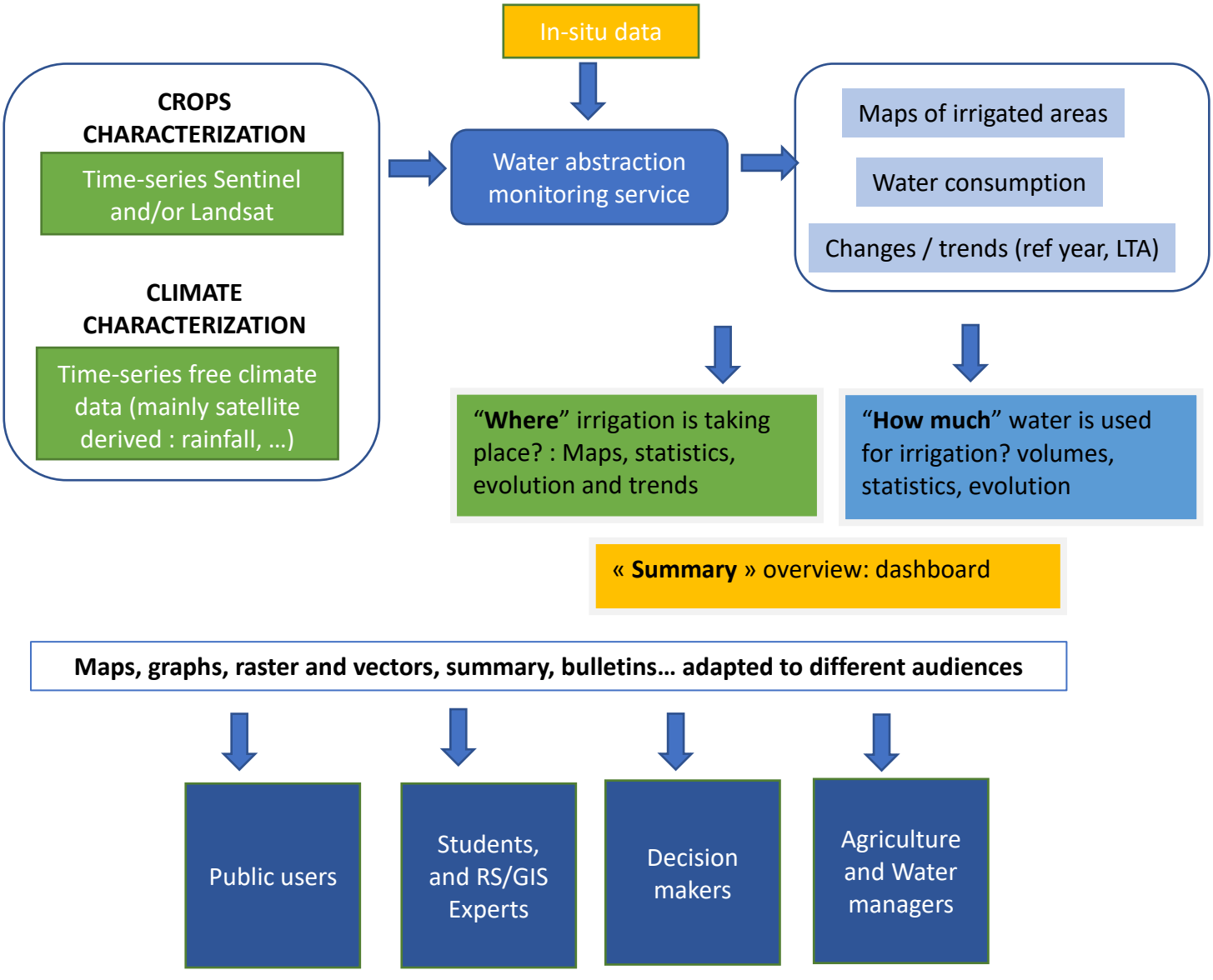


Figure 2: General overview of the water abstraction surveillance service

The consultant(s) is expected to detail the processing workflow in the technical offer and is free to suggest new relevant products and functionalities (water productivity, ET- crops water requirement …).

