European Commission

COPERNICUS AND EARTH OBSERVATION IN SUPPORT OF EU POLICIES

Part I: Copernicus Uptake in the European Commission

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Table of Contents

Forward

In June 2017, the European Commission launched a study into the internal use of Earth observation data and derived information to understand current and future geoinformation demands. The EU has made large investments in its Earth observation programme Copernicus which significantly supports policy decisions and EU economic growth. This study's objective was to assess the European Commission's current uptake of data, information and services provided by the Copernicus programme. Insights helped identify opportunities for increased and enhanced use either through the evolution of the Copernicus services or through applications downstream in the Earth Observation sector. Our analysis also considered sources of Earth observation data and information from outside of Europe that provided input directly or indirectly to the European Commission policy Directorate-General (DG).

The study was carried out by the Commission's DG GROW/DEFIS and JRC, in close collaboration with relevant policy DGs of the Commission, in order to gather first-hand use cases and identify further requirements. The study provides insights into the current and potential uptake of Earth observation data and information. Findings support on-going reflections on the increased exploitation of Earth Observation in the EU and on the Copernicus Services' evolution.

The outcome of the study is summarised here. We are counting on a continued interest and support for the user-driven evolution of the Copernicus services and for exploring new cases of policy support for which observation-based evidence is needed. In this way, the Copernicus programme can exploit the great potential of Earth observation to support policy design, monitoring and implementation in the European Commission in a transparent and consistent way across Europe. Copernicus represents a formidable enabling capacity at the nexus of priorities for the new Commission, specifically with the focus on *A European Green Deal* and *A Europe fit for the digital age*.

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Executive Summary

This study examines the extent to which Copernicus supports policymaking in the European Commission, all while assessing user perspectives for increased uptake. Alternative forms of Earth observation data and information that supports EU decision making was considered.

A substantial amount of use of the services comes from policies that monitor land-use, climatic and environmental conditions, a trend expected to increase in light of anticipated demands by the new Common Agricultural Policy and the Land Use, Land-Use Change and Forestry Regulation. Information of the Climate Change Service on optimal land-use that targets specific human activities which harnesses the beneficial opportunities of climate change provides policy makers with a new set of adaptation measures.

Several lines of action have been identified to improve uptake: Increasing engagement within the policy Directorates-General; fostering feedback loops between end-users and Copernicus services; increasing communication, information and training; setting standards and guaranteeing quality controls; enabling full integration of different datasets.

Policy context

The Copernicus programme for Earth observation represents a significant investment by the EU, justified by expected returns in public governance and private business. Copernicus is user- and policy driven. The programme provides cross-domain products and services with a full free and open data policy, where possible taking up new technologies and research.

The other services of the Copernicus programme provide an interdependent information toolkit that can support land use monitoring. The atmosphere service monitors air quality measures. The marine service provides input to the information system for marine knowledge. The emergency service supports disaster risk reduction measures and a resilient build-up of society. Finally, the security service provides vital political context where land and water resources are at the origin of conflict and migration.

The Copernicus programme uniquely empowers the EU to assert itself as a global player, successfully achieving SDGs and international conventions because of its long-term sustained commitment and strong international dimension. The space programme remains one-of-a-kind in its capacity and accessibility.

1 Introduction

Copernicus: user driven from the beginning

The European Union's Earth observation (EO) and monitoring Programme, Copernicus, has been framed by user requirements since its inception. Policy makers' needs in particular conditioned the programme's satellites and services: the spatial, spectral and temporal characteristics of the satellite measurements, the derived products, delivery mechanisms, associated ground networks and product quality control protocols all respond to specific user demands. Now in its 21st year, the programme is particularly dynamic and agile. Established user needs evolve as their policies evolve, and new policy domains emerge, bringing with them new demands. Copernicus continues to engage with users and to adapt accordingly.

Continuity and quality: cornerstones for operational uptake

Copernicus is a fundamental pillar of EU Space Policy, as laid down in the EU Space regulations No. 377/2014, No.1285/2013 and No. 912/2010. This Policy framework ensures the programme's continuity. The European Commission (EC) will continue to lead the partnership with other stakeholders in the 2021-2027 Multi-Annual Financial Framework. Within this framework, follow-on satellite missions are already on the table. Thus, policy makers, both current and future, can plan to use the Copernicus Earth observation data and information streams to underpin policy over the long term because they will continue to flow and the services that turn the data into products will continue to operate; there is no risk that policy will be framed around a vanishing evidence-base.

The Copernicus programme recognises that the use of EO-derived information in a policy context demands quality output. Scientific and technical engagement by Europe's scientific community assures this quality. Scientifically robust assessments of measurement fidelity, product specifications and validation are crucial in a policy context. Both the policy makers and the policies' beneficiaries must be able to trust the output. The Directorate-General Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), from January 2020 onwards under the Directorate-General Defence Industry and Space (DG DEFIS), provides overall leadership, delegating the management and execution of the six different Copernicus services (as described in Box 1) to a number of "Entrusted Entities".

The Joint Research Centre (JRC) provides the EC in-house scientific and technical support to help checking the fitness-of-purpose and, where needed, redirecting as set out in COM/2018/447 – and Council 7481/19, an EU commitment to sustained quality today and into the future. To maintain its reference role for Earth Observation science in support to policy needs, the JRC nurtures technical competences in standardisation, quality control, calibration and validation and the definition of reference datasets, as well as skills in algorithm development, advanced techniques such as deep learning and machine learning, product prototyping and data system architectures required to best process and analyse large data sets, as well as manage the knowledge and data this generates.

A force for good in the world

Copernicus and the other elements of Europe's Space Policy operate in a global context. Technical and technological transformation have seen public and private entities from around the world fund an increasing number of EO missions, develop data processing, storage and access facilities, and combine these with analysis capabilities. Copernicus has to operate in this new environment – offering cooperation where it can and competing effectively when needed. Copernicus aims to maximize the benefits of EO for Europe's policy makers, science, society and economy, yet cooperate, share and add to global science, in addition to the knowledge base needed to address global challenges, such as those embodied by Agenda 2030 and its Sustainable Development Goals, or the Paris Agreement and need for Climate Action.

The whole is greater than the sum of its parts

The Copernicus programme consists of a complex set of systems, collecting data from multiple sources: a space component with six different types of EU-operated Earth observation satellites and access to additional satellites, and an in-situ component with

ground-based, airborne and sea-borne sensors and measurement campaigns. This complexity is part of

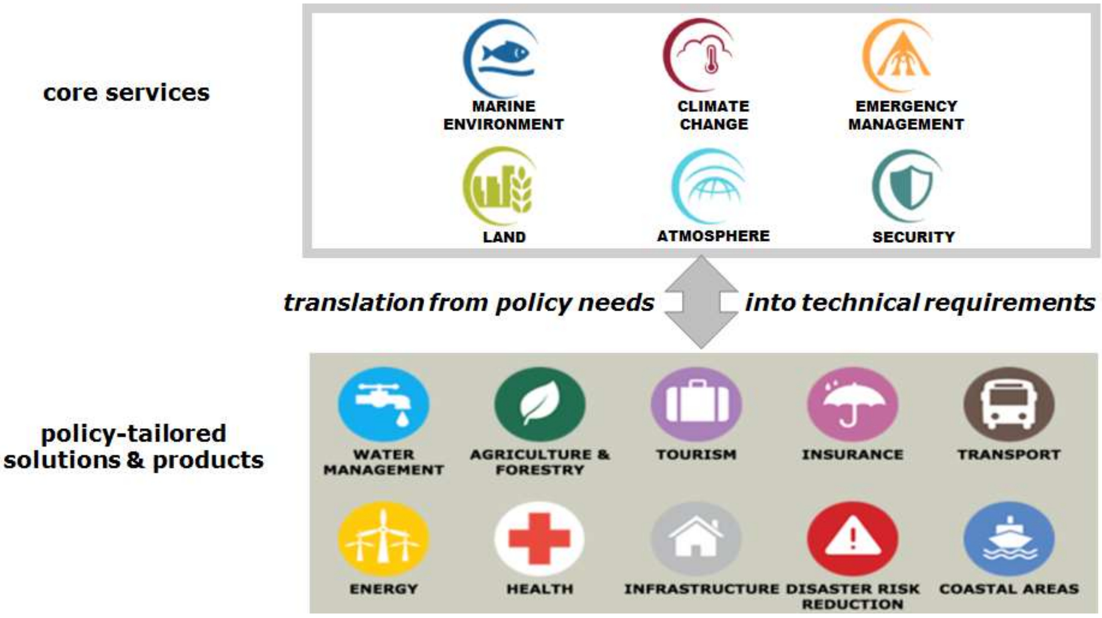
its strength. It provides Europe with guaranteed access to comprehensive Earth observation satellite constellations (including optical imagers, radar scanners, and atmospheric sounders, providing high-resolution imagery as well as a daily scanning of the globe). These data are valorised through six thematic services covering land, marine, atmosphere and climate change monitoring as well as security and emergency management. They provide fully validated and freely available information products to users in Europe and across the globe on a routine basis. More information on the individual Services is given in box 1.

