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Mid-term evaluation of the Copernicus programme (2014-2020)

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Content

1. Executive summary

The Copernicus Earth Observation Programme was launched on 2014[1] to build on and continue the experience of the previous Global Monitoring for Environment and Security (GMES) programme. It aims at building a European capacity to deliver services in the environmental and security fields. Copernicus primarily responds to operational needs of its users – public authorities and companies - through six thematic services (Land, Marine, Atmosphere, Climate Change, Emergency and Security). These services support the development of many applications potentially impacting businesses and organizations in day-to-day business and operations, and facilitating decision and policy making processes. The Copernicus programme thus provides data and services that support added value products and services in several non-space domains, such as for example agriculture, forestry, urban planning, energy and environment. The programme is articulated in three components: space infrastructure, services and in-situ data, inherited from the previous programme (GMES)[2] as well as the governance model, with the delegation of operations and services to delegated bodies.[3]

As requested by the Regulation, an evaluation has been performed, the results of which are here reported, based on an external study including extensive consultation of all stakeholders.[4]The evaluation covers Copernicus first three years of activity (April 2014- April 2017). Five criteria have been applied to assess the programme achievements: effectiveness, efficiency, relevance, coherence and EU-added value. The Programme objectives as defined in the Copernicus Regulation are: monitor the Earth and, more specifically, support the protection of the environment, civil protection and civil security; ensure the European independent access to environmental knowledge and key technologies for earth observation and geo-information services; maximize socio-economic benefits; support the Europe 2020 strategy; foster the development of a competitive European space and services industries and maximise opportunities for European enterprises to provide innovative Earth observation systems and services; and support and contribute to European policies and foster global initiatives such as GEOSS[5].

The evaluation has assessed that the Copernicus programme is globally on track, in line with the achievement of the objectives, and that these objectives are still relevant with current EU political priorities and users' needs, although significant changes in the global socio-economic environment and in the Earth observation domain would require a fine-tuning of the original objectives. The implementation of Copernicus provides tangible benefits. In terms of governance, the Copernicus programme is coherent, both internally between its various components, and externally vis-à-vis other EU measures with similar objectives. EU action is regarded as providing large added value, especially when compared with what could be achieved at national level.

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[1] Regulation (EU) No 377/2014 of the European Parliament and of the Council of 3 April2014 establishing the Copernicus Programme and repealing Regulation (EU) No 911/2010

[2] Global Monitoring for Environment and Security programme- Regulation(EU) No 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES).

[3] European Space Agency (ESA), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), European Centre for Medium-Range Weather Forecasts (ECMWF), Mercator Océan, European Border and Coast Guard Agency (FRONTEX), European Maritime Safety Agency (EMSA), European Union Satellite Centre (EUSC), European Environment Agency (EEA)

[4] PwC "Copernicus interim evaluation", ET-04-17-742-EN-N

[5] Global Earth Observation System of Systems

The Space component of the programme is well advanced in terms of deployment, operations and data delivery. The Copernicus satellites, the Sentinels, are performing very well producing a large quantity of high quality data. Copernicus Services performance regarding the products relevance, the timeliness of delivery and their availability is perceived as satisfactory by the users.

The in-situ component (data from land, air and sea sensors measurements), under coordination of the EEA, demonstrated good results over the period, resulting in a wider catalogue of datasets. However, managing in-situ data has proved to be challenging due to the differences among the providers regarding the data availability, data quality and quantity or licence conditions.

The collection of user requirements for the evolution of the different Copernicus components is well integrated in the programme management processes, although the task remains challenging, considering the wide span of users, both from the research community and the private sector, with sets of different requirements. There is a clear need for a prioritisation exercise between requirements in order to consolidate system specification evolution. In this framework a new procedure for new products has been set up in agreement with stakeholders.

The open data policy is a strong asset for the Programme, stimulating the uptake by the private sector in particular: the number of registered users in the main dissemination hub (the Open Access Hub) reached 82 000 in May 2017, well exceeding the target set at the beginning of the programme. In line with the programme's ambition of being a world leader in Earth Observation data provision, nearly 22 million Copernicus products had been downloaded from ESA's hubs by the end of 2016. This might also be due to the ambitious user uptake activities programme launched since 2015 by the Commission, including awareness events, training courses, start-up support programmes, and regional initiatives. The sizeable socio-economic benefits are encouraging considering the share of the total investment actually spent at this stage. The huge amount of data and information produced represents a challenge for the traditional access and distribution routes planned at the onset: the Commission is responding by launching innovative Data and Information Access Services (DIAS) that shall be operative as of January 2018.

The financial state of the programme shows that the spending is under control. Over the three years under scrutiny, the European Commission commitments to the Entrusted Entities for the implementation of the Services were in line with the initial forecasts, and the development of the Sentinels did not face significant over-costs notwithstanding limited delays for two of them, due to the unavailability of Russian launchers identified as the best economic option for launchers at the time they were procured.

The results show that Copernicus is the most comprehensive Earth Observation programme in the world today and one of the largest data providers (behind Google), making it a real driver for the development of Europe's digital economy.

The complexity of the interaction among the programme's activity clusters (space infrastructures, services supply and users' access) has, however, highlighted the need for a simplification of procedures, to deliver the best results in terms of industrial policy implementation and boost the market uptake efforts. In this framework, the evaluation suggests the possibility of looking into an involvement of an operational agency, for tasks

linked to communication, market uptake, user uptake or services evolution, provided this agency has the necessary resources and expertise.

2. Introduction

2.1 Purpose of the evaluation

Regulation (EU) No 377/2014 of 3 April 2014 establishing the Copernicus programme and repealing Regulation (EU) No 911/2010 sets out in Article 32 the obligation for the Commission to report by 31 December 2017 on the achievements of the objectives and the tasks financed by the programme. To meet this obligation, the Commission has started, at the end of 2016, an evaluation aimed at verifying the sound management of the programme, its achievements as well as the weaknesses of its implementation. Although Copernicus is known to have satisfied and sometimes exceeded all expectations in its first years of activity, many changes in the space sector, both on the internal scene (as the definition and publication of the European Space Strategy), and at international level (for example: the emergence of a new space economy), suggest that the moment is appropriate to assess the validity of this flagship initiative against its original intents. As such, the evaluation might provide relevant inputs for a better implementation in the remaining years, a base for potential future legislative proposals and for the long-term evolution of this EU space programme.

2.2. Scope of the evaluation

For the purpose of this evaluation the time taken in consideration covers the period from April 2014, when the Copernicus Regulation was officially launched, until April 2017. The assessment covers the first achievements in the areas corresponding to the programme's objectives and the first key results in all its components. The downstream service development; the user uptake trend; the management and governance structure performance; the development of an international cooperation activity, and the impact of the Copernicus data and information policy are assessed as well.

