e-shape

EuroGEOSS Showcases: Applications Powered by Europe

D5.3 First Market Trends Observatory

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ABSTRACT

The overall aim of WP5 is the long-term sustainability of e-shape Pilots, their penetration in the public and private markets and the support of their upscaling. This will be achieved by providing a wide range of support measures that will be accessed in a dedicated online environment – the e-shape Sustainability Booster, complemented by on-demand services supplied by qualified experts. The first component of the e-shape Sustainability Booster is the Market Trends Observatory, which in its first version is described in this report.

The Market Trends Observatory will be monitoring market trends, policy priorities and technological developments in order to produce insights that could help e-shape partners, and the wider EO community as well, to capture associated opportunities. These insights will be accessible through a dedicated online environment, the content of which is going live with the submission of this report. The first batch of such insights is presented in this report along with screenshots of the online environment. The selection of the topics has been done in fully synch with the e-shape pilots. Subsequent batches will expand on these topics while adding new perspectives as markets, policy and technology evolve.

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1 INTRODUCTION

The overall aim of WP5 is to enable the long-term sustainability of the e-shape Pilots, their penetration in public and private markets and to support their upscaling. In that regard, Task 5.2 focusses on providing e-shape partners with “Market Penetration Support”. As part of this process, a “Market Trends Observatory” has been designed and will operated throughout the duration of the project – and hopefully beyond. This deliverable (5.3) explains the **need for up-to-date market intelligence** (chapter 2) when aiming at long-term sustainability of the pilots developed in e-shape, and presents the technical/procedural (chapter 3) and content (chapter 4) aspects of the Market Trends Observatory. The report concludes with a summary of the steps that will be taken (chapter 5) to ensure this resource provides value to e-shape and beyond.

2 NEED FOR MARKET INTELLIGENCE

The Sustainability Booster, as a whole, aims at supporting e-shape’s Pilots in maximising their sustainability potential, whether in the real market (i.e. commercial exploitation) or within follow-up research and development activities. It does so by offering active support (e.g. business planning), but also by providing access to knowledge that can guide the meaningful development of the EO-based services developed in e-shape.

The Market Trends Observatory component of the Sustainability Booster has a focus on the latter. It is designed and will be operating as a tool that monitors, analyses and interprets developments and trends in market (and technology) that are defining and changing the EO sector and the thematic areas which it supports.

Market intelligence – information about developments and trends in relevant markets, policy priorities, user requirements – enables better informed decisions both for the design of the products or services as well as business models and sustainability strategies (e.g. regarding market entry, internationalisation, commercialisation)[1]. Market intelligence is also a key resource allowing solution developers to identify relevant markets for their products/services and draw strategies on how to approach these markets. In that regard, it helps not only to ensure up-to-date awareness of the markets’ status quo but also to find impulses for innovation, identify gaps in own or competitors’ offerings, spot opportunities or threats, source technologies and assess risks.

The Market Trends Observatory within the e-shape Sustainability Booster will make such knowledge available particularly in the context of the e-shape Showcases and their Pilots. This will be a progressive effort, supported by means of desk research and expert interviews. This way developments and trends will be identified, analysed, and described. Insights derived from this activity will be presented as actionable information to the e-shape partners and to the EO community. This can form the basis for on-demand support provided by the Sustainability Booster – a tool that is conceived with a long-term operation in mind.

The “First Market Trends Observatory” (described herein) will implement its online environment and present first observations dedicated specifically to the e-shape Showcases.

[1] R. Rohrbeck, Corporate Foresight: Towards a Maturity Model for the Future Orientation of a Firm, Physica-Verlag, Springer, Heidelberg, 2010

3 First Market Trends Observatory

The Market Trends Observatory aims to provide knowledge to e-shape partners and pilots, as well as to the broader Earth Observation (EO) community. Knowledge is provided in the form of online articles about developments and trends in the market, including policy priorities and market activities related to the thematic areas addressed by the e-shape showcases. These articles elaborate on implications for EO and are matched with e-shape showcases as well as EO application fields to ease access to relevant content for the users. In the following months of the project – and towards full operational maturity of the Sustainability Booster of which the Market Trends Observatory is part – additional items such as “brief insights” or “expert opinions” will be produced.

3.1 Technical implementation

The technical implementation of this first version has been realised next to the e-shape public website under the subdomain https://sustainability.e-shape.eu/insights as a set of pages and functions for filtering and search. The content management system serving the website (WordPress) allows editing and categorising market trends contents as well as suggesting the user related content.

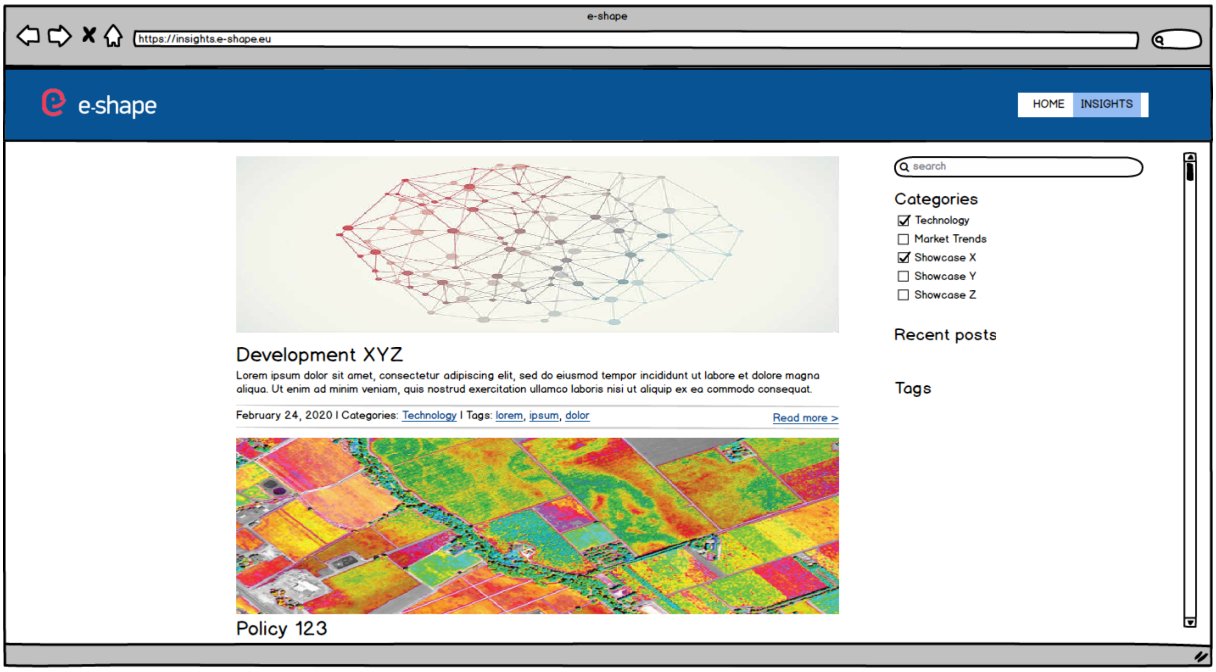

Figure 1: Landing page "First Market Trends Observatory", initial mock-up

Following the development of an initial mock-up – shown above, the full development took place and is presented in a series of screenshots below.

