SPARK WORKSHOP REPORT: How might remote sensing support biodiversity monitoring?

Report written by Satellite Applications Catapult with support from Oxford to Cambridge pan-Regional Partnership, & Buckinghamshire and Milton Keynes Natural Environment Partnership

October 2023

The workshop and report were funded by Buckinghamshire and Milton Keynes Natural Environment Partnership (the "NEP"), Oxford to Cambridge pan-Regional Partnership and Satellite Applications Catapult Limited

The workshop took place in September 2023.

The report was written in November 2023.

Authors of the report: Rob Maslin, Anastasia Bolton, Liz Scott, Mark Hennen, Hemul Goel, Luisa Doughty

CONTENTS

GLOSSARY

Term	Definition
BNG	Biodiversity Net Gain
EO	Earth Observation
UAV	Unmanned Aerial Vehicle
HSE	Health and Safety Executive

1. INTRODUCTION

BACKGROUND

"Between 1990 and 2020, around 420 million hectares of forest (mainly tropical forest) has been lost and a further 10 million hectares, an area the size of Scotland and Wales combined, is being lost each year." – The Royal Society

We are in the middle of a global mass extinction event affecting biodiversity, yet we rely on nature and the services it provides to survive and thrive. We are facing ever-growing development pressures (residential and commercial) especially across the Oxford Cambridge (OxCam) area, alongside other global and local pressures on the environment resulting from climate change, pests and diseases, pollution and tourism. The UK has lost a significant proportion of its plants, animals and fungi, making it one of the most nature depleted countries on our planet (State of Nature 2023). This increasing loss of biodiversity has created a greater need to equip experts working in biodiversity management with improved tools and solutions for biodiversity management.

In addition to composition, location and scale of habitat and species, it is factors like habitat health and regular monitoring that support effective decision making for biodiversity management. Regular monitoring is key to identifying the trends and impacts of various policies and decisions on the environment. Currently, it is expensive and labour-intensive to monitor the condition of habitats. The data collected is often site-specific, and can be reliant on monitoring capacity, scarce funding and volunteer networks. Some habitat condition data cannot be collected regularly due to capacity or funding, so it can be dated (e.g. last "priority habitat" monitoring at any sample scale across Buckinghamshire was in 2010).

This creates a need for using new and remote technologies that are quicker, extensive, and most importantly repeatable over time. The data thus collected can be used by national and local governments (along with other players) to monitor biodiversity trends and nature recovery.

Satellite Applications Catapult convened a conversation around the different challenges and opportunities in space technology innovation for biodiversity management. We collaborated with the Buckinghamshire and Milton Keynes Natural Environment Partnership and the Oxford to Cambridge Partnership, collectively aiming to pioneer innovative approaches in biodiversity management. Participants from local government bodies, non-profit organisations as well private companies were brought together for an interactive session to help them explore the art of the possible in biodiversity management using space intelligence. Imagery-based solutions generated through earth observation and drones were the primary foci of the session.

Our work commenced with an extensive survey aimed at gaining a thorough understanding of the participants' backgrounds and their familiarity with remote sensing technology. Following this, we conducted a full-day workshop with the primary objective of formulating proposals to tackle challenges related to biodiversity. Participants were encouraged to leverage their knowledge and expertise to generate innovative solutions during this workshop.

WORKSHOP OBJECTIVES

The workshop was focused on fulfilling the following aims by taking the participants through a design thinking-based collaborative approach.

- Uncover opportunities for the UK space sector to address the challenges and needs of organisations involved with biodiversity management.
- Build awareness among industry regarding the use of satellite-enabled imagery, such as earth observation and drones, for monitoring biodiversity.
- Facilitate opportunities for networking and community building between organisations working in the sector.
- Generate project proposals for near, mid, and longer-term collaborations.

2. ABOUT THE ORGANISATIONS

ABOUT SATELLITE APPLICATIONS CATAPULT

Innovating for a better world, empowered by Space.

Satellite Applications Catapult is at the heart of the satellite services revolution, driving the take-up of space technology and applications to shape, and sustain, the world of tomorrow. We're driven by how our actions help the organisations we work with, both large and small, bring new services to market.

By connecting industry and academia, we get new research off the ground and into the market more quickly. With the mission 'to innovate for a better world, empowered by space,' Catapult is committed to facilitating the use of satellites to support the delivery of the Sustainable Development Goals.

Through our Sustainable Earth Mission, we are looking to accelerate the uptake of space tech to address human well-being, climate, nature and broader environmental challenges.

We help organisations use, and benefit from, satellite technologies, and bring together multi-disciplinary teams to generate ideas and solutions in an open innovation environment.

SUSTAINABLE FINANCE, INVESTMENT & RISK

As part of its 2023-2028 strategy, the Satellite Applications Catapult has identified Sustainable Finance, Investment & Risk as a program of work that we describe as an intervention.

Space offers a unique lens on the global climate, nature and wellbeing crises providing a neutral, large-scale view of changes over time and across landscapes.

The Catapult will work with key stakeholders within financial institutions, corporations and problem owners to advance how space technologies and space-derived data can support decision-making for climate, nature and socially positive outcomes. Earth observation (EO) combined with machine learning (ML) have the potential to transform how we measure, monitor and manage climate and nature-related risks.

ABOUT THE OXFORD TO CAMBRIDGE PAN-REGIONAL PARTNERSHIP

The Oxford to Cambridge Pan-Regional Partnership brings together a powerful coalition of local authority Leaders, Growth Boards, the nine universities from across the region that make up the Arc Universities Group (AUG) and England's Economic Heartland (EEH), the sub-national Transport Body.

With a mission "to secure a future in which our communities prosper from the very best in environmentally sustainable ways of living and working", the Partnership was created to propel the region's innovation strengths to achieve significant environmental enhancements and to unlock investment for inclusive, high-quality, sustainable development.

The Partnership is endorsed by the Department of Levelling-Up, Housing and Communities and works with several government departments and agencies, including the Department for Business and Trade (DBT), Department for Science, Innovation and Technology (DSIT), Department for Environment, Food and Rural Affairs (Defra) and its agencies such as the Environment Agency and Natural England.

Oxford to Cambridge pan-Regional Partnership

ABOUT BUCKINGHAMSHIRE & MILTON KEYNES NEP

The Buckinghamshire and Milton Keynes Natural Environment Partnership (the "NEP") is the Local Nature Partnership for the area that brings together a diverse range of individuals, businesses and organisations to drive positive change in the local natural environment.

The NEP promotes the value of the natural environment in decision making at all levels and takes a strategic view of the challenges and opportunities facing nature. It is working alongside a broad range of sectors (local authorities, businesses, health, education, communities and conservation) to embed appropriate consideration of the natural environment in growth, economic & health strategies. It is also focused on developing interventions and collaborative programmes for delivery.

The partnership aims to establish a unified voice for advocacy and policy to emphasise the value of the natural environment and its benefits for people, communities, and the local economy.

The NEP highlights the importance of creating resilient habitats and green spaces at a landscape scale and in local spaces to secure natural capital, enhance wildlife populations, and enable adaptation to climate change and other pressures. We then align partners to deliver collectively to improve the local natural environment.

nep
THE ENVIRONMENT IS OUR BUSINESS

3. WORKSHOP PROCESS

ATTENDEES

ORGANISING TEAM

Satellite Application Catapult: Rob Maslin, Anastasia Bolton, Liz Scott, Mark Hennen, Hemul Goel