3. Background

3.1 Description of the Programme and its objectives

Copernicus is the Union programme for Earth observation and monitoring, repealing the old GMES programme. It actually gives continuity to the previous space initiative, by transforming it into a fully-fledged operational industrial programme. The impact assessment associated to the Copernicus programme was in fact largely based on the existing implementation experience of GMES, its preparatory actions, its initial operations and all related research and development initiatives that provided sufficient justifications for the launch of a new space programme.

Article 4(1) of the Copernicus Regulation sets out the programme's general objectives to monitor the Earth and, more specifically, to support the protection of the environment, civil protection and civil security; to ensure the European independent access to environmental knowledge and key technologies for earth observation and geo-information services; to maximise socio-economic benefits; to support the Europe 2020 strategy; to foster the development of a competitive European space and services industries and to maximise

opportunities for European enterprises to provide innovative earth observation systems and services; and to support and contribute to European policies and foster global initiatives such as GEOSS. To achieve these main objectives, specific objectives have been set in Article 4(2) of the Regulation: delivering accurate and reliable data and information to users, on a long-term and sustainable basis; providing sustainable and reliable access to space borne data and information from an independent European observation capacity and building on existing European and national assets and capabilities; providing a sustainable and reliable access to in-situ data relying on European, national and international capacities and networks.

Structure of the programme

The Copernicus Regulation confers to the European Commission for the period 2014-2020 the responsibility for the implementation and management of Copernicus and its components, i.e. the overall responsibility for the strategic management, the coordination among the different components and the budget execution. Most of the operational, project-management, coordination- and implementation tasks, however, have been delegated to ESA and partially EUMETSAT. Services rely, instead, on the support of Service Operators (ECMWF, EEA, Mercator Océan, FRONTEX, EMSA and EUSC) with whom delegation agreements have been concluded.

To assist the Commission in the implementation of the Programme, the Regulation foresees the Copernicus Committee, chaired by the European Commission, composed of Member States representatives, meeting four times per year, and involving delegated bodies as observers. There is also a Security Board, as a specific configuration of the Committee, where security aspects are analysed. The Copernicus User Forum is advising the Copernicus Committee on user requirements aspects, on the annual Work programme and on market uptake and data dissemination activities. To fulfil its tasks, Copernicus' structure is composed of the following elements (article 2 of Regulation):

- a space infrastructure, (the "Sentinels" satellites and a ground segment where space borne data are processed, distributed and archived, as well as the access to contributing missions' data);
- 6 services providing data products and information (Land, Marine environment and Atmosphere monitoring, Climate change, Emergency management and Security) and
- in-situ data (air, land and sea-based).

Space Component

The Copernicus Space Component includes the overall space infrastructure, including satellites design and manufacturing, the satellites launches and their operations, the operation of the ground infrastructure and the distribution of Sentinels and contributing missions' data. The European Commission has entrusted the European Space Agency (ESA) to lead the technical coordination, procurement and operations for the Sentinels fleet, and EUMETSAT for the operation and maintenance of some of the Sentinels.

Services Component

The **Copernicus service component** aims to deliver data products and information freely available for a wide variety of users. Six services integrate space-borne, in-situ data and model (if required) to offer Copernicus products, tailored to the needs of end-users. Each of the six services responds to very specific issues identified as key for the European society and is delegated to competent service operators (Entrusted Entities) that manage the Copernicus

services, creating new operative products and performing research activities as needed to maintain the products updated:

- Land Monitoring Service - delegated to the European Environment Agency (EEA) and the DG Joint Research Centre
- Emergency Management Service - delegated to the DG Joint Research Centre. To be noted that the operational coordination of the service is delegated to DG ECHO's Emergency Response Coordination Centre (ERCC) which is the single entry point for activating the mapping service.
- Marine Environment Monitoring Service - delegated to Mercator Ocean
- Atmosphere Monitoring Service - delegated to the European Centre for Medium-Range Weather Forecasts (ECMWF)
- Climate Change Service - delegated to the European Centre for Medium-Range Weather Forecasts (ECMWF)
- Security Service - delegated to the European Border and Coast Guard Agency (FRONTEX), the European Maritime Safety Agency (EMSA) and the European Union Satellite Centre (EUSC)

In-Situ Component

The **Copernicus In-situ component** provides coordinated access to in-situ data (meaning ground-based, airborne and seaborne observation data) as needed by the operational Copernicus Services. The component relies on existing data sources and capacities, as well as on EU Member States' data sources and third party in-situ data sources at the international level.

3.2 Baseline

The programme was established with a total funding of EUR 4.3 billion for the period 2014-2020. 79% of the total funding is allocated to the development of the Space component, while the remaining 21% is allocated to the service and in-situ components.

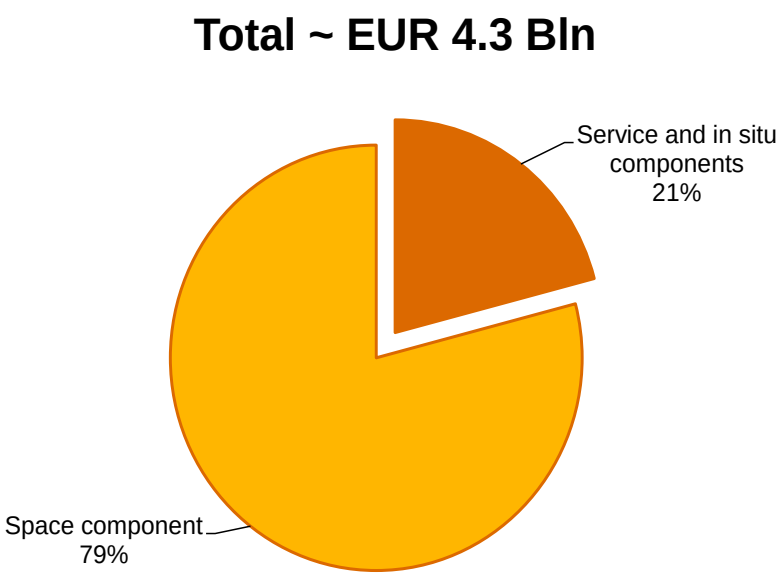

Table 1. Copernicus budget allocation (2014-2020)

Copernicus Space component

The Sentinels have been intended to provide a unique set of observations for Copernicus. They consists of three twin satellite missions (Sentinel-1A and 1B, 2A and 2B, 3A and 3B) and two payloads (Sentinel-4 and 5) integrating different sensors. At programme inception, the Sentinels were planned for launch between 2014 and 2020 (Table 3 in Annex).