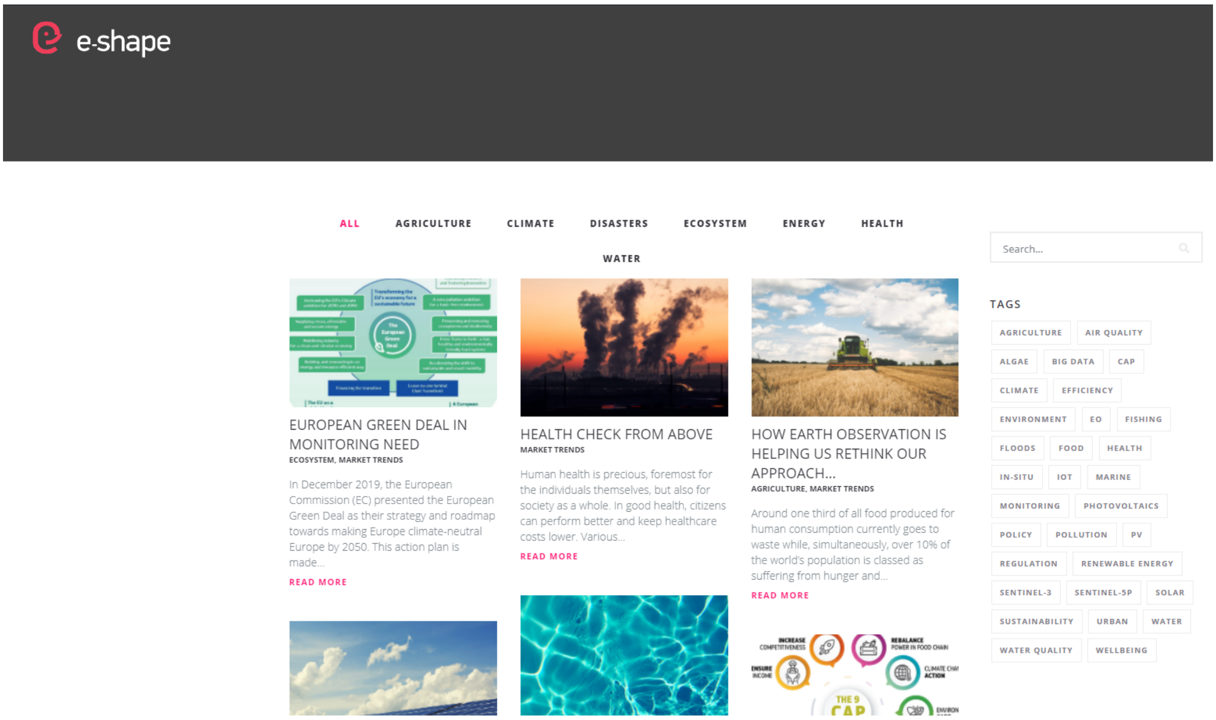

Figure 2: Insights section of the Sustainability Booster online presence, landing page

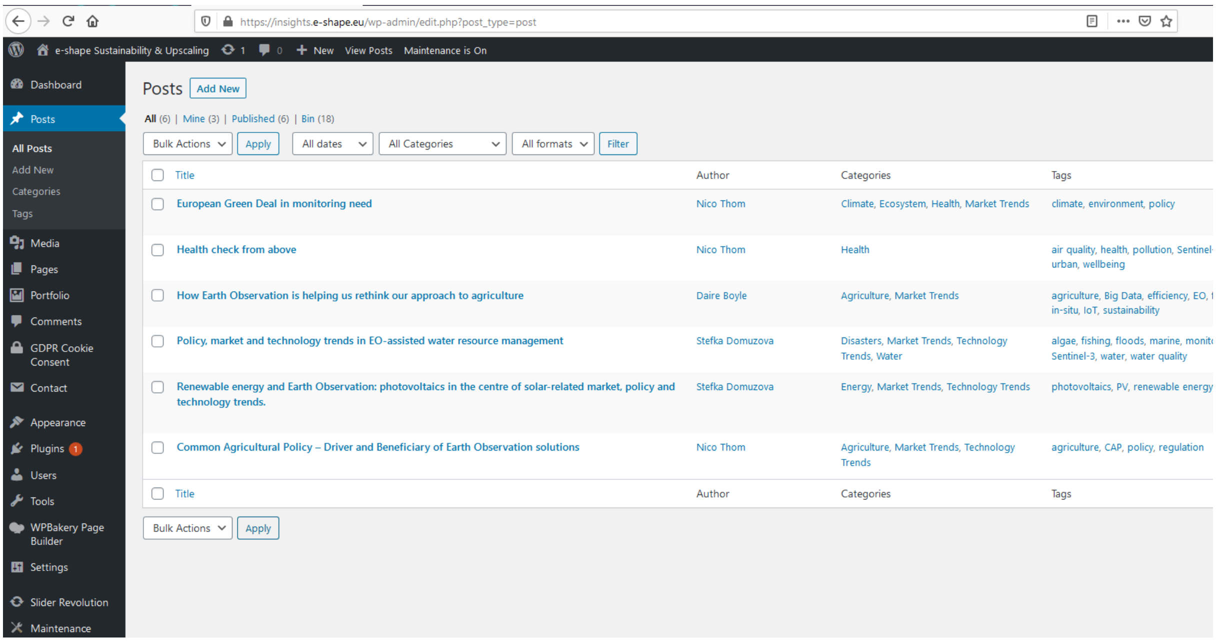

Figure 3: Content Management view (WordPress backend)

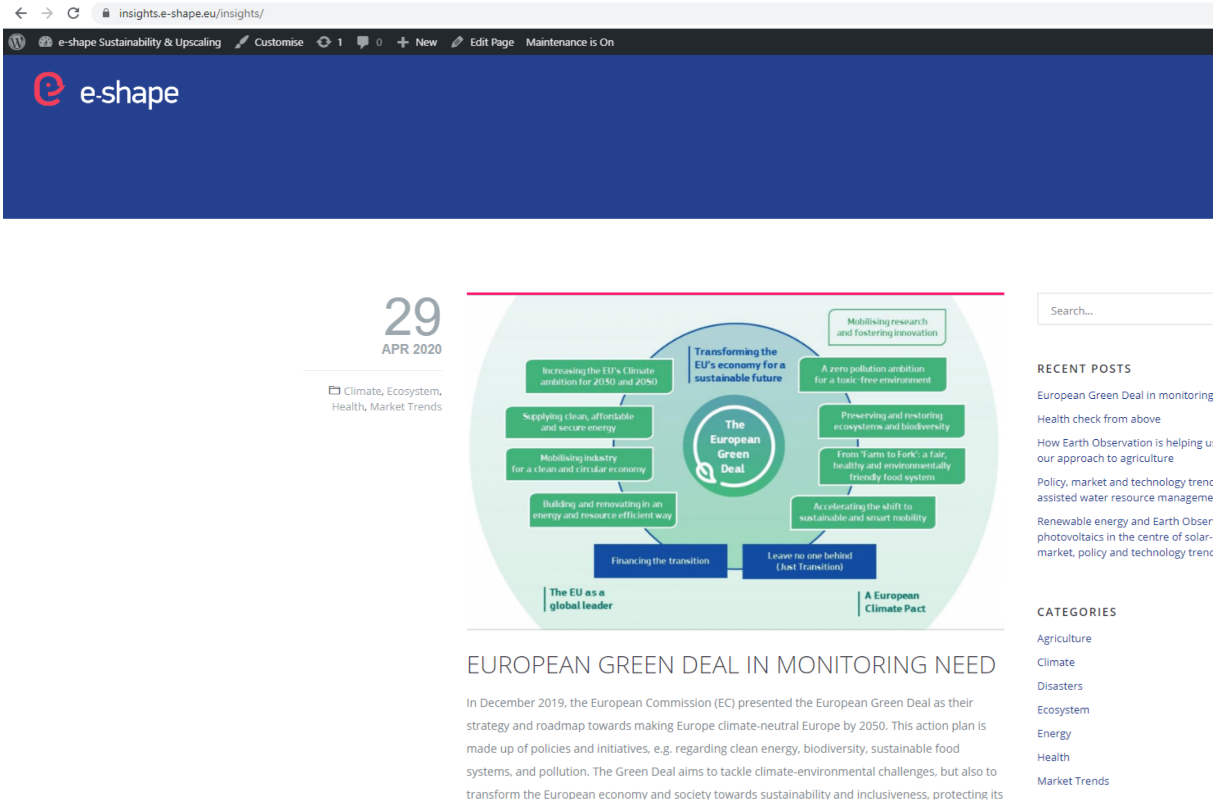

Figure 4: First Market Trends Observatory, live version

A link on the e-shape website (located at https://e-shape.eu/index.php/sustainability) guides users of the website to the Market Trends Observatory insights.

