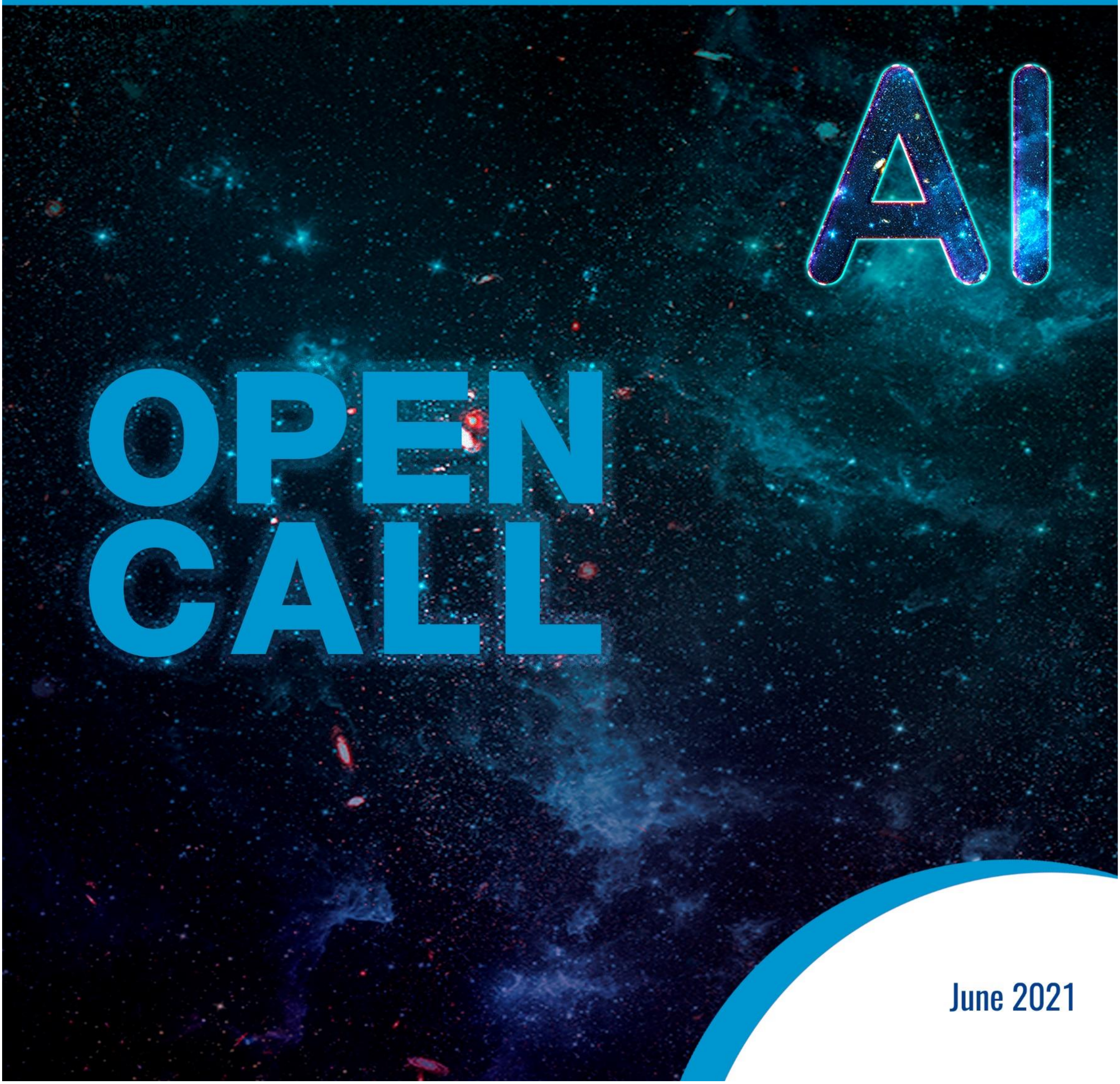
Annex 2.1:

Indicative Scenarios

Reinforcing the AI4EU Platform by Advancing Earth Observation Intelligence, Innovation and Adoption



June 2021

Table of Contents

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 101016798.

1. Introduction

The subsection provides details on indicative, exemplary scenarios for use cases and small-scale experiments of the scope and complexity expected by the project and covering the four high-value areas targeted by AI4Copernicus.

The AI4Copernicus Open Calls aim to target the needs of a diverse, broad spectrum of stakeholders including industrial users (hi-tech and low-tech companies, technology, and data providers), research and academia, the civil society (citizens and NGOs) and the public sector (governmental organizations, policy makers, public authorities).

2. The Ideal Project

The ideal project is an AI Solution based on AI technologies, where the scenarios demonstrate the reusability and effectiveness value of the resources and services brought by AU4Copernicus, while they also cover the four high impact value areas of the first wave of open calls (Security, Agriculture, Health and Environment and Health).

Applicants should be technology providers and their use cases to be addressed to people involved in the fields of industry and research, being government's employees or just being citizens.

Indicative Open Call Projects are provided in the following sections:

3. Pollution Predictions

"Pollution Predictions"	
Sector/Thematic Area: Health/Environment Domain	**Social Cause:** Various
Context: **<u>Challenge:</u>** Air pollution affects world-wide populations with an estimate of 7 million	

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premature deaths every year according to the World Health Organization, and close to half a million in Europe alone, according to the European Environmental Agency. Air of insufficient quality can not only be the direct cause of these deaths, but it can also exacerbate existing diseases in an individual, and the range of diseases where it is thought that air pollution is a driver or a factor is ever increasing including lung cancer, asthma, heart problems, pulmonary issues, or dementia.

