EOEP-5, Block-4: EO Science for Society

EO Applications Platforms element: Enabling Industry Growth

The Enabling Industry Growth element is organized along three main lines as follows:

- Expand Demand
- New Opportunities & Actors
- Consolidate best practices

Each of these lines involves working with specific user communities.

For the Expand Demand component, activities will be carried out for user sectors where requirements are well-known through previous work, but that offer significant potential to grow the use of EO enabled by taking advantage of enhanced ICT capabilities (i.e. the Applications Platforms concept). Candidate sectors are identified as: Oil & Gas, Law Enforcement Port Operations and e-Maritime, Renewable Energy, Corporate Reporting and Analysis Processes and Corporate Sustainable Development.

For the New Opportunities & Actors component, activities will focus stimulating radical innovation through exploring disruptive ideas, and via the involvement of new players (entrepreneurs, start-ups) from new (non-EO) disciplines (i.e. social media).

For the Consolidate best-practices component, activities will be carried out for user sectors where initial use of EO has been made, but a comprehensive understanding of the EO potential needs to be established, and where there are industrial champions ready to enlarge the use of EO within the sector through trade associations/organizations. Candidate sectors are identified as: Agro-Chemicals, Agro-Insurance, Geo-Hazard Risk, Mining, Polar Tourism and rail Transportation.

A first (draft) analysis of the relevant issues regarding these user sectors now follows.

Expand Demand: User Sectors

These candidate user sectors have been identified through the previous ESA activities, and are understood to have requirements for EO-based information that would be for large-scale and/or Near Real-Time (NRT) applications that would require the enhanced ICT capabilities being offered by the Applications Platforms concept (eg. easy & efficient access to multiple sources of EO data, massive computing facilities).

- Oil & Gas,
- Law Enforcement,
- Port Operations and e-Maritime
- Renewable Energy
- Corporate Reporting & Analysis Processes
- Corporate Sustainable Development.

For each of these sectors, preliminary information is given on: the background/context, the issues to be addressed, the types of actions proposed, and the potential impacts that can be achieved.

Oil and Gas

Context

The oil and gas sector is increasingly under pressure to implement and comply with Health Safety and Environmental (HSE) regulations (ISO, EU, National and CSD) throughout all phases of an oil and gas project. Recently a sharp decline in oil price is forcing the operators to investigate innovative and more cost effective solutions, looking into alternative technologies like EO instead of potentially more expensive in-situ surveillance. Another challenge is the fact that remaining untapped oil and gas resources often are located in challenging and remote locations making it more difficult to rely on in-situ information. All of these factors together with an increased emphasis on corporate big data solutions is supporting the case for the potential increased uptake of EO based capabilities.

Issues to be addressed

The proposed approach to address these challenges is to develop straightforward access to highly customized information products available at low cost, but maintaining confidentiality with respect to protecting commercial in confidence information. These information products must cover wide range of thematic domains (subsidence, change detection, pollution etc.) for multiple sites (at least covering key infrastructures and surrounding areas) with short revisit times and short information latency.

Actions to be executed

Implementation of customized portal and high performance data access, processing and analysis capability consistent with Oil and Gas working practices will be carried out to showcase EO capabilities, beyond what can be realized in a traditional project based approach. Solutions for implementation of secure access and protection of commercial in confidence information will be studied and discussed with the actors in the oil and gas sector. Development of customized information layers addressing spatial and temporal scales of relevance to Oil and Gas Operators customized for the different phases of an oil and gas project (pre-license, exploration, development, production and de-commissioning) will be done to showcase the wide variety of solutions EO can bring to the table.
An important aspect will also be to develop customized fusion capabilities (e.g. integration of seismic data, platform radars, video & IR sensors with information derived from satellite EO) and provide for possibilities of benchmarking EO based products and services.

Expected Outcomes and Impacts

The target for this development will be to implement standard interfaces and custom information products results for at least 3 large oil and gas operators regularly accessing EO derived information via customized portal, with the objective to get clear statements from representative oil and gas operators on value, impact and fitness for purpose of EO derived information by the end of the activity.

Law Enforcement

Context

Law enforcement agencies in Europe are making increased use of data mining and information fusion capabilities to detect and track illegal activities, investigate criminal actions already committed and manage situations where public order may be impacted. These are based on the collection and management of large volumes of diverse datasets including video and image data, transaction information, intelligence feeds and other data. To date this has not included information from EO satellites.