The WordPress implementation allows for categorisation and tagging of content, providing the users with possibilities to search using keywords as well as filtering by application fields, content types, and e-shape showcases.

3.2 Content creation and delivery

A structured list of topics (topic repository) has been curated over time with a continuous review and selection process in place. Interviews with experts from among the e-shape partners have been conducted for a first batch of articles. Moreover a "backend" of relevant sources to be monitored has been compiled in the form of a database.

The First Market Trends Observatory has been populated with this first content for the go-live of its website. An editorial process is in place to ensure regular updates with further content throughout the project. This process aims at an equal coverage of all sectors and aspects as well as a continuous flow of published content.

4 Initial content of First Market Trends Observatory

The online solution has been populated with the first batch of contents, which is also included below. This first set of articles aims to set the context of future articles by addressing all e-shape showcases with a general overview, confirming the relevance of EO in these sectors. In developing these articles, the WP5 leaders have conducted targeted interviews with e-shape showcase leaders (or contributors in some cases). This ensures that (i) the produced insights are capturing the current knowledge of subject-matter experts, (ii) areas where additional research can be conducted by the WP5 Leaders' analysts can be identified.

Throughout the lifetime of the e-shape project, the Market Trends Observatory will be regularly updated with further content, that will provide more detailed analysis of a specific development or trend.

4.1 European Green Deal in need of monitoring solutions

In December 2019, the European Commission (EC) presented the European Green Deal as the strategy and roadmap that will guide Europe towards becoming climate-neutral by 2050. The European Green Deal is made up of policies and initiatives, e.g. regarding clean energy, biodiversity, sustainable food systems, and pollution. It aims to tackle climate-environmental challenges, but also to transform the European economy and society towards sustainability and inclusiveness, protecting its natural assets as well as health and wellbeing of its citizens.

Earth Observation (EO) will be crucial for assisting the monitoring of key environmental aspects, by using both using in-situ observations and remote sensing. It will also enable tracking the evolution of climate change over time as well as the impact of measures, with the help of services such as the Copernicus Climate Change Service. At the same time, the Copernicus Atmosphere Monitoring Service supports monitoring pollutants in the atmosphere, while the Copernicus Land Monitoring Service will provide the basis for monitoring greenhouse gas emissions created by land use.

The Green Deal related energy policies will increase the demand for renewable energy and enabling infrastructure. EO can contribute to the detection of suitable locations for alternative power generation, planning and monitoring of infrastructure, and forecasting renewable energy supply. To support pollution policies, EO can monitor air and water quality and detect polluters as well as contribute to reducing pollution e.g. by means of precision agriculture and smart urban planning. Further, EO can monitor ecosystems in marine (e.g. through the Copernicus Marine Environment Monitoring Service), urban, or rural areas, detecting their condition, as well as informing measures that will help preserve and restore ecosystems.

All these different applications are powered by in-situ and satellite data as well as by advanced modelling techniques. Thanks to the Copernicus free, full and open data policy, a vibrant and highly innovative community of researchers and industrial actors has now easy and constant access to an immense stream of world-class observations. Using a wide range of methods, this community – strongly represented in the flagship e-shape project – is developing solutions that can directly contribute to monitoring and implementing the European Green Deal policies. Thus, through its showcases and pilots (e.g. Pilot 7.1 "Global Carbon and Greenhouse Gas Emissions", Pilot 4.2 "mySITE", or Pilot 2.2 "EO-based surveillance of POPs pollution"), e-shape aspires to support the realisation of the EU Green Deal goals.

As these goals become the centrepiece of European policy making going forward, it is expected that strong demand will be created and thus opportunity for EO-enabled products and services across all thematic areas covered by e-shape. This will take the form of heavy investments, a significant amount of which is to be expected to go into monitoring. Addressing the monitoring needs of the European institutions, international bodies, as well as sectors contributing to climate change would be an additional value proposition.

To help e-shape partners identify and capture associated opportunities, the Market Trends Observatory will be closely monitoring EU Green Deal-related news and developments.

4.2 Health check from above

Human health is precious, foremost for the individuals themselves, but also for society as a whole. In good health, citizens can perform better and keep healthcare costs lower. Various factors influence our health, including the air we breathe, the food we eat and the way we lead our lives. Our overall wellbeing is also influenced by socioeconomic factors such as social environment, wealth, or education. In this context, many policies have our health at their heart, and many solutions are developed with the aim of monitoring or addressing health risks. In that regard, Earth Observation (EO) can contribute to detecting factors impacting health as well as support planning efforts that seek to safeguard more favourable – for our health – conditions.

This is precisely the case of the Health Surveillance showcase of e-shape. Two, out of three, pilots are focused on detecting highly toxic pollutants:

- Pilot 2.1 (EO-based surveillance of mercury pollution) is dealing with mercury that may enter the food chain. Remote (i.e. satellite-based) and in-situ observations serve as input for monitoring and modelling mercury in the environment, supporting the Minamata Convention on Mercury.
- Pilot 2.2 (EO-based surveillance of POPs pollution) is improving means of detecting, collecting, and interpreting information on Persistent Organic Pollutants (POP) in support of the Stockholm Convention.

Environmental treaties and policies such as those mentioned above are providing the framework within which EO-based solutions tackling respective issues are developed. A high demand such solutions is in urban areas, where an increasingly large part of the world's population is living (by 2050, an estimated 70%). This is further addressed by Pilot 2.3 (EO-based pollution-health risks profiling in the urban environment) of e-shape, which is specifically looking at cities to support health assessment and urban planning with respect to Air Quality (AQ).

Up to now satellite data has been too coarse to accurately measure AQ conditions on the ground, at scales that make sense for urban applications. Traditionally, measurements are made with in-situ equipment. However, the new satellite sensors, such as onboard Sentinel-5p, are considered capable to track pollution in urban areas. In practice, this means fusing satellite observations with in-situ data to improve air quality simulations and forecasts. Such approach has already yielded a mature product in NOx monitoring.

A key component in such solutions is ground-based measurements. In that regard, an important trend is associated with the proliferation of low-cost sensors for a large variety of pollutants. They are spread across cities, enabling real-time air quality information. This brings "citizen scientists" into the picture, by allowing them to add their own, highly local measurements. Citizen science is not only a technology-driven trend; it is, perhaps, first and foremost a societal one, whereby citizens can actively participate in and contribute to issues with direct impact in their lives such as health associated with air quality. This has made public authorities embrace such paradigms and empower or encourage citizens to contribute. Eventually this gives rise to public-private initiatives e.g. in the direction of supporting outdoor activities and tourism. The quality assurance of such data and their integration into official workflows is one aspect that needs special attention and is dealt within Pilot 2.3.

Beyond pollutants monitored by satellites in the context of air quality, Earth Observation can also support the monitoring of infectious disease outbreaks. Malaria forecasts can be made based on measurements of environmental conditions. For instance, suspect sites can be identified by satellite in the combat of Ebola. And satellite data can provide evidence of correlations between high infection rates with environmental aspects or urban characteristics. Ultimately this information is combined in maps that help to forecast the effect on health as well as reveal where help is needed.

But satellites can do more than detect health hazards. They also serve city planners in making urban spaces more liveable. Imagery can detect and supplement other geospatial information for mapping urban characteristics, green and blue spaces, the ratio between concrete and green, building heights and street canyons, or population density which all can serve as indicators for wellbeing. Once mapped, the images can be overlaid with socioeconomic data such as education, health infrastructure, recreation, or health data. Insights gained help urban planners in improving spaces (e.g. planning for parks or pedestrian areas, better ventilation), infrastructure, or mobility solutions.

While urban spaces contribute to pollution, transboundary pollution can also affect areas in the distance. Accurate forecasts that combine data from various sources can help e.g. rural areas to be prepared for such pollution that could affect not only health but also yield in crop farming. The Copernicus Atmosphere Monitoring Service (CAMS) provides such forecasts at the regional level. Being able to profile an area could guide in choosing crops that are less sensitive to a specific condition.