All Copernicus services are already fully operational and they all combine service continuity with evolution. For example, the Land and Marine Environment Monitoring services currently provide data, information and tools developed with the existing space infrastructure, yet both also transition to more biological, ecological and environmental analysis services. The Copernicus programme's data capture and service elements are sufficiently diverse that they can address the needs of policy makers and citizens in dozens of different domains. The capacity for cross-policy, cross-domain use also continues to grow, and combining the output from multiple services, or using data from multiple sources has still not reached its full potential.

1.1 Consultation and co-design, a basis for future services

The Copernicus programme will meet new EU policy needs most efficiently through a sustained dialogue both within and across sectoral policy areas. Energy, climate, environment, agriculture, fisheries and development cooperation represent the policy areas where such dialogue is most urgently needed. Such dialogue must translate requirements from the policy-user Directorates-General (DGs) into specific solutions, products and services that Copernicus may deliver in the future, as well as ensuring that existing solutions, products and services are fit-for-purpose, as illustrated in Fig. 1.

Fig. 1: Translation from policy needs into technical requirements, such that the six Copernicus services can deliver policy-tailored solutions and products



The uptake of Copernicus-based products and solutions by the EU's policy makers across all user DGs needs to be periodically assessed. Gaps identified through this process should be filled in the future. Such an assessment should also include cross-policy aspects, both from the perspective of synergy and cost-effectiveness. Cost-effective solutions will focus on areas where a single set of Copernicus products can meet the needs of more than one policy (pay once, use twice!) whilst synergy should be sought through greater policy coherence. Moreover, potential synergies with other components of the space programme, such as Galileo / EGNOS and GOVSATCOM should be thoroughly exploited. This report provides a window into the findings of the first Copernicus Uptake study.

Box 1: The six Copernicus services

The Copernicus Climate Change Service (C3S) supports European climate policies and actions. Its mandate requires it to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide. The service, run by the European Centre for Medium range Weather Forecasts (ECMWF), complements capabilities existing at national level and those being developed through a number of climate-change research initiatives. Results are provided to the Climate ADAPT platform and contribute to the World Meteorological Organization (WMO) Global Framework for Climate Services and its Climate Monitoring Architecture. As an example, the pilot project "Service for Water Indicators in Climate Change Adaptation (SWICCA)" developed a sectorial information service of water management. The climate service provides not only essential climate variables that are monitored over long time period, but also sector-specific options to climate adaptation on e.g. water management, the energy sector etc.

The Copernicus Land Monitoring Service (CLMS*)* plays an essential role in crop monitoring and yield forecasting activities, notably for the Land Parcel Identification System and the GeoSpatial Aid Application (a GSAA app). Since forests are a key element in the zero-emissions option and afforestation is not only a measure of mitigation but also adaptation, tree cover density layers or forest type fraction estimations from the CLMS can also be used to monitor climate adaptation measures. Another product made possible by the CLMS is the World Atlas on Desertification giving concrete examples on how human activity leads to land degradation. As such, the land service informs on optimal land-use, harnessing the beneficial opportunities of climate change and provides a new set of land-use measures, also in view of the new common agricultural policy.

The Copernicus Marine Environment Monitoring Service (CMEMS) provides regular and systematic reference information on the physical and biogeochemical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas. The observations and forecasts produced by the service support all marine applications. For instance, the provision of data on currents, winds and sea ice help to improve ship routing services, offshore operations or search and rescue operations, thus contributing to marine safety. The service also contributes to the protection and the sustainable management of living marine resources in particular for aquaculture, sustainable fisheries management or regional fishery organisations decision-making process. Physical and marine biogeochemical components are useful for water quality monitoring and pollution control. Sea level rise is a key indicator of climate change and helps to assess coastal erosion. Sea surface temperature elevation has direct consequences on marine ecosystems and appearance of tropical cyclones. As a result of this, the service supports a wide range of coastal and marine environment applications. Many of the data delivered by the service (e.g. temperature, salinity, sea level, currents, wind and sea ice) also play a crucial role in the domain of weather, climate and seasonal forecasting.

The Copernicus Atmosphere Monitoring Service (CAMS) is monitoring air pollutants with a transboundary impact (such as for the ozone levels) and provides measurements that are complementary to those of the ground measurement networks. Also clean air is an important natural resources for which the European Commission takes care with national emission ceilings directives (monitoring air pollutant concentration levels exceeding limits), point source emissions (with public pollutant release transfer register) and fuel directives (for low sulphur content)

The Copernicus Emergency Management Service (CEMS) provides data, information and services for disaster risk reduction, a sector also linked to climate adaptation. The management of climate-related disaster threats (in particular in the case of floods, fires and droughts) is facilitated via its Risk and Recovery Mapping component, which provides maps combining hazard information with socio-economic data to support effective preparedness, prevention and disaster risk reduction activities. Local governments can use Copernicus, through their national contact point, to have up-to-date risk assessments in support of their planning processes. Recent examples include flood risk assessment in Sardinia, flood risk in Bolivia and multi-risk assessment in Madeira.

The Copernicus Security Service (CSS) provides information in response to Europe's security challenges. It works in three key areas: Border surveillance, Maritime surveillance and Support to EU External Action. In the area of border surveillance, the main objectives are to reduce the death toll of illegal immigrants at sea, to increase the internal security of the European Union and to the fight against cross-border crime. FRONTEX is entrusted with the service's operation. In the area of maritime surveillance, the overall objective of the European Union is to support Europe's maritime security objectives and related activities in the maritime domain. The corresponding challenges mainly relate to safety of navigation, support to fisheries control, combatting marine pollution, and law enforcement at sea. The entrusted entity is EMSA. The EU External Action Support takes care of the responsibility of the EU as global actor to promote stable conditions for human and economic development, human rights, democracy and fundamental freedoms. In this context, EU can provide assistance to third countries in a situation of crisis or emerging crisis and help preventing global and trans-regional threats having a destabilising effect. EUSATCEN is the entrusted entity for this part of the service.

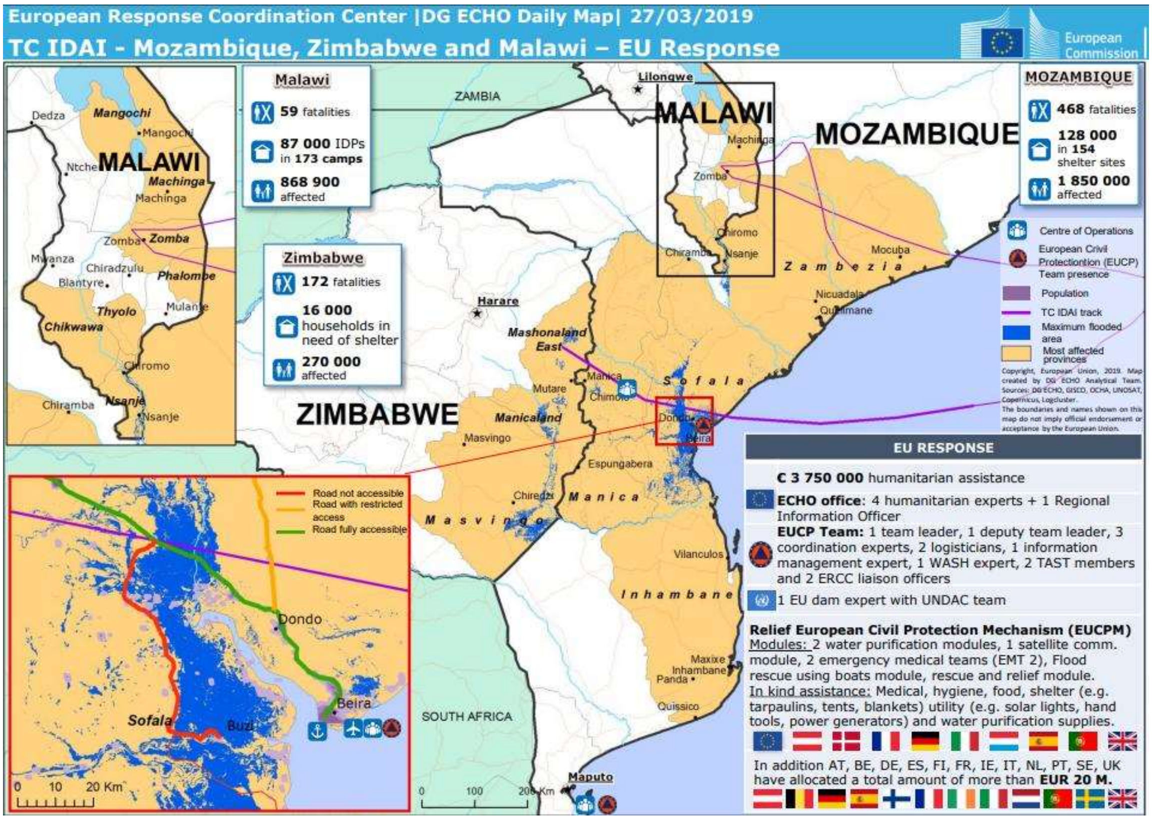
2 Selected Case Studies of EO Uptake

The dialogues with policy makers in different policy Directorates-General confirmed an increasing interest, trust and use of Earth-observation related data and information. Although tailor-made products differ strongly amongst the policy DGs, the need for using EO information, and the support for translating policy requirements into technical criteria show large similarities. Case studies per policy DG have been selected to illustrate these needs and the ways for approaching and ingesting the EO information, Copernicus products into the policymaking.