On-going and completed demonstration exercises in cooperation with law enforcement agencies have highlighted the potential value and impact from integrating satellite derived information into operational working practices and many have indicated strong interest in working with ESA to progressively expand operational use of EO. However, the scale of the monitoring and analysis required by this community represents a step change over the level of service demonstrated to date. In particular, this community requires persistence levels, response times and coverage far in excess of what can be provided during a limited budget demonstration activity and which, in order to be cost effective and sustainable, requires an evolution in terms of how data are acquired, processed, integrated and analyzed.

Issues to be addressed

Extended interactions with the law enforcement community has resulted in the following priorities:

1 reliable detection of targets, features, anomalies etc based on the fusion of multiple datasets for any geographic location over extended time periods with regularly updated information (in some cases daily or weekly)
2 straightforward integration and fusion of EO derived information with standard analysis and investigative processes in a manner that is consistent with working practices and legal requirements (eg evidence traceability)
3 flexible adaptation of analyses techniques to different monitoring and investigation scenarios

Actions to be executed

To address the issues highlighted, the following actions shall be implemented in the framework of a dedicated development contract:

1 Development and verification of customized feature/anomaly detection capabilities. These shall be based on the flexible integration of diverse datasets supporting both tactical monitoring and offline investigations, compilation of strategic intelligence and analysis of patterns of crime. These detection and analysis capabilities operate on extremely large volumes of data and run effectively and efficiently on scalable cloud based processing infrastructure. They shall include a customized orchestration element that ensures appropriate access to the relevant datasets, analysis software and processing resources
2 Analysis processes shall be developed that can integrate the various feature/anomaly detection capabilities to support the detection and analysis of chains of connected illegal

activity. These shall include orchestration that ensures the appropriate analysis packages, processing resources and data are effectively combined.

3 Dedicated routines shall be developed in support of the analysis packages that ensure effective combination of the various EO and non-EO datasets. This shall be supported by the development and deployment of ICT resources that ensure access to, and processing of, all relevant datasets using a Data-as-a-Service type interface.

Expected Outcomes and Impacts

The actions elaborated above will result in the development and verification of the following capabilities which will ensure that user requirements for persistence, response time, coverage, flexibility, reliability and traceability are all met:

1 feature and anomaly detection and identification capabilities based on EO data which generate outputs that are consistent with operational working practices, analysis processes and information formats and standards already in use by law enforcement agencies

2 a framework to easily and intuitively integrate various related analysis capabilities to investigate or monitor connected illegal activities with complete traceability on all analysis and data used

3 a flexible, responsive monitoring and analysis capability that meets operational requirements for large area coverage, extended persistence for priority areas of interest and fast response times

This will result in standard access protocols for the law enforcement community for relevant EO derived information products as well as the increased integration of these information products within operational analysis and investigation processes with a full understanding of capabilities, limitations and caveats associated with each information product being used.

Port Operations and e-Maritime

Context

Port management organizations and maritime operators are require to provide increasing levels of information, documentation and certification. These may cover issues such as personnel authentication, administrative processes (eg cargo status and content), logistics, health and safety issues, environmental protection and security. At the same time, the range of information services being provided to these entities is also expanding – eg environmental information, status of infrastructure (eg engines, hull integrity), situation awareness and economic data (eg spot prices of commodities being transported). Increased maritime traffic volumes and climate change driven environmental conditions are also impacting on maritime transport business processes (eg increased average temperatures in ports make power storage more hazardous).

Over recent years there has been a progressive adoption of electronic data exchange which is contributing to improved efficiency and supporting more sophisticated management of maritime and port operations (eg optimized arrival in port) but significant improvements are still possible, in particular with respect to environmental protection, safety and security. Effective integration of customized EO based information services with datasets built on the e-Maritime information layers offers an innovative path towards addressing this demand. However this requires highly adaptable, persistent access to different EO datasets over extended periods of time to both newly acquired data (usually in near real time) as well as access to, and analysis of, historic data covering both recent short term history (eg a few days for roll-back analysis) to months/years (eg linked to environmental analysis).