Other sectors could benefit from EO data on air quality, health & wellbeing aspects as well: tourism for routing and recreation, health insurers for health and life expectancy indicators, emergency services for early warning, or the industrial sector that show increased interest in knowing their environmental footprint and adapting accordingly.

Environmental observation by means of in-situ measurements and satellite data can greatly influence the good health of citizens and economies by guiding policies, measuring compliance and effectiveness of these, and supporting better planning in urban, rural, and industrial environments. Improvements in quality, quantity, analysis, and integration of data are met with high demand, globally.

The Market Trends Observatory will be monitoring developments both at the bigger picture level but also at a more granular, pilot-related level and generate insights.

This article incorporates elements from an interview taken from Evangelos Gerasopoulos from NOA, lead partner of e-shape Pilot 2.3.

4.3 How Earth Observation is helping us rethink our approach to agriculture

Around one third of all food produced for human consumption currently goes to waste while, simultaneously, over 10% of the world's population is suffering from hunger and malnutrition. If we could reduce these enormous food wastages, it is estimated we could feed an additional 1 billion people and reduce our global carbon footprint by 4.4 Gt CO_2, equating to over 8% of global greenhouse gas emissions. This startling information alone should be enough for us to realise that we must rethink our means and methods of food production, streamlining our processes and reducing the negative impact of our agricultural practices wherever possible.

In a recent conversation with Mr. Sven Gilliams, the Agricultural Application Team Leader at VITO, showcase leader for Food Security & Sustainable Agriculture under e-shape, the role that Earth Observation (EO) technologies can play in helping us push our agricultural practices to the next level, in terms of efficiency and sustainability was highlighted. In discussing the forthcoming trends and technologies that will be most impactful in the domains of agriculture and EO, Mr. Gilliams spoke of the further integration of EO data with in-situ or "Internet of things" (IoT) technologies. For a number of decades, EO data has been used within agriculture to monitor parameters such as vegetation growth, crop condition, crop type, land use, and soil moisture levels, with these applications being quite widely used and understood within the agricultural sector. However, the emergence of "Big Data" integration, which can take traditional EO data and merge it with a multitude of other data sources, from in-situ field measurements to roving IoT data sources, such as autonomous robots, is fast becoming the new technological horizon in farming. Satellite data is becoming one of many data sources, which machine learning algorithms can take as one of their numerous inputs to perform highly complex computations that ultimately drive "real world" actions back on earth. Autonomous in-field machines and unmanned aerial vehicles (UAVs) such as drones can use on-board cameras and sensors to gather local data on crop health. Then, in conjunction with satellite imagery, these systems will support treatment regimes, efficient irrigation schemes and optimum harvest times. This "next level" of highly efficient farming can only be made possible due to the rich and varied data available from EO sources, which keep a watchful eye over our crops and farms all year round.

In discussing upcoming policies relevant to the EO and agriculture sectors, Mr. Gilliams remarked that the most influential policy, albeit an obvious one, is most certainly the CAP (Common Agricultural Policy). Mr. Gilliams commented "Changes in the CAP will promote Earth Observation data massively, moving towards continuous monitoring, rather than spot checks of our agricultural land". It is the desire for continuous monitoring of our farming operations that lends itself perfectly to the use of EO data, as frequent and constant data streams which monitor a vast array of parameters can be achieved. Mr. Gilliams also commented that the European Environment Agency (EEA) is pushing for more and more high-resolution EO data for agricultural monitoring and in particular, they will continue to emphasise the need for more detailed scrutiny of the environmental impacts of our agricultural practices. He noted that government agencies, particularly in Europe and the USA will begin to heavily adopt high-resolution temporal and spatial EO data to both help manage their domestic food production strategy as well as drive agricultural policy decision making.

The role that EO will play within agriculture is undoubtedly going to be an intrinsic and ever evolving one. Continuing integration of EO data with smart decision-supporting software and action-taking machines is the next huge technological hurdle to overcome. In terms of agricultural policy, the role EO will play at governmental level is set to become one of the most vital, given its ability to provide law-makers with the most all-encompassing perspective available.

4.4 Policy, market and technology trends in EO-assisted water resource management

A lot of the recent technological and market developments in the realm of Earth Observation (EO)-assisted water resource management evolve in parallel with European policies where EO can have an impact. These are legislations such as the Water Framework Directive (WFD), the Marine Strategy Framework Directive (MSFD), and the Floods Directive. The close relation between policy, market and technology can be seen within each of the e-shape pilots involved in Water resources management.

- Pilot 5.1 (Improved historical water availability and quality information – coordinated by SMHI) integrates EO data into numerical models in order to assess water quality and availability parameters needed to be reported under the WFD. While this is done on a country scale within the project, the method is potentially applicable on European and on global scale.
- Pilot 5.2 (Satellite Earth Observation-derived water bodies and floodwater record over Europe – coordinated by LIST) focuses on flood management and potential contributions to the Floods Directive. The pilot is being developed in close relation with important stakeholders such as the European Flood Awareness System (EFAS) under the Copernicus Emergency Management Service and the Global Flood Partnership (a JRC initiative aiming at establishing flood services). Pilot 5.2 contributes to the venture by enriching the EO-assisted services.

For marine environments, three pilots show how EO can help in implementing the MSFD and for monitoring the related (qualitative and quantitative) indicators:

- Pilot 5.3 (Diver Information on Visibility in Europe – coordinated by PML) uses EO data to determine the water transparency and colour. In the specific instance, it is aimed at serving the needs of approximately 3.2 million active scuba divers in Europe, but its purpose can be extended further, as transparency is one of the main parameters to be considered when talking about water quality in marine areas.

- Pilot 5.4 (Sargassum detection for seasonal planning – coordinated by CLS) uses EO-data and numerical modelling in order to create services for sargassum monitoring and long-term forecasting. This algae species can have negative consequences for water quality. Particularly in the case of the Caribbean, the presence of sargassum has shown relevant negative impacts on tourism and fishing, raising the need of efficient planning of cleaning and gathering efforts. The ability to assess and foresee the presence of algae, sargassum and others, is essential for water quality and suitable to be integrated into a directive-related reporting mechanism.
- Pilot 5.5 (Monitoring fishing activity – coordinated by IPMA and DEIMOS) uses satellite data (EO, as well as AIS communication data) to monitor fishing activities and possibly for reporting under the MSFD in relation with the anthropogenic pressure indicator. The pilot is focused on tuna and sword fish within the Portuguese exclusive economic zone, but once established can be extended to other species.

Most of the demand on the market of EO-based water resource management applications comes from the public sector – and specifically from (water monitoring and management) public bodies. Nonetheless, the private sector is increasingly getting more involved in dialogues for the use of similar services.

Many public institutions react on the need to report based on directives and legislations and an increase of demand can already be seen. At the same time, it is a challenge that EO-based methodologies are not expressively referred to as reference methods under different directives. Experience shows that stakeholders are open to testing the EO potential but going into operational cooperation can be more difficult (e.g. due to issues in dedicating public budget for non-reference methods). Setting it as a reference method would increase not only awareness but also confidence in using EO products in water monitoring and management. This is primarily the case for the WFD which has a generally wider background than other directives and hence can set reference methods. The MSFD, on the other hand, is less specific in terms of indicators promoted and reference methods are rarely identified; this creates more difficulties for stakeholders to implement in the best possible way. Some research has also highlighted a relation between EO and MSFD indicators – however this should be explored further given that EO is an appropriate mean for monitoring some, but not all, specific parameters (e.g. impossibility to assess marine biodiversity through EO).