The service should run without in-situ data, based on "by-default" values of certain parameters. For example, if soil data is not available, the world soil database or any other source deemed relevant is used.

1.2. Agriculture seasonal monitoring

Because of its position in the arid zone, the North Africa region faces three major challenges: aridity, recurrent drought and desertification. The economy and people's livelihoods are primarily based on natural resources exploitation including water and land. Therefore, agriculture monitoring using satellite imagery can play an important role in early warning, assessing the actual agriculture campaign situation and monitoring the growing season and yields forecasting, quantifying the impacts and run scenarios for climate change integration in decision making.

Agricultural geospatial information is critical for agriculture monitoring agricultural policy formulation and decision making. Satellite imagery made possible the regional assessment and monitoring of crop cover, crops growth and states, forecast yields and deliver insight on the agriculture campaigns. Decision makers awareness needs to be raised through evidence-based proofs based on geospatial-derived information.

The main objective of the service is a regular delivery of a timely information on crop monitoring and the agriculture campaign. This will allow the assessment of crop conditions and yield forecast, produce early warnings alerts of drought.

The imagery provided by Sentinel-2 enables a new approach for agriculture monitoring and the combination of the spectral, spatial and temporal resolutions will gain a relevant analysis and lead to a decision-making process improvement.

The service can be seen as an operational instrument relying on robust scientific and technical approaches allowing the delivery of seasonal information on agricultural campaign to decision makers and agriculture managers at the first place.

At the regional level, the service will provide an overview for crops conditions assessment and vegetation monitoring through low spatial resolution vegetation indicators and derived products, such as VCI, VHI and NDVI abnormalities. The consultant(s) is called to suggest relevant topics and datasets for agriculture monitoring at the regional level.

At the pilot site level, the core-service provides four (04) main products:

- **Cropland mask**: dynamic binary map identifying the cultivated land at 10 m spatial resolution. This mask may be produced/updated at monthly basis and/or aggregated at seasonal basis. This will allow a first rough appreciation of the cultivated areas and to compare the changes with the last year or with the reference year.
- **Crops maps**: dynamic crop type map for the main crops over the pilot sites. This will provide the users with an overview of the spatial distribution of crops
- **Vegetation status**: this product (or set of products: NDVI, NDVI metrics, LAI …) will inform agriculture managers and decision makers on the evolution of the green vegetation corresponding to the crop vegetative development.
- **Drought early warning** alerts through EO-derived indicators interpretation (SPI, VCI, …) at the regional level in GIS format (Tiff, SHP, … GeoPDF). This information provides an overview of the crop response to climate variables and to make decision makers and agriculture managers aware on drought presence, extent and severity.

