Publishable Executive Summary

- Final-

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

Assessing the Economic Value of Copernicus:

"European Earth Observation and Copernicus Downstream Services Market Study"

CONTENTS

1 INTRODUCTION

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[1] downstream services for the Non-Life Insurance sector.

2 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).

3 KEY ASSUMPTIONS AND ENABLING FACTORS

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

1. **Catalytic effect of free and open data provision[2]:** 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.
2. **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

[1] 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).

[2] 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.

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:

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

b. **Data Availability and Access:** Simplified access to Copernicus Sentinel datasets at ready-to-use processing levels (L1)[3] for high-volume distribution, thereby responding to the needs of the value-adding industry, ideally avoiding the duplication of efforts at national level.

c. **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*"[4].

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

[4] COM (2011) 808, final, p. 10.

4 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.

4.1 Market Overview

The European EO downstream market is currently estimated at € 0,7 Bn, against € 0,2 Bn for the midstream and € 0,6 Bn for the upstream. According to a study published by Euroconsult, the EO downstream market will, in 2015, reach approximately € 1 Bn in Europe (and over € 2 Bn globally), growing at a Compound Annual Growth Rate (CAGR)[5] of 7%.

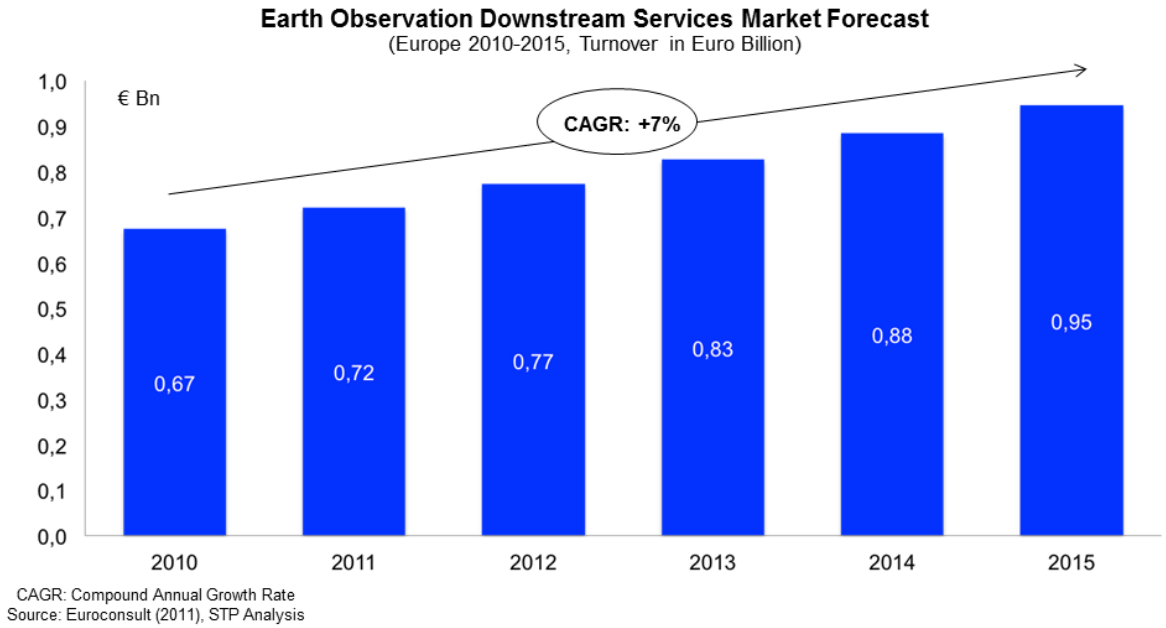


Figure 1: Earth Observation Downstream Services Market Forecast

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

4.2 Sector Analysis

The present study used Eurostat's NACE[6] 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:

1. Agriculture

A cost-benefit analysis[7] 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.

2. 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.

3. Oil and gas

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.

4. 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.

[6] 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.

[7] Knight et al., 2009.

5. 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 1: 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.