As for the growing interest from the private sector, it mostly comes from aquaculture, fisheries and fishing companies, interested to monitor direct risks such as harmful algae blooms (HAB) and sea surface temperature (SST) variations. EO has as well potential for optimising fishing areas selection: this method is not straightforward and is species-specific, but there is increasing engagement on behalf of stakeholders. Another sector is tourism, where companies look for providing innovative solutions to other private companies. Existing solutions, for instance, provide tourism indicators based on marine water quality and inland water quality and availability, as well as others related to sustainable tourism.

The biggest recent push for advancement of the EO-assisted water resource management industry has been the launch of Sentinel-3 and its multispectral capabilities, as more bands are optimised for water monitoring. It also resulted in the establishment of long time series both in space and time for water-related parameters based on data from the Ocean Colour Climate Change Initiative (OC-CCI) and even from the Copernicus marine environment monitoring service and the Copernicus land monitoring service. Overall, reliable data from different providers are largely available and ready to be used for development/improvement of services. As the Sentinel-3 time series will evolve in terms of quality and spatiotemporal resolution (i.e. from 1-4 km resolution for some parameters and even coarser for others will go into hundreds of meters), the conditions are expected to become even more beneficial for the development of EO-based water quantity and quality services.

e-shape partners involved in the aforementioned pilots will be actively monitoring these developments in order to ensure the sustainability of the produced solutions and maximise the value they bring to users. The Market Trends Observatory will be supporting these efforts by taking deep-dives in relevant topics.

This article is based on contributions from: Nuno Grosso (DEIMOS), Nuno Catarino (DEIMOS), Ilias Pechlivanidis (SMHI).

4.5 Renewable energy and Earth Observation: photovoltaics in the centre of solar-related market, policy and technology trends

This contribution is the first from a series of articles dedicated on the use of Earth observation (EO) within the Renewable Energy (RE) sector. While we will continue exploring different sub-sectors of RE, for now we focus exclusively on solar energy.

The drying-up of non-renewable energy resources and the need to cut emissions and minimise as much as possible the negative anthropogenic impact that led to climate change, has caused many debates. As a result, humanity is continuously looking into renewable energy (RE) solutions, as a cleaner and potentially low-cost source, compared to non-renewables. Its use has been strongly promoted on a high level by the United Nations (SDG 7 aiming at "Ensuring access to affordable, reliable, sustainable and modern energy for all"), the European Commission (Renewable energy directive), and many others. The **Green deal** itself largely promotes and advocates the uptake of renewables.

Many of the up-and-coming trends in the RE sector are related to the exploitation of solar energy through the development and deployment of photovoltaic (PV) systems. This is, to a large extent, due to technological developments (reduction of cost in manufacturing PV systems with high energy efficiency) and a marked paradigm shift in policies in many countries across the world that favour or even subsidise the implementation of PV installations. In turn, this leads into solar becoming the world's cheapest source of energy by the 2030s, and the one attracting the largest investments. This megatrend is also observed inside the e-shape project, with many pilots focussing on the role Earth observation can play in better exploiting solar energy.

Pilot 3.1 (nextSENSE: solar energy nowcasting & short-term forecasting system) has a two-fold purpose: upstream – for site selection analyses for large-scale solar farms, and downstream – for influence of meteorological factors for the nowcasting and short-term energy yield forecasting. Satellite and numerical weather model based (e.g. from Copernicus CAMS and EUMETSAT/Meteosat) data is used for the purpose and the nowcasting and forecasting deriving from it address notably the need of transmission system operators (TSO) managing the electric grid on different temporal and spatial scales.

Pilot 3.2 (High photovoltaic penetration at urban scale) addresses another big trend in PV: urban PV production. As an increasing amount of people live in cities, around 75% of the global energy supply is consumed in urban environment, and the percentage is expected to grow even further with the progressive adoption of electric vehicles as means of public transport. This increasing need for energy can be addressed adequately by urban PV technologies, as it is more efficient when the energy is consumed where it has been produced, and PV energy production does not affect negatively the air quality of the areas where solar plants are installed. Urban PV systems can be implemented on different scales – surely, there is the individual PV system on a rooftop, the way we are used to think about it, but another possibility is to have a set of larger PV installations on big urban surfaces such as the roofs of supermarkets, parking shades, etc. A challenge in both cases is the shadow effect caused by buildings themselves, roof superstructures and vegetation. To address this, there is an already established and growing market of solar: high-resolution solar cadastre. This means identifying available spaces with strong solar potential and high efficiency for installation of PV in the city, with a corresponding solar resource evaluation for each, taking into account the shadow effect and the local orientations of the roofs. Within e-shape, the next step for PV development at urban scale is being addressed. For example, the variability induced in the urban electric by PV is addressed through providing forecasts on short-term scales, allowing distribution system operators and households to make informed and efficient grid management decisions. These forecasting abilities stimulate the creation of new jobs in energy-trading, and specifically in re-grouping portfolios of PV systems: one can become a part of such a portfolio in order to get information allowing to sell energy at the best price available on the energy market. Another way EO contributes to urban energy planning, is through mapping the different zones of a city, i.e. where people live in the city and where they work, to understand better the amount, regularity, and distribution of electricity needs (e.g. foresee daytime consumption in office areas). Such data is readily available and can contribute to more efficient production and consumption of energy.

Compared to other energy sources, solar has advantages, as well as disadvantages: the amount of surface needed to produce a certain amount of energy is much larger in the case of solar and this can be a potential barrier to social acceptance. Providing the adequate space for PV and solar development has proved to be extremely challenging in some countries, and a solution is to share the surface with other activities (e.g. agriculture, fisheries) and enable its dual use. EO provides an excellent source for that, and interesting combinations of land use have emerged, such as the use of artificial lakes and water bodies to deploy floating PV development.

Another emerging trend is the use of bifacial PV modules: modules that are sensitive on both sides, which can be placed vertically and require less surface, while increasing the surface of PV – with possible consequences on architectural integration of PV into buildings. Moreover, bifacial PV use both the direct sunlight and its reflection off the ground to capture more light. This new factor – the complex way how the ground is reflecting the sun – described by the spectral bidirectional reflection distribution function (BRDF) can as well be mapped as relevant data are operationally obtained by EO satellites.

Another important aspect is the efficiency of PV modules. This depends notably on the energy distribution within the light spectrum, as different PVs have different spectral sensitivities. If one has data for the spectrum of light reaching the PVs, the best PVs can be selected to fit the particular spectral distribution of energy in a specific location or climate. The variability is mostly dependent on presence of aerosols (dust, sea salt, black carbon, etc.), water vapor, ozone and other gases in the atmosphere. This information is available through in situ data and numerical weather modules (e.g. CAMS provides information on water vapor, ozone, and aerosol). With the advancement of PV technology there is a “zoo of PV technologies”, to choose from in order to increase efficiency while decreasing at the same time the costs.

As for policy trends, beyond the abovementioned commitment on behalf of UN and EU, renewable energy policies are very country-specific (with different overall energy needs and needs for different types of energy). However, they often point at the same goal: increase the share of renewables within the country. As a consequence, the implementation means can coincide in different countries, and one example is self-consumption of solar energy; in May 2017, France allowed users having a PV installed to self-consume the energy when possible. Later, a similar law passed in Spain and in other countries, reflecting the trend of self-consumption. Another general policy trend in RE within Europe is the tendency for a country to push the RE sector to develop by itself relying less (if at all) on incentives. And the reason for this independence form government help lies in the maturity of the sector, which has reached a point to offer competitive products and services based on (already) cheap and renewable sources. Given the importance of exploiting renewable energy as a means to achieve the EU Green Deal goals and the SDG 7, and in view of the role EO can play in that regard, the e-shape Market Trends Observatory will continue monitoring relevant trends and generating appropriate insights.

This article is based on contributions from: Philippe Blanc (MINES ParisTech) and Lionel Menard (MINES ParisTech).

4.6 Common Agricultural Policy – driver and beneficiary of Earth Observation solutions

The production of food, development of rural communities, and environmentally sustainable farming are all high on the agenda of the European Union (EU). Policies and support mechanisms for agriculture aim, among other, to secure the sufficient and sustainable production of safe food, employment and innovation in the sector, and a positive impact on linked communities and the economy at large.