Copernicus Services component

At the onset of Copernicus, the land monitoring service and the emergency management service were already operational and were based on the data provided by contributing missions under the GMES programme. The marine environment monitoring and the atmosphere monitoring services were in pre-operational phase, while the climate change and the security monitoring services were in the design/development phase.[6] (See table 4 in the annex).

In-situ component

The data coordination for Copernicus services is done at two levels: (a) the day-to-day operational management and ingestion of the in-situ data and pre-processing, provided by the services themselves, allowing also for exchanges between services to avoid duplication; (b) the overall in-situ data coordination by the European Environment Agency provided whenever a common approach should be ensured, when coordination and partnership with one data provider/network should be established and maintained for different services of the programme.

[6] Interim Evaluation of the European Earth Monitoring Programme (GMES) and its initial Operations (2011-2013) – Final report – January 2013 –by CSES (page 8)

Copernicus has inherited from GMES a great synergy with the INSPIRE[7] programme with which it interacts for the operational context of the core services and data distribution platforms. Copernicus conformity with INSPIRE online services and interoperability is mandatory to ensure effective and efficient integration with all other geospatial data resources

4. Evaluation Questions

The evaluation answers the following 15 questions which relate to the overall objectives and key evaluation criteria as detailed in the table below:

Criteria	Question
Effectiveness	○ To what extent has the Programme achieved its objectives and implemented the tasks set out in its mandate? What are the key factors influencing/restricting progress? ○ How appropriate is the progress in relation to the Copernicus initial needs and expectations? ○ How effective are the adopted operational solutions in meeting the programme objectives, across the space, services and in-situ components? ○ How effective have the Copernicus and its components been in anticipating and dealing with constantly evolving user requirements and expectations or with new policy priorities, such as the ten priorities of the current Commission?
Efficiency	○ What are the first tangible benefits associated with the implementation of Copernicus? To what extent are the financial investments proportionate to these benefits? ○ What aspects are the most efficient or inefficient in implementing the tasks set out in the programme mandate? ○ To what extent are the mechanisms for programming, monitoring, reporting and evaluating Copernicus and its components adequate for ensuring operational and financial accountability and appropriate assessment of the overall performance of the programme?
Relevance	○ How far are the original Copernicus objectives and actions still aligned with key EU political priorities? ○ Which Copernicus actions are necessary to continue implementing existing and evolving obligations under the Treaties and EU legislative framework? ○ Are the objectives set out in the Copernicus regulation still appropriate given current user needs?
Coherence, Complementarity and Cooperation	○ To what extent does the cooperation between the European Commission services, the Member States, the Delegated Bodies and other agencies and bodies ensure complementarity and avoid duplication of efforts? Which areas can be improved? ○ To what extent are the different Copernicus services cooperating and what procedures are in place to ensure complementarity and

[7] DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

	avoid duplication of efforts? ○ To what extent are the procedures and mechanisms put in place effective to ensure that Copernicus cooperation activities are coherent with the policies and activities of its stakeholders?
EU added value	○ What is the EU added value of Copernicus? ○ What could be achieved on merely national level, and which issues yet require action at EU level?

Table 2. Evaluation questions

5. Methodology

The evaluation is based on a study contracted by the European Commission to an external consultant. Data gathering and review on one side, and stakeholders consultations on the other side have provided the framework for the analysis. The stakeholders' consultation has been organised first drawing from the results of the large open survey for the European Space Strategy, and concluded few months before the launch of the evaluation. Six on-line surveys have been developed and held for six categories of stakeholder, covering the whole value chain of Copernicus (Copernicus Committee and User Forum members; ESA, EUMETSAT and other Entrusted Entities; Space / ground upstream industry (manufacturers); Contributing missions owners / space data providers and Service providers and Users). Face to face interviews and written free contributions from Members of the Copernicus Committee and User Forum, have completed the consultation, that produced 241 responses in total, covering the whole value chain. Answers were distributed between web questionnaires (143), direct interviews (94), and 4 written contributions by those Member States that had not answered the web-questionnaire.

The distribution of stakeholders that replied to the consultation (interviews and surveys) shows that 43% of the sample was made of representatives of core user organisations, while other users counted for the remaining 57%. In terms of geographic distribution, European users accounted for 91% of the stakeholders consulted, while the remaining 9% was made of international users notably in Australia, China, South Africa or the USA. An evaluation framework identifying the most important key performance indicators has been developed to consolidate the results of both review and surveys. The framework contained all the KPIs and indicators defined to support the definition of the answers to the evaluation questions and were structured around the five objectives of the programme as defined in the Copernicus Regulation. A triangulation of results followed to validate them.

6. Results

Implementation of the Copernicus Space component

The Space component of the programme is well advanced in terms of deployment, operations and data delivery. The Sentinels satellites are performing very well producing a large quantity of high quality data and representing the core element of data provision. With the successful launch of Sentinel-2B in March 2017, the Sentinels constellation now counts 5 satellites in orbit. These 5 in-orbit satellites should be followed by 4 additional satellites, that will complete the constellation and help addressing specific needs, namely Sentinel 3B, Sentinel-4 (atmospheric composition), Sentinel-5 (atmospheric composition as well) and Sentinel-6 (global sea-surface).Development of the follow-on satellites (C and D) is also on track.

Satellite	Initial launch date	Actual launch date
Sent-1A	Q2 2014	3 April 2014
Sent-2A	Q2 2015	23 June 2015
Sent-3A	Q4 2015	16 February 2016
Sent-1B	Q2 2016	25 April 2016
Sent-2B	Q2 2016	7 March 2017

Table 3- Launch date vs. initial schedule for currently flying Sentinels

Out of the 5 flying satellites, 3 have been launched in accordance with the initial schedule (S1A, S2A and S1B), while S3A has registered a limited delay, and S2B has been delayed by about ten months. These delays are associated to the unavailability of the launchers: both satellites were planned to be launched on the Russian Rockot launcher, mainly for economic reasons. The deterioration of the political context and the impact on the supply chain affected the launch schedule. While S3A was maintained on Rockot, the launchers of S2B and S3B, respectively planned on Rockot and Vega, were swapped in order to mitigate the launch delays. Hence S2B has been launched on Vega while S3B is now to be launched on Rockot. It can be noted that Europe is now in a political position to move towards non-dependence with regards to Russian launchers. The launch of S5P (on Rockot), originally planned mid-2016, has been delayed and is now expected for autumn 2017, and the launch of S3B is now planned for the end of 2017 instead of mid-2017. It is important to keep in mind that the delays remain relatively moderate for a space programme of this scale and with a lifespan of 7-15 years. Furthermore a delay in the commissioning of a Sentinel is not critical to the programme's progress and success considering the availability of the contributing missions.