Reliable and timely information about air pollution, especially forecasts, can help in two complementary ways: informing citizens about their exposure to pollution can help them adapt their behaviour; informing decision makers can support them for taking emission mitigation decisions (such as banning or reducing traffic or certain activities). However, the current most reliable operational air quality forecasts provided by the Copernicus Atmosphere Monitoring Service (CAMS) have a spatial resolution of 10 km, which is similar to the resolution of meteorological forecasts. This is not always sufficient, in particular for big cities with heterogeneous air quality and there is a need for downscaling information to finer spatial resolutions.

Scope: The solution in response to this challenge shall be to provide innovative machine learning models to predict the air quality at sub-city district level using various data sources that provide global and local information relevant to pollution. Solutions can be global or local for a specific area or large city or conurbation.

Dataset sources: Concentration map of air pollutants, Sentinel data, land use and topography data, meteorological data and local monitoring data (such as local pollution ground measurements and traffic information).

Some of the datasets can be accessed here:

● API interface for CAMS and C3S datasets from http://cds.climate.copernicus.eu (C3S products including ERA5, seasonal forecasts) and http://ads.atmosphere.copernicus.eu (CAMS products including reanalyses, analyses and forecasts of air quality in Europe and worldwide).

● For satellite data (mostly from S-3 and S-5P), this can be used through WEkEO or one of the other DIASes.

● CORINE Land cover product provided the Copernicus Land Monitoring Service over

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Europe, as well as global land cover products.
Output and coverage: The expected output would be a containerized service accessible through standard APIs, that can be hosted on different hardware and execution environments. This service would be able to be plugged into existing workflows and to generate improved estimates of pollution forecasts on local and peripheral level. The estimates should be re-trainable and adjustable for new data inputs and datasets that will become available in the future.
Usage of AI4Copernicus Services: As part of AI4Copernicus, bootstrapping services will be made available to support the challenge and the use of machine learning tools in the context of Copernicus data and the DIASes.
Expected Impact (technical social, economic, environmental, policy etc.): Technical ● Development of deep learning techniques to merge large scale prediction information with local information on a finer (potentially unstructured) grid. ● Development of machine learning techniques that take multi-scale behaviour of atmospheric dynamics into account in both space and time, such as Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks. ● Support scientific researches with vanilla solution for machine learning down-scaling applications on the DIASes. Social ● Improve awareness of exposure of society to pollution and the related impacts on health and well-being. ● Warn individual citizens with personalised risks estimated according to their location and activities. ● Highlight best practices in the world to tackle air pollution.

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Economical

● Stimulate tourism in small cities or the countryside with better air quality.

● Support development of real estate in cleaner areas.

Environmental

● Identify critical areas in a region.

Policy

● Advice policy makers on pollution related questions regarding city developments and traffic regulations.

● Advice policy makers on health impact of various sources of pollution.

● Advice policy makers on urban and suburban design plans.

4. Greenhouse gases emissions

"Greenhouse gases emissions"	
Sector/Thematic Area: Health/Environment Domain	**Social Cause:** Various
Content: **Challenge:** As part of the Paris Agreement under the auspices of the United Nations' Framework Convention on Climate Change (UNFCCC), the governments from all over the world agreed to establish political measures in order to reduce the accumulation of greenhouse gases in the atmosphere in order to limit global warming to +1.5 to +2 degrees compared to the pre-industrial period. In particular, the Green Deal aims to transform Europe into the first carbon-neutral continent in the world by 2050. Estimating greenhouse gases emissions is essential to monitor progress towards this ambitious target and more generally of the efforts of all the countries in the world.	

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However, the current state of the art to estimate these emissions generally relies on accounting of emission sources which are often uncertain. As part of Copernicus, a new element of the Copernicus Atmosphere Monitoring Service (CAMS) is being developed to enable monitoring of anthropogenic emissions of CO2. It will rely on new satellite observations as well as on very advanced processing techniques, which are required for disentangling human emissions from the other sources and sinks in the carbon cycle.

Scope: The solution in response to this challenge shall be to provide innovative machine learning models to support the estimation of greenhouse gases concentrations and emissions by combining Earth observation data combined and other types of information and building on the information in particular available from CAMS. Solutions should focus on specific areas or large cities and aim at refining the information that is already available from Copernicus.

Dataset sources: Atmospheric concentrations and emissions inventories of greenhouse gases, Sentinel data, land use and topography, meteorological data and local monitoring data (such as local greenhouse gases ground measurements, traffic information, factory localization).

Some of the datasets can be accessed here:

- API interface for CAMS and C3S datasets from http://cds.climate.copernicus.eu (C3S products including ERA5, seasonal forecasts) and http://ads.atmosphere.copernicus.eu (CAMS products including emissions inventories of greenhouse gases, as well as reanalyses, analyses and forecasts of CO2 and CH4 worldwide).
- For satellite data (methane from S-5P), this can be used through WEkEO or one of the other DIASes. Other satellite data such as from OCO-2 (NASA) or GOSAT (JAXA) may also be used.
- CORINE Land cover product provided the Copernicus Land Monitoring Service over Europe, as well as global land cover products
- European Forest Fire Information System (EFFIS)

Output and coverage: The expected output would be a containerized service accessible through standard APIs, that can be hosted on different hardware and execution environments. This service would be able to be plugged into existing workflows and to