The EU's common agricultural policy (CAP) is a partnership between agriculture and society, and between Europe and its farmers. A common policy for all EU countries, it supports the above-mentioned goals through nine objectives:

- Enabling a fair income
- Increasing competitiveness
- Rebalancing power in the food chain
- Fostering action regarding climate change
- Encouraging environmental care
- Preserving landscapes & biodiversity
- Supporting generational renewal
- Keeping rural areas vibrant
- Protecting food & health quality

Since 1962, and throughout a series of reforms, the CAP has not only supported farmers in their efforts to supply EU citizens with good quality and safe food; it has also been guiding the implementation of sustainable agriculture across the EU. One element to achieve the CAP's objectives are direct payments and subsidies to farmers through paying agencies in the EU Member States (direct payments and rural development making up roughly 80% of the CAP). These paying agencies claim expenditures from the EU budget to be reimbursed by the European Commission (EC) to the EU countries. Management and checking systems are in place to ensure the eligibility of fund applications.

The latest amendment on the CAP regulation, introduced in May 2018, attempts to modernise the implementation of checks for area-based payments and for cross-compliance requirements. This landmark change foresees that modern solutions such as geo-tagged photos, E-GNSS enabled receivers, and data from Copernicus Sentinel satellites are used to carry out checks. One initiative to the CAP modernisation is the project New IACS Vision in Action (NIVA), in which nine paying agencies bundle their efforts for a streamlined approach to an Integrated Administration and Control System (IACS).

Meeting the CAP's objectives, drives the development of Earth Observation (EO)-based services for agriculture, food security, and environment. Thus, the CAP explicitly encourages farmers to apply precision farming, and Member States to use Big Data and new technologies for monitoring and checks. EO data is already used as evidence when checking area-based CAP payments to farmers. The Sentinels for Common Agricultural Policy (Sen4CAP) project, set up by the European Space Agency (ESA) in collaboration with the European Commission, aims at providing CAP stakeholders such as Paying Agencies with validated algorithms, products, workflows and best practices for agriculture monitoring relevant for the management of the CAP. In that context, e-shape Pilot 1.2 (EU-CAP Support) aims to support farmers in being CAP-compliant and in utilising the data also for optimising the performance of their farms. Similarly, the project "PeRsonalised public sErvices in support of the implementation of the CAP" (RECAP) created a Software-as-a-Service platform to facilitate compliance with the CAP. Such projects, but also contracts with public authorities represent great business opportunities for EO service providers.

To fulfil their duties, paying agencies rely on data and IT systems that enable evaluation checks with that data – one system for farmers making declarations, one system for agencies controlling. Different countries, or even regions, have different approaches for implementing solutions: some develop their own, others may outsource data services (sometimes even the analysis of data) as well as systems and infrastructure to the private sector, which in itself represents business opportunities. The solutions enabling compliance checks need to constantly evolve, e.g. to involve farmers more, increase accuracy of crop detection and variety of crops, etc. This opens up the space for new business, but also new actors, e.g. coming from a machine learning and Artificial Intelligence (AI) background.

Data for CAP monitoring may come from Sentinel-1 and -2 or Landsat (all free). Specific applications or crops and smaller parcels may require higher resolution data provided by commercial providers (e.g. Maxar, Airbus, Planet, etc.). Every paying agency through their contract with European Commission or their national space agencies has access to 3-7 high-resolution images per year. Some paying agencies have contracts with commercial providers themselves. Other agencies have instances in one or more of the Copernicus Data Information Access Services (DIAS) or host their own Cloud platform – the landscape of EO platforms is currently cluttered.

In all cases, the data is most often used for crop classification, i.e. to check whether eligible crops are being grown at the right time of the year. Other aspects include change detection of agricultural activities (e.g. mowing, harvest). Minimum agricultural activity on eligible areas can be verified through e.g. detection of cattle, mowing stripes, or spraying tracks. Also, through geometry checks, which requires high resolution imagery, ineligible features can be detected.

A general trend in requirements and solutions is that for more automation. The classic approach is to manually check every image and mark anomalies. Machine Learning approaches (e.g. Deep Neural Networks) show promising results for automating these steps obtaining information on crop types and agricultural activities. Other means to reduce manual workload are provided by image segmentation software that splits parcels into smaller segments, reducing the amount of non-relevant data to be processed. Agencies require an online platform they can use, need to be able to understand the tools behind, and prefer open source solutions accessible in-house and integrated with their other systems.

Providing agencies with automated solutions is a great opportunity for service providers, and the time is ripe: Currently, Member States have to randomly check 5% of their country's parcels. Soon, they will be moving to "checks by monitoring", putting together national-scale monitoring systems, which for some will require significant IT system changes to provide compatibility of data, workplaces, interoperability with dedicated systems etc. The growing amount of data to be processed implies further capacity needs.

Beyond compliance checks, EO can support farmers to optimise production in a more sustainable way: monitoring their crops; analysing soil, climate, and weather conditions; enabling variable rate application of seeds, water, and fertiliser; or evaluating damage for insurance or compensation. e-shape Pilot 1.1 (GEOGLAM), for instance, addresses the processing and analysis of agricultural information from combined sources. Pilot 1.3 (Vegetation-Index Crop-Insurance in Ethiopia) provides a geodata-driven insurance to smallholder farmers. Pilot 1.4 (Agro industry) provides agriculture with services to resist and adapt to climate change.

Overall, modernising the CAP will require more use of new imaging technology, and changing from a traditional rule-based approach to new intelligent Machine Learning solutions. The agencies will have to trust Deep Learning algorithms. Synergies between different satellite data types (i.e. radar and optical) will enable more dense time series. And algorithms are constantly trained to recognise a larger variety of crops and conditions. Developments in agricultural monitoring and enabling technologies such as exemplarily mentioned above will be monitored and presented by the e-shape Market Trends Observatory.

This article has been provided with the support of Yorgos Efstathiou from e-shape partner NEUROPUBLIC.

4.7 Navigating the landscape of EO platforms

The first images of Earth from space were taken in 1946 from aboard a V-2 rocket sent to space by the United States. They had no market as such, but less than two decades later the first weather satellites sent their images back to Earth. Ever since, the amount of satellites, of the data they capture, and the applications and business models they serve has vastly increased.

To be able to make use of this data and to eventually turn it into insights requires solutions to store, process, and analyse data and to make the data itself as well as the retrieved information and associated services accessible and usable. This asks for online, Cloud-based solutions with high performance computing and innovative processing and analytical capabilities.

And such solutions exist plenty, provided by ICT players, Earth Observation (EO) companies, as well as a growing number of start-ups and SMEs with solutions for different aspects that can be divided into four major tiers:

- The "**Data Generation Tier**", which includes open EO data catalogues (e.g. Sentinels, Landsat), proprietary data from private operators, or higher-level/derived products.
- The "**Resources Tier**", where Cloud-based computational services enable users to process data in the Cloud.
- The "**Platform Tier**", which provides web-interface services and toolboxes to add value to the data and produce or expose services.
- The "**Knowledge Tier**", where end-users gain access to the derived insights.

Navigating the complex landscape of EO platforms and understanding what each platform has to offer is essential for companies and entrepreneurs who want to bring their services to the market. However, there is currently a lack of consolidated knowledge about the existing resources – datasets, platforms, communities – and their fit with a specific task. In particular, an overview of sources of in-situ observations seems unavailable. And even if platforms have been identified, they vary to a degree that making a choice is not always obvious: the type of data they offer (e.g. global or local, real-time, spatial, from different sources), the quality of the data, the price of the offering, data policies, data that is differently curated and archived, different APIs to interact with thematic data etc., and certain tasks may require using multiple platforms.

