

# SPACE FOR GREEN APPLICATIONS



VISIT [SPACESOLUTIONS.ESA.INT](https://spacesolutions.esa.int) FOR MORE DETAILS

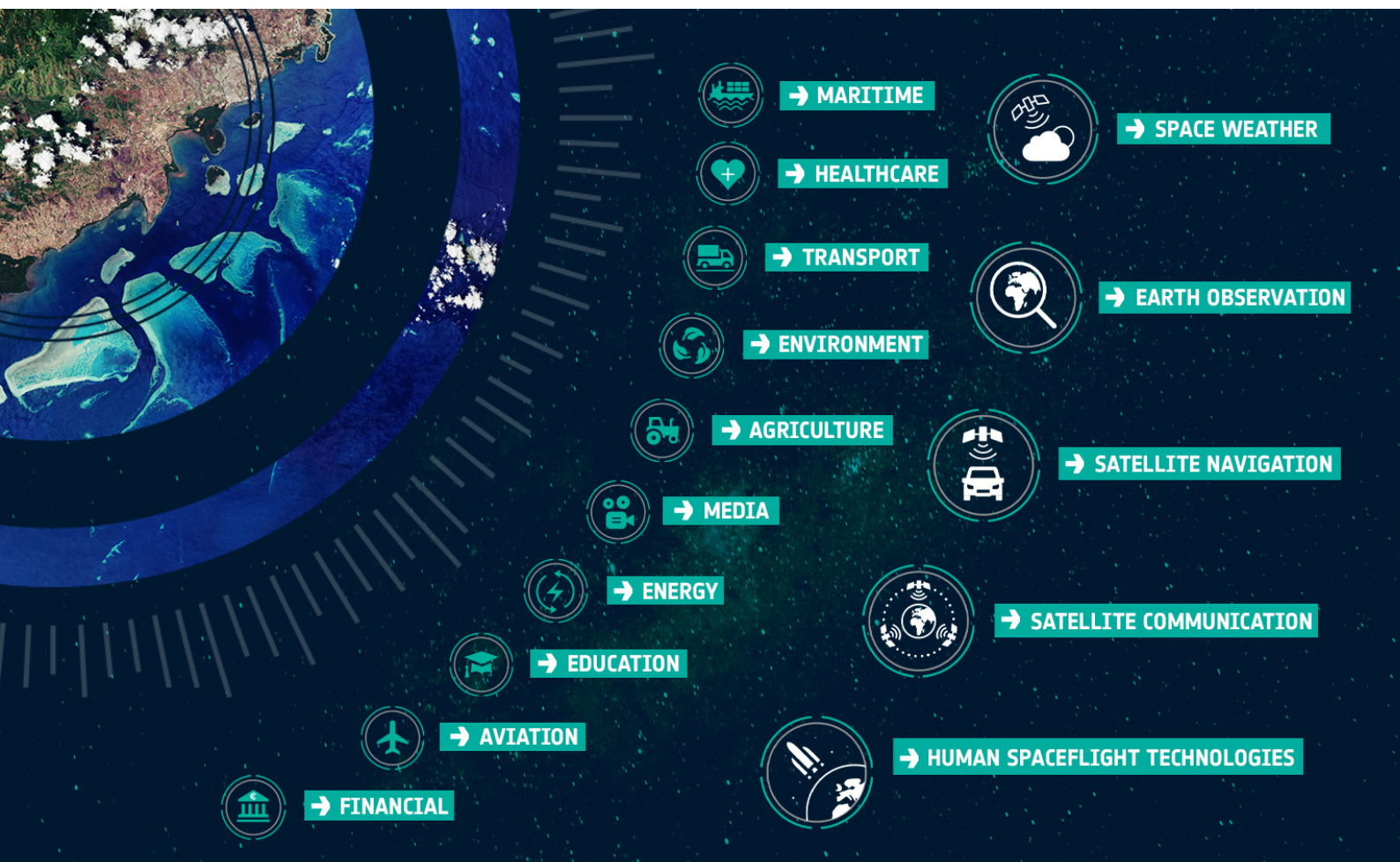
ESA SPACE SOLUTIONS



# ABOUT THIS BOOKLET

This booklet was created by ESA Space Solutions, which is the go-to place for business ideas involving space across all sectors. Its mission is to support entrepreneurs in Europe to develop space applications using space data and technologies.