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generate improved estimates of greenhouse gas concentration and emission. The estimates should be re-trainable and adjustable for new data inputs and datasets that will become available in the future.
AI4Copernicus Services: As part of AI4Copernicus bootstrapping services will be made available to support the challenge and the use of machine learning tools in the context of Copernicus data and the DIASes.
Expected Impact (technical social, economic, environmental, policy etc.): Technical ● Development of deep learning techniques to fuse datasets to enhance local information. ● Development of machine learning techniques that take multi-scale behaviour of atmospheric dynamics into account in both space and time, such as Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) features) networks. ● Support scientific researches with vanilla solution for machine learning down-scaling and data fusion applications on the DIASes. Social ● Improve knowledge about greenhouse gas emissions that are driving anthropogenic climate change. ● Inform individual citizens and policy makers and allow them to attribute greenhouse gas emissions and sinks to local features. Economical ● Identify sources and sinks of greenhouse gases to provide additional information for emission trading. Environmental ● Identify sources of greenhouse gases within a region. Policy ● Advice policy makers on local greenhouse gas emissions. Monitor the impact of private companies on greenhouse gases emissions ● Monitor progress towards regional or national-level targets (such as Nationally Determined Contributions) and contribution to the stocktake exercises of the Paris Agreement.

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5. Disease spread forecasting

<table>
<tr><th colspan="2">“Disease spread forecasting”</th></tr>
<tr><td>Sector/Thematic Area:
Health/Environment Domain</td><td>Social Cause:
Various</td></tr>
<tr><td colspan="2">Content:

<u>Challenge:</u> Air pollution and particular weather conditions can play a role in the spread of some diseases, such as Malaria, the Flu, or Covid both directly and indirectly by affecting human behaviour (indoor vs outdoor, etc..). Forecasting the probability of occurrence of these diseases can help the management of outbreaks and health service resources. However, conventional approaches used to predict these probabilities do not allow to “learn” the behaviour of these diseases as they appear and evolve in time.

<u>Scope</u>: The solution in response to this challenge shall be to provide innovative machine learning models to forecast risk for development and spread of certain diseases using pollution and weather past (analyses, reanalyses) and forecasts data.</td></tr>
<tr><td colspan="2">Dataset source: Concentration map of air pollutants, Sentinel data, land use and topography, meteorological data and local monitoring data (such as local pollution, ground measurements, local weather observations, health information).

Some of the datasets can be accessed here:
API interface for CAMS and C3S datasets from http://cds.climate.copernicus.eu (C3S products including ERA5, seasonal forecasts) and http://ads.atmosphere.copernicus.eu (CAMS products including analyses and forecasts of air quality in Europe and worldwide).
For satellite data (mostly from S-3 and S-5P), this can be used through WEkEO or one of the other DIASes.
CORINE Land cover product provided the Copernicus Land Monitoring Service over Europe, as well as global land cover products.</td></tr>
</table>

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Output and coverage: The expected output would be a containerized service accessible through standard APIs, that can be hosted on different hardware and execution environments. This service would be able to be plugged into existing workflows and to generate improved estimates of disease spreads based on pollution and weather (climatological and forecast) data. The estimates should be re-trainable and adjustable for new data inputs and datasets that will become available in the future.
AI4Copernicus Services: As part of AI4Copernicus, bootstrapping services will be made available to support the challenge and the use of machine learning tools in the context of Copernicus data and the DIASes.
Expected Impact (technical social, economic, environmental, policy etc.): Technical ● Development of deep learning techniques to fuse datasets from environmental science and health applications. ● Support scientific researchers with vanilla solutions for machine learning for health applications. Social ● Improve knowledge of the impact of environmental data on the spread of diseases. ● Inform individual citizens and policy makers about areas at risk for the spreading of diseases. Economical ● Allow to respond to risk alerts for specific diseases and to adapt travel plans, for example for tourism. Policy ● Help policy makers in the management and prevention of outbreaks of diseases and to allow for the timely distribution of medical resources.

6. Climate security understanding

''Climate security understanding''

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Sector/Thematic Area: Security Domain	**Social Cause:** Various

Content:

<u>Challenge:</u> The society continuously faces security threats. In the last decade, these threads have increased and proceed from causes not considered a priority in the past. For instance, changes in climate patterns can introduce major risks in some regions, extreme weather events can lead to forced population displacements, natural or man-made hazards can result in air pollution, illegal activities can damage ecosystems, uncontrolled fires can endanger citizens and damage ecosystems, unforeseen measures can bring about socio-economic hardships for citizens.

Documenting and understanding Earth's changing climate allows to support decision making for the security of our planet. As climate security is a quite new topic, AI tools are not completely exploited in this domain. These model analyses are even more important as climate security is a cross-domains, that regroups different expertise.

<u>Scope:</u>

The solutions in response to this call shall be able to extract relevant information that allow to address scenarios in which climate change is affecting safety and security of people (e.g. forced migration caused by environmental hazards, food insecurity due to climate variations in vulnerable areas, scarcity of resources due to climate changes (e.g. water).

Dataset sources: Sentinel data (mandatory), meteorological data (asset), statistical data - e.g. population density, economic indicators or number of conflicts- (asset), other remote sensing data (e.g. Landsat), navigation/localization data.

It is important to use at least two different data sources.

Any other data can be used if relevant for the call scope. In this case, the data must be accessible (free of charge or not) so a possible operational use of the solution is guaranteed.

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Output and coverage:

- Services (available through API and Dockers)
- Datacube (e.g. from heterogeneous datasets)
- Models (e.g. statistical relationship between different variables)

AoI shall be selected outside EU territory.