Issues to be addressed

The primary issue to address is the development of, and access to, EO based information services that are appropriately customized to enable straightforward integration with the monitoring and analysis infrastructure operated by the port management entities and national authorities. This incudes developing relevant data fusion and information mining capabilities based on the integration of diverse EO data sets together with the various datasets contained within the e-Maritime infrastructure.

Given the increasing globalization within the port management sector, these customized information services must be available and verified for the main geographic areas of interest including SE Asia, Europe, the Middle East, East Asia and Central America.

The third issue is to address longer term analysis capabilities to address climate related concerns such as increased average temperatures, alterations in coastal processes and the associated need to actively manage coastal ecosystems to account for their increased sensitivity as a result of the climate change driven evolution in environmental conditions.

Actions to be executed

Development and verification of customized EO based information services shall be based on the following actions:

1) development of required data access capabilities and information extraction routines for all relevant datasets (EO-and non-EO)
2) development and testing of customized data fusion and mining techniques as components of customized information services
3) integration of custom EO based information access capabilities within port management and e-maritime ICT systems

Expected Outcomes and Impacts

The main outcomes will be the implementation and demonstration prototype capabilities to fuse EO based information layers with datasets already accessible and integrated into the e-maritime infrastructure and the ICT systems operated by international port authorities.

In addition, all required EO data access and processing infrastructure shall be available through an interface with appropriate functionalities.

These will ensure that the EO information generation capability is capable of the required levels of persistence, flexibility and performance required by port authority and other stakeholders within the e-Maritime sector.

Renewable Energy

Context

As the worldwide energy demand increases and many countries start transitioning towards a low-carbon economy, it is expected that the importance of the share of Renewable Energy (RE) in the energy mix will in turn keep increasing, with greater contributions to the power generation, heating/cooling and transport sectors. Indeed, on a percentage basis, renewables continue to be the fastest-growing power source, and deployment continues to shift towards energy-hungry emerging markets. The potential of RE technology is significant, as resources are abundant, safe, sustainable and distributed globally, in contrast to conventional sources. Apart from stable, long-term policy frameworks with adequate market designs and flexible power systems, scaling up deployment requires a nexus approach in addressing resource potential/distribution and land availability/suitability.

Issues to be addressed

Although historically EO has played an important role in the mapping of renewable resources (see e.g. solar resource assessment using geostationary meteorological satellites), the availability and usage of EO-based information for RE remains very fragmented, in spite of the obvious benefits (continuous, consistent and large-scale monitoring). This appears to be partly because of the wide range of information requirements of the various RE sectors, but also a consequence of the numerous types of sensors in orbit today and in the past, with potential to cover some of these requirements. Also, a nexus approach to understand the potential and impact of RE alternatives is lacking.

Actions to be executed

The proposed approach is to develop an EO multi-stakeholder data-driven platform, capitalising on the latest data repositories and technologies to:

- Adopt an integrated approach, considering the potential of all renewable types for the same geographic area (energy mix) and how "exploiting one affects the others" and the effect of different land use scenarios,
- Define and address "Essential Energy Variables", i.e. taking stock of historical archives to achieve cross-calibrated and harmonised higher-level datasets maximized in quality, fitness-for-purpose and temporal and spatial coverage, and known to be relevant for one or more RE sectors,
- Enable the integration and harmonisation of EO with in-situ measurements.

Expected Outcomes and Impacts

Through this action new products (both standard and customized) and best practice procedures will be established. Innovative elements will be brought to established RE sectors (e.g. solar and onshore wind) and EO-based support offered to emerging RE technologies (e.g. wave/tide) as well as to decision-making for optimal land and energy resource utilisation.

Corporate Sustainable Development

Context

During the last two decades, large corporations have been incorporating non-financial issues (e.g. environmental, social governance) into their reporting procedures, mainly to show their commitment to sustainability. This trend is also driven by the appearance of reporting frameworks from the private sector (such as GRI, IIRC, SASB, CDP) but also from European regulations (such as the EU Directive on non-financial reporting). In addition, many rating and ranking organizations are now rating and ranking products to publicly listed companies worldwide. The reporting on non-financial issues has yet to attain the critical mass required to unleash significant improvement in the environmental and societal protection needed to lead to a green and inclusive economy. Earth Observation (EO) from space can play a key role here, as "If you can't measure it, you can't manage it",

Issues to be addressed

The issue today is that there is a lack of critical mass in using EO in sustainability reporting, despite many key benefits (e.g. consistency, global scale, continuity of monitoring). In addition, a holistic and data-driven accounting system is lacking to measure how values is generated within a company and what impact it has on social aspects and the environment.

