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IMPACT ASSESSMENT

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Identification

The European Earth Observation programme Copernicus (originally called GMES, Global Monitoring for Environment and Security), is coordinated by the GMES/Copernicus unit of DG Enterprise and Industry.

1.2. Organisation and timing

This Impact Assessment is foreseen to accompany a legislative proposal for a Regulation of the European Parliament and the Council on the European Earth observation programme (GMES/Copernicus). It is based on a previous version that was elaborated in consultation with an impact assessment steering group that met four times and was consulted on the draft impact assessment. The following DGs were invited to the IASG: ENV, CLIMA, RTD, AGRI, ESTAT, JRC, TAXUD, DEVCO, ECHO, INFSO, ENER, MOVE, EEAS, MARE, REGIO, JUST, HOME, OLAF, BUDG and SG.

This report also builds on previous impact assessment studies, in particular those accompanying the Commission proposal on the GMES/Copernicus programme and its Initial Operations[1] (GIO) and the Commission Communication on the challenges and next steps for the GMES/Copernicus Space component[2]. As the existing Regulation concerns the initial operations period and runs until 2013, there is a need for a new Regulation and for a new impact assessment.

- This is the first impact assessment of GMES/Copernicus that is looking at the programme as a whole, including the three components (space, *in situ* and services) and at all the six services.

- By now two services (i.e. Emergency Management Service and Land Service) are already operational, while the other four services are close to being operational and more information is available on costs and benefits of those services.

The major study used for this impact assessment is the cost-benefit analysis commissioned by the EC and conducted by SpaceTec Partners in 2013 (see Annex I). This, in turn, builds on Booz & Company's "Cost- Benefit Analysis for GMES" (CBA[3]) completed in 2011 and on SpaceTec Partners' "Assessing the Economic Value of GMES/Copernicus: European Earth Observation and GMES/Copernicus Downstream Services Market Study" completed in 2012. The executive summaries of these studies are presented in the Annexes V, VI and VII.

1.3. Stakeholders consultation

This impact assessment is based on a continuous consultation of external stakeholders which started early in the GMES/Copernicus development process.

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1. SEC(2009)639 of 20.5.2009
2. SEC(2009)1440 of 28.10.2009
3. Hereafter referred to as "Booz CBA" - available at http://copernicus.eu/pages-principales/library/study-reports/

Since the creation of the European Commission's "GMES Bureau" in 2006 a rolling process of stakeholders' consultation has been in place on GMES/Copernicus. This consultation process, launched with the Communication entitled “GMES: from concept to reality”[4], led firstly to the adoption of the 2008 Communication entitled "GMES: we care for a safer Planet"[5]. Further consultation was carried out in order to prepare the Commission proposal for a Regulation on the European Earth monitoring programme (GMES) and its initial operations (2011-2013)[6] and the Communication entitled "Global Monitoring for Environment and Security (GMES): Challenges and Next Steps for the Space Component"[7].

This multiannual consultation process included:

- Thematic workshops with users of Earth observation-based information services;

- Extensive consultation of independent expert groups including "implementation groups" for envisaging the blueprints of future services. The consultation of national GMES/Copernicus coordinators, appointed by their respective Member States, in the framework of the GMES Advisory Council, an expert group with the mandate to provide strategic advice, foster the co-ordination between European and national activities, and facilitate consensus-building in the relevant communities around the development of GMES/Copernicus. This consultation continued in a more structured and formal manner with the creation of the GMES Partners Board[8], an expert group assisting the Commission with an enlarged mandate compared to the Advisory Council. National coordinators were tasked to consult stakeholders at national level and report back at the level of the Partners Board. This process, in full respect of subsidiarity, has been delivered and best practices have been developed and exchanged;

- Workshops and conferences[9], by successive EU Presidencies, dedicated to GMES;

- An Information Day was organised in September 2009 with industry;

- A public consultation on the successor of the Competitiveness and Innovation Programme (CIP) also touched upon innovation in the space and Earth observation sector. Out of the 676 persons who participated at the survey, 75% considered support for satellite applications and other space based services relevant[10]. Results from the impact assessment study on the successor of the Competitiveness and Innovation Programme confirm space as an important sector for future priorities in innovation financing. The study concludes

[4] COM (2005) 565 final of 10 November 2005

[5] COM(2008)748 final of 11.12.2008

[6] COM(2009) 223 final of 20.5.2009. Regulation (EU) 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011-2013) – OJ L276 of 20.10.2010, page 1.

[7] COM(2009)589 final of 28.10.2009

[8] COMMISSION DECISION of 5 February 2010 setting up the GMES Partners Board (2010/67/EU) – OJ L35 of 6.2.2010, page 23.

[9] See e.g. the "GMES operational capacity workshop" in Sofia on 25-26 March 2010; the "GMES downstream services" conference in Tallin on 6-7 May 2010; the "Space and Africa" conference organised by the Belgian Presidency on 16 September 2010; the “2-nd GMES Operational Capacity Workshop” in Sofia on 17-18 March 2011; a Space conference by the Hungarian Presidency in Budapest at 12 and 13 May 2011 and the “GMES and Climate Change” conference held in Helsinki, on 16-17 June 2011.

[10] Results from the online questionnaire closed on 11 February 2011.

that EU intervention to support the application and adoption of European Satellite Initiatives among non-space sectors should be expanded.

- Regional authorities' point of view, as well as that of local 'final users', has been monitored through FP7 projects such as Graal[11] and DorisNet[12], which also set up Regional Contact Offices both to raise awareness on GMES/Copernicus and to better understand local users' needs. In the same context the network of European regions using space technologies[13] has organised conferences and built publications to spread GMES/Copernicus knowledge at the regional level.

- Since the entry into force of the GMES Regulation in 2010[14], the consultation of Member States and users has continued through the new governance bodies set up by the Regulation itself: the GMES Committee (which has met 10 times from 27th January 2011 till 10th December 2012) and the User Forum[15]. The establishment of a 'User Forum' composed of user representatives has the objective of preparing recommendations concerning the scope, architecture and implementation for each GMES/Copernicus area. The work of these groups culminated in public conferences which are reported in the following table:

Table 1 User Forum Meetings and Thematic Workshops

9th March 2011	GMES USER FORUM: PREPARATORY WORKSHOP ON **LAND MONITORING**
17th May 2011	1st GMES User Forum
26th September 2011	GMES USER FORUM PREPARATORY WORKSHOP on **ACCESS TO GEOSPATIAL REFERENCE DATA** FOR GMES Land Monitoring and other services
27th October 2011	GMES USER FORUM PREPARATORY WORKSHOP on ATMOSPHERE MONITORING
30th November 2011	2nd MEETING OF THE GMES USER FORUM
12th 13th January 2012	WORKSHOP on GMES Data and Information Policy
25th January 2012	GMES USER FORUM PREPARATORY WORKSHOP on the **GMES MARINE MONITORING SERVICE**
7th March 2012	USERS MEETING on the GMES Initial Operations of the Emergency Management Service - Mapping
16th March 2012	3rd MEETING OF THE GMES USER FORUM

11 http://copernicus.eu/pages-principales/gmes4regions/graal/
12 http://copernicus.eu/pages-principales/gmes4regions/doris-net/
13 NEREUS
14 See note 4
15 The GMES user forum gathered for the first time on 17 April 2011. The GMES Committee on 18 April 2011. Before stakeholders and users were consulted through working groups on the different thematic.

11th May 2012	Expert meeting on the Delegated Act for GMES Data and Information Policy
19th June 2012	GMES USER FORUM PREPARATORY WORKSHOP ON **GMES SECURITY**
2nd July 2012	Expert meeting on the Delegated Act for GMES Data and Information Policy
23rd October 2012	4th MEETING OF THE GMES USER FORUM
15th January 2013	USER FORUM WORKSHOP ON GMES/COPERNICUS EMS **Rush mode implementation**
22nd March 2013	5th MEETING OF THE GMES USER FORUM

Over time, the consultation has confirmed the interest and need for the GMES/Copernicus Programme and is now focusing on different design options, in particular for the GMES/Copernicus services. Stakeholders have indicated that the uninterrupted and guaranteed availability of the information coming from GMES/Copernicus services is the cornerstone for the success of the programme and for its benefits to be fully materialised.

The network of European regions using space technologies has also expressed a need for a long term perspective and a consequent and timely implementation of GMES/Copernicus[16]. The European Association of Remote Sensing Companies recommended that financial support is assured in the multi-annual European Budget to continue the GMES/Copernicus programme[17].

1.4. Scrutiny by the Commission Impact Assessment Board

Two versions of this Impact Assessment have been scrutinised by the Impact Assessment Board (IAB), firstly in October 2011 and secondly in March 2013. Following these submissions the IAB has made a number of suggestions for improvement. Those related to the first submission were taken into account in the re-submitted document and those from the second submission have been responded to in this version.

The first version of the Impact Assessment analysed different options with respect to the overall funding, and with respect to governance issues. Since the European Council has decided on 8 February 2013 that GMES/Copernicus should be financed from within the EU MFF budget and has decided on a maximum budgetary level, the re-submitted Impact Assessment no longer compared different options with respect to budget size and funding sources but rather analysed alternative ways of allocating the budget within the same budgetary envelope[18].

16 NEREUS, Position Paper, April 2011.
17 EARSC Position Paper on GMES, March 2011.
18 An analysis of the impacts of different budget volumes can be found in the Booz CBA study referenced above.

In its opinion of March 2013 on the revised Impact Assessment, the IAB made further suggestions for improvement. This Impact Assessment addresses these suggestions as far as practically possible (and to the extent that they remain relevant). A structured summary of the responses to the latest IAB suggestions for improvement is provided separately.

2. CONTEXT

Copernicus is the European Earth observation system, previously called GMES. Earth observation systems provide information about planet Earth's physical, chemical and biological systems, and hence enable the monitoring of the natural environment. They produce crucial information for a better management of our environment, including the availability of resources, enhanced security of the citizens and evidence-based policies.

As a monitoring system, GMES/Copernicus includes both space based and non-space based facilities, including airborne, seaborne and ground based installations (referred to as "*in situ*"). Data collected through satellites and *in situ* infrastructure are processed to enable the provision of information services. This will allow, for example, the more efficient management of natural resources and biodiversity, the monitoring of the state of the oceans and the chemical composition of our atmosphere (important factors for understanding climate change and evaluation of the adaptation actions for policy-making), the response to natural and man-made disasters and ensuring border surveillance in a more effective way.

Since GMES/Copernicus was launched in 1998[19], continuous and substantial efforts have been made by the EU (through Framework Programmes for Research and Development, Preparatory Actions and GMES Initial Operations), the European Space Agency ESA and its Member States, together with contributions from EU Member States and European organisations, for the development of services, the provision of access to space and *in situ* data, and for the development of a dedicated observation infrastructure.

During the period 2000-2006, the concept of GMES/Copernicus started to be designed and tested. On the EU side, preliminary projects were supported by the 5th and 6th Framework Programmes for Research, Technological Development and Demonstration. The first concrete steps started with the development of the pre-operational GMES fast track services using available funds from the FP6 Space Theme. In parallel, ESA launched its first activities in support of GMES at the Ministerial Council in November 2001 with the Earth Watch programme and its GMES Service Elements activities. At the political level, an important step was achieved with the first Space Council meeting in 2004, a joint and concomitant meeting of the ESA Council at ministerial level and the EU Competitiveness Council.

The period from 2007 to 2013 saw major achievements on GMES architecture, governance and funding. GMES became a reality with the adoption of a Regulation on the Initial Operations. Moreover, more funding was made available from the EU (FP7 Space Programme, Preparatory Actions, and operational funding allocated to the Regulation) and ESA Member States, for the development of pre-operational services and for the continued development of a dedicated space infrastructure (the Sentinels). The launch of the first GMES/Copernicus Sentinel is scheduled for October 2013 while, until the Sentinels are operational, satellite data come only from contributing missions. Some of the services are already generating and disseminating products to users. For example, the Emergency Management Service has been operational since 1st April 2012 and has been activated in the so-called "rush-mode" on 21 occasions, of which 60% concern an EU continental territory. For instance, after the serious earthquake that hit the Italian region of Emilia Romagna, new

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19 Declaration during the Baveno Manifesto

reference maps were made available, facilitating the work of the emergency teams. Other interventions took place in Bulgaria, France, Germany, Hungary, Italy, Portugal, Romania, Spain and Sweden dealing with floods, forest fires and earthquakes using GMES/Copernicus satellite images.

An Urban Atlas (Land Service product) provides digital mapping for urban planning. Different projects and activities have been undertaken under the supervision of GMES/Copernicus Unit to disseminate knowledge and demonstrate the potential of the programme; six projects have been selected to build demonstrators using GMES/Copernicus and Galileo services combined, exploiting the synergies between the two European programmes which is an area of potential enhanced benefit[20].

The **GMES/Copernicus activities** paid under the Preparatory Action (PA) and the GMES Initial Operations (GIO) have been **evaluated by an independent body**[21].

As far as the Preparatory Action is concerned, the evaluator stressed the important role they played in stimulating the formation of user communities especially in the emergency management field. The GMES/Copernicus PA provided the main lesson that obtaining regular user input is critical in adapting services to meet evolving user needs. The PA has helped to encourage greater networking and coordination among user communities in specific fields (e.g. ice monitoring, emergency management) and has promoted the exchange of information between relevant actors.

As far as the GIO is concerned, it has been considered that operations have been managed and implemented efficiently and effectively, under the overall coordination of the GMES/Copernicus Unit. JRC, EEA and ESA have provided the appropriate technical expertise to manage and implement the three components, space, *in situ* and services. The GIO has achieved the objective of developing two fully operational services within the 3 year programming period, an important outcome at 'results' level.

Some lessons learnt from the GIO provide important pointers to GMES future success: the availability of quality and timely reference data, sufficiently well-resourced services and the need to close the data gaps of *in situ* data. Challenges remain in terms of the lack of harmonization between national reference datasets based on a common methodology and gaps in country coverage.

The evaluator stressed the necessity of raising awareness about GMES/Copernicus and about innovative downstream applications that build on its services. Although good progress has been made in strengthening awareness about GMES/Copernicus services and the potential downstream benefits, further work is needed to encourage user uptake among specific types of users that are less familiar, such as local and regional authorities and some of the New Member States. This process is ongoing, for example through the funding of EMMIA projects and through the different communication activities, such as the European Space Expo. Moreover, as suggested in the evaluation, studies have been recommended to better understand the size and the type of potential downstream markets for GMES/Copernicus, the results of which are already integrated in this Impact Assessment.

[20] http://www.mobilise-europe.mobi/
[21] CSES, Centre for Strategy & Evaluation Services, UK. See Annexes III and IV

In its Communication on the Budget Review, the Commission has acknowledged the major strategic importance of large scale projects, such as GMES[22]. In the context of the Europe 2020 strategy, the Commission has also underlined that the GMES/Copernicus Programme contributes to reaching the Europe 2020 goals: the Flagship initiative n°5 « An industrial policy for the globalisation era » explicitly mentions GMES: « *to develop an effective space policy and (...) in particular to deliver (...) GMES* »[23].

The Communication towards a space strategy for the European Union that benefits its citizens[24], clearly mentions the importance of GMES/Copernicus for space policy and states: "The current priority is to ensure that it is implemented quickly and effectively, in partnership with the Member States, and that it is fully operational by 2014".

The Competitiveness Council has reaffirmed the need for the Commission to ensure a quick and effective implementation of the GMES/Copernicus programme by 2014, in partnership with the Member States and has recognized the necessity and importance of guaranteeing continuous and long term sustainable access to Earth observation data and Earth monitoring services provided by GMES/Copernicus in order to encourage the development of a European industry of well-diversified downstream services[25]. At its meeting of 31 May 2011, the Competitiveness Council invited the Commission to present by the end of 2011 a proposal for the operations and to clarify the governance of GMES/Copernicus from 2014 onwards. The conclusions[26] of the 31 May 2011 Council meeting recognised the necessity and importance of guaranteeing continuous and long term sustainable access to earth observation data and derived Earth monitoring services provided by GMES/Copernicus.

The European Economic and Social Committee (EESC)[27] supported the Regulation on Earth Observation and its initial implementation (GIO), considering it to be a strategic step in the establishment of a new framework to bring European space policy to maturity.

The European Parliament showed strong support for GMES/Copernicus by voting in favour of the Commission's GIO proposal in its first reading[28].

A Regulation governing the initial operations of the GMES/Copernicus programme 2011-2013 was adopted in 2010 by the European Parliament and the Council[29]. The GMES/Copernicus programme now has a legal basis that prepares its transition from mere research activity to operational activities.

The European Council decision of the 8th of February 2013 has given to GMES/Copernicus a maximum level of commitments of € 3.786 Mio[30]. This Impact

22 COM (2010) 700 point 4.3
23 Communication (2020) 2010
24 COM(201) of 4.4.2011
25 Competitiveness Council, 31 may 2011.
26 Council of the European Union, Brussels, 31 May 2011, 1090/11.
27 Opinion of the European Economic and Social Committee of 20 January 2010
28 European Parliament legislative resolution of 16 June 2010 on the proposal for a regulation of the European Parliament and of the Council on the European Earth observation programme (GMES) and its initial operations (2011–2013) (COM(2009)0223 – C7-0037/2009 – 2009/0070(COD))
29 See note 7.
30 Throughout this document the convention for representing 'thousands' is by using the separator "." and for decimal numbers the separator ",". Although this is not in accordance with common English usage it is

Assessment estimates the Cost-Benefit ratios for different scenarios related to different apportionment of the proposed budget, based on the analysis of the costs and of the social, environmental and economic benefits.

employed here to reflect common Commission practice.

3. PROBLEM DEFINITION

3.1. The problem that requires action

Insufficient existing earth observation services

In the last thirty years, substantial R&D efforts in the field of Earth Observation have been made by the EU, the European Space Agency (ESA) and their respective Member States, with a view to developing infrastructure and pre-operational Earth Observation services. However, many of the existing Earth Observation services in Europe are insufficient due to infrastructure gaps and lack of guarantees on their availability in the long term. Data provided through the currently existing services, either do not cover all the parameters needed by policy makers[31], or are not provided on a continuous basis, in particular because the lifetime of the service or the underlying observation infrastructure is limited due to budgetary and/or technical constraints. GMES/Copernicus is conceived to address this potential weakness for the long term.

Continuity of GMES/Copernicus is of paramount importance. Any interruption of GMES/Copernicus services would hamper the harmonization and standardization efforts of the geospatial information products at European level and would thus lead to a decrease of efficiency for inter-country comparison of environment information. Moreover, since many areas of environmental issues – such as climate change mitigation and adaptation policies – require thinking globally and acting locally, discontinuing GMES/Copernicus would reduce dramatically the European added value and capacity to address environmental policies caused by a lack of coordination between national/regional and European / global programmes.

Economic investments at risk

The GMES/Copernicus programme based on the GMES Initial Operation regulation has financed, during the period 2011 – 2013, a range of operational activities. A first step has been made towards the definition of a comprehensive Earth Observation system. However, it is still limited in time (i.e. 2011-2013).

To date, the **total investment** made by the EU, ESA and its Member States accounts for **more than € 3.000 Mio**. If GMES/Copernicus were to be discontinued, almost all past investments would be lost, with an additional risk to disrupt national capacities to maintain their investment in space earth observation activities as the EU dimension would no longer provide a political and programmatic framework. It is thus very likely that the situation would go back to fragmented and uncoordinated space activities with remaining gaps, unsolved redundancies, and lack of economies of scale, as they existed before the creation of GMES/Copernicus.

This risk of discontinuity represents a major concern for end-users like public authorities, but also for downstream service providers, as they are unlikely to invest significantly in non-mature, risky markets and will face additional difficulties in raising capital.

[31] In particular, information aggregated at European or global level with a sufficient quality is currently not available to European policy makers.

Innovation potential at risk

The risk of discontinuity would also imply that R&D investments are not translated into innovation. Therefore the potential to unleash the innovation capacity linked to GMES/Copernicus, which is mainly a service related innovation, will not be exploited. This would be regrettable especially taking into account that the EU innovation policy should be more targeted to the services sector, as different studies show[32].

Autonomous access to reliable, traceable and sustainable information on environment and security is strategic

GMES/Copernicus is expected to provide key tools and products for enabling the definition, implementation and monitoring of EU policies on environment and security. The six thematic services as defined in the GMES/Copernicus Regulation are currently developing more than 400 products to be issued either on a routine basis, either every day (e.g. air quality information), or on demand (e.g. damage assessment maps following a major disaster).

Hence through GMES/Copernicus, the EU has significant influence in international programmes and negotiations such as the three Rio Conventions (Climate Change, Desertification and Biodiversity), post-Kyoto Treaty, GEO, CEOS, GCOS, and in bilateral discussions on space activities.

Finally, GMES/Copernicus gives the EU an autonomous capacity on access to information. Without it, the EU would have to rely on non-European (e.g. US) satellites or international sources of information (e.g. International Charter, international conventions), or even on uncoordinated sources from its Member States for the implementation of its policies.

Employment at risk

Satellite applications systems are the main source of income for the European space industry (€ 3.100 Mio), and are the main domain of exports (with € 1.130 Mio).[33] One of the two most significant segments in terms of income is Earth Observation (e.g. GMES/Copernicus Sentinels). Currently, Earth Observation systems account for around 30% of the total income for the European space industry. Besides this direct impact on industry sales, GMES/Copernicus has a significant impact on the competitiveness and the profitability of the European space manufacturing industry. Export and trade vastly depend on the relative competitive position of the sector.

Recent studies[34] have explored the impact of GMES/Copernicus data availability on downstream markets development and have added the figures of downstream sector employment to the figures of jobs development in the space related sectors. Considering the GMES/Copernicus contribution along the Space value chain, GMES/Copernicus can be seen as a driving force for creating highly skilled job opportunities and can have indirect effects on the wider economy by 2030.

[32] See for instance Next generation innovation policy, the future of EU innovation policy to support market growth, CEPS and Ernst & Young, 2011.

[33] The European Space Industry in 2010, ASD-Eurospace, 15th edition, June 2011.

[34] SpaceTec Partners 2012.

Downstream: Maintaining and creating more than 9.000 direct jobs cumulatively, provided that full data continuity is assured for GMES/Copernicus in the long term, and the EO market potential is realised, with enabling factors in place.
Upstream and Midstream: Maintaining and creating 2.740 direct jobs under the GMES/Copernicus funding scenario of full data continuity.
An aggregate of 11.900 direct jobs will be created and maintained across the entire GMES/Copernicus and EO value chain.
A high-level analysis of potential economic multiplier effects (based on Oxford Economics' Space industry multipliers, provided by the European Commission) suggests that more than 36.000 indirect jobs could be maintained and created, yielding an overall employment impact of approximately 48.000 jobs in Europe by 2030.

3.2. Upgrading the system to routine operational status

The GIO (GMES Initial Operation) Regulation will be valid until the end of 2013. In the meantime a new budget has been proposed by the European Council for GMES, which is entering its operational phase from the start of 2014 under the new name of Copernicus. These changes require a new Regulation which will propose decisions on, among other topics, the issues of programme governance, of ownership of the infrastructure and of budget apportionment between the different components. In addition, a Delegated Act on Copernicus Data and Information Policy, to be applicable to the operational phase, has been prepared and enshrines the principle of full, open and free-of-charge data access for all users. It is crucial that this 'upgrade' of the programme results in a smooth transition to the new operational phase, especially from the perspective of existing and potential users, with the highest level of continuity and the efficient apportionment of the budget, as well as efficient governance choices.

3.3. Underlying drivers of the problem

As shown above, stakeholders widely agree that a public intervention in basic operational services is a prerequisite for wide-ranging operational services to emerge. Without such intervention operational services useful for policy makers and others will not become available.

The market fails in providing the operational services without public intervention. This is mainly due to intrinsic high fixed costs, while at the same time returns generated by selling data to public authorities or commercial players are risky and hard to estimate. This makes the investment not sustainable for the private sector given the very long time span required to reach the break-even point of the investment[35].

Although the overall benefits from the programme are estimated to largely exceed the costs, they are partly of a public nature linked for instance to monitoring climate change or to deforestation[36]. Moreover the benefits coming from downstream market development require the continuous availability of GMES/Copernicus data to incentivize private investments in the sector. For these reasons, the continuation of the Programme has to be assured and the most appropriate budget allocation and apportionment approach has to be adopted. This

[35] See also the Impact Assessment accompanying the Commission Communication on the European Space policy, SEC(2007)505 of 26.4.2007, p. 10.

[36] See for instance: Socio-economic benefits, PWC, 2006 or the results of the Booz Cost/benefit analysis in chapter 6 of this impact assessment. .

impact assessment will therefore look into different options regarding alternative allocations of the budget foreseen by the European Council for GMES/Copernicus.

3.4. Establishment of an appropriate governance structure

The shifting from a research phase to an operational phase requires re-thinking of the governance structure. The reasons are manifold: research projects are smaller in terms of budget and objectives, limited in duration and conceived as prototypes of what the whole Copernicus structure could look like. It is exactly building on those experiences, and taking into account internal financial and human resource constraints, that the GMES Unit has been analysing different options and proposing the most efficient governance framework for Copernicus. Final decisions on governance in the proposed Copernicus Regulation have taken account of discussions with other interested Commission Services and in stakeholder meetings such as the User Forum and GMES Committee. Past evaluations and personal experiences have been taken into account in choosing the "delegation solution". The main reasons that lead to this decision are the increasing number of management tasks and the need for specialised personnel to address the specific services development: it is exactly to avoid duplication that the Regulation proposes the delegation of tasks to external actors who already have the required skills and organisation. In addition, certain management responsibilities could exploit existing Commission resources or could be covered by seconded experts. Thus, through a combination of outsourcing and exploiting internal resources, the effective capacity of the GMES Unit for managing the programme will be appropriately increased.

3.5. Who are the most affected groups?

GMES/Copernicus is a user-driven programme, thus requiring the continuous, effective involvement of users, particularly regarding the definition and validation of service requirements, aiming at providing information services in the field of environment and security. Up to now, during the build-up phase, the user consultation process has been based on interaction with Member States (GMES Advisory Committee, Partners Board, GMES Committee), on recommendations from the User Forum, and took stock from outcomes of the demonstration activities financed through the FP7 programme, conclusions of specific studies, results of dedicated workshops and dialogues with stakeholders, and reports from the Implementation Groups.

GMES/Copernicus services are based on more than 30 applications with over 400 products. The **user community** is large and diverse, spanning from international stakeholders to European citizens. The most affected groups include:

– At European level, **Commission services** (13 DGs) are already using or are planning to use GMES/Copernicus products, e.g. ECHO for emergency management services, ENV for land, marine and atmosphere monitoring services, AGRI for agri-environmental monitoring, MOVE for oil spill and ice monitoring, MARE for ocean monitoring and forecasting, REGIO for land use and CLIMA for forest monitoring and climate change mitigation and adaptation.

– **EU agencies** are also important users and actors (EEA, EMSA, FRONTEX, EUSC…), as well as the European External Action Service (EEAS), intergovernmental European agencies (ECMWF, EUMETSAT, EDA, ESA), and European programmes, associations and networks (EMEP[37], EUMETNET, Eurogeographic, Eurogeosurvey, OSPAR, HELCOM…).

– At **international** level, GMES/Copernicus is developing relationships with GEO partners, UN agencies (FAO, WFP, UNEP, UNOSAT…), NGOs, and international research programmes (ESSP[38] with DIVERSITAS, IGBP, WCRP, IHDP) since the scientific community is an important user of GMES/Copernicus data and services;

– **National Authorities** (Ministries of Environment, Transport, Interior, Agriculture, Energy, Fisheries, Land Management, Maritime Affairs …) and Public Local Authorities (e.g. in urban planning issues), but also specific entities such as Civil Protection Authorities and Risk Control Agencies.

– A wide range of users in the **industry** framework (space manufacturing sector and related operations, service provision, data production and dissemination sector, development of value added services in the downstream sector), and ultimately European **citizens** who will use the final products.

As far as the downstream sectors are considered, a specific analysis has already identified the more promising ones and estimated the potential turnover. An estimate of the European GMES/Copernicus' downstream market potential has been performed and is included in the Cost-Benefit Analysis below.

3.6. Foreseen evolution of the problem

The challenge is to ensure the continuity and evolution after 2013 of appropriately designed services to meet the users' needs. This continuity of services presupposes the continuity and evolution of GMES/Copernicus infrastructure providing the necessary data. Without good policy management, the "raison d'être" of the Programme is put into question, as users will only rely on GMES/Copernicus if a sustained flow of data is ensured. Without appropriate funding given to services, the continuity will be exposed at risk.

In this context, and given the € 3.786 Mio that are allocated to GMES/Copernicus inside the Multiannual Financial Framework for 2014-2020, the baseline scenario for this impact assessment is that the above budget would be spent on GMES/Copernicus, and include financing the following actions:

– The uninterrupted provision and adaptation of GMES/Copernicus **services** according to evolving user needs. The earth Observation (EO) downstream evolution will largely depend on the continuous input of information produced in the framework of GMES/Copernicus services.

– The **exploitation** of GMES/Copernicus **infrastructure currently developed** specifically for GMES/Copernicus (the prototypes of the Sentinel missions),

[37] the European Monitoring and Evaluation Programme is a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution for international co-operation to solve transboundary air pollution problems

[38] Earth System Science Partnership

- The **recurrent units** (i.e. identical copies of existing prototypes needed e.g. to increase the frequency of observations and extend the time span of data provision with a relatively low investment compared to the prototypes);
- The **renewal of space infrastructure** developed specifically for GMES/Copernicus (taking into consideration the long design and construction lead times for satellites (8–10 years), including decisions on the second generation of Sentinels);
- The user friendly **access to space data from contributing missions** (i.e. existing or new space infrastructure at national or international level which is not developed specifically for GMES/Copernicus) and co-ordination activities in the European Earth observation sector;
- A **contribution** for the coordination of the ***in situ*** **component**.
- It should be recalled that the long-term GMES/Copernicus funding approach should be developed in a modular way. This means that new expansions in the scope of GMES/Copernicus services and every new evolution of GMES/Copernicus will be assessed against the criteria of cost efficiency, user needs and EU policy interests.
- However, while the overall budget has been decided, the allocation of the budget among the three main components of GMES/Copernicus (space infrastructure, in situ infrastructure and services) is not predetermined by the decision. This impact assessment will therefore compare three alternative options, without regarding any one of them as the baseline. The impacts in terms of costs and benefits will be analysed in absolute and relative terms for all three scenarios.

3.7. The risk of non-sustainability

The primary area of risk for both the downstream exploitation of the Copernicus Services and also the upstream sector is the inherent uncertainty in the funding model, based, as it is, on the European Union's MFF funding strategy. This currently guarantees sustainability of the Copernicus programme only for 7 years. Hence, as time passes and the guarantee period diminishes so the various actors whose businesses depend on the programme might become less confident about the future. Unless this loss of confidence over time can be mitigated, several negative impacts may emerge, including the likelihood that the profile of benefits revealed by the Cost Benefit Analyses may turn out to be over-optimistic. In order to mitigate these risks the Commission should take steps at an appropriately early stage (perhaps starting at the mid-term review) to instil confidence by firmly and publicly stating its commitment to securing funding for Copernicus beyond 2020. In addition the Commission should develop and publish a long-term strategy for Copernicus, including its funding, so that the confidence of those with vested interests in the programme can be maximised.

3.8. Does the EU have the right to act?

The legal basis for a European Earth observation programme (GMES/Copernicus) is Article 189 of the TFEU, which allows the EU to act. Article 2 of the Regulation 911/2010 on the European Earth Monitoring programme (GMES) and its initial operations establishing the

GMES/Copernicus Programme already lists activities included in the programme. Moreover, the delivery of GMES/Copernicus is a strategic objective of Europe 2020.

Responsibility for funding the exploitation and the renewal of space infrastructure developed with EU and intergovernmental funds cannot be optimally achieved by individual Member States because of the costs incurred. In the field of space-based observation for operational meteorology, European States have pooled their resources to develop and exploit meteorological satellites in the framework of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). European States also developed demonstrators of environmental satellites either through ESA or through national space agencies. They could not, however, find a way to co-operate with regard to the funding of sustained operational programmes in the field of environmental monitoring similar to that for meteorology. The need for continuing such observations is becoming critical, considering the increasing political pressure on public authorities to take informed decisions in the field of environment, security and climate change and the need to respect international agreements.

For the services with a pan-European (or even global) coverage, Member States cannot sufficiently achieve the objectives of the proposed action, as the inputs from different Member States have to be aggregated at European level. The provision of other services (e.g. emergency maps or thematic land monitoring maps of a more limited geographical scope) can be better achieved by the EU for two reasons. First, a more coherent and centralised management of input data, from space based or *in situ* sensors will allow *for economies of scale*. Secondly, an uncoordinated provision of Earth observation services at Member State level would lead to duplications and would render the monitoring of the implementation of EU environmental legislation on the basis of transparent and objective criteria difficult or even impossible. If information produced at Member State level is not comparable, it will not be possible for the Commission to ascertain whether environmental legislation has been implemented correctly in all Member States. Moreover, action at European level will create economies of scale leading to a better value for public money.

The action proposed for the operational phase of GMES/Copernicus does not replace existing services at national or regional level, but rather complements and optimises them, coordinates them or ensures their continuity. EU institutions and policy makers will be among the main users and beneficiaries of the GMES/Copernicus information and services; moreover the provision of GMES/Copernicus data at a European level is necessary to build trust in the final users and to foster investment in downstream applications.