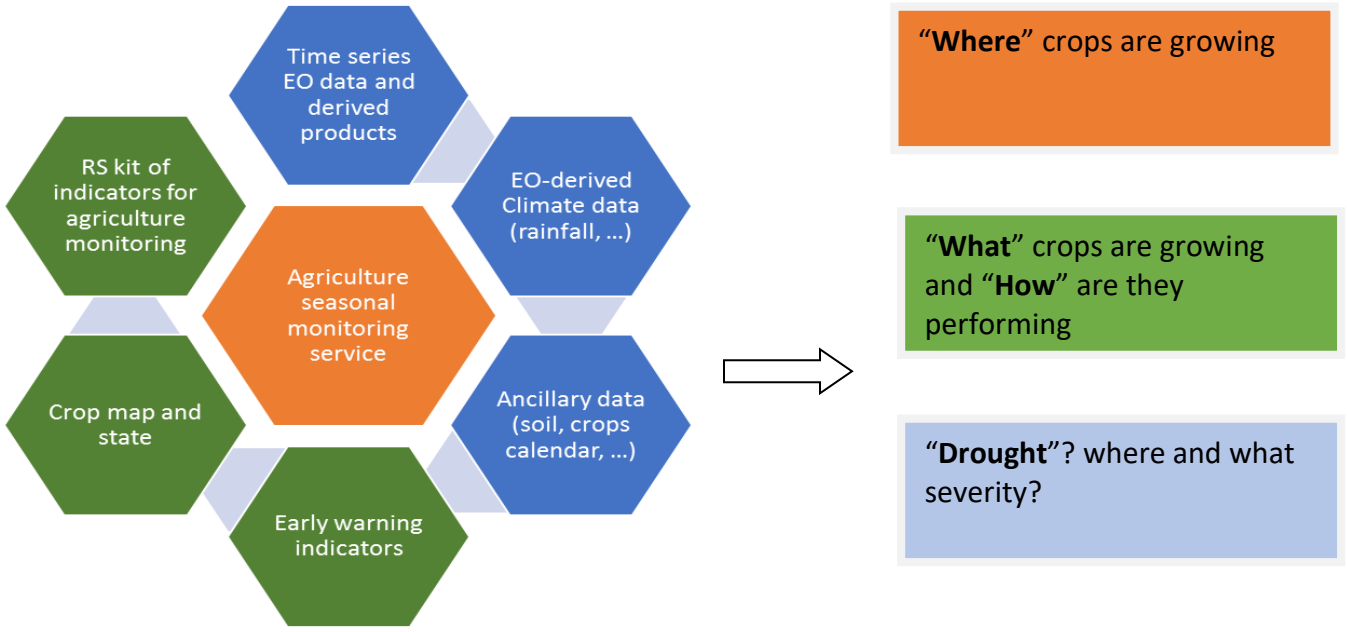


Figure 3: General overview of the agriculture monitoring service

1.3. Land degradation monitoring

Globally, 80 percent of land degradation is caused by agriculture. Since 1950, 65 percent of Africa's cropland, which millions depend on, has been affected by land degradation by mining, poor farming practices and illegal logging. [1]

The North African sub-region represents the full range of aridity indicator, as extended areas of hyper-arid and arid climate with relatively limited areas of semi-arid and arid sub-humid conditions in the highlands of the sub-region.

Most Northern African countries experience – in addition to highly variable rainfalls – recurrent long and severe drought spells. Algeria, Tunisia and Libya experienced droughts in the late eighties till 1993. Morocco has experienced a drought in one year out of every three years over the past few decades, UNEP (2002).

For that, the land degradation monitoring service aims to provide evidence-based proofs on land degradation and its spatiotemporal distribution and therefore on the hotspots where priority action should be conducted or awareness-raising campaign should be planned. It will provide reliable information on land degradation and trends will support the countries to combat degradation in one or more of the land use categories for better program planning and awareness raising.

At the regional level, the basic indicators will include the three main sub-indicators of SDG15.3.1, namely: LULC and its changes, land productivity and carbon stocks (surface and underground). These sub-indicators represent a minimum that should be complemented and enhanced by national (or sub-national) indicators for a more accurate picture of land degradation (rainfall erosivity, terrain slope, soils erodibility, socio-economic factors …), according to the country specificities as well as data availability and accessibility.

Land degradation is defined by UNCCD as a complex issue that refers to the long-lasting reduction or loss of biological and economic productivity of lands caused by human activities, sometimes exacerbated by natural phenomena.

In addition to LDN sub-indicators, the service will provide land degradation hotspots (LDHs), which are produced via the analysis of time-series vegetation indices data and are used to characterize areas of different sizes, where the vegetation cover and the soil types are severely degraded.

It's worth noting that degradation can be caused by different factors: excessive human pressure, drought conditions, forest fires, hydrological erosion… The idea behind is not to determine the causes, but to highlight the consequences, and raise awareness to take these facts into consideration in plans development and intervention strategies.