Usage of AI4Copernicus Services: The following bootstrapping services will be made available:

- Pre-processing chains for Sentinel-1 and Sentinel-2 data products in order to obtain ready to use images for algorithms based on AI
- Processing pipelines for Sentinel-1 and Sentinel-2 data products (e.g. change detection pipeline)
- OpenStreetMap-derived vector data (e.g. line of communications, buildings)

Expected Impact (technical social, economic, environmental, policy etc.):

Technical

- Quantitative step forward in the use of AI technologies in EO-based applications for security scenarios;
- Interoperable solutions to be able to work in multi-disciplinary environments;
- Increased capacity of processing and analysing large volumes of Copernicus Earth Observation data;
- Develop statistical tool to infer about the relationship between climate and security;
- Create and/or enlarge existing data-cubes with heterogeneous data for climate and security (e.g. EO, statistical, meteo);
- Increased performance and/or automation of image processing, in order to have pre-operational services to be used in GEOINT tasks.

Socio-Economic

- Enlargement of the number of solution providers in security;
- Foster the use of Sentinel data and other data sources;
- Enhance the understanding of security threats for the general public, including EU citizens and international actors.

Policy

- Foster the use of EO data analysis for policy and decision-making in global (e.g. UN Sustainable Development Goals) and EU domain (e.g. EU Common Foreign Security

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Policy, EU Green Deal); ● Contribute with the results to the different active initiatives in the EO domain, including the GEO Space and Security Community Activity and EuroGEO.

7. Anomaly detection on critical infrastructures

"Anomaly detection on critical infrastructures"	
Sector/Thematic Area: Security Domain	**Social Cause:** Various
Content: **<u>Challenge:</u>** Critical infrastructure is defined as systems and assets so vital that the disruption of the service provided would have a debilitating or catastrophic impact on security or safety of a nation or a group of nations. Examples of critical infrastructure are dams, water treatment facilities, oil fields, pipelines, pumping stations, airports, highways and governmental buildings. These infrastructures face certain risks associated with different threats, regardless of whether they are a result of accidents, natural events or international acts. The identification of critical infrastructure under threat enables crisis management officials and first responders to prepare for possible damages. However, this work requires a complex analysis of the influential factors, both spatial and non-spatial, which is currently performed with an intense human effort due to the lack of automatized means to detect and/or identify features of interest. **<u>Scope:</u>** The solution in response to this challenge shall be to provide innovative AI models to detect and/or identify automatically man-made infrastructures (e.g. roads, buildings, ports) and estimate if these infrastructures present anomalies (e.g. road blockages, infrastructure dismantling) or relevant changes, considering time series.	

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Dataset sources: Sentinel-1 and/or Sentinel-2 data (mandatory), VHR data (asset), navigation/localization data, meteorological data

Any other data can be used if relevant for the call scope. In this case, the data must be accessible (free of charge or not) so a possible operational use of the solution is guaranteed.

Output and coverage: The expected output is a service (available through API) or a tool (dockerized) that can be executed in different AoIs to generate "anomaly maps" (as vector and/or raster).

Note: AoI can be selected by the bidders but the methodology shall be applicable in other AoI. Although it is expected a higher performance in specific areas, a good performance in any area will be considered an asset.

AI4Copernicus Services:

The following bootstrapping services will be made available:

- Pre-processing chains for Sentinel-1 and Sentinel-2 data products in order to obtain ready to use images for algorithms based on AI
- Processing pipelines for Sentinel-1 and Sentinel-2 data products (e.g. customizable S2 change detection pipeline based on CVA)
- OpenStreetMap-derived vector data (e.g. roads, buildings)
- Ground truth data (for validation, according to the area proposed and its availability).

Expected Impact (technical social, economic, environmental, policy etc.):

Technical

- Quantitative step forward in the use of AI technologies in EO-based applications for security scenarios;
- Interoperable solutions to be able to work in multi-disciplinary environments;
- Increased processing and analysis capacity for large volumes of Copernicus Earth Observation data;
- Develop operational tools for feature detection and anomaly detection;
- Increased performance and/or automation of image processing, in order to have pre-operational services to be used in GEOINT tasks.

Socio-Economic

- Enlargement of the number of solution providers in security;
- Foster the use of Sentinel data and other data sources;
- Enhance the understanding of security threats for the general public, including EU

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citizens and international actors. Policy ● Foster the use of EO data analysis for policy and decision-making in EU domain (e.g. EU Common Foreign Security Policy); ● Contribute with the results to the different active initiatives in the EO domain, including the GEO Space and Security Community Activity and EuroGEO.

8. Maritime situational awareness identification

''Maritime situational awareness identification''	
Sector/Thematic Area: Security Domain	**Social Cause:** Various
Content: **Challenge:** Current maritime navigation, surveillance, and communications systems, combined with today's network technologies, create enormous amounts of data collected providing information of vessels operating worldwide. This information is crucial to enhance maritime situational awareness, to plan safe and rescue operations for coast guards and to detect illegal activities. However, the available data come from different domains and data providers (e.g. AIS, Copernicus, Search and Rescue, coast cameras), what makes the fusion of different data sources quite complicated. Thus, the sources are often used separately. Moreover, the vast amounts of data cause that one specific event of interest is often lost in the regular traffic patterns. All these problems result in difficult, delayed or impaired decision-making in front of a real scenario. **Scope:** The solution in response to this challenge shall provide innovative AI models to extract relevant information to support safe and secure activity in maritime domain (e.g. vessel direction, vessel speed, route anomalies), using one or more data sources.	