ACTING CLIENTS:
Natural Environment Partnership: Nicola Thomas

OxCam Partnership: Nathan Vear

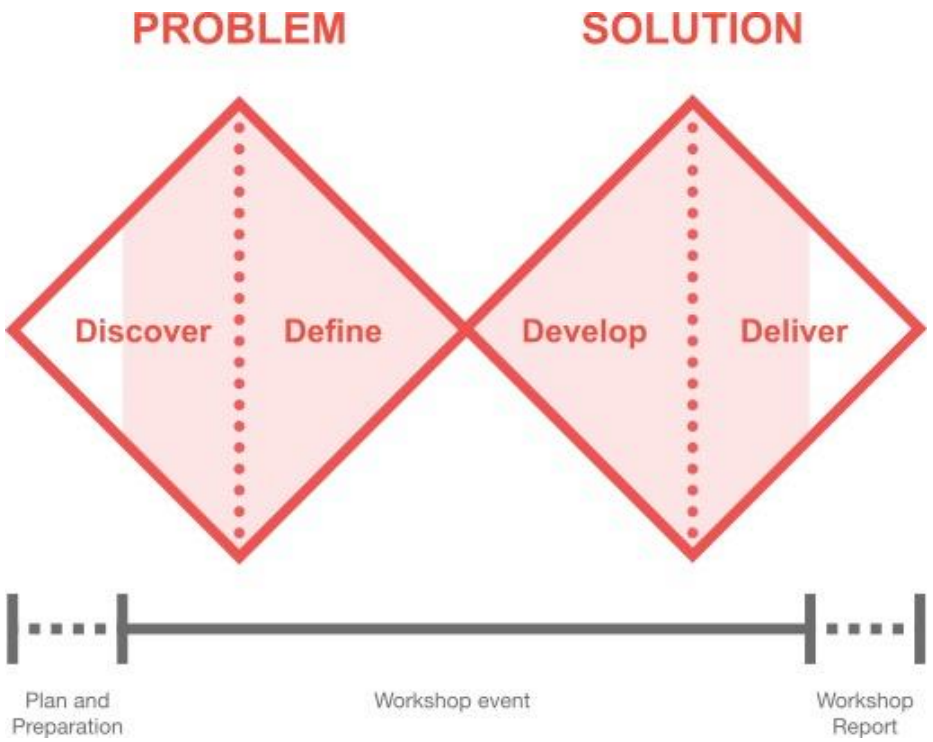
18 PARTICIPANTS REPRESENTING ORGANISATIONS:
Gentian Ltd | Coombs Services Limited | Ngage Solutions | Buckinghamshire Local Enterprise Partnership | Thames Water | Oxford Brookes University | Rothschild Foundation | The Greensand Trust | Wildlife Trust BCN | Natural England | Buckinghamshire Council | The Oxford Cambridge Partnership | Buckinghamshire and Milton Keynes Natural Environment Partnership

SPARK WORKSHOP: A CO-CREATIVE DESIGN APPROACH

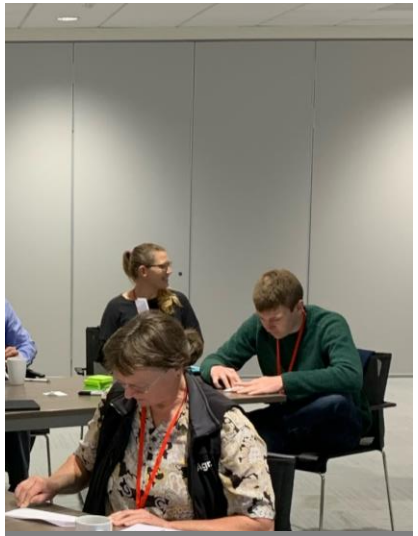
A lot of thought goes into preparing SPARK workshops, before the event. Firstly, the scope and aims are agreed upon and then a workshop structure is created.

As a co-creative process, the SPARK workshops harness insights from the subject expertise and lived experience of the workshop attendees, making it important to identify and invite attendees with the right range of skills and experience for the challenge.

The workshop is delivered with design-led facilitation following proven creative problem-solving practices. The double diamond (Design Council, 2004) is the simplest illustration of how the SPARK process moves through divergent generative activities and convergent decision-making activities to both understand the problem and find a solution. The process can be iterative and complex, but navigating it is made simpler with support from the Catapult's design, technical and subject matter experts.



ACTIVITIES

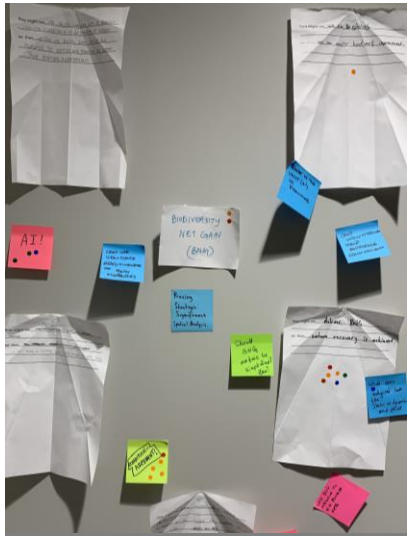


Icebreaker

Participants were asked to introduce themselves and share three words that described their skills.
Skills shared included dancing, saxophone playing and wild swimming!

How Might We UAV

They were introduced to the concept of a ‘How Might We’ statement and asked to draft their own. The drafted statements were folded into paper UAVs and launched across the room.

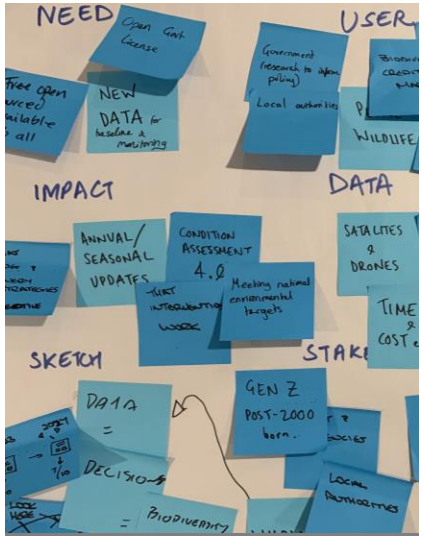


Affinity mapping

Statements with similar interest areas were grouped under similar categories that led to the development of broad ‘themes’.

Discussion

Participants used dots to vote on the themes they wanted to prioritise. This was followed by a facilitated discussion on the prioritised themes, with participants realising the systemic nature of challenges.



Proposal development

Armed with technical knowledge, the last activity involved participants developing and presenting proposals to solve biodiversity-related challenges.

4. WORKSHOP OUTCOMES

SUMMARY OF WORKSHOP PROPOSALS

CROSS-CUTTING GROUP THEMES

There is a sense that biodiversity data collection efforts are working on borrowed time. For example, attendees discussed working to a *2020 baseline, without having established a full definition of the baseline measurements. A whole range of historical data sets with potential were mentioned; among them, satellite imagery has a strong role, considering it is also very consistent and from a neutral source.

While there is time pressure to gather data on biodiversity, the funding and incentives do not match the sense of scale or urgency attendees of the workshop expressed. Innovative ways of creating a joined-up system are needed that can harness more value than the sum of the parts.

WORKING AS A SYSTEM

Each proposal is independently created, but the proposals do complement each other to form a vision for what a systemic solution might look like:

OPEN DATA FOR BIODIVERSITY creates accessible data availability, which can help derive a ***HABITAT BASELINE.*** The baseline informs the model that can offer better data for **INCENTIVISED LAND USE**, which helps to uncover and value **OVERLOOKED BIODIVERSITY** with traditional orchards as an example case study.

The proposals are detailed in the next pages.

#1

OPEN DATA FOR BIODIVERSITY

Up to date open biodiversity data for habitat monitoring

#2

HABITAT BASELINE

Baseline for informed decision-making regarding land use

#3

INCENTIVISED LAND USE

Incentivising land use to support biodiversity enhancement

#4

OVERLOOKED BIODIVERSITY

Valuing a habitat for its contribution to biodiversity

**Refer to Annexe 2 for additional information*

PROPOSAL #1: OPEN DATA FOR BIODIVERSITY

CHALLENGE

How might we encourage, monitor and verify small-scale habitat changes by enabling open access to up-to-date biodiversity data?

- Meaningful data is needed to support decisions and track whether we meet local, national and international targets.
- Opening data sets can help harness more collective effort from experts and enthusiasts, but it comes with challenges of consistency and governance to ensure the data is trusted, reliable and credible.

USERS

Government | Landowners | People involved in the wildlife sector

SOLUTION

A simple way to get access to and find open data - a portal which brings together data from satellites, drones and other sources that support tracking of biodiversity and monitoring the impact of recovery strategies. Features of such a solution might include:

- Ease of use and accessibility for diverse users in a cost effective and time-effective manner
- Ability to access seasonal, local, national, international data for the tracking of targets
- Knowledge sharing, partnerships and communication to run the portal

TECHNOLOGY

Drone data | Satellite data | Other data sources | A platform for data sharing

The forthcoming Earth Observation Data Hub (EODH) is a government-backed project which is due to be delivered in Pilot phase in 2025; the requirements of this proposal are likely to be covered by connecting to EODH. It would be advisable to avoid unnecessary proliferation of individual and likely unconnected portals/hubs.