4. OBJECTIVES

4.1. General objectives

The over-arching objectives of defining, financing, establishing and operating a GMES/Copernicus, long-term operational programme of activities as described in the proposed Regulation on establishing the European Earth Observation Programme (Copernicus) are to actively address the problems described in Section 3 above.

By forming a key element of the EU's Space Policy, an overall objective of GMES/Copernicus can be defined as contributing to reaching the following Europe 2020 goals by creating:

« a more resource efficient, greener economy »
« a more competitive economy »
« an economy based on knowledge »
« an economy based on innovation »
« a high-employment economy »
« economic, social and territorial cohesion ».

- The GMES/Copernicus services aim to enable public policy makers in particular to:
  - prepare national, European, and international legislation, for instance in the field of environmental matters, including climate change;
  - monitor the implementation of this legislation;
  - access comprehensive and accurate information concerning safety and security matters (e.g. for border surveillance, civil protection activities, …)[39].
  - Additional objectives concern the need of assuring continuous data provision to foster downstream markets development.

These objectives will be pursued in the context of international cooperation, while at the same time guaranteeing a minimum level of autonomy of the EU when it comes to accessing crucial information to inform its policy decisions.

4.2. Specific Europe 2020 policy objectives

Delivering GMES/Copernicus and Galileo Programme is one of the objectives stated in Europe 2020 strategy. GMES/Copernicus aims to contribute to the Europe 2020 objectives in the following ways:

« a more resource efficient, greener economy », i.e. in particular the preservation and management of environmental resources and ecosystems and biodiversity (knowledge of biomass and land use, monitoring of oil spills…); achieving efficiency gains as a result of better enforcement of EU policies (environment, agriculture, maritime policies…).

[39] The security aspect is not included in the Cost-Benefit Analysis.

« a more competitive economy », as a flagship on industrial and space policies, GMES/Copernicus aims to foster the competitiveness of EU industry and its technological edge in space (manufacturing) and beyond (services + applications); it specifically aims to create business potential for SMEs by boosting innovation (SMEs represented half of the downstream sector in 2009).

« an economy based on knowledge », GMES/Copernicus aims to contribute to a better understanding of global challenges (e.g. climate change, tropical deforestation, desertification, land degradation and emergency preparedness); it supports the development of research/science by the provision of critical data.

« an economy based on innovation », GMES/Copernicus allows the emergence of highly innovative downstream services (e.g. for the management of the environment, security, meteorology, civil protection and risk management); it aims to create partnerships between research and business communities and can set benchmarks for transfer of research and development into business;

« a high-employment economy », GMES/Copernicus creates additional potential for new jobs (e.g. in the satellite manufacturing industry and in the downstream sector[40]) by boosting additional demand for highly-skilled workers and fostering new markets development.

« economic, social and territorial cohesion », i.e. need for new ground infrastructure in particular in the EU-12; creating new business potential for SMEs in all EU Member States (also for services and applications in countries with weaker industrial base, thanks to the full and open data access principle of GMES/Copernicus). GMES/Copernicus will give an impetus to those countries lacking behind in land or emergency services and will therefore contribute to the objective of an increased cohesion among the Member States. GMES/Copernicus services are by definition pan-European and respond to European requirements.

4.3. Operational policy objectives

The decision of the European Council integrates GMES/Copernicus inside the MFF, setting the ceiling for the maximum level of commitments to € 3.786 Mio from 2014 to 2020. The operational objective now is to **allocate that amount in the most cost-effective way** when developing the different components of GMES/Copernicus. On **governance**, and based on principles of good governance, the operational objective is to separate supervision, management and technical implementation.

4.4. Consistency with and relevance to other EU policies

In the operational phase GMES/Copernicus will be able to deliver information services to policy makers, public authorities, businesses and European citizens. This means that GMES/Copernicus, as an EU autonomous source of information, aims to support all relevant Union policies, instruments and actions, where understanding the way environmental changes affect our planet is paramount.

Examples of GMES/Copernicus contribution to other EU policies include following:

[40] For an analysis of the Downstream service in Europe, see Annex VI.

- **International cooperation policies**: extending GMES/Copernicus services to Africa represents a concrete contribution to EU development policies. Satellite Earth Observation, for instance, enables the monitoring of crop conditions during the agriculture season and the development of Food Security Early Warning System for at-risk regions worldwide. In addition some applications of GMES/Copernicus could provide policy makers with information on natural resources in Africa.

- **Transport policy**: by optimising ship routing GMES/Copernicus Marine service could minimise fuel consumption and emissions.

- **Environmental policies**: the GMES/Copernicus services provide systematic or periodic information at various scales which are necessary for monitoring on a continuous basis the state of the Marine, Atmosphere and Land environment. In this context environmental images collected through GMES/Copernicus could provide the basis to monitor the targets of the new European biodiversity strategy, as announced in May 2011, or as a tool to monitor the efficient use of resources such a wood, water, minerals, land, air (quality) and many others at European and global scale

- **Humanitarian aid**: GMES/Copernicus services also play an important role in emergency response activities inside and outside the EU, providing up-to-date information which is crucial for decision makers, operation planners and field teams.

- **Energy**: GMES/Copernicus can provide Europe with a reliable source of information, monitoring nuclear proliferation or decommissioning of nuclear sites and protecting vital infrastructure such as pipelines.

- **Regional policy**: at Pan-EU level GMES/Copernicus Land Service provides harmonised land cover and land cover change products. This information is essential for land use and urban policies purposes.

- **Climate change policy**: There are several GMES/Copernicus services that touch upon climate-related issues such as forest monitoring and land carbon information, monitoring sea and ice level, analysis of greenhouse gases and fluxes.

- **Internal affairs and security**: GMES/Copernicus can contribute to border surveillance and maritime surveillance. In this framework since 2008, DG ENTR and DG HOME have established a close cooperation.

- **Agriculture**: Agri-environment monitoring could contribute to the improvement of the timely and accurate monitoring of agricultural land use state and its changes at European, national and regional levels by providing common methodologies and indicators covering various temporal, spatial and thematic scales. The common agriculture policy could use GMES/Copernicus in order to monitor the ‘set-aside’ policy.

- **Marine related policies**: GMES/Copernicus allows understanding the ocean, its dynamic processes and its impact on climate change. Applications in this domain include: Maritime Security, Oil Spill, Marine Resources management, Climate Change, Seasonal Forecasts, Coastal Activities, Ice Surveys and Water Quality.

4.5. Synergies with other DG Enterprise programmes

There are clear synergies between Copernicus and other DG Enterprise programmes, which have been exploited in the past and may be exploited in the future. The main Programmes to be mentioned are the space elements of Horizon2020[41] and COSME (Competitiveness of enterprises and SMEs). The fact that Copernicus is now entering its operational phase does not mean that it will not need research activities also in the future. The Copernicus services build on the results of FP7 projects (e.g.: MACC II, MyOcean2, etc) and there will be a similar need from the Space projects of the framework programme Horizon 2020 to provide further guidance and inspiration – obtained through multi-national European projects – to help in the onward development of Copernicus, especially regarding the less mature elements (e.g. the Climate Change Service) and the future evolution (e.g. through emerging technologies). Other examples include contributions to the provision of better tools to access and analyse the data, to studying innovative downstream applications of Copernicus data and services and to support the establishment of Space Surveillance and Tracking capability. As far as COSME is concerned, in the past there has been cooperation especially for the European Mobile and Mobility Industries Alliance (EMMIA) projects: a European Commission initiative which fosters the cooperation between industries, especially SMEs, and regional authorities in the field of mobility and mobile services. A specific call[42] was made to help entrepreneurs who want to build downstream applications using Copernicus and Galileo and new initiatives are foreseen for the future.

41 Only the space component of Horizon 2020 is mentioned here, for the safe of briefness; nonetheless other research areas are clearly related to Copernicus and its services (e.g. Climate Change, Transport).

42 Already € 3.5 million have been mobilized in 2012 to fund 6 demonstrators and an additional action providing more traditional business support for entrepreneurs developing new services relying on the two Commission space Flagships.

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5. OPTIONS AND IMPACT ANALYSIS

Preamble

The whole of Annex I and the large majority of this Section, while based on material from a Specific Contract with Space Tec Partners under the Framework Service Contract 89/PP/ENT/2011 – LOT 3, has been edited and updated to reflect the Commission's proposal for a Regulation establishing the Copernicus programme.

This section presents the key results from the overall impact analysis. A more comprehensive description, along with details of the analysis methodology, is presented in Annex I. It is important to note that the most up-to-date version of the so-called "Injection Paper" (the deliverable from the Specific Contract) has been used in this updated Impact Assessment (and is included as Annex I). The most significant difference from previous version is the assumption that the level of funding for Copernicus in the period 2021-2030 will be the same as that applicable during the current MFF. This change was requested and allows an analysis that is not complicated by guesses of future budget variability which are necessarily based on mere speculation. It does not impact in any way the opinions expressed by the IAB on the previous submission.

Preliminary considerations

All options in this impact assessment share some common elements that are described below.

Infrastructure at Member State level

GMES/Copernicus is partly based on an existing infrastructure at Member State level, of so-called "*in situ*" components (airborne or ground-based sensors) and space components (so-called "contributing missions"). The starting assumption is that Member States will continue to invest in their space and *in situ* infrastructure for their own purposes, as they have done in the past.

Principle of modularity

The modularity principle refers to the possible differentiated implementation of GMES/Copernicus based on budget constraints. The principle applies both to the services and to the infrastructure investment. For instance, if under one of the options, the available budget would be still somewhat lower than what is foreseen in the option, the services can be slightly reconfigured and still be provided with a reduced portfolio of products. Therefore the GMES/Copernicus programme has no systemic risk of cost overrun.

5.1. Different options on budget allocation

Given the amount of funding decided by the European Council for the Copernicus programme, the three scenarios (options) described in this section examine the effects of varying the amount apportioned to the three main components: **space infrastructure**, contribution to the ***in situ*** **infrastructure** and the financing of the **Services**. The analysis emphasises the trade-off between investments in space infrastructure and services, while keeping the expenditure on the *in situ* stable, given the inherent nature of this component (primarily reliant on national investments).

The logic applied in designing the three cost breakdown scenarios in this analysis proceeds as follows:

Previous studies have identified minimum annual budget levels for the three components, below which realisation of benefits falls rapidly.

The first scenario represents the maximum investment in the Service component.

The remaining two scenarios adjust the levels of the Space component upwards, and apportion the remaining budget to the Services component.

The analysis of the possible funding scenarios shows that investment should be proportionally higher than previously envisaged in the service component, including their initial set up and the continuous improvement of the specific services. Nonetheless, a large investment in the space component still remains necessary since this will provide the EC with the essential source of sustained, independent and comprehensive Earth Observation data, whose exploitation is underpinned by a well-defined full and open Data Policy. This is of crucial importance when it comes to private business development: a stable and transnational regulatory framework is one of the enabling factors for private entrepreneurs to invest to develop businesses with Copernicus data.

For the space component, ESA has proposed a revised strategy for Sentinel satellite development and deployment which reflects the reduction in the available budget but which responds to the essential need for continuity of space-based observations. This re-planning includes three major changes when compared with the previously agreed Copernicus Long-Term Scenario (LTS) as follows:

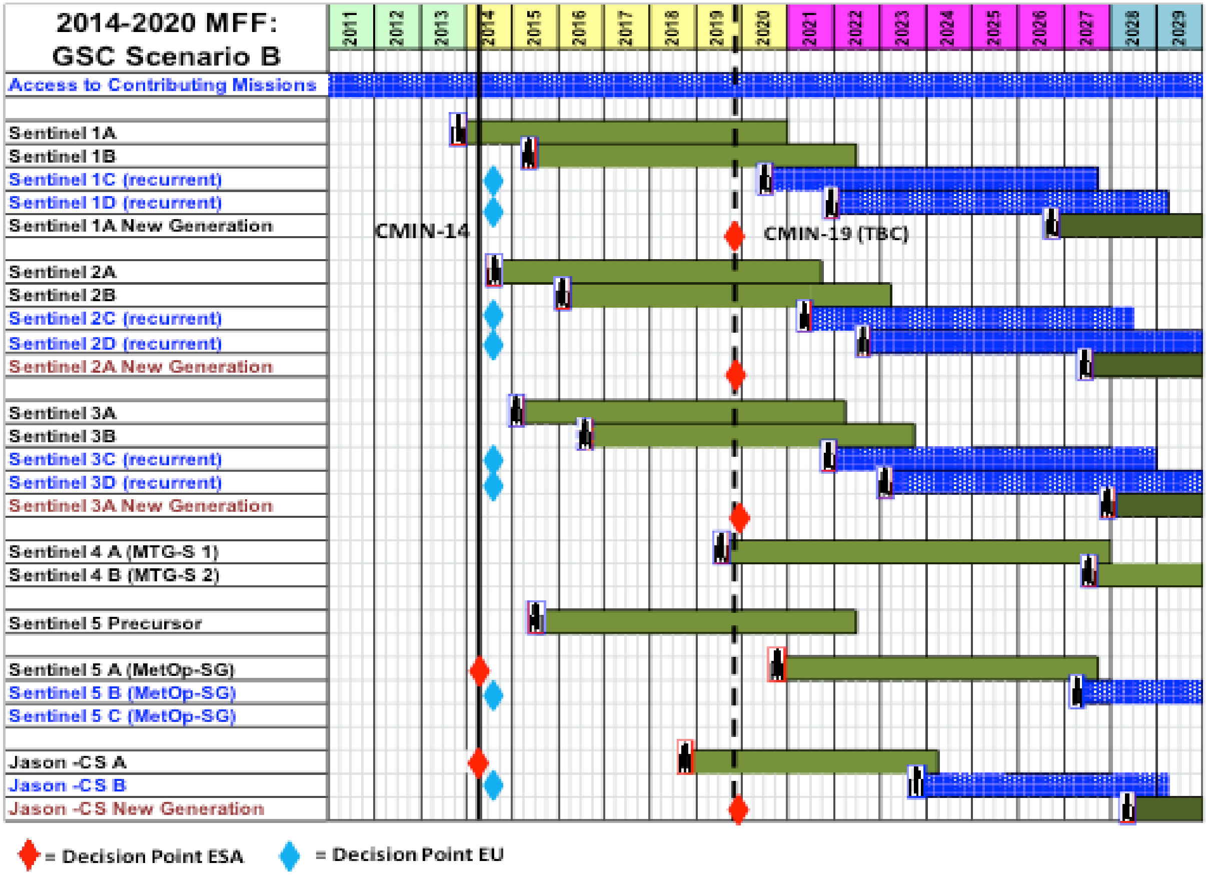
Recurrent –C and –D units of all the Sentinels are introduced. These provide for data continuity and have the benefit of the economies of scale at the expense of postponing the evolution of observational needs. The development of these units will take place during the MFF period, although their eventual launch and operations will occur post 2020;

Related to the above point, the development of the Sentinel-NG (Next Generation) satellites is deferred beyond 2020;

Less funds than previously foreseen will be committed to securing access to data from contributing missions (i.e. satellites other than the Sentinels). The impact of this decision is mitigated by the fact that data from the Sentinels will become available progressively over time, obviating the continued need/importance of some third-party data sets.

This approach clearly puts the onus on the Services and the downstream applications to exercise their creativity and expertise to the maximum extent to continually find new and novel ways of making the most benefit from the existing data while, at the same time, to expend effort in capturing the changing requirements that must be consolidated for the planning of future (post 2020) developments with confidence.

This approach results in the revised Sentinel development/deployment baseline described in the diagram below.



5.2. Methodology

In 2011 Booz & Company was commissioned by the European Commission to undertake a Cost-Benefit Analysis (CBA) of the GMES programme. The main focus of this study was the assessment of four broad funding levels for GMES and its operational services. The evaluation of benefits was mainly based on the role EO infrastructure plays in supporting the implementation of government policies aimed at better managing the environment and issues related to security. Based on this assumption, the study analysed the value of information GMES provides to support policy action and resource management across the EU and further afield.

In order to establish these benefits (and how GMES may reduce various costs), a literature review of the economic value of information, combined with interviews and desktop research, enabled the development of assumptions around the incremental benefit from better EO information. Four options were provided for analysis under the cost-benefit assessment:

Option A (Baseline Option with no on-going commitment to replace infrastructure or investing significantly in services);

Option B (Baseline Option Extended, but still with no on-going commitment to replace infrastructure over the longer term and invest significantly in services);

Option C (Partial Continuity, with commitment to provide Sentinel infrastructure and invest considerably in services, with limited support to ensuring continuity of data from Contributing Missions); and

Option D (Full Continuity with commitment to provide Sentinel infrastructure and enhanced support for the continuity of data from Contributing Mission with full investment in services).

The quantification of benefits was based on an approach that attributes to GMES an incremental improvement in outcomes, e.g. measured as a change in baseline environmental damage costs. This recognised that the attainment of particular outcomes in each benefit area is a result of multiple factors, of which the contribution by GMES is only one part. The extent of GMES contribution was taken into account in the analysis for each benefit area.

A new study was commissioned from SpaceTec Partners to re-examine the original CBA in the light of potential budgetary and governance choices. The methodology adopted in the Booz CBA was based on a Copernicus "full continuity" scenario (referred to as Option D), and then applying progressive degradation to each of the other options in relation to this scenario. This scenario was used as the reference case in the new SpaceTec Partners study. The "progressive degradation" principle is applied in the present analysis to establish the baseline for analysing the changes in the allocation of funding amongst the different main cost areas, and the like-for-like estimation of benefits, subject to the understanding that there are limits to the validity of this principle, such as minimum and upper thresholds on benefit realisation.

The CBA regards each of its options "as being discrete" (Booz CBA, p. 99), meaning that the benefits do not grow linearly in relation to the level of investment, but are the outcome of different configurations of the Space, Service and In Situ components within the options. In other words, a step function is at work, with threshold boundaries separating unconnected plateaux of benefit escalation.

This is particularly true in the case of the Space component; since the Sentinels are deployed in units, there are limits as to what can be achieved with specific levels of funding. Minor deviations around these step changes do not serve to alter the benefit profile in a significant way. Whilst this proposition is not readily observable in the Booz CBA because of the proportionally large gap between the funding levels of each option, it is recognised that in each case, a step change in commitment (and hence, benefits) has taken place.

In order to refine the analysis, the SpaceTec 2013 study examined the extent to which benefits scale in relation to the level of funding allocated between the Space and Service components, in particular. This analysis allows a comparison of the three scenarios analysed in this Impact Assessment, that all share the same budgetary envelope. The following assumptions underpin the present analysis as regards the scaling of benefits:

Investment in the Space component is a **necessary, but insufficient** condition for the realisation of benefits.

In order for benefits to arise, **parallel investments must be made in Services.**

A step change in benefits occurs once investment in Space reaches a certain threshold. Beyond this threshold:

Additional investment in Space does not bring about linear increases in benefits

Step-changes in benefits are contingent on additional investment in Services.

Benefits linked to investments in services are more linear, with incremental benefits possible through service improvement, extension to scope, and the development of new services. These nonetheless remain dependent on upgrades or enhancements to the underlying

Space infrastructure for larger step changes, accompanied by more major service-supporting developments such as improved access to data and the enabling of the downstream sector[43].

While the *in situ* component also plays a role in the scaling of benefits, it is not shown here as the Space-Services relationship is considered to have the most impact on the present analysis.

5.3. Options description

The Cost-Benefit Analysis will analyse the three scenarios described below:

Service Delivery Pull

This scenario foresees a relatively large share of the available budget being used to finance the provision of services. This scenario allows for a level of funding for the Space component in line with previous studies (namely the Booz CBA option B). The realisation of additional, programme-wide benefits rests on the development of the Service component and on the implementation of its enabling factors. In this scenario, the deployment of the Space component is assumed to follow a serial approach (i.e. the Sentinel series of satellites are deployed in series). This scenario would therefore try to combine the minimum investment in space infrastructure with the maximum possible financial allocation to services.

Intermediate

The “Intermediate” scenario increases the investments in the Space component with respect to the first, while the Services component is reduced proportionally. In this scenario, as in the previous one, the deployment of the Space component is assumed to follow a serial approach. This scenario illustrates the impact of adding emphasis to the evolution in contrast to that attributable to the impact of evolving services.

Technology Driven

This scenario foresees the highest possible investment in the Space component while the Services component would be reduced to the bare minimum. This scenario would be completely driven by advances in Space-based remote sensing technology but would not necessarily embrace the priorities elaborated by the users of the Services.

[43] For full considerations regarding enabling factors, refer to Annex I

5.4. Analysis of impact of options on budget allocation

The budgetary allocation assumptions for each scenario, given a fixed total budget, and the benefits for each of the scenarios are presented in the tables below:

Table 2 - Cost Distribution by Scenario (Annual Averages)

		I - Service Delivery Pull			II - Intermediate			III - Technology Driven			
		Space	*in situ*	Services	Space	*in situ*	Service s	Space	*in situ*	Services	Annual average
TOTAL 2014-2030	€ Mio	400	22	119	422	22	97	438	22	81	**541**
	%	**74%**	**4%**	**22%**	**78%**	**4%**	**18%**	**81%**	**4%**	**15%**	

Source: SpaceTec Partners 2013.

Table 3 - Benefit Simulation by Scenario

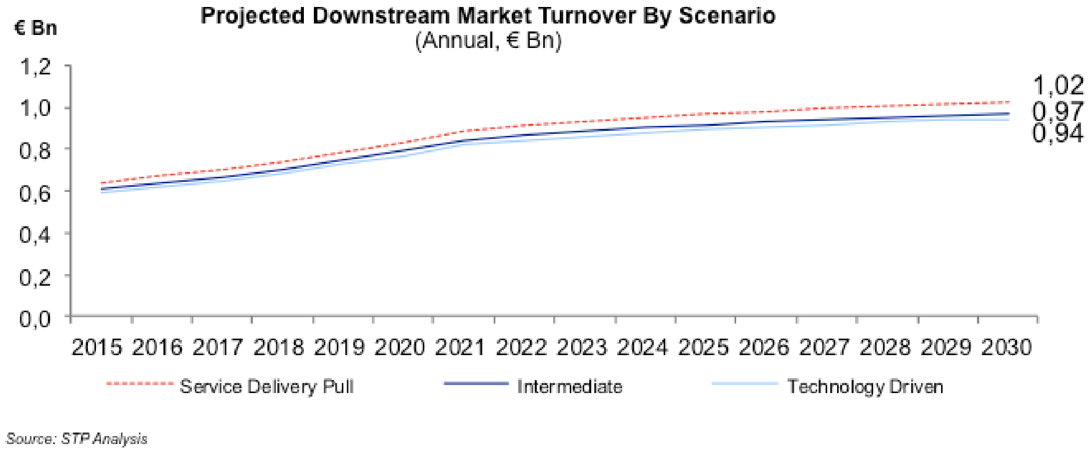
	2014-2020	2021-2030	TOTAL (2014-2030)	*Integrated contribution to European GDP*	*Integrated Benefit Cost Ratio (BCR)*
	Cumulative, € Bn			%	Ratio
I - Service Delivery Pull	6,3	23,0	29,4	0,164%	3,30
II - Intermediate	6,1	22,1	28,2	0,157%	3,17
III - Technology Driven	5,9	20,8	26,7	0,149%	3,01

Source: SpaceTec Partners 2013.

Downstream Impact

In addition to the direct benefit analysis, the economic impacts associated with the Earth Observation and GMES/Copernicus downstream market have been estimated by scenario, as illustrated in the chart below.

Figure 1 - Projected Downstream Turnover By Scenario (2014-2030, € Bn)



Source: SpaceTec Partners 2013.

Impacts on employment

The impact on employment has been estimated for each scenario, considering direct and indirect employment separately. The effects of different funding inputs have been modelled according to the cost scaling parameters outlined in Annex I.

Table 4 - Employment Impact by Scenario

(US: Upstream, MS: Midstream, DS: Downstream, DE: Direct Employment, IE: Indirect Employment, T: Total)

(Figures rounded up to nearest 10)

		I - Service Delivery Pull			II - Intermediate			III - Technology Driven		
		DE	**IE**	**T**	**DE**	**IE**	**T**	**DE**	**IE**	**T**
		Number of jobs created / maintained by 2030								
TOTAL (2014-2030)	**US**	2.030	5.270	**7.300**	2.140	5.550	**7.690**	2.220	5.770	**7.980**
	MS	710	1.830	**2.540**	680	1.750	**2.420**	650	1.690	**2.340**
	DS	7.170	29.340	**38.510**	8.710	27.850	**36.550**	8.460	27.070	**35.530**
	T	**11.900**	**36.440**	**48.330**	**11.510**	**35.150**	**46.650**	**11.330**	**34.520**	**45.840**

Source: SpaceTec Partners 2013.

Economic, Environmental and Social Benefits

The benefits of each scenario have been categorised according to their economic, environmental, and social dimensions, both qualitatively and quantitatively.

Table 5 - Summary of Economic, Environmental and Social Benefits (Quantitative)

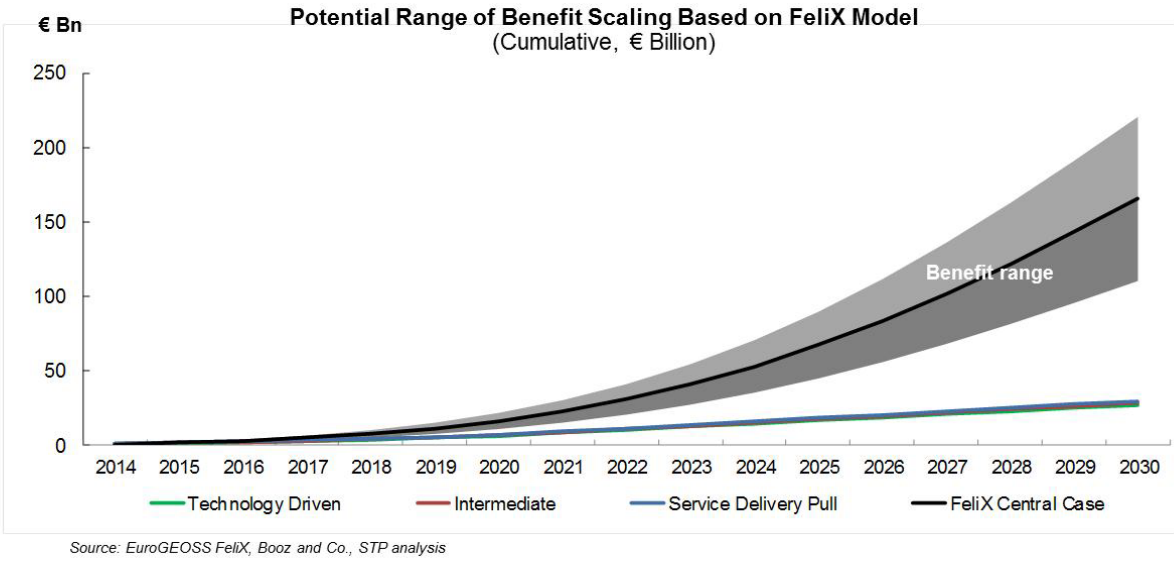
Benefit Categories	Values		I - Service Delivery Pull	II - Intermediate	III - Technology Driven
Economic	**Total Space Turnover (2014-2030)**	€ Mio	8.002	8.306	8.542
	Total Downstream Turnover (2030)	€ Mio	1.034	981	954
	Combined Δ Scen. I	%	**0%**	**-2%**	**-4%**
Environmental	**Total (2014-2030)**	€ Mio	17.611	17.005	16.158
	Δ Scen. I	%	0%	-3%	-5%
Social	**Total (2014-2030)**	€ Mio	11.585	11.045	10.415
	Employment Impact[44] (2030)	#	48.330	46.650	45.840
	Δ Scen. I (Benefits)	%	**0%**	**-5%**	**-10%**
	Δ Scen. I (Employment)	%	**0%**	**-4%**	**-5%**

In order to complement the analysis being carried out by Booz, the SpaceTec study used an additional model, the FeliX model, a system dynamics model and benefit simulator, which takes into account the complex relationships between natural and socio-economic systems has been developed by SpaceTec. The model forecasts benefits that are in the order of magnitude of € 21.700 Mio cumulatively by 2020 and € 220.000 Mio by 2030 (undiscounted), substantially higher (~8 times, in the long term) than the 'static' benefit projections of the present study. This is due to the enlarged scope of the FeliX model, and its broad assumptions of underlying infrastructure (namely GEOSS[45], to which Copernicus is expected to constitute the EU's major contribution). The comparison with the FeliX output serves to highlight the strong potential for higher-order magnitudes of benefits when Copernicus is viewed as part of a broader system of systems. The figures used in this impact assessment are therefore considered to be conservative estimates.

Figure 2 - Potential Range of Benefit Scaling Based on FeliX Model

44 Refers to total direct and indirect new and maintained jobs associated with Copernicus.

45 Global Earth Observation System of Systems.



Source: SpaceTec Partners 2013.

5.5. Cost-Benefit Analysis

This section summarises the results of the scenario analysis presented in this chapter.

Table 6 - Integrated Impact Simulation by Scenario (Undiscounted)

			I - Service Delivery Pull	II - Intermediate	III - Technology Driven
2014-2020	Cumulative Benefits	€ Bn	6,3	6,1	5,9
2021-2030	Cumulative Benefits		23,0	22,1	10,8
TOTAL (2014-2030)	**Cumulative Benefits**		**29,4**	**28,2**	**26,7**
	Downstream Impact in 2030		**1,03**	**0,98**	**0,95**
	Integrated contribution to European GDP	%	**0,164%**	**0,157%**	**0,149%**
	Integrated BCR	ratio	**3,30**	**3,17**	**3,01**

Source: SpaceTec Partners 2013.

The analysis has examined three scenarios with different proportional allocations of budget amongst Space, *in situ* and Services. The scenario "Service Delivery Pull" has the highest benefit potential, at € 29,4 Bn cumulatively over the 2014-2030 period, and the highest integrated Benefit Cost Ration (BCR) at 3,30.

Scenario I: Service Delivery Pull

The larger benefits projection in this scenario is due to the increase in investment in services, coupled with the serialised deployment of the Space component, conferring the

necessary longevity and programme commitment for the development of the downstream sector.

Overall, this scenario represents an interesting mix of investments. It capitalises on the marginally increased investment in Services against a "legacy" level of Space component investment. The programme's continuity is assured until 2030. The level of funding for the Space component should include some allowance for preparatory activities leading into developing the next generation of Sentinels. It is assumed also that ESA will continue to fund, to a large extent, all the preparation and pre-development activities for the future generation satellites, plus the development of the prototype units.

The impact of funding services at this level leads to a higher, relative level of benefits, given the strong coupling between services and benefits. The impact should be ensured by an appropriate expansion of the Copernicus services, by ensuring access from everywhere in Europe to the services and data, by enforcing adequate standards for products, by supporting the expansion of the downstream sector and sustaining the user community in the access to and adoption of new products, services.

Scenario II: Intermediate

This scenario represents less of an increase in benefits with respect to "Service Delivery Pull", due to the higher spending in Space at the expense of Services.

The objectives and extent of the investment in Services remain substantially the same as in the previous scenario, only to a slightly lesser degree.

The Space component has additional margin for preparing the next generation, but part of this extra should be dedicated to ensuring wider circulation of data to different user categories (science, commercial, downstream, regional, etc.). This amount does not allow a change in philosophy from the serial deployment of Sentinels. As in the previous one, it relies heavily on the Contributing Missions.

Scenario III: Technology Driven

This scenario presents a significant drop in overall benefits with respect to the previous ones, as the transfer of funding from the Services to the Space component does not compensate for the loss in benefits.

This scenario does not offer many reasons to be recommended. It poses questions about the use of the extra funding for Space (for example, starting a different family of Sentinels, or adding C/D units) and does not sufficiently encourage the expansion of services and their availability to a much wider user community.

All projected benefits in this analysis are contingent on the implementation of a set of enabling factors, including regulatory and market development actions, summarised in Annex I.

5.6. Key enabling factors and the impact of a reduced budget

The initial phase has mainly been based on research projects, which have also led to the birth of the first two operational services (i.e. Land and Emergency Management). On the basis of this experience, the GMES Unit is now presenting the proposal for the Regulation with the aim of putting in place the framework necessary for the theoretical benefits to be realised. In particular, sustained data availability, quality and continuity, underpinned by a data policy that ensures full, open and free-of-charge access, combined with a strategy ensuring historic data preservation, appear to be necessary factors for the private sector to invest in the use of Copernicus data to develop new businesses and also for the public sector to have the information they need to support their policies and their monitoring roles. The budget apportionment and the governance choices will particularly affect the quality and the continuity of data provision.

To some extent, the reduction in the budget could be foreseen as a likely outcome of the MFF debate and so, in anticipation of the decision of Council, analyses of several possible funding scenarios were conducted with the aim of mitigating the impact of an eventual reduced budget. The key drivers were to ensure the continuity of space-based observational inputs (necessitating some re-planning of the Sentinel developments and deployments) and to preserve the effectiveness of the services – and hence maximising their downstream impact – by assigning as much of the remaining budget as possible to them. The decision on the apportionment of the available budget to the three component areas is informed by the analyses and reflects the most favourable scenario analysed.

The proposal had to be adjusted to take account of the fact that the MFF cut the initial amount by over 2 Billion EUR. In order to preserve service delivery, the Commission had to cut expenditure for new developments of the space component during the MFF period. ESA will take over responsibility for the development of the next generation of the Sentinels. Moreover, the introduction of the next generation will be postponed. Instead, the D-Units of the Sentinels will be procured as explained in section 5.1 of the Impact Assessment. This will maintain the quality and continuity of the satellite data whilst postponing the introduction of a more modern generation of Sentinels to the second part of the next decade.

