Key trends in the European Earth observation sector

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Earth observation (EO) might well be the most complex of the three major space applications. It is used for civilian and military activities, it involves public and private actors, and it is at the crossroads of scientific and commercial endeavours. As a matter of fact, the EO sector is currently experiencing a boom. It is expected that 250 EO satellites will be launched between 2009 and 2018, compared to 128 during the previous decade[i]. This is explained by the variety of applications derived from EO and by the attractiveness of EO satellites for new entrants, especially among emerging spacefaring nations[ii].

There are four major categories of EO data users: defence, science and R&D institutes, civil governments and private users. This paper will focus mostly on the three latter, although defence users will be included in the analysis on the growing commercialisation of the EO sector. However, dedicated military surveillance satellites will be left out from the analysis, as the problems and challenges attached to it are quite different from those of commercial or scientific projects. Military EO constellations in Europe are linked to sensitive issues such as cooperation in the defence area, sovereignty transfers and the emergence of a European identity in defence and security policy[iii]. However, defence considerations will not be completely ignored in the analysis, as the growing trend towards dual-use[iv] should be accounted for.

The two most significant global trends in EO in the recent years have been an increasing focus on climate change issues, and the growing commercialisation of the EO sector. Several space agencies, most prominently ESA, NASA and JAXA, recently launched dedicated missions to study the effects of climate change[v]. At the same time, the global EO data market has grown by a CAGR (Compound Annual Growth Rate) of 25% in the last five years, reaching $1.3 billion in 2010, and is expected to represent $4 billion by 2020[vi].

Developments in Europe are in line with these two global trends, although with certain specificities. As a whole, Europe's policy in the field of EO supports two broader EU policy priorities identified at the 5th Space Council[vii]: space for climate change and space as a contribution to the Europe 2020 strategy[viii]. This reflects the fact that EO is at the intersection of science and the market. However, the current uncertainties over the future of GMES (Global Monitoring for Environment and Security), which is to become the cornerstone of Europe's EO architecture, could compromise both the scientific and commercial benefits reaped from EO applications.

An ambitious EO policy could bring significant benefits to Europe both regarding the fight against climate change and the competitiveness of its EO industry and service sectors.

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This paper will first shed light on the contribution of EO missions to the climate change debate in the European context (1). It will then focus on recent developments in European data policy, as these have consequences both for the scientific community and for the commercial market (2). Finally, the characteristics and challenges of the commercial EO sector in Europe will be analysed, insisting on the central role played by public actors (3).

EO in support of climate change policies

As it is the case everywhere else in the world, governmental EO satellites in Europe are used in support of a broad range of public policies (agriculture, transportation, energy, disaster management etc…). In addition to that however, climate change gradually became a top priority on Europe's political agenda in the last two decades. In the course of this process, EO was recognised as a crucial tool to conduct evidence-based policies in this field, and ESA adopted a more comprehensive perspective on EO. ESA's Earth Explorers missions and the EU's GMES programme are meant to implement Europe's EO policies.

Europe as a leader in the fight against climate change

The issue of climate change has gradually moved to the top of political agendas worldwide. The United Nations Climate Change Conference (UNCCC), which took place in Copenhagen in 2009, was to be a major milestone in the global fight against climate change. Despite some partial successes however, the Copenhagen Summit fell short its aspirations[ix]. A coordinated global response on climate change is made difficult by the structural opposition between developed and emerging economies, and by the lack of consensus within the U.S. on climate change policies.

In this challenging political context, Europe has always remained a strong supporter of the fight against climate change. In December 2008, the EU adopted the so-called "Climate Energy Package", setting very ambitious objectives to be met by 2020, in order to transform Europe into a low-carbon economy. The EU committed itself to reduce its overall greenhouse gas emissions to at least 20% below its 1990 levels, to increase its share of renewable energy by 20% and to reach a 20% cut in overall energy use[x].