In creating this booklet, data from 90 ESA Space Solutions Feasibility Studies and Demonstration Projects were collected, covering a 10 year period from 2010 to 2020; This represents an investment by ESA Member States of over 40 million Euros. Please visit [spacesolutions.esa.int](https://spacesolutions.esa.int) for more information.



# INTRODUCTION

In recent times, there has been a drive towards tackling environmental and climate-related challenges through sustainable development. Satellite Applications have an important role to play in the development of green services across every sector. Partnerships are central to this development and the European Space Agency (ESA) has created a network - a green alliance - to strengthen collaboration, encourage connections, and develop innovative green services.





# TABLE OF CONTENTS

- 4** Green Topics in This Report
- 5** Energy - Clean, Affordable and Secure Energy
- 8** Industry - Industry for a Clean and Circular Economy
- 11** Construction - Energy and Resource Efficient Buildings
- 14** Transport - Sustainable and Smart Mobility
- 17** Agriculture - Green Farm to Fork
- 20** Biodiversity - Restoring Biodiversity and Ecosystems
- 23** Pollution - Reducing Pollution
- 26** Conclusion



# GREEN TOPICS IN THIS REPORT

This booklet highlights how satellite applications can address environmental challenges and support sustainable development in the following green areas:

1. Energy - Clean, Affordable and Secure Energy
2. Industry - Industry for a Clean and Circular Economy
3. Construction - Energy and Resource-Efficient Buildings
4. Transport - Sustainable and Smart Mobility
5. Agriculture - Green Farm to Fork
6. Biodiversity - Restoring Biodiversity and Ecosystems
7. Pollution - Reducing Pollution

These seven topics align with themes of the European Union's (EU) Green Deal, which sets out a plan to tackle climate and environmental challenges through political, legal, and financial commitments. Since the coronavirus outbreak in 2019, the European Green Deal has become key to the EU's recovery strategy, seeking to stimulate a wave of innovation.





# ENERGY

## SPACE APPLICATIONS FOR CLEAN, AFFORDABLE AND SECURE ENERGY

Satellite applications can be used to help plan, monitor, predict, and improve renewable energy production, especially when complemented by Artificial Intelligence (AI), Internet of Things (IoT), and drones.



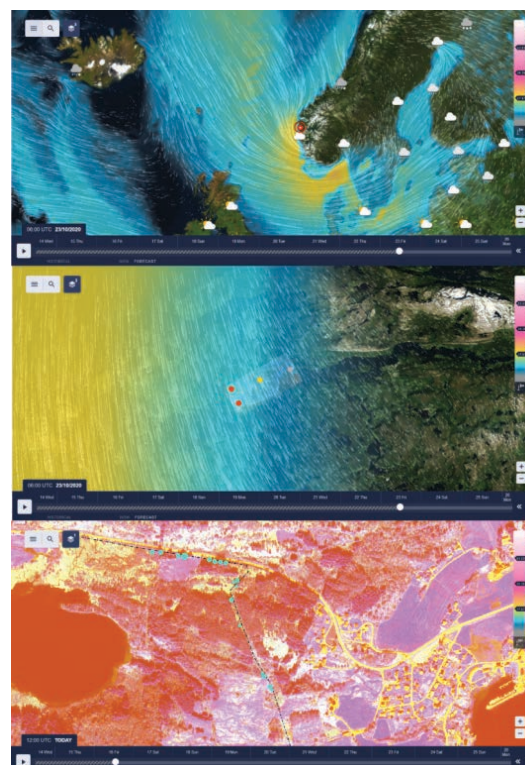
### THREE KEY ENERGY CHALLENGES

- 1** Power generated from natural sources, for example by solar panels or wind turbines, can be unpredictable. Maintaining equilibrium between supply and demand can be challenging.
- 2** Installation of large renewable plants is expensive; this is especially true when considering the distance between the energy source and the grid.
- 3** It can be difficult to maintain remote energy plants or to predict and fix problems during operation.

## ENERGY SHOWCASE: GRID EYES

Vegetation Management is a significant maintenance expense for many power companies. GridEyeS uses AI and satellite Earth observation to automatically monitor power lines, reducing the cost and time of electric lines inspection by replacing ground-based crew, helicopter, or drones inspection with satellite data analytics.