The following seven subsections illustrate the EO / Copernicus uptake with examples of DG ECHO (long-standing uptake), DG AGRI (diversified growth in uptake with different applications), DG ENV (with a substantial uptake from several Copernicus services), DG CLIMA (in-depth growth in uptake for forest monitoring), DG ENER (as new user), DG DEVCO (targeting in particular the African Union) and DG REGIO (as user with growing experience).

2.1 Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO)

Fig. 2: Example of Copernicus Emergency Service input to DG ECHO



DG ECHO supports implementation of the Sendai Framework for Disaster Risk Reduction and contributes to the Global Campaign of 'Making Cities Resilient' by the UN Office for Disaster Risk Reduction (UNISDR). The heart of the EU Civil Protection and Humanitarian Aid Operations is the Emergency Response Coordination Centre (ERCC), which coordinates a quick response to disasters both inside and outside Europe, making use of real-time information on disasters and hazards. Geospatial needs are those required for Disaster Risk Management with emphasis on the support of preparedness for emergency interventions. Thereto DG ECHO relies fully on the Copernicus Emergency Management Service and directly employs the flood awareness system, the fire information system, the drought observatory and the on-demand rapid mapping for crisis impacts, risks and recovery. Furthermore ECHO also uses the Climate Data Store of the Copernicus Climate Change Service, land cover products developed under the Copernicus Land Monitoring Service, the global human settlements layer in particular, and even the products of the Copernicus Security Service.

2.2 Directorate-General for Agriculture and Rural Development (DG AGRI)

DG AGRI oversees several Common Agricultural Policy (CAP) processes for which geospatial information is key. Several types of data are needed:

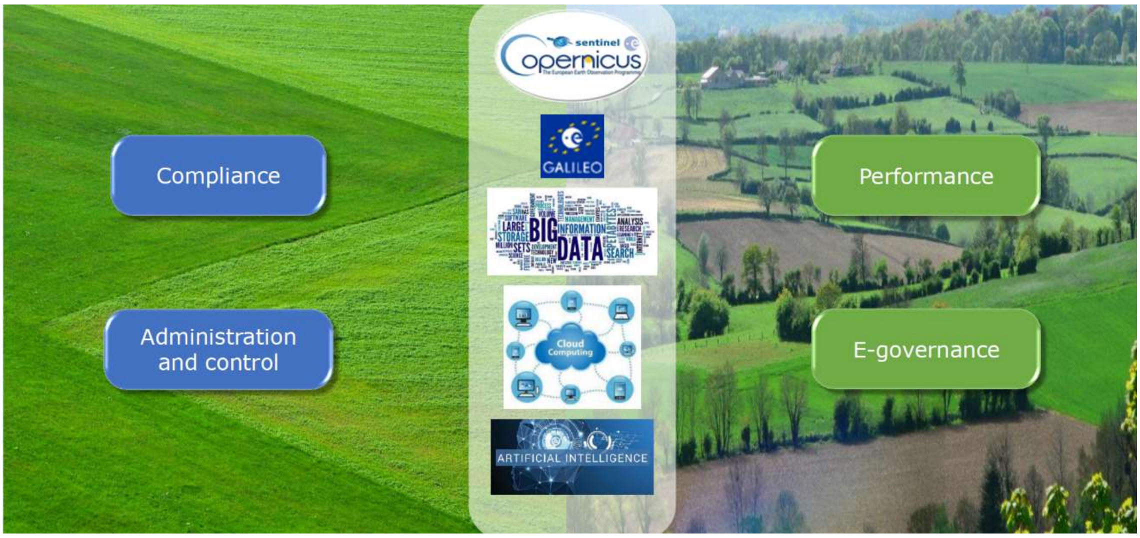
(i) the Land Parcel Identification System (LPIS) covering the entire European territory and based on image sources (aerial or satellite);
(ii) on-demand Earth observation data, samples or field activities for checks over selected areas;
(iii) high resolution Sentinel 1 and 2 data with high revisit time for monitoring agricultural practices;
(iv) Sentinel 3 data for yield forecasting and identifying exceptional circumstances;
(v) other data supporting and informing on-farm agronomic practices.

Fig. 3: Digitisation and simplification of parcel monitoring: information on mobile

As part of the post-2020 CAP, Copernicus data and (Copernicus Land Monitoring Service) information will also be used to improving the environmental performance of farms, through systems such as the proposed Farm Sustainability Tool and Platform, which can support both environmental compliance measures and environmental commitments.

With the new CAP, indicators monitoring progress towards targets can also be developed using Copernicus data. Smart use of combined technologies, with high revisit Sentinels 1 and 2 satellite data, the LPIS, e-government tools and precision farming devices (incl. handheld) will allow a move towards a year-round monitoring of all aid applications and subsidies. While the Member States are given greater responsibility, EU technical support – based on increased inter-service cooperation and state-of-the art data exploitation technologies - will be needed for optimal data use, interoperability and mutualisation of costs and solutions at EU level.

Fig. 4: The new Common Agricultural Policy



2.3 Directorate-General for Environment (DG ENV)

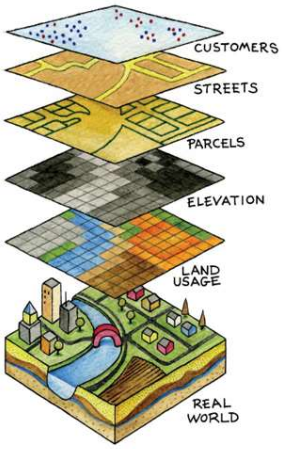
DG ENV is a main user of Copernicus data and its use of Earth observation data products seems mature. It is starting to build a support system collecting Earth observation evidence in an organized way, also for evaluating compliance with policies in force. Earth observation data for the evaluation of a case of environmental non-compliance has been accepted by the European Court of Auditors. This created a precedent and testament to the applicability of Earth observation (EO) data within the field of Environmental Compliance. EC's Environmental Compliance and Governance Action Plan requires: (i) compliance promotion (e.g. with EU's air quality index), (ii) compliance monitoring (e.g. on maritime security and oil spills) using inspections (in-situ or remote) to provide solid evidence for enforcement, incl. examination of complaints by the public, (iii) follow-up and enforcement (e.g. with infringement cases as experienced with the Habitats Directive).

A capacity of geospatial intelligence making use of Earth observation monitoring and Copernicus data is considered to complement the reported information and back up enforcement mechanisms. Using a more structured approach with systemic monitoring over larger areas for longer periods (raising alerts in case of anomaly detection) and ad hoc monitoring that is launched in case of a complaint/petition/written question, compliance will be assessed for the following environmental policy areas:

(i) waste (landfills, ship recycling),
(ii) protected areas (Natura 2000 sites),
(iii) water quality and quantity,
(iv) industrial emissions, and
(v) air quality.

Looking forward, Copernicus plans to address, in a more targeted way, a broad range of Policies under DG ENV's remit. One specific example is the support to the Marine Strategy Framework Directive (MSFD) as well as the Water Framework Directive (WFD). Over the past years, CMEMS has developed a unique capacity to observe and forecast the biogeochemical content of seas and oceans such as content in nutrients, but also plankton types or water optical properties On the MSFD, CMEMS is planning, in the context of its Service evolution for the next MFF, additional elements to better address marine biogeochemistry, ecology and coastal regions and therefore to better serve the needs of European and EU Member State institutions working on these topics.

Fig. 5: Geospatial intelligence framework for Environmental Compliance



GEOINT gathering disciplines (method) with geospatial data:

- Measurement/signature intelligence
- Signals intelligence
- Imagery intelligence
- Human intelligence
- Open-source intelligence

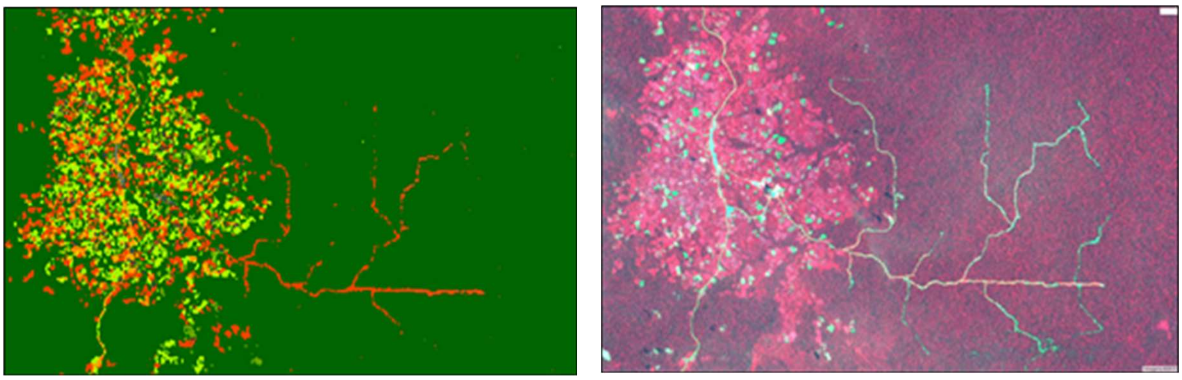
2.4 Directorate-General for Climate Action (DG CLIMA)

DG CLIMA has recently increased its use of Copernicus data in the "Land Use, Land-Use Change and Forestry" (LULUCF) sector. Forest cover is considered important as net CO_2 sink in temperate and boreal countries and is taken up in the climate targets of the EU. Under the LULUCF regulation the MS are required to inventory and report land use using geographical tracking of land area, making use of the Land Use Cover Area frame Survey (LUCAS) as well as Earth observation data from Copernicus (Land Cover products) and services from Galileo. Long time periods (from 1990 onwards) need to be covered with high accuracy for spatially-explicit change detection by inferring geo-tracked conversions between subsequent years.