The combination of these two factors opens a political window of opportunity for Europe. It could strengthen its leadership in climate change policies on the international scene. Space tools would constitute valuable assets in this perspective, as they enable evidence-based policy making.

Space as a tool for climate change policies

Due to their characteristics (full coverage of the Earth's surface, frequent revisit time, data continuity over time), EO satellites constitute ideal platforms to study climate change. They provide the necessary environmental data to feed the scientific models which are crucial to better understand the effects of climate change. They also help mitigating and managing the consequences of climate change. Concretely, environmental satellites can monitor the atmospheric accumulations of greenhouse gases, global deforestation trends or the evolution of glaciers[xi].

The importance of EO to support climate change policies was recognised by the international space community. In 2006, the Committee on Earth Observation Satellites (CEOS) responded to the data needs expressed by the Global Climate Observing System (GCOS). This was a tangible manifestation that space-based sensors are a major contribution in the fight against climate change[xii].

European developments are in line with these global trends. ESA's *Living Planet Programme* launched in the mid-1990s adopted a comprehensive approach towards satellite observations for Earth sciences. A new paradigm emerged, considering the Earth as a coupled set of dynamical systems. Concretely, the scientific discipline known as "Earth System Science" is studying the dynamic processes in the atmosphere, the solid Earth, the hydrosphere, the cryosphere, the biosphere and the anthroposphere. The two ultimate rationales for studying and understanding climate change are sustainability and biodiversity[xiii].

An impressive fleet of EO satellites

In line with the policy objectives set by ESA's Living Planet Programme, there has been a paradigm shift in the type of mission launched[xiv]. Large and expensive multipurpose missions such as the European Remote Sensing (ERS) satellites 1 and 2 or Envisat have been replaced by smaller, less-expensive and single-purpose missions. ESA's so-called Earth Explorers are the new cornerstone of ESA's Living Planet Programme: each satellite is focusing on one specific mission, but taken together they increase our knowledge of the interaction between these components and on the impact of human activity on the Earth System[xv].

Among the approved missions, GOCE and SMOS (both launched in 2009) study the Earth's magnetic field and the hydrosphere respectively, ADM Aeolus (to be launched in 2013) will focus on the atmosphere, CryoSat-2 (launched in 2010) studies the cryosphere, Swarm (due for launch in 2012) will concentrate on the Earth's interior and EarthCARE (to be launched in 2015) will foster our understanding of the Earth's radiative balance[xvi]. Besides these dedicated missions, a transversal "Climate change service" should also be set up as part of the GMES architecture.

In addition to its own satellites, ESA is also acquiring, processing and distributing data from other EO satellites, the so-called "Third Party Missions". Some of these are governmental missions, some others are managed by private operators and some are Public-Private Partnerships (PPPs). The data distribution is governed by specific agreements with each operator[xvii]. This shows that EO is at the crossroads of science and the market, but it also highlights the crucial importance of data policy.

EO data policy in Europe: bringing together science and the market

The major challenge for EO data policy in Europe is to satisfy the scientific community while fostering the development of a commercial market for added-value services. As a consequence, ESA's data policy recently evolved towards a "free and open" policy.

Major principles of data policy

Data policy refers to all the decisions linked to data access, data protection, data distribution, pricing policies and data archiving[xviii]. These elements are generally established for an entire class of missions but can also be specifically tailored for single missions[xix]. Data policies – in particular pricing policies – can be analysed from three points of view: for science purposes, for commercial uses and regarding security and privacy-related restrictions.

For space science missions, the free availability of data (or the availability at cost of reproduction) is justified by the fact that the science output is the main criterion of a mission's success. This scientific return can only be maximised if the data is distributed in the widest possible way to the scientific community[xx].

In the field of commercial EO, things are more complex, as commercial endeavours are geared towards the vast field of applications. Their purpose is to provide (commercial) services to direct users, for which it is essential to transform the raw data collected by satellite sensors into ready-to-use products[xxi]. The rationale for the free availability of data is to foster the development of a value adding industry by providing the raw data for free[xxii].