RISKS

- Lack of funding for any portal development
- Delay in delivery of EO Data Hub as a central data sharing platform
- There is some fear that open-source data could make it vulnerable to being skewed for political agendas

FURTHER CONSIDERATIONS

- There are already other data portals for biodiversity-related data: the MAGIC portal and National Biodiversity Network for example. How would these be linked and how best to avoid data duplication?
- Data needs to be FAIR – Findable, Accessible, Interoperable and Reusable. We need to ensure users can at least find the data they need and are made aware of its existence
- Could a biodiversity data sharing platform connect into the EODH? What is the funding needed for bringing such a project to life?

TECHNICAL RECOMMENDATIONS #1: OPEN DATA FOR BIODIVERSITY

Biodiversity monitoring involves multiple considerations. Infrequent reporting, including the State of Nature 2023 report provide an excellent overview of current biodiversity condition of the individual countries of the UK, but gives little information on specific locations. Meanwhile, currently there is no existing biodiversity framework in the UK which promotes consistent monitoring from one place to the other beyond the Biodiversity Metric. To form an effective data sharing portal, there should be some minimum standards for datasets being submitted. Datasets should be identified and categorised according to a certain criteria, and where relevant covering the 6 essential biodiversity variables (EBVs), including:

- Genetic composition
- Species populations
- Species traits
- Community composition
- Ecosystem structure
- Ecosystem function

Each of these EBVs can be/are monitored/measured in different ways, and at different scales, making it difficult for users to know which data they should use, and at which spatial and temporal scales.

It is possible that many of the data required for small-scale (local) biodiversity monitoring may not exist (depending on location and local monitoring organisations). However, there will likely still exist a set of regional, or national scale data which could provide a useful baseline for local users. Therefore, any portal created should primarily be set-up to collate, index and distribute large-scale biodiversity baseline data.

The first step should be to do a data review, identifying all the national inventories of existing biodiversity data. These data should then be grouped according to the EBVs, with clear metadata/labelling to describe data quality, including sampling strategy (point/area), frequency of observation, and accuracy assessments. Depending on the scope (funding/time) of the project, these datasets can either be accessed directly from the portal or can provide a series of hyperlinks to the relevant data sources on other portals such as the National Biodiversity Network.

This data search will identify areas/regions poor in biodiversity information, including the extent to which each of the EBVs are covered.

We should develop a group of local users and biodiversity authorities to participate in the development of the portal, ideally which connects into other data ecosystems such as EO Data Hub and National Biodiversity Network. Users can help to develop guidance on data requirements, while the authorities can be invited to provide local scale data.

Once the portal is operational, the service should be demonstrated at national conferences, inviting both users and authorities to participate and expand the coverage of local scale data.

PROPOSAL #2: HABITAT BASELINE

CHALLENGE

How might we establish a habitat baseline of quality to support land use decision-making and compare the resulting changes?

- We need a baseline with the condition of the land and indicators of its biodiversity, with consistent, ongoing updates.
- "We need a baseline yesterday!" The need for a baseline is already on borrowed time, with reference to a 2020 baseline to comply with international frameworks and some of the Biodiversity Net Gain requirements.
- It doesn't need national coverage; even specific regions would be useful.

USERS

Farmers | Government; Local authorities | Landowners | Land managers | Public developers

SOLUTION

A baseline is to be created using 2020 satellite data from archives. It should be presented as a user-friendly geospatial map layer that can be accessed at different scales according to a user's requirement. It should offer insights regarding the current condition of a habitat and support informed decision-making for designing appropriate interventions and monitoring the impact of change.

TECHNOLOGY

The ambitious suggestion is to integrate all the data layers that might be available.

Satellites | Drones | On-ground sensors | Ground truthing | Existing historical survey data

RISKS

- Costs related to building, storing and maintaining this dataset on an ongoing basis
- There could be challenges of consistency across the various input data sources
- Ground truthing may be a challenge – data will be from a mix of sources including professional ecologists and citizen scientists

FURTHER CONSIDERATIONS

- How would long-term maintenance of the dataset be facilitated?
- Challenges around how it is possible to make such maps, baselines and metrics both credible and accessible for different users and their requirements.
- How can data from historical surveys, aerial photography and satellite data be combined to create an appropriate baseline?

TECHNICAL RECOMMENDATIONS #2: HABITAT BASELINE

- A quality baseline dataset requires an underlying metric, which is consistent across all areas and scales so that the baseline can be approximated in all regions.
- This is unrealistic with boots on the ground assessment, as resources (people, time, funds) required to do this sufficiently will be too vast for local authorities. Furthermore, point scale observations from individual surveys are difficult to translate into continuous measurements.
- Therefore, objective, and spatially consistent earth observation data is the only way to observe all areas, frequently and in all seasons.
- Data should be continuous, rather than categorical, so that change over space and time can be captured.
- Producing a biodiversity baseline will require selection of appropriate EO imagery data, selection of additional input data, and geospatial analysis to derive habitat types and condition.
- Work should be done to research appropriate remote sensing data to quantify an indicator of biodiversity condition.
- Natural Environment Partnership has already created a natural capital basemap (based on habitat type not condition) using a selection of geospatial datasets – build up on this using EO based data inputs to create a basemap from a different archive, eg: 2020 basemap etc.
- NDVI (Normalised Differential Vegetation Index) methods used with Sentinel-2 satellite imagery reveal chlorophyll content which indicates vegetation vigour; this can be used as a rudimentary proxy for biodiversity abundance. Other indices can also be used to indicate water abundance, soil moisture, etc.
- Appropriate data could include optical imagery such as Senitnel-2, SAR such as Sentinel-1, LiDAR data from aerial survey such as that from Environment Agency. All these datasets are open source.
- Additional data could come from other open source habitat classification datasets such as Living England and ESA Worldcover
- Geospatial data analysis:
    - Look for similarities in monitoring indicators, identify which areas are poor in essential biodiversity variables (EBVs - see project 1)
    - Develop a framework which accounts for each of the EBVs
    - Calibrate EO data with EBV measurements to fill gaps in spatial and temporal coverage.
- Baseline will come through consultation with ecological experts, to value ease of the EBVs and provide a single value for each area unit (probably pixel size dependant) for each location in the UK.

PROPOSAL #3: INCENTIVISED LAND USE

CHALLENGE

How might we incentivise biodiversity enhancement as a priority land use strategy for landowners?

- Farmers, land owners or local authorities can be the biggest agents of change in nature management. Funding acts as a barrier in their ability to realise value from positive action on the environment.
- Due to the role land management plays for different purposes, like flood prevention, agriculture, and biodiversity habitats, technology can be an important tool in allocating land use based on the relative importance of each purpose in an area.

USERS

Farmers | Land owners | Local Authority | Developers

SOLUTION

A marketplace for habitat creation that supports farmers and land owners in developing and sharing proposals aligned with local biodiversity goals. Once submitted, the proposal would be assessed by local authorities and/or government bodies. Proposals approved as the most appropriate course of action for maintaining/enhancing local biodiversity would have the opportunity to be funded independently.

This would reduce the burden on farmers having to choose between economic growth versus biodiversity management (for example under the Environmental Land Management Schemes).

**Refer to Annexe 2 for additional information*

TECHNOLOGY

Online marketplace platform with geospatial tools

RISKS

- Complexity of the approach
- Building a fair and accountable system that will respond to local priorities and policies
- Policy gaps regarding the mitigation hierarchy*
- As an unintended consequence, there could be a fear of it being used to implement fines and point fingers at people

FURTHER CONSIDERATIONS

- How do you rank and prioritise local goals when choice ranges between different purposes, e.g. flood alleviation versus recreational biodiversity?
- What kind of success metrics might be put in place for biodiversity impacts that cannot be monitored remotely? For example, *IoT based measures – water quality?*
- Lots of small use cases can have a large aggregated biodiversity impact; however, small use cases might cascade complications, for example, if schools plant trees they will need annual HSE assessments.