These three snapshots (right) from the GridEyeS platform show the multilayer interactive map displaying vegetation condition, satellite data and weather.



## HOW CAN SPACE HELP THE ENERGY SECTOR?

**Hydroelectric** - Satellite Earth observation can be used in services to improve water flow monitoring, prediction systems, flood warnings, real-time river state measurements, change detection of lakes and reservoirs, and environmental footprint monitoring.

**Wind & Solar** - Weather data can improve energy production forecasts, satellite data can be used to optimise positioning of wind and solar farms, and telecommunications can be used to improve operations on offshore and remote farms.

**Microgrids** – Satellite-based services can improve mapping, planning and monitoring of microgrids

**Smart Grids** – Satellite images can be combined with drone data to improve situational awareness - especially in the case of extreme weather events and operation.



# ENERGY: NEW AVENUES



## **Space-Based Services for Marine Energy**

A Call for Space-Based Services for Marine Energy will open towards the end of 2020. It will focus on logistics and operations of marine energy installations, increasing durability of marine energy installations, assessing resources at different sites and supporting environmental impact assessments.



## **Global Alliance for Sustainable Energy**

ESA was recently invited to take part in the Global Alliance for Sustainable Energy; a platform enabling ESA and partners to directly engage with worldwide renewable energy players.



## **Space to Advance Innovation on Circular Cities**

ESA plans to launch the initiative “Space to Advance Innovation on Circular Cities” with the support of ENEL. This call will support the development of space-enabled applications for energy security and environmentally sustainable mobility.

VISIT [BUSINESS.ESA.INT](https://business.esa.int) FOR MORE DETAILS

ESA SPACE SOLUTIONS



# INDUSTRY

## INDUSTRY FOR A CLEAN AND CIRCULAR ECONOMY



### THREE KEY INDUSTRIAL CHALLENGES

- 1** A shift in consumer habits has meant that customers demand sustainability, traceability, and transparency on the goods they consume.
- 2** Industry struggles to understand the holistic impact of decisions made. For example, policies encouraging diesel-powered cars positively impacted CO2 emissions, but resulted in public health concerns. Supply shocks can arise from geopolitical turmoil or climate change-related extreme weather events.
- 3** The industry sector is a high consumer of electricity and second to none in raw material consumption. It faces a greater challenge than most to comply with long-term environmental constraints.

## INDUSTRY SHOWCASE: DIGITAL MINE

Digital Mine uses telecommunications, Earth observation and satellite navigation to create digital twins of quarries. This enables mining companies to visualise their sites, track activities on a dashboard, and analyse the health of their mines. The service helps companies to improve operational efficiency and minimise their impact on the environment.



## HOW CAN SPACE HELP INDUSTRY?

**Tracing Origins** – satellite navigation can be used to track and trace goods from origin to end point, helping suppliers to comply with sustainability regulations and goals.

**Reducing Impact of Industry on the Natural Environment** – Remote monitoring can help ensure that mining activities are reducing their impact on surrounding water sources, rehabilitating land after extraction, and develop more efficient and less wasteful mining techniques.

**Detecting and Stopping Illegal Activities** – Illicit activities can undermine the work of legitimate industry. Machine learning applied to Earth Observation can detect and report on illegal activities, like unlawful mining and waste dumping.

**Improving Re-use, Recycling and Improved Waste Management** – Dynamic routing can optimise waste collection, while satellite navigation can help tracking and tracing of dangerous waste.



# INDUSTRY: NEW AVENUES



## **Circular Economy Kick-Start**

ESA will launch a Circular Economy funding call in 2021. Teams will be invited to submit ideas relating to circular food & drinks, fashion & textiles, urban life, and waste systems.



## **Space Applications for Circular Cities**

ESA has partnered with ENEL to advance innovation on circular cities. The Call focuses on supporting the transition of public transport towards zero carbon emissions, service optimisation, and dynamic mapping system management. The Call is open until January 2021.