5.7. Expenditure profile considerations

The Commission shall establish a multi-annual plan for the implementation of the Copernicus programme. In order to optimise the implementation, a mix of annual and multi-annual work programmes will be adopted. Moreover, such is the nature of the transition to routine operations, it is also envisaged that the allocation of funds during the MFF period shall reflect the 'ramping up' characteristic of the various Copernicus Services over time as well as reflecting the expenditure needs resulting from the revised satellite development and deployment. Hence an adjusted yearly allocation of the budget, constrained by the overall envelope, will be needed. This is anticipated to result in a peak of expenditure in 2017 and 2018. Administrative expenditure (including human resources) is expected to remain at a constant level throughout the MFF period.

The analysis of benefits performed by Space Tech Partners did not attempt to reflect the year on year variability in expenditure but rather assumed a constant average spend each year. This was decided due to the uncertainties currently present in the spending profile combined with the likely marginal impact that might be expected (since benefits are generally shown as cumulative).

5.8. Conclusion

The above Cost-Benefit Analysis shows that within the budget foreseen by the European Council, **Scenario I (Service Delivery Pull) would have the highest benefits and therefore would be most cost-effective scenario**.

6. OPTIONS AND IMPACT ANALYSIS ON GOVERNANCE

Preamble

The content of this section has, to some extent, been overtaken by internal discussions and other events since it was first presented in the IA. However, since not all questions have yet been completely addressed, it has been retained in this version for the sake of completeness.

6.1. State of play

- The objective for governance is to assure that all aspects ranging from policy supervision to technical implementation are clearly fulfilled by mandated organisations:

– The *policy supervision and overall coordination* consists in defining the policy objectives, the high level orientations and content of the programme, the associated budget requirements, the main organisational and architecture principles, and the overall guidelines for programme implementation. It also covers the coordination of funding commitments from stakeholders.

– Management: the managing authority follows the political guidelines and is in charge of the management of budgets for the implementation of tasks. It prepares and implements the work programmes and supervises the implementation of tasks. It is responsible for the preparation of administrative arrangements (e.g. calls, grants, delegations…) to the entities who will be in charge of the technical implementation of the tasks;

– Technical coordination: is usually carried out by the management authority, but in some cases, the latter may delegate some tasks to a body, e.g. preparation of contracts and Service Level Agreements, monitoring of the task implementation, certification of products and services, consolidation of user and service requirements.

– The technical implementation is ensured by the operating entities (industrial companies, networks of centres…) in charge of specific tasks (construction of satellites, delivery of services). The assignment of this responsibility will follow a competitive approach (e.g. Calls for Expressions of Interest) to ensure transparency and fairness.

- Under the current GMES/Copernicus programme[46], the Commission is in charge of the political supervision and overall coordination of the GMES/Copernicus programme, including management of the services, and of the EU budget[47]. The technical coordination of some activities, including budget management for the implementation of tasks, are outsourced to external entities such as ESA for the space component, or the European Environment Agency (EEA) for the *in situ* component.

[46] The Commission described its overall approach for the governance of GMES in its Communication of 28 October 2009 entitled "Global Monitoring for Environment and Security (GMES): Challenges and Next Steps for the Space Component".

[47] See Annex VI, Evaluation of the Activities of the GMES, Bureau: Executive Summary.

- The responsibility for the technical implementation of the services must, on the one hand, take into account the invaluable experiences gained during the GIO (and earlier) phases while, on the other hand, pay due respect to the principles of open competition. The latter concern should take account of the presence of the open competition that underpinned the awarding of the FP7 funded pre-cursor services as well as ensuring that principles of open competition are embraced by the coordinating entities of the services through the selection of partnership arrangements.

- The topic of governance has been discussed at different occasions. Stakeholders agree that the GMES/Copernicus programme is very complex and the technical implementation could be done by an external agency, enabling the European Commission to focus on political supervision.

6.2. Options on programme governance

6.2.1. Option A: Commission in charge of overall coordination and management

Under this option, the Commission would remain in charge of the political supervision and the overall coordination of the programme, including the management of tasks. The technical coordination of space infrastructure would be outsourced to competent bodies, such as ESA and EUMETSAT, and agencies such as EEA and ECMWF for the *in situ* component and/or the technical implementation of appropriate services. The Commission would take decisions regarding the daily management of the programme and would also implement the budget.

6.2.2. Option B: Delegation of the management to an existing European Agency

The Commission would remain in charge of the overall coordination and political supervision of the programme but not of its management. Management activities, such as the budget implementation, would be delegated to an external entity/Agency (or to several entities) who already possess the appropriate skills. The Commission would remain in charge of relationships with partners and users.

6.2.3. Option C: Delegation of the coordination and management to the European Space Agency

The Commission would no longer be in charge of the programme. The overall coordination, including budget management and implementation of tasks, would be delegated to ESA, subject to the appropriate amendment of the constituent acts or to functional arrangements. The Commission would no longer be in charge of the political supervision of the programme and of relationships with partners and users.

6.2.4. Option D: Delegation of the management to a new Agency

Compared to the options described above, a new Agency would be set up for the programme management of GMES/Copernicus and the implementation of the corresponding budget. This new agency could be an EU Agency or an international one.

6.3. Impact analysis on governance

6.3.1. Option A: Commission in charge of management

The advantage of this option is that the current set up would not be disrupted. With the outsourcing of tasks, the impact on the EU resources would be limited. However, the Commission would remain involved in the direct management of the operational phase of the programme, including the budget implementation, while it should concentrate on its core business, namely the political supervision of the programme.

6.3.2. Option B: Delegation of the management to an existing European agency

The Commission would play a political role of supervision and coordination. The daily management would be entrusted to entities more suited to this role with more specialized staff, under the control of the Commission. The delegating tasks to an Agency would still have an impact on EU resources. This option is in full respect with the separation principle between supervision and management. Moreover, operational efficiencies could be created if synergies with other programmes can be realised.

6.3.3. Option C: Delegation of the coordination and management to the European Space Agency

The management would be entrusted to an entity with experience in this role and the impact on EU resources would be minimised. However, the Commission would lose political control over the programme and its influence in defining the objectives and requirements. In addition, the implementation of and access to GMES/Copernicus infrastructure and services may be reduced to a few Member States willing to continue their investments into GMES/Copernicus. GMES/Copernicus would then risk becoming a technology pushed programme instead of a user driven one. The management of an operational programme such as GMES/Copernicus could require amendments to the ESA Convention, which could be difficult to obtain and require a long time (ESA currently being a research and development Agency, ESA Member States may not necessarily be prepared to amend its statute). It should also be clear that ESA is a space agency whereas GMES/Copernicus has a large part of activities that go beyond launching satellites. This may mean that under ESA management the services and *in situ* component of GMES/Copernicus are liable to receive a lower level of focus.

6.3.4. Option D: Delegation of the management to a new agency

In this option, the Commission would play a political role of supervision/coordination. The daily management would be entrusted to entities more suited to this role, under the control of the Commission. Opting for an international organisation would not impact EU resources. This option is however likely to make the institutional landscape more complex with one new entity. Synergies would not be maximised, with potential risks for the implementation of the programme. In addition, creating a new entity could prove either too complex and long (e.g. international organisation) or incompatible with the EU policy of not creating new agencies. A new Agency would require substantial additional resources.

6.4. Decisions on governance

Various options for the governance of Copernicus are described above. An assessment of these options and other factors has led to the following governance proposal.

General considerations:

The Commission, assisted by a dedicated Copernicus Committee, should have the overall responsibility for the Copernicus programme; it should define its priorities and objectives, in accordance with the Copernicus Regulation, ensure the overall coordination and supervision of the programme;
The implementation of the programme should be delegated to entities with the appropriate expertise. The Commission should rely, whenever possible, on the capacities of competent Union agencies.

Specific considerations:

The Commission shall entrust to ESA the development tasks of the space component;
The Commission shall entrust the operational tasks of the space component to ESA and to EUMETSAT in accordance with their respective mandates;
The Commission may entrust the operational tasks of the in-situ component to the operators of the services;
The Commission shall award responsibility for the operation of the services to agencies who respond to a call for expressions of interest and who satisfy the Commission as regards their capabilities, experience and financial/operational capacity and suitability.

6.5. Considerations on ownership

Decisions on ownership of the Sentinels cannot be considered in isolation of decisions on governance. EU ownership of infrastructure, developed specifically for GMES/Copernicus (in particular space infrastructure), would result in direct control of the assets by the EU.

With ownership of assets comes responsibility for associated risks and liabilities. For the Sentinel satellites, which represent the largest value assets, the highest risks occur in relation to their launch and early in-orbit life and also in respect of their potential susceptibility to damage from space debris, along with the implementation of the end-of-life scenario (i.e. de-orbiting). By deferring the transfer of ownership until after the satellites have been launched and successfully completed their respective in-orbit validation (IOV) tests, the first risk category is all but eliminated. Furthermore, the proposed Copernicus Regulation specifically identifies an operational activity delegating the physical preservation of the satellites to the agencies responsible for their routine operations, thereby addressing the second risk category.

While the risk from ownership is low, it has to be noted that EU should not forego the benefits of ownership stemming from such a major investment. In fact, it would be inappropriate for the EU to invest some 3.8 Bn EUR without acquiring ownership of the space infrastructure and all the data and information thereby produced. Thus, it is suggested that the EU should assume ownership of the tangible and non-tangible assets of the programme.

Co-ownership of GMES/Copernicus assets by different public entities could be more costly than EU ownership only. This could lead to a governance structure for GMES/Copernicus that is too complex and potentially to higher costs.

In a data purchase scheme, the EU would not own infrastructure, but would acquire ownership or exclusive licences for parts or all data collected by one or more satellites. The advantage of this option would be that the EU would avoid direct involvement in the complex technical operations of the space infrastructure, which, however, could also mean that the EU cannot influence strategic decisions taken by the infrastructure owner. The inconvenience would be that the data policy would largely depend on the commercial strategy of the seller. Moreover, given the present structure of the satellite industry, the EU could find itself paying a large portion of the funds to satellite data providers of third countries, thus supporting the development of the satellite industry of those countries rather than investing in the development of the European satellite industry.

7. Monitoring and Evaluation

7.1. Evaluation

On-going evaluation will take place through the User Forum. An ex-post external evaluation will be organised in 2014, at the end of initial operational activities, and also it is planned that there shall be a mid-term evaluation of the operational programme in 2017.

Three main indicator types will be considered:

Sectoral performance indicators – e.g. context, trend and strategic indicators

Policy indicators – setting out the link between objectives, the achievement of policy goals and the criteria needed to measures progress towards these.

Programme indicators linked to the implementation of specific activities – indicators that measure progress towards the achievement of goals linked to activities within specific Copernicus' services, and those few that can be aggregated.

The GMES unit has already undertaken some work to develop ***sectoral performance indicators***. These are important indirect proxies of the programme's success, but are contextual in nature. It is important that the indicator framework builds on these existing indicators.

An overview of those suggested is provided below:

Upstream indictors, relating to space infrastructure and services such as satellite application systems, launcher systems, scientific systems and ground systems, as well as the manufacturing and development of earth-based infrastructure (sensors etc...);

Midstream indicators relating to the production, distribution, dissemination of data and data processing; and

Downstream indicators on the use of EO services and products both by the public sector and the commercial one, focussing on the opportunities for spin-off companies.

These indicators provide a useful framework to develop a better understanding of the enabling factors that will lead to the development of EO products and services. They are also interrelated, with the development of *downstream* applications and services having knock-on *upstream* effects by potentially creating an increase in demand for data and enhancing the commercial viability of space infrastructure.

At this stage, monitoring the development of downstream services can mainly be achieved indirectly through sectoral performance monitoring. In the future, it may be possible through evaluation and improved monitoring processes within Copernicus full operations to capture the *direct* longer term results and impacts of the development of downstream, measured in terms of their contribution to employment and growth.

There is also a need to develop indicators to assess programme outcomes, measured in terms of outputs and results. A study requested by the Commission to CSES advocated including a small number of indicators for the overall services *(e.g. service user uptake, financial* *implementation)*, and then some supporting indicators relevant to each of the two services, EMS-Mapping and the GIO land.

Examples of quantitative indicators are: the number of registered users, the number and volume of data downloads, the number of service activations, the number of data products used, etc. Qualitative indictors will also provide some interesting information that can be used as indicators. These could include ease of access to reference data, harmonisation for available data between Member States etc.

The indicator framework should include specific indicators relevant to each service so as to provide monitoring information about the extent of usage of data products, the purpose for which these are being used and the uptake of specific services. It would also be useful to incorporate indicators in the framework that can be aggregated across Copernicus services to complement service-specific ones.

Within this broad set of indicators, the main types of indicators that should be taken into account are:

- **Inputs** – indicators that monitor the level of resource requirement to implement a particular policy measure, initiative or action.
- **Outputs** – indicators that monitor immediate outcomes and are useful for internal management purposes.
- **Results –** indicators to assess medium-term, intermediate policy outcomes. It should also reflect the intervention logic of the specific objective under which measures / initiatives have been supported.
- **Impacts** – longer-term indicators that relate to the achievement of high-level global objectives and their effects (e.g. economic and employment impacts, impacts on innovation, technology transfer and progress towards strengthening space industrial competitiveness).

A set of performance indicators is proposed in the table below. Although these are based only on an analysis of the **fast-track services implemented under the GIO**, they could nevertheless be considered as a template for the assessment of future services.

Some of the performance indicators relate to monitoring internal processes e.g. Length of time to produce reference maps and some to user uptake and exploitation. Context indicators relating to sectoral performance of the upstream and downstream EO industry are also included in the table.

Table 7: Proposed indicators

Performance indicators *Service –specific (EMS)*	*No. of service activations* *(i) Rush Mode and (ii) Non-Rush Mode* *Sub-indicators for internal management purposes: by type (earthquake, explosions, fire, floods)*	*Organisation responsible for collecting data*	*Output*
	No. of Member States triggering the service	DG ECHO/ MIC	Output

	- EMS-Rush mode - EMS-Non-rush mode - EFAS		
	No. of downloads of EMS-Mapping data products	DG ECHO/ MIC	Output
	No. of downloads of EFAS products	JRC	Output
	Length of time to produce: - Reference maps - Delineation maps - Grading maps Baseline (i) from point of service activation (ii) from point of reception of raw data	Service contractor	Output
	Length of time between the production of maps and their dissemination to end-users	DG ECHO/ MIC	Output
	No. of users of EMS-Mapping data products - Rush mode - Non-rush mode - EFAS	DG ECHO/ MIC Survey of members of the NFP network belonging to MIC to ascertain how widely used among civil protection agencies.	Result
Service-specific indicator – GIO Land	Number of GIO land product downloads - Pan-European component - Local component - Global component	EEA	Output
	Number of public authorities and wider organisations using land applications / services - Pan-European component - Local component - Global component	EEA	Result
	Number of new applications / services developed using GIO land data products	EEA's Corine Land Cover User Application Database	Result
	No. of Member States having harmonised reference datasets through INSPIRE	EEA	Output
	No. of Member States making their datasets interoperable to the EC/ EEA/ JRC	EEA/ JRC	Output
	No. of Member States for which GIO land data is the only reference data available	EEA/ JRC	Output
Aggregate Copernicus indicators	Number of companies that have used GIO data to develop downstream applications and services		Output
	Estimated number of jobs created as a result of these applications and services		Result
	Number of companies relying on GMEs data for over 20% of their turnover		Result

Indicator type	*Indicator*	*Data source*	*Type of indicator*
Sectoral indicators Upstream	•Number of commercial and institutional launches •Share of launchers sales (and trends) •European satellite manufacturing market share (commercial and institutional) •Number of potential international clients with which there are trade barriers (in public procurement and other barriers) •Value of orders (by sector) •EU upstream trade balance	ESPI, Eroconsult, companies data Arianespace data Company data , Euroconsult Ad hoc analysis Company data Eurostat	Context
Sectoral indicators Midstream	•Turnover from EO data •Employment in midstream sector •EBIT / EBITDA of operators •Level of vertical integration between space actors	Companies data Companies data, ASD Eurospace Ad hoc qualitive analysis	Context
Sectoral indicators Downstream	•Employment •Share of SMEs in total firms in the sector / TO •Number of patents developed in downstream services •Ease of access to finance for start-ups •Number of application and services developed	Ad hoc qualitive analysis	Context

Source: CSES 2012

7.2. Monitoring

The Commission will ensure that contracts and grants concluded in the framework of the Copernicus programme provide for supervision and financial control by the Commission, if necessary by means of on-the-spot checks, including sample checks, and audits by the Court of Auditors. If need be, the Commission could be assisted by external technical experts when monitoring the implementation of the programme. On the basis of the results of the on-the-spot checks, the Commission will ensure that, if necessary, the scale or the conditions of allocation of the financial contribution originally approved as well as the timetable for payments are adjusted.

In addition to financial supervision, the Commission will put in place mechanisms to ensure the continuous quality of the services provided. This will be realised by measuring users' satisfaction on one side and by technical audits on the other side. Finally, the Commission will organise user fora in order to ascertain that services are user-driven.

7.3. Anti-fraud measures

The setting up of the operation will mainly take place through our partners: ESA for the space component and EEA for the in-situ component. The delegation agreements allow the financial flow to be fully controlled. Public procurement will be used to subcontract, and grants are limited, hence we can consider Copernicus not to be fraud-sensitive.

ANNEXES

The annexes attached to this Impact Assessment are listed below along with a short rationale for their inclusion.

#	Title	Rationale for Inclusion
I	**Injection paper by SpaceTec Partners**	This annex forms the primary input into the cost-benefit analysis underpinning this Impact Assessment. The document provides substantive and methodological material supporting the key conclusions in Section 5 "Options and Impact Analysis".
II	**List of acronyms and definitions**	Lists acronyms and definitions used in this Impact Assessment.
III	**Reference studies and documents**	Lists other supporting studies and reference material.
IV	**Evaluation of the GMES Preparatory Action (Conclusions)**	Summarises the conclusions of the Evaluation.
V	**Evaluation of the GMES Initial Operations (Executive Summary)**	Summarises the conclusions of the Evaluation.
VI	**Assessing the Economic Value of Copernicus: "European EO and Copernicus Downstream Services Market Study" – Executive Summary**	Summarises the conclusions of the study, which forms an important input to the Impact Assessment's evaluation of downstream impacts.
VII	**Summary of the Booz & Co's Cost-benefit Analysis on GMES**	Summarises the conclusions of the study, undertaken by Booz&Co. in 2011, which provide a key benchmark underpinning the cost-benefit analysis in the Impact Assessment.
VIII	**The FeliX Model**	Provides a description of the FeliX model, which serves as a high-end benchmark against the CBA conclusions.
IX	**Comparison of the PwC 2006 study and Booz & Co's 2011 study**	Compares the two major cost-benefit studies on Copernicus.
X	**GMES programme - overview on the evolution and funding until 2013**	Provides an overview of the evolution and various funding inputs and their sources until 2013.

ANNEX I Injection Paper by SpaceTec Partners

Injection Paper

Specific Contract under the Framework Service Contract 89/PP/ENT/2011 – LOT 3[1]

Key Analysis for Copernicus Impact Assessment

[1] This paper, while based on material from the Specific Contract referred to above, has been edited and updated to reflect the Commission's proposal for a Regulation establishing the Copernicus programme.

1. SUMMARY AND CONCLUSIONS

The budget for the next Multi-Annual Financial Framework (MFF, 2014-2020), decided by the European Council on the 7th and 8th of February 2013, set **the maximum level of commitment for the Copernicus programme at € 3.786 M.**

Based on this financial envelope for the Copernicus programme, the present study analyses the costs, benefits and impacts of three scenarios for the Copernicus programme with respect to the budgetary distribution across the Space, *In Situ* and Services cost categories. The expected impact is expressed in terms of:

The socio-economic and environmental benefits;

The economic impact generated by the future, potential downstream services market;

The overall impact on employment in the upstream, midstream and downstream markets.

Two approaches have been applied in this analysis: a like-for-like comparison with the costs and benefits of the options in Booz & Company's "Cost- Benefit Analysis for GMES" (CBA[2]), completed in 2011 (using the same budget distribution), and a scenario analysis of the costs and benefits of three scenarios, varying the budget proportions between the three cost categories given the funding envelope for Copernicus. **In each case, two time horizons and total Copernicus funding assumptions are considered: €3,8 Bn in 2014-2020 (the 7-year timeframe of the MFF) and € 5,4 Bn in the second 2021-2030 period (the following MFF, plus an additional 3 years)**.

Seen in terms of the average annual budget, the Copernicus funding envelope (€ 541 M for 2014-2020; € 541 M for 2021-2030; €541 M average overall) falls between Options B (€ 362 M overall annual average) and C (€ 730 M) of the Booz CBA The benefits are therefore calculated based on enhancement of Option B, but not reaching the level of Option C. In the like-for-like analysis, the proposed funding envelope is referred to as Option X. The associated impact on the downstream market and employment has been modelled as a proportional decrease based on the funding deficit.

The scenario analysis establishes three scenarios, varying the breakdown amongst the Space, *In Situ* and Services cost areas. The three cost budget distribution scenarios are shown below.

		I - Service Delivery Pull			II - Intermediate			III - Technology Driven			Total
		Space	*In Situ*	Services	Space	*In Situ*	Services	Space	*In Situ*	Services	€ Mio
TOTAL (2014-2030)	€ Mio	**400**	**22**	**119**	**422**	**22**	**97**	**438**	**22**	**81**	**541**
	%	74%	4%	22%	78%	4%	18%	81%	4%	15%	

Table 8: Cost Distribution By Scenario (Annual Averages in the 2014-2030 period)

[2] Referred to as "Booz CBA" from here on out. All data in this study are evaluated "as given"; responsibility for any errors in the document lies with the original authors.

The analysis ranks Scenario I, "Service Delivery Pull", as the option with the most benefit potential. The cumulative benefits, downstream impacts and associated Benefit-to-Cost Ratios are shown in the table below.

			I - Service Delivery Pull	II -Intermediate	III - Technology Driven
2014-2020	Cumulative Benefits	€ Bn	6,3	6,1	5,9
2021-2030	Cumulative Benefits	€ Bn	23,0	22,1	20,8
TOTAL (2014-2030)	**Cumulative Benefits**	€ Bn	29,4	28,2	26,7
	Downstream Impact in 2030	€ Bn	1,03	0,98	0,95
	Integrated contribution to European GDP	%	**0,164%**	**0,157%**	**0,149%**
	Integrated BCR	:	**3,30**	**3,17**	**3,01**

Table 9: Integrated Impact Simulation By Scenario (Undiscounted)

The FeliX model (a system dynamics model and benefit simulator, which takes into account the complex relationships between natural and socio-economic systems) forecasts benefits that are in the order of magnitude of € 21.7 Bn cumulatively by 2020 and € 220 Bn by 2030 (undiscounted), substantially higher (~8 times, in the long term) than the 'static' benefit projections of the present study. This is due to the enlarged scope of the FeliX model, and its broad assumptions of underlying infrastructure (namely GEOSS[3], to which Copernicus is expected to constitute the EU's major contribution). The comparison with the FeliX output serves to highlight the strong potential for higher-order magnitudes of benefits when Copernicus is viewed as part of a broader system of systems.

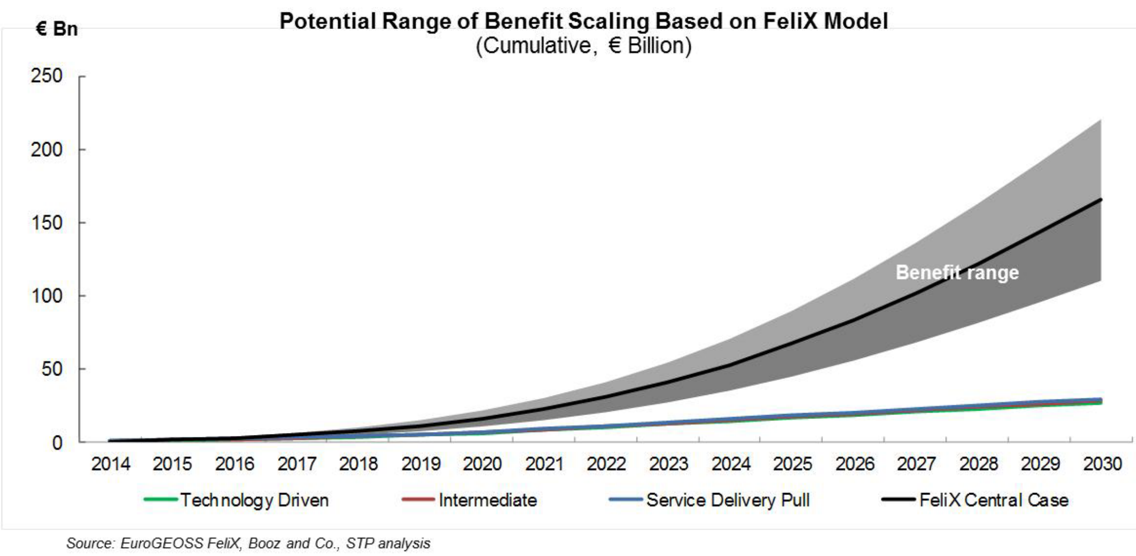


Figure 3: Potential Range of Benefit Scaling Based on FeliX Model

[3] Global Earth Observation System of Systems.

In compliance with the EC Impact Assessment Guidelines, the benefits of each scenario have been categorised according to their economic, environmental, and social dimensions, both qualitatively and quantitatively. A summary of the quantitative analysis is provided below.

Benefit Categories	Values		I - Service Delivery Pull	II - Intermediate	III - Technology Driven
Economic	Total Space Turnover (2014-2030)[4]	€ Mio	8.002	8.306	8.542
	Total Downstream Turnover (2030)		1.034	981	954
	Combined Δ Scen. I	%	0%	-2%	-4%
Environmental	Total (2014-2030)	€ Mio	17.611	17.005	16.158
	Δ Scen. I	%	0%	-3%	-5%
Social	Total (2014-2030)	€ Mio	11.585	11.045	10.415
	Employment Impact[5] (2030)	#	48.330	46.650	45.840
	Δ Scen. I (Benefits)	%	0%	-5%	-10%
	Δ Scen. I (Employment)	%	0%	-4%	-5%

Table 10: Summary of Economic, Environmental and Social Benefits (Quantitative)

Scenario I: Service Delivery Pull

The larger benefits projection in this scenario is due to the increase in investment in services, coupled with the serialised deployment of the Space component, conferring the necessary longevity and programme commitment for the development of the downstream sector.

Overall, this scenario represents an interesting mix of investments. It capitalises on the marginally increased investment in Services against a “legacy” level of Space component investment. The programme’s continuity is assured until 2030. The level of funding for the Space component should include some allowance for preparatory activities leading into developing the next generation of Sentinels. It is assumed also that ESA will continue to fund, to a large extent, all the preparation and pre-development activities for the future generation satellites, plus the development of the prototype units.

The impact of funding services at this level leads to a higher, relative level of benefits, given the strong coupling between services and benefits. The impact should be ensured by an

[4] This figure includes the indirect effects of the Space industry on the wider economy, which is €163Mio, €152Mio and €152Mio for the three scenarios, respectively.

[5] Refers to total direct and indirect new and maintained jobs associated with Copernicus.

appropriate expansion of the Copernicus services, by ensuring access from everywhere in Europe to the services and data, by enforcing adequate standards for products, by supporting the expansion of the downstream sector and sustaining the user community in the access to and adoption of new products, services.

Scenario II: Intermediate

This scenario represents less of an increase in benefits with respect to "Service Delivery Pull", due to the higher spending in Space at the expense of Services. The objectives and extent of the investment in Services remain substantially the same as in the previous scenario, only to a slightly lesser degree.

The Space component has additional margin for preparing the next generation, but part of this extra should be dedicated to ensuring wider circulation of data to different user categories (science, commercial, downstream, regional, etc.). This amount does not allow a change in philosophy from the serial deployment of Sentinels. As in the previous one, it relies heavily on the Contributing Missions.

Scenario III: Technology Driven

This scenario presents a significant drop in overall benefits with respect to the previous ones, as the transfer of funding from the Services to the Space component does not compensate for the loss in benefits. This scenario does not offer many reasons to be recommended. It poses questions about the use of the extra funding for Space (for example, starting a different family of Sentinels, or adding C units) and does not sufficiently encourage the expansion of services and their availability to a much wider user community.

All projected benefits in this analysis are contingent on the implementation of a set of enabling factors, including regulatory and market development actions, summarised below

	Enabling Factors
Space	• Continuity of Sentinel data • Research and development for the next generation of Sentinels • Continuity of current arrangements for sharing of responsibilities between ESA and EU, in particular concerning the preparation of the next generation developments • Continuity of access to contributing missions (primarily European, but not exclusively) • Simplified access to Sentinel data for widespread distribution • Development of international cooperation in order to complement Contributing Missions
Services	• Accessibility to services / products • Supporting the operations and evolution of the Copernicus services, in their transition to operations • Enlarging the range of the Copernicus services • Service development and evolution • Enabling of downstream sector • Demand incubation at regional and local levels aimed at commercial users • Continued promotional and communications efforts

	• Continued, coherent action to federate, consolidate and update user needs and requirements
In Situ	On-going coordination and harmonisation efforts in complement to the subsidiarity principle
Regulatory	• Free and open data policy • Governance, assurance of data and service continuity • Quality assurance and standards-building

Table 11: Enabling Factors

2. INTRODUCTION AND OBJECTIVES

The budget for the next Multi-Annual Financial Framework (MFF, 2014-2020) was decided by the European Council on the 7th and 8th of February 2013[6]. **The maximum level of commitment for the Copernicus programme was set at € 3.786 M.**

The present document aims to provide input to the European Commission's Impact Assessment (IA) following the announcement of the new Copernicus funding envelope. This Impact Assessment is based on Booz & Company's "Cost- Benefit Analysis for GMES" (CBA) and further study and analysis performed by SpaceTec Partners.

The Copernicus budget for the period 2014-2020 represents a significant milestone in the history of the programme. The programme stands to move definitively past the foundational R&D basis on which it has been established and transition into a genuine, operational system. This budget represents a somewhat unique opportunity to make Copernicus operational, and the realisation of this opportunity is hinged on the question of how to best deploy the relatively scarce resources available, for the benefit of the EU taxpayer.

The objective of the Impact Assessment is not to support a decision on the funding level, but rather how the given budget should best be deployed amongst the three key programme cost areas: **Space**, ***In Situ*** and **Services.**

Since the Booz CBA was published, additional studies have been performed on the impacts of the Copernicus programme, particularly with regard to the downstream sector. These projections need to be taken into account in the Impact Assessment.

The present study has the following main objectives:

Given the funding envelope for Copernicus within the next MFF, evaluate the **programme benefits** on a like-for-like basis as a function of the options defined in the Booz CBA

Integrate the results of 2012 study on the future potential Copernicus **downstream market**, performed by SpaceTec Partners, into this analysis

Perform a **sensitivity analysis** of projected benefits based on different scenarios/allocations of funding amongst the three major programme cost areas, **Space**, ***In Situ*** and **Services**

In the chapters, which follow, these objectives will be dealt with in turn.

3. METHODOLOGY AND INTEGRATION OF IMPACTS

[6] The budget is, at the time of writing, yet to be finally approved by the European Parliament.

This chapter firstly introduces the methodologies used in the present analysis, and in the studies which served as key input material. The key studies are the Booz & Co. “Cost Benefit Analysis for GMES”, and the 2012 European Earth Observation (EO) and GMES Downstream Services Market Study by SpaceTec Partners. The FeliX System Dynamics Model is introduced, and its application to the present analysis discussed. Thereafter, the approach to the integration of the study inputs in the present analysis is outlined, concluding with a section on the enabling factors, which underpin the conclusions of the analysis.

3.1 Booz and Co. Cost Benefit Analysis

This chapter reports the main methodological aspects and approach of the Booz CBA. Booz & Company was commissioned by the European Commission to undertake a Cost-Benefit Analysis (CBA) of the Copernicus programme. The main focus of this study is the assessment of four broad funding options for Copernicus and its operational services. In carrying out this exercise, it is important to bear in mind that Copernicus represents a unique public investment programme which is designed to support a wide array of public policy objectives. Copernicus is Europe’s contribution to the Global Earth Observation System of Systems (GEOSS), a multi-lateral initiative of States and the international scientific community involved in EO and climate research.

As Copernicus is a major EU effort to enhance our understanding of Earth science**, a major benefit of Copernicus will be the Value Of Information** it provides to support policy action and resource management across the EU and further afield. The Value of Information (VOI) depends on a number of factors regarding the circumstances of decision makers, including the level of uncertainty that they face, what is at stake, the cost of using information, and the cost of the next-best information substitute. A review of academic literature supports the view that there is inherent value in information. Based on this review, there are valid reasons to suggest that the overall extent of the VOI is incremental. These include the ability of Copernicus to provide additional information that may assist decision making and add to analysis incrementally, rather than provide a transformational difference to a particular sector. These incremental benefits accrue over time as extended time series of observations are available, particularly for strategically important fields such as climate change. As such, Copernicus has the potential to deliver significant economic value through enhanced EO information.