[1] Source : http://www.ipsnews.net/2018/08/land-degradation-triple-threat-africa/

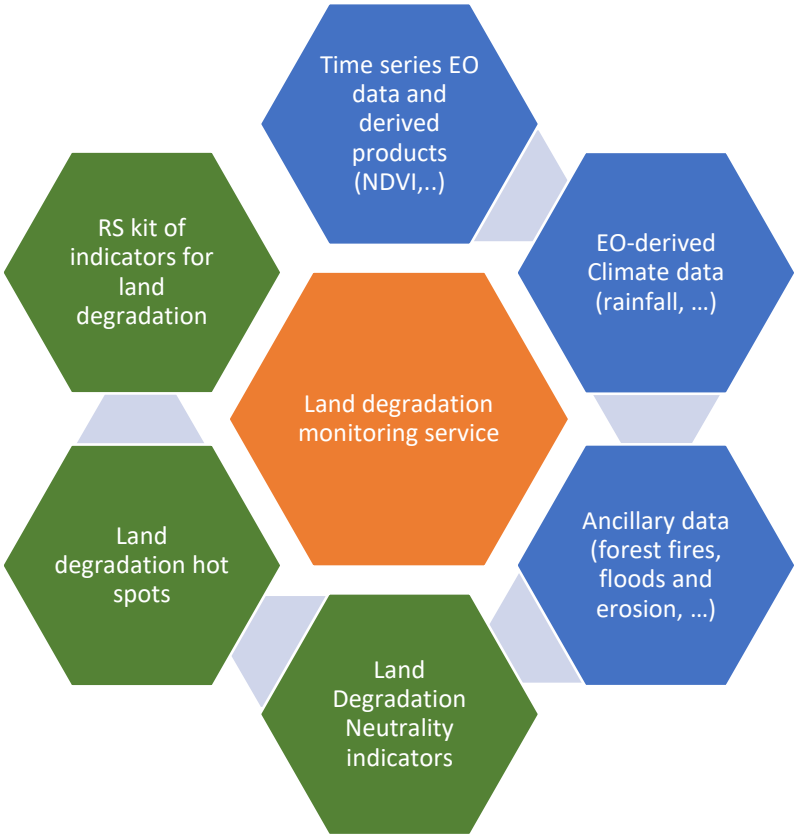


Figure 4: Overview of Land Degradation Service

Therefore, Vegetation loss/gain Hotspots will be calculated through the analysis of time-series vegetation indicators data, trends of vegetation loss and gain can be calculated and updated every year. Therefore, trends and changes can be quantified and analyzed and impact of policies and strategies as well as actions on the ground can be assessed.

It's recommended to include the Landsat time-series data and derived products (relevant vegetation indicators and other products) in the processing chain, because of the long-term archive availability at higher spatial resolution (30m).

2. Overview of the common characteristics of DSS

2.1. Products delivery format

The delivery format is tailored to the specific end-user needs and depends on their expertise in processing and interpreting EO products:

- **GIS format** (raster and vector formats): data is delivered via FTP server or download links, and will be available for free through the dissemination platform (developed by the OSS).
- **Web maps**: data is available through a web portal as interactive maps with interrogation and export capabilities,

Summary materials: data is summarized in statistics in tables and graphs for decision makers and water resources managers. This will raise awareness and support the improvement of strategies and direct decision-making process by providing timely information on irrigation areas and extension as well as on water consumption.

- **Periodic bulletins** to target a larger audience: mainly observed climate trends from EO data and products summary
- **Technical report** details the developed/adapted approach and the interactions with the water abstraction monitoring service.

An interactive Help module must also be integrated where more details on the technical processes and parameters as well as the interpretation of the different indicators will provided in two languages (FR/EN)

2.2. Time frequency of output products

The service will integrate a systematic collection of new satellite derived data and ancillary data (NDVI, rainfall, …) as well as new Sentinel-2 acquisitions from the Copernicus catalog and other relevant sources. As soon as the images downloaded, the products are updated and fetched to the visualization interface.

For example, the availability of a cloudless image of Sentinel-2 image acquired in the data and being available for download will trigger its collection from the Copernicus Hub (or other relevant sources) to the OSS data center, its processing to estimate the evapotranspiration and its availability through the service visualization dashboard.