Outside Europe, the EU has been fighting illegal logging with the Forest Law Enforcement Governance and Trade (FLEGT) agreements, a voluntary scheme to ensure only legally harvested timber is imported. The UNFCCC broadened this with the multilateral incentive for Reducing Emissions from Deforestation, forest Degradation (REDD+) to conserve and sustainably manage forests and their carbon stocks. These policies require tropical countries to assess and document changes in forests based on transparent, reliable and repeatable methods. Sentinel 2 satellite data complemented with airborne Radar and Lidar data allows for independent monitoring if frequent acquisitions are available. Web platforms and online decision support tools were built so that partners can analyse the data. With higher resolution, disturbances are characterized even better and help protect road-free intact forests.

The results can be also monitored by the Global Climate Observing System (GCOS) via the Essential Climate Variables (ECV), addressing a.o. the global carbon cycle. Ultimately, also the anthropogenic GHG emissions are an example of an ECV, for which an operational capacity of observation-based monitoring and verification support is building up, to complement the national inventories in the transparency framework of the Paris Agreement.

Fig. 6: Comparison of forest map at 30 m resolution and Sentinel2 imagery at 10m resolution in the Democratic Republic of Congo to characterise forest-cover disturbances during 2016-2020 (under the REDD+ policy)



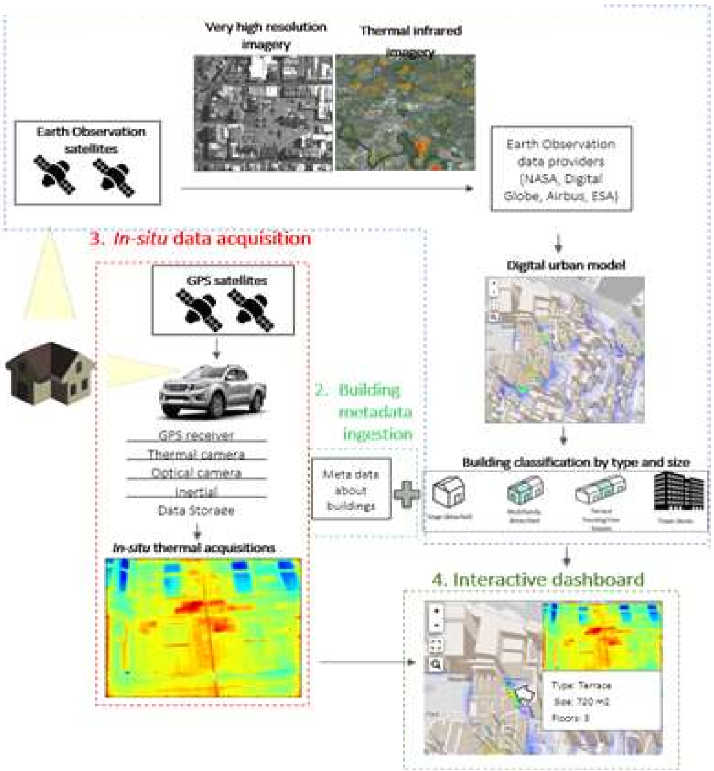
2.5 Directorate-General for Energy (DG ENER)

DG ENER is under the 2030 energy and climate package (and subsequent clean energy winter-package of 2016) pushing for the deployment of renewable energy sources, for the increase of energy efficiency and for the reduction of GHG emissions. The selection of appropriate regions for installing photovoltaic (PV) solar panels or wind generators needs an assessment of the meteorological conditions, and for the latter of soil roughness properties. The Copernicus Climate Change, Land and Atmospheric Monitoring Services provide input data that are helpful for this assessment. Information on desert dust and other aerosols are provided to prevent power efficiency losses of solar power plants. Even for the hydropower, the design and capacity of the reservoirs need input on the current and future climatic conditions.

Moreover, the research community enabled the use of high-resolution Earth observation data to support the installation of rooftop photovoltaic panels. Operational applications using Earth observation data to monitor and enhance energy efficiency monitoring are in place. Very high resolution optical, multispectral and potentially thermal infrared satellite data could be used to make wide area data sets of urban environments from which buildings of highest interest for in-situ thermal scanning could be selected. However, a feasibility study is still pending.

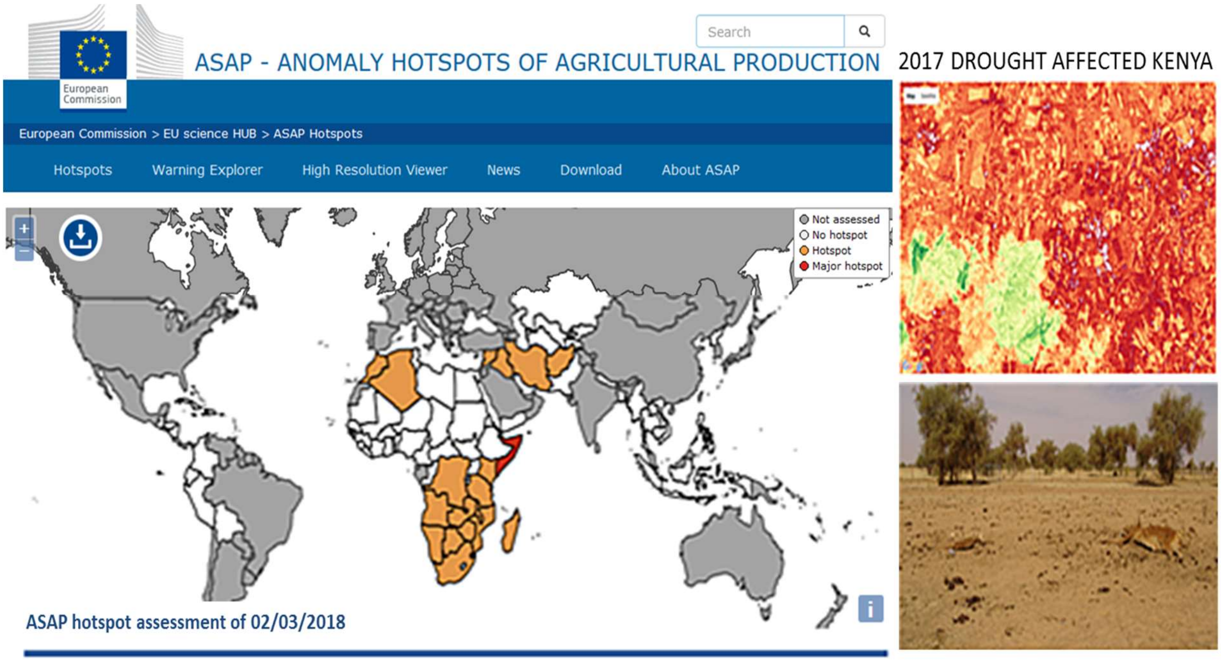
Similarly, the sector of marine renewable energies that is developing in Europe and worldwide is keen on using ocean forecast products, reanalysis and climate records for site assessment and energy efficiency planning using the Copernicus marine service and the Copernicus climate change service (specially using currents, waves, tides and wind information products).