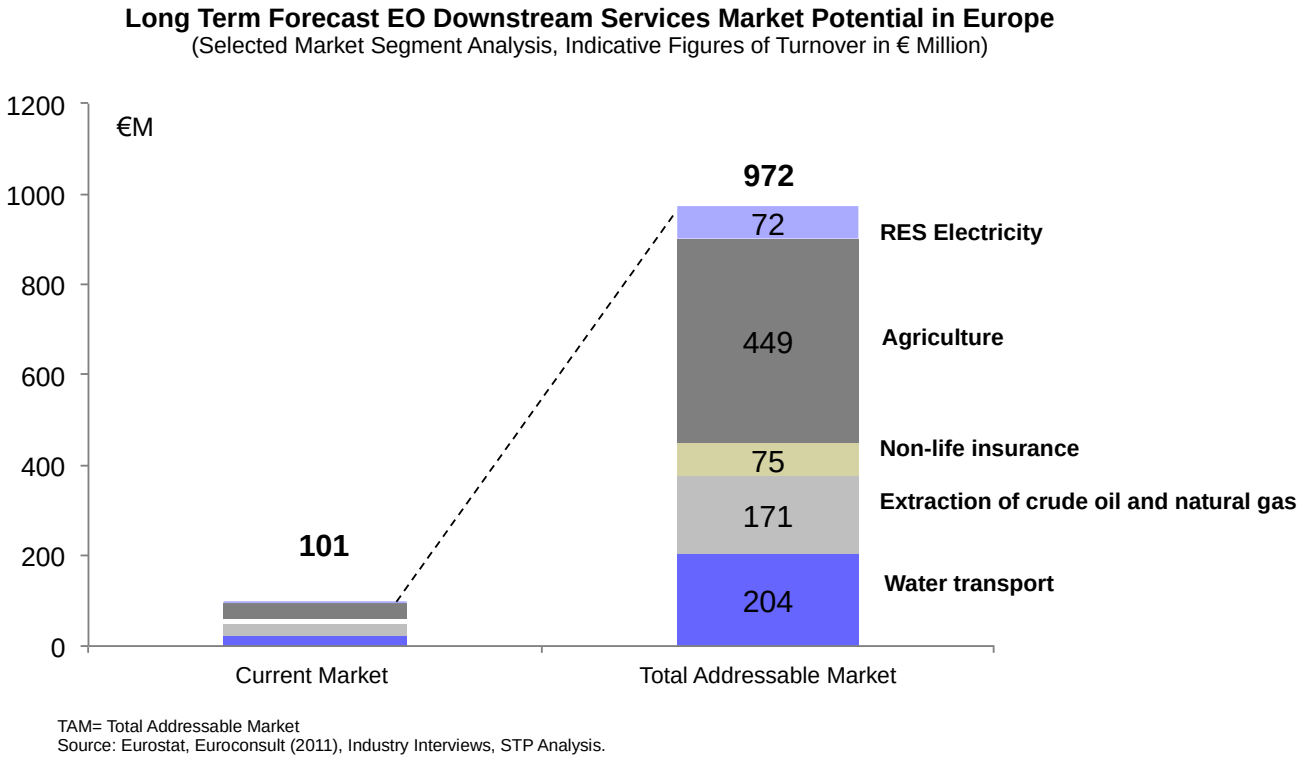


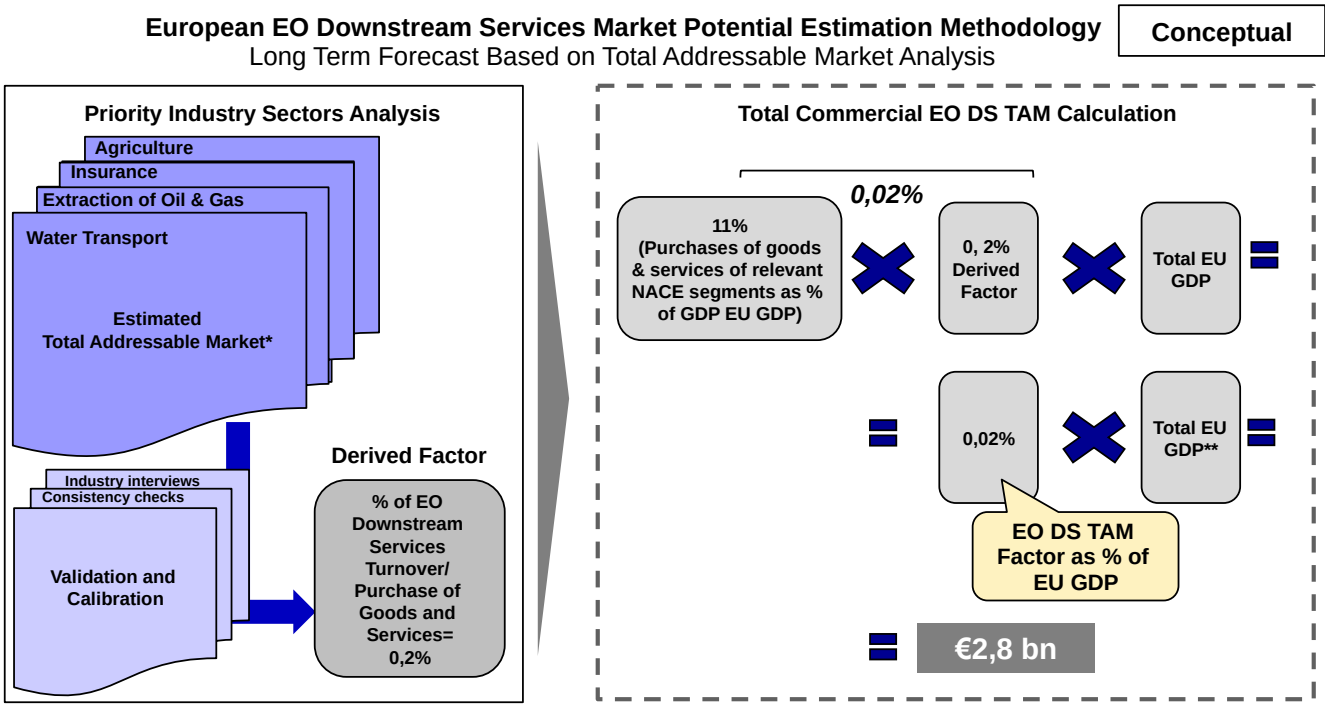
Figure 2: Long Term Forecast EO Downstream Services Market Potential for the 5 Pilot Segments

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.

4.3 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 3: 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.

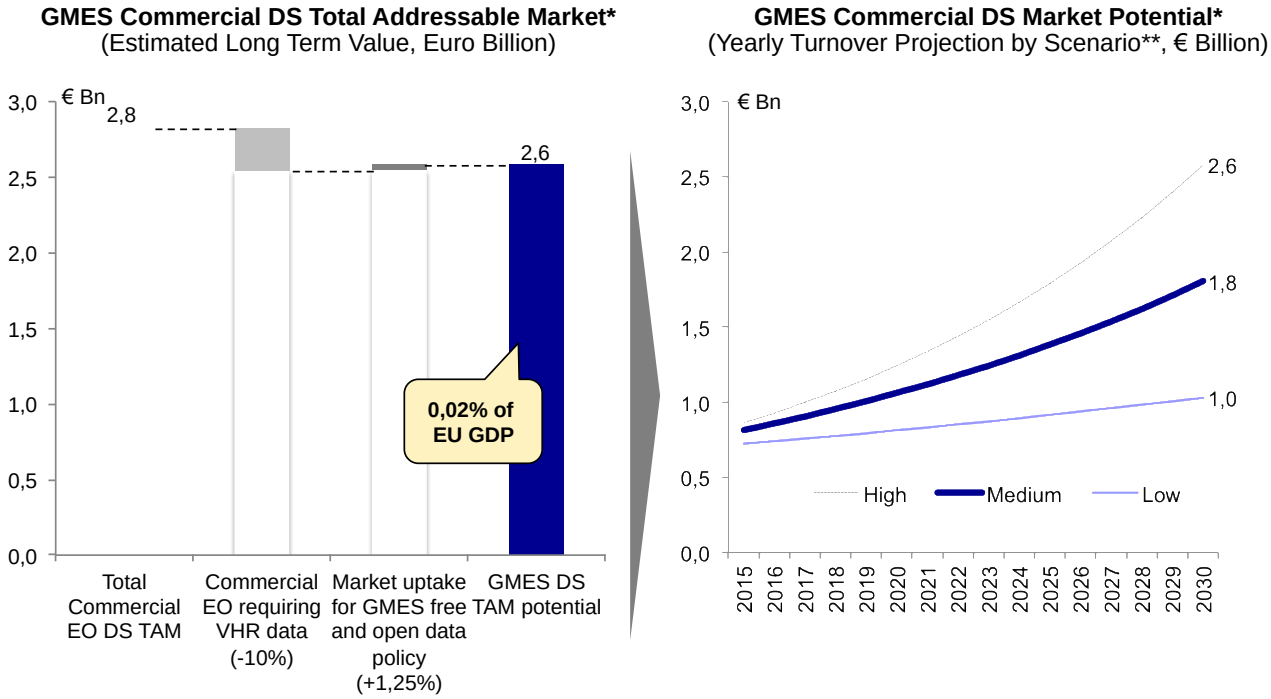
Copernicus may to some extent impact the (less valuable) EO data market for non-VHR (5% of total EO data sales market value) served by commercial data providers. This may urge some providers to focus more on the VHR data market or expand their capabilities towards value-adding activities. Those operators 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 2: COPERNICUS Downstream Market Development Scenarios

This leads to a Copernicus downstream potential turnover ranging between € 1,0 Bn, € 1,8 Bn and € 2,6 Bn by 2030, as illustrated in the figure below.