## **Extractive Industry**

Mining can spoil the natural environment and contaminate water supplies. ESA created a community of over 200 members – called MineSense – with the United Nations Interregional Crime and Justice Research Institute (UNICRI) and Satellite Applications Catapult to tackle these key challenges. In 2021, ESA Space Solutions will launch a competition on Space Resources, which will support the development of sustainable mining services. Join MineSense here:

<https://sa.catapult.org.uk/minesense/>

# CONSTRUCTION

## ENERGY AND RESOURCE-EFFICIENT BUILDINGS

Green buildings make use of space-based data and IoT sensors to place new buildings in ecologically safe zones, conserve energy, reduce the heat island effect, achieve circularity, and support green renovations.



### THREE KEY CONSTRUCTION CHALLENGES

- 1** Traditionally, building houses has taken a linear approach, where resources are extracted, used in construction, and then discarded after demolition. This “take, make, waste” model is unsustainable and must change to reduce its environmental impact.
- 2** During design, it is important to consider natural features of the land to reduce building loads, reduce wastewater and improve indoor environmental quality. It is especially important to avoid selecting sites like flood plains, ecologically sensitive land, or habitats for rare or endangered species.
- 3** Buildings can create a ‘heat island’ effect when they conserve energy poorly. For buildings to operate close to net-zero, it is essential to move towards renewable sources for energy generation, control heat dissipation and ventilation, and adopt green roofs.



## INDUSTRY SHOWCASE: THERMCERT

Energy supplier E.ON and Earth Observation specialists at Astrosat developed a tool to report on the thermal efficiency of houses.

ThermCERT pinpoints households in fuel poverty or those at risk and helps to prioritise where energy efficiency measures are needed most in the UK.

## HOW CAN SPACE HELP CONSTRUCTION?

**Efficient Construction** – IoT sensors and space-based data can analyse a building's natural surrounding and built environment to assess risks like flooding, and help safely plan and monitor construction.

**Effective Renovation** - Satellite applications can advise on natural ventilation, renewable energy and smart grid options, thereby helping to determine the correct renovation strategy.

**Improving Thermal Efficiency** – Services can use satellite Earth observation data to monitor energy consumption, identify areas lacking in thermal efficiency and detect zones that are contributing to the heat island effect.



# CONSTRUCTION: NEW AVENUES

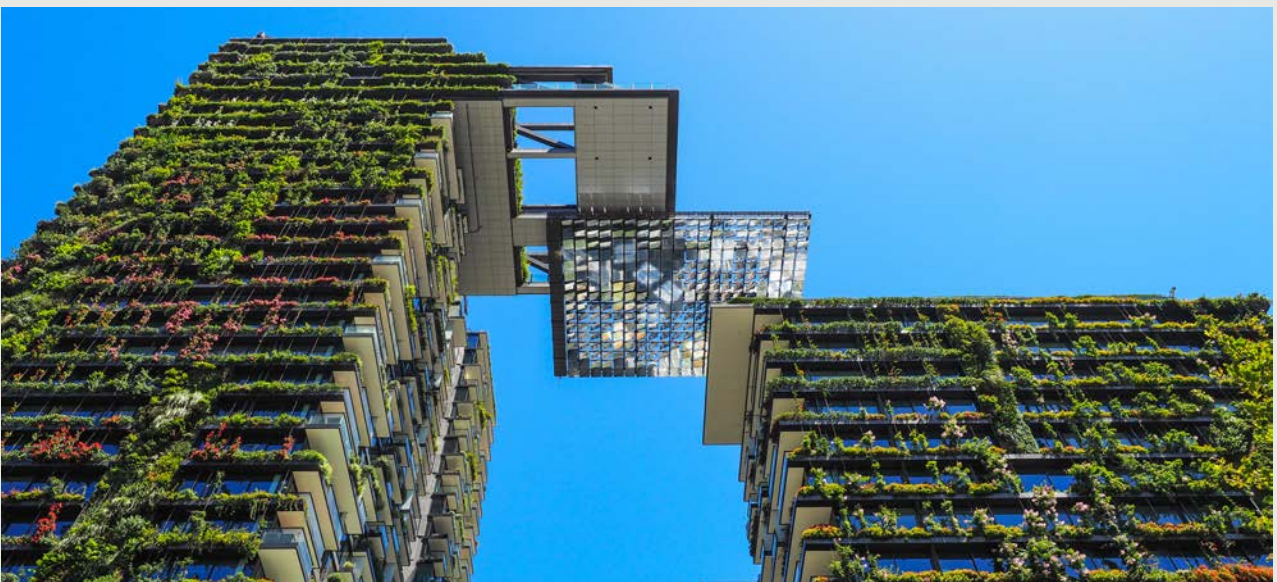


## **Green Urban Areas**

ESA Space Solutions will launch a new initiative to develop services focused on Green Urban Areas. It will open in 2021 and will complement the 2020 Space and Green Buildings Call by focusing on green surroundings around built environments.