The quantified cost-benefit assessment requires the identification and calculation of benefits arising from Copernicus. These benefits almost exclusively arise from Copernicus being an enabler of better policy responses to key public policy issues. In order to establish these benefits (and how Copernicus may reduce various costs), a literature review of the economic value of information, combined with interviews and desktop research, enabled the development of assumptions around the incremental benefit from better EO information.

The benefit areas considered in the Booz CBA study have environmental, economic and social impacts. They are reported in the table below along with the policy sector and service area which they refer.

Policy Sector	Service Area	Main Applications
Global Climate Change Action		
	Climate	Climate Change Mitigation & Adaptation
Resource Management		

	Atmosphere	European Air Quality
	Land	European Deforestation (Forest Fires)
	Land	Global Desertification
	Marine	Unlawful Oil Discharge in Sea Vessel Operations
	Marine	Major Accidental Oil Spills
	Marine	Maritime Navigation
	Land	EU CAP Monitoring
	Land	Regional Policy (Urban Development)
Emergency Response (Europe)		
	Emergency	Europe - Geohazards (Earthquakes)
	Emergency	Europe – Flooding
	Emergency	Europe - Forest Fires
	Emergency	Europe – Other, including storms and landslides
	Emergency	European Natural Disaster Reconstruction Support (EU Solidarity Fund)
Global Humanitarian Aid		
	Emergency	Natural Hazards - Rest of World
	Security / Emergency	Humanitarian Aid in Conflict Situations
	Emergency	EU Humanitarian Aid
Other		
	All	Wider Economic[7]

Table 12: Key Benefit Areas for the Cost-Benefit Analysis (Booz CBA)

Four options were provided for analysis under the cost-benefit assessment:

Option A: Baseline Option with no on-going commitment to replace infrastructure or investing significantly in services;

Option B: Baseline Option Extended, but still with no on-going commitment to replace infrastructure over the longer term and invest significantly in services;

Option C: Partial Continuity, with commitment to provide Sentinel infrastructure and invest considerably in services, with limited support to ensuring continuity of data from Contributing Missions; and

Option D: Full Continuity with commitment to provide Sentinel infrastructure and enhanced support for the continuity of data from Contributing Mission with full investment in services.

Each option contains profiles of investment in infrastructure (Space, *In Situ*), Services and user take-up. The quantification of benefits is based on an approach that attributes to Copernicus an incremental improvement in outcomes, e.g. measured as a change in baseline environmental damage costs. This recognises that the attainment of particular outcomes in

[7] The wider economic impacts include the economic activities of industries that support the upstream Space sector through the provision of material and labour inputs, activities of the housing and retail sector linked to expenditure by the Space sector, and the wider economic benefits associated with economic spillovers that are linked to the R&D aspects of the Space sector.

each benefit area is a result of multiple factors, of which the contribution by Copernicus is only one part. The extent of Copernicus contribution has been taken into account in the analysis for each benefit area.

Key results for each of the four options are presented in the table below. The table shows total benefits, total programme costs and the associated net benefits over the 2014 – 2020 and 2021-2030 time periods. Results are cumulative undiscounted and discounted at 4% per annum. All values are expressed with 2010 as the base year.

	Option A			**Option B**			**Option C**			**Option D**		
	P1	**P2**	**T**	**P1**	**P2**	**T**	**P1**	**P2**	**T**	**P1**	**P2**	**T**
	Cumulative, Undiscounted, € Bn											
Benefits	2,0	0,9	**3,0**	6,0	11.0	**17.0**	13.0	36.6	**49.6**	18.0	53.0	**71.0**
Costs	2,1	1,0	**3,0**	3,7	3.4	**7.0**	5.0	9.9	**14.8**	6.4	12.4	**18.8**
Net Benefits	0,0	0,0	**0,1**	2,4	7.6	**10.0**	8.0	26.7	**34.7**	11.6	40.7	**52.3**
	Cumulative, Discounted, € Bn											
Benefits	1,5	0,6	**2,1**	4,5	6.2	**10.7**	9.5	19.9	**29.4**	13.2	28.8	**42.0**
Costs	1,6	0,6	**2,1**	2,8	1.9	**4.7**	3.7	5.4	**9.1**	4.8	6.7	**11.5**
Net Benefits	0,0	0,0	**0,0**	1,7	4.3	**6.0**	5.9	14.5	**20.4**	8.4	22.1	**30.5**
BCR	**1**			**2,3**			**3,2**			**3,7**		

Table 13: Results of Cost Benefit Analysis (Booz CBA. P1: 2014-2020; P2: 2021-2030, T: Total)

The methodology adopted in the Booz CBA is based on a Copernicus "full continuity" scenario (referred to as Option D), which is used as a reference case, and then applying progressive degradation to each of the other options in relation to this scenario. The scaling parameters applied to the other options are listed in the following table. Meaning that in the Booz Model the cost to benefit discount ratio is (1:1,3).

	Cost Reduction on "undiscounted" Values		*Resulting Benefit Fulfilment*		*Resulting benefit discount*		*Ratio benefit/cost discount*		
	2014-2020	**2021-2030**	**2014-2020**	**2021-2030**	**2014-2020**	**2021-2030**	**2014-2020**	**2021-2030**	**Total average**
Option A	-67%	-92%	11%	2%	-89%	-98%	1,3	1,1	**1,3**
Option B	-43%	-73%	34%	21%	-66%	-79%	1,6	1,1	
Option C	-22%	-20%	72%	69%	-28%	-31%	1,3	1,6	
Option D	0%	0%	100%	100%	0%	0%			

Table 14: Cumulative Cost and Benefit Scaling Parameters Across Booz CBA Options

This "progressive degradation" principle will be applied in the present analysis to establish the baseline for analysing the changes in the allocation of funding amongst the different main cost areas, and the like-for-like estimation of benefits, subject to the understanding that there are limits to the validity of this principle, such as minimum and upper thresholds on benefit realisation.

3.2 SpaceTec Partners Downstream Study

The principle goal of this study was an assessment of the value of the potential downstream market for Earth Observation (EO) Value-Added Services (VAS) arising as a result of the provision of data and services from the Copernicus programme.

The study was based on a high-level assessment of market potential across relevant sectors of economic activity, such as insurance, water transport, agriculture, extraction of oil and gas and the production of electricity. Using a combination of case-based bottom-up analysis and top-down industry assessments, the study sought to project the future markets for downstream services over a broad time horizon (2015-2030). The study also included an analysis of the impact on direct and indirect employment in the downstream, upstream and midstream sectors.

3.2.1 Downstream Impact

The expected continued availability of Copernicus data is essential for the purposes of downstream market development. This applies both to the immediate implications during the next MFF and – crucially – to the longer-term 15-year timeframe[8]. The forecast scenarios in the STP EO and Copernicus downstream market study depend on the assumption of full data continuity, underscored by an average yearly budget of € 800 M in the high scenario. **Therefore, any funding option which threatens full data continuity will generate a less favourable impact on the downstream market**.

In addition, the downstream market development is linked to the development of the Services component. Without active and continuous provision of Copernicus service, the market for downstream services is unlikely to evolve beyond the relatively limited boundaries of the services funded under FP7. The correlation between the Services component and the downstream market is reflected in the modelling undertaken for the purposes of this analysis.

In the STP downstream study, long-term market potential was assessed through the concept of the Total Addressable Market (TAM). This concept expresses hypothesised market penetration, under specific assumptions and within certain limitations. It serves as a metric of the underlying revenue potential of a given opportunity - in this case, downstream market turnover - and should be treated as a "bounded theoretical maximum". The three downstream turnover scenarios presented in the STP downstream study are summarised below, for reference.

[8] Along which the Booz CBA also extends.

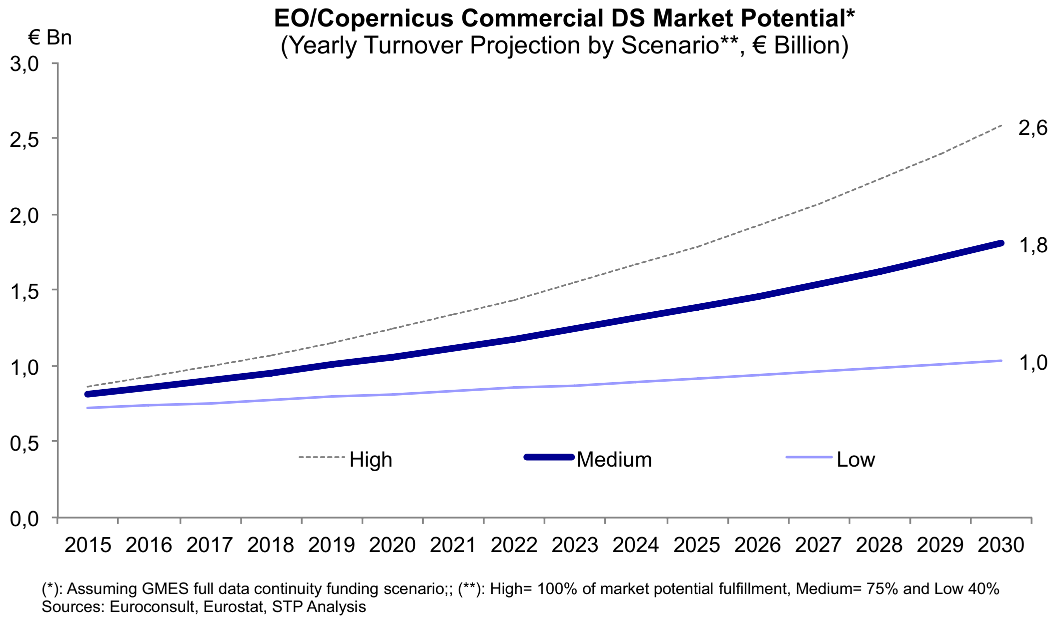


Figure 4: Downstream Market Scenarios, STP Downstream Study

The foreseen € 3,8 Bn envelope for Copernicus translates into an annual budget of € 541 Mio in 2014-2020. This has the following implications for the assessment of impact on the future downstream market:

The closest corresponding budget scenario is the "STP Low" case, against which the annual average budget for the entire period represents a -14,1% reduction.

It is assumed that the same € 541 M (or a higher) annual budget level will be committed in the 2021-2030 period to assure programme continuity in the longer term.

3.2.2 Impact on Employment

The approach utilises a methodology based on the relationship between industry labour productivity and projections of:

EO/Copernicus downstream turnover (for the downstream);
Copernicus funding in the Space component (for upstream and midstream).

Labour productivity represents a measure of the relationship between "a volume measure of input to a volume measure of output" (OECD, 2002). It is calculated by proxy, as the quotient of industry turnover and the total number of employees, or FTEs (Full-Time Equivalents) in the sector. Dividing the cost or turnover inputs by the labour productivity for each sector serves as a proxy of the number of jobs created or maintained in each case. Labour productivity is assumed to be approximately € 179,000 in the upstream and midstream sectors, and € 113,000 in the downstream. The key data used in the employment analysis are summarised in the table below:

Input	Data Type	Labour productivity
Description		€ / Employee

Upstream	Space component - Satellites only	Programme budget forecast	179.000
Midstream	Space component - Contributing Missions and Services component	Programme budget forecast	179.000
Downstream	Downstream services Total Addressable Market (TAM)	Turnover forecast	113.000

Table 15: Key Inputs for Employment Analysis

The remainder of this section provides the background to the methodology used in the STP downstream study, for reference and as a baseline input to the core analysis in the chapters which follow. In the context of this analysis:

Direct employment refers to persons employed by an organisation operating in the Space industry (upstream, midstream or downstream);

Indirect employment refers to persons employed in other industries which are impacted by the Space industry, either because they form part of the Space industry supply chain, or because the industry supplies other goods and services (such as retail or financial services). In both cases, these industries benefit from increased employment in the Space sector.

The STP study introduced three cost scenarios[9] representing different levels of Copernicus-related funding in the upstream and midstream sectors. The scenarios correspond to variations of the "Copernicus data continuity" options outlined in the Booz CBA (Options C and D), and are summarised below.

Cost Scenario	Upstream	Midstream	Total	*In Situ*	Grand Total
STP High (as Booz Option D)	535	215	**750**	50	**800**
STP Medium (as Option D excluding Jason Mission)	487	198	**685**	50	**735**
STP Low (as Option C)	424	176	**600**	30	**630**
Total	**1.446**	**589**	**2.035**	**130**	**2.165**

Table 16: Copernicus Programme Cost Scenarios 2014-2020, STP Downstream Study (€ M, Annual Averages)

The resulting employment scenarios from the STP downstream study are presented below. **Any decrease of the programme funding scenario would reduce the associated impact on employment.**

[9] These are referred to as STP High, STP Medium and STP Low, and should not be conflated either with the Booz CBA Options A-D, nor the Scenarios I-III outlined in this document

		Upstream	Midstream	Downstream	Total
STP High	Direct	3.500	1.300	23.000	27.800
	Indirect	9.100	3.380	73.600	86.080
	Total	**12.600**	**4.680**	**96.600**	**113.880**
STP Medium	Direct	3.300	1.200	16.000	20.500
	Indirect	8.580	3120	51.200	62.900
	Total	**11.880**	**4.320**	**67.200**	**83.400**
STP Low	Direct	2.900	1.100	9.000	13.000
	Indirect	7.540	2.860	28.800	39.200
	Total	**10.440**	**3.960**	**37.800**	**52.200**

Table 17: Aggregated (Direct and Indirect) Downstream Employment Scenarios, STP Downstream Study (Number of Employees, 2030)

It is important to point out that these figures do not necessarily represent new employment positions, although a large proportion will indeed be new, particularly in the downstream and midstream sectors. The numbers also indicate other cases of employment impact, such as jobs, which are maintained by the inflow of funding, or the expansion in scope of existing roles.

In the calculation of the downstream employment, the budget change between the two periods is not modelled, since the average across both is used to establish the turnover baseline. For upstream and midstream, the drop is evident in the funding between the two periods, but to avoid inconsistencies, in the analysis the combined average between the periods is taken as an order-of-magnitude measure of the employment impact across the timeframe. Therefore, when employment impact is reported, this is not done per period, but only as a total over the entire timeframe.

3.2.3 Scaling of Benefits

The Booz CBA regards each of its options "as being discrete" (Booz CBA, p. 99), meaning that the benefits do not grow linearly in relation to the level of investment, but are the outcome of different configurations of the Space, Service and *In Situ* components within the options. In other words, a step function is at work, with threshold boundaries separating unconnected plateaux of benefit escalation.

This is particularly true in the case of the Space component; since the Sentinels are deployed in units, there are limits as to what can be achieved with specific levels of funding. Minor deviations around these step changes do not serve to alter the benefit profile in a significant way. Whilst this proposition is not readily observable in the Booz CBA because of the proportionally large gap between the funding levels of each option, it is recognised that in each case, a step change in commitment (and hence, benefits) has taken place.

The extent to which benefits scale is, therefore, assumed to differ in relation to the level of funding allocated to the Space and Service components, in particular. The following assumptions underpin the present analysis as regards the scaling of benefits:

Investment in the Space component is a **necessary, but insufficient** condition for the realisation of benefits.

In order for benefits to arise, **parallel investments must be made in Services and *In Situ*.**

A step change in benefits occurs once investment in Space reaches a certain threshold. Beyond this threshold:

Additional investment in Space does not bring about linear increases in benefits

Step-changes in benefits are contingent on additional investment in Services.

Benefits linked to investments in services are more linear, with incremental benefits possible through service improvement, extension to scope, and the development of new services. These nonetheless remain dependent on upgrades or enhancements to the underlying Space infrastructure for larger step changes, accompanied by more major service-supporting developments such as improved access to data and the enabling of the downstream sector. These considerations are elaborated in Section 0, "3.5 **Enabling Factors**.

The figure below is a simplified representation of the relationships described above. It serves to conceptually highlight the key points of reference for the modelling exercise in the analysis.

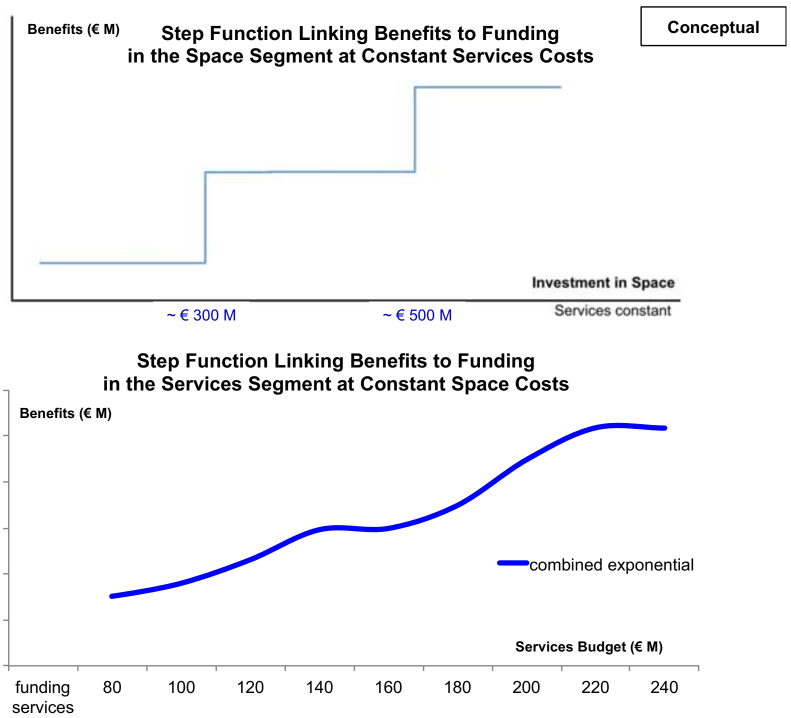


Figure 5: Conceptual Relationships of Benefit Scaling Based on Investments in Space and Services

Evidently, the ***In Situ*** component also plays a role in the scaling of benefits. It is not shown here, in the interests of parsimony, and because the Space-Services relationship is considered to have the most impact on the present analysis.

3.3 FeliX System Dynamics Model

The EuroGEOSS FeliX[10] model is a systems dynamics model developed in order to represent conceptually the interrelationships between environmental, economic and social subsystems. It provides a modelled example of how EO data can influence future development based on government policy decisions and human behaviour. The FeliX model has been used to illustrate a potential maximum-benefit scenario through investment in a comprehensive EO system at European in order to augment Member States' EO networks.

It is important to recognise that FeliX has not been used to model specific Copernicus scenarios, and it is difficult to identify the extent to which Copernicus services are reflected in the underlying model structure and assumptions, and the likely added value of Copernicus over and above other available EO systems. Copernicus represents the EC's contribution to GEOSS. Benefits projected by the FeliX model may therefore be seen as a way of demonstrating the value of a comprehensive GEOSS architecture.

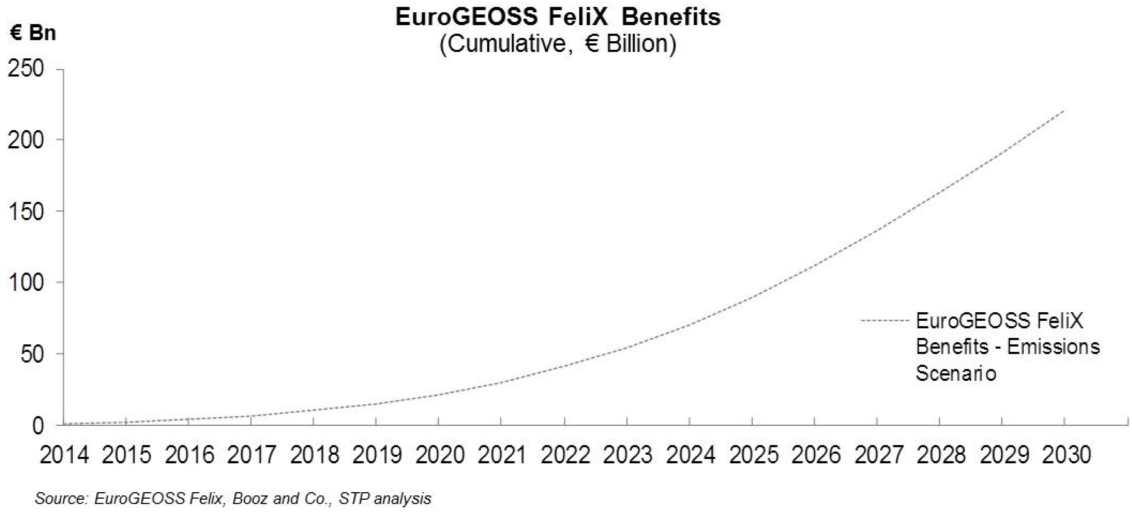


Figure 6: EuroGEOSS FeliX Benefits (2014-2030)

The FeliX model shows that potential benefits in the order of magnitude of € 220 Bn can be generated (cumulatively by 2030, using undiscounted values). This is substantially higher than the 'static' benefit projections of the present study (by a factor of 7,5 to 8,2 at period end) due to its enlarged scope and broad assumptions of underlying infrastructure (GEOSS).

3.4 Integrated Approach

This chapter describes the methodological approach used in the analysis, and establishes a methodology by which the outputs of various input studies can be effectively combined, in order to arrive at a synthetic conclusion. The major outputs of the STP downstream study and the Booz CBA are summarised below:

[10] Full of Economic-Environment Linkages and Integration dX/dt.

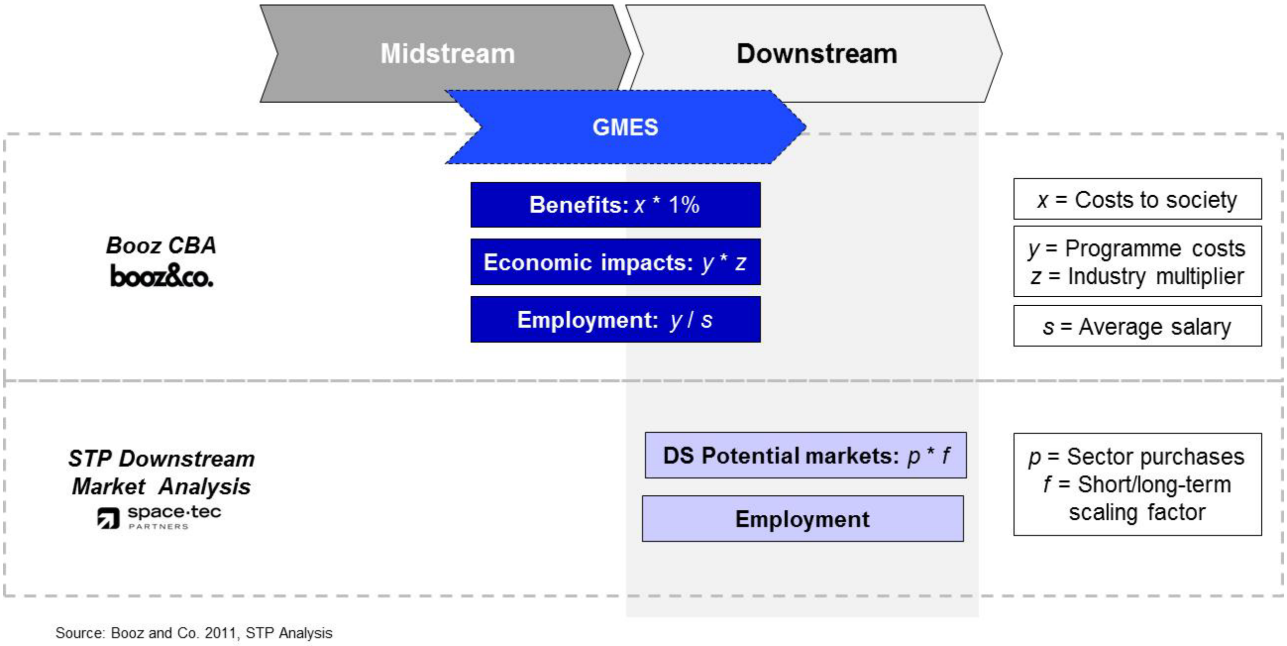


Figure 7: Outputs of Booz CBA and STP Downstream Study

The STP downstream study is subject to the following **key assumptions**:

Catalytic effect of free and open data provision[11]: Copernicus services are expected to enable and stimulate the downstream sector by freely and openly providing access to basic pre-processed data and modelling outputs, more cheaply than would be the case if companies had to undertake such basic processing and modelling themselves. The business case for Copernicus is that the services improve the efficiency of the downstream sector, allowing the industry to offer better value for money in products and services to end users.

Full and assured continuity of Copernicus: In order for the potential of future markets for Earth Observation downstream services to be realised, the continued long-term availability of Copernicus data services is assumed. The investment incentives are crucially tied to both political and financial commitments at an institutional level. This continuity of services presupposes the continuity and evolution of Copernicus infrastructure providing the necessary data. Without continuity, the "raison d'être" of Copernicus is put into question, as users will only rely on Copernicus if a sustained flow of data is ensured. Without appropriate funding, existing services will cease their activities.

Therefore, a Copernicus funding envelope, which is not able to assure full data continuity will impact the fulfilment of the downstream market potential. Furthermore, a set of **enabling factors** has been identified, on which action and associated investments are considered necessary for the realisation of downstream market potential. Certain institutional conditions are necessary to enable and accelerate the market dynamics foreseen in this study, linked, *inter alia*, to market development and capacity building. They are summarised below:

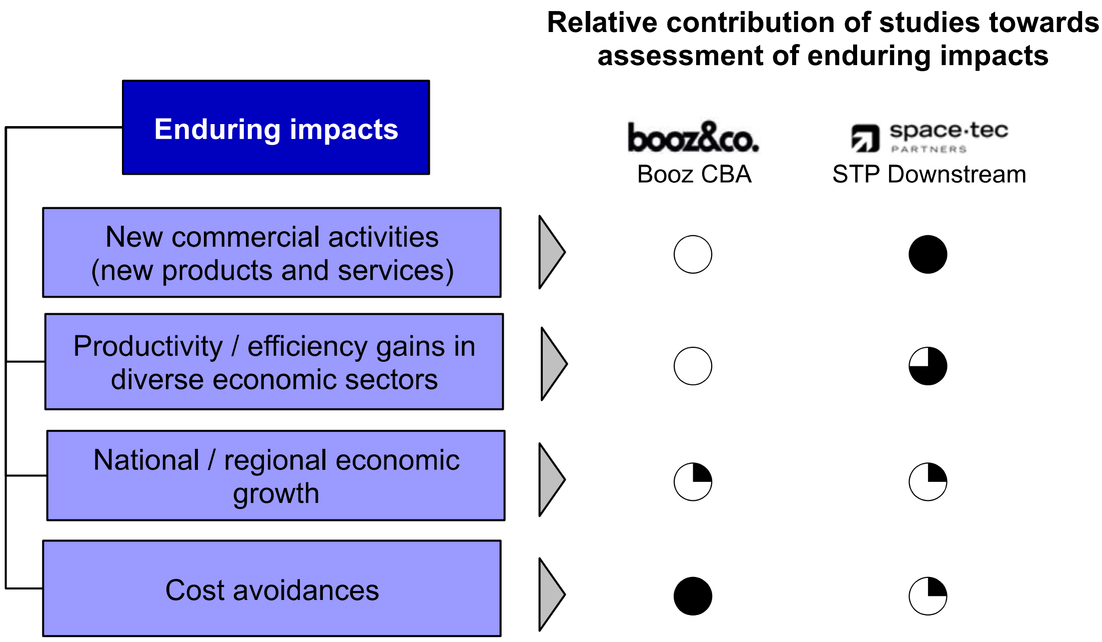
Regulation: Free and open data policy; assurance of data continuity; quality assurance and standards-building.

11 This refers to data derived from the Copernicus family of dedicated satellites, the Sentinels

Data Availability and Access: Simplified access to Copernicus Sentinel datasets at ready-to-use processing levels (L1)[12] for high-volume distribution, thereby responding to the needs of the value-adding industry, ideally avoiding the duplication of efforts at national level.

Demand/Market: Continued dissemination efforts; regional/local demand incubation and communication schemes aimed at commercial users; federation / consolidation of user needs and industry requirements; further integration of EO information as a supplement to traditional systems.

The figure below shows the potential impacts from investments in Space programmes, comparing the outputs of the Booz CBA and the STP downstream analysis. The notion of "enduring impacts", distinguished from "temporary impacts", refers to causal implications beyond the development phase of a programme. The impact categories are drawn from the model presented in OECD (2011).



Source: Adapted from OECD (2011); STP Analysis

Figure 8: Relative Contribution of Studies Towards Assessment of Enduring Impacts

The economic impacts and the benefits as defined in the Booz CBA should be regarded as separate, but parallel measures of potential causal effects, each with a different and distinct methodology, scope and interpretation. It should follow that there is no possibility to establish overlaps between the two types of measurement. This makes it logically inconsistent to simply add them together.

There is, however, a potential approach, which may allow the production of an integrated picture. The approach is based on establishing the impact of both benefits and impacts on EU Gross Domestic Product (GDP) and the integrated impact on employment (excluding any double-counting), allowing the comparison of like with like.

[12] L1 includes geometric and radiometric pre-processing.

In order to be fully compliant with the EC Impact Assessment Guidelines, the derived integrated impacts have been associated with economic, environmental and social dimensions. The approach is visualised below:

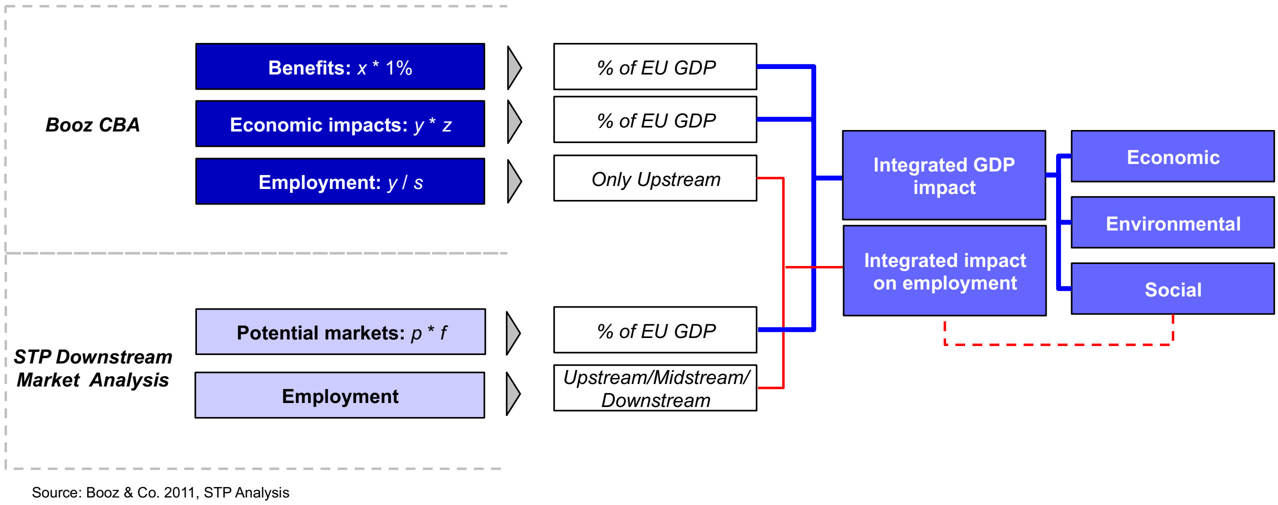


Figure 9: Potential Integrated Impacts Approach

In this analysis, the approach to integrated benefits will incorporate only the conclusions from the STP downstream analysis, and exclude the impact on employment presented in the Booz CBA.

The benefit categories and associated indicators used to evaluate the impact of each scenario are presented in the table below.

Benefit Categories	Quantifiable Indicators	Qualitative Indicators`[13]
Economic	• Space industry turnover • Downstream sector turnover • Wider economy impact	• Functioning of the internal market and competition • Competitiveness, trade and investment flows • Operating costs and conduct of business/Small and Medium Enterprises • Administrative burdens on businesses • Public authorities • Property rights • Innovation and research • Consumers and households • Specific regions or sectors • Third countries and international relations • Macroeconomic environment
Environmental	• Global climate change mitigation & adaptation • European air quality • European deforestation • Global desertification • Oil spills	• The climate • Transport and the use of energy • Air quality • Biodiversity, flora, fauna and landscapes • Water quality and resources • Soil quality or resources • Land use • Renewable or non-renewable resources • The environmental consequences of firms and consumers • Waste production / generation / recycling • The likelihood or scale of environmental risks • Animal welfare • International environmental impacts
Social	• Maritime navigation • EU CAP Monitoring • Urban development • Emergency response • Global humanitarian aid • Employment impact	• Employment and labour markets • Standards and rights related to job quality • Social inclusion and protection of particular groups • Gender equality, equality treatment and opportunities, non -discrimination • Individuals, private and family life, personal data • Governance, participation, good administration, access to justice, media and ethics • Public health and safety • Crime, Terrorism and Security • Access to and effects on social protection, health and educational systems • Culture • Social impacts in third countries

Table 18: Economic, Social and Environmental Benefits Description

3.5 Enabling Factors

To conclude this chapter, it is necessary to elaborate on the precept underpinning all conclusions in this analysis, namely **that all projected benefits are contingent on the implementation of a set of enabling factors**. The enabling factors are summarised in the following table.