The service will guarantee the data collection and processing the data in order to:

- **Develop baseline datasets**: rainfall long term average, NDVI long term average,
- **Generate products**: EO-derived products, such as water consumption maps and spatial extent of irrigated areas, are systematically produced and fetched to the visualization component.
- **Time series analysis**: Identification of abnormalities and the comparison of time series products between years (swipe view for example)
- **Summary** and time-series samples at an administrative level (watershed, basin, district)

2.3. Geographic Coverage

Two different levels can be distinguished:

- **Regional level**: where low spatial resolution products are used to provide a general overview of the three topics at the North Africa level. This may include regional evapotranspiration products, climate isohyet, rainfall abnormalities and forecasts, SPI…
- **Pilot site level**: where high spatial resolution is used for water abstraction monitoring and agriculture assessment.

Combination between both levels can be foreseen if ancillary data are not made available. For example, if soil and climate data are not available, satellite-derived estimated rainfall along with other climate data and soil are used instead to assess the crops water requirement. Therefore, crops water requirement as well as rain forecasts can be assessed in an interactive way by farmers for instance.

The **pilot sites** will be provided in advance, with the customization possibility of the geographic coverage. In other words, the service must foresee the geographic coverage functionality, that administrators can upload the region of interest in vector format (shape file for example), expressed by the end-users.

It's important to suggest EO-derived products and additional relevant functionalities. The decision makers will have the possibility, through these datasets and derived products, to monitor for example the climate-related data and assess the vegetation response.

2.4. Target users

Therefore, different categories are expected to use and discover the GMES services, including agriculture and water resources managers (irrigation related), environmental agencies, decision makers, student and researchers and academia, as well as general public audience.

Hence, the service should adapt the visualization interface to meet the main different end-users categories:

- **Decision makers**: who are interested in an overall summary over the pilot site in a very intuitive and simple way
- **Water and natural resources managers**: who want to get, at the parcel level as well at the regional level a catalogue of products, such as the irrigated areas perimeters and water consumptions, crops type maps and growth status, …. with a possibility of products exports for their use in field visits or in their reports (maps, statistics, …)
- **RS experts**: who want to be able to zoom at the parcel level/national or regional level, to conduct more advanced analysis with cross-validation schemes and export functionalities (in GIS format)
- **Public users**: who want to discover the products at the pilot sites level, as well as over the country level.

The web interface must be developed in a way that different users can be able to discover and export the products.

The web interface scheme should be included in the technical proposal. It's recommended to draw inspiration from **COPERNICUS Land Service** described in the link below as well as from references in the "**useful links and references**" section:
https://www.copernicus.eu/sites/default/files/Copernicus%20Land%20Monitoring%20Service%20factsheet%20status%20October%202018.pdf

2.5. Ancillary data management

Two scenarios should be foreseen, and the service is expected to run in both cases:

- **No input data is provided** by the end-users: the service will use the freely available climate Data and time-series satellite imagery, as well as other ancillary data available in international data sources (Soil, crop calendar...)
- **Ancillary data are made available**: these data can be used in the more advanced modeling and calculation, so upload functionalities and processing integration must be taken into consideration. For example, soil description and the known water inputs (Rain and Irrigation), climate data, crop types, ….

The service prototype will be developed using the first option, means that no input data are provided. The first prototype will be validated using the data provided by a champion user and covering a well-defined pilot site demonstration area.