At a high-level perspective related to platforms in different or even across tiers, the following platforms should be mentioned:

- The Copernicus Data and Information Access Services (DIAS) aim to ensure easy, cost-efficient and reliable access to Copernicus data and provide storage, computing, processing tools, software packages, etc. Today, five such services are available: Creodias, Mundi, ONDA, Sobloo, and Wekeo, each with a specific value proposition on top of basic access to data. A good overview on the capabilities of each DIAS is being maintained by EARSC.

- Google Earth Engine and Amazon Web Services are the most widely used platforms. They offer access to major open-source EO data catalogues alongside scalable Cloud-based infrastructure.
- Satellite imagery providers are increasingly shifting to data analytics services executed through their own platforms. Examples would be Maxar's GBDX and Planet's Explorer.
- Sector-specific platforms providing fit-for-purpose analytical tools are also on the rise. Thus, a number of Thematic Exploitation Platforms have been launched, alongside FAO's SEPAL and many other web portals.

But there is much more out there. Within e-shape's Work Package 3, a high-level framework is being developed to understand platform offerings and their APIs, and to catalogue these platforms. More than 30 such platforms, mostly located in Europe, have been identified and classified. With further feedback from e-shape pilots, the framework will take shape and will be made available to contribute to the European GEO System of Systems. The e-shape Market Trends Observatory will be closely monitoring the progress of this work and all associated developments in order to produce insights that could be used by e-shape pilot partners and the EO community at large.

This article has been informed by Marie-Francoise Voidrot-Martinez from the Open Geospatial Consortium.

4.8 Monitoring the status, function, and disruption of ecosystems

Ecosystems are open, dynamic, and highly complex systems of coexisting organisms and their natural environment. Keeping these systems stable and in balance can be desirable if it affects biodiversity, the food chain, other resources and functions critical for humans, and the liveability on Earth in general. Manmade and natural disasters, the climate, and the use of land, the oceans, and even airspace can disturb this balance.

To keep things under control, it is necessary to observe ecosystems to understand their status, their functioning and importance, as well as what impacts them in a good or bad way. This is not an optional effort, as policies and agreements on national and international levels demand the protection of ecosystems. The European Environment Agency (EEA) would be one of the authorities looking into ecosystems.

Observations may take place on the ground or by means of remote sensing. A plethora of data is available on ecosystems and the aspects affecting them. This enables, for instance, the production of land cover maps for the assessment and monitoring of ecosystems. Fed by satellite imagery, timeseries are produced and are visualised in maps that present changes in land cover e.g. caused by deforestation, urbanisation, or water distribution. Satellite data is also used to assess disturbance events affecting key parameters in an ecosystem, e.g. by observing vegetation phenology.

To observe ecosystems and their functions, a wide range of indicators need to be measured. To achieve that a number of different sensors is required. Here, the Copernicus Sentinels are well equipped to cover aspects of land use, marine ecosystems, or the atmosphere where such indicators can be found. Their global coverage with free and open access could (and does) enable many applications dedicated to the monitoring of ecosystems. Valuable data would come from e.g. the Copernicus Land Monitoring Service, the Copernicus Marine Environment Monitoring Service, the Copernicus Atmospheric Monitoring Service, or the Copernicus Climate Change Service. Another example is the EnMAP mission, which provides measurements of ecosystems' processes and supports applications for measuring climate change impact, biodiversity, hazard risks, and other processes and aspects. Other missions, e.g. by NASA, will enable surface chemistry analysis with hyperspectral sensors. The Canadian

Space Agency utilises their RADARSAT and SMOS missions to monitor indicators for ecosystems, and many other satellites and sensors in support of ecosystem monitoring exist given the diversity of indicators needed.

Combining the various sources and types of information consistently to derive actionable information – e.g. for policy making, measuring impact of measures, or defining initiatives – is a challenge on its own and an opportunity for Earth Observation (EO) companies to create value. The e-shape myEcosystem showcase is addressing the integration of in-situ and remote sensing data for different aspects of ecosystems in three pilots:

- Pilot 4.1 (mySPACE) is developing ways to monitor and model trends and states of ecosystems, integrating remote sensing maps and in-situ data in support of e.g. environmental agencies or policy makers.
- Pilot 4.2 (mySITE) is developing ecosystem status indicators, visualising and combining in-situ and satellite data.
- Pilot 4.3 (myVARIABLE) is developing a framework for measurements for biodiversity changes and services based on such data, coming from in-situ or remote sensing sources.

Across these pilots, data is being combined such as canopy chlorophyll concentration, land surface phenology, vegetation height, species frequency data, snow cover, land surface temperature, sea surface temperature, meteo-climate data, data from most of the Copernicus Services, data from other satellites such as Landsat, and a plethora of in-situ data.

Overall, ecosystem monitoring is a challenging opportunity. Policy makers need reliable information, and the knowledge about and positive influence on function and status of ecosystems is in the interest not only of science, but also of economy and society.

The Market Trends Observatory will monitor the evolution of market needs in this domain and enablers (technology, market or policy-related) for efficient ecosystem monitoring.

4.9 EO achievements for disaster resilience bring new business opportunities

Improving disaster resilience is a key global challenge that unites different stakeholders across the planet. Between 1998 and 2017, around 4.5 billion people have been affected by disasters, with catastrophes such as the Australian bushfires of 2019-2020 killing 1.25 billion animals and affecting biodiversity to an unprecedented extent. Furthermore, in 2018 alone a sample of 63 countries have reported $17.5 billion in direct economic loss, with agricultural losses reaching $13 billion. Specialists estimate that real economic losses amount to hundreds of billions of dollars – in 2019 the figure reached $232 billion. The grim reality represented in these figures becomes even more critical when considering that both natural and human induced disasters such as floods, droughts, fires, extreme weather events and geo-hazards, are predicted to increase in frequency and intensity due to climate change, unplanned and rapid urbanization, poverty, and other factors.

Building resilience is a key factor in addressing this reality. In that regard, Earth Observation (EO) plays an important role as it allows for real- and quasi-real-time monitoring, forecasting and assessment of disasters and their impact. The advancement of both the EO sector and the EO-enabling technologies such as more efficient data gathering, processing, or analysing, make EO-based solutions more effective in supporting disaster resilience, and give rise to new market trends associated with significant opportunities for business growth.

Enabled by technological developments, EO has greatly increased its role in security and emergency response in the last 10-15 years. This is perhaps best exemplified in satellite-powered global real-time information services such as the Copernicus Emergency Management Service (EMS). Today, EO has a critical role in discovery, monitoring, and assessment of crises and emergencies, identifying affected areas, mapping infrastructures and their damages, evaluating how many people are at risk, and designing mitigation measures. Dr. Haris Kontoes, Research Director in the Institute for Astronomy and Astrophysics Space Applications and Remote Sensing of the National Observatory of Athens (NOA, leader of the e-shape's Disasters Resilience showcase),Coordinator of the BEYOND Center of Excellence, emphasises that *"Earth Observation goes beyond monitoring and assessment of disasters"*. Indeed, sophisticated simulation modelling that incorporates satellite data enables a variety of new added value services such as predicting bushfires in Australia and preventing large-scale damage in the future.

This capability can be nicely understood when considering floods, the most widespread hazard in Europe with around 85% of all European civil protection measures addressing this issue. For flood hazard and risk assessment, the images from Copernicus Sentinel-1A and -1B satellites are processed and classified in an automated way, combined with in-situ data and population density information. Integration of different data inputs, classification through trained algorithms and simulation modelling enable not only predicting the hazard, but also more efficient rescue and recovery efforts and fast and precise damage assessment. For instance, the flood maps created by the researchers of the Luxembourg Institute of Science and Technology (LIST), processed using the algorithm the scientists had developed, were used in the aftermath of the hurricanes Harvey and Irma that ravaged the United States in the end of summer 2017. Similarly, EO informs a better and more efficient crisis response and recovery in the case of other disasters.

