



EO for Water Management

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Findings from the Sentinel Benefits Study (SeBS)

EARSC@ECSECO 22nd January 2025



SeBS in a nutshell

Showcasing the benefits brought by the usage of Copernicus Sentinels data to society, environment and economy through bottom-up assessments based on traceable impacts along selected value chains

Use cases reports

22* Long and 15 Short cases



<https://earsc.org/sebs/all-cases/>

Robust Methodology

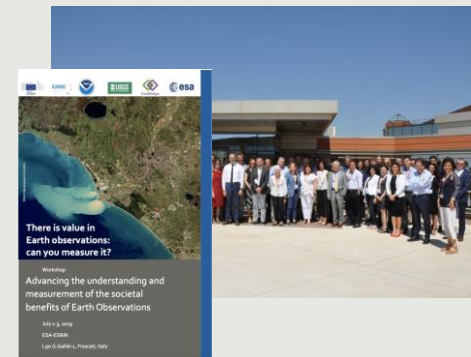
Based on use-case-specific value chains, assessment of impacts across 6 dimensions of value



<https://earsc.org/sebs/wp-content/uploads/2020/12/SeBS-Methodology-2020.pdf>

Workshops

with end-users and in international fora



<https://earsc.org/sebs/workshop-2019/>

Cross-cutting Analyses Reports

complementing and expanding the use case findings



<https://earsc.org/sebs/cross-cutting-reports/>

*3 of which developed as part of legacy ESA pilot project

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Companies

Timeline: March 2017- Summer 2024



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Europe's eyes on Earth

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A rich portfolio of cases analysed across sectors, geographies & Sentinel usage



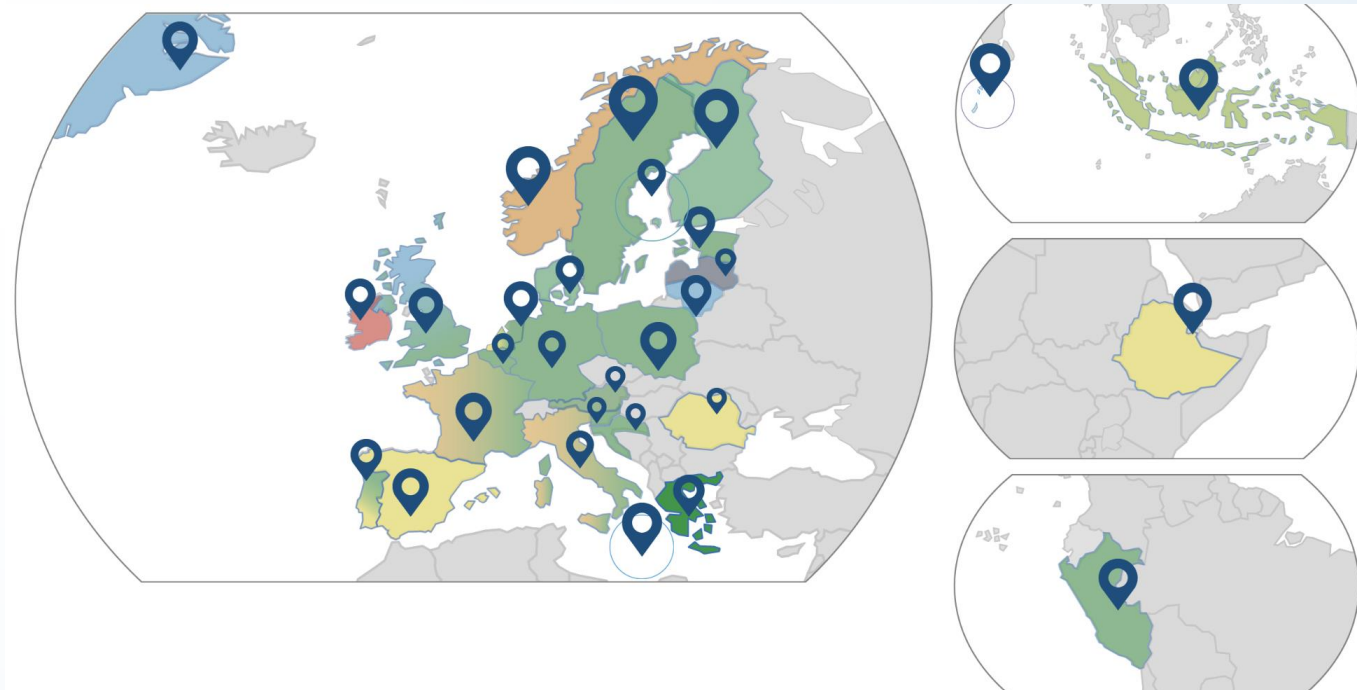
+ 300 candidate cases collected

22 fully developed cases

15 short cases

Detailed statistics:

https://earsc.org/sebs/wp-content/uploads/2024/11/SeBs_Final-Overall-report_2024_vFinal.pdf