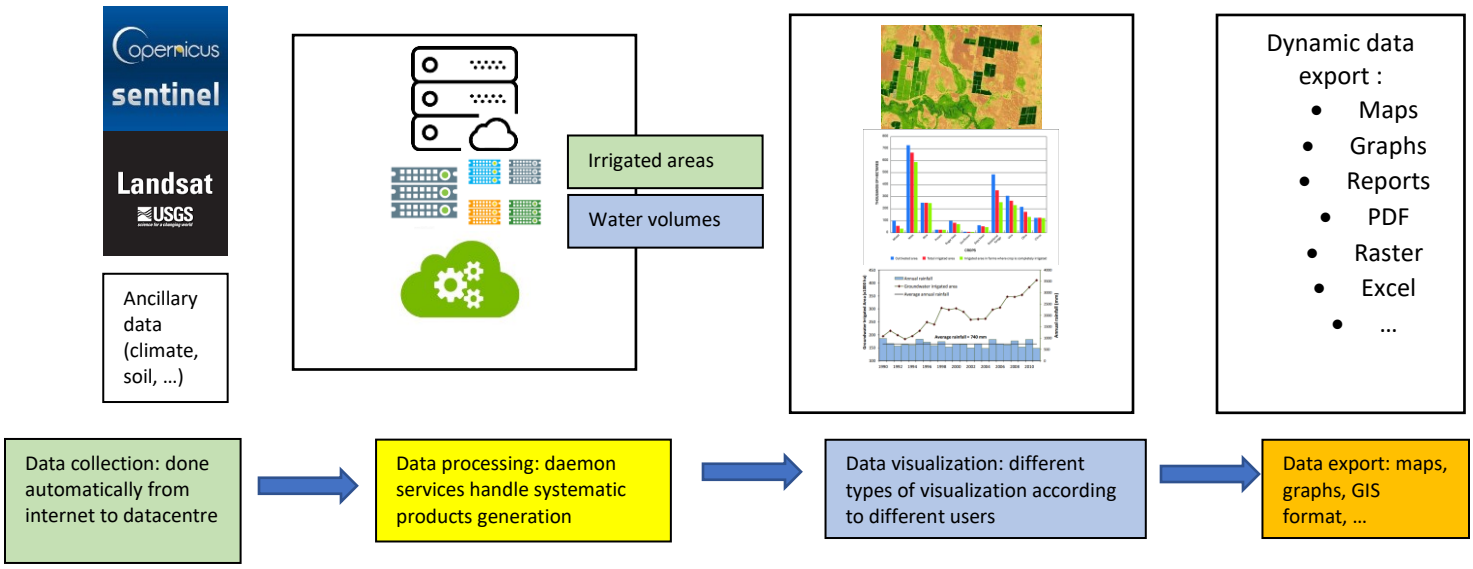
It's worth noting that the service will integrate the authentication access for administrators and granted users. The registered partners (GMES national partners) will have access to geospatial products covering their respective countries, can download/upload data and can edit the data to make corrections they deem necessary, hence changes made are depicted on the map directly.

A disclaimer will be produced to announce the model chosen and the accuracy expected.

It's worth noting that the approaches chosen, the products as well as the functionalities will be discussed during the kick-off meeting with the steering committee which will be defined later by the OSS.

3. Components

The service can be decomposed according to the following scheme to different components: data centre for data collection and storage, webservices for data processing and visualization, and capacity building materials (trainings, help,)



3.1. Datacentre

"A datacentre is a physical facility that organizations use to house their critical applications and data. A data center's design is based on a network of computing and storage resources that enable the delivery of shared applications and data".[2]

The datacentre should ensure:

- **Storage infrastructure**: 100 Tb of storage are foreseen, extensible
- **Computing resources**: 16 cores minimum
- **Networking infrastructure**: in order to ensure the connection with the OSS-servers (public IP) using high-debit linkage

This datacentre will be provided in the framework of this consultancy, deployed and hosted at the OSS premises. This platform should offer tailored tools and services for handling big Earth Observations and geospatial data triggered by the requirements specifications of the services characteristics.

As for the IT equipment, the consultant will advise the technical team on the system requirements based on the initial estimations of data volumes, processing ability and hosting issues. Then, he will be in charge of delivering the IT equipment of the agreed characteristics, setting them at the OSS premises and deploying the system.