## **PropTech Kick-Start**

ESA Space Solutions will also support the use of space in combination with novel technologies in the real estate sector; digital dashboards, smart home technology, and digital twins enhanced by space-based data can make the sector more environmentally sustainable. A funding call on the topic of PropTech is open until the end of February 2021.





# TRANSPORT

## Sustainable & Smart Mobility

Digital technologies, satellite navigation, and connectivity can improve smart mobility and logistics services, help develop versatile transport plans, and mitigate transport's environmental footprint.



### THREE KEY TRANSPORT CHALLENGES

- 1** Transport represents a significant share of greenhouse gas emissions and energy consumption. Major cities around the world are faced with the challenge of enhancing mobility, while also reducing congestion, accidents and pollution.
- 2** Increased urbanisation means that fleets of vehicles are expected to grow significantly. Sustainable transport plans to modernise rail, subway, and ground transit systems; enhance ticketing; and build out cycling and pedestrian infrastructure are crucial to addressing urban congestion, air quality and noise pollution.
- 3** Enhanced connectivity is a major challenge and precondition for smart mobility and smart logistics, enabling vehicle-to-vehicle and vehicle-to-infrastructure communication.

## INDUSTRY SHOWCASE: AITO

TeleRetail's on-demand service uses robots to deliver goods autonomously. The AITO robots are designed to cover long distances, up to 50 miles, and to serve rural and suburban markets along with city residents. TeleRetail uses computer vision systems, sensors, satellite imagery, and satellite navigation for autonomous navigation and precise localisation.



## HOW CAN SPACE HELP TRANSPORT?

**Effective Routing** – AI, maps and satellite navigation can be used to improve travel routes, traffic flows and fleet organisation.

**Improved Tracking and Tracing** – sensors used with satellite navigation and telecommunications can allow cargo to be accurately tracked and traced from origin to end point; this is important when goods need to be kept under certain ambient conditions.

**Reduced CO2 Emissions and Fuel Consumption** – Satellite navigation and observation can improve strategic planning of transport infrastructure and management of fleets to reduce fuel consumption and harmful emissions.

**Automated Vehicles** – Courier robots and delivery drones, which rely on navigation technologies, could reduce the cost, time and footprint associated with logistics.

**Encouraging Multi-modal Transport** – Services can use telecommunications and navigation to locate and communicate with vessels and trucks to improve haulage, voyages and port operations.



# TRANSPORT: NEW AVENUES



There are several upcoming transport competitions planned for the end of 2020 and 2021.

## **Social & Environmentally Friendly Mobility**

The first competition is called Social & Environmentally Friendly Mobility and focuses on smart, sustainable mobility solutions like shared transport, mobility-as-a-service and new driving solutions.

## **Urban Air Mobility**

Urban Air Mobility is another exciting topic, key to sustainability in the aviation industry. ESA's Urban Air Mobility funding call will investigate how space data and satellite technology can be used alongside image-recognition algorithms, crowd-sourcing, and big data analytics to make flight around cities possible.

## **5G for L'ART**

This Call focuses on the specific needs of stakeholders in L'Aquila, Abruzzo Region, Rome, and Turin (L'ART). ESA will support the development of satellite applications for advanced traffic management systems, advisory travel services, and safe public transport systems.

## **Space and 5G Convergence: Transport & Logistics**

This Call, organised in collaboration with the UK Government's department for Digital Culture Media and Sport (DCMS), will support services in the logistics sector that use both 5G terrestrial and satellite communication networks.

# AGRICULTURE

## GREEN FARM TO FORK

Track and trace solutions, enabled by satellite navigation, can enhance supply chains and reveal the origins of food to consumers. Satellite applications can improve sustainable food production, prevent waste and food loss, and aid sustainable food processing and distribution channels.