The Sentinels have reached and exceeded the expected volume of data to be produced every day: as of March 2017, they were producing about 12 TB of data per day, well above the formal requirements. As for the Ground segment of Copernicus, it has been primarily designed to serve the Copernicus Services and Copernicus participating States with a large quantity of data, to be then transformed into higher level products and information. The success of the open access hub (COAHub) rose issues regarding the ability of the IT infrastructure to answer the high demand. Upgrades have been implemented, and currently the GEANT network enables network traffic up to 20 Gbps, with an upgrade held in March 2017 to double its capacity. In addition to the traffic and downloading capacity, the data hubs are also regularly upgraded to reduce in particular the interruptions of services. To this core infrastructure Member States added "collaborative activities" including additional local

stations to receive the data from the satellites, data processing, mirror sites and archives, to serve the requirements of public and commercial users in some Member States. However, 'collaborative' activities, through the deployment of parallel processing facilities, risked to lead to fragmentation, as well as duplication of infrastructure and investments that could weaken the status of the core ground segment funded by the Commission, as well as the governance of Copernicus, including its international relations. Since mid-2015 a task force was then created to promote the setting up of an Integrated Copernicus ground segment to reinforce synergies between the Core and the collaborative ground segment and coordinate with initiatives in the Big Data area.

The data produced by the Sentinels are perceived by the users as reliable, accurate and precise, and generated by high quality sensors. All the data acquired by the satellites are controlled, calibrated, based on in-situ data, and validated before being published, ensuring a homogeneous quality level. For some users these aspects act as a game changer for their business, and the overall data quality and reliability stand out as key assets for the Copernicus programme.

As Sentinels alone cannot provide all the types of data relevant to final users and to the Services products, Copernicus Contributing Missions (CCM) are vital to the programme, providing Very High Resolution data. In addition, from a chronological point of view, Contributing Missions data have allowed the Copernicus Services to be operational before the launch of the Sentinels.

As for the security aspects, Article 23 of the Regulation defines the limitations to the full, open and free data policy. Each entrusted entity however, counts on internal measures to face data security threats.

Besides the access to Copernicus Services platforms, the main data access channel consists in the 4 ESA hubs:

- The **Copernicus Open Access Hub (COAHub)** – previously Scientific Hub – is open to all users without restriction and gives free access to all Sentinels data. The **Copernicus Services Data Hub (ServHub – previously CopHub)** is only open to Copernicus Services and European institutions.
- The **Collaborative Data Hub (ColHub)** is open to the GSC[8] and Copernicus participating States following a signature of a Collaborative Ground Segment agreement with ESA.
- The **International Access Hub (IntHub)** is open to international partners which have signed an arrangement.

By April 2017, the main dissemination hub, COAHub, reached over 82,000 registered users, way above the target of 55,000. The registered users of the Copernicus COAHub are mainly located in Europe, Asia and South America are the two other main users locations. The IntHub is available to 4 international partners (3 in the US, 1 in Australia), below the target of 5. These partnerships rely on a principle of data reciprocity, where partners provide data which should be useful to the Copernicus Services and other European users, in return for a privileged access to Copernicus data on a hub isolated from the thousands-users of COAHub. Additional arrangements are foreseen, with countries from Latin America in particular, but at this stage the way the partnership could be beneficial to both parties is still under investigation, especially when the partners cannot provide Earth observation data.

[8] GMES Space Component

To respond to the huge volume of data and products, the Copernicus Data and Information Access Service (DIAS**)** has been designed, aimed at improving ICT performances by increasing downloading capacity when many users are logged on, and offering a unique platform serving as a one-stop shop and product catalogue. They are planned to be operational as from early 2018.

Implementation state of the Copernicus Services component

As the Services have been created at different times and target different types of usages, they do not have the same level of maturity and it is challenging to build comparisons among them. Generally speaking, the more mature services (Marine environment monitoring, Emergency Management, Atmosphere and Land monitoring) have a consistent and proven portfolio of products while some other services are still in pre-operational phase (Climate Change and the Security sub component of support to external action) and are still ramping-up in their offer and their operational performance. However, the less mature services are demonstrating their improvement over time by raising their timeliness or their number of registered users. Limitations are represented mainly by two factors: the fragmentation of data offer to the users and the partial response by Copernicus data, products and services to user specific needs. According to the consulted stakeholders the process established by the Entrusted Entities delegation agreements is complex and presents many layers of approvals, delaying the implementation time.

Table 4 – Status of the implementation of Services in 2017

Service	Development phase	Pre-operational phase	Operational phase	Notes
Land monitoring Service (CLMS)			✓	Operational since 2012 as GMES Initial Operation (GIO) Land service
Emergency management Service (EMS)			✓	Operational since 2012 as GIO EMS - Mapping
Marine (CMEMS) environment monitoring Service			✓	Operational since 2015
Atmosphere monitoring Service (CAMS)			✓	Operational since 2015
Climate change monitoring Service (C3S)		✓		Pre-operational since 2016
Security Service		✓	✓	Operational since 2016

CAMS is valuable as it reduces the fragmentation for air-quality products offer and supports many applications in a variety of domains including health, environmental monitoring, renewable energies, meteorology, and climatology. It ensures a high availability of its website

CMEMS performance is above the targets defined for its availability and products timeliness. This contributes to the very high satisfaction of users, who evaluated the service at 4.75/5. As of today, however, commercial users still represent a small share of the total (25%) that could be increased in the future.

CLMS portfolio is considered consistent and coherent with its objectives. The pan-European component continued to update its products in order to respond to users' needs. No critical problem on the local component occurred during the reporting period.

C3S, as a more recent service, is still in a pre-operational phase. However, the service is already on good track as the number of users doubled between 2015 and 2016 and has reached about 11,000.

EMS appears very relevant as 80% of the surveyed users emphasized consistency of the products with their request. The service faced issues regarding its timeliness, but progress is constantly made as by the end of 2016 23% of the satellite images were delivered late compared to 50% at the beginning of the year. Since 2012 there have been 240 activations of the mapping services with the production of 3195 maps (964 reference maps; 1424 delineation maps, and 807 grading maps).

The Security service is harder to assess with regards to its objectives as it is more recent than the other services and still lacks indicators to be assessed on.

Implementation state of play of in-situ component

For the in-situ data, the overall coordination activity done by the European Environment Agency (EEA) is performing well, as illustrated by the provision of cross-cutting in-situ data through CORDA (with a threefold increase of the number of users in 2016) and the fluent management of partnership agreements with the providers.