TECHNICAL RECOMMENDATIONS #3: INCENTIVISED LAND USE

- This project follows on from Project 2 taking the developed baseline and using it within a habitat/land marketplace where developers searching for offsetting land and local authority users and/or landowners can assess the biodiversity value of a given land parcel (field, farm, amenity land, etc...).
- Habitat banking solutions as an equivalent to the carbon credits economy allow landowners to advertise parts of their land for others to utilise when offsetting biodiversity improvements for disassociated projects. This way, developers offsetting habitat as part of BNG could part-fund the creation and maintenance of new or improved habitats.
- Such a system would need an intuitive graphical user interface, a map-based interface for specifying sites for habitat upgrades and a secure means for submitting proposals. The marketplace platform would need to ingest data from multiple sources including the habitat baseline dataset, archive satellite imagery from multiple date ranges, topographic mapping, potentially land ownership mapping, and a range of environmental and ecological datasets to incorporate as much relevant/available data for the most robust assessments.
- Assessments could be carried out manually by local authority users analysing a combination of geospatial layers, but the system could also take a data feed from other services that may offer pre-analysed data to help make faster decisions. Such services are likely to be proliferating in the coming months/years as companies look to create value added biodiversity related data products.
- Note that habitat banking solutions already exist, such as that from Environment Bank; ESRI (UK) Ltd also offer a solution for use by local authorities.
- A follow-on project could be a platform for the ongoing monitoring of habitats created as part of BNG commitments, to ensure that developers are sticking to their responsibilities of creation and maintenance within the dates pledged.

PROPOSAL #4: OVERLOOKED BIODIVERSITY

CHALLENGE

How might we gain a better understanding of the value of habitats not usually recognised for their biodiversity?

- The case study this group focused on was traditional orchards, but the team felt there would be other similar use cases.
- Traditional orchards have often only been valued either as an unimportant woodland or for their agricultural products, when they, in fact provide habitat for rich biodiversity. Can monitoring uncover greater biodiversity value in various historic habitats, which might reflect their lesser-known role in supporting birds and insects?

USERS

Local planning authorities | Organisations involved in biodiversity credit markets

SOLUTION

Create a methodology that can illustrate the biodiversity-related benefits offered by traditional orchards. The project would analyse biodiversity-related data across time series for selected study sites, and assess the comparative value a traditional orchard has on local biodiversity compared with other nearby sites which have differing habitat values.

The project would look to validate a methodology for proving the value of orchards, which could then be followed for re-assessing other habitat types that may also be currently overlooked.

TECHNOLOGY

High-resolution satellite data to analyse vegetation | Site surveys | Additional data would include historic maps and wildlife survey data

Training data, historic imagery? Ground truthing of test sites

RISKS

- Lack of access to relevant data – imagery may be too costly if it is found that high resolution commercial imagery is needed rather than open source imagery
- Potential for the methodology to not succeed in proving the relative value of traditional orchards
- Perceived value of the endeavour to be able to get buy-in

FURTHER CONSIDERATIONS

- Is the technology sufficiently refined?
- Is it sufficiently high priority for it to get funding and development buy-in?
- With the biodiversity net gain credit value for traditional orchards being set at the lowest possible financial value - will the project be able to showcase the impact it promises?

TECHNICAL RECOMMENDATIONS #4: OVERLOOKED BIODIVERSITY

- This project is initially reliant on the work from other suggested projects. That is, it needs the available habitat condition data to form a baseline, which will be one of the datasets used to make a local assessment.
- Without the other projects, this will still be possible but using either the BNG metric tool or the natural capital assessment method.
- The main point is to assess each traditional orchard test site as part of the wider area, and account for each of the EBV when deciding the best approach.
- Comparing orchard test sites with other habitats that are currently valued at different levels would hopefully provide data-derived evidence that orchards should not be classed at the lowest value.
- A selection of indices could be used in conjunction with satellite imagery for providing an indication of biodiversity abundance. (Indices are methods for analysing satellite imagery.)
- The starting point would be using the Normalised Differential Vegetation Index – NDVI, which a measure of amount of chlorophyll in leaves. This can be used as a basic indicator of biodiversity abundance.
- Other indices could be analysed in addition, to measure and compare with other habitats.
- The project would look to analyse orchards alongside nearby other habitats to show how the vegetation indices compare, with the expected result being that the values are comparable with those of woodland or higher
- The project would also use field survey data of wildlife in the area to analyse the composition and abundance of species using the orchard compared with using other habitat areas, including woodland.
- Field surveys would need to be conducted at different points during the different seasons to capture breeding species as well as those using the orchard for winter feeding (e.g. migratory birds. This will have to be undertaken using both diurnal and nocturnal surveys.

5. NEXT STEPS

RECOMMENDATIONS

Our workshop highlighted the critical need for biodiversity management in the face of escalating global challenges. As we proceed, let's focus on the urgency of our mission and the transformative potential of the proposed projects.

A big thank you for all the great ideas and insights shared in our workshop. We really appreciate your input. Your continued involvement is crucial as we shape and refine these initiatives to meet local needs effectively.

Adopting Innovation and Space Technology:
In our commitment to effective biodiversity management, we're placing a strong emphasis on innovation. The integration of advanced space technology, including satellite imagery, earth observation, and drone technology, marks a significant shift in our approach. By adopting these cutting-edge developments, we position ourselves at the forefront of technological solutions for conservation.

Aligning with Local Priorities:
The proposed projects are all about tackling the real biodiversity challenges our local communities face. By aligning with local priorities, we ensure the relevance and impact of our initiatives on the ecosystems that surround us.

Collaborating and Advancing Project Implementation:
Success relies on collaboration. Continued partnerships between stakeholders, local users, authorities, and the business sector will help maximise the potential of these projects. As we progress from conceptualisation to implementation, a critical aspect involves exploring and obtaining funding, gaining support, and translating these innovative concepts into actionable projects. We invite your thorough examination, collaborative ideation, and strategic planning to propel these initiatives forward.

Exploring Funding Opportunities:
Securing funding is pivotal. We will explore the potential for public-private partnerships and various grant opportunities to advance these project ideas. Continued collaboration and strategic planning will be instrumental in turning these aspirations into tangible, impactful initiatives.

Establishing Feedback Mechanism:
To enhance ongoing collaboration, we propose establishing a structured feedback mechanism. This platform, in collaboration with the Natural Environment Partnership, ensures stakeholders have a dedicated space to express thoughts, concerns, and suggestions, fostering transparent communication. These recommendations not only guide us towards effective biodiversity management but also provide a valuable tool for monitoring the development, implementation, and progress of suggested projects. Your continued commitment and collaboration will be essential.

ANNEXE #1: INTRODUCTION TO EARTH OBSERVATION FOR BIODIVERSITY MONITORING

(slides taken from workshop presentation)

Introduction to Earth Observation for Biodiversity Monitoring

Dr Mark Hennen
Senior Earth Observation Consultant

We work with Innovate UK

CATAPULT Satellite Applications

CONTENTS

- Why do we need to monitor biodiversity?
- What is satellite based remote sensing?
- What Earth Observation (EO) data is available?
- How can we use EO to monitor biodiversity?

BIODIVERSITY CRISIS, COMPARABLE TO CLIMATE CHANGE

- Biodiversity is critical to ecosystem functionality
- Globally, > 60,00 species lost annually*
- 52% decline in wildlife populations since 1980's**
- Sustainability of human activity is in jeopardy (e.g., pollinators)
- Urgent need for data to close gaps in our ability to monitor biodiversity

*Dirzo, etal. (2014). Defaunation in the Anthropocene.Science345, 401–406
**Living Planet Report (2014) https://www.worldwildlife.org/pages/living-planet-report-2014