### THREE KEY CHALLENGES

- 1** Supply chains can be complex, involving multiple stakeholders before food reaches its final destination. Transparent and traceable food processing and distribution is important in ensuring ethical origins and fair trade. Efficient management is crucial to ensure waste is minimised and food is safely transported.
- 2** The increasing global population means that food producers face the challenge of increasing production significantly in a sustainable manner.
- 3** More frequent and dramatic extreme weather events, like floods and droughts, have an increasing impact on food production.



## INDUSTRY SHOWCASE: DRYGRO

DryGro has developed a satellite-enabled technology to produce an inexpensive, high-protein ingredient of animal food called lemna. It uses 99% less water than soy production, grows in arid regions and drastically reduces the reliance on long, complex supply chains. The project is currently being trialled in Kenya.



## HOW CAN SPACE HELP AGRICULTURE?

**Precision Agriculture** - Satellite imagery and weather data can improve irrigation and optimise fertiliser usage by precisely monitoring and detecting changes.

**Improved Trading** - Satellite imagery, time stamping and blockchain technologies can create peer-to-peer marketplaces for trading agricultural products.

**Accurate Yield Prediction** - Remote sensing enables yield to be better predicted and crop health better monitored.

**Land Restoration** - Sensors on the ground and monitoring via satellite can ensure that land is restored after harvest.

**Agricultural Logistics** - Satellite navigation can improve harvest logistics and transportation of agricultural goods, meaning that perishable goods arrive fresh on time.

**Pest Detection** - Satellite Earth observation can be used to detect pests and can reduce the need for harmful pesticides.

# AGRICULTURE: NEW AVENUES



## **Responsible Agri-Tech**

ESA's Responsible Agri-Tech competition opens at the end of 2020 and focuses on sustainability, fairness and competitiveness in agriculture. It also aims to support teams in developing ideas using space and robots that can help farmers in daily tasks, High Altitude Platforms (HAPS) that assess the environmental condition of fields and surroundings, smart materials to optimise plant growth, and 3D printed machinery.



## **Prevent and Detect Food and Beverage Fraud**

ESA will have a call for proposals on the darker aspect of the food chain: "Prevent and Detect Food and Beverage Fraud". This will support ideas that facilitate the detection of counterfeit food and beverages.



# BIODIVERSITY

## RESTORING BIODIVERSITY AND ECOSYSTEMS

Space applications can help to monitor factors that exacerbate biodiversity loss – such as climate change, ocean acidification, and anthropogenic impacts – and support services that protect biodiversity.



### THREE KEY BIODIVERSITY CHALLENGES

- 1** The continued growth of human populations and per capita consumption has led to the unsustainable exploitation of Earth's biodiversity. Industrial-scale fishing and tourism, for example, contributes to overfishing, by-catch, the spread of invasive species, and destruction of marine life.
- 2** Transportation networks can exert pressure on biodiversity by cutting through unique ecosystems, polluting natural surroundings and harming wildlife.
- 3** Industrial waste can cause chemicals, wastewater and hazardous waste to destroy natural habitats.

# BIODIVERSITY

## INDUSTRY SHOWCASE: TRANSPARENTSEA

TransparentSea is a service that targets the issue of illegal, unregulated and unreported fishing. It uses Automatic identification system (AIS) and satellite communication to seamlessly track and certify fishing fleets around the world. This means that seafood products can be transparently traced from catch to plate.



## HOW CAN SPACE HELP BIODIVERSITY?

**Wildlife Monitoring** – Satellite Earth observation and navigation can help to monitor animal populations, analyse migration patterns and improve surveying. Wildlife tracers and satellite communication can ensure that wildlife can be easily and robustly monitored and tracked.

**Wildlife Protection** – AI applied to satellite imagery can spot suspicious activities like poaching and illegal wildlife trade by picking up unusual changes in “patterns of life”.

**Monitoring Invasive Species** – Satellite Earth observation applications can help to detect habitats affected by invasive plant species and can present the extent of the damage caused.

**Assessing Habitats** – Satellite applications can assess the quality of natural surroundings and can consistently monitor changes in the environment. This can help with conservation and restoration.