The coordination of in-situ data provision is complex, as well as the data gathering (due to the heterogeneity of data availability, reluctance to provide data for free, mismatch with services requirement, data quality, and licence conditions) and would require more resources to improve the results. Several milestones, however, have been achieved in 2017:

- Copernicus in-situ data requirements have been revised and updated for all six Copernicus services;
- Critical in-situ data gaps have been listed, including proposals for gap closing activities;
- Data access agreements have been signed with selected European networks;
- Copernicus Reference Data Access (CORDA) node became operational;
- A plan for the involvement of selected global level networks has been agreed with the services;
- A cross-service register of stakeholders, partnerships and data access arrangements was constituted.

The agreement with international networks of partners such as EUMETNET [9] has established a single interface providing access to several dozens of partners. It is recognised as an example of efficiency with a strong push toward reduction of number of interface and streamlining of processes, and therefore as a best practice for other programmes.

As for the user uptake, market uptake and communication, the European Commission launched different activities: thematic workshops, publications and info-sessions. Two

[9] European Meteorological Services Network

European networks for Copernicus user uptake, the Copernicus Relays and the Copernicus Academy have been set up to boost the promotion at regional and local levels. The number of participants has strongly increased (61 Copernicus Relays (over 25 countries including 2 non-European) and 78 Copernicus Academy members). The Copernicus support office was set up by the European Commission in October 2016 in order to provide support to the different stakeholders contributing to the promotion of the Programme at European, national, regional and local levels. Copernicus Masters prize has registered 900 submissions and 50 winners (organised jointly with ESA). 40 start-ups benefited from the first Copernicus Accelerator, a one-year coaching programme where 5 or 6 people receive a prize and are followed by a mentor that helps them develop their business. Positive feedback was received from all contestants. A series of actions are developed and supported in order to enhance geo spatial data skills development (Copernicus skills programme) under the New Skills Agenda Blueprint action, and with the Knowledge Innovation Communities (KICs). Moreover, the idea of a "KIC Space" is shared at the level of the operational contacts in the EIT[10] and DG EAC.

Common didactic background materials in different EU languages were created by the Commission over the last year. Communication on the web and on social media has also been subjected to a drastic change through a reinforced cross-fertilisation policy with the existing social media profiles. Dedicated Copernicus profiles on Twitter, Facebook, YouTube and Instagram were created and have known a significant success (e.g. over the last 1.5 years: from 957 to 4.637 Facebook followers; and from 1.216 to 8.026 Twitter followers).

Communication and user uptake activities however face a certain number of challenges:
Copernicus is promoted only in specialised area. There are not enough activities oriented towards the general public and the Copernicus.eu website does not raise more adhesions. There is no media monitoring (hence no tracking of the number of publications or quotation indexes). Direct talk to the media is difficult, which makes it hard to develop communication for the private sector. The Copernicus programme is not sufficiently promoted outside Europe.

7. Answers to the evaluation questions

Effectiveness

The general perception concerning achievement of the objectives set in the Copernicus regulation is that the program is on track with the planned achievements, even if not all objectives are being achieved to the same extent, keeping in mind that the margin for improvement is directly linked to the recent beginning of service operation. In fact, the quality and reliability of data provided by the Copernicus space component, in particular by the Sentinel satellites, combined with the adoption of the free data policy, is one of the programme strengths and main success story. Because the services have been created at different times and target different types of usages, they do not have the same level of maturity and it is challenging to build comparisons among them. Generally speaking, the more mature services (CMEMS, CLMS for instance) have a consistent and proven portfolio of products while some other services are still fine-tuning their offer and their operational performance. However, other services too are demonstrating their improvement over time by improving their timeliness for instance (such as for the CEMS) or their number of registered users (such as the C3S).

[10] European Institute of Technology

There is consensus that the programme is lined-up with European policy priorities and will provide major support to the implementation of major EU policies. According to stakeholders Copernicus' alignment with new policy priorities (European Commission's priorities on Jobs, Growth and Investment, Digital Single Market, Internal Market, Climate, Migration and EU as a Global Actor) is very high. Among the concrete results: CAMS provides daily information on solar radiation (particularly useful for the planning of solar energy production) and the global atmospheric composition at global and regional scale; CLMS provides several indicators useful for biomass production or energy infrastructure monitoring (e.g. dams). CLMS also provides information on vegetation health and condition, including the measure of dry matter productivity, as well as burnt areas. Furthermore, CMEMS supports oil & gas production and renewable marine energies initiatives, including, among others, wind fields at sea for wind farms (already operational at regional and global scale), sea surface currents for tidal power plants, waves height, directions for tidal and wave power plants, and sub-surface currents.

As an example of support to migration, during the refugees' crisis in Europe in 2015 and 2016, Copernicus dealt with evolving national authorities and NGOs requirements to provide imagery used to monitor ports and beaches identified by FRONTEX as departure points for migrant vessels; it also helped detecting rubber boats leaving the coast of Libya and contributed to saving the life of 350 persons in October 2015[11]. Another example lies in the Emergency Management Service, which significantly contributes to place EU as a stronger Global Actor when dealing with floods (e.g. Sentinel-1 imagery used during floods in Australia[12] and Peru in March 2017).

Copernicus also fosters international cooperation: administrative arrangements on data access have been developed with international partners, based on reciprocity. Partnerships are also under consideration with Ukraine, India and several Latin American, but they are still in preliminary stages of discussion.

Through the funding of the GMES & Africa project, implemented in cooperation with the African Union Commission, the EU supports capacity building, training and awareness raising with African public institutions, notably to foster the deployment of local industry and activity linked to specific Earth observation services such as water and natural resource management, marine and coastal monitoring. Copernicus is also offering opportunities for collaboration between European and African enterprises.

The Copernicus Regulation also states that Copernicus is the European contribution to GEOSS (Global Earth Observation System of Systems), part of GEO (Group on Earth observations). Stakeholders surveyed in the frame of this mid-term review expressed the opinion that the links between Copernicus and GEOSS could be strengthened even more. Copernicus also contributes to CEOS (Committee on Earth Observation Satellites) due to the European Commission's membership. Since the launch of the Sentinels, the European Commission's role in this committee has increased and the European Commission will be the chair of CEOS for a year starting in October 2017. Copernicus is also involved in other multilateral initiatives: UN cooperation (through CEMS), United Nations Environment Programme (UNEP) around the Sustainable Development Goals (SDG), UN Office for Outer

[11] European Commission, March 15th 2016, European space capacities support responses to the refugee crisis. Available at: http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8706 (Accessed: April 25th 2016)

[12] Floods caused by the cyclone event Debbie: http://emergency.copernicus.eu/mapping/list-of-components/EMSR200

Space Affairs (UNOOSA), WMO (World Meteorological Organisation), and GCMS (coordinated through GEOSS initiative).