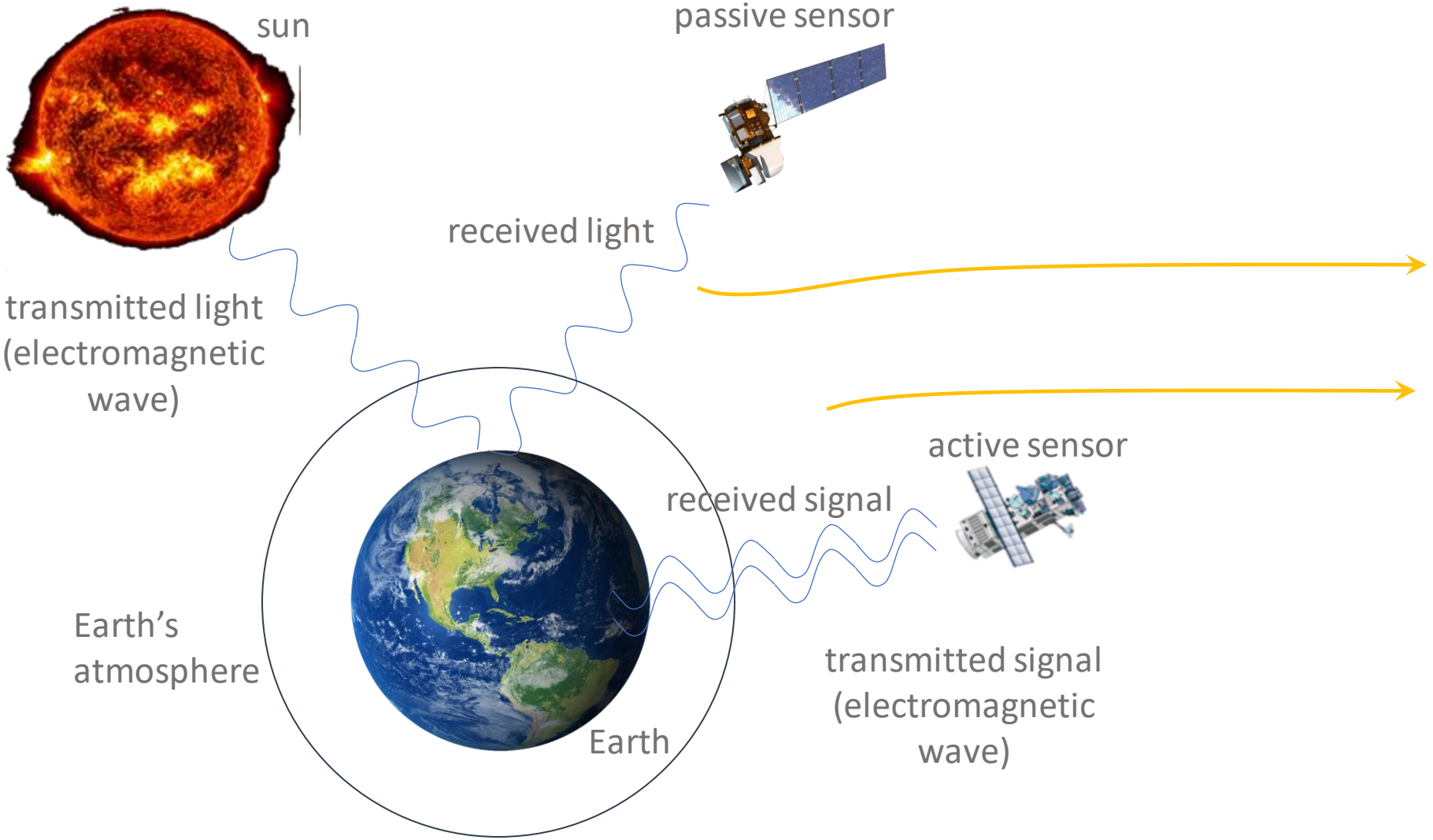
What is earth observation remote sensing?

Earth Observation or ***Earth Remote Sensing*** is a technology that measures electromagnetic radiation to extract information about Earth's land surface, sea, and atmosphere

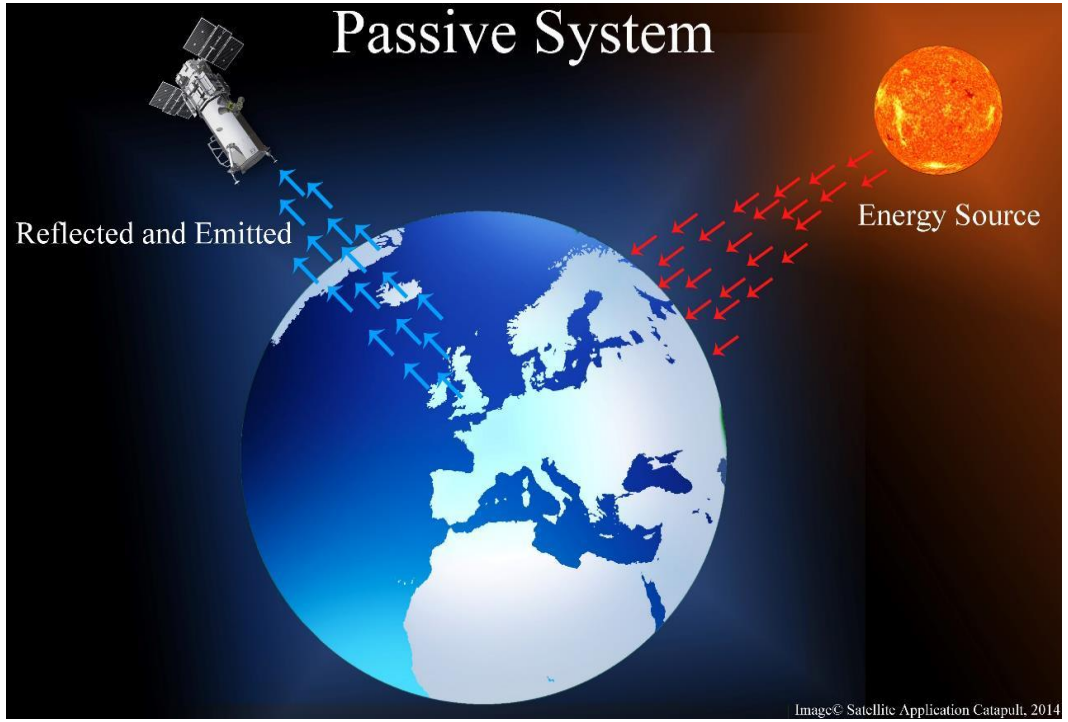
- SCALE
- COST
- SPEED

…ELECTROMAGNETIC RADIATION

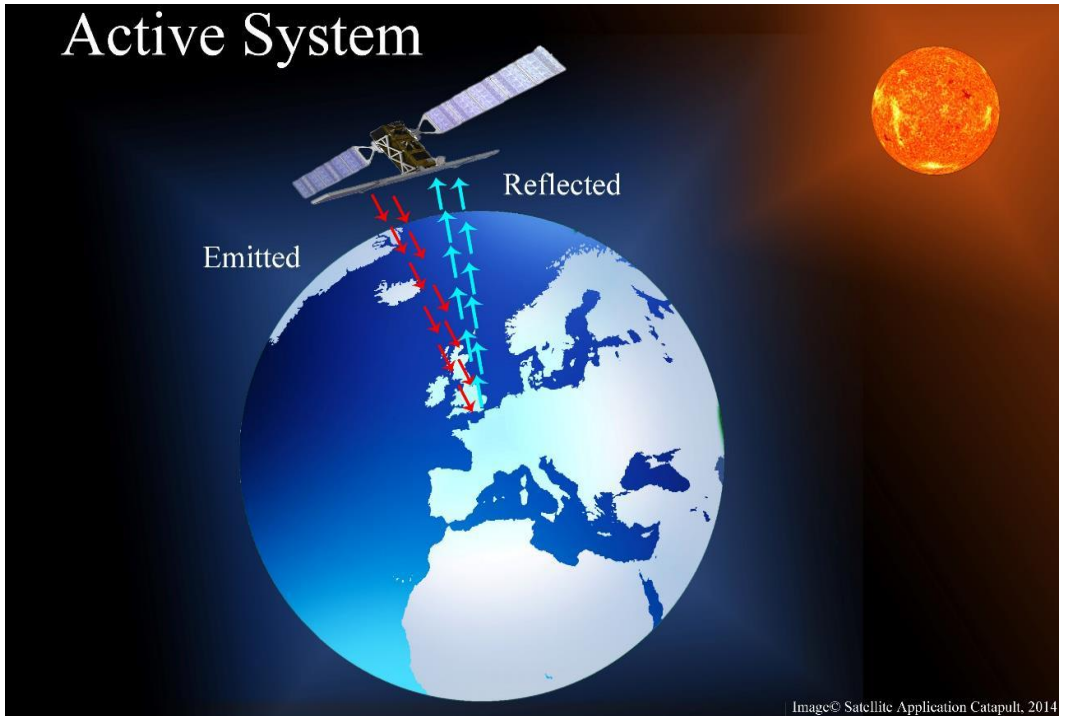
the “**electromagnetic spectrum**” is the main physical concept behind remote sensing