The increasing role of EO in disaster resilience building is enabled by technology and data availability and quality. Copernicus Sentinels-1, -2, and -5p with their regular revisit times provide vast amounts of high-resolution data (SAR, multispectral) which can then be "translated" into actionable information thanks to advanced algorithms. As pointed out by Dr. Kontoes, *"the current exponential growth in the amount of data brings great advantages, but also challenges for ensuring capacity and capabilities needed for processing it"*. In numbers, NOA/BEYOND receives 80.000 images per day covering the whole globe and in a seasonal estimate for one region in Greece processes 1.000 terabytes of information. According to global estimations, less than 5% of available data is currently being used and less than 10% of disasters are mapped. Therefore, technologies and solutions such as Cloud Computing, data cubes, Cloud repositories, or machine learning are crucial. For instance, Artificial Intelligence (AI) is used in crisis management for applications such as the TSAR AI platform which automates analysing and annotating disaster maps.

By improving disaster resilience, EO has a role in achieving specific goals agreed by the United Nations and stated in major political frameworks – most notably the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals of the 2030 Agenda (SDGs: 2-zero hunger, 11-sustainable cities and communities, as well as 1-no poverty, and 13-climate action). Collaboration between international, but also national and regional authorities and EO actors is identified as an important pre-requisite for efficient resilience building. For example, institutions such as the National Observatory Athens partner up with both regional authorities and Copernicus for research and development of services enabling real-time crisis support for floods, fires, earthquakes, etc. Dr. Kontoes stresses the urgency of action needed from all involved parties: "*We all know the specific* *targets we need to reach by 2030. We have the necessary data; we have the capacity. If we want to be successful in achieving these targets, we have to be chasing them today.*"

The EO industry and its SMEs must build their maturity and convince the governments and private companies to use the solutions proposed by the EO community in the pursuit of these goals. In addition, there is a need to develop services evaluating the efficiency of the proposed solutions. "*We need to be able to understand to what extent a particular service has addressed a specific target of the SDGs already today, in 5 years from now, and in 10 years from now, which is the timeframe by which the SDGs have to be achieved,*" says Dr. Kontoes.

In recent years, the EO sector has extended the circle of the stakeholders involved in disaster resilience building, to include not only the civil society, civil protection authorities, or government institutes, but also private actors representing commercial sectors and different industries. In that regard, the know-how of modelling and simulations developed at the highest TRL levels can be used to propose services targeting markets which benefit the most from EO-powered risk assessment and forecasting. New stakeholders include insurance companies, the construction industry, energy companies, the aviation industry, and others.

The pilot projects developed within e-shape serve as concrete examples to that effect as they have been conceived with the vision of an "umbrella" of services helping authorities, but also enabling a commercial application. More specifically, within Pilot 6.1 (EO4D ASH - EO Data for Detection, Discrimination & Distribution (4D) of Volcanic ash), meteorological modelling combining in-situ data and remote EO data can provide volcanic ash spread estimations to **commercial airlines**. Pilot 6.2 (GEOSS for Disasters in Urban Environment) enables more precise predictions for high impact weather events in urban and peri urban environment and provides decision-making support to Civil Protection Agencies, hydro-meteorological predictions agencies, and disaster risk reduction institutions. Pilot 6.3 (Assessing Geo-hazard vulnerability of Cities & Critical Infrastructures) allows detecting small-scale ground deformation and forecast damages to pipeline networks, informing **energy companies** on which parts of their underground network need inspection to avoid leakage damaging for both the company and the general society. Pilot 6.4 (ReSAgri - Resilient & Sustainable ecosystems including Agriculture & food) integrates an advanced hazard forecasting system with EO based assimilation processes and provides risk assessment at parcel scale to **insurance companies**, **agriculture agencies**, **farming cooperatives** and even **individual farmers**.

The **insurance sector** can be singled out as one of the sectors that can the most directly benefit from both the technology, as well as the vast expertise in risk evaluation and damage assessment that can be provided by EO companies. EO helps building the competitiveness and viability of the insurance sector by increasing the accuracy of risk assessment and reducing the costs of damage assessment. For instance, CyStellar uses machine learning enabled algorithms to analyse multispectral, high resolution images provided by Copernicus Sentinel 2b satellites. The images inform about the state of the roof, presence of solar panels (increasing risk of accidents, damages, fire), state of other nearby buildings, any vegetation (increasing risk of fire), and other risk increasing or mitigating factors. This information is coupled with other data from the insurance company and third parties to provide a more informed assessment of the rate of the insurance policy. Furthermore, EO can enable expanding insurance business to areas where no viable risk assessment data has been previously available. For example, Geodata for Inclusive Finance and Food (G4IFF) initiative can provide both the insurance and the smallholder farmer crucial information on weather, drought, and soil moisture, thus providing access to financial services for farmers in the most rural areas.

Despite its strong demonstrated capability to help in disaster resilience building, the EO sector has many technical challenges to face. This includes issues such as constant calibration and validation, including complex weather influences such as strong wind, adopting systematic and automatic mapping of large areas to improve the reliability of models, or improving mapping exercises for complex areas such as urban spaces. These technical or scientific challenges are tackled and improved together with the development of the upstream sector. According to Dr. Kontoes *"the main challenge that needs to be addressed at this stage, is the upscaling of these solutions and engagement of the user communities."* An important barrier towards a more widespread development of market applications is the need for capacity building to enable and spread the use of these high-level services. In other words, users need to be trained and scientific information transformed into information accessible by the user. In addition, knowledge of the specific needs of sectors can be improved to tailor solutions that are perhaps less complex, but therefore target these needs more precisely. Alongside this capacity building, constant re-evaluation of skills or gaps in skills is necessary to maintain the competitiveness and advancement of the sector.

Special thanks to Dr. Haris Kontoes and Ms. Alexia Tsouni from the National Observatory of Athens for their time and contributions in the process of writing this article.

5 NEXT STEPS

The First Market Trends Observatory is the first deliverable and component of the Sustainability Booster. Preceding the implementation of the complete Sustainability Booster with all its components, including the final Market Trends Observatory (D5.20, M36), will be consultations about information and support needs and the creation of a business plan (D5.19, M36).

Meanwhile, the First Market Trends Observatory will be dynamically growing in content. From its launch, a continuous editorial process will be put in place that includes the identification of relevant topics and editorial meetings for review, selection, and assignment of topics. Insight articles will be elaborated by authors with the help of experts, were required. A continuous publication will ensure at minimum bi-weekly updates with new contents.

With the finalisation of all components of the Sustainability Booster and their technical implementation, the online environment of the Market Trends Observatory and its embedding within the overall Sustainability Booster will be finalised as well.

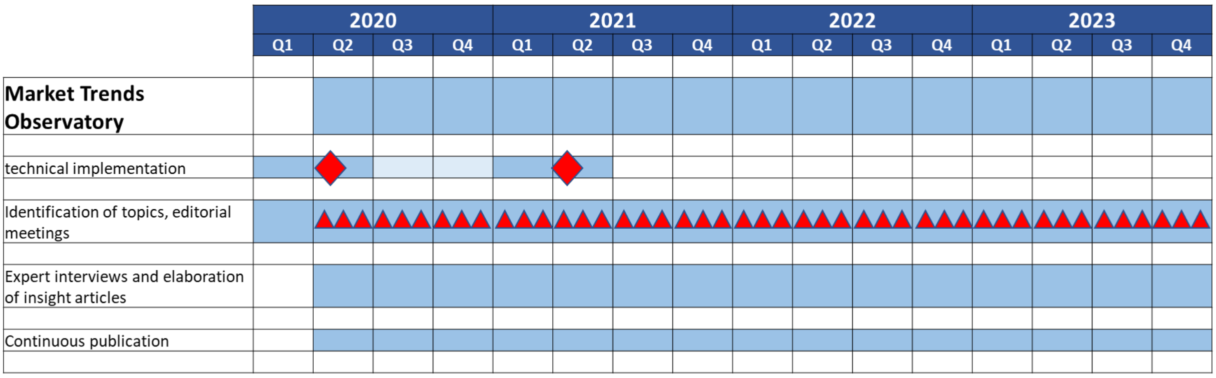

Figure 5: Timeline Market Trends Observatory