Fig. 7: Thermal imaging concept for buildings in ThermCERT exploratory project



2.6 Directorate-General for International Cooperation and Development (DG DEVCO)

Fig. 8: Global network against Food Crisis



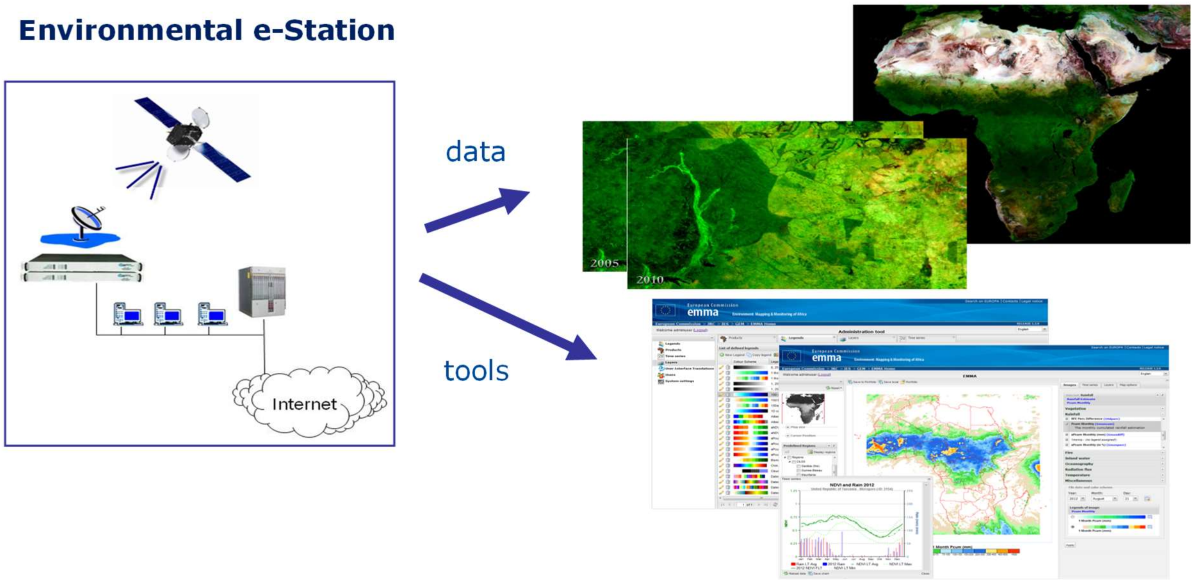
DG DEVCO is in charge of development policy in a wider framework of international cooperation, adapting to the evolving needs of partner countries and tackling roots and conditions of the extreme poverty in which today about 767 million people continue to live. Roughly two-thirds of the extreme poor live in rural areas and directly depend on natural resources for their subsistence (mainly Sub-Saharan Africa and South Asia). Food and nutrition insecurity, caused by increasing land pressures under the exponential population growth and continued climate change, is a growing concern of peace and stability and drive of migration. DG DEVCO has managed for several years the GMES-Africa project to promote the use of Earth Observation and Copernicus services by African countries and to support this region in overcoming major challenges.

For countries with limited access conditions, such as protracted crisis countries or in conflict situations, EO analysis can provide useful information on food production, degradation or unsustainable management of natural resources, illegal logging, insecure protected areas, unmanaged polluted sites, destruction of infrastructure and human displacement. For example, tools that monitor pollution, fisheries activities at sea and coastal activities are essential for developing countries where most of the population lives in coastal zones. Early warning systems generally make use mainly of medium and low-resolution satellite data for retrieval of near real-time biomass information and weather indicators. EO-derived geospatial information is increasingly used in projects that couple nature conservation with socio-economic development goals, such as for Biodiversity and Protected Areas Management.

However, as is the case for crop monitoring, the necessary baseline layers also benefit from high-resolution imagery such as that provided by Sentinel or LandSat imagery. Both continental and national EO based early warning systems are integrated in crop insurance or risk management systems. Index based crop and livestock insurance projects are becoming progressively operational and managed internationally. Major early warning systems using EO include the EC's "Anomaly Hotspots of Agricultural Production" (see Fig. 8). Multi-stakeholder initiatives such as the recently launched G20 initiative GEOGLAM provide global agricultural production estimates and early warnings in order to inform the Agricultural Market Information System (AMIS) and to reduce food price volatility.

Land planning and territorial & infrastructure development can also highly benefit from EO information. In order to respond faster and become more resilient to extreme weather conditions, environmental e-stations (see Fig. 9) that upgrade climate stations are set up and further equipped to predict crop yield loss locally in a timely manner.

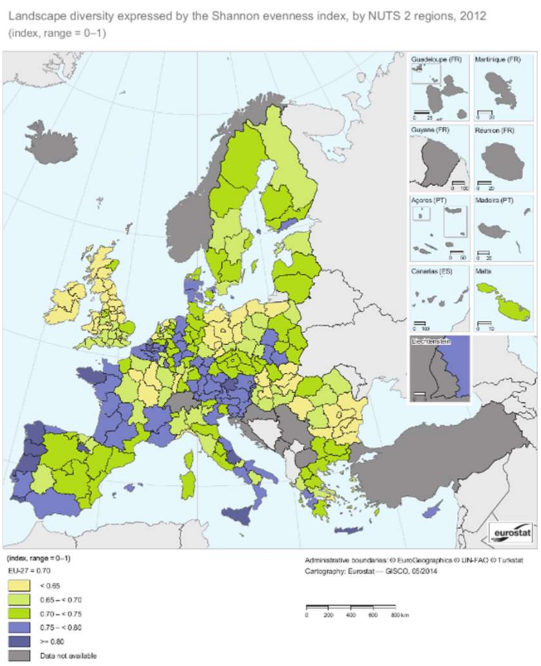
Fig. 9: The environmental e-station in African - Caribbean – Pacific countries



2.7 Directorate-General Regional and Urban Policy (DG REGIO)

DG REGIO is responsible for the implementation of cohesion policy and interregional development in Europe, including the economic analysis. DG REGIO coordinates EU policies linked to cities both within the EU and globally, by means of the European Regional Development Fund (ERDF), the Cohesion Fund (CF) and the European Social Fund (ESF). The territorial dimension of Cohesion Policy has become increasingly prominent, with more need for spatial and high-resolution data. DG REGIO uses GIS data and relies on ready-to-use final products, such as the CORINE Land Cover inventory and Copernicus Urban Atlas (with long time series of land use and land cover data for functional urban as well as rural areas), the Global Human Settlement Layer (informing about the presence of built-up areas and population for the epochs 1975, 1990, 2000 and 2015), the high resolution maps of the European Settlement and Imperviousness Layers.

Fig. 10: Land Use/Cover Area frame Survey at NUTS level 2 (EuroSTAT, 2012)



The Land Use/Cover Area frame Survey (LUCAS) is still used as an indicator on artificial land use for EU's Sustainable Development Goals, but this could be replaced by the CORINE Land Cover inventory if temporal and spatial resolution increase. In addition to the very high spatial resolution, DG REGIO expressed interest in building heights, building footprints and road width. Further increasing update frequency and improving land-use data are key for enhancing uptake in regional policymaking.

3 Overall Results on Copernicus Uptake

3.1 Established users see potential for increased uptake in the short term

The study provided a granular and detailed series of sections describing current and potential uptake of EO derived data (in particular from Copernicus) for policymaking. Each section of the report was devoted to a specific policy Unit and was the result of a dedicated dialogue with the policy DG.

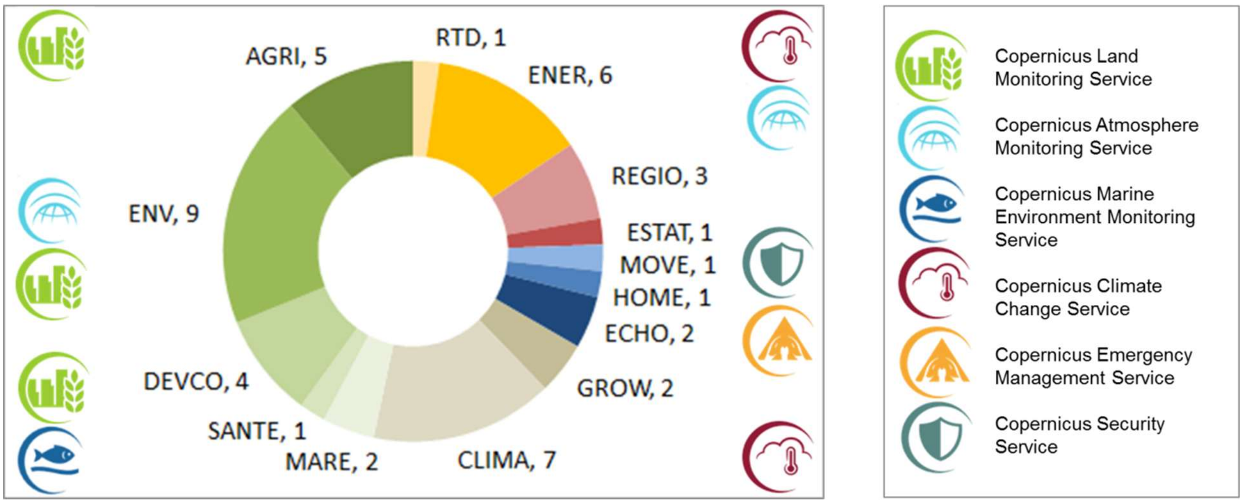
Fig. 11 gives a thematic overview of the different sections in the report, grouped by the type of Copernicus product uptake (from the Copernicus land monitoring service, to the Climate Change service, to the Emergency service). The DG ENV sections represent 20% of the report, followed by DG CLIMA 16%, ENER 13%, AGRI 11% and DEVCO 9%.

This overview already brings certain EU polices into focus, as areas where in-depth co-design needs to be further pursued. Most examples of early uptake are drawn from the environment and climate domains, for which several policy Units use products and information from the Land Monitoring and Climate Change services, along with Emergency and Marine services.

Large uptake is observed for DG Environment (DG ENV), DG Agriculture (AGRI), DG Energy (ENER) and DG Climate Action (CLIMA). For DGs AGRI and CLIMA, this is not a surprise. Both policy areas have a long history of using geospatial data, including from EO sources. Environment, climate, CAP and development cooperation policy all demonstrate interest in the increased availability of high-resolution (spatial resolutions of 10m) and improved temporal resolution (close to weekly revisit) capabilities.