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Dataset sources: Sentinel-1 and/or Sentinel-2 data (mandatory), VHR images, AIS data (asset), meteorological data.

Any other data can be used if relevant for the call scope. In this case, the data must be accessible (free of charge or not) so a possible operational use of the solution is guaranteed.

Output and coverage: The expected output is a service (available through API and Dockers), which can include models (e.g. machine learning tools) and generate images (as vectors and raster) and databases (e.g. csv files with coordinates).

AoI can be selected by the bidders but the methodology shall be applicable to other AoI.

AI4Copernicus Services: The following bootstrapping services will be made available:

- Pre-processing chains for Sentinel-1 and Sentinel-2 data products in order to obtain ready to use images for algorithms based on AI
- Processing pipelines for Sentinel-1 and Sentinel-2 data products (e.g. change detection pipeline)

Expected Impact (technical social, economic, environmental, policy etc.):

Technical

- Foster the use of new data sources relevant for maritime awareness and the identification of data or technology gaps to be filled;
- Quantitative step forward in the use of AI technologies in EO-based applications for security scenarios;
- Interoperable solutions to be able to work in multi-disciplinary environments;
- Increased processing and analysis capacity for large volumes of Copernicus Earth Observation data;
- Develop operational tools for increase the capacity in the maritime awareness domain;
- Increased performance and/or automation of image processing, in order to have pre-operational services to be used in GEOINT tasks.

Socio-Economic

- Enlargement of the number of solution providers in security;
- Foster the use of Sentinel data and other data sources;
- Enhance the understanding of security threats for the general public, including EU citizens and international actors.

Policy

- Foster the use of EO data analysis for policy and decision-making in EU domain (e.g.

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EU Common Foreign Security Policy);
- Contribute with the results to the different active initiatives in the EO domain, including the GEO Space and Security Community Activity and EuroGEO.

9. Synergy of EO and geolocation data for security applications

"Synergy of EO and geolocation data for security applications"	
Sector/Thematic Area: Security Domain	**Social Cause:** Various

Content:

Challenge: The evolving space and security environment is facing the rise of new technologies and business models in different domains including Space, ICT, Security and Communication. Collateral data sources could be used to complement the evidence derived by satellite data and enhance the information provided to users / decision-makers in the Space and Security domain.

In recent years, the use of mobile applications has arisen significantly to the point that millions of users all over the globe make large and heterogeneous volumes of georeferenced data available. These data, fused with conventional EO imagery, can enhance the results by providing new elements to be considered in the analysis.

Synergies between EO data and geo-location data are not yet completely exploited (e.g. data availability, licensing issues, privacy issues) and their fusion could add a value to the standard practices in the security domain.

Scope: The solutions in response to this call shall extract information of human and activity patterns using EO and geolocation data (e.g. from GNSS) to detect potential risks in critical situations (e.g. hot-spot in migration routes, identification of road blockages, disruption in supply chains, etc.).

Dataset sources: GNSS data or derived geo-location data (mandatory), Sentinel data, VHR images, other remote sensing data (e.g. Landsat) and open source data (e.g. population density, economic indicators or number of conflicts).

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Any other data can be inserted if relevant for the call scope. In this case, the data must be accessible (free of charge or not) so a possible operational use of the solution is guaranteed.
Output and coverage: ● Services (available through API and Dockers) ● Models (e.g. statistical relationship between different variables) ● Datasets (e.g. geo-location files) AoI can be selected by the bidders but the methodology shall be applicable in other AoI.
AI4Copernicus Services: The following bootstrapping services will be made available: ● Pre-processing chains for Sentinel-1 and Sentinel-2 data products in order to obtain ready to use images for algorithms based on AI ● Processing pipelines for Sentinel-1 and Sentinel-2 data products (e.g. change detection pipeline)
Expected Impact (technical social, economic, environmental, policy etc.): Technical ● Quantitative step forward in the use of AI technologies in EO-based applications for security scenarios; ● Interoperable solutions to be able to work in multi-disciplinary environments; ● Increased capacity of processing and analysing large volumes of Copernicus Earth Observation data ● Develop operational tools that demonstrate the use of geo-location data with EO data in the Space and Security domain; ● Increased performance and/or automation of image processing, in order to have pre-operational services to be used in GEOINT tasks. Socio-Economic ● Enlargement of the number of solution providers in security; ● Foster the use of Sentinel data and other data sources; ● Enhance the understanding of security threats for the general public, including EU citizens and international actors. Policy ● Foster the use of EO data analysis for policy and decision-making in EU domain (e.g. EU Common Foreign Security Policy);

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- Contribute with the results to the different active initiatives in the EO domain, including the GEO Space and Security Community Activity and EuroGEO.

10. Crop dynamic monitoring

''Crop dynamic monitoring''	
Sector/Thematic Area: Agriculture Domain	**Social Cause:** Various
Content: **Challenge:** The main source of food for the population of the world is agriculture. Today, the latter faces two major challenges, the demographic explosion and climate change. That is why intensive farming practices which are thought to be sustainable have been developed to slow the deterioration of agricultural land and even regenerate soil health. In this context, there is a strong requirement for monitoring crop growth in near-real time. This information is valuable for a combination of purposes: react to extreme climatic events, anticipate food production shortages to ensure food security in the most vulnerable regions, identify factors influencing crop stress, highlight the best practices in terms of sustainability, etc. **Scope:** The solution in response to this challenge shall be to provide innovative AI models to extract phonological parameters of vegetation from complete time-series satellite images in order to monitor the full cycle at field level.	
Dataset sources: Sentinel-2 and/or Sentinel 1 data, other satellite data, in situ measurements for calibration, HR-VPP data from VITO, Land Cover, Meteorological data, Administrative Divisions dataset (GADM). Any other data can be used if relevant for the call scope. In this case, the data must be accessible (free of charge or not) so a possible operational use of the solution is guaranteed.	