TWO PRINCIPLE EO SATELLITE SENSOR



- Detect emitted and reflected naturally occurring radiation
- **Optical satellites**. Images eyes read and understand
- Limitation include clouds, night or day
- Weather, Climate, Environment, Agri, Ocean



- Generate and emit own radiation energy, that's reflected or scattered back to sensor
- Radar sensor/ **Synthetic Aperture Radar (SAR)**
- Unaffected by clouds, night or day
- Defense, Natural Hazards, Infrastructure, Water

EARTH OBSERVATION CONSIDERATIONS

- Spatial resolution and Observation frequency
- Spectral resolution
- Limitations
- Cost

SPATIAL RESOLUTION

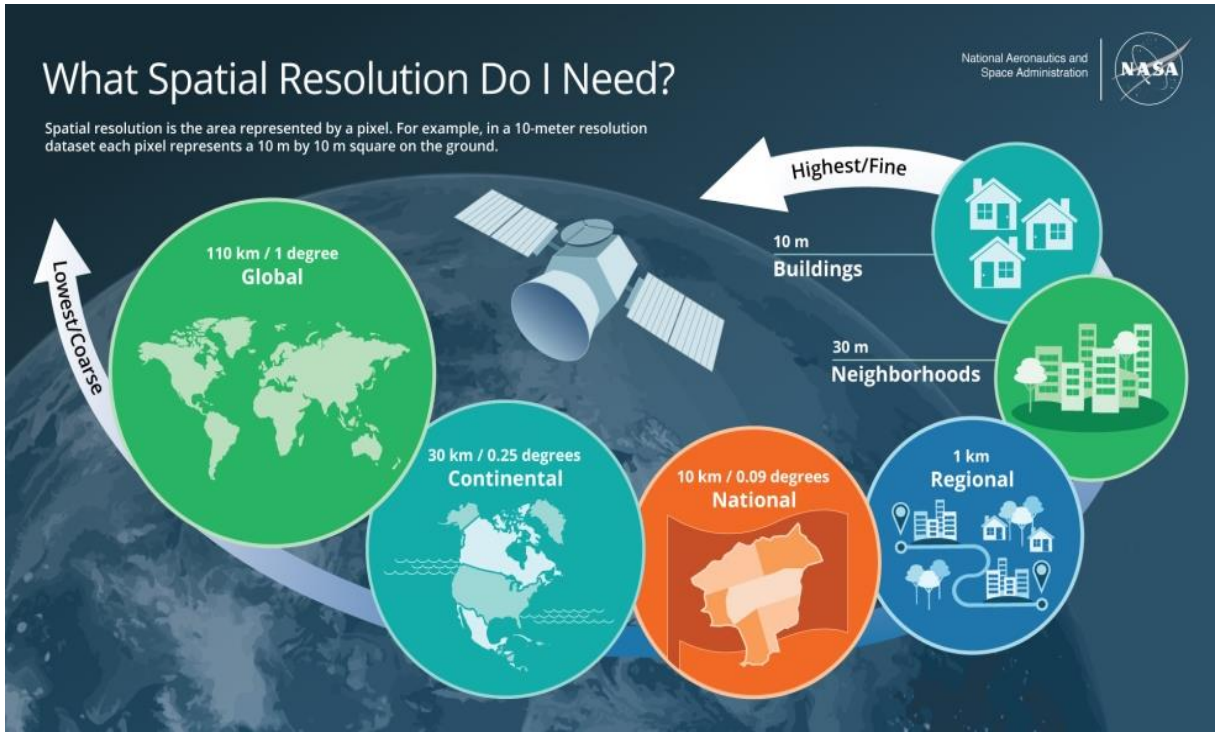
Size of each pixel on the Earth's surface

- Defines observation accuracy and data processing needs
- Restricted spectral capabilities

Landsat 8 image of Reykjavik, Iceland, acquired July 7, 2019, illustrating the difference in pixel resolution. Credit: NASA Earth Observatory.

SPATIAL RESOLUTION AND OBSERVATIONAL FREQUENCY

- Different spatial resolutions can be used for specific observational or research needs
- Research scale defines which sensor is best suited (regional, national, continental, etc.)
- Spatial resolution is typically linked to observation frequency
- Higher frequency = lower resolution
- Constellation development changes that equation

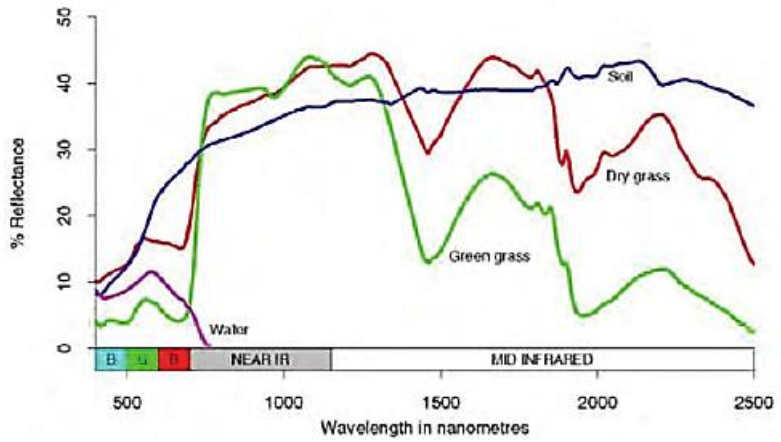


Source: NASA Earthdata

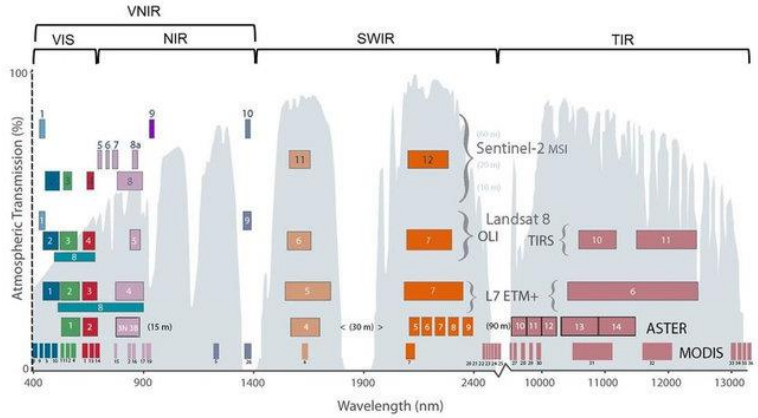
Source: European Space Agency (ESA)

SPECTRAL RESOLUTION

- The primary source of the energy observed by satellites, is the Sun.
- Reflectance depends on albedo and roughness.
- Energy comes in many different wavelengths.
- All things on Earth reflect, absorb or transmit energy in a unique way (spectral signature).
- Spectral signature is described by reflectance in different wavelengths.
- Insights are driven by extracting spectral signature from different spectral bands.



Ashraf et al., 2011, *Biomass and Remote Sensing of Biomass*



Hirschmugl et al., 2021, *Land*

HOW CAN EO HELP BIODIVERSITY MONITORING

Essential biodiversity variables

- Genetic composition
- Species populations
- Species traits
- Community composition
- **Ecosystem structure**
- **Ecosystem function**