Efficiency

The implementation of Copernicus provides tangible benefits, the most important being its open and free data policy creating significant socio-economic benefits**.**

Since the launch of the programme and up to the end of 2016, the overall transactional value generated by the investment in the Copernicus programme can be estimated to be around EUR 5.44 billion. This value represents the Gross Value Added (GVA) in the European economy, before considering the benefits generated by the exploitation of Copernicus data. It corresponds to the total investments up to the end of 2016 in the space component (EUR 3.03 billion[13]) and in the service component (EUR 0.88 billion[14]) to which is applied a multiplier of 1.39[15] , also called "GDP multiplier". This represents the total impact of the investment made in the programme on the European GDP, when adding together the direct impact (impact of spending into the space industry), the indirect impact (economic activity supported by the expenditures of suppliers of the space supply chain) and the induced impact (economic activity supported by the people directly and indirectly employed, when spending their income). The sum of these impacts is then compared to the initial investment, and thus the multiplier can be interpreted as "1€ spent within the Copernicus programme (for both the space industry and the non-space industry), creates 1.39€ of total Gross Value Added in the wider European economy". An assumption is made on the GDP multiplier of 1.39, as it was computed based on the cost and spending structure of the GMES programme.

Since 2013 the share of the spending associated to the services component has become more important, increasing from almost nothing up to over 20% of the total spending. This change in the cost structure should impact the multiplier, as for instance the expenses related to the Copernicus services occur more in ICT related industries than in the space upstream industry, generating different kind of direct, indirect and induced impacts. However from an economic point of view, investments in the information and communication services industry tends to have a higher economic impacts than the manufacturing industry, when considering apparent labour productivity and gross operating rate[16]. Hence the value adopted in this case (1.39) can be expected to be higher for the services component, leading to a conservative assumption and therefore conservative values for the GDP impact of the Copernicus programme.

Consequently to the investment in the space and service components of the programme, the availability of Copernicus data and products enabled an economic activity in the Earth observation downstream market (intermediate users). Though no figure exists on the total revenues enabled by Copernicus in the downstream sector, these revenues are estimated between EUR 71 million and EUR 138 million[17] for the period 2014 – 2016 in Europe, on the basis of 8 selected sectors: Agriculture, Forestry, Urban Monitoring, Insurance, Oil & Gas, Ocean Monitoring, Air Quality and Renewable Energies. These values are based on stakeholder consultation across the value chains, to define the share of their revenues that can

[13] PwC-Strategy&, Study to examine the GDP impact of Copernicus in the EU, 2015 ; ESA, Copernicus Space Component Quarterly Implementation reports, 2014 to 2016
[14] PwC-Strategy&, Study to examine the GDP impact of Copernicus in the EU, 2015 ; Copernicus Entrusted Entities, Services Quarterly Implementation reports, 2014 to 2016
[15] PwC-Strategy&, Study to examine the GDP impact of Copernicus in the EU, 2015
[16] Eurostat, http://ec.europa.eu/eurostat/statistics-explained/index.php/Information_and_communication_service_statistics_-_NACE_Rev._2 ; http://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacturing_statistics_-_NACE_Rev._2 , last accessed May 2017
[17] PwC, Study to examine the socio-economic impact of Copernicus in the EU, 2016

be associated to Copernicus data. This share is then extrapolated to the overall intermediate users' revenues for each value chain.

This range can therefore be seen as a rather low in absolute number, however it should be noted that this value concerns only 8 value chains over a period of two years after the launch of Copernicus. Across these 8 sectors, the revenues enabled by Copernicus in the downstream are estimated to have supported 500 to 1000 person-years[18]. The same precautions have to be taken in the reading of these values which include both newly created and already existing jobs. Similarly to the upstream, the jobs supported on the downstream in the frame of Copernicus are rather highly skilled employees. They contribute to the development and/or maintenance of a critical mass of experts within the firms, hence contributing to the competitive advantage of the company. As an illustration the involvement of CLS in the CMEMS enabled the company to develop its skills through the design, implementation and operation of the system architecture across Europe.

Beyond the downstream sector, Copernicus data also benefits the wider industry including non-Earth observation actors from various sectors (such as the ones mentioned above). The overall Copernicus-enabled revenues on these end-users markets is more challenging to assess due to the number of industrial sectors and the variety of companies and practices in each sector. However, the economic impact of Copernicus on these markets can be expected to be much higher (as it includes much more than EO-related activities) and as an illustration, a previous PwC study[19] estimates these enabled revenues up to EUR 595 million on 2014 – 2016 for 3 sectors (Oil & gas, Insurance and Urban Monitoring), underlining the high potential of Copernicus economic benefits in the EU economy.

On the budgetary aspect, the findings are positive. The programme is progressing well with no cost overruns and limited utilisation of management reserves. The Services have heterogeneous costs and commitments profiles, given their lifetime and specific needs. The space component costs and commitments are below the initial forecasts (it mostly reflects a shift in the implementation schedule for some Sentinels), yet without impacting the expected cost-at-completion. In particular, the procurement process is very efficient (generating excellent feedbacks from ESA, EC and industrial partners) thanks to the appropriate distribution of responsibilities between stakeholders based on their area of expertise.

At Programme level the governance is efficient, as the mechanisms established for programming, monitoring, reporting and evaluating Copernicus are adequate to ensure operational and financial accountability. However some duplication of efforts are noted**,** generated by the red tape and the lengthy approval process of the Delegation Agreements, which should be improved to gain flexibility in the future.

From a social standpoint, urban products based on Copernicus provide sound social benefits. Urban Atlas ensures a VHR mapping for urban sprawl monitoring of the main European cities as well as of artificial surfaces (e.g. roads), helping to monitor the various issues linked to the phenomenon. From an environmental standpoint, the development of precision farming applications based on Sentinel data enable farmers to produce food of better quality. The integration of Sentinel data in forestry related-projects also contributes to improving the monitoring of deforestation and forest degradation and to a better prevention of forest fires. Copernicus data also boost sustainable fishing and limits environmental nuisance, by enabling fishermen to better target fishing zones. There is also a good quantity of unexpected benefits especially in the utilisation of Earth Observation data in support of educational activities. The

[18] PwC, Study to examine the socio-economic impact of Copernicus in the EU, 2016
[19] PwC, Study to examine the socio-economic impact of Copernicus in the EU, 2016

spending related to the space component is in line with the forecasted budget on the period 2014 – 2016, with no over costs at this stage and therefore the same cost-at-completion.