Actions to be executed

The proposed approach to address these challenges is to develop an EO multi-stakeholder platform, capitalizing on the latest technologies, to:

- Develop EO products and standards tailored to the new generation of environmental and social reporting practices including a series of pilot projects and asset sustainability mapping in partnership with large corporations.
- Enable the co-design of EO-based solutions between service providers, standard setting organizations, practitioners, analysts and other experts.
- Foster the development of Corporate Digital Transition Labs to foster digital innovation using EO in the development of a reporting framework,
- Explore new business models, governance to scale up the take up of EO across investors, from banks to development agencies,

Expected Outcomes and Impacts

The target for this development will be to implement new customized products, standard procedures, and open innovation practices to foster the use of EO reporting in large corporations, with the objective to get clear statements from representative on the value, impact and fitness for purpose of EO derived information by the end of the activity.

Consolidate best practices: User Sectors

These candidate sectors have been identified through the previous ESA activities, and are understood to be ready for a comprehensive mapping of EO products against the end-end business operations, with industrial companies also ready to 'champion' the wider use of EO across the sector.

- Agro-Chemicals,
- Agro-Insurance,
- Geo-Hazard Risk,
- Mining,
- Polar Tourism,
- Rail Transport

For each of these sectors, preliminary information is given on: the business processes operating in the sector, the current utilization of EO, and the industry partners/organisations interested to be involved in further consolidating the use of EO.

Agro Chemicals

1. Business processes

Ensuring food security for the worlds rapidly increasing population is a priority, both for individual countries and international organizations like the UN WHO. In ensuring this goal, the agro chemical industry is playing a role in developing fertilizers and pesticides that have the potential to increase the crop yield per hectare. The sector is investing heavily into R&D to develop new and better products that requires field trials and certification before a license is granted allowing the product to enter the market. Today the major agro chemical industry players are increasingly developing integrated information platforms towards farmers, instead of just selling fertilizers and pesticides in the traditional way. These integrated ICT solutions provide farmers information about drivability of the fields, optimal timing for seeding and planting, timing for application of agro chemical products, input to variable rate spraying, yield forecasting and guidance for precision harvesting. A trend is also that these solutions are integrated with the farming machinery.

2. Utilization of EO

EO is applicable to all phases of agro chemical business processes. Site similarity products based upon historical indexes can be used in the EPPO biological assessment report instead of field trials. Soil humidity together with precise terrain models can support decisions about drivability and which machinery to put into the fields. Both Sentinel 1 and 2 are currently revolutionizing the monitoring of crop health, leading to increased precision and update frequency at field level of individual crops. This information is increasingly used for all sorts of precision agriculture, ranging from guiding seeding/planning to timing and selection of harvesting.

3. Industry partners/associations

The licensing of new agro chemical products is regulated by the European Plat Protection organization (EPPO), after which a product can be taken to market.

The European Association of Agrochemical Companies (EAACC) is an alliance of companies specialized in the trade of plant protection products. The association represents its members' interests vis-à-vis policy makers at national and EU level

Agro Insurance

1. Business processes

Agriculture insurance dates back to a policy against hail in Germany in 1791 and index-based and producer-revenue insurance were later introduced to include catastrophic insurance for small- and medium-income farmers. Modern agro insurance business is rapidly evolving, also driven by the by challenges like increasing damage and income fluctuations. The unpredictability of climate change and associated increase in extreme natural events is one of the factors the sector needs to manage and plan for. This has an impact on most relevant business processes from policy pricing and underwriting to loss estimation and claims management. Especially in the first part the role of risk model development is crucial, since they form the basis for hazard validations and vulnerability assessments. Rapid loss estimation in remote locations following a natural event is another challenge becoming more and more relevant, with subsequent claims management requiring access to local information.