[2] Source: https://www.cisco.com/c/en/us/solutions/data-center-virtualization/what-is-a-data-center.html

3.2. Webservices

The webservices are expected to be intuitive and interactive. They should integrate the following functionalities:

- **Data collection**: the webservice is in charge of collecting input data into the datacentre, as well as new acquisitions as soon as they are available (Sentinel-2 and Landsat-8 imagery for example). The list of data products contains:
    - **Sentinel-2 datasets** covering the pilot sites (provided in vector file). It's recommended to use the Copernicus OpenSearch libraries[3].
    - **Landsat-8 imagery** and derived datasets NDVI and thermal bands
    - **Climate data**: rainfall (CHIRPS or RFE), temperature, …
    - **Soil data**: Harmonized World Soil DataBase (HWSDB)
    - **FAO kc table**

This list is not exhaustive, it is a changing list which may be updated according to the service evolution as well as the requirements of the proposed approaches.

It's recommended that the plugin will be written in Python. An example can be seen through the link below: https://github.com/USGS-EROS/espa-bulk-downloader/blob/master/setup.py
This will guarantee an efficient portability and mutualisation of codes (Webservice & GIS plugin) since the main codes related to data collection, processing and even visualization are the same.

- **Data processing**
    - **Output products** of the three services
    - **Global datasets** related to the three services
- **Data visualization:** the service must integrate an intuitive dashboard for data visualization and interpretation allowing:
    - **Visualization** of time-series data (satellite imagery, NDVI, evapotranspiration, …)
    - **Analysis** of changes and trends
    - **Interact** with data: interrogate values, inspect elements,
    - **Summary** of data per area, per district or predefined delimitation boundaries (shape file uploaded by the user)
    - **Interactive** dashboard: per region / per district where results are aggregated
    - **Map export**: geo-pdf, PDF, JPG, and in SIG format (georeferenced raster/vector data)
    - **Statistics export** for reporting and advanced-analysis
    - **Animation** of the different indicators (NDVI reflecting the crop growth, evapotranspiration, …)
- **Service Monitoring**: statistics on service usage, plugin-download...
- **Capacity building and Help modules**: interactive help and guiding tour as well as capacity building materials (video, tutorials, …) must be provided.

The summary products are produced through the aggregation of the different results at a defined area of interest, which can be a digitized polygon, administrative boundaries levels (district …). Hence, the service will allow the export of statistics, graphs and summary.

[3] Source: https://scihub.copernicus.eu/userguide/OpenSearchAPI

INTERACTIVITY, USER-FRIENDLY AND INTUITIVE HANDS-ON OF THE WEB SERVICE EXAMPLE OF PROTOTYPE FOR WATER ABSTRACTION MONITORING SERVICE

The web service must be interactive and intuitive. It serves to multiple sets of users with different backgrounds.

For example, the interactive interface should allow the user to pick the region, the period of simulation, the evapotranspiration model (SEBAL, FAO-56, …), the climate variables (either open data or rain gauge stations data provided by the user), the management options (agriculture practices, irrigation type…) ... Therefore, the user can run different models' simulations to obtain the irrigation areas perimeters and the crops evapotranspiration at different spatial levels, without opening and modifying any database or changing any parameter. More advanced users can interact with more advanced parameters.

The user will be able to visualize the spatially distributed variables estimated by the models (irrigated area perimeters, water consumption use …) and analyze and export the results (both in JPG and GIS formats). The users also can use the interrogation tools (available through the visualisation interface) for mapping and plotting the different outputs of the simulations.

The web service must allow the easy models' customization, whilst ensuring a certain level of friendliness and interactive customization of parameters values. The tool will integrate a by-default database of parameters (crop phenology, parameters for simulation of water dynamics in the soil, for stimulating soil temperature, for soil runoff and erosion in addition to the physical and chemical properties of the local soils, …). The advanced users with more expertise can also upload and modify the parameter file related to the model implementation.

If ancillary data are available, the interface will also their upload for service calibration.