[13] Simplified from questions taken from European Commission's Impact Assessment Guidelines, SEC(2009) 92

	Enabling Factors
Space	• Continuity of Sentinel data • Research and development for the next generation of Sentinels • Continuity of current arrangements for sharing of responsibilities between ESA and EU, in particular concerning the preparation of the next generation developments • Continuity of access to contributing missions (primarily European, but not exclusively • Simplified access to Sentinel data for widespread distribution • Development of international cooperation in order to complement Contributing Missions
Services	• Accessibility to services / products • Supporting the operations and evolution of the Copernicus services, in their transition to operations • Enlarging the range of the Copernicus services • Service development and evolution • Enabling of downstream sector • Demand incubation at regional and local levels aimed at commercial users • Continued promotional and communications efforts • Continued, coherent action to federate, consolidate and update user needs and requirements
In Situ	• On-going coordination and harmonisation efforts in complement to the subsidiarity principle
Regulatory	• Free and open data policy • Governance, assurance of data and service continuity • Quality assurance and standards-building

Table 19: Enabling Factors

If the enabling factors are not in place, the benefits are not expected to materialise to the projected levels. An indicative and conceptual analysis of the extent to which the enabling factors are linked to the fulfilment of benefits is supplied below.

	Level of Fulfilment		
Enabling Factors	**Basic**	**Medium**	**High**
Continuity of data	• No guarantees of data continuity	• Data continuity assurances in the medium term, up to the end of the "serialised" Sentinel schedule (2025)	• Fully assured data continuity in the long term (2025+)
Accessibility to services / products	• Services as they are today • Service products accessed through disparate websites Commercial access to products not catered for • No unified perception of Copernicus	• Service accessibility by commercial service providers becomes viable • Copernicus services are presented under a common visual identity	• "One-stop shop" for service products • Organised coordinated databases of information generated by services • Interfaces for real-time data streaming when required • Availability of Software Development Kits (SDK) for programmatic data retrieval
Service development and evolution	• No clear roadmap for new services Climate change: a slow starter, or a bad example? • No perspective for users	• Expanding the range of products of services • Enlarging the range of services Limited set of standards for services	• Roadmap for continuous improvement and innovation of services: for the first time a long term plan appears in this sector of industry • EU actors have access to substantial databases (climate, environment, agriculture, disasters and emergencies, monitoring of European waters etc.) obeying coherent standards and easily applicable to local and regional situations • Europe-wide product standards
Enabling of downstream sector	• Minimal funding of DS sector through R&D (FP7) No overarching market development strategy  • The piecemeal approach at its worst	• Initial action in the downstream sector: support to development outside R/D budgets • Limited funding for downstream services targeting public needs • Attention and support to services targeting regional ad hoc requirements	• Broad support to downstream services, for public and commercial needs: expanding the information society and advancing Europe to the same level as the most advanced competing countries

TODAY

2014+?

Indicative Downstream Benefits Scaling Within Given Scenario	20%	40%	80%

Table 20: Indicative Dependency of Benefits on Enabling Factors

Given that the benefits are clearly mainly driven by the investment in services, there are some additional enabling factors which should be considered as multipliers, or at least as necessary conditions for such benefits to materialise.

These factors concern essentially the availability and accessibility to a wider public of:

Data from the Sentinel satellites, and

Products and information generated by the services.

This obviously derives from the fact that a wider user base is more likely to generate ideas and new services, because of the well-known mechanism in Earth Observation that allows science and research results to move smoothly into operational applications and services[61].

Investment in data and products accessibility, coupled with an enlargement in scope, number and quality of the initial Copernicus services, accompanied by continuous support to the downstream industry, **may indeed act as a real multiplier of benefits, both in the preservation and creation of jobs and in overall economic value.**

The costs of this wider availability should be borne by the Space component and the service component. The current assumptions about the allocation of funding to the three components are certainly compatible with this suggestion.

The areas to be addressed are, in more detail:

Making Sentinel data accessible for the **scientific community**

Making Sentinel data available for **European SMEs** involved in value-adding activities

Making products and information generated by the Copernicus services accessible to **value-adding industry**

Ensuring the **evolution of current Copernicus services**: wider scope, additional products

Favouring the addition of new Copernicus services

Supporting the development of downstream services of European interest

Creating an **adequate distribution network** in support of the above points

Developing the capability to **follow and assess the development of services**: the quality of their products, the degree of adoption by user organisations, and their impact in terms of socio-economic benefits.

Preparatory work on these areas should lead to a 'service implementation plan', as a set of guidelines.

61 The involvement of scientists in, for example, operational meteorological services, has historically been deep, and determinant in both their success and their ubiquity.

4. LIKE-FOR-LIKE COST-BENEFIT ANALYSIS

In this chapter, the Copernicus benefits associated with the new MFF funding level for the 2014-2020 period are evaluated on the basis of a "like-for-like" comparison with the options presented in the Booz CBA. "Option X", the reference scenario for the like-for-like analysis, is defined as follows:

	Option X			
	2014-2020		2021-2030	
	Annual Average			
	%	€ Mio	%	€ Mio
Space	79%	427	79%	427
In Situ	4%	22	4%	22
Services	17%	92	17%	92
Total	**100%**	**541**	**100%**	**541**

Table 21: Option X Costs, Budget Distribution and Annual Values

4.1 Costs and Benefits

The Copernicus costs reported in the Booz CBA Options are presented below. In the Booz CBA, costs are increased year on year to account for price escalation in line with real GDP growth (~2% per annum) and subsequently discounted to reflect the time value of money (4% per annum).

	2014-2020		2021-2030		TOTAL	
	Uninflated	**Inflated**	**Uninflated**	**Inflated**	**Uninflated**	**Inflated**
	Cumulative, Undiscounted, € Mio					
Option A	1.925	2.054	809	961	2.734	3.015
Option B	3.430	3.669	2.723	3.378	6.153	7.047
Option X	**3.786**	**4.025**	**5.410**	**6.839**	**9.196**	**10.864**
Option C	4.620	4.969	7.810	9.869	12.430	14.838
Option D	5.950	6.384	9.790	12.372	15.740	18.756
% Δ X to B	*10,4%*	*9,7%*	*98,7%*	*102,4%*	*49,5%*	*54,1%*
% Δ X to C	*-18,0%*	***-19,0%***	*-30,7%*	***-30,7%***	*-26,0%*	***-26,8%***

Table 22: Comparison of Costs Across Booz CBA Options and Option X (Cumulative, 2014-2020, € M)

The Copernicus MFF funding level falls between Options B and C of the Booz CBA. With this as a starting point, **an estimation of benefits is presented** based on the following assumptions, whilst respecting the principles of benefit scaling outlined in the section "Scaling of Benefits"

Like-for-like benefits accrue in the first period according to a change in the budget with respect to Booz Option B;
In the second period, because the foreseen budget is considerably higher (in the order of 100%) than that of Option B, an alternative method has been used to establish a benefits baseline (both for Option X and in the ensuing scenario analysis).In particular, the benefits baseline in the analysis has been calculated as follows: for the first period (2014-2020), benefits are assumed to fall in line with those projected by Option B in the Booz CBA. In the second period (2021-2030), because the cost base is higher in the present analysis than in Option B, a different benefits profile has been assumed. As with all of the Options in the Booz CBA, this is based on a proportional degradation of the benefits of Option D, relative to the cost difference. Specifically, the benefits of Option D in the second period are degraded by 59%, based on a cost difference of 45% and a benefits scaling ratio of 1,3, which is the average for each of the cost-benefit relationships across the Booz CBA options.
The second period benefits across the Booz options are generally considerably higher than the first period benefits, due to the combined effect of longer-term user uptake and downstream fertilisation activities, incremental improvements to services, deeper integration with operational platforms and potential upgrades and improvements to the space and ground segments.

The proposed funding level can be expressed as a 10% increase to Option B (comparing uninflated and undiscounted figures in each case) in the first period, and a roughly 100% increase in the second. For the first period, the like-for-like analysis therefore places the benefits of Option X in the same order of magnitude as those described in the Booz CBA Option B. In practice these are regarded as being equivalent for the purpose of this analysis, assuming that the split between the Space, *In Situ* and Service components follows the proportions of the Booz CBA.

In the second period, the benefits are higher due to the increased budget, coupled with the assumptions about the incremental accrual of benefits expressed in the Booz CBA, and summarised in the Methodology chapter. The costs and benefits of Option X are summarised in the table below, which includes the discounted figures based on the Booz CBA.

	Option X					
	2014-2020		**2021-2030**		**TOTAL**	
	Undiscounted	**Discounted**	**Undiscounted**	**Discounted**	**Undiscounted**	**Discounted**
	Cumulative, € Bn					
Benefits	6,0	4,8	21,9	12,0	27,9	16,8
Costs	-3,8	-4,0	-5,4	-6,8	-9,2	-10,9
Net Benefits	2,3	0,8	16,5	5,1	18,7	6,0
Benefit to Cost Ratio (BCR)	**1,60**		**4,04**		**3,04**	

Table 23: Option X Costs and Benefits (Cumulative, € Bn)

The Space component of Option X is assumed to follow the serialisation strategy outlined in the section on “Scaling of Benefits**Error! Reference source not found.**”.

4.2 Downstream Impact

The impact on the downstream market is estimated as a function of the decreased programme budget with respect to the existing cost scenarios outlined in the STP downstream study (see section on Methodology). The closest corresponding scenario is “STP Low” at € 630 Mio, against which the annual average Copernicus budget over the whole period (2014-2030) - namely € 541 Mio - represents a decrease of 14,1%. The projected downstream market size under this programme funding scenario is € 0.77 Bn in 2020, and € 0,97 Bn in 2030.

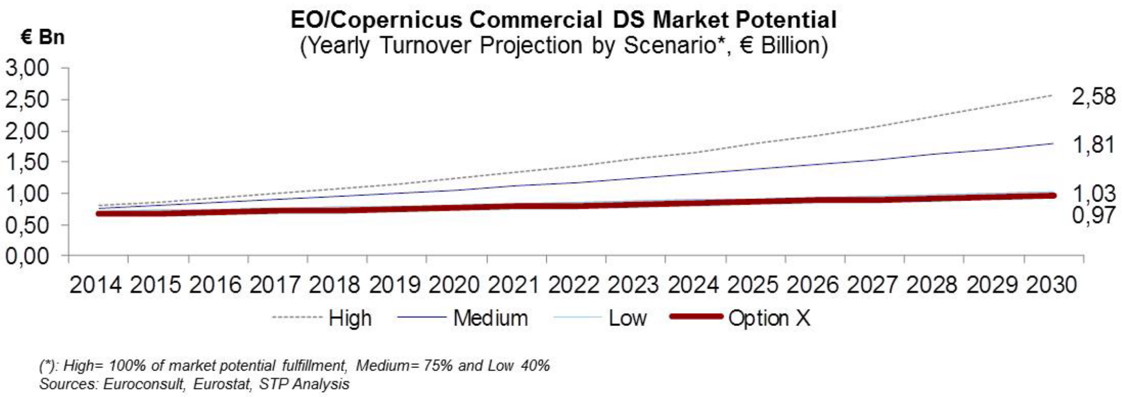


Figure 10: STP Downstream Market Development Scenarios and Option X

4.3 Impact on Employment

The corresponding impact on direct and indirect employment is presented in the following table.

	Option X	Direct	Indirect	Total
		# of jobs created / maintained by 2030		
TOTAL (2014-2030)	**Upstream**	2.170	5.650	**7.820**
	Midstream	670	1.750	**2.420**
	Downstream	8.620	27.590	**36.210**
	Total	**11.460**	**34.990**	**46.450**

Table 24: Direct and Indirect Employment Impact in Option X (Jobs Created or Maintained by 2030)

In conclusion, the like-for-like analysis of Option X results in the following outcomes:

	Option X		
2014-2020	**Cumulative Benefits**	€ Bn	6,0

2021-2030	**Cumulative Benefits**		21,9
TOTAL (2014-2030)	**Cumulative Benefits**		27,9
	Downstream Impact in 2030		0,97
	Integrated contribution to European GDP	%	**0,155%**
	Integrated BCR	:	**3,14**

Table 25: Option X, Total Impacts By Area (Undiscounted)

Option X, overall, represents a positive return on investment, with a Benefit to Cost Ratio (BCR) of 3,0. The integrated impact, expressed as a percentage of EU GDP, is 0,155%. The aggregate impact on direct and indirect employment by 2030 is estimated at approximately 46,500 (new or maintained) jobs.

5. SCENARIO ANALYSIS

This chapter evaluates the sensitivity of projected programme benefits to different allocations of funding amongst the three major programme cost areas, **Space**, ***In Situ*** and **Services**.

5.1 Analysis Background

In order to provide a baseline for comparison, the cost breakdown provided in the Booz CBA study serves as a key initial input. The costs reported below apply to the period 2014-2020 only, and are expressed in 2010 prices, uninflated and undiscounted.

Cost Components	Option A	Option B	Option C	Option D
Space component	180	370	500	600
In Situ component	10	20	30	50
Service component	65	80	100	150
Total GMES	**255**	**470**	**630**	**800**
Competitiveness and Innovation Framework Programme (CIP)[62]	20	20	30	50
Total EU	**275**	**490**	**660**	**850**

Table 26: Average Spend per Annum (2014 – 2020, € M, 2010 Prices, Uninflated, Undiscounted)

Derived from the above information, the proportional split between Space, *In Situ* and Services in the four options of the Booz CBA is shown below.

	Space	*In Situ*	Services
Option A	71%	4%	25%
Option B	79%	4%	17%
Option C	79%	5%	16%
Option D	75%	6%	19%
Average	**76%**	**5%**	**19%**

Table 27: Percentage Breakdown of Costs by Booz CBA Option (2014-2020)

The proportions across the four options are broadly comparable, with the average being 76% for Space, 5% for *In Situ* and 19% for Services. A baseline scenario has been established, based on the

62 Expenditure associated with supporting service take-up is funded through CIP.

allocation of budget in the same proportions as Booz CBA Option B (79%, 4%, and 17% respectively). Booz Option B was used as a reference point since it is the closest to the 2014-2020 MFF funding level. The three scenarios are built around this reference scenario and its associated benefit profile.

	Option X			
	2014-2020		2021-2030	
	Annual Averages			
	%	€ Mio	%	€ Mio
Space	79%	427	79%	427
In Situ	4%	22	4%	22
Services	17%	92	17%	92
Total	100%	541	100%	541

Table 28: The Baseline Scenario (equivalent to Option X)

The lowest cost option in the Booz CBA is Option A. Under this option, overall costs are largely equivalent to benefits, meaning that the Copernicus programme "breaks even" with a BCR of 1.

The assumption is therefore taken that there are levels of funding for Space, *In Situ* and Services, which constitute the "minimum requirement" for the realisation of benefits. Below these levels, the benefits do not exceed the costs, and the BCR would fall below 1. Based on previous studies, and through additional consultation, minimum thresholds for benefits realisation as well as upper limits (ceilings, i.e. in terms of absorptive capacity) on annual expenditure have been established. Both of these are presented in the table below.

	Minimum Threshold	**Ceiling** (Absorptive Capacity)
	€ Mio, Annual	
Space	300	≈600
In Situ	20-30	60
Services	70	170

Table 29: Minimum Thresholds for Benefit Realisation and Upper Limits on Annual Expenditure

5.2 Scenario Descriptions

Given the amount of funding which has been made available to the Copernicus programme, the scenarios described in this section examine the effects of varying the amount allocated to the three cost areas: Space, *In Situ* and Services. The analysis preferentially emphasises the trade-off between Space and Services, maintaining the *In Situ* component relatively stable.

The logic applied in designing the four cost breakdown scenarios in this analysis proceeds as follows:

Minimum annual budget levels have been identified for the three components, below which realisation of benefits falls rapidly towards zero. Such levels are approximately € 320 Mio for Space, € 20 Mio for In Situ, and € 90 Mio for Services.

The first scenario represents the maximum investment in the Service component.

The remaining two scenarios adjust the levels of the Space component upwards, and apportion the remaining budget to the Services component.

The cost-benefit analysis therefore establishes the three scenarios described below.

Service Delivery Pull

The Space component is held at a level just below the Booz CBA Option B threshold (74%), and investment in the Services component is maximised at 22%, whilst 4% is allocated to the *In Situ* component. This scenario allows for a level of funding for the Space component in line with previous studies. The realisation of additional, programme-wide benefits rests on the development of the Service component and on the implementation of its enabling factors. In this scenario, the structure of the Space component is assumed to follow the serialisation strategy for Sentinel deployment.

Intermediate

The "Intermediate" scenario raises the Space component by 4% with respect to the first, and the Services component is reduced proportionally (to 18%). In this scenario, as in the previous one, the structure of the Space component is assumed to follow the serialisation strategy for Sentinel deployment.

Technology Driven

Investment in the Space component is maximised (81%). The Services component is decreased to 15%. Under this level of investment, it would be feasible to consider the deployment of the C units of Sentinels 1-3, but this would not affect the benefits profile without a corresponding increase in investment in the Services component.

5.3 Costs and Benefits

The budgetary allocation assumptions for each scenario, given a fixed total budget, are presented in the table below:

I - Service Delivery Pull			II - Intermediate			III - Technology Driven			Total
Space	***In Situ***	**Services**	**Space**	***In Situ***	**Services**	**Space**	***In Situ***	**Services**	€ Mio

TOTAL (2014-2030)	€ Mio	**400**	**22**	**119**	**422**	**22**	**97**	**438**	**22**	**81**	**541**
	%	74%	4%	22%	78%	4%	18%	81%	4%	15%	

Table 30: Cost Distribution By Scenario (Annual Averages)

The percentage differences between the baseline costs and the costs of each of the other scenarios are reported in the table below.

	I - Service Delivery Pull	II - Intermediate	III - Technology Driven
	%		
Space	-6%	-1%	3%
In Situ	0%	0%	0%
Services	29%	6%	-12%

Table 31: Cost Scaling Relative to Baseline Scenario (applicable to both periods)

Based on the average correlation between cost and benefit scaling (1:1.3) derived from the Booz CBA model, the above cost changes imply the following percentage changes in benefit for each scenario:

	I - Service Delivery Pull	II - Intermediate	III - Technology Driven
	%		
Space	-6%	-1%	3%
In Situ	0%	0%	0%
Services	32%	6%	-13%

Table 32: Benefit Scaling Relative to Baseline Option

The benefits for each of the Scenarios I-III are calculated by applying the benefit scaling factors to the Baseline Scenario benefits.

	2014-2020	2021-2030	TOTAL (2014-2030)	*Delta on Scen. I*
	Cumulative, € Bn			%
Service Delivery Pull	**6,3**	**23,0**	**29,4**	0%
Intermediate	**6,1**	**22,1**	**28,2**	-4%

Technology Driven	5,9	20,8	26,7	-10%

Table 33: Benefit Simulation By Scenario

The model outcome is the result of pre-existing relationships of proportion between the costs and benefits of the options defined in the Booz CBA.

5.4 Sensitivity Analysis

A sensitivity analysis on the 2014-2020 period has been performed, in order to elucidate the potential impact on benefits, while changing the proportional allocation of the services or space components on a total given budget . The results are highlighted below.

Scenarios		**Selected Scenarios**			
Cost Breakdown (%)	**I+**	**I**	**II**	**III**	**III+**
Space	71%	74%	78%	81%	85%
Services	25%	22%	18%	15%	11%
In-Situ	4%	4%	4%	4%	4%
Total Benefits Outputs (2014-2020, € Bn)	**6,7**	**6,3**	**6,1**	**5,9**	**5,7**
Delta on Scenario I	***6%***	***0%***	***-4%***	***-7%***	***-11%***
Delta Services on Scen I	*14%*	*0%*	*-18%*	*-32%*	*-50%*

Table 34: Sensitivity Analysis of Different Potential Scenarios (at Constant Total Costs)

The analysis shows that, for a given total budget envelope, every +10% increase in the services funding results in a +2% increase of total benefits, while an equivalent +10% increase in the Space funding (up to the next step ceiling of approx. €500 M defined in "Scaling of Benefits"), to the disadvantage of the Services component, will result in an approximately -7% decrease of total benefits, as illustrated below.

Conceptual Analysis	**+/- Delta**	**Scenario I**	**+/- Delta**
Delta Services Costs vs Scenario I	-10%	0%	10%
Delta benefits vs Scenario I	**-2,1%**	**0%**	**2,1%**
Delta Space Costs vs Scenario I	-10%	0%	10%
Delta benefits vs Scenario I	**11,2%**	**0%**	**-7,1%**

Table 35: Correlation between Incremental Variations of Services and Space Costs and Resultant Benefits

5.5 Downstream Impact

In addition to the benefit analysis, the economic impacts associated with the EO and Copernicus downstream market have been estimated by scenario, as illustrated in the chart below.

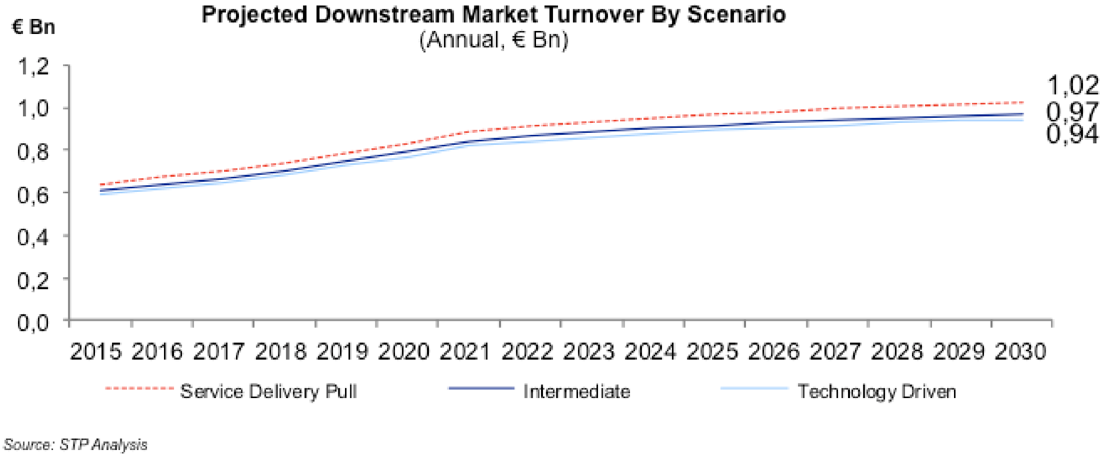


Figure 11: Projected Downstream Turnover By Scenario (2014-2030, € Bn)

The chart shows a sharp increase in the first period, which tapers off gradually from 2021, whilst still rising steadily.

5.6 Impact on Employment

The impact on employment has been estimated for each scenario, considering direct and indirect employment separately. The effects of different funding inputs have been modelled according to the cost scaling parameters outlined above.

		I - Service Delivery Pull			II - Intermediate			III - Technology Driven		
		DE	IE	T	DE	IE	T	DE	IE	T
		# of jobs created / maintained by 2030								
TOTAL (2014-2030)	US	2.030	5.270	**7.300**	2.140	5.550	**7.690**	2.220	5.770	**7.980**
	MS	710	1.830	**2.540**	680	1.750	**2.420**	650	1.690	**2.340**
	DS	9.170	29.340	**38.510**	8.710	27.850	**36.550**	8.460	27.070	**35.530**
	T	**11.900**	**36.440**	**48.330**	**11.510**	**35.150**	**46.650**	**11.330**	**34.520**	**45.840**

Table 36: Employment Impact By Scenario (both periods, figures rounded up to nearest 10; US: Upstream, MS: Midstream, DS: Downstream, DE: Direct Employment, IE: Indirect Employment, T: Total)

5.7 Economic, Environmental and Social Benefits

This section combines the economic indicators resulting from the analysis above with qualitative considerations in order to assess the overall impact of the scenarios in terms of three areas: economic, environmental and social. The economic impact is linked to the development of the Space industry, the downstream sector and cascading economic impacts on the wider economy. The environmental impact is loosely hinged on the climate change and under certain extent to resource management benefits, and the social impact is linked to the emergency response/security benefits, other resource management benefits like maritime navigation, CAP monitoring and urban planning, as well as to the employment benefits. It is worth noting that in order to derive the scenario-related benefits from the quantitative assessment table below, the Social and Environmental totals should be added to the Wider Economic row.

The benefits in each of these benefit categories have been assessed both qualitatively and quantitatively. In the latter case, data from the cost-benefit analysis has been linked with outcomes in each benefit category. For the qualitative analysis, reference is made to the list of impact areas in the EC Guidelines for Impact Assessment[63], which are qualitatively ranked in terms of the impact of Copernicus.

[63] SEC(2009) 92: "Impact Assessment Guidelines", January 2009.

Benefit Category	Impact Area	Scenario Ranking		
		I	II	III
Economic	Functioning of the internal market and competition	++	++	++
	Competitiveness, trade and investment flows	++	++	++
	Operating costs and productivity	++	++	++
	Small and Medium Enterprises development	+++	++	+
	Administrative burdens on businesses	++	++	++
	Public authorities	++	++	++
	Property rights	++	++	++
	Innovation and research	++	++	++
	Consumers and households	++	++	++
	Specific regions or sectors	++	++	++
	Third countries and international relations	++	++	++
	Macroeconomic environment	++	++	++
	TOTAL (Relative)	3	2	1
Environmental	The climate	+++	+++	+++
	Transport and the use of energy	+	+	+
	Air quality	+++	+++	+++

	Biodiversity, flora, fauna and landscapes	+	+	+
	Water quality and resources	+++	+++	+++
	Soil quality or resources	+++	+++	+++
	Land use	+++	+++	+++
	Renewable or non-renewable resources	+++	+++	+++
	The environmental consequences of firms and consumers	+++	+++	+++
	Waste production / generation / recycling	+++	+++	+++
	The likelihood or scale of environmental risks	+++	+++	+++
	Animal welfare			
	International environmental impacts	+++	+++	+++
	TOTAL (Relative)	2	2	2
Social	Employment and labour markets	+++	++	+
	Standards and rights related to job quality	+++	+++	+++
	Social inclusion and protection of particular groups	+	+	+
	Gender equality, equality treatment and opportunities, non -discrimination	+	+	+
	Individuals, private and family life, personal data	+	+	+
	Governance, participation, good administration, access to justice, media and ethics	+	+	+
	Public health and safety	+++	+++	+++

	Crime, Terrorism and Security	+++	+++	+++
	Access to and effects on social protection, health and educational systems	+++	+++	+++
	Culture	+++	+++	+++
	Social impacts in third countries	+	+	+
	TOTAL (Relative)	3	2	1

Table 37: Economic, Social and Environmental Benefits by Scenario – Qualitative Assessment

		I. Service Delivery Pull			II. Intermediate			III. Technology Driven		
	Quantifiable Indicators	P1	P2	T	P1	P2	T	P1	P2	T
Economic	Space industry turnover (€ M)	2.802	4.003	6.805	2.953	4.220	7.173	3.067	4.382	7.449
	Downstream impact (€ M, at period end)	815	219	1.034	774	207	981	752	202	954
	Wider economy	38	125	163	35	116	152	33	107	140
	Total (€ M)	**3.655**	**4.347**	**8.002**	**3.762**	**4.543**	**8.306**	**3.852**	**4.690**	**8.542**
	Delta vs scen. I	***0%***			***-2%***			***-4%***		
Environ-mental	Global climate change	1.033	8.213	9.246	987	7.846	8.833	952	7.336	8.288
	European air quality	1.345	3.793	5.138	1.282	3.616	4.898	1.235	3.429	4.664
	European deforestation	2	6	8	2	6	8	2	5	8
	Global desertification	790	2.280	3.070	804	2.320	3.124	814	2.250	3.064
	Oil spills	39	109	148	38	104	142	36	97	134
	Total (€ M)	**3.210**	**14.401**	**17.611**	**3.113**	**13.892**	**17.005**	**3.040**	**13.118**	**16.158**
	Delta vs scen. I	***0%***			***-3%***			***-5%***		
Social	Maritime navigation	102	282	384	97	268	365	93	251	345
	EU CAP Monitoring	12	35	47	12	33	45	11	31	42
	Urban development	9	27	37	9	26	35	9	24	33
	Emergency response	705	1.859	2.565	668	1.761	2.430	641	1.650	2.291
	Global humanitarian aid	2.269	6.284	8.552	2.167	6.003	8.171	2.091	5.613	7.704

	Total (€ M)	**3.098**	**8.487**	**11.585**	**2.953**	**8.092**	**11.045**	**2.845**	**7.570**	**10.415**
	Employment impact	**48.330**			**46.650**			**45.840**		
	Delta vs scen. I (benefits)	**0%**			**-5%**			**-10%**		
	Delta vs scen.I (empl)	**0%**			**-3%**			**-5%**		

Table 38: Economic, Social and Environmental Benefits by Scenario – Quantitative Assessment

5.8 Concluding Remarks

The analysis has examined three scenarios with different proportional allocations of budget amongst Space, *In Situ* and Services. The scenario "Service Delivery Pull" has the highest benefit potential, at € 29,4 Bn cumulatively over the 2014-2030 period.

The combined impacts of the socio-economic benefits and the downstream stimulus are presented in terms of their integrated contribution to European GDP in the table below.

			I - Service Delivery Pull	II - Intermediate	III - Technology Driven
2014-2020	Cumulative Benefits	€ Bn	6,3	6,1	5,9
2021-2030	Cumulative Benefits	€ Bn	23,0	22,1	20,8
TOTAL (2014-2030)	**Cumulative Benefits**	€ Bn	29,4	28,2	26,7
TOTAL (2014-2030)	**Downstream Impact in 2030**	€ Bn	1,03	0,98	0,95
TOTAL (2014-2030)	**Integrated contribution to European GDP**	%	**0,164%**	**0,157%**	**0,149%**
TOTAL (2014-2030)	**Integrated BCR**	:	**3,30**	**3,17**	**3,01**

Table 39: Integrated Impact Simulation By Scenario (Undiscounted)

Only marginal benefits will arise from increased investments in Space, even if substantially increased. **The benefits of Copernicus will arise in parallel with the expansion of the quality and range of services, enabling a manifold increase in the volume of products and correspondingly of the used base served.** This, in turn requires substantial investments on the Services side, sustained over time. If the role of Copernicus is to make available information where and when required, this must occur through the mechanism of services. Their creation, establishment, acceptance, reliability will be more than proportional to the investment made.

The FeliX model (a system dynamics model and benefit simulator, which takes into account the complex relationships between natural and socio-economic systems) forecasts benefits that are in the order of magnitude of € 21.7 Bn cumulatively by 2020 and € 220 Bn by 2030 (undiscounted), substantially higher (~7 times, in the long term) than the 'static' benefit projections of the present study. This is due to the enlarged scope of the FeliX model, and its broad assumptions of underlying infrastructure (namely GEOSS[64], to which Copernicus is expected to constitute the EU's major contribution). The comparison with the FeliX output serves to highlight the strong potential for higher-order magnitudes of benefits when Copernicus is viewed as part of a broader system of systems.

[64] Global Earth Observation System of Systems.

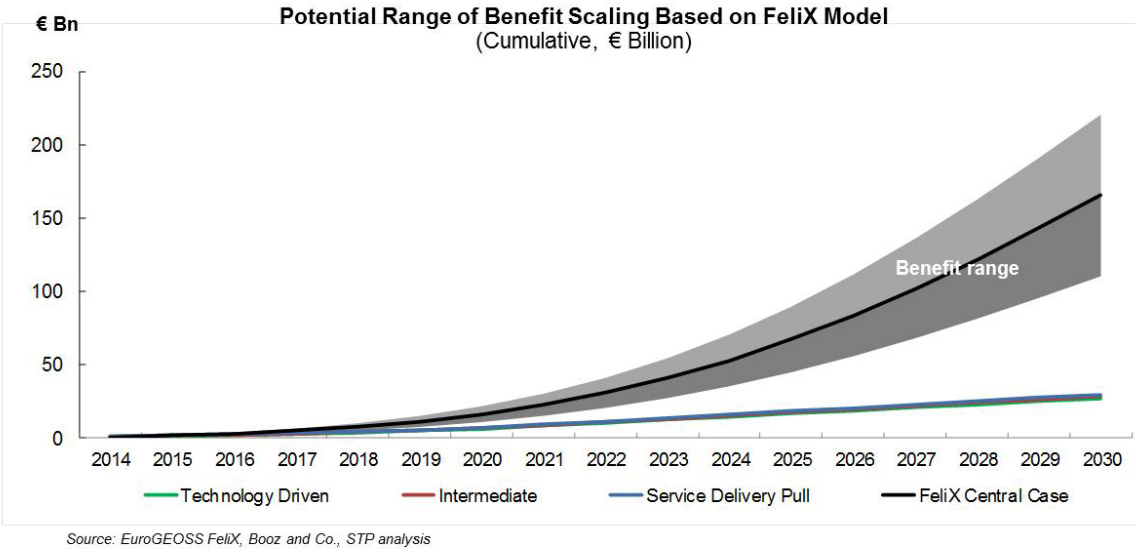


Figure 12: Potential Range of Benefit Scaling Based on Felix Model

All projected benefits in this analysis are contingent on the implementation of a set of enabling factors, including regulatory and market development actions. Any delays in the implementation of these factors will have a knock-on effect on the service uptake and downstream market development. **It may be interesting to consider the use of other budgets in support of the implementation of enabling factors, given that these can be associated with other initiatives and EU policy goals, chiefly in respect of SMEs (i.e. COSME) and regional and local development.**

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ANNEX II: List of acronyms and definitions

Abbreviations & Acronyms

Acronym	Explanation
BCR	Benefit/Cost Ratio
BOOZ	Booz & Company
C/B analysis	Cost-Benefit analysis
CIP	Competitiveness and Innovation Framework Programme
COR	Committee of the Regions
CSES	Centre for Strategy and Evaluation Services
DG	Directorate-General
DG CLIMA	The Directorate-General for Climate Action
DG MARE	The Directorate-General for Maritime Affairs and Fisheries
EEA	European Environment Agency
EU	European Union
ECFIN	The Directorate-General for Economic and Financial Affairs
ECV's	Essential Climate Variables
EDA	European Development Agency
EESC	European Economic and Social Committee
EGNOS	European Geostationary Navigation Overlay Service
EIB	European Investment Bank
EIF	European Investment Fund
EMMIA	European Mobile and Mobility Industries Alliance
EMSA	European Maritime Safety Agency
EO	Earth Observation
ESA	European Space Agency
ESE	European Space Exposition
EU	European Union
EUMETSAT	The European Organisation for the Exploitation of Meteorological Satellites

FAO	Food Agriculture Agency
FP6	The Sixth Framework Programme
FP7	The Seventh Framework Programme
Galileo	European Global Satellite Navigation System
GCOS	Global Climate Observation System
GIO	GMES Initial Operations
GSC	GMES Space Component
GTOS	Global Terrestrial Observing System
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
HELCOM	The Baltic Marine Environment Protection Commission
ICEMAR	Iceberg Forecasting project
IGPB	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme
INSPIRE	Infrastructure for Spatial Information in the European Community
Meteosat	European meteorological geostationary satellite
MFF	Multiannual Financial Framework
MS	Member States
MSFD	Marine Strategy Framework Directive
NASA	National Aeronautics and Space Administration
NEREUS	Network of European Regions Using Space Technologies
obsAIRve	Air quality observation project
OECD	Organisation for Economic Co-operation and Development
OSPAR	the Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic.
PA	Preparatory Action
Pan-EU	Involving all European nations
PwC	PricewaterhouseCoopers
R&D	Research and Development

SME	Small and Medium Enterprise
SPV	Special Purpose Vehicle
SSA	Space Situational Awareness
STP	SpaceTec Partners
TFEU	Treaty on the Functioning of the Union
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOSAT	United Nations Institute for Training and Research
US	United States
VC funds	Venture capital funds
VEGA	VEGA Group PLC
VHR	Very High Resolution
WCRP	World Climate Research Programme
WFD	Water Framework Directive
WFP	World Food Program

Definitions

Term	Explanation
Altimetry	The science and techniques involved in making relative or absolute height measurements.
Contributing missions	GMES relevant satellite missions. Around 30 Earth observation missions, operated by European national or multinational organisations, are in orbit today or will be flying within the next few years.
Credit rating	A published ranking, based on detailed financial analysis by a credit bureau, of one's financial history, specifically as it relates to one's ability to meet debt obligations. The highest rating is usually AAA, and the lowest is D. Lenders use this information to decide whether to approve a loan.