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Output and coverage: The expected output is a service (available through API) or a tool (dockerized) that can be executed in different AoIs to generate maps that present one or more parameters related to crops (e.g. phenological parameters, fertilization parameters, crop stress parameters, etc.) (as vector and/or raster).
Note: AoI can be selected by the bidders but the methodology shall be applicable in other AoIs. Although it is expected to have higher performance in specific areas, a good generalization capability to other areas will be considered an asset.

AI4Copernicus Services: The following bootstrapping services will be made available:

- Standard pre-processing chains for time-series of Sentinel-2 data products
- Gap filling techniques for reconstructing time series taking into account cloud cover and irregular acquisitions in different areas
- Classification tool based on Long-Short Term Memory (LSTM) deep neural network from time-series Sentinel-2 data that can used to have an initial identification of crop type and field boundaries

Expected Impact (technical social, economic, environmental, policy etc.):

Technical

- Develop AI techniques to monitor crops growth and phonological parameters in near-real time to significantly enhance the accuracy of present systems.
- Generate accurate products based on the trend of vegetation, water and fertilization indices at crop level (considering different use of the same field in the same agronomic season) and large scale.

Socio-economic

- Information regularly extracted and comparisons among the productivities of different fields enable the definition of best practice for improving productivity.
- Improving crops monitoring and management has huge effects on food security and provides information for company insurance
- Identification of the different factors influencing crop stress to improve productivity.

Environmental

- Proper monitoring and management of crops can have a dramatic impact on the environment (e.g. in terms of rationalization of the use of chemical additives or pesticides).
- Providing best practices in terms of sustainability

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Policy
<u>Policy</u> ● Demonstrated adoption of the results of using AI in an area that is central in the policy of the European Commission and has not benefited yet from the huge potential of AI.

11. Crop type mapping

<table>
<tr><th colspan="2">"Crop type mapping"</th></tr>
<tr><td>Sector/Thematic Area:
Agriculture Domain</td><td>Social Cause: Various</td></tr>
<tr><td colspan="2">Content:
<u>Challenge:</u> Mapping crop type allows national and multinational agricultural agencies to make inventories in order to predict yields, collect crop production statistics, facilitate crop rotation records, map soil productivity, etc… However, this information is generally collected from census and ground surveys that generate multiple databases with different information extraction strategies which are not easy to integrate.
In this context, remote sensing offers an efficient and reliable means for collecting the information required. Moreover, due to the increase of the number of Earth Observation data available, crop identification can benefit from the use of multi-temporal and multi-sensor data. Indeed, certain crops are easier to discriminate at some specific periods, and different sensors can extract complementary information. For instance, optical data provide information on the chlorophyll content of the plants and radar provides information relating to plant structure and moisture.
<u>Scope:</u> The solution in response to this challenge shall be to provide innovative AI models to extract crop boundaries and/or identify crop type at country or continental level from time series of satellite images. This can be achieved by leveraging the promising activities developed in this domain in the past two years.</td></tr>
<tr><td colspan="2">Dataset sources: Sentinel-2 and Sentinel-1 data, Landsat data, HR-VPP data from VITO, Land Cover, Meteorological data, Administrative Divisions dataset (GADM). Any other data can be used if relevant for the call scope. In this case, the data must be accessible (free of charge</td></tr>
</table>

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or not) so a possible operational use of the solution is guaranteed.
Output and coverage: The expected output is a service (available through API) or a tool (dockerized) that can be executed in different AoIs to generate "crop type maps" and/or "crop boundary maps" (as vector and/or raster). Note: AoI can be selected by the bidders but the methodology shall be applicable in other AoIs. Although it is expected to have higher performance in specific areas, a good generalization capability to other areas will be considered an asset.
AI4Copernicus Services: The following bootstrapping services will be made available: ● Standard pre-processing chains for time-series of Sentinel-2 data products ● Gap filling techniques for reconstructing time series taking into account cloud cover and irregular acquisitions in different areas. ● Classification tool based on Long-Short Term Memory (LSTM) deep neural network from time-series Sentinel-2 data ● Large dataset with crop-type labelled samples coming from H2020 ExtremeEarth project (useful to train deep learning models)
Expected Impact (technical social, economic, environmental, policy etc.): Technical ● Develop AI techniques to map crops and their boundaries with Sentinel-2 and/or Sentinel 1image times series to significantly enhance the accuracy of present systems. ● Generate accurate products based on the trend of vegetation, water and fertilization indices at crop level (considering different use of the same field in the same agronomic season) and large scale. Socio-economic ● An improved capability of extracting semantic information for supporting mapping and management of agricultural areas at large scale. ● Improving crops monitoring and management has huge effects on food security. Environmental ● Proper management of crops can have a dramatic impact on the environment (e.g. in terms of rationalization of the use of chemical additives or pesticides). ● Management of resources (e.g. water for irrigation) is crucial for the environment. Policy

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- Demonstrated adoption of the results of using AI in an area that is central in the policy of the European Commission and has not benefit yet of the huge potential of AI.
- Contribute with the results to the different active initiatives in the use of EO for agriculture, enhancing the extraction of the semantic information from data with customized machine learning technologies.