Ecosystem structure

- Fractional cover
- Land cover
- Vegetation height
- Structural diversity

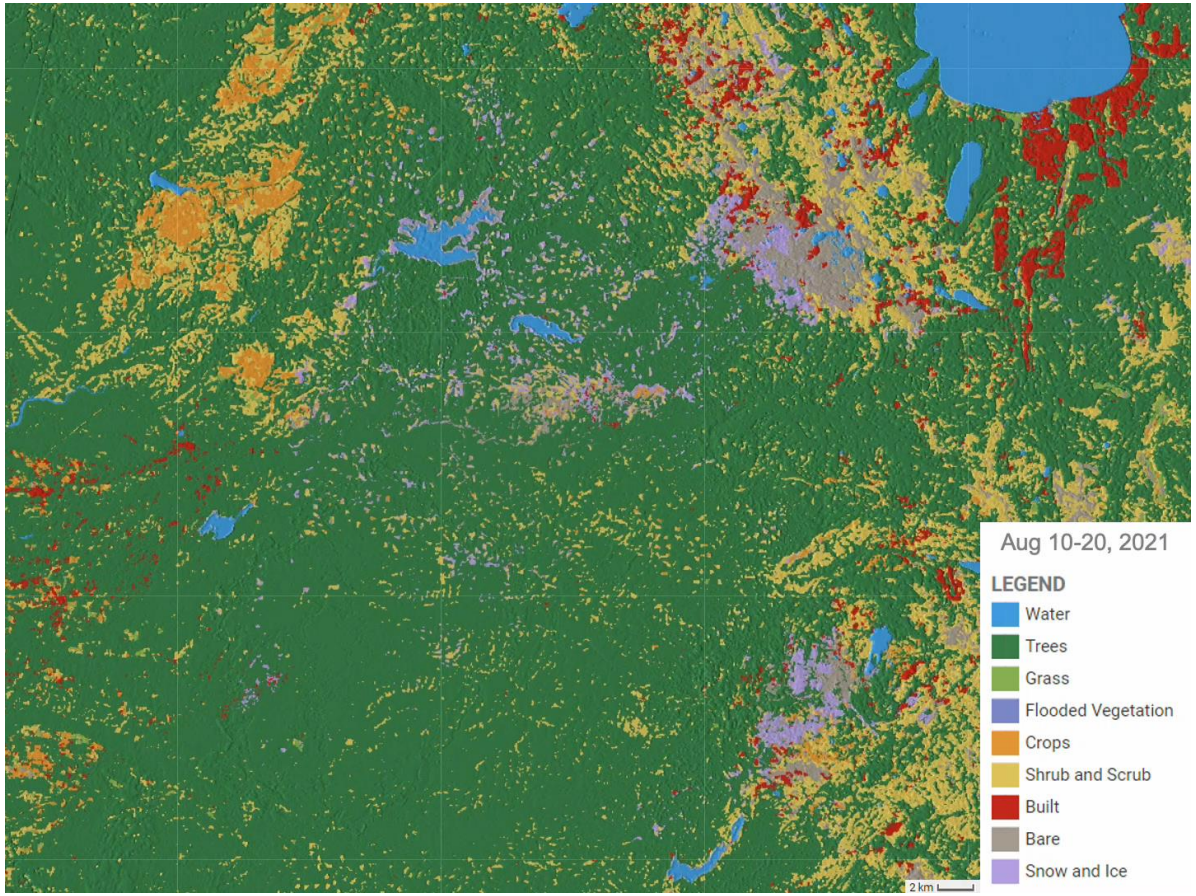
Ecosystem Function

- Photosynthetically active radiation
- Leaf area index
- Vegetation (terrestrial and aquatic) phenology
- Above ground biomass
- Disturbances (fire/flood/invasive species)

ECOSYSTEM STRUCTURE: LAND COVER CLASSIFICATION

Land use on the Earth's surface:

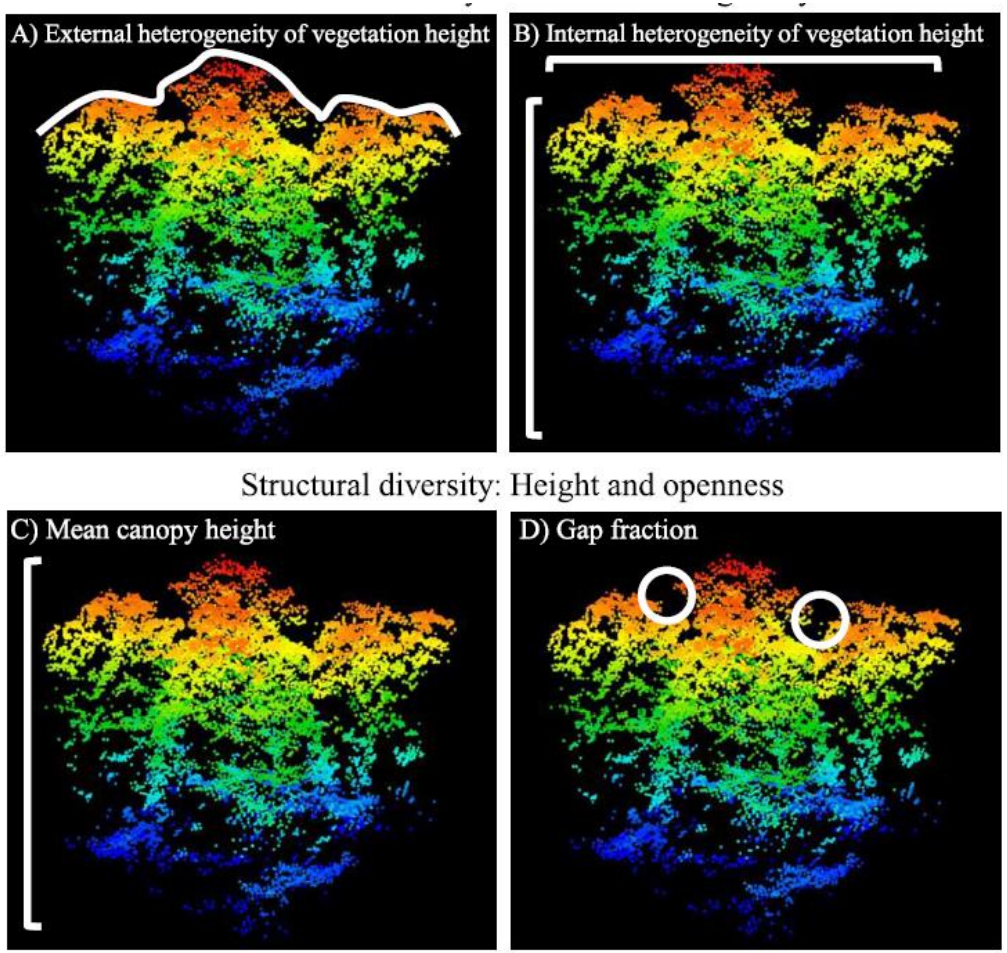
- Variations and detail of land types can be mapped as determined by the available data to derive the information from.
- Land cover classifications are perfect for generating baseline studies to visually and quantifiably identify change to land use overtime.
- The update frequency could be defined by the requirements of the application and the availability of data.



Open access - Near real-time (2-5 days global maps depending on Sentinel-2 acquisitions) – powered by AI, 9 land cover classes, 10m resolution.

ECOSYSTEM STRUCTURE: STRUCTURAL DIVERSITY

- Structural diversity is a key indicator of biodiversity.
- The production of niche spaces promotes co-existence of species through altering environmental conditions and shelter.
- Predictor of ecosystem functions, including productivity, energy, and nutrient dynamics.



GEDI ECOSYSTEM LIDAR

LaRue *etal.* (2023) Structural diversity as a reliable and novel predictor for ecosystem productivity

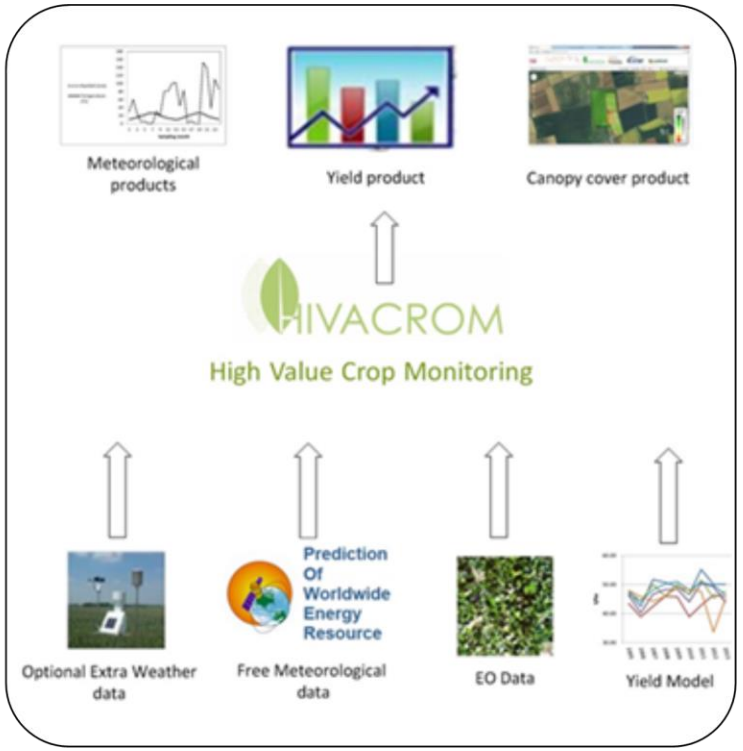
ECOSYSTEM FUNCTION: PHOTOSYNTHETICALLY ACTIVE RADIATION

The Catapult working with Precision Decisions Ltd have developed a simple decision support tool to help farmers determine if variability exists in their fields, and so whether they should invest in precision agriculture services.