Term	Explanation
Discounting	Most policy options result in costs and benefits that arise at different times. Building a railway line has an immediate cost, but provides benefits over a long period. When beneficiaries receive a constant amount of money over a set period of time, their benefit will worth more on the first year than on the last year of the programme. Conversely, costs to be paid in the future are less onerous. The *discount rate* is a correction factor reflecting these facts. All in all, discounting allows the direct comparison of costs and benefits occurring in different points in time, valuing immediate costs and benefits more highly than those that occur later. When 'discounting' is used, it should be applied both to costs and benefits. A standard discount rate (4%) should be used for impacts that occur in the future. The total of the discounted costs and benefits of a policy option is called its net present value. (*EC Impact Assessment Guidelines, SEC(2009) 92,15 January 2009*)
ETF Startup	Part of the EC's Growth & Employment Initiative aiming to provide risk capital to innovate SMEs through investment in relevant specialised venture capital funds.
GMES-dedicated satellites	Missions, developed specifically for the operational needs of the GMES programme.
Impact	Economic, social and environmental consequences of a policy or solution, either direct or indirect, either positive or negative.
In situ	Sensor - usually ground based, airborne or sea based - closely located to the observed phenomena, as opposed to remote sensing
INSPIRE Directive	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community. It will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe.
Jason-CryoSat (Jason-CS)	A satellite that will carry a radar altimeter package to continue the high-precision, low-inclination altimetry missions of Jason-2 and 3 satellites.
Meteosat Third Generation	Satellite programme established through cooperation between EUMETSAT and ESA. The Meteosat Third Generation (MTG) programme is expected to bring a step change in capability for operational meteorology, by providing significant improvement over the capabilities of the current Meteosat generation. The programme should guarantee access to space-acquired meteorological data until at least the late 2030s.

Term	Explanation
Radar altimeter (RA)	Active sensors that use the ranging capability of radar to measure the surface topography profile along the satellite track. It provides precise measurements of a satellite's height above the ocean by measuring the time interval between the transmission and reception of very short electromagnetic pulses.
Remote sensing	The technique of obtaining information about objects through the analysis of data collected by special instruments that are not in physical contact with the objects of investigation
SEED Initiative	Global partnership for action on sustainable development and the green economy. It supports innovative small-scale and locally driven entrepreneurships around the globe which integrate social and environmental benefits into their business model. Founded by UNEP, UNDP and IUCN at the 2002 World Summit on Sustainable Development in Johannesburg.
Sensitivity analysis (SA)	Study of how the variation in the output of a model (numerical or otherwise) can be apportioned, qualitatively or quantitatively, to different sources of variation.
Sentinel missions	Satellite missions, developed specifically for the operational needs of the GMES programme. Five families of Sentinels are being developed up to now.
Synthetic aperture radar	Airborne or space borne side looking radar system which utilizes the flight path of the platform to simulate an extremely large antenna or aperture electronically, and that generates high-resolution remote sensing imagery.

ANNEX III: Reference studies and documents

A number of external studies, some specifically targeting Copernicus and others Earth observation from a more general perspective, are available. In addition, a specific study on the Copernicus downstream sector's competitiveness has been performed by an external contractor. Finally, cost information on services can be derived from past and current development activities, co-financed by the Commission under FP6 and FP7. For the space component, the ESA Long Term Scenario provides detailed cost figures.

The Impact Assessment builds on the Impact assessments accompanying the 2008 Communication "GMES: we care for a safer planet", the proposal for a Regulation on the European Earth observation programme (GMES) and its initial operations, and for the 2009 communication "GMES: Challenges and Next Steps for the Space Component".

Further data on costs and benefits of the GMES services was also gathered. On the cost side, the Commission services interacted with partners such as ESA and the EEA to obtain an update of cost figures. The Impact Assessment builds on the outcome of the cost-benefit analysis performed by SpaceTec Partners in 2012. This is based on SpaceTec Parnters' 2012 study on the downstream market potential of GMES and on a cost-benefit analysis which was performed by BOOZ & Co in 2011 complementing the 2006 PWC study entitled "Socio-economic benefits of GMES".

a) Studies performed by external contractors

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– SpaceTec Partners. Assessing the Economic Value of Copernicus: “European Earth Observation and Copernicus Downstream Services Market Study". Dec 2012.

– Booz&Co. Cost-Benefit Analysis for GMES. Sep 2011.

– the CBA carried out for the "GMES service elements" (GSE), i.e. service demonstrator projects financed by ESA, including the CBA procured by ESA for following GSE: COASTWATCH; Icemon; RISK-EOS; Urban Services; TerraFirma; RESPOND; Northern view; PROMOTE; ROSES; ForestMon; GMFS; SAGE.

– a PWC study on the socio-economic benefits of GMES procured by ESA (see http://www.esa.int/esaLP/SEMJZ10DU8E_LPgmes_0.html;

– an ECORYS study on the GMES downstream sector procured by the Commission;

– sections concerning GMES in the ECORYS study on the European space programme, procured by the Commission;

– the GEOBENE study, financed by the Commission under FP 6;

– the HEIMTSA study, financed by the Commission under FP 6.

b) Cost estimates. Cost estimates for different Copernicus components have been prepared:

– ESA Long term scenario (LTS) for the GMES space component;

– Costs for the in situ component prepared in the frame of the FP7-funded GISC study carried out by the EEA;

– Service costs were calculated in-house by the Copernicus Bureau and then discussed with member States[65], and in the Boss4GMES study.

c) Other supporting studies

– Impact Assessment of the European Space Policy, including GMES http://ec.europa.eu/enterprise/space/off_docs_en.html

– GOSIS study (funded under FP6) on GMES governance models http://ec.europa.eu/enterprise/space_research/pdf/gosis.pdf

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ANNEX IV: Evaluation of the GMES Preparatory Action (Conclusions)

Overall conclusions

Overall, the GMES Preparatory Action (PA) has played a valuable role in laying the basis for, and structuring the development of GMES Initial Operations 2011-13.

The PA has been an appropriate instrument in supporting the development of GMES by providing additional funding to promote greater take-up of data products developed through FP7 precursor services. The contribution made however has been project-specific, given the varied nature of the five projects, which are difficult to evaluate as a coherent whole.

It was not necessary to have a formal annual work programme for the PA, given its experimental nature, relatively small budget compared with other GMES funding streams and the fact that a description of the topics for the annual calls for tenders was included in the DG ENTR Annual Work Programme.

The contribution made by the PA has been important for both operational services funded through the GIO. In the case of the EMS-Mapping Service, the main contribution was in structuring the user community through linkER[66] while the GIO land has benefited through funding for the development of the first pan-European reference data products covering EEA-39, the EU-DEM and EU-HYDRO.

Although there were criticisms of the approach to the development of reference access data under the PA, it is not possible presently to produce pan-European datasets on an EEA39 basis using bottom-up data in the absence of harmonised and comparable national datasets.

In order to address gaps, the EEA therefore implemented a combination of a centralised approach to the procurement of European datasets combined with a decentralised approach through INSPIRE to harmonise national datasets to European specifications over the medium-long term.

Since this exercise is on-going and far from complete, it is clear that a top-down approach to the development of comparable European datasets was necessary in the interim period.

Since problems remain in terms of the lack of harmonisation of reference datasets between EU countries and gaps in country coverage, it is important that NMCAs work together with the EC and the EEA through the INSPIRE process in order to ensure that national data is interoperable with EU reference datasets.

GMES stakeholders were sometimes unsure what the difference was between the Preparatory Action and wider funding instruments that are contributing to the common goal of ultimately having six operational services within GMES.

Relevance

It is not appropriate to assess the internal coherence of the GMES Preparatory Action as an instrument in its own right, but rather how it has contributed to supporting the implementation of pre-operational services and in prepaing for operational services.

[66] Establishment of a network of NFPs composed of civil protection agencies

The projects supported through the PA were relevant in addressing the specific identified needs of users. A distinction can be made between projects that addressed needs across a whole service area within GMES, such as linKER/ emergency management and those that were focused on specialised areas of downstream and only one part of the service (e.g. ICEMAR / maritime and obsAIRve / atmosphere).

Projects supported through the PA have led to useful feedback being obtained on evolving user needs. These lessons have been incorporated by the EC, EEA, JRC and service contractors responsible for contracts under GMES Initial Operations and some adaptations to services and data products have been made.

Efficiency

The limited overall budget of € 10.2 Mio for the GMES PA meant that funding support for preparatory technical projects to support the development of intial and full operations could not be provided across all GMES Services[67].

The GMES PA demonstrates high efficiency. For instance, there have been no budgetary overruns and the administrative overheads in managing the PA within the Commission were low.

Effectiveness

Among the lessons learned through the implementation of the PA were that obtaining regular user input is critical in adapting services to meet evolving user needs. This was taken into account in planning the configuration of the future GIO EMS-Mapping Service.

The PA was successful in supporting take-up of GMES pre-operational services funded through FP7. As a result of intensive awareness-raising activities through linkER, for instance, more users became aware about the potential utility of GMES data (especially in EU12 MS), and the number of activations increased over time.

A factor hindering the linkER project's effectiveness was that users had to rely on non-validated reference data provided through SAFER because it was funded through an FP7 research environment. In comparison, the new EMS-Mapping Service in the GIO is able to provide an operational service using validated data.

The PA has allowed for a piloting approach to testing and developing innovative, customised downstream services and applications that build on GMES services. This has enabled new service areas to be tested, such as the development of on-board ship ice monitoring services (ICEMAR).

However, there remain low awareness levels among the private sector about the specific GMES data that will be available in future, and uncertainty with regard to the structure and size of public user markets and how the private sector can access these markets.

[67] For instance, in the marine field, a project on ice monitoring was funded an but there was no possibility to address other areas served by the Marine Service within FP7 (MyOcean 2).

Since Preparatory Actions are an EU financial instrument that operates outside the constraints of a full EU programme, the PA has allowed the Commission to experiment and test the first initial operational downstream services (e.g. obsAIRve and ICEMAR).

The linkER project helped to ensure that there was strong user input into the development of data products and services developed through FP7 SAFER. This in turn has fed into the effectiveness of the design and configuration of the EMS-Mapping Service under the GIO.

Results and impacts

Since most projects are on-going, it is too early to evaluate the final results and impacts achieved. Nevertheless, a number of findings can be noted at interim stage:

A key result of linkER was that it structured the user community in the emergency management field. This was viewed as having been critical in laying the basis for the development of future GMES Services within the EMS-Mapping under the GIO.

The ICEMAR and obsAIRve projects helped to demonstrate the potential of GMES to facilitate the development of downstream EO services and applications. However, it remains unclear at this stage how viable it will be to provide services on a fully commercial basis.

The new pan-European reference access data products developed through the RDA project Lot 1 – EU-DEM and EU-HYDRO) have directly contributed to the implementation of the GIO land's pan-European component (in particular, to the development of the 5 thematic HRLs).

This demonstrates continuity between the Preparatory Action and the GIO in resolving long-standing challenges in strengthening the comparability of reference data between Member States.

With regard to sustainability, the PA has helped to encourage greater networking and coordination among user communities in specific fields (e.g. ice monitoring, emergency management) and also the exchange of information.

Community Added Value

The linkER project promoted the development of a pan-European community of civil protection users of GMES data. This added value by promoting better and more effective coordination between civil protection agencies and wider users.

It was recognised by stakeholders that there was a need for EU intervention to promote the development of downstream GMES services and applications since these remain in their infancy.

Sustainability

The projects funded through the PA could not have gone ahead without EU assistance.

The projects supported through the PA have led to concrete results and outcomes that have already fed into the implementation of GMES services within the GIO. As such, the results achieved through the PA are likely to be sustainable, since follow-up is broadly assured. For instance:

linkER project 2008 - a network of NFPs has been established and a customised user interface and has been developed supported by the installatoin of an IT platform through which users can access GMES-derived data products and reference maps.

RDA project Lot 1 2009 – two new pan-European datasets have been developed that cover EEA39, the EU-DEM and EU-HYDRO. These are essential for the development of the 5 thematic HRLs and also for European environmental reporting and monitoring purposes

ANNEX V: Evaluation of the GMES Initial Operations (Executive Summary)

Conclusions - the Emergency Management Service – Mapping

The EMS-Mapping Service was already fully operational by April 2012 and has been able to provide data products to users from the outset. It was therefore possible to carry out an initial assessment of the service's relevance, efficiency, effectiveness and utility to users in the civil protection community. Conclusions in respect of the initial period of implementation of the EMS-Mapping service were that:

The transition process from the pre-operational Emergency Response Service ("ERS") under FP7 SAFER to the EMS-Mapping Service has generally been effective. However, there were difficulties in the first 3 months for users of the 'Rush Mode' service in accessing image data beyond those that had activated the service directly. This problem has now been resolved.

The EMS-Mapping Service meets identified user needs for the timely provision of reference data and 'before and after' reference maps. Among the advantages of the new EMS-Mapping in Rush Mode are that users are able to work with vector data and on validated data products.

The EMS-Mapping Service has been effective in incorporating the cumulative practical experiences and knowledge built up over several years about user needs in the emergency response field through dedicated thematic workshops, working groups and user meetings organised through the GMES precursor project SAFER (FP7) and through the linkER project supported through the GMES Preparatory Action.

The transition from SAFER (FP7) to the new EMS-Mapping Service under the GIO was regarded as having been effective, with strong continuity in the quality of service provision for authorised users. However, there were some initial difficulties in ensuring that civil protection agencies beyond those that had requested the service activation were able to receive the data.

There remains a challenge in the timeliness of data product availability in Rush Mode for civil protection agencies since there are difficulties linked to external factors for the service provider in meeting the target timeframe for post-event delineation and grading maps[68].

The network of National Focal Points (NFPs) set up through the linkER Preparatory Action and coordinated by DG ECHO's MIC has played an important role in disseminating ESM-Mapping satellite imagery / data products to relevant actors at regional and sub-regional levels. NFPs in some Member States have been especially active in putting in place mechanisms to structure the user community whereas in other Member States, there remains more work to do in this area, which is also important from an awareness-raising point of view.

There were high levels of satisfaction among service users with final image products. However, some civil protection users of EMS-Mapping data products stated that they would like to have access to primary datasets through ESA's DWH so as to be able to integrate these into operational workflows.

The EMS-Mapping Service could be made more effective if the space component were to be supplemented where appropriate in Rush Mode with very high resolution in-situ data for specific types of emergencies (e.g. airborne remote sensing data for earthquakes).

Conclusions – the GIO land

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68 This problem was also identified under the SAFER GMES precursor sevice and is presently largely out of the control of the service conrtactor given it is linked to the availability of sufficiently recent satellite imagery through ESA's DWH, which in turn depends on satellite flyover frequencies.

The data products produced through the GIO's local, pan-European and global components will not be available until 2013 at the earliest (in many cases only in 2014 and 2015). It is therefore too early to provide a comprehensive evaluation of the GIO land service. Nevertheless, significant progress has already been made in the specification of land data products and in the design and configuration of the above three service components. Findings in respect of the implementation to date of the GIO land are set out below.

Management and implementation

The EEA has played an effective role as the technical coordinator for GIO land and in assuming management responsibility for the pan-European and local components. Likewise, the GMES Bureau has made good progress in the preparatory stages of the global component. As part of its coordination role in respect of the pan-European and local components within GIO land, the EEA has strengthened links between GMES and INSPIRE (Infrastructure for Spatial Information in Europe).

The EEA has played a constructive role in structuring the GMES land community in particular through its coordination role in EIONET[69]. This network – which includes a dedicated working group on GMES - has been especially effective in bringing together appropriate stakeholders to cooperate on outstanding technical matters relating to data harmonisation and interoperability of land cover and land change products (although outstanding issues remain in harmonising national reference datasets).

Through its coordination role on EIONET, the EEA has improved cooperation between EU level actors in GMES and Member States' national and regional environmental authorities[70].

The EEA has also been effective in promoting greater awareness about INSPIRE and how it can benefit GMES through the EIONET and the User Forum.

The JRC has made a valuable input to the preparatory stages in the development of the global land component.

Clarity should be provided by the Commission as to whether GMES includes formal cooperation with EFTA countries and with Candidate Countries in the Balkans and in Turkey, given the potential for GMES to support the European Neighbourhood Policy (ENP).

The GIO land service

The GIO land has successfully built on a number of existing land monitoring services and data products, notably the Land Cover and Land Change products (Image 2006 and the recent CLC Image 2012) and the imperviousness and forest layers.

The outputs produced through the GIO land have strong relevance to identified user needs. Once available, they should help to inform evidence-based policy making and enable the overall situation across the EU and EEA39 to be assessed. Data products being developed through the GIO land's pan-European component on an EEA39-wide basis should meet the identified needs of European users. Comparable data products are needed for reporting and monitoring purposes at European level by the EEA. Many EU environmental indicators will be directly informed by GMES land data, for instance, in the EEA's update on the European State of the Environment due in 2015.

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[69] EIONET is a partnership network of the European Environment Agency and its member and cooperating countries, connecting National Focal Points. The network supports the collection and organisation of data and the development and dissemination of information concerning Europe's environment.

[70] The main network to facilitate this cooperation has been the NRCs for Land within EIONET and the GMES working group within EIONET.

Although many national authorities and environmental agencies and currently make use of national Land Cover and Land Change usage datasets (especially in smaller EU countries where the scale of reference data and spatial resolution may be higher), EEA39 datasets produced through GMES should benefit national authorities, for instance by facilitating inter-Member State benchmarking and macro-regional geographic comparisons. Since pan-European and national datasets serve different purposes, they should continue to exist in parallel.

Pan-European datasets will also help Member States to carry out monitoring activities to meet environmental reporting requirements under various key EU Directives[71]. The availability of pan-European data products covering EEA39 will moreover provide an important input to enable Member States' to meet their commitments under Annex II (Land Cover) and Annex III (Land Change and environmental monitoring) of the INSPIRE Directive.

The development of five thematic High Resolution Layers ("HRLs") through the GIO represents a major step forward. The data will provide new environmental information that can be built upon and further customised through the integration of datasets that build on 'core' land products by either the public or private sectors. This should in turn promote the development of downstream services and applications.

It is not yet possible to produce comparable data across EU27 (and even less so on an EEA39 basis) using a bottom-up approach despite the significant EU investment made through EU programmes (by DG INFSO and DG ENTR) in funding NMCAs to carry out technical work to address this problem and to strengthen the harmonisation of national datasets.

Despite progress, the interoperability of European reference datasets produced using a top-down approach and national datasets remains problematic in instances where access and use restrictions relating to the use of national datasets prohibits proper linking. There is a need to engage with NMCAs in order to resolve this issue and strengthen access to reference data within the in-situ component of GMES.

The division of the imperviousness and forestry layers into regionalised Lots across EEA39 had both advantages and disadvantages. While it promoted supplier diversity and ensured that the responsible service contractor had strong regional knowledge, there has been a lengthy period to develop product specifications during the streamlining phase, with methodological and technical challenges faced by the contractors responsible for the different Lots to harmonise the production of data products.

Although at an earlier stage of development, the GIO global land component has potential to support evidence-based policy making, especially for external EU policies in domains such as agriculture, food security, environment, desertification, drought monitoring and tackling climate change at international level. It should also help the Union to meet its existing European commitments under international treaties and conventions by contributing to GEOSS, thereby fulfilling the EU's international commitments regarding earth observational systems.

Key evaluation findings

[71] Examples are the Water Framework Directive, Air Quality Directive, Birds Directive, Habitats Directive and the monitoring of Natura 2000 areas.

An assessment was carried out of key evaluation issues pertaining to the implementation of GMES Initial Operations.

Relevance

The GIO was found to be highly relevant to the identified needs of users, especially those at European and national level, but less relevant from the point of view of some local and regional stakeholders. This is because GMES 'core' data products have been designed to provide comparable data at European level across EU Member States, with a need for further customisation of data (and the incorporation of additional thematic datasets) before the products have strong utility at local/ regional levels. With regard to *coherence*, although the GIO Regulation was adopted before the Europe 2020 strategy was adopted, the programme is coherent with the Europe 2020 aims of promoting smart, sustainable and inclusive growth, for instance, through the development of downstream services, which will contribute to growth and jobs, although there are barriers to maximising the potential linked to lack of awareness among enterprises and a demand for higher resolution data (see case study 4).

Effectiveness

Overall, the GIO is likely to be an effective mechanism for developing fully operational GMES services. It is clear that the objective of establishing the first operational services has been achieved. The transition towards a pre-operational environment has been effective and generally smooth, although there have been particular challenges in the land field as part of the structuring phase for the development of the five HRLs.

Significant progress has already been made in the development of fully operational land and emergency management services. However, budgetary limitations have meant that only two services out of the intended eventual six could be developed, which risks underming the overall coherence of GMES in terms of programmatic structure and the development of services in parallel. This raises a question as to whether an appropriate balance has been struck between the budgetary allocation for the space and service components of GMES. The services component represents a very small share and this has restricted the pace of development of operational services.

There is a question mark as to whether Regulation 911/2010 provides sufficient clarity as to the programme's strategic objectives during initial operations in the 2011–2013 period. There is no clear distinction between the general and specific objectives in the annex which outlines the 'objectives'. It is therefore difficult to assess how far at this early stage the GIO will contribute to the Europe 2020 Strategy's objectives. Only tentative conclusions can be reached with regard to GMES' contribution to growth and jobs since there have been long developmental lead times within GMES before data products have been made available for public and private sector usage. However, this is beginning to happen, especially in the past 12-24 months.

Efficiency

Overall, stakeholders were very satisfied with *management and implementation arrangements* within the GIO. Specifically, they were satisfied with the delegation of specific functions to the JRC, the EEA and DG ECHO's MIC in relation to for the development of two GMES services and the provision of technical expertise by the JRC and the EEA to steer the development of the EMS-Mapping and GIO land services, and to ensure adequate coordination in defining data and imagery needs to ESA.

Although it is not appropriate to make direct comparisons with precursor GMES services (since R&D is inherently more cost-intensive compared with running an operational service), GMES Initial Operations should deliver value for money, because lessons have been learned from precursor projects, and user needs have been incorporated into the procurement of service contractors and into service design and implementation.

Overall, although premature to provide a full assessment, the two main GMES services developed through the GIO are likely to deliver good value for money. At this early stage in implementation, results are only partially available (e.g. data products / maps available through the EMS-Mapping).

Results and impacts

The GIO appears on track to achieve the objective of developing two fully operational services within the 3 year programming period, an important programme 'result'. The key achievement to date of the EMS-Mapping Service is the availability of a fully operational service from the outset of the service's launch accessible by national focal points capable of delivering data products in both rush and non-rush mode. However, since the non-rush mode service has not yet been activated, the rush mode service appears likely to have a greater impact on assisting the user community, particularly in the civil protection field.

The GIO land has already made a number of important achievements, particularly within the pan-European component, through the initial design configuration of 5 thematic HRLs covering EEA39. However, It is however too premature at this stage to assess the GIO's results and impacts since it will take another 12 – 24 months years to produce the data products that are envisaged. Impacts will consequently need to be assessed at ex-post evaluation stage. Nevertheless, the data products under development are based on previous evidence from the development of data products such as CLC data using Image 2006, the products should be useful to a wide variety of environmental stakeholders and public authorities at European and national levels.

European Added Value

GMES is a European flagship programme and by definition, the activities supported within it have an inherent European dimension.

In the emergency management field, the GIO also demonstrates European Added Value since they address users' cross-border EO monitoring needs. In the land monitoring domain, pan-European data products in the land and land cover change field and the wider thematic HRLs being developed through the GIO in 2011-2013 will provide unique data products, for which in the case of the former there is already demonstrable demand from EU policy makers and agencies, with benefits for Member States in having fully comparable data.

Likewise, the development of the EU-DEM and EU-HYDRO pan-European reference access data products produced through the predecessor GMES RDA project under the GMES Preparatory Action have strong European Added Value. The development of comparable, relevant and timely reference access data on a pan-European and EEA39 basis was an essential precursor for the development of EU-wide GMES services in future and represents a European level innovation in that such datasets were not previously available.

Sustainability

The services being provided and data products being produced through the GIO **could not be continued without public funding**, pointing to high financial additionality. However, this also means that uncertainty about future funding can act as a barrier to future development. One of the weaknesses of INSPIRE's contribution to the effective development of GMES operational services is that the directive and supporting technical processes are limited to EU27, whereas GMES data products produced through the Land Service need to ensure geographic coverage across EEA39 countries.

ANNEX VI: Assessing the Economic Value of Copernicus: "European EO and Copernicus Downstream Services Market Study" – Executive Summary

This document presents the summary of the Final Report of the **"European Earth Observation (EO) and GMES Downstream Services Market Study"**, performed under the first Specific Contract of the Framework Service Contract 89/PP/ENT/2011 – LOT 3 ("Support to GMES related policy measures").

It contains a high-level summary of key findings of the analysis of the potential market value for European Earth Observation and GMES[72] downstream services for the Non-Life Insurance sector.

STUDY OBJECTIVES

In the context of Copernicus programme implementation, several studies have been carried out, focusing on costs and benefits in the context of European Commission (EC) regulatory actions. Independently, industry surveys and market analyses have described the state and structure of the Earth Observation market. However, the economic value of these markets in relation to Copernicus has not yet been the subject of detailed investigation, particularly with regard to the potential impacts on growth and employment. The specific objective of the study is to assess the **potential market value for European Earth Observation and Copernicus downstream services (with a focus on non-institutional markets), and the potential resultant impact on employment**. The study seeks to project the future markets for downstream services over a long-term time horizon (2015-2030).

KEY ASSUMPTIONS AND ENABLING FACTORS

The study is subject to the following **key assumptions**:

Catalytic effect of free and open data provision[73]: Copernicus services are expected to enable and stimulate the downstream sector by freely and openly providing access to basic pre-processed data and modelling outputs, more cheaply than would be the case if companies had to undertake such basic processing and modelling themselves. The business case for COPERNICUS is that the services improve the efficiency of the downstream sector, allowing the industry to offer better value for money in products and services to end users.

Full and assured continuity of Copernicus: In order for the potential of future markets for Earth Observation downstream services to be realised, the continued long-term availability of Copernicus data services is assumed. The investment incentives are crucially tied to both political and financial commitments at an institutional level. This continuity of services presupposes the continuity and evolution of Copernicus infrastructure providing the necessary data. Without continuity, the "raison d'être" of Copernicus is put into question, as users will only rely on Copernicus if a sustained flow of data is ensured. Without appropriate funding, existing services will cease their activities.

Furthermore, a set of **enabling factors** has been identified, on which action and associated investments are considered necessary for the realisation of downstream market potential. Certain institutional conditions are necessary to enable and accelerate the market dynamics

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72 GMES will hereafter be referred to as Copernicus, following the recent decision by the European Commission to change the name of the programme (as per http://europa.eu/rapid/press-release_IP-12-1345_en.htm).

73 This refers, in the first instance, to data derived from the Copernicus family of dedicated satellites, the Sentinels. The transitory phenomenon of Contributing Mission data will be dealt with in a follow-on study on the midstream, scheduled for 2013.

foreseen in this study, linked, *inter alia*, to market development and capacity building. They are summarised below:

Regulation: Free and open data policy; assurance of data continuity; quality assurance and standards-building.
Data Availability and Access: Simplified access to Copernicus Sentinel datasets at ready-to-use processing levels (L1)[74] for high-volume distribution, thereby responding to the needs of the value-adding industry, ideally avoiding the duplication of efforts at national level.
Demand/Market: Continued dissemination efforts; regional/local demand incubation and communication schemes aimed at commercial users; federation / consolidation of user needs and industry requirements; further integration of EO information as a supplement to traditional systems.

Examples of relevant enabling activities, which already exist in Europe, include:

Tools for Copernicus Sentinel data pre-processing, which are already being piloted in selected Member States.
The provision of support to the promotion of Space applications-related ideas (e.g. GMES Masters) and business incubators.
Easy access to credit for entrepreneurs willing to invest in the value-added service sector.
Support to training programmes in geospatial sciences to ensure availability of necessary talents for these applications.
The building of networks and the organisation of dedicated events to consolidate user needs and industry requirements.

These activities should be built upon, extended and promoted in order for the full potential of the market to be realised. Under the EU's Horizon 2020 strategy, "*it is expected that around 15% of the total combined budget for all societal challenges and the enabling and industrial technologies will go to SMEs*"[75].

KEY FINDINGS

In this study, the Earth Observation value chain is divided into three areas of activity, each with specific markets, actors and industry structure:

Upstream refers to the providers of EO Space infrastructure, comprising satellite and ground system manufacturers and operators, as well as the providers of launch capabilities.
Midstream refers to data providers, who make use of upstream infrastructure for commercial and institutional purposes. The core activities include the acquisition, production, processing, archiving and distribution of Space-derived data.
Downstream represents companies offering Value-Added Services (VAS). Such companies typically develop commercial applications based on EO data provided by the commercial data resellers.
Market Overview

The European EO downstream market is currently estimated at € 700 Mio, against € 200 Mio for the midstream and € 600 Mio for the upstream. According to a study published by Euroconsult, the EO downstream market will, in 2015, reach approximately € 1.000 Mio in

[74] L1 includes geometric and radiometric pre-processing.
[75] COM (2011) 808, final, p. 10.

Europe (and over € 2.000 Mio globally), growing at a Compound Annual Growth Rate (CAGR)[76] of 7%.