12. Support irrigation management

<table>
<tr><th colspan="2">“Support irrigation management”</th></tr>
<tr><td>Sector/Thematic Area:
Agriculture Domain</td><td>Social Cause: Various</td></tr>
<tr><td colspan="2">Content:
<u>Challenge:</u> While most water services are allocated, regulated and measured, it is not the case for the irrigation sector. However, with the expansion of irrigation systems and the increasing trend towards more frequent and severe droughts, there is a real need to know the amount of water consumed and whether it is used efficiently.
Monitoring the amount of water in agricultural soils allows not only to increase water savings but also to get better crop production. Currently, this information is generally extracted from flow meters and soil moisture probes, but with the impressive proportion of land dedicated to agriculture, it is not possible to install these systems everywhere. In this context, remote sensing offers an efficient and reliable means of collecting data, above all soil moisture and plant evapotranspiration.
<u>Scope:</u> The solution in response to this challenge shall be to provide innovative AI models to support irrigation management from Earth Observation data.</td></tr>
<tr><td colspan="2">Dateset sources: Sentinel-1 and Sentinel-2 data, other satellite data, in situ measurements for calibration, Land Cover, Meteorological data, Administrative Divisions dataset (GADM). Any other data can be used if relevant for the call scope. In this case, the data must be</td></tr>
</table>

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accessible (free of charge or not) so a possible operational use of the solution is guaranteed.
Output and coverage: The expected output is a service (available through API) or a tool (dockerized) that can be executed in different AoIs to generate maps presenting variables related to irrigation(e.g., soil moisture, evapotranspiration, etc.) (as vector and/or raster). Note: AoI can be selected by the bidders but the methodology shall be applicable in other AoIs. Although it is expected to have higher performance in specific areas, a good generalization capability to other areas will be considered an asset.
AI4Copernicus Services: The following bootstrapping services will be made available: ● Standard pre-processing chains for time-series of Sentinel-2 data products ● Gap filling techniques for reconstructing time series taking into account cloud cover and irregular acquisitions in different areas.
Expected Impact (technical social, economic, environmental, policy etc.): <u>Technical</u> ● Develop AI techniques to estimate and monitor water use at single field level to significantly enhance the accuracy of present systems. ● Generate accurate, efficient and reliable products to collect data based on remote sensing techniques in the agricultural sector to support irrigation systems <u>Socio-economic</u> ● Information regularly extracted on the water use and comparisons among the productivities of different fields with respect to the irrigation strategy enable the definition of best practice for improving productivity. ● Improving the effectiveness of the irrigation system has huge effects on food security and on the productivity of producing crops. ● Increased investment in micro-irrigation technologies <u>Environmental</u> ● Better management of irrigation, water resources ● Increased awareness in relation to water resources <u>Policy</u> ● Demonstrated adoption of the results of using data incentive technologies AI in an area that is central in the policy of the European Commission ● Help farmers to be aware of the quantity of water consumed and to optimize crop production versus the amount of used water.

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- Water use and related impact on the production is a fundamental information for irrigation departments to manage periods of water scarcity, provide equity in water supplies, and to guide investment in micro-irrigation technologies for better irrigation management.
- Enhance informed decision-making capabilities of public authorities

13. Exploring optimal locations for renewable energy infrastructures

''Exploring optimal locations for renewable energy infrastructures''	
Sector/Thematic Area: Energy	**Social Cause:** Various

Content

Challenge: Renewables made up 26.2 percent of global electricity generation in 2018, and it is expected to rise to 45 percent by 2040. Most of the increase will likely come from solar, wind, and hydropower. In this context, energy companies urgently need to explore optimal locations in terms of renewable energy resources in order to get to a more sustainable future.

Currently, geospatial analytics are used to find these locations. However, Earth Observation data can provide additional, complementary and valuable layers of information.

For instance:

- In the case of wind farms, wind parameters can be estimated from LiDAR or SAR data. These spot measurements can be used to validate and improve existing models, to increase their granularity. For example, radar measurements can be converted to wind speed by measuring wave height generated by the wind
- In the case of solar panels, the main obstacle to capturing the solar energy comes from cloud shadows (from the terrain) or aerosols (particles in the atmosphere). These can all be measured or modelled based on Earth Observation data and Digital Elevation Models (DEMs)
- In the case of hydropower plant, their potential can be estimated from DEMs

Scope: The solution in response to this challenge shall be to provide methods based on

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geospatial analytics and AI models to explore the optimal locations in Europe for the various types of renewable energy infrastructure.

Dataset sources: Sentinel data, Commercial EO data, Concentration map of air pollutants, Shuttle Radar Topography Mission (DEM), Meteorological data and geo-localisation data.

Output and coverage: The expected output will be a service (available through API and Dockers), which can be integrated as a layer in a GIS system for further analysis or directly into a web map. The data will be in an open geospatial format (e.g. the layers delivered in Rapid Action on coronavirus and EO (esa.int).