2. Utilization of EO

Indexed based agro insurance schemes have been introduced in some countries (India, USA etc.), and efforts are underway by FAO to introduce such approaches to micro-farms in the developing world. Direct insurance of individual farms and fields based upon remote sensing data, was for many years suffering from not having affordable and frequent access to the right remote sensing data. With the Sentinel satellites in orbit this is now rapidly changing, making it possible to monitor crop health (for prevention) and crop damage at field level with weekly updates at a global scale. The evolving UAV market is also adding to the amount of detailed data that can be made available loss adjusters. Rapid loss estimation following a hailstorm, or implementing preventive measures together with the farmers is therefore increasingly becoming feasible, with the promise to be integrated into working practices of the agro insurance companies and players.

3. Industry partners/associations

AIAG is the International Association of Agricultural Production Insurers. AIAG unites the world's leading agricultural production insurers as well as reinsurers and brokers closely involved in this line of business. Members include private, semi-governmental and public law enterprises.

Geo-hazard risk management

1. Business processes

According to the insurance/re-insurance sector the implementation of the Sendai Framework, the world's comprehensive agreement on Disaster Risk Reduction, shows the importance to include the private sector in disaster risk management. In many major disaster events economic losses have a strong impact on the private sector. It is clearly recognized that the private sector and financial systems have critical roles to play and services to offer which will help to build resilience to disasters at the global and local levels. This is true for geo-hazard risks i.e. risks associated to geological and hydrogeological hazards such as for instance underground terrain motion and subsidence. The business processes of the insurance sector include underwriting, risk modeling, claims management, reinsurance and broking, event handling and information management. In the domain of geo-hazards such as the business is likely to evolve in several ways: the evolution of the insurers' exposure to claims for indemnification of settlements, the accuracy of the assessment of environmental risks underwritten, the evolution of the offering and geographic markets of the insurance sector. All these can be affected by the availability of geo-information services that new satellite EO missions can provide.

2. Utilization of EO

Insurers are interested in geo-hazards over their assets and measurement of underground deformations and subsidence risk is something that has traditionally been done from historical claims data or other influencing factors (e.g. geology, tree proximity etc.). EO data sources have the ability to measure actual terrain motion using post processing of radar data which is of interest to insurers as an input into their pricing models. EO based terrain motion can offer a benefit to insurer's business decisions as the measurement shows actual terrain motion over a period of time. Most methods currently used allow characterization of areas subject to geo-hazards from surrounding influences. Actual historical measurements help to characterize subsidence and/or uplift and how these relate to assets at an address level thus allowing for more accurate premium and risk decisions to be made. Historical data over wide areas already exists in several geographic markets such as for instance the extended archives from ERS, ENVISAT and the new Sentinel-1 mission that provides data with a geometry suitable for terrain motion with systematic observations over more than 20% of world land surfaces. Nevertheless, today many industry players have engaged into exploiting satellite based geo-information solutions to support their business.

3. Industry partners/associations

There are several international groups of insurance and re-insurance organisations. For instance the Chief Risk Officers (CRO) Forum is a group of professional risk managers from the insurance industry that focuses on developing and promoting industry best practices in risk management. The Forum consists of Chief Risk Officers from large multi-national insurance companies looking at a wide range of business issues, such as the impact of new technologies on the insurance value chain.

Mining

1. Business processes

Undoubtedly, 2015 will go down in the history books as one of the worst years on record for mining companies, hit by record-low commodities prices that forced them to cut jobs, dividends, production and sell assets. Price volatility, geopolitical turmoil, rising costs, and a general lack of financing could make 2016 another challenging year for the global resources sector requiring the sector to focus on the pursuit of operational excellence, i.e. re-thinking their traditional operational processes and costs. Innovation could play an important role in facing these challenges by leveraging emerging technologies such as satellite remote sensing. This could involve considering innovation throughout the full cycle of a mining project, from prospecting/exploration/feasibilities, to construction, operation and decommissioning.

2. Utilization of EO

EO capabilities are relevant to all phases of a mining project. Geology mapping, including minerals prospecting and exploration is an area where satellite EO has been used extensively for decades, heavily exploiting Landsat type of optical sensors. Geo-hazards assessments, including tailings storage facility monitoring and slope stability is an area where interferometric SAR has been used successfully. Then there is of course the whole aspect of environmental monitoring and assessments, which is increasingly becoming important driven by stronger legislative frameworks. Demonstrating CSD compliance is another area where satellite EO has been successfully demonstrated, perceived as an impartial assessment from space.