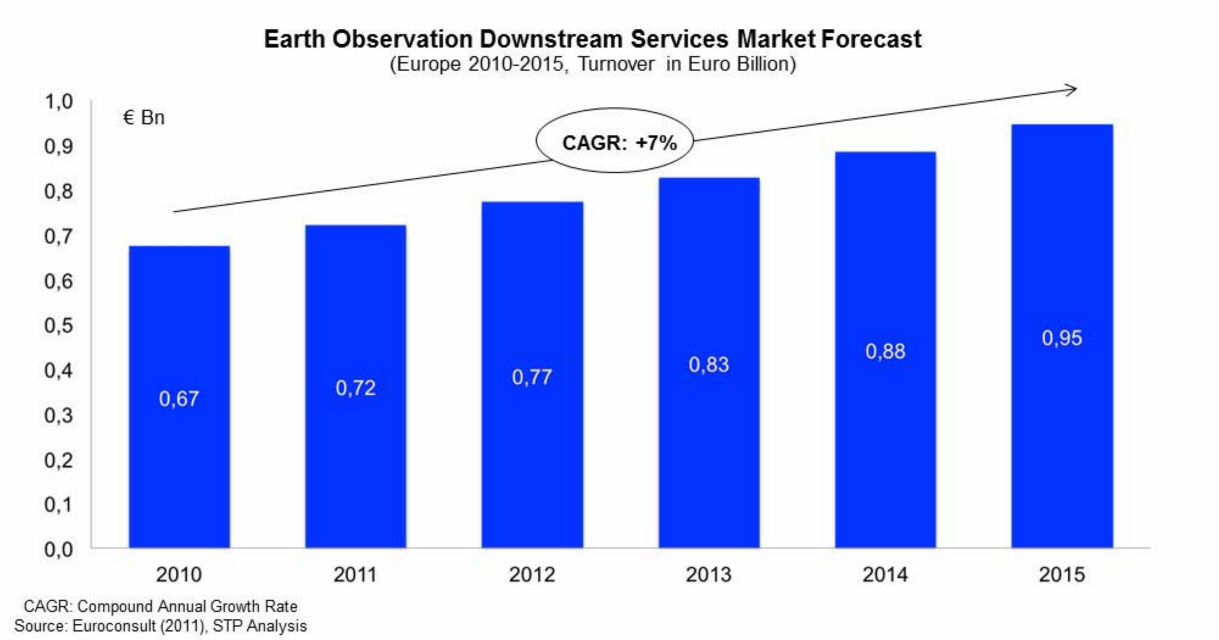

Figure 13: Earth Observation Downstream Services Market Forecast

Sector Analysis

The present study used Eurostat's NACE[77] taxonomy as a basis for the identification of potential industrial application areas for Copernicus downstream services. Five initial pilot sectors, considered to have a high market development potential, have been selected for priority analysis:

Agriculture

A cost-benefit analysis[78] shows that net economic benefits of more than € 5 per hectare can be achieved, thanks to savings in nitrogen, better crop quality (increased protein content) and increases to overall crop yield. A positive environmental impact is also gained by avoiding the dispersal of excessive nitrogen into the water, air and soil.

Non-life insurance

Continuous and reliable Earth Observation information can play a role in reducing costs and introducing efficiencies in non-life insurance business processes. Remote sensing information can substantially improve the accuracy of catastrophe models, thus helping insurers to improve risk management and compliance practices. In addition, claims management functions can be supported by damage or disaster assessment information supporting loss quantification and exposure mapping.

Oil and gas

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76 The Compound Annual Growth Rate expresses the smoothed annualised growth rate of an investment or of a business element (in this case, industry turnover).

77 NACE is a standardised classification system for describing economic sectors and their activities in the European Union. The second revision of the NACE taxonomy has been used in this study.

78 Knight et al., 2009.

In the oil and gas sector, Earth Observation exploitation is currently still limited. Satellite imagery and GIS systems can, however, usefully complement geological surveys and improve the readability of complex geoscience datasets, used by engineers in order to identify areas where it is geologically likely that petroleum or gas deposits might exist. Moreover, satellite imagery can contribute to improved asset management: seismic planning and subsidence mapping help to highlight geo-hazard risks and to ensure safer management of reservoirs and pipelines.

Water transport

In the water transport sector, Earth Observation information offers benefits through a number of different applications. Satellites provide continuous and large-scale information about sea currents, which can be converted into current forecast models. These models allow ships to optimise their routes, yielding fuel efficiency benefits and the reduction of CO_2 emissions. Satellite imaging applications can also improve traffic management in major ports and harbours.

Electricity generation from renewable sources

Earth Observation can contribute to the optimisation of renewable energy systems for power production, and to the provision of information for optimal integration of traditional and renewable energy supply systems into electric power grids. Energy sources such as solar, wind, and wave power facilities, which offer environmentally-friendly alternatives to fossil fuels, are particularly sensitive to environmental conditions. Data on cloud cover, solar irradiance, and on wind/wave speed and direction (combined with other environmental parameters such as land elevation and land cover models) are vital elements in developing a strategy for the location and operation of solar, wind, and wave power facilities.

Examples of practical downstream applications in these sectors include solar power site selection and plant monitoring, damage assessment for insurance claim management, oil pipeline encroachment monitoring and precision agriculture maps.

These and many other examples of the use of EO data demonstrate that the free and open provision of Copernicus data is an essential driver for the creation of new business opportunities.

The long-term market potential for these pilot segments has been assessed through the concept of the Total Addressable Market (TAM). This concept expresses hypothesised market penetration, under specific assumptions and within certain limitations. It serves as a metric of the underlying revenue potential of a given opportunity, and should be treated as a "bounded theoretical maximum". The approach and key inputs for the estimation of the EO downstream services' Total Addressable Market for each pilot segment are illustrated in the following table.

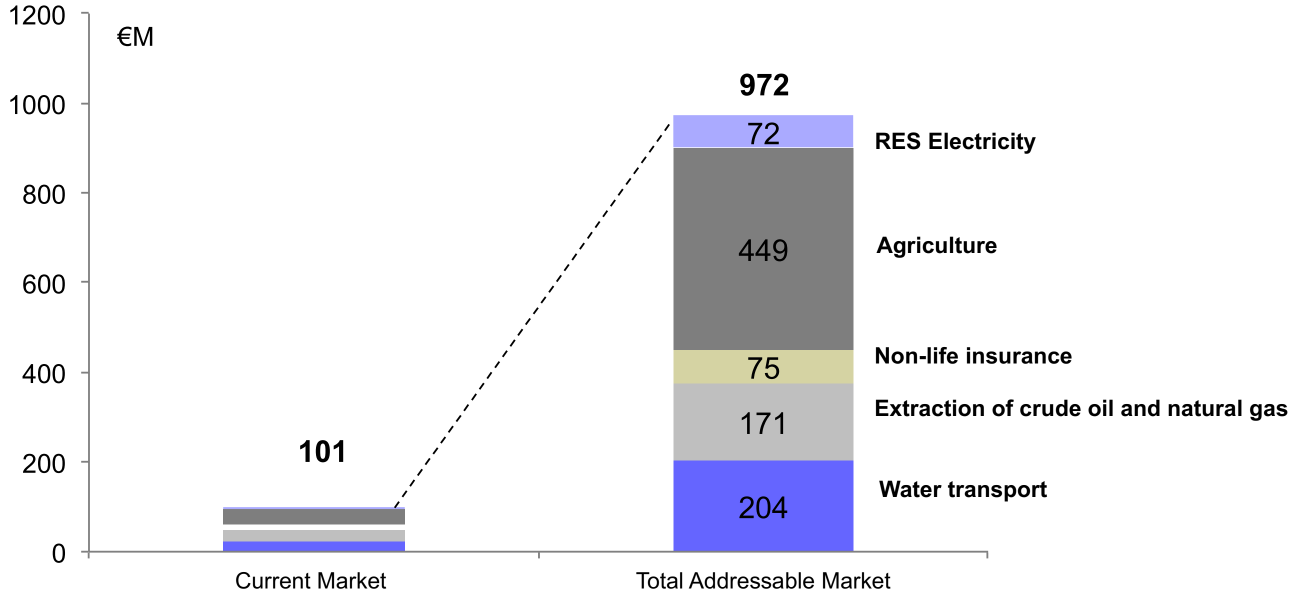
Pilot NACE Sector	Sector Turnover	Approach to Estimate the EO Downstream Market Potential
Agriculture	€342 Bn	• UAA with adequate size* • Multiplied per average price of EO data & services / ha. • Per % DS retained share
Non-life insurance	€276 Bn	• No. of enterprises • Multiplied per average spend for risk assess.& modelling per enterprise • Per % spent on risk modelling • Per % EO DS adoption rate in 2030
Extraction of crude oil and natural gas	€124 Bn	• No. of enterprises • Multiplied per Avg. surveying spend per enter. • Per % spent on EO • Per avg. share retained by downstream • Per downstream adoption rate in 2030
Water Transport	€95 Bn	• No. of enterprises • Multiplied per average EO spend per enterprise • Per average share retained by downstream • Per downstream adoption rate in 2030
Renewable Energy Resources (RES) Electricity	€46 Bn**	• Applied derived 0,2% average ratio (of TAM/Purchases of goods & services) from the other four sectors above

(*): Utilised Agricultural Area (UAA) at least 1 ESU, with >100 ha; (**): RES electricity generation of 34%, corrisponding to EU RES consumtpion target of over 20% by 2020
TAM = Total Addressable Market
Source: Eurostat, Euroconsult (2011), Industry Interviews, STP Analysis.

Table 40: Approach and Key Inputs for Estimating EO Downstream Market Potential

The results of the analysis performed for the five pilot market segments are illustrated in the following figure.

Long Term Forecast EO Downstream Services Market Potential in Europe
(Selected Market Segment Analysis, Indicative Figures of Turnover in € Million)



TAM= Total Addressable Market
Source: Eurostat, Euroconsult (2011), Industry Interviews, STP Analysis.

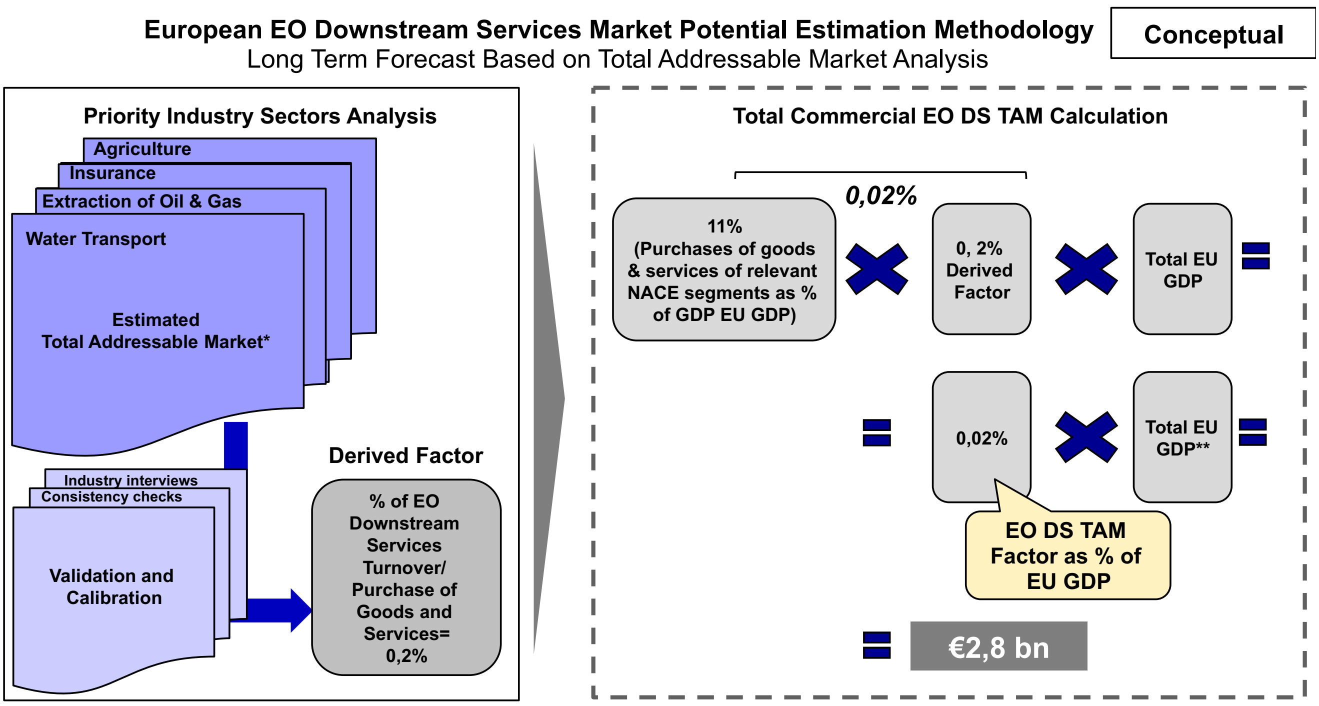
Figure 14: Long Term Forecast EO Downstream Services Market Potential for the 5 Pilot Segments

The approach used for the pilot sectors has been applied to the wider European economy by qualitatively evaluating the remaining NACE segments on their potential for uptake of EO value-added services. 15 out of the 21 top-level NACE sectors have been identified as being strong candidates for EO downstream service applications. The demand potential is moderate to high for more than half of these sectors. The total turnover of these sectors represents 19% of European GDP.

EO and Copernicus Downstream Market Potential

On the basis of the selected industry sectors and EO relevance analysis, expert interviews and information from previous studies, the total European EO downstream market potential has been assessed.

The analysis has resulted in the identification of an indicative economic factor (EO downstream Total Addressable Market as % of European GDP) and a total estimated EO downstream long-term market potential of € 2,8 billion, as shown in the scheme below.



(*): with different approaches as deemed appropriate on the basis of industry characteristics; (**): Equal to €12,6 trillion in 2011
Sources: Euroconsult,Eurostat, Industry interviews, STP Analysis

Figure 15: Methodology for Estimation of European EO Downstream Services Market Potential

Due to the nature of the TAM concept as well as to the uncertainty of future market projections, it is difficult to predict when the estimated potential will be reached. Therefore, the potential growth scenarios have been calculated in two example cases (2015 + 10 years and 2015 + 15 years, resulting in a CAGR of 11% and 7% respectively). These results have been triangulated with data from other studies, including Euroconsult (2010, 2011). The potential growth rates of EO downstream markets display consistency with the projected growth rates drawn from these sources.

In order to derive the Copernicus downstream market potential the following considerations must be highlighted.

The downstream services and applications considered in the analysis do not, in general, require Very High Resolution (VHR) data, i.e. the required resolution for these services is higher than 2,5 meters. Only a small fraction (approximately 10%) of the commercial downstream services for the different sectors would require VHR data as an input. This fraction is therefore excluded from the analysis of the addressable markets resulting from the availability of Copernicus services.

Copernicus is expected to provide impetus to the downstream services industry by offering specific technical advantages through the Sentinel satellites along with free and open access to data. This can represent an incentive for new users as well as downstream service providers to engage in EO service solutions.

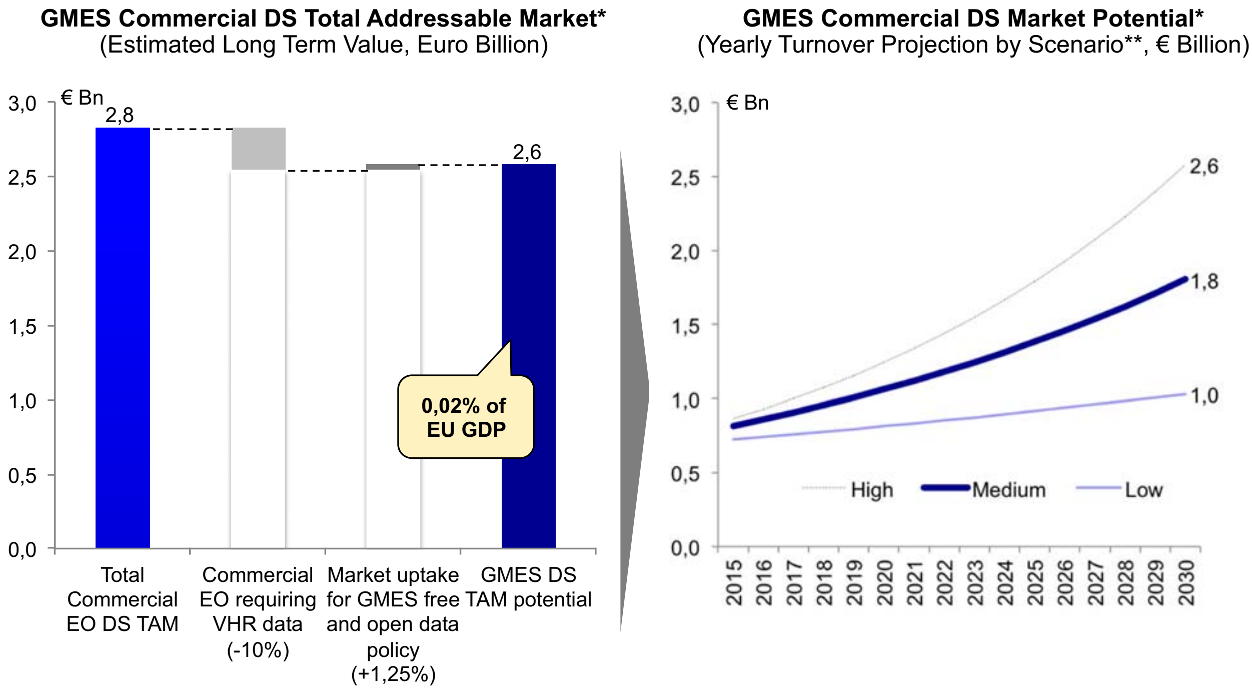
Copernicus may to some extent impact the (less valuable) EO data market for non-VHR (5% of total EO data sales market value) served by commercial data providers. This may urge some providers to focus more on the VHR data market or expand their capabilities towards value-adding activities. Those operators who provide data to Copernicus through Contributing Missions are expected to see some non-institutional markets strengthened and others opened up.

Taking into account the considerations above, three scenarios have been developed, representing different levels of market potential fulfilment (40%, 70% or 100%).

Scenario	Market fulfilment	2015-2030 CAGR
High	100%	7,6%
Medium	70%	5,5%
Low	40%	2,4%

Table 41: COPERNICUS Downstream Market Development Scenarios

This leads to a Copernicus downstream potential turnover ranging between € 1.000 Mio, € 1.800 Mio and € 2.600 Mio by 2030, as illustrated in the figure below.



(*): Assuming GMES full data continuity funding scenario;; (**): High= 100% of market potent[illegible]
Sources: Euroconsult, Eurostat, STP Analysis

Figure 16: Copernicus Downstream Services Market Potential

Since the complete fulfilment (100%) of the market potential is rather unlikely, it can be considered as a "theoretical maximum", while the low case can be seen as a “minimum boundary”. Therefore, in the analyses which follow, the medium scenario is retained in each case.

Impact on Employment

In the following sections, this revenue potential is translated into direct employment effects in the downstream area which was the focus of this study. Estimates have also been derived for the upstream and midstream sectors. To assess a further indirect impact, the European Commission proposed the application of a methodology based on a previous study by Oxford Economics (2009). In the context of this analysis:

Direct employment refers to persons employed by an organisation operating in the space industry (upstream, midstream or downstream);
Indirect employment refers to persons employed in other industries which are impacted by the Space industry, either because they form part of the Space industry supply chain, or because the industry supplies other goods and services (such as retail or financial services). In both cases, these industries benefit from increased employment in the Space sector.

Downstream Direct Employment

The market dynamics projected in the analysis are expected to result from the positive effects on the downstream market brought about by a combination of Copernicus data and service availability and a set of institutional market development actions.

SMEs are expected to play a key role in this process: it is estimated that over 200 value-adding SME service providers exist in Europe (Euroconsult, 2011), and under the EU’s

Horizon 2020 strategy, new funding instruments will be implemented in order to support early-stage, high-risk R&D innovation by SMEs[79].

The market development can therefore be associated with a corresponding impact on direct employment, which is defined as persons employed by organisations operating within the downstream sector.

The approach utilises a methodology based on the relationship between projected Copernicus downstream turnover and industry labour productivity. Labour productivity is calculated by proxy, as the quotient of industry turnover and the total number of employees, or FTEs (Full-Time Equivalents) in the sector. Three employment impact scenarios are presented below, based on the varying fulfilment of market potential.

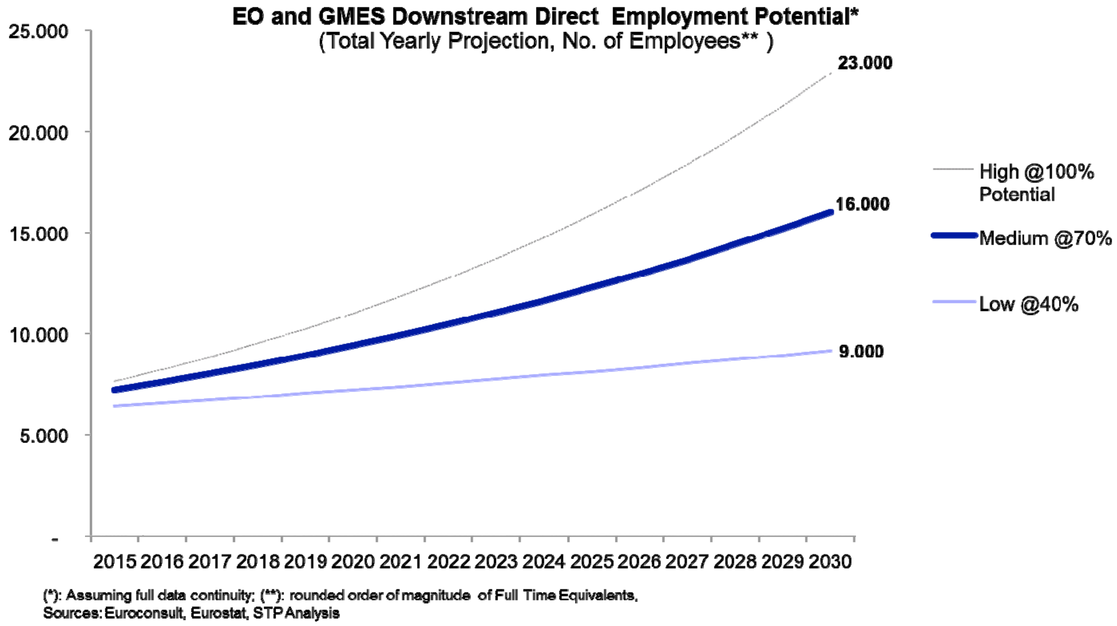


Figure 17: EO and Copernicus Downstream Services Direct Employment Potential

The medium scenario suggests that the impact on direct EO downstream employment will be approximately 16.000 cumulatively by 2030. This includes both newly created positions, and existing jobs maintained in the EO downstream sector.

The cumulative growth until 2030 in comparison with 2011 is 12.600 new jobs in the downstream sector.

Upstream and Midstream Direct Employment

A preliminary estimation of the related job impact for the upstream and midstream sectors has been performed, to be read in conjunction with the analysis done for the downstream, and as a complement to it. The estimation is based on the application of three scenarios representing different levels of Copernicus-related funding in the upstream and midstream sectors. The scenarios correspond to variations of the "Copernicus data continuity" options C

79 See http://ec.europa.eu/research/horizon2020/pdf/press/fact_sheet_on_sme_measures_in_horizon_2020.pdf .

and D outlined in the Booz & Co. Cost-Benefit Analysis[80]. The high scenario implies a funding level of approximately € 900 Mio annually, with approximately € 800 Mio for the medium scenario and € 700 Mio for the low scenario.

The same methodological principles as used in the analysis of downstream employment potential have been applied to the upstream and midstream sectors, using relevant industry productivity measures in each case. The preliminary results of the long-term employment analysis in the Copernicus upstream and midstream segments provide a rough order of magnitude estimate of **approximately 4.000 - 4.800 jobs to be maintained and created in total by 2030.**

Cost Scenario	Aggregate jobs maintained and created through COPERNICUS by 2030		
	Upstream	Midstream	Total
High	3.500	1.300	**4.800**
Medium	**3.300**	**1.200**	**4.500**
Low	2.900	1.100	**4.000**

Table 42: Aggregate Direct Employment Potential (Rounded N. of Employees/FTEs, 2030)

Aggregate Employment Impact

The total impact on **direct employment**, in terms of new jobs, is calculated by subtracting the current estimated employment figures from the projected estimates. The High scenario is disregarded in each case. The table below summarises the aggregated results of the analysis for the downstream, midstream and upstream sectors.

Aggregate Jobs Maintained and Created through Copernicus (No. FTEs)					
2030 Projection		**Upstream**	**Midstream**	**Downstream**	**Total**
Scenario	**High** (Theoretical Maximum): @100% DS market potential and Copernicus full data continuity and scope	3.500	1.300	23.000	**27.800**
	Medium ("Most Likely"): @70% DS potential and Copernicus full data continuity and reduced scope	3.300	1.200	**16.000**	**20.500**

80 This study, performed in 2011 by Booz & Co. and SpaceTec Partners serves as an underpinning to the current analysis of projected programme costs. It will be referred to as "Booz CBA" in this text, for short. See http://ec.europa.eu/enterprise/policies/space/files/Copernicus/studies/ec_Copernicus_cba_final_en.pdf.

	Low ("Minimum Boundary"): @ 40% DS potential and low Copernicus funding case	2.900	1.100	9.000	**13.000**
Current Baseline		2.300		3.400	**5.700**
Delta Medium Projection vs Baseline (New Jobs)		**2.200**		**12.600**	**14.800**

Table 4: Total Estimated Impact on Direct Employment[81]

The aggregate level of direct employment indicates an **order of magnitude of approximately 15.000 new jobs across the entire Copernicus and EO value chain**.

[81] Due to the method of calculation, it is not possible to distinguish between upstream and midstream employment for the baseline.

Indirect employment effects are typically calculated using industry employment multipliers to estimate the effects of economic stimulus and job creation outside the immediate industry under consideration.

The multiplier approach is based on the understanding that one job in the Space industry can support additional jobs in other sectors, in other industries or based on individual spending of Space (application) industry employees. Indirect employment is likely to include the retail, financial and business services sectors, as well as manufacturing, and "induced" employment in retail and service industries.

Specific multipliers for the Space industry were developed by Oxford Economics in 2009 in order to estimate the indirect effects of increased employment in the Space upstream and downstream sectors in the UK. The additional employment is "*supported through purchases of goods and services by companies in the Space industry, and from employment supported by employees in the Space industry (whether direct or indirect) using their income to purchase goods and services for their own consumption*."[82] The employment multipliers[7] derived for the UK are 2,6 for upstream (2,6 jobs supported for every job in the Space industry) and 3,2 for the downstream (3,2 jobs supported for every job in the Space industry). It is assumed for the purposes of this study that the multiplier for the midstream is comparable to that of the upstream; since no specific multiplier is available, the upstream multiplier will also be used for the calculation of the indirect employment of the midstream.

Based on the medium scenario above (3.300 upstream and 16.000 downstream maintained and created direct jobs), the analysis suggests that approximately 63.000 "indirect" jobs could be supported in industries outside the Space sector in the year 2030 (figures have been rounded up to the nearest hundred).

Integrating the direct employment analysis with the indirect employment analysis based on Oxford Economics' industry employment multipliers, **the overall employment impact amounts to approximately 83.500, including jobs maintained and created in the wider economy**, as summarised in the following table:

	Employment 2030	Upstream	Midstream	Downstream	Total
Medium Scenario	**Direct**	3.300	1.200	16.000	**20.500**
	Oxford Economics Multiplier	*2,6*	*2,6*	*3,2*	
	Indirect	8.700	3.100	51.200	**63.000**
	Total (New and Existing)	**12.000**	**4.300**	**67.200**	**83.500**

Table 5: Total Direct and Indirect Jobs Estimate

82 Source: Oxford Economics, The Case for Space, 2009.

Applied (Type II) employment multiplier is equal to (direct impact + indirect impact + induced impact) / direct impact. We have simplified it in the table to provide more intuitive reference for calculation. The following explanation is taken from the original Oxford Economics study: "The number of dependent jobs in the supply chain is computed by assessing how many workers would be required in the supply chain to produce the amount of goods and services demanded by the space industry. To calculate the number of jobs supported through the induced impact, we model the additional effect on domestic demand in the UK economy that salaries generate through consumer spending. This is then converted into jobs using average productivity across the economy."

CONCLUSIONS

A number of non-Space sectors benefit from Copernicus

The study identifies industrial sectors, which may benefit from Copernicus, and analyses five in particular: water transport, oil and gas, non-life insurance, power generation from renewable sources and agriculture. Examples of practical applications are solar power site selection and plant monitoring, damage assessment for insurance claim management, precision farming and oil pipeline encroachment monitoring. These and many other examples of the use of EO data demonstrate that free and open Copernicus data provision is an essential driver for the creation of new business opportunities.

Enabling factors are necessary for the realisation of market potential

A number of existing activities are underway to support market growth. The implementation of a set of enabling factors would ensure that the identified potential can be assured, in particular in the downstream segment:

Regulation: Free and open data policy; assurance of data continuity; quality assurance and standards-building.
Data Availability and Access: Simplified access to Sentinel datasets at ready-to-use processing levels (L1)[83] for high-volume distribution, thereby responding to the needs of the value-adding industry, ideally avoiding the duplication of efforts at national level.
Demand/Market: Continued dissemination efforts; regional/local demand incubation and communication schemes aimed at commercial users; federation / consolidation of user needs and industry requirements; further integration of EO information as a supplement to traditional systems.

The estimated EO Downstream market potential attributable to Copernicus is € 1,8 billion by 2030

The estimated Earth Observation downstream services total market value potential is € 2.800 Mio, of which € 2.600 Mio could be attributable to the Copernicus-enabled downstream, i.e., value-adding activities building on Copernicus data and products. This is based on the expected stimulus to the market catalysed by the free and open data policy of Copernicus. **Projecting the addressable market potential over the period 2015-2030 leads to approximately € 1.800 Mio in downstream services turnover attributable to Copernicus by 2030,** assuming the “most likely” medium scenario of 70% market potential fulfilment**.**

Considering the Copernicus contribution along the Space value chain, Copernicus can be seen as a driving force for creating highly skilled job opportunities and can have indirect effects on the wider economy by 2030.

Downstream: Maintaining and creating approximately 16.000 direct jobs cumulatively, provided that full data continuity is assured for Copernicus in the long term, and the EO market potential is realised, with enabling factors in place.
Upstream and Midstream: Maintaining and creating 4.500 direct jobs under the Copernicus funding scenario option of full data continuity.
An aggregate of 20.000 direct jobs will be created and maintained, of which 15.000 are new jobs, in total across the entire Copernicus and EO value chain.
A high-level-analysis of potential economic multiplier effects (based on Oxford Economics’[84] Space industry multipliers, provided by the European Commission) suggests that 63.000

[83] L1 included geometric and radiometric pre-processing
[84] Oxford Economics (2009).

indirect jobs could be maintained and created, yielding an overall employment impact of approximately 83.000 jobs in Europe by 2030.

Copernicus demonstrates that ecological and economical goals can be mutually beneficial; environmental sustainability can promote economic development. In fact, Copernicus and Earth Observation satellite data can support the development of useful applications for a number of different industry segments (e.g. agriculture, insurance, transport, and energy) creating an appealing downstream/ value-added services market.

Overall Conclusion

The European Commission has commissioned a study investigating the economic impact of the Copernicus programme beyond the institutional sector, with a focus on the downstream market. Initial results show that Copernicus is not only a monitoring tool for institutional needs, but can also stimulate economic growth and employment in a wide range of industrial sectors, leading to the creation or maintenance of approximately 20.000 direct jobs in Europe by 2030, if enabling factors are put in place. With highly skilled jobs in this sector typically impacting employment in other sectors, the economic stimulus by Copernicus could also result in a wider economic effect, with an additional 63.000 indirect jobs secured or created by 2030. Overall the impact on employment from Copernicus is estimated at approximately 83.000 jobs in Europe by 2030.

ANNEX VII: Summary of the Booz & Co's Cost-benefit Analysis on GMES

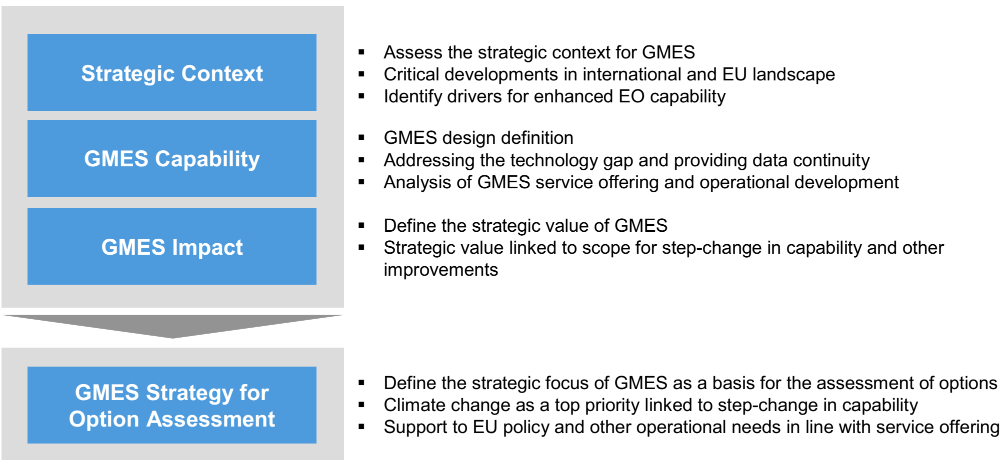
1. Introduction & Assessment Approach

Global Monitoring for Environment & Security (GMES) is a joint undertaking of the European Commission, its Member States, the European Space Agency (ESA) and the European Environment Agency (EEA). It is an Earth Observation (EO) programme that seeks to develop operational information services in the fields of environment and security. Through investments in new space infrastructure, the programme aims to create an independent European capacity in EO.

Booz & Company was commissioned to undertake a cost-benefit analysis of the GMES programme by the European Commission. The main focus of this study is the assessment of four broad funding options for GMES and its operational services. In carrying out this exercise, it is important to bear in mind that GMES represents a unique public investment programme in that it is designed to support a wide array of public policy issues. Therefore, we have developed a strategic evaluation framework based on our understanding of the space and EO sectors, and the role EO infrastructure plays in supporting the implementation of government policies aimed at better managing the environment and security.

The figure below provides an overview of the process we have followed in defining and evaluating the impact of GMES at a strategic level, and how this can be used to support the assessment of the options.

Approach to Evaluating GMES Impact & Investment Options



2. GMES Components and Services Domains

The GMES system is composed of 3 main building blocks: (i) the Space component, (ii) the in situ component and (iii) the service component.