Finally, the availability of data can be restricted for security or privacy considerations. First, EO data is a strategic asset, as high-resolution radar or optical images are military relevant.[xxiii] As a consequence, restrictions can be imposed on data distribution for a certain period of time, over certain areas, or for images above a certain resolution. However, security concerns are usually not relevant for data stemming from ESA missions, as their relatively low resolutions (under 10m) make them irrelevant for defence users. In addition, personal privacy rights can potentially be infringed by high-resolution satellite data. This problem is more likely to appear in the case of operational programmes such as GMES, and doesn't concern science satellites[xxiv].

Taking into account the three above-mentioned perspectives, ESA recently reformed of its data policy.

A shift towards open data policies

The two pillars of ESA's data policies are stated in the ESA Convention. The scientific results of space missions should be disseminated in the widest possible way (Article III), and ESA's industrial policy goal is to improve the world-wide competitiveness of European industry (Article VII)[xxv], including the value-adding industry.

Before the 2010 revision, the data policies of ESA's scientific missions were derived from the concepts developed for the Envisat mission. A distinction was made between the data destined to be used by the scientific community (Category 1 data) and the data for all other uses, including commercial uses (Category 2 data). Category 1 data was provided at reproduction cost, or free of charge for scientific projects approved by ESA's Earth Observation Programme Board. The distribution of Category 2 data was delegated to distributing entities, which were paying ESA to get the data[xxvi].

However, this policy had mixed results: while Category 1 data was widely disseminated, contributing to many successful research projects, the distribution of Category 2 data did not lead to the expected broadening of the market and user base. Only a few private firms have taken advantage of this scheme, despite the low cost at which ESA was providing the data. To tackle this issue, ESA adapted its GMES Sentinel data policy and initiated a revision of its ERS, Envisat and Earth Explorers data policies[xxvii].

Discussions between ESA and the European Commission (EC) on the Sentinel data policy are still ongoing, but some key principles have already been laid down. The access to Sentinel data will be free and open, with restrictions linked to national laws or security considerations[xxviii]. The same principle of open and free access was adopted for other ESA data policies. The only restriction concerns "limited datasets", including Synthetic Aperture Radar (SAR) data from the ERS and Envisat missions: due to financial and technical constraints, user demands had to be prioritised[xxix].

These evolutions are in line with trends in governmental EO missions at the international level, as testified by the free and open data policy adopted by the Landsat mission or by the Brazilian-Chinese CBERS constellation for example[xxx]. They are also complying with the EU INSPIRE[xxxi] directive from 2007, whose goal was to foster the open and free sharing of spatial information among European public sector institutions[xxxii]. Besides these trends in governmental EO missions, data policy is also relevant given the growing commercialisation of the EO sector at the global level in general, and in Europe in particular.

The growing commercialisation of the EO sector in Europe

Despite a clear trend towards the privatisation of EO activities in Europe, public institutions remain key actors as data providers, data customers and by establishing the adequate framework conditions for commercial activities.

A trend towards privatisation

Europe constitutes the second largest market for EO data after North America[xxxiii]. A number of specific trends show a shift towards more private-oriented schemes in Europe. Indeed, there is a growing tendency towards dual-use systems, whose data is used both for defence and for commercial purposes. Private operators are (or will be) commercialising imagery from these dual-use satellites: e-GEOS for the Italian Cosmo-Skymed constellation, Astrium Geo-Information Services for the future French Pléiades satellites and HISDESAT for the future Spanish SEOSAR spacecraft[xxxiv].