The procurement model based on the Procurement Board has proven to be very efficient and is appreciated by the main stakeholders (European Commission, ESA and industrial primes). The development of the Sentinels did not face any significant over cost and overall was kept under control. Between 2014 and 2016, the scope of activities managed by ESA underwent some evolutions. Some activities which were not part of the EU-ESA Copernicus Agreement originally are expected to be included in the scope, like satellites launch insurance (developed against the risk of launch failure after the delays registered for Rockot launches), and DIAS.

The management and governance model set out since 2014 was appropriate to implement the tasks defined in the programme mandate. The set of delegation agreements were efficient tools to implement the tasks set out it the Copernicus Regulation related to the services and the infrastructure. More flexibility in their implementation rules would however ease the bureaucratic and approval process. This issue of the bureaucratic and approval process is a concern for the impact it could have on the implementation of the system operations and service provision. In order to favour these activities, more flexibility in the implementation rules (especially concerning the reallocation of funds within the delegation agreement, and the enlargement of service product portfolio) and a leaner approval process would be welcome. The mechanisms established for programming, monitoring, reporting and evaluating Copernicus were adequate to ensure operational and financial accountability.

Relevance

Perception of the consulted stakeholders is that Copernicus is aligned with key EU political priorities and also promoted synergies with other programmes. The products portfolio is good and the procedure to offer new products has been recently agreed among stakeholders.

To remain relevant to the political priorities, the products and information delivered by the Core services may evolve. This evolution is a point that needs improvement. The Copernicus open data policy is a necessary pillar to continue implementing existing and evolving obligations related to the use of earth observation data. Broader EU legislations that do not always specifically target space programmes also require Copernicus actions (e.g. the Single Market Initiative, the Common Agricultural Policy, the Energy policy, EU's Artic policy, and numerous environmental directives). The objectives set out in the Copernicus Regulation are still appropriate, as well as the main identified user needs.

Coherence, complementarity and cooperation

As already described in the answers to previous questions, there is a very positive perception of the internal and external coherence of the programme governance. Role and responsibilities are well defined and the communication flow is efficient. Streamlining of current governance with increased communication and more transparency on the decision making process for programme budgetary management would, however, be more than welcome to facilitate next programme phases.

A certain degree of effort duplication is experienced between the Commission and the Entrusted Entities in the implementation of the delegation agreement, and between the Commission and the Member States for the provision of data. Cooperation between delegated bodies and the Copernicus Services is considered smooth and satisfactory but increased coordination between Entrusted Entities is envisaged, for better communication about Copernicus services and more user uptake.

DG GROW cooperates with 13 European Commission Directorate Generals (11 of which already make use of Copernicus) (i.e. DG JRC, DG RTD, DG ENVI, DG AGRI, DG HOME, DG MOVE, DG MARE, DG ECHO, DG DEVCO, DG CLIMA, DG ENER).There has been a considerable uptake of Copernicus data by the European Commission, but it could be promoted more, especially in the area of agriculture. This could be achieved through a legislation to use only Copernicus data in the European Commission DGs, instead of using other sources of Earth Observation data.

It is recognized that Horizon 2020 R&D is functional to deployment and evolution of the Copernicus system. Nevertheless, closer cooperation with H2020 innovation processes could speed up adaptation of Copernicus products to market needs and build new capabilities. Current H2020 procedures are considered too slow to incorporate Copernicus services provision requirements and there is the need for a better coordination.

EU-Added value

European Union support to the Copernicus programme is considered outstanding, especially at political level and for ensuring the appropriate funding and continuity of action. It is also perceived as very efficient, especially when compared to support provided by international and third country governments to other space programmes. EU action is regarded as providing large added value, especially when compared with what could be achieved at national level. Implementation of task at national and regional level might considerably increase duplication of efforts and risks of inefficiency. Therefore stakeholders do not see any possible alternative to implementing the programme under the lead of the European Union, especially for all the activities related to the deployment of the space infrastructure and promotion of interoperability at international level and distribution.

Nevertheless for activities concerning the development of applications and services and the creation of a European market, a stronger role of the Member States, under the overarching political guidance of the EU, is envisaged and believed to be beneficial for the achievement of the programme objectives.

For worldwide issues such as the management of global climate change (e.g. related to the C3S), managing Copernicus at EU level enabled higher visibility within international initiatives, compared to what could be achieved by single Member States. In these initiatives the image of the European Union is reinforced through Copernicus, leading to cooperation with third countries.

8. Conclusions

The Copernicus programme can be globally assessed as being a success, just over 3 years after the first Sentinel launch. The program is in line with the achievement of the objectives set out in the Copernicus Regulation, and these objectives are still relevant with current EU political priorities and users' needs. The implementation of Copernicus provides tangible benefits, the main of which being the economic impacts (macro-economic transactional impact, enabled revenues on the downstream, supported employment) and the uptake of data and products by institutional and commercial actors, supported in particular by the free and open data policy. On the budgetary aspect, no significant costs overrun have been identified. In terms of governance, the Copernicus programme is coherent, both internally between its various components, and externally vis-à-vis of other EU measures with similar objectives. Synergies with the programme INSPIRE ensure an easy access to all geospatial data required by the Copernicus core services. EU action is regarded as providing large added value, especially when compared with what could be achieved at national level.

Copernicus main strengths lie in its open and free data policy, its user-driven approach through the implementation of its services, based on the deployment of its space component that provides high quality and reliable data. Copernicus is also significantly contributing in promoting the image and role of European Union and in establishing international cooperation with third countries. Many political priorities of the EU are delivered thanks to Copernicus services and products, from the fight to climate change to food safety, from maritime surveillance and migration policies to emergencies management. Some examples of success stories are described in the annex.

The space component, as regards to both the space segment and the ground segment, is evolving as planned, the development of the Sentinels was achieved with minimal delays, and the delayed launches were mainly caused by the geo-political tensions in supplying countries. The space component fully commits to the Programme objectives by providing more Earth observation data than expected (12 TB per day) with an unmatched quality. As the use of Copernicus data by the institutional, commercial and individual users is a key success factor for the Programme, the large amounts of data downloaded demonstrate the success of Copernicus. Copernicus services provide a good level of satisfaction to their users regarding the products relevance (yet with evolutions to be expected in the coming years), the timeliness of delivery and the availability of the products. The collection of user requirements for the evolution of the different Copernicus components is well integrated in the programme management processes. Users have the opportunity to raise their needs through the various helpdesks, questionnaires on data hubs and they benefit from the technical bilateral cooperation between the European Commission and the Entrusted Entities and between the European Commission and the upstream industry. This task remains challenging considering the wide span of users, both from the research community and the private sector, and of different requirements to be satisfied. It therefore necessitates a prioritisation exercise between requirements to consolidate system specification evolution.