Documenting accuracy, and ensuring it is good enough to provide independent observation-based evidence for determining policy compliance has resulted in greater acceptance of EO for reporting and compliance. Policy DG Units dealing with environment, climate and agriculture all show where Copernicus data and information was used at different stages of the policy cycle: in the anticipatory phase (based on global information), in the policy design phase (e.g. LULUCF policy), in the implementation and even in the law enforcement phase (e.g. for environmental compliance).

Fig. 11: Overview of the uptake of the Copernicus services by different policy DGs. The different services target different policy DGs (the land service for AGRI, ENV, DEVCO and SANTE; the atmosphere service for ENV and ENER, the marine service for MARE; the climate service for CLIMA, RETD and ENER, the emergency service for ECHO and the security service for MOVE and HOME)



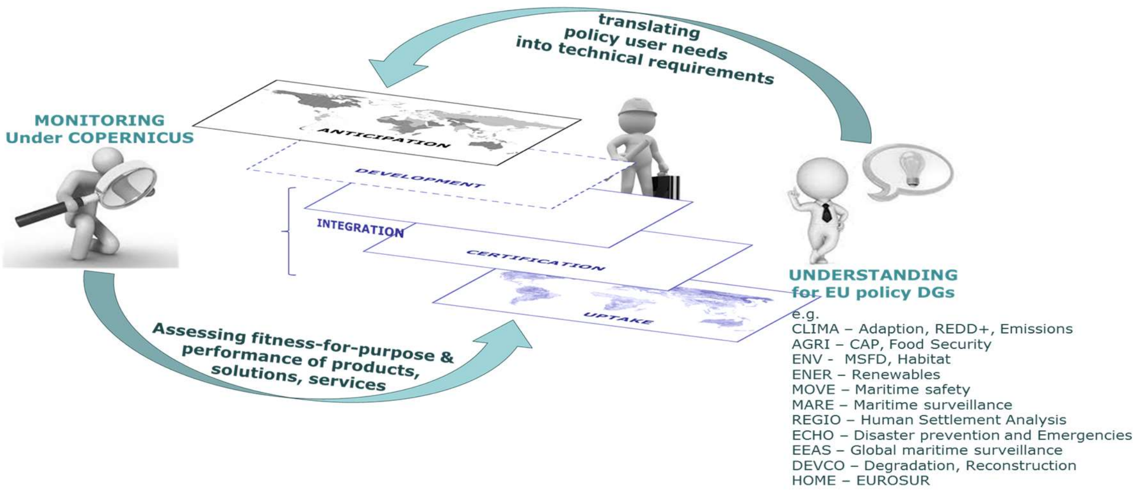
3.2 Medium-term uptake from emerging policy issues

For DG ENER, a strong interest in climate-related impacts on the planning of renewables based on space-borne observations is observed. In order to achieve a higher GHG reduction target, as present in the Green Deal, DG ENER would like to make use of observations-based evidence of emissions of carbon dioxide as well as methane from fossil fuel use. For DG Environment (DG ENV), many sections with a prominent uptake of EO and Copernicus derived data are covered. Complete coverage was not obtained, and the exercise should continue to engage the different policy DGs with dialogues. Security-related policies need further evolution towards higher acceptance and uptake of EO information. The topic is more sensitive and EU-level Earth observation still needs to be further developed for applications within the Copernicus Security Service. The specific user requirements to the Security service would deserve further analysis of the requirements for EU's Foreign Policy (CFSP/CSDP), in order to boost the currently lower level of user uptake.

International challenges are addressed through UN agreements, such as the Paris Agreement, the UN Convention for Combating Desertification (UNCCD) or the Biodiversity Convention (CBD), the UN ocean decade of Science as well as the UN Agenda 2030 with the *Sustainable Development Goals*. EU is collaborating with UNFCCC, UN Environment Programme (UNEP) and FAO. FAO and UNEP are also known as Custodian Agencies for Sustainable Development Goals on e.g. hunger, water, soil. Whilst in the early 2000s Earth observation was presented as a tool for monitoring countries' status or activities, in 2015 with the Paris Agreement and the Agenda 2030, Earth observation is mainly promoted as a tool that supports the follow-up of environmental actions, climate change measures and sustainable development. EuroGEO is the European component of the Global Earth Observation System of Systems (GEOSS) under the Group on Earth Observations (GEO) and focuses on coordination and scaling up user-driven applications for Europe's benefit. Countries and citizens increasingly recognise the value of Earth observation tools for monitoring the implementation of such actions in a transparent way around the globe.

Fig. 12: JRC Support to the translation of policy requirements into EO System requirements

Lessons learned



Addressing the needs of European Union policy remains a key driver in identifying requirements for the evolution of the Copernicus Programme on Earth observation. Copernicus needs to be responsive to current and emerging EU policy priorities and periodically undertake gap analyses to ensure that the observations, products and services remain fit-for-purpose. Copernicus needs to manage geospatial data and to provide user driven products, services and predictions for policies where a Commission mandate is essential. Within the European Commission, the JRC aims at supporting DG GROW in translating the policy requirements into EO system requirements.

For a policy-driven Copernicus service, it is necessary to help the policy DGs translate the EO-derived data into actionable information with indicators that can be used for monitoring. Entrusted Entities in charge of Services, are constantly working to reach this goal under the leadership of DG GROW. For the future, however, to enable better policymaking, there is a need to evolve from merely monitoring Earth-observation-based indicators to understanding the impact of human activities on the Earth. Such a transition requires scientific and technical support. Vice versa, the translation of policy requirements and targets into technical criteria is a complex process of continuous dialogue between different communities with different jargon. A prime example of such translation is given for the 2030 Agenda with the Sustainable Development Goals, where statistical offices of the UN Custodians of an SDG need to evaluate a set of data, which can be EO-related: the Global Surface Water Explorer has succeeded to be accepted by the Expert Group on the SDG Indicator 6.6.1 for Water-related Ecosystems and creates a precedent of an Earth-observation driven SDG Indicator dataset. The Ocean acidity monitoring indicator produced by the Copernicus Marine Service has been defined as the baseline to produce the equivalent EU SDG14 indicator by EUROSTAT. Other examples, such as the Copernicus Land Productivity Dynamics are expected to follow. These two examples are illustrated with Figures 13 and 14 on the Global Surface Water Explorer and the Land Productivity Dynamics, respectively.

Fig. 13: Global Surface Water Explorer (providing SDG6.6.1 on water-related ecosystems)

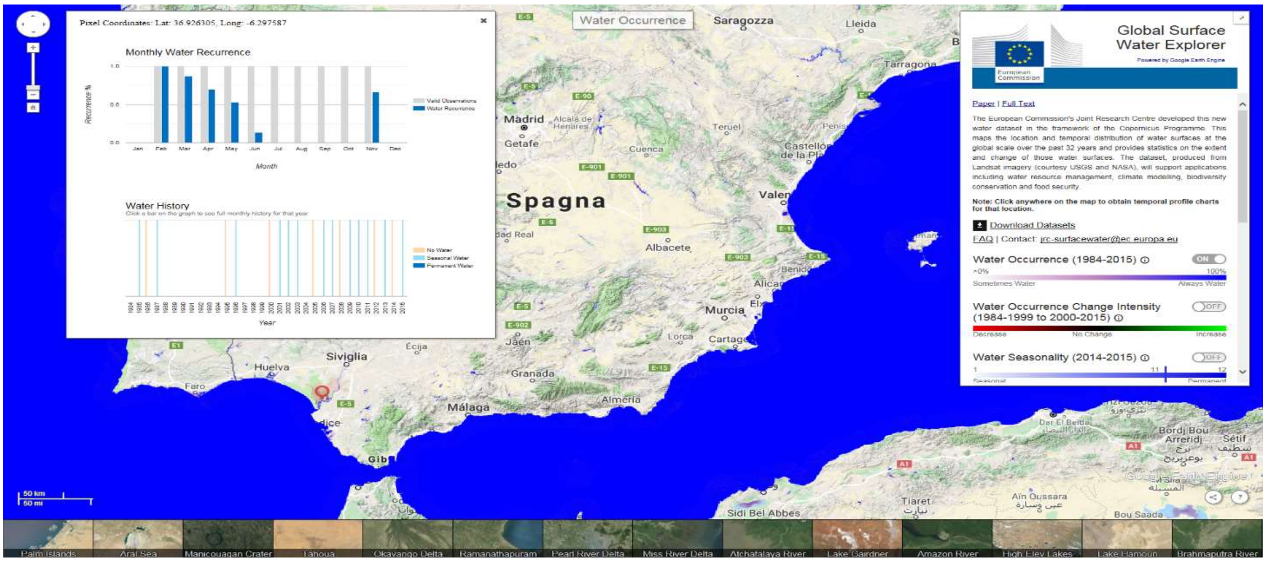
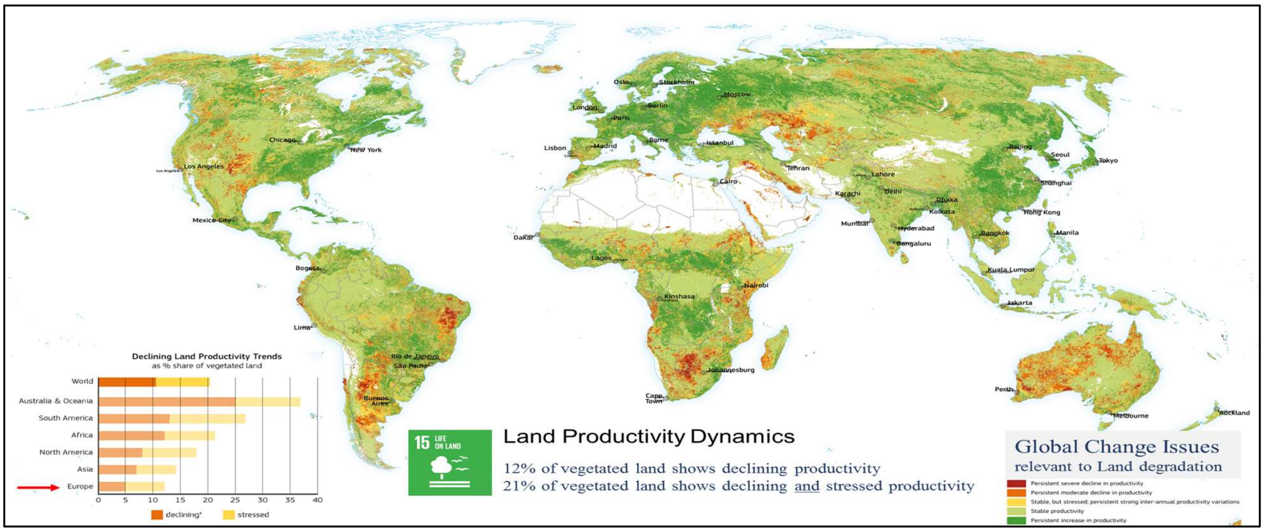