Such PPPs are not only used for dual-use systems, but also for civilian-only systems. The two German civilian radar satellites TerraSAR-X and TanDEM-X were both co-financed by the German space agency (DLR) and by a private actor (Astrium Geo-Information Services). As a result, Astrium Geo-Information Services has exclusive rights to commercialise the radar data[xxxv]. In the field of optical EO, privatisation even went a step further, as the French government announced that it would not participate in the financing of the next-generation Spot satellites. As a consequence, Astrium Services is spending €500 million to build and launch Spot 6 and Spot 7[xxxvi].

The growing commercialisation of the EO sector at the global level also means that European EO actors have to face an increasing competition. The generalisation of free and open data policies could endanger the business model of some private data providers, especially those relying on medium resolution instruments (such as Deimos, RapidEye or DMC)[xxxvii]. To counter this threat, there is a trend towards better spatial resolutions (Spot 6 and 7 will have a resolution of 1,5m, TerraSAR-X of 1m and Pléiades of 0,5m). Indeed, the medium resolution segment of the commercial market is usually composed of governmental satellites providing their data for free, while the high resolution segment is purely commercial[xxxviii]. Another response to the increasingly competitive environment has been a wave of concentration in the European EO sector, with manufacturers moving down the value chain (EADS Astrium Services integrated SPOT Image into its Geo-Information Services division, and Thales is present on the data and service market through Telespazio)[xxxix]. However, the evolving international environment is also bearing new opportunities for European satellite manufacturers and EO service providers: there is a growing demand for both EO satellites and EO products, especially coming from new governmental entrants, and European companies are actively seeking these new markets.

The central role of public actors

Despite an increasingly commercial environment, public actors continue to play a key role in the EO sector. Besides providing data through governmental satellites and setting the regulatory framework for commercial EO activities[xl], public actors (mainly from the defence sector) are driving the market growth as data customers.

The size and health of the EO sector is strongly dependent on institutional demand, in particular on defence and security spending[xli]. In this respect, a striking difference between Europe and the U.S. is the absence of long-term service contracts between governments and commercial data provider in Europe. The so-called EnhancedView contracts recently signed between the

National Geospatial-Intelligence Agency (NGA) and the U.S. firms DigitalGlobe and GeoEye have no equivalent in Europe. The contracts recently signed between ESA and RapidEye[xlii], or between the EU and Astrium Services as part of GMES[xliii] could be seen as a first step in this direction. These are however much more modest in scope than the 10-year multibillion EnhancedView contracts.

Government support is also crucial given the uncertainties over the commercial data market. Many potential EO data customers are not aware of the benefits of EO products for their business. Apart from the energy sector, very few private actors buy EO data and products. The recent bankruptcy of the German EO company RapidEye is a reminder of the fragility of the commercial EO market. In addition, other market segments, such as radar data, do not seem to be ripe for a full privatisation. As a matter of fact, Germany was expecting its next radar satellite to be fully financed by the industry, but revised its position given the weak prospects for a radar imagery commercial market[xliv]. Finally, in the context of the crisis, governments are reducing their spending and thus their demand for EO data and products[xlv].

All these elements show that the commercial market for EO data and products remains fragile in Europe, and that a strong backing by public authorities will probably be needed for some more time. A potential option would be to implement long-term service contracts between public institutions (such as the EU) and private EO services companies. GMES could be the adequate framework for such endeavours, but this in turn calls for a clear and long-term financial commitment to the programme.

Conclusion

Earth observation is both a source of opportunities and challenges for Europe. From a public perspective, an ambitious EO policy could bring significant benefits to Europe in the fight against climate change. From a private perspective, European players have the clear potential to play a central role on the commercial EO market. In addition, the growth of the commercial EO sector offers a unique opportunity to strengthen the European industrial basis by fostering a value adding industry. To reach these objectives however, data continuity is a key condition, which can only be ensured by a strong public commitment. The current turmoil around the GMES programme linked to its uncertain future is in contradiction with this objective. The best signal that the EU could give to the EO community, not only in Europe but worldwide, would be to reintegrate GMES into the next Multiannual Financial Framework (MFF).

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