(*): Assuming GMES full data continuity funding scenario;; (**): High= 100% of market potential fulfillment, Medium= 75% and Low 40%
Sources: Euroconsult, Eurostat, STP Analysis

Figure 4: 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.

4.4 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.

4.4.1 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[8].

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.

[8] See http://ec.europa.eu/research/horizon2020/pdf/press/fact_sheet_on_sme_measures_in_horizon_2020.pdf.

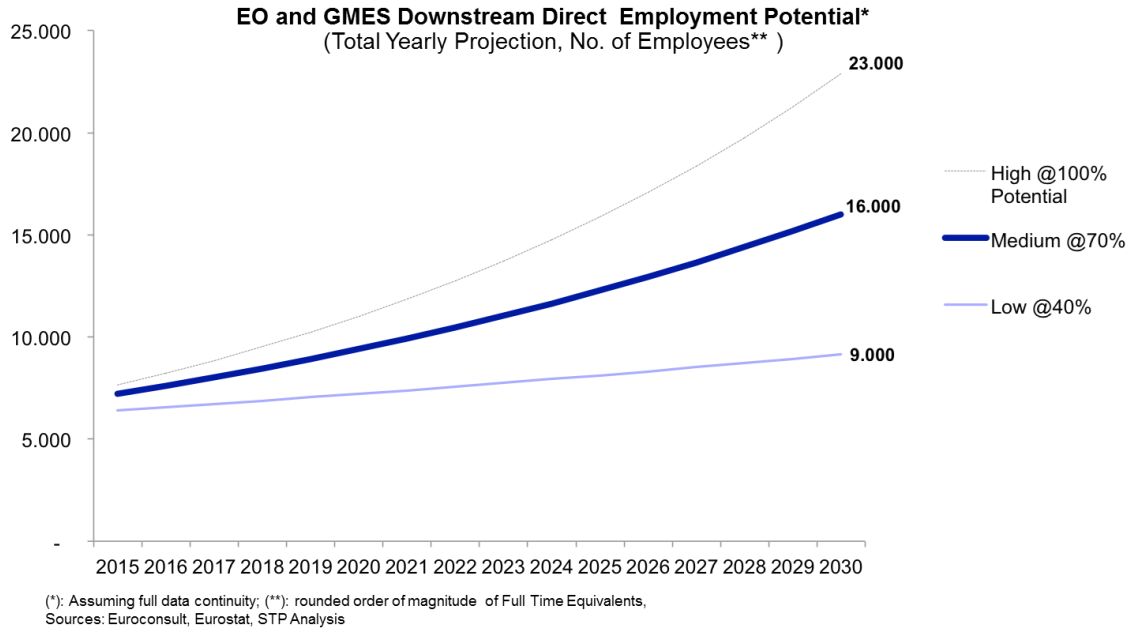


Figure 5: EO and Copernicus Downstream Services Direct Employment Potential

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.

4.4.2 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 and D outlined in the Booz & Co. Cost-Benefit Analysis[9]. The high scenario implies a funding level of approximately € 900 million annually, with approximately € 800 million for the medium scenario and € 700 million 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.**

[9] 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.

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

4.4.3 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**
	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

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**.

[10] 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*."[11] 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

[11] 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."

5 CONCLUSIONS

1. **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.

2. **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)[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.

3. **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 € 2,8 billion, of which € 2,6 billion 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 € 1,8 billion in downstream services turnover attributable to Copernicus by 2030,** assuming the “most likely” medium scenario of 70% market potential fulfilment**.**

[12] L1 included geometric and radiometric pre-processing

4. **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'[13] Space industry multipliers, provided by the European Commission) suggests that 63.000 indirect jobs could be maintained and created, yielding an overall employment impact of approximately 83.000 jobs in Europe by 2030.

5. **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.

[13] Oxford Economics (2009).

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