The new MiSat tool has been integrated within the Precision Decisions existing MiFarm app suite and exploits various crop indices such as NDVI and EVI to highlight variation in crop health across multiple fields.

DATA FUSION

The High Value Crop Monitoring (HiVaCroM) project centred on the creation of an agronomic sensor network supported by terrestrial and satellite wireless communications to deliver real-time intelligence of crop status and nutrition requirements.



WATER RESOURCE MONITORING

Mapping parameters **of water quality**

- Turbidity
- Algal Blooms
- Eutrophication
- Ph
- Pollution
- Sediment
- Bathymetry
- Habitat monitoring e.g., saltmarsh, mangrove

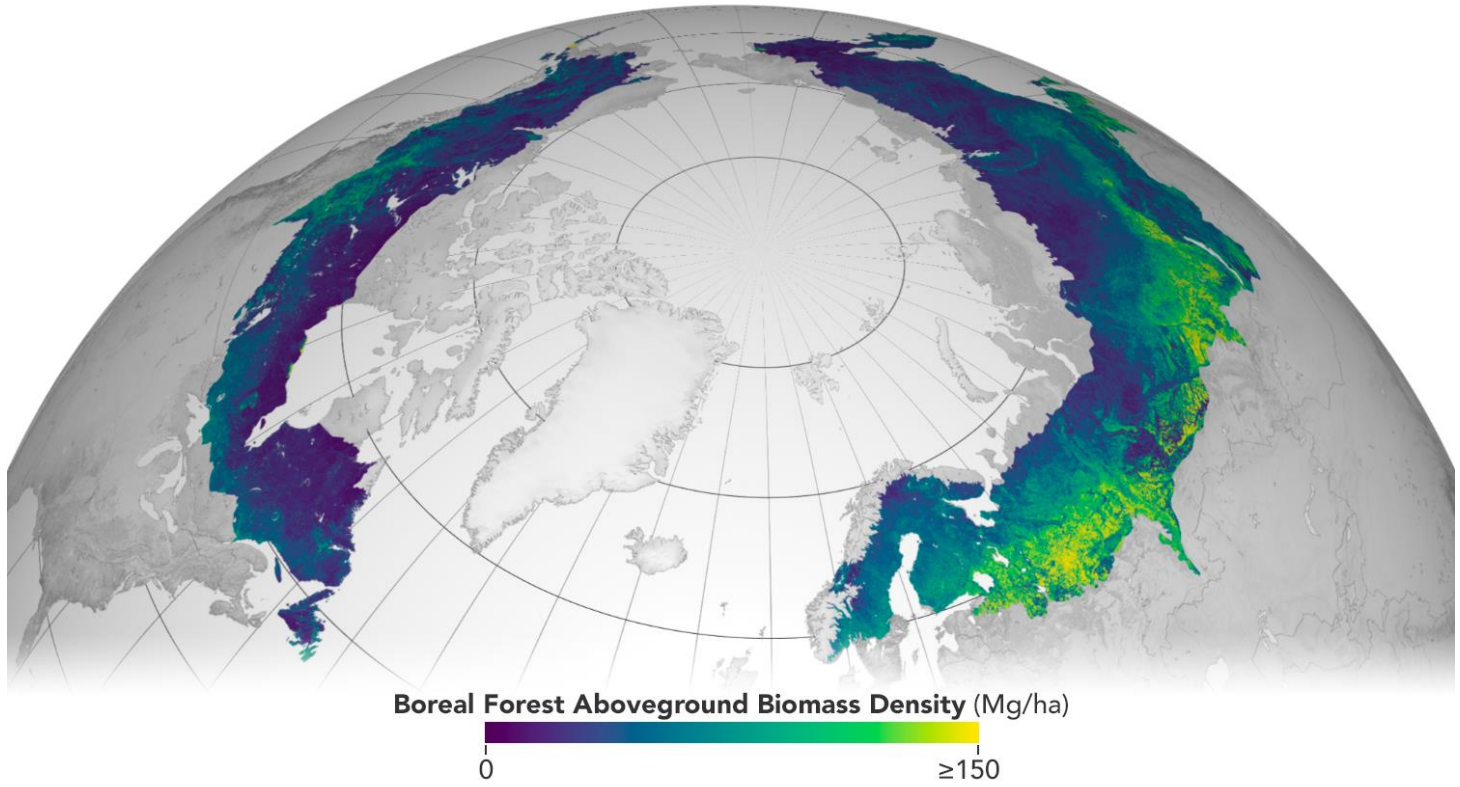
Chlorophyll -a

Turbidity

Total Absorption

ECOSYSTEM FUNCTION: ABOVE GROUND BIOMASS

- Determining variability in forest canopy
- Fusing data to provide greater insights
- Monitoring changes over time



Circumboreal forest biomass density mapped at high spatial resolution (30 m) with NASA's ICESat-2, the joint NASA/USGS Landsat-8, and ESA Copernicus Digital Elevation Model (DEM) data.

ECOSYSTEM FUNCTION: DETECTING DISTURBANCE

- Vegetation disturbance detected through changes in spectral signature
- Fire, flood, drought, land cover change
- Utilise multiple EO platforms

Source: ESA

ANNEXE #2: ADDITIONAL RESOURCES

2020 BASELINE

The following policy-related developments are key regarding the 2020 baseline:

- As part of the Environment Act requirements, the upcoming Local Nature Recovery Strategies will need to be reviewed every 3-10 years, including mapping where action for nature recovery has been taken. Local stakeholders agree that understanding a baseline of habitat condition and being able to monitor change in this over time will significantly complement this requirement.
- In terms of the upcoming mandatory biodiversity net gain policy requirements, the Environment Act includes measures to allow local planning authorities to recognise any habitat degradation since 30th January 2020 and take the earlier habitat state as the baseline for BNG purposes. The Government hasn't yet stipulated the evidence that will be needed to identify the habitat state as at 30th January 2020. The reason for this date is to discourage potential development sites being degraded by developers. This would mean that the 10% BNG uplift being applied to a lower baseline condition would make the 10% target easier to reach, which is why the government wants to practice caution in this regard.

READING RESOURCES

Biodiversity Net Gain *(Link)*

"Biodiversity net gain (BNG) is a strategy to develop land and contribute to the recovery of nature. It is a way of making sure the habitat for wildlife is in a better state than it was before development."

You will need to understand the requirements of BNG if you're a:

- land manager
- developer
- local planning authority"

Mitigation Hierarchy *(Link)*

"A mitigation hierarchy is a set of guidelines as opposed to a legislative framework, and developers can utilise it to clearly define and establish how to improve the biodiversity value of the project.

'The measurement of biodiversity loss can be categorised into the following four stages:

- Complete avoidance
- Minimisation, where possible
- Restoration of areas within the development
- Offsetting, either onsite or offsite"

State of Nature Report *(Link)*

"The report provides the most comprehensive overview ever of species trends across the UK, including specific assessments for England, Northern Ireland, Scotland and Wales, and for the UK's Overseas Territories. Its conclusions are based on millions of records collected by thousands of volunteer 'citizen scientists' spanning terrestrial, freshwater and marine species.

The report makes for a compelling reading. It lays bare the stark fact that nature is still seriously declining across the UK, a country that is already one of the most nature-depleted in the world."

Additional resources:

- Finding common ground: Integrating data, science and innovation for better use of land
- Environmental Improvement Plan 2023

FUNDING RESOURCES

Some samples of the funding calls that now closed:

- **Innovation in environmental monitoring**
  For projects demonstrating innovative approaches toward environmental monitoring at a sensor or systems-based level, with collaborative applications encouraged from across the environmental science, environment-focused informatics and wider data science communities.
  Opportunity link

- **Tools for automating image analysis for biodiversity monitoring**
  To develop software systems, which will help to improve biodiversity monitoring by automating the analysis of images and videos.
  Opportunity link

Active/open:

- **SBRI: Plant health innovations for biosecurity**
  Aims to accelerate the effective development of innovative solutions, technologies or practices that enhance plant health and biosecurity activities. With a focus on regulated pests, diseases and of future operational deployment.
  Opportunity link