The collection of EO data from space is the primary infrastructure component of GMES. In its operational configuration, the GSC will rely on data provided by dedicated GMES missions (the Sentinels), as well as Contributing Missions from national or commercial providers.

The in situ component is based on observation infrastructure owned and operated by a large number of stakeholders and coordinated by the European Environment Agency (EEA). The observation means include ground-based, airborne and ship- or buoy-based sensors and instruments. The need for in situ observation activities, and associated infrastructure, stems from a range of national, EU and international regulatory agreements.

The service component refers to the evolving networks of service providers involved in the production and delivery of GMES services. GMES service provision is organised in terms of six domains: atmosphere monitoring; climate change monitoring; emergency management; land monitoring; marine; and security applications. These are described as follows:

Climate Change: Monitoring in support of adaptation and mitigation policies through production of Essential Climate Variables (ECVs).

Atmosphere: Monitoring atmospheric chemistry and composition to contribute toward ECVs, as well as measurement of European air quality

Land Monitoring: Monitoring of land use to protect ecosystem and facilitate environmental protection and resource management.

Emergency Management: Services to allow better coordination, preparation and response from natural and man-made disasters. This includes disaster extent and damage assessment maps, to support post-event recovery.

Marine: Ocean forecasting and monitoring to contribute to ECVs, monitoring marine environments and contribute to maritime navigation by creating and calibrating three-dimensional models used in prediction and forecasting.

Security: Use of EO to support EU external actions at land and maritime level to promote security.

3. GMES Value-Added

EO is seen globally as a critical source of data to enable monitoring and modelling of major issues of global importance using technology that removes many of the limits of national or localised observation systems. GMES is Europe's contribution to the Global Earth Observation System of Systems (GEOSS), which itself identifies key societal benefits that are the objectives of these systems including:

Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;

Reducing loss of life and property from natural and human-induced disasters; and

Understanding environmental factors affecting human health and well-being.

By providing the EU contribution to GEOSS, GMES provides a strategic role for the EU in Earth Observation by:

Ensuring Europe remains a leading contributor to GEOSS and is recognised as such;

Enabling greater collaboration between members of GEOSS, enhancing EU policy goals by ensuring access to information from global contributors;

Enhancing the credibility of the EU at international negotiations by having its own data sources in order to demonstrate its commitment to understanding the global environment; and

Ensuring the EU has an independent source of information to guarantee the veracity of information used for EU policy purposes at global and European levels.

GMES contributes towards maintaining the strategic influence of the EU in important global policy areas. The GMES programme of dedicated satellite capacity (the Sentinels), have been designed to augment existing satellite and in-situ data sources. In total, the Sentinels will make a significant contribution to the collection of Essential Climate Variables (ECVs) that provide input to climate models to forecast future climate change scenarios. In addition, the collection of new data on atmospheric, marine and land conditions can support a wide range of policies at European and national level.

Given that climate change is a top priority goal of the EU, with the European Climate Change Programme (ECCP) and the EU commitment to achieving multilateral agreement on climate change within the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), it is apparent that the most significant impact of GMES will be to collect observations to enhance the modelling of future climate change scenarios. This will enable greater confidence in these forecasts which will impact on strategies for mitigation of and adaptation to climate change, and support EU positions at international negotiations.

In addition to supporting the EU global and internal efforts to mitigate and adapt to climate change, the GMES programme will enhance the EU's understanding of and options to respond to other key policy areas of environmental impact. The EU has a wide range of policy initiatives and strategies directly related to the environment, including the Europe 2020 Strategy and the EU Sustainable Development Strategy. In particular, GMES can assist in understanding and taking steps towards objectives in a number of areas including:

Biodiversity (e.g. deforestation, desertification, threats to sensitive ecosystems) as expressed through the Biodiversity Action Plan;

Promotion of improvements in air quality in Europe to improve public health through the Clean Air for Europe programme;

Prediction, response and reconstruction associated with major natural disasters (through the Space and Major Disasters Charter and the Community Civil Protection Mechanism);

Improved targeting of humanitarian aid and assistance programmes to developing countries; and

Better compliance with funding from the Common Agricultural Policy.

Investment in GMES infrastructure also contributes to the EU's industrial policy, by helping to develop the EU space sector and by facilitating the development of a downstream sector which can take advantage of new data series to sell services to end users on a commercial basis. This supports the EU's endeavours to promote economic growth and employment, based on new technologically-led industries that have an environmental focus.

4. Economic Value of GMES

As GMES is a major EU effort to enhance our understanding of Earth science, the main benefit of GMES will be the value of information it provides to support policy action and resource management across the EU and further afield. The value of information depends on a number of factors regarding the circumstances of decision makers, including the level of uncertainty that they face, what is at stake, the cost of using information, and the cost of the next-best information substitute. A review of academic literature supports the view that there is inherent value in information. Based on this review, there are valid reasons to suggest that the overall extent of the VOI is incremental. As such, GMES has the potential to deliver significant economic value through enhanced EO information.

5. Approach for the Quantified Cost-Benefit Assessment

The approach supporting the cost-benefit analysis combines an understanding of timing (e.g. when services are operational and the build-up period before benefits fully materialise), the level of actual benefits realised (e.g. the degree to which service guarantee and level of investment in developing and promoting services impact), the programme itself (e.g. infrastructure capability and availability), and most importantly the explicit level of impact placed on the value of information provided to decision makers and market actors.

Four options have been assessed:

Option A (Baseline Option);

Option B (Baseline Option Extended);

Option C (Partial Continuity); and

Option D (Full Continuity).

Each option contains profiles of investment in infrastructure (space, in situ), services and user take-up. The analysis is supported by a comprehensive review of GMES services to take account of the level of foreseen operations by 2014. It has provided a strong basis for setting a service baseline for 2014, and demonstrates where additional funding is required to reach operational maturity. The outcome is specific assumptions for each benefit area covering operational readiness and time to full maturity. The quantification of benefits is based on an approach that attributes to GMES an incremental improvement in outcomes, e.g. measured as a change in baseline environmental damage costs. This recognises that outcomes consist of several factors, of which the contribution by GMES is only one part.

6. Cost-Benefit Analysis

The study has confirmed through qualitative and quantitative analysis that GMES has the potential to be developed into a powerful tool for the EU. GMES enables the EU to engage positively at the global level, but also to work towards achieving EU-wide policy objectives. The quantified cost-benefit analysis assesses four broad funding options.

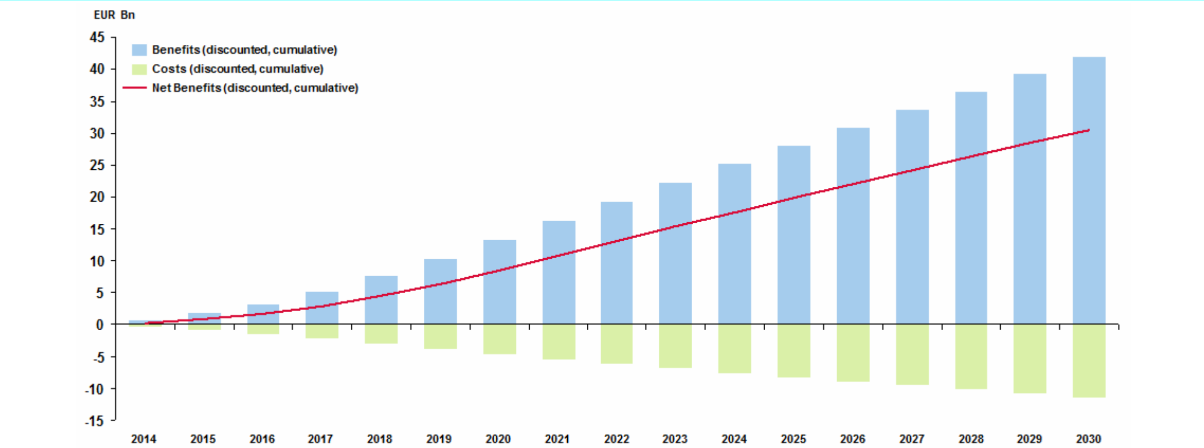
Key results for each of the four options are presented in the figure below. It shows total benefits, total programme costs and the associated net benefits over the 2014 – 2030 time period of the assessment. Results are cumulative undiscounted and discounted at 4% per annum. All values are expressed with 2010 as the base year.

The analysis has demonstrated the value of remaining committed to the GMES programme. Option A with no on-going commitment to replace infrastructure or investing significantly in services is the one with the lowest net benefits. Increasing levels of commitment to the programme, supported with increasing investments in Sentinel Missions, and hence improving service guarantees, provide increasing levels of benefits. This is demonstrated in Options B and C, although the step-change in Option C is also associated with a much higher level of benefits. However, Option C only provides partial continuity as data from Contributing Missions is not guaranteed. This is addressed through Option D where there are additional investments to provide a full continuity of data from Sentinel and Contributing Missions.

In the case of Option D, the figure shows the cumulative build-up of benefits and costs over time in discounted terms. Option D enables the capture of a full range of potential benefits from investing in GMES, including those relating to the development of a comprehensive long-term response within the climate change domain (accounting for 40% of total benefits). The option also provides a strong basis for achieving the EU key strategic policy objectives, including securing GMES within the context of industry policy and the wider economy.

Figure 6

Option D – Cost-Benefit Analysis, € billion, 2010 prices



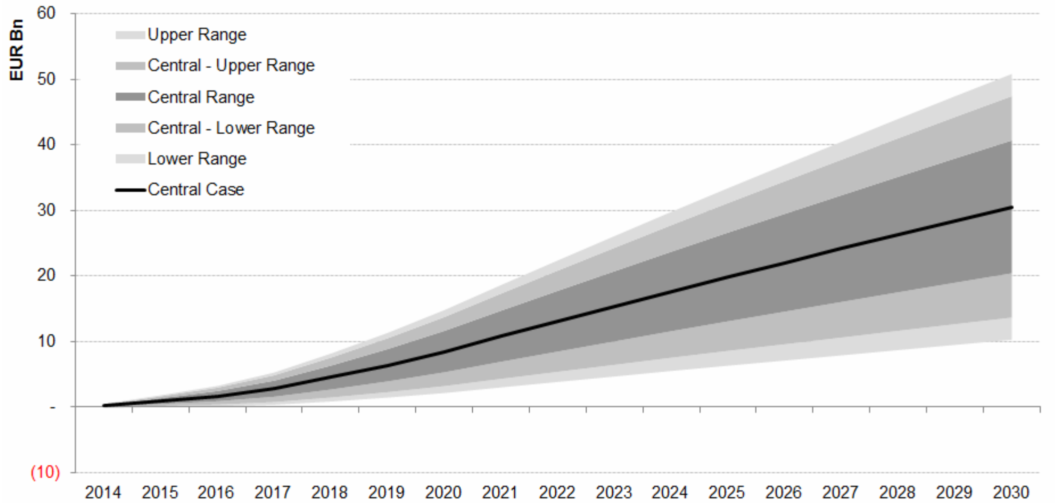
Source: Booz & Company analysis. 2011

Option D will provide the space and downstream sectors, including SMEs, a basis for developing capabilities and competitiveness within the sector. These advantages can support future industrial development and support a strong positioning in comparison with non-EU competitors and firmly secure the EU EO sector in the longer term. In particular, it is important for businesses – and actors in general - to have sufficient confidence that investments are supported by a long term funding commitment. If this is not in place, it is most likely that benefit realisation will fall short of expectations, particularly in relation to realising benefits from climate change action. It is only through guaranteeing the continuity of data that this is secured.

However, it remains clear that Option D requires the EU to make a substantial – and sustained - funding commitment over a long time period. Option D represents a significant step-change in commitment, and provides a basis for establishing GMES as a key tool to inform climate change mitigation and adaptation. However, given the overall uncertainty on key parameters, further careful consideration may be required. It is possible to gauge the wide range of potential outcomes from the following figure, which illustrates the range from € 10.300 Mio to € 50.800 Mio from varying the assumed GMES contribution, with the black line in the middle of range showing the Central Case projection. The range for benefit-cost ratios is 1.9 – 5.4.

Figure 7

Option D – Low, Central and High Case net Benefits with + / - 50% change in GMES Benefits for 2014 - 2030, € billion, 2010 Prices, Cumulative, Discounted



Source: Booz & Company analysis. 2011

Sensitivity analyses have been used to compare results to the Euro-GEOSS FeliX model and the PWC study of socio-economic benefits of GMES. The FeliX model is shown to generate benefits that are substantially higher (up to 2.9 times more than in Option D). It illustrates a potential up-side scenario to investing in GMES. Furthermore, total benefits projected in the current study are shown to be lower by 2030 than in the PWC study. However, the PWC study assumed the majority of benefits to start from 2011. Comparing the results of this study with a PWC benefit projection on a comparable basis (i.e. take-up from 2014), it is actually possible to demonstrate a higher result by 2030. Overall, these findings provide some key reference points for interpreting the results and validating the findings of this study.

Finally, it should be stressed that this study represents a first attempt at placing the benefits of GMES within the context of different investment options. It may have provided an objective basis for selecting a preferred option. However, it remains clear that additional option refinement and cost-benefit assessment work is required to optimise any option.

7. GMES Benefit Enablers

For the full potential of GMES to be realised, some key enablers need to be addressed in the short term. Without resolution of these issues, GMES may still develop and expand its role (and benefits), but there are risks of higher costs, reduced uptake by public sector users and growth from the downstream sector. If these risks are not carefully managed then a substantially lower benefit profile may eventuate. These issues have been highlighted by stakeholders, both public and private sector.

The key steps that should be taken to enable the potential of GMES include:

Incorporating a more central role for users in strategic development of the GMES programme;

Development of a strategic approach to the downstream sector to catalyse engagement and interest, and gain feedback on key priorities for that sector;

Development of a longer term funding and financing strategy that enables procurement and contracting arrangements to go beyond the FP funding periods;

Development of a long term data policy that addresses issues of intellectual property, privacy, data archiving, access policy and relationships with Contributing Missions and in-situ locations;

Further definition of the selected option, with an ongoing process of optimising expenditure on infrastructure and services, with a dynamic view of benefits and priorities over time; and

Determination of ownership and operational control of the Sentinels after they have been deployed.

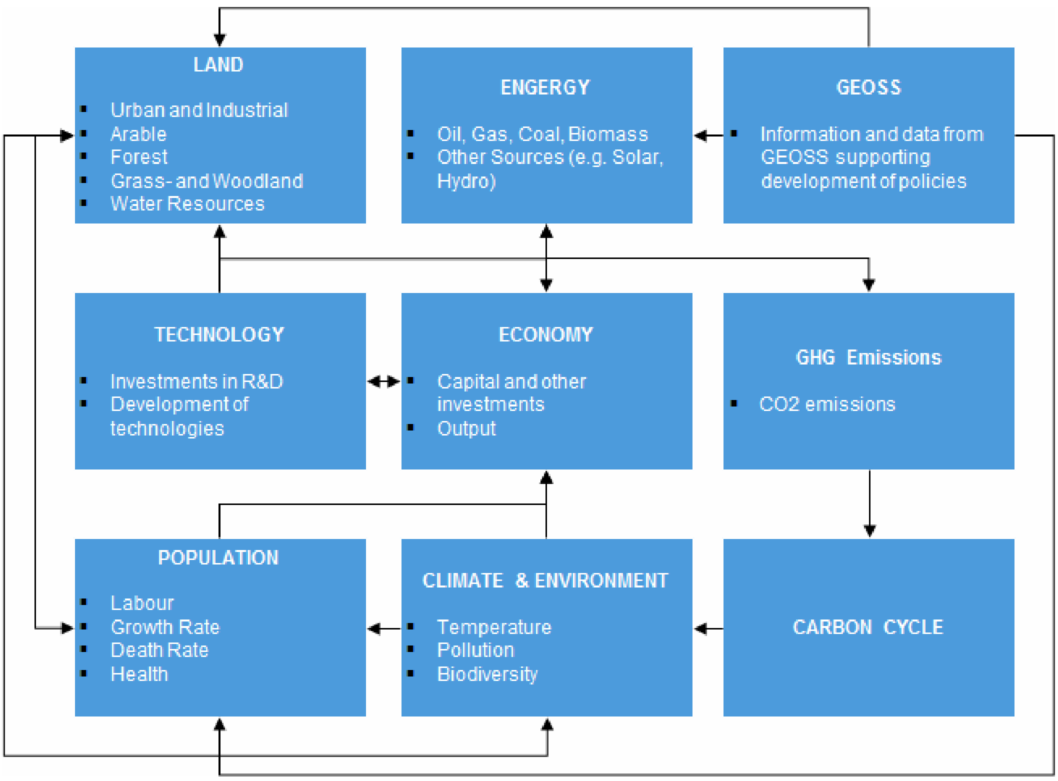
In this context, programme governance is identified as a top priority. GMES requires strong strategic leadership, with a programme approach that is dynamic, has a professional risk management strategy and will engage with users and the downstream sector in the ongoing development and delivery of its programme. It should be focused on delivering across the high impact benefit areas such as climate change, environmental policy and facilitating the development of the downstream sector.

If governance is addressed, it can also provide a strategic foundation for the EU developing GMES as a world-class, leading base for EO with a downstream sector that is growing to its potential. Given the sheer scale of investment involved, it would be in the best interests of the EU to maximise the potential return from this, and to take GMES from being an interesting research and development project that is delivering useful services, to being seen as an invaluable contribution to a wide range of public policy and private purposes. It can do this with a body that is empowered, strategically focused, user oriented and dynamic.

ANNEX VIII: The FeliX Model

The FeliX model, which stands for Full of Economic-Environment Linkages and Integration dX/dt, is a dynamic and integrated approach to identifying and quantifying the benefits of GEOSS. It is provided through the application of systems dynamics models. Developing such a model and carrying out simulations of different EO scenarios was a main output from the GOE-BENE project and is being continued and refined as part of EuroGEOSS. This work included the development of a systems dynamics model, which can be used to test the potential impacts of GEOSS.

Figure 8: FeliX Model Overview



Source: GEO-BENE Deliverable D10(T30) - Draft GEO-BENE Synthesis Report

The benefit of systems dynamics modelling is that it recognises the complex interdependencies between the earth's various social, economic and environmental subsystems. Under this approach, a series of interrelated systems models are connect via a series of feedback loops such that changes in one model or subsystem has consequences for other subsystems.

The FeliX model represents these relationships at a global level, with subsystems models representing various relationships for and between production and consumption variables including, land, energy, the development of technology, the economy, population and the carbon cycle, etc. A high level representation of the sub-models and interrelationships in the FeliX model is shown in the figure above. Under this approach, each of the GEOSS SBAs have been embedded into the model's subsystems. Stocks (e.g. population, knowledge) and flows (e.g. birth and death rates, learning and forgetting, etc.) are modelled through causal relationships and crucial feedback loops to establish linkages between each of the key sectors of a global socio-economic and environmental system.[85]

The model represents these causal relationships and linkages at a global level and the model has been calibrated using 100 years of statistical data. This data reveals that there are relatively stable long-term relationships between the key variables that have been included in the model. The model can then forecast changes in production and consumptions under a base scenario (i.e. with no change to GEOSS capability) and a set of scenarios that assume various enhancements to GEOSS that support an improved output in the model's subsystems[86].

85 Each sector is represented using a model module that is based on widely accepted modelling structures. For example, the economy model is based on neo-classical growth theory that separately considers capital accumulation and labour, and includes factors to capture their levels of productivity. As another example, world population is modelled as an ageing chain. Linkages between the models are provided via feedback mechanisms. For example, climate change and its impacts are represented in the economy model, etc.

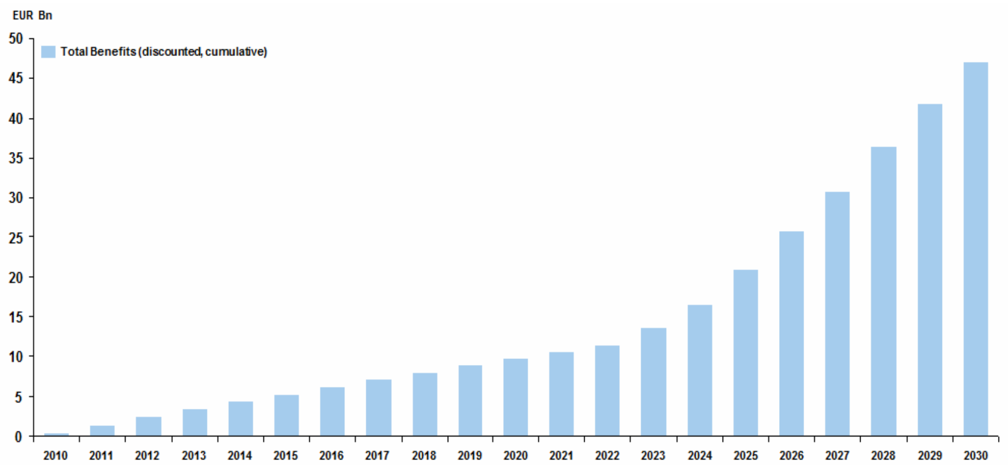
86 A FeliX model simulator is publicly available on the GEO-BENE website, see www.geo-bene.eu

ANNEX IX: Comparison of the PwC 2006 study and Booz & Co's 2011 study

Previous effort to quantify the benefits of GMES was performed by PwC in 2006. The results are summarized in the figure below:

Figure 9:

PWC Study - GMES Total Benefits, € billion, 2010 Prices, Cumulative, Discounted



Source: Booz & Company analysis. 2011

All values have been adjusted to 2010 prices and discounted to 2010 by Booz & Company to enable the comparison with the results of the latest CBA study.

The PwC study generates substantial benefits for the time period up to year 2030 (€ 46.800 Mio).

The recent Booz & Company study projects € 32.700 Mio of total benefits in Option C scenario (30% reduction compared to the PwC assessment) and € 36.700 Mio in Option D (22% reduction compared to the PwC assessment), both for the 2014-2030 time period.

Booz & Company projects reduced total benefits from the GMES programme, as illustrated in the figure below. PwC's study result are impacted by the assumption GMES programmes will be developed enough and operational from 2011, thus will start to cumulate benefits.

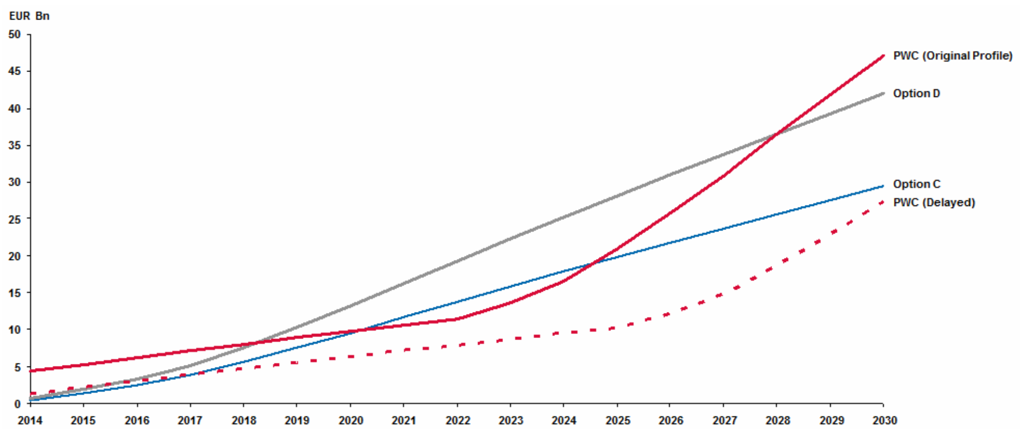
More appropriate method to compare the benefits assessed in the two studies is by delaying PwC's benefit projection quantified by three years (see "PwC delayed" curve). Making the assumption that benefits come into effect from 2014 and not from 2011 significantly impacts the final results. PwC's "delayed" benefit projection by 2030 equals € 27.500 Mio and is therefore lower than both Option C and Option D projections in the Booz & Company study.

This confirms the high socio-economic value of the GMES programme.

Figure 10:

Cumulative Total Benefits Options C, D, PWC, and the delayed PWC Profile,

€ billion, 2010 Prices, Discounted



Source: Booz & Company analysis, 2011.

ANNEX X: GMES programme - overview of programme evolution and funding until 2013

Situation until 2013

GMES/Copernicus is currently financed at European, intergovernmental and national levels, based on partnerships among the different players. The EU does not finance the totality of the cost of the development and operations of all the space based and the *in situ* installations providing data for the GMES/Copernicus services. GMES/Copernicus is set up in partnership with the Member States[87]. The EU will rather concentrate on domains where an EU-intervention will provide a clear added value.

The EU will both coordinate these partnerships and manage its own contribution to GMES/Copernicus, which consists of development activities and an operational phase.

Regarding development activities, this contribution currently consists, in particular, of the co-financing of research activities under FP6 and FP7:

- a co-financing of space infrastructure developments[88] that are carried by the European Space Agency (ESA) in order to fill gaps in existing space infrastructure;
- *in situ* research;
- funding of pre-operational demonstrator services.

Within FP6, the EU has spent € 100 Mio on GMES/Copernicus projects, whereas ESA has invested another € 100 Mio in the GMES/Copernicus Service Elements projects. In the space theme of the specific programme "cooperation" of FP7, the EU will make available approximately € 430 Mio for GMES/Copernicus service projects and procurement of data for these Services between 2007 and 2013. Additionally, € 624 Mio from the space theme of FP7 have been and will be used to contribute to the development of the ESA Space component programme, which amounts to € 2.246 Mio in total (including funds contributed by ESA Member States).

First operational activities, in particular in the field of emergency management and land monitoring, are financed under the GMES/Copernicus programme and its initial operations in addition to some other operational elements in the land domain (Corine Land Cover, Urban Atlas). Funds allocated to initial operations are € 107 Mio. Other services such like marine, atmosphere, security and climate change are financed through FP7. All of these services are close to operational status.

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87 Existing space missions that will provide data for GMES include Spot, TerraSAR-X, EUMETSAT satellites, CosmoSkymed, DMC Deimos, Ikonos, GeoEye, Quickbird, and ENVISAT.

88 ESA is currently developing 5 "Sentinel" missions under its GMES Space Component Programme.

Europe and the Member States have invested significant resources in the development of GMES/Copernicus space infrastructure and pre-operational services in order to ensure an uninterrupted provision of accurate and reliable data and information on environmental issues, climate change and security matters to decision makers in the EU and its Member States. This information is needed by public authorities in the Member States and regions who are in charge of the policy conception and implementation. The Commission also needs this information for evidence based policy making and monitoring. As a total, the EU has spent/earmarked about € 3.200 Mio for development and initial operations of GMES/Copernicus. But GMES/Copernicus also makes use of infrastructure (satellites, in-situ networks, ICT capacities, etc…) existing and financed at National level worth several billion euros and of international mechanisms of cooperation.

Continuous and significant financing efforts have been made by GMES stakeholders, namely the EU (through Framework Programmes for Research and Development, Preparatory Actions), ESA Member States (GMES Space Component Programme, Earth Watch and GMES Service Elements, Earth Observation Envelope Programme), together with direct contributions from Member States and European organisations, for the development of services, the access to space and in situ data, and for the construction of a dedicated observation infrastructure.

With the entry into force of the European Earth monitoring programme (GMES) and its initial operations (2011-2013) on 9 November 2010, GMES is now entering into a new phase with a dedicated operational budget.

This document provides an overview of the overall funding of GMES since the early stage of the initiative (1998 Baveno Manifesto) until the end of 2013.

Mobilising funding resources

1st phase: 2000-2006: designing the concept of GMES

Different financial instruments have been mobilised depending on the nature of the activities to be funded for GMES.

On the EC side, preliminary thematic projects and networks have been supported by the 5th Framework Programme for Research, Technological Development and Demonstration. The first concrete steps started with the development of the pre-operational GMES fast track services (2004-2006) using available funds from EC/FP6 Space & GMES Theme (€ 100 Mio).The first ESA activities in support to GMES were adopted at the ESA Ministerial

Council in November 2001 (e.g. Earth Watch proposal and GMES Service Element). The ESA contribution through the GMES Service Elements amounts to € 130 Mio. Additional studies were launched by ESA for the GMES space component (€ 30 Mio)

2nd phase: 2007-2013: from concept to reality

The EU contribution for this period comes from four sources:

– FP7: Under the Seventh Framework Programme for Research (FP7), 2007 – 2013 the European Commission has made € 1.400 Mio available in support of space related activities, out of which about 85% was made available for GMES, with a split between services and the space component (€ 365 Mio and € 624 Mio at current economic conditions for the services and for the space component respectively, and € 9 Mio for the in situ component);
– GIO: The GMES Regulation on the Initial Operations provides an operational budget of € 107 Mio;
– Preparatory Actions: some € 10 Mio have been made available for funding operational activities in view of the implementation of the GMES Regulation;
– DG REGIO: additional funding was made available by DG REGIO for supporting the development of the Urban Atlas.

Details of the FP7 and GIO appropriations are presented in table 1.

ESA contribution

On its side, ESA received contributions from its Member States for the following activities:

– € 1,621 Mio (2008 e.c.) for the GMES Space Component (for both segments 1 and 2);
– € 32 Mio for further developing some GMES Service Element projects;
– And € 75 Mio for the Climate Change Initiative.

Space Component

The space component includes:

– The construction, launches and operations of Sentinel satellites or instruments developed specifically for GMES;
– The GMES Space Component Data Access (GSCDA) which is composed of an access infrastructure and a data buy mechanism enabling the access to GMES Contributing Missions (GCM) developed and operated outside GMES.

The total development cost of the GMES Space Component is € 2,300 Mio (2008 e.c.) of which ESA Member States provide 72% and the EC 28%.

According to the GSC Programme Declaration adopted at the CMIN'08 Segment 1 and Segment 2 have been merged into a unique set of activities.

Other contributions

Other contributions should be taken into consideration for consolidating the overall past funding of GMES, namely:

– Member States with their in kind contribution of in situ data which can be estimated at more than € 300 Mio/year, and their respective national space programmes which leverage the access to the GMES contributing missions;
– FP consortia who participated to GMES projects with a share of approximately half of the EC contribution, thus in the order of € 230 Mio for the whole period until 2013;
– Intergovernmental agencies such as EUMETSAT and ECMWF who provide access to some of their infrastructure, skills and data at no cost for GMES (e.g. computing facilities at ECMWF, meteorological data…);
– Other Commission services (DG ECHO, DG ENV, DG JRC…) who provided additional funding to GMES related activities (e.g. CORINE Land Cover, EFAS, …).

Global overview

– As a whole, the overall funding made available until 2013 by the EU and ESA has reached over € 3.000 Mio (table 2):
– For the *in situ* and service components: the EC provided funding above € 520 Mio, completed by € 240 Mio from ESA;
– For the space component, ESA made some € 1,650 Mio available and the EC € 780 Mio (FP7 and GIO funding).

Access to space data has been supported by dedicated FP7 budgets with € 48 Mio through a FP7 grant, completed by € 53 Mio as part of the EC/ESA Delegation Agreement, and additional € 43 Mio from FP7 as a complement to the GIO budget.

A summary is given in the following table:

M€ (2000-2013)	ESA	EU	others
Sentinels	1,651	632	
Data Access			
Access infrastructure	-	40	
Data buy	-	104	
Services			
Core Services	-	262	~116 (FP7 consortia)

other FP7	-	256	~120 (FP7 consortia)
GSE+CCI	237	-	-
In-situ	9		
Total	**1,888***	**1,303***	

(*): figures are not fully comparable since ESA figures are based on 2008 e.c. and EC figures on c.e.c. Readjusting the table to 2008 e.c. would reduce the EC contribution with a factor related to the inflation rate.

INDICATIVE OVERVIEW - Global Monitoring for Environment and Security (GMES) - Appropriations available under the 7th Framework Programme for Research and the European Earth observation programme and its initial operations (2011 - 2013)

	2007-2010		2011 - 2013									TOTAL 2007 - 2013	
			2011		2012		2013		total 2011-2013				
	FP7 - 7th framework programme for research	preparatory action (2008 - 2010)	FP7 - 7th framework programme for research	GMES initial operations programme	FP7 - 7th framework programme for research	GMES initial operations programme	FP7 - 7th framework programme for research	GMES initial operations programme	FP7 - 7th framework programme for research	GMES initial operations programme	grand total	Total	of which from FP7
SERVICE COMPONENT													
Land (incl. Climate-related activities)	22	3		2,7		10,0		13,3		26			
Emergency	27	3		2,7	8	4,3		5,0		12			
Marine (incl. Climate-related activities)	34	4	28										
Atmosphere (incl. Climate-related activities)	12		19										
Climate	9				6								
Security	19		1		14								
Downstream, service development, market uptake, international cooperation	69		8		10	2,0		3,0		5			
GMES & Africa	5		1										
S/TOTAL SERVICE COMPONENT	197	10	57	5,4	38	16,3	73	21,3	168	43	211	418	365
DATA ACCESS FP7 GRANT	48											48	48
IN SITU COMPONENT	3				6				6			9	9
SPACE COMPONENT INCLUDING DATA ACCESS	165		120	3,6	159	23,7	180	33,7	459	61	520	685	624
Maximum planned amount	413	10	177	9,0	203	40,0	253	55,0	633	104	737	1160	1046
Additional appropriations in FP7 as referred to in the proposed GMES Regulation			10		15		18		43		43	43	43
Administrative Expenditures - Support to policy measures				1,0		1,0		1,0		3	3	3	
TOTAL AVAILABILITY	413	10	187	10	218	41	271	56	676	107	783	1206	1089

Table 1: overview of the funding made available under FP7 and GIO for the period 2007-2013