AI4Copernicus Services: The following bootstrapping services will be made available:

- Pre-processing tools for Sentinel-1 and Sentinel-2 data products, as well as optimized tiling techniques for reconstructing time series
- Air-quality five-day forecasts provided the Copernicus Programme, through its CAMS service
- ERA5 reanalysis data to extract local weather observations
- Ground truth data of onshore and offshore locations - https://www.emodnet-humanactivities.eu/ and SETIS - SET Plan Information System (europa.eu)

Expected Impact (technical, social, economic, environmental, policy etc.):

Technical

- Develop AI techniques and products based on Earth Observation data to provide complementarity and value added to existing geospatial data layers

Socio-economic

- Reducing the investment costs and operational costs related to renewable energy sources
- Better location of renewables (e.g. solar and wind farms) can reduce their intermittency thus leading to smaller costs to integrate renewables into the power system

Environmental

- More efficient use of renewable energy resources (wind, sun, water, etc.) can increase their penetration reducing the reliance on fossil fuels

Policy level

- Provide improved tools for policy level planning of energy supply of renewable energy sources

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• Demonstrated adoption of the results of using AI in an area that is central in the policy of the European Commission

14. Precision maintenance support on energy infrastructures

"Precision maintenance support on energy infrastructures"	
Sector/Thematic Area: Energy	**Social Cause:** Various
Content **<u>Challenge:</u>** An efficient and reliable energy infrastructure is vital to society. With pipeline and electrical corridors stretching across vast expanses of land, city-sized solar farms and supply chains that demand ever-increasing security, there is a strong energy industry demand for monitoring their infrastructure. Traditional methods are often based on expensive, systematic and labour-intensive human inspection. Earth Observation can provide an innovative and cost-effective way to support asset management (e.g. information about when to clean solar panels, cutting vegetation that disturb electrical installations) and risk management (e.g. natural hazards such as fire, flooding and land subsidence). Accidents on energy infrastructures (e.g. oil and gas pipeline) tend to be high-impact events that affect public safety, environmental protection and entire energy markets, so it is crucial to quickly detect potential risks before they have an impact. **<u>Scope:</u>** The solution in response to this challenge shall be to provide innovative AI models	

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to detect anomalies on energy infrastructures, which require human intervention.
Dataset sources: Sentinel-2 and Sentinel-1 data, Commercial EO data, Land use and Meteorological data
Output and coverage: The expected output will be a service (available through API and Dockers), which can be integrated as a layer in a GIS system for further analysis or directly into a web map. The data will be in an open geospatial format (e.g. the layers delivered in Rapid Action on coronavirus and EO (esa.int).
AI4Copernicus Services: The following bootstrapping services will be made available: ● Pre-processing tools for Sentinel-1 and Sentinel-2 data products, as well as optimized tiling techniques for reconstructing time series ● ERA5 reanalysis data to extract local weather observations ● CORINE Land cover product provided the Copernicus Land Monitoring Service ● Ground truth data of onshore and offshore locations - https://www.emodnet-humanactivities.eu/ and SETIS - SET Plan Information System (europa.eu)
Expected Impact (technical, social, economic, environmental, policy etc.): Technical ● Develop AI techniques and products based on Earth Observation data to detect anomalies on energy infrastructures, which require human intervention Socio-economic ● Reduction of operational costs (e.g. labour cost, material cost) related to energy infrastructures ● Improved energy supply security through improving the management of energy infrastructures ● Reduced risks of accidents related to energy infrastructure increasing public safety and fluctuation on energy markets. Environmental ● Reduced risks of accidents related to energy infrastructure decreasing possible negative impact on the environment Policy level ● Demonstrated adoption of the results of using AI in an area that is important in the policy of the European Commission

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15. Energy consumption understanding

''Energy consumption understanding''	
Sector/Thematic Area: Energy	**Social Cause:** Various
Content **<u>Challenge:</u>** Urban areas presently consume around 75% of global primary energy supply, which is expected to significantly increase in the future due to urban growth. Understanding urban energy consumption patterns may help to address the challenges to urban sustainability and energy security. However, urban energy analyses are severely limited by the lack of urban energy data. To overcome the scarcity of urban-level energy data, Earth Observation data can be a first answer to monitor and quantify urban energy utilization patterns. For instance, High-resolution satellite images are used to identify and classify various urban settlement types based on their physical and textural analysis. The resulting classification can be correlated with energy consumption in order to generate statistics. Another means to extract patterns and estimate energy consumption at suburb-level is to use night-time images, which capture light emission from human settlements only. **<u>Scope:</u>** The solution in response to this challenge shall be to provide innovative AI models to extract energy consumption patterns in order to better understand energy distribution.	
Dataset sources: Sentinel-2 and Sentinel-1 data, Commercial EO data, Land use, Meteorological data and local energy consumption data.	
Output and coverage: The expected output will be a service (available through API and Dockers), which can be integrated as a layer in a GIS system for further analysis or directly into a web map. The data will be in an open geospatial format (e.g. the layers delivered in Rapid Action on coronavirus and EO (esa.int).	

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AI4Copernicus Services: The following bootstrapping services will be made available:

- Pre-processing tools for Sentinel-1 and Sentinel-2 data products, as well as optimized tiling techniques for reconstructing time series
- CORINE Land cover product provided the Copernicus Land Monitoring Service

Expected Impact (technical, social, economic, environmental, policy etc.):

Technical

- Develop AI techniques and products based on Earth observation data to estimate energy consumption at suburb-level

Socio-economic

- Improved forecasting of consumption at the settlement level
- Increased efficiency of demand side policies through better information energy consumption of settlements
- Improved forecasting of the demand at the settlement level can decrease the integration cost of renewables into the electricity system

Environmental

- Reduced integration costs of renewables into the electricity system will increase their competitiveness compared to fossil fuels and reduce CO_2 emissions

Policy level

- Improved policy decision as a result of better monitoring and quantification of urban energy utilization patterns
- Demonstrated adoption of the results of using AI in an area that is important in the policy of the European Commission

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