3. Industry partners/associations

ICMM is the International Council on Mining and Metals. The International Council on Mining and Metals (ICMM) was founded in 2001 to improve sustainable development performance in the mining and metals industry. Today, we bring together 23 mining and metals companies as well as 34 national and regional mining associations and global commodity associations to address core sustainable development challenges.

Polar Tourism

1. Business processes

During the past two centuries tourism has grown to become the single largest human presence in many Arctic regions. Visitors to the Arctic now greatly exceed their host population at many popular destinations, and Arctic communities are increasingly reliant on the jobs, income, and business revenues tourism generates. Travel to the polar regions is now raising concern that the fragility of polar environments may be compromised by the number of visitors and the activities undertaken. These in turn may put additional pressure on land, wildlife, water and nature-based resources. There are also safety concerns centered on the capacity of countries and the international communities to respond to an accident involving say a cruise ship. In August this year, the cruise ship Crystal Serenity will transverse the North West passage. If successful, the trip, which ends in New York City, will mark the first crossing of the passage by a luxury cruise ship. In ensuring the successful implementation of such a cruise, the planning that includes risk analysis, route planning, emergency plans and training is of course crucial. During the execution, skilled navigators will be required to sail in ice-infested waters, where sea-ice and icebergs could pose serious dangers. The recently IMO legislated "Polar Code" will come into force January 2017, introducing a more rigorous regulatory framework for sailing in Polar waters, demanding ships to be certified for entering specific geographic regions, and captains to be trained on obtaining up-to-date ice information.

2. Utilization of EO

Satellite EO is a well-established technique for monitoring sea-ice and icebergs, and ice-charting services have been provided routinely by European and Canadian national entities for decades. Historical analysis of ice edge location and iceberg densities is important for establishing the statistical background for doing risk analysis; while near real time products play a key role in day-to-day tactical operations during a cruise.

3. Industry partners/associations

IAATO (International Association of Antarctic Tour Operators) is a member organization founded in 1991 to advocate and promote the practice of safe and environmentally responsible private-sector travel to the Antarctic. Currently, more than 100 Antarctica-bound out-fitters are members. AECO (Association of Arctic Expedition Cruise Operators) is an international association for expedition cruise operators operating in the Arctic and others with interests in this industry.

Rail transport

1. Business processes

Rail transport infrastructure management includes activities to monitor and mitigate risks of natural hazard associated to trunk road network and other components of the infrastructure (signaling, electrification, stations, etc.) alongside with activities associated to the transportation of dangerous goods. Railway network management requires to address the risks associated to hazards such as landslides and managing risks associated to hazardous material transportation requires access geo-information about exposure and the asset at risk. In situations of accident on incident with hazardous material synoptic, objective and reliable exposure mapping needs to be accessible as and when needed over all concerned areas. As far as risks of natural hazards associated to the railway network are concerned, the lengths of the road and the slope lengths concerned are generally substantial. Maintenance and construction projects can limit hazards or exposure through measures such as higher capacity or better forms of drainage, or debris traps, etc. Monitoring activities include to identify areas of perceived high hazard and to perform inspections to minimize the potential impacts of debris flows on the network. Monitoring measures can include for example the installation of rain gauges. The risk assessment methodology includes exposure assessment and a hazard ranking together with appropriate management approaches.

2. Utilization of EO

Satellite EO can be used to provide geo-information including the exposed assets in areas potentially affected by accidents associated to the transportation of hazardous material and hazard information such as inventories of landslide and debris flows and hazard mapping with the integration over space and time of series of inventories. Alongside with a wide range of Optical based products to support mapping the asset at risk and its environment, EO based terrain motion services such as using radar interferometry are a robust solution to support risk assessment. In particular, long historical time series of SAR data and continuous regular repeat acquisitions from High (e.g. Sentinel-1) and Very High Resolution SARs (e.g. TerraSAR and CosmoSkymed) contribute to monitoring.

3. Industry partners/associations

The European Railway Agency is looking at the construction of a safe, modern integrated railway network for the EU. Railways must become more competitive and offer high-quality, end-to-end services without being restricted by national borders. The European Railway Agency was set up to help create this integrated railway area by reinforcing safety and interoperability. The Agency also acts as the system authority for the European Rail Traffic Management System (ERTMS) project, which has been set up to create unique signaling standards throughout Europe.