Fig. 14: Land Productivity Dynamics as SDG 15.3.1 on land degradation (Copernicus Global Land Service)



4 Way Forward

The Copernicus uptake study shows the remarkable progress achieved at EC level in raising awareness and acceptance of the potential of Copernicus for policy and in getting an increasing number of Commission services to use, or want to use, Copernicus-based information products in their sectors and policy areas. The study also shows that further refinement of instruments and working methods at the Commission level is needed to fully utilize Copernicus data and information products for informing EU policy cycles (from development to implementation).

In line with the Commission's aspiration for better cooperation on data use and the development of digital solutions, policy DGs are increasing capacities to use Copernicus data and information to inform EU policy. The study shows the potential, and a lot of room for improvement, for getting most relevant Commissions services on board as active users of Copernicus-based products, i.e. as dynamic generators of demand and feedback for products included in their work processes.

This study identified several lines of action improve uptake:

Increased engagement within the policy Directorates-General

The Copernicus Inter-service Group, in synchrony with other internal Commission knowledge management work streams, will be solicited in a more proactive and coordinated use. It is envisaged to integrate other work streams and increase awareness of the potential and benefits of using geospatial information through the Copernicus Inter-Service Group contact points. For a better understanding of the capabilities of Earth observation data and information in the policy DGs, it is recommended to build up small teams of colleagues in the DGs themselves or delegated to the DGs, who are – or could be – promoters and active users of Copernicus-based products, able to express clearly the need for information products. This should take part in the iterative development of such products, in close collaboration with policy and operational Units.

Feedback loops between the end-users and Copernicus services

New working methods are envisaged to generate efficient feedback loops that include, first and foremost, the final users of the information products in the DGs. For an engaged uptake of Copernicus-based products, a dialogue between the users and the product providers of complex geospatial information products is necessary. These dialogues are different for the distinct policy DGs and part of a new working method for policy makers working with digital information using advanced IT and decision support tools instead of pre-packaged reports.

Increasing communication, information and training

The uptake of EO-derived data and information should be accompanied by training in order to foster an agile and policy-centric approach to the demand for, and creation of, information products in the Commission. Policy makers should be made better aware of what Earth observation/ Copernicus can offer technically, and Copernicus developers should be made better aware of policy needs and processes. Training and demonstrations are key to success. The availability of widely known, easily accessible and user-friendly platforms is a fundamental pre-requisite.

Guaranteeing QA/QC and standards

Creation of particular standards and reference datasets will be increasingly needed for the policy DGs, given the seemingly exponential growth in available Earth observation data and information, and related tools. The quality assessment and control of Copernicus products and tools, in particular with regard to their fitness for purpose, is essential and will be of use to evaluate also other Earth observation information obtained outside the Copernicus programme.

Enabling full integration of different datasets

Ensure the availability not only of high-quality data but also enabling easy combination of different datasets. The new cloud-based platforms, providing centralised access to Copernicus data and information and to processing tools, known as the Data and Information Access Services (DIAS) should be the vehicle for this. Specific dashboards or information systems tailored to the needs of policy DGs are proposed as user-friendly access of the information to the various EU services. Concerning applications to the Commission internally, the JRC Earth Observation Data and Processing Platform (JEODPP) could have a role.

Setting the example at top level

Changing the source of data requires resources and time to check the differences and assess the suitability. Support at higher hierarchical level for a deeper involvement of the different EC DGs is needed for a smooth transition including also Earth observation data and information for enhanced policy planning and implementation. Setting Earth observation as a priority with the purpose to take up observation-based evidence has proven to be essential for its increased uptake.

Within this fast-evolving scientific field, it is necessary to keep scanning the horizon as new products and better data are becoming available at ever-greater frequency. Bringing these latest products and data into the policy field to define tailor-made products requires a proactive building-up of collaboration between the Earth observation scientists and the policy DG. Fresh demand for products should be stimulated with innovative solutions brought by the best information providers on the market, both public and private. This will have the added benefit of engaging the downstream Copernicus sector in meaningful work to meet the needs of the public sector, including Commission services.

In today's ocean of information, a more structured and proactive EC-level approach is needed that supports current users and gives better guidance to new users.

5 Conclusion

The six Copernicus services support citizens and policy makers in monitoring the environment and security globally, over land and ocean. The User Intake study indicates an extensive use of the services by DG AGRI, DG CLIMA, DG DEVCO and DG ENV for monitoring land-use and climatic and environmental conditions, a trend expected to increase in response to demand from the new Common Agricultural Policy as well as the Land Use, Land-Use Change and Forestry Regulation.

Information created by the Climate Change Service on optimal land-use that targets specific human activities provides policy makers with a new set of adaptation measures by harnessing the constructive opportunities of climate change. With this holistic approach, the atmosphere service can monitor air quality measures used in DG ENV. The marine service provides input to the DG MARE information system for marine knowledge, which supports several initiatives such as the Common Fisheries Policies. The emergency service supports DG ECHO with disaster-risk-reduction measures as well as DG DEVCO for the resilient build-up of society. Finally, the Security service provides vital information where land and water resources are at the origin of conflict and migration, as used by DGs ECHO and ENV.

This initial study offered insights and lessons from an evaluation of the Copernicus data uptake for each target policy unit. Interestingly, most policy units do not directly use the satellite data and instead allocate processing to satellite data experts. However, an increasing number of agriculture, environment or climate related policies explicitly mention the use of Copernicus data to monitor the implementation of the policy measures. Long-term expertise on land service for DG AGRI, DG CLIMA and DG ENV provides the recognition by the policy makers of the value of Sentinel data. This is also true for DGs with global outreach, such as DG DEVCO, DG ECHO and DG MARE; while the global monitoring dimension with the same standardised data provides a great benefit, the Copernicus data are not all exploited fully. It might be useful to create user communities at the policy DG level in order to foster additional uptake. Additionally, some target policy units with strong technological interest, such as DG ENER or DG MOVE, show large interest in potential future use of Copernicus data.

The extensive Copernicus Programme has now become mature. Over the past five years, it has considerably increased its uptake within the private sector, creating an entire downstream market, as well as with governmental organisations that have Earth Observation-derived information uptake for policymaking. Policy Directorates-General are becoming increasingly aware of the tremendous potential for geospatial intelligence, homogeneous and objective Earth Observation-derived data for monitoring indicators of environment and climate, air and water quality and their availability for multiple policies. Observation-based evidence is increasingly demanded to streamline EU policies and to assess coherence. A veritable transformation in the scale of uptake of Copernicus and Earth Observation-related data and information can be stimulated and this will require the Commission's technical expertise to further bridge the technical data from Copernicus sensors and services in order to deliver actionable information for policy makers.

References

Copernicus uptake Study: Kucera, J., Janssens-Maenhout, G., Brink, A., Greidanus, H., Roggeri, P., Strobl, P., Tartaglia, G., Belward A. (ed.), Copernicus Uptake in the European Commission, JRC report 115133, 2019

EC Document on Copernicus User Requirements: Commission Staff Working Document of 2019, User Requirements for the Copernicus Programme, forthcoming 2019.