Main limitations identified so far refer to data dissemination: accessing Sentinels data is not considered as intuitive unless stakeholders are familiar with the Earth Observation eco-system. Actions have already been taken to improve this aspect (i.e. the forthcoming DIAS initiative) but it is still too soon to evaluate the impact of this mitigation plan.

Additionally, it should be pointed out that there is a lack of awareness of the Copernicus programme and its opportunities among users which are not Earth Observation specialists. Copernicus data is used by a variety of types of users, both institutional and commercial, nevertheless a high level of awareness is currently observed almost only in the scientific community. Though the current user uptake is already substantial, this lack of awareness remains a barrier to the market uptake, and especially to the expanding of the end users base.

9. Recommendations

Regarding the access to space, Europe should keep orienting its policy towards non-dependency on foreign technology for this programme, as the consequences have been illustrated through the delays on several Sentinels.

In the frame of its future evolutions the Payload Data Ground Segment (PDGS) infrastructure should be streamlined. The fragmentation of the current infrastructure (different centres between the Services and between the geographical locations) creates some duplication of efforts and technical complexity: this aspect should be preserved but with a better trade-off regarding efficiency. The uptake of Copernicus services would benefit from a unified access

offering a single interface. Similarly to the access to the products of the services, access to Sentinel data should be unified and simplified in order to avoid multiple channels, which creates complexity for the users. This centralisation of entry points should not curb the technical performances of the data access (downloading speed for instance), and therefore should address the user interface (single link, common visual identity etc.) rather than the actual IT infrastructure, which may require to rely on multiple nodes of distribution.

In the frame of the evolution of the services Copernicus should guarantee long-term observations in the framework of climate change mitigation which requires a long-term approach to be effective. In particular, space-borne observations of greenhouse gases should be included as part of its portfolio.

There is a need to expand communication and user uptake activities beyond specialists' communities, by broadcasting more use cases and showing concrete examples to users. This would enable to widen the potential user base. Additionally, users surveyed in the frame of this mid-term review pointed out that more information online should be available in national languages. Copernicus services websites should be harmonised. No tracking of the number of publications or quotation indexes related to Copernicus has been done, making it hard to develop communication for the private sector. A solution might be to externalise communication on operational activities. More promotion activities should be undertaken outside Europe (especially in China, the US, the BRICS and Africa) to facilitate access to international markets – i.e. beyond EU borders – for European Earth Observation companies in the downstream sector

To address the evolving needs of Copernicus users, there is a need for additional mechanism(s) to foster innovation, with a more practical approach to define research priorities and a leaner process cycle than the H2020 mechanism. This new mechanism(s) would require coordination between the innovation projects and the Copernicus services and data users.

Although satisfied with the governance model, in order to fill the gaps identified, and to face the new challenges of the space sector and of the management of such a complex programme, a more suitable solution with the reassignment of responsibilities for the operational phase could be suggested, provided the experience in the Earth Observation sector by any new stakeholder is ensured.

10. Annexes

Table 1: *Copernicus intervention logic*

Needs	Objectives	Activities	Results & impacts
• Earth observation gaps, • Lack of data and information	• To monitor the Earth, support the protection of the environment, civil protection and civil security; • To provide sustainable and reliable access to space borne data and information from an autonomous European earth observation capacity building on existing European and national, complementing them whenever necessary	• Development of space infrastructure, agreements with delegated bodies, promotion of interoperability of data and systems; coordination of space initiatives	• Constellation of Sentinels, production of data and 6 Copernicus services products to support the three policies
• Lack of use of earth observation in applications and services, • Small economic growth	• To maximize socio-economic benefits supporting Europe 2020 strategy	• Initiatives for the uptake of data and products	• Wide data and service uptake, creation of new markets, expansion of the existing ones
• Declining competitiveness of European space and services industries compared to emerging or stronger non-EU players	• To foster the development of a competitive European space and services industries and to maximise opportunities for European enterprises to provide innovative Earth observation systems and services	• Creation of a European market for space infrastructures and services; ensure their development and evolution; promote their competitiveness on a global scale	• Market penetration of European space industry and creation of new markets for downstream operators ; defending a Copernicus standard on the global market
• Dependence from extra EU powers to guarantee a sustainable access to earth observation and state of the art technology. • European cutting edge research lacking appropriate means for developmet	• To ensure the European independent access to environmental knowledge and key technologies for earth observation and geo-information services. • To deliver accurate and reliable data and information to Copernicus users, supplied on a long term and sustainable basis enabling the services referred to in Article 4(1) and responding to the requirements of Copernicus Core Users	• Development of space infrastructures and services; agreements with agencies and bodies; coordination of National initiatives and other relevant European initiatives	• Constellation of Sentinels and appropriate ground infrastructures providing a sustainable and reliable access to space borne and in-situ data and information, as well as to Copernicus services' products
• Demonstrate how a European civil space programme could provide crucial support to other policies implementation and enable the EU to play an international role in global observation systems	• To support and contribute to European policies and foster global initiatives such as GEOSS.	• Mainstream the space policy in all other policies; agreements with third countries and organisations; endure links with other relevant Union policies, instruments, programmes and actions	• Wide uptake of Copernicus data and products in support of EU policies and global initiatives

Table 2

Table 3: Sentinel sensors and launch dates as planned in the Indicative Copernicus Constellation Schedule[20]

	Type of data	Planned launch date
Sentinel-1A and 1B	All-weather, day and night radar imagery for emergency (floods) land and ocean services.	The first Sentinel-1 satellite planned for launch in 2014.
Sentinel-2A and 2B	High-resolution optical imagery for land and emergency services.	The first Sentinel-2 satellite planned for launch in 2015.
Sentinel-3A and 3B	High-accuracy optical, radar and altimetry data for marine and land services.	The first Sentinel-3 satellite planned for launch in 2015 with routine operations shared between ESA and EUMETSAT.
Sentinel-4	Data for atmospheric composition monitoring. Sentinel-4 is a payload embarked on Meteosat Third Generation (MTG).	Planned for launch in 2021, operated by EUMETSAT.
Sentinel-5	Dedicated to atmospheric composition monitoring, Sentinel-5 is a payload embarked on a MetOp Second Generation satellite, also known as Post-EPS.	Planned for launch in 2021, operated by EUMETSAT.

Table 4: Copernicus services status at the beginning of 2014

Service	Development phase	Pre-operational phase	Operational phase	Notes
Land Monitoring Service			✓	Operational since 2012 as GMES Initial Operation (GIO) Land service
Emergency Management Service			✓	Operational since 2012 as GIO EMS - Mapping
Marine Environment Monitoring Service		✓		
Atmosphere Monitoring Service		✓		
Climate change Service	✓			
Security Service	✓			

20 Copernicus EU-ESA Agreement,