## BIODIVERSITY: NEW AVENUES

Biodiversity loss and ecosystem collapse is one of the biggest challenges facing humanity. ESA Space Solutions is therefore planning a new funding call on Water Scarcity to identify ways that space applications can help to monitor and improve desalination plants, reduce groundwater depletion, and reduce water loss during distribution.

VISIT [BUSINESS.ESA.INT](https://business.esa.int) FOR MORE DETAILS



# POLLUTION

## REDUCING POLLUTION

Satellites can be used alongside High Altitude Platforms (HAPS), drones, and in-situ measurements to accurately monitor and establish the source of emissions. Water pollution and soil pollution can similarly be monitored from space.



### THREE KEY CHALLENGES

- 1** When tackling pollution, the first key challenge is to minimise the insertion of new pollutants.
- 2** The second is to remove existing pollution from ecosystems.
- 3** While space assets have traditionally monitored pollution, the new challenge is to turn space data into actionable information that results in an effective reduction of pollutants from air, land and sea.



## INDUSTRY SHOWCASE: AIRMINE

Airmine combines air pollution satellite data with other data sets - like weather and population density - to give hourly insights into air quality around the world. Users of the Airmine app can track symptoms relating to air pollution and pollen and uses machine learning to develop customised dose-response functions.

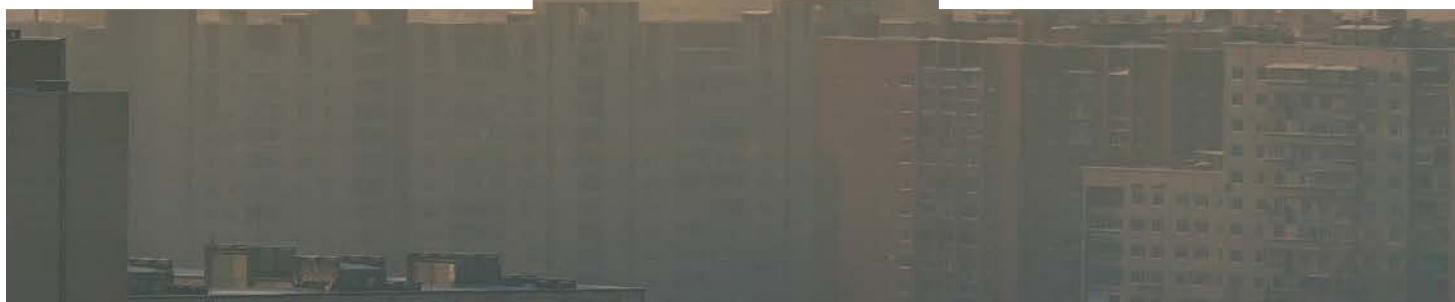


## HOW CAN SPACE HELP POLLUTION?

**Addressing Traffic-related Emissions** - Satellite navigation and Earth observation data can help urban areas tackle problems relating to vehicle emissions by improving traffic models and traffic management systems.

**Air Quality Monitoring** – Satellite data and sensors can help to accurately monitor air quality in real time, and can forecast future air quality.

**Water Quality Monitoring** – Services can use satellite Earth observation data and sensor networks to monitor the quality of surface water in a timely way, and can issue warnings to alert users to take mitigation measures.



# POLLUTION: NEW AVENUES

Pollution Cycle Monitoring and Reduction - ESA Space Solutions will be supporting studies that tackle air, land and water pollution. The funding call on “Pollution Cycle Monitoring and Reduction” will open in 2021.



# CONCLUSION



space solutions

Satellite applications are integral to the development of many green services. When integrated with other technologies, space data can address environmental and climate-related challenges across a wide range of sectors. Data for space assets and technologies are instrumental not only to the monitoring of environmental parameters, but also to delivering economically sustainable solutions and contributing to the green transformation of economic sectors.

ESA Space Solutions is preparing a number of green initiatives, which will progress existing partnerships and establish additional collaborations. It will encourage the integration of space-based data with other innovative technologies, mitigate environmental impacts and deliver environmentally sustainable services. To find out more about these initiatives and to apply for funding from ESA Space Solutions visit our website.

**[SPACESOLUTIONS.ESA.INT](https://spacesolutions.esa.int)**