EU Space Regulation: Regulation (EU) No 1285/2013 of the European Parliament and of the Council of 11 December 2013 on the implementation and exploitation of European satellite navigation systems and repealing Council Regulation (EC) No 876/2002 and Regulation (EC) No 683/2008 of the European Parliament and of the Council

EU Regulation No 377/2014 of the European Parliament and of the Council of 03.04.2014 on establishing the Copernicus Programme

EC Communication on Agriculture: Communication from the Commission to the European parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: The Future of Food and Farming, COM(2017) 713 final,

Common Agricultural Policy Regulation: Regulation (EU) No 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) No 352/78, (EC) No 165/94, (EC) No 2799/98, (EC) No 814/2000, (EC) No 1290/2005 and (EC) No 485/2008

EC Note on the Strategy of DG AGRI: European Commission DG AGRI, Strategic Plan 2016-2020, Ref. Ares(2018)255561 - 16/01/2018

EU Regulation on Land Use, Land-use Change and Forestry: Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU

EU Regulation on Greenhouse Gas Monitoring: Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities.

UNFCCC Paris Agreement: United Nations Paris Agreement UNFCCC of December 2015, https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

EC Communication on Forest Strategy: Commission Communication COM(2013) 659 of 20.9.2013 on A new EU Forest Strategy: for forests and the forest-based sector.

EC-JRC Report on CO_2 monitoring planning: Pinty B., G. Janssens-Maenhout, M. Dowell, H. Zunker, T. Brunhes, P. Ciais, D. Dee, H. Denier van der Gon, H. Dolman, M. Drinkwater, R. Engelen, M. Heimann, K. Holmlund, R. Husband, A. Kentarchos, Y. Meijer, P. Palmer and M. Scholze (2017): An Operational Anthropogenic CO_2 Emissions Monitoring & Verification Support capacity - Baseline Requirements, Model Components and Functional Architecture, doi: 10.2760/08644, European Commission Joint Research Centre, EUR 28736 EN

EC-JRC Report on cooperation & development within Africa: EC JRC, 2017. Science for the AU-EU Partnership: building knowledge for sustainable development. Luxem-bourg. doi:10.2760/429935

EC Document on Energy in International Development Cooperation: EU Energy Initiative EUEI, (2017), The European Portfolio on Energy in International Development Cooperation, European Union Energy Initiative Partnership Dialogue Facility

EC Decision on Pan-African Programme: Commission Implementing Decision of 19 July 2016 C(2016) 4513 final on the Annual Action Programme 2016 for the Pan-African Programme to be financed from the general budget of the European Union, with Action Document for the GMES and Africa Support Programme.

EC Communication on Disaster Manage-ment: Communication from the Commission to the European Parlia-ment and the Council, COM(2017) 773 of 23.11.2017 Strengthening EU Disaster Management: rescEU – Solidarity with Responsibility.

EC Document on Disaster Risk Reduction Action Plan: Commission Staff Working Document SWD(2016) 205 final/2 of 17.6.2016 Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030 – A disaster risk-informed approach for all EU policies

EC Decision on a Union Civil Protection Mechanism: European Union Decision no 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism.

EC Directive on Energy from renewables: Directive of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) (Text with EEA relevance), OJ L 328, 21.12.2018, p. 82-209

EU Regulation on the Energy Union: Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013, of the European Parliament and of the Council (Text with EEA relevance), OJ L 328, p.1-77

EC Communication on Soil Protection: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, COM/2006/0231 final, Thematic Strategy *for* Soil *Protection* [SEC(2006)620] [SEC(2006)1165]

EC Directive on Environmental Project Assessment: Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, OJ L 26, 28.1.2012, p. 1–21.

EC Directive on Environmental Programme Assessment: Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ L 197, 21.7.2001, p. 30–37.

EC Document on EU Environment Reporting and Monitoring: Commis-sion Staff Working Document, SWD(2017) 230 final, Fitness Check of Reporting and Monitoring of EU environment Policy, Accompanying the document: Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Actions to Streamline Environmental Reporting COM(2017) 312 final.

EC Communication on Environmental Compliance: COM(2018) 10 final of 18 January 2018, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: EU actions to improve environmental compliance and governance SWD(2018) 10 final.

UN 2030 Agenda on Sustainability: United Nations, Transforming our world: The 2030 Agenda for Sustainable Development, Resolution adopted by the General Assembly on 25 September 2015, A/RES/70/L/1

UN Publication on EO for Statistics: United Nations, Earth observation for Official Statistics – Satellite Imagery and Geospatial Data Task Team report of 5th December 2017, White Cover publication,

EC Communication on Raw Materials: Communication COM(2011) 25 of 2 February 2011 on Tackling the challenges in commodity markets and on raw materials

EC Communication on Hybrid Threats: Joint Communication JOIN(2016) 18 final of 6 April 2016 to the European Parliament and the Council: Joint Framework on Countering Hybrid Threats: A European Union Response

EC Directive on Vessel Traffic Monitoring: Directive 2009/17/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system (Text with EEA relevance)

EC Regulation on illegal fishing: Commission Regulation (EC) No 1010/2009 of 22 October 2009 laying down detailed rules for the implementation of Council Regulation (EC) No 1005/2008 establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing

EC Communication on EU's outermost regions: Communication COM(2017) 623 final frp, the Commission to the European Parliament, the Council. The European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A stronger and renewed strategic partnership with the EU's outermost regions

EC Document on Cities: Commission Staff Working Document, with the agreement of UNHABITAT, 2016, The State of European Cities 2016 – Cities leading the way to a better future, ISBN 978-92-79-64260-9, doi: 10.2776/770065

EU Regulation in response to the severe floods in Central Europe: Council Regulation (EC) No 2012/2002 of 11 November 2002 establishing the European Union Solidarity Fund as amended by Regulation (EU) No 661/2014 of the European Parliament and of the Council of 15 May 2014

EU Regulation on plant pests: Regulation (EU) No 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants

List of abbreviations and definitions

AGRI	Agriculture and Rural Development
CAMS	Copernicus Atmosphere Monitoring Service
CAP	Common Agricultural Policy
C3S	Copernicus Climate Change Service
C4EC	Copernicus for the European Commission
CFSP	EU Common Foreign and Security Policy
CEMS	Copernicus Emergency Management Service
CGLS	Copernicus Global Land Service
CLC(+)	CORINE Land Cover (enhanced)
CLMS	Copernicus Land Monitoring Service
CLIMA	Climate Action
CMEMS	Copernicus Marine Environment Monitoring Service
CNECT	Communications Networks, Content and Technology
CSDP	EU Common Security and Defense Policy
CSS	Copernicus Security Service
DEFIS	Defence Industry and Space
DEVCO	International Cooperation and Development
DIAS	Data Integration and Analysis System
EAGF	European Agricultural Guarantee Fund
ECHO	European Civil Protection and Humanitarian Aid Operations
ECMWF	European Centre for Medium-range Weather Forecasting
ECV	Essential Climate Variable
EEA	European Environment Agency
EEAS	European External Action Service
EMSA	European Maritime Safety Agency
ENER	Energy
ENV	Environment
EO	Earth observation
EPA	Environmental Protection Agency of USA
ESTAT	European Statistics Office
FADN	Farm Accountancy Data Network
FAO	UN Food and Agriculture Organisation
fAPAR	Fraction of photosynthetically active radiation absorbed by the vegetation

FLEGT	Forest Law Enforcement Governance and Trade
FPI	Foreign Policy Instruments
FRONTEX	European Border and Coast Guard Agency
GIEWS	Global Information Early Warning System
GMES	Global Monitoring and Environmental Security
GROW	Internal Market, Industry, Entrepreneurship and SMEs
GSAA	Geospatial Aid Application
GSWE	Global Surface Water Explorer
HFC	Hydrofluorocarbon
HOME	Migration and Home Affairs
IACS	Integrated Administration and Control System
LPIS	Land Parcel Information System
LSA-SAF	Land Surface Analysis – Satellite Application Facility
LUCAS	Land Use Cover Area frame Survey
LULUCF	Land use, Land-use Change and Forestry
MAOC	Maritime Analysis and Operation Centre
MARE	Maritime Affairs and Fisheries
MARS	Monitoring Agricultural Resources
MCYFS	MARS Crop Yield Forecasting System
MMU	Minimum Mapping Unit
MOVE	Mobility and Transport
MS	Member State of EU28
MSFD	Marine Strategy Framework Directive
NDVI	Normalised Difference Vegetation Index
NEAR	European Neighbourhood Policy And Enlargement Negotiations
REDD+	Reducing Emissions from Deforestation, forest Degradation, conservation, sustainable management of forests and enhancement of forest carbon stocks
REGIO	Regional Policy
RTD	Research and Innovation
SANTE	Health and Food Safety
SCHIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY
TOC	Top of Canopy
TS4FNS	Technical and Scientific Support for Food and Nutrition Security
TROPOMI	Tropospheric Monitoring Instrument
UNCBD	UN Convention of BioDiversity
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention of Climate Change
(V)HR(L)	(Very) High Resolution (Layers)
WAD	World Atlas of Desertification
WFD	Water Framework Directive

List of Boxes

List of figures

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