For decision makers and stakeholders, the products will be aggregated at the different administrative levels according the provided data for ADM (district, governorate, regional and national levels)

By default, planting and harvesting dates are integrated in the database. The user can customize the value; hence the tool will integrate a dedicated interface for that.

The system will be somehow linked to the dissemination platform where the products will be delivered through. The linkage will be part of the call. The architecture as well as the technical specifications of the dissemination platform required for this linkage will be provided.

Admin users are able to check the service use statistics, the storage, service feedback, functionalities log, … through a dedicated dashboard for admin users.

All codes must be well documented, preferably in python. The architecture of the web-service as well as the main functionalities must be documented as guide and/or short videos. **The technical offer must detail the processing methodology as well as the platforms and literature to be used**

3.3. Plugin QGIS

The plugin must include the same functionalities as the web service: data collection, processing, analysis and visualization. It should also integrate the possibility of connection into the GMES platform to visualize and download the data directly.

3.4. Documentation and trainings

All codes should be well documented, the detailed description of each module should be provided along with the webservice:

- Technical guide describing the modules and the inter-relation between.
- Technical guide describing the processing steps and the scientific background behind (evapotranspiration estimation, irrigated area mapping…), the algorithms used and their scientific background
- Tour guide for the webservice interface for non-experts users
- The service customization guide
- The service maintenance guide
- Materials judged relevant to ensure the service appropriation and easy hands-on

The consultant will be mobilized to guarantee the end-users trainings in 06 countries, or to guarantee the training of trainers (ToTs) who will be in charge of providing the trainings at the national level. During these trainings, end-users will learn how to use the service and customize and interpret the output products.

The consultant will produce an extension kit for end-users, the content of which will be specified in the methodology note. This kit should include at least the extension modules that will be used during the training sessions, explanatory booklets in web video and paper format and/or tutorials.

Annex 2 - References and useful links

- GMES-NA Service Development Plans (SDP's)
- OneSoil platform for crop monitoring : https://map.onesoil.ai/2018#2/44.35/-43.66
- IRRISAT platform for irrigation monitoring : https://irrisat-cloud.appspot.com
- EEFLUX METRIC platform: https://eeflux-level1.appspot.com
- JRC ASAP High Resolution Viewer : https://mars.jrc.ec.europa.eu/asap/hresolution/?region=214
- TOPS Satellite Irrigation Management Support : http://ec2-54-196-147-232.compute-1.amazonaws.com/dgw/sims/

Annex 3 - GMES Services

Three services will be developed under the project:

L122 : Monitoring, follow-up and evaluation of water in irrigated areas

- Mapping irrigated areas and their long-term spatial and temporal monitoring.
- Multi-scale methodologies for estimating, monitoring and evaluating the areas irrigated by remote sensing as well as the volumes of water withdrawn for irrigation.
- Indicators on resource status and anthropogenic pressures and natural factors, crop water productivity.
- A system for monitoring uncontrolled/unauthorized irrigated area extensions and overexploitation of aquifers.
- Simulation and projection of scenarios of the evolution of the state of water resources and their uses for decision-making.

→ Use and impact of results: Development of approaches for quantitative estimation of water withdrawals.

L221: Monitoring and assessment of land degradation

- Multi-scale indicators on land degradation.
- Operational land degradation monitoring services at regional and local scales.
- Capacity building of agencies on indicator calculation.
- Characterization and analysis of land degradation hotspots.
- An online degradation information system.

→ Use and impact of results: Development of integrated approaches to land degradation assessment - Contribution to the analysis of indicators for monitoring degradation.

L231 : Seasonal Agricultural Monitoring, Early Warning and Assessment

- Multi-scale maps of land use and its changes.
- Remote sensing indicators for monitoring agricultural campaigns.
- Methodologies for spatio-temporal monitoring of agricultural areas.
- Tools for disseminating agricultural campaign monitoring products at defined time intervals (newsletters and information systems).
- Drought early warning bulletins (water and agricultural).

→ Use and impact of results: Assessing pressures on biodiversity - Contribution to regular monitoring of ecosystem status.