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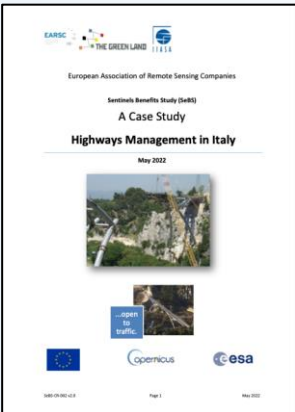
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What does a SeBS “long” case look like?

- Approx. 70-pages report
- Rich contextual analysis
- Explicit assumptions validated with key stakeholders
- Full value chain analysis
- Quantitative assessment of economic outputs
- Qualitative assessment of impacts in 6 dimensions of value
- Extrapolation
- An easy-to-read flyer



Services/
Benefits

Beneficiaries

TIER 1	TIER 2	TIER 3	TIER 4
Satellite imagery	Ground Movement maps	Risk or damage to infrastructure	Efficient road infrastructure.
Service Provider: Planetek	Primary User: ANAS	Road maintenance Construction Road operators	Transport companies and road users
Ministry of Transport Civil protection Authority Geological Survey of Italy Environmental Agencies			



	Minimum	Maximum
Tier 1 – Service Provider (Planetek)	n/a	n/a
Tier 2 – Primary User (ANAS)	€3.8m	€8.6m
Tier 3 – Construction Companies & Highway operators	€1.0m	€2.0m
Tier 4 – Citizens and Society	€0.8m	€3.0m
Total	€5.6m	€13.6m

Economic	Environmental	Societal	Regulatory	Innovation & Enterprise	Scientific & Technological
★★★★★		★★	★	★★★★	★★★★

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A robust and tested methodology, enhanced and improved over time

Robust, tested methodology

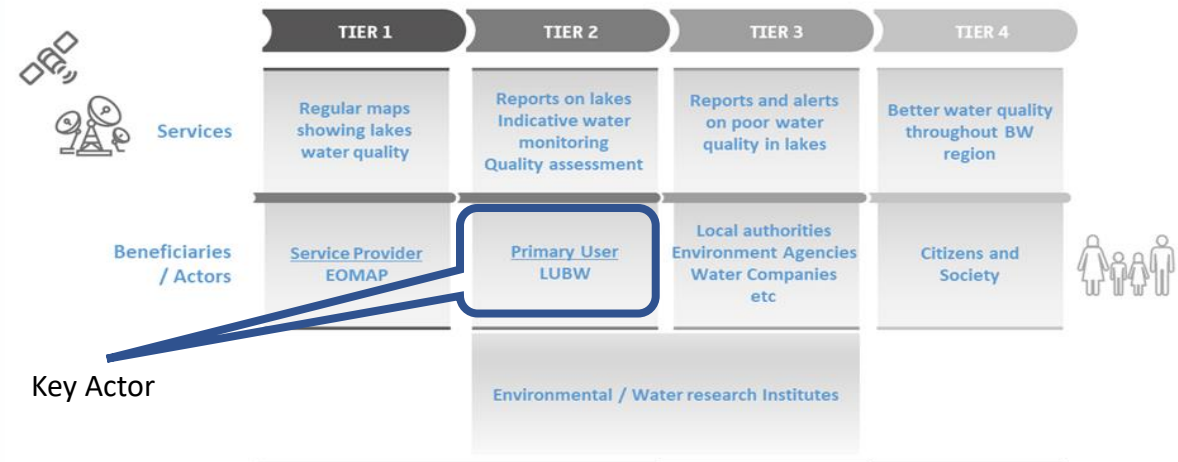


<https://earsc.org/sebs/wp-content/uploads/2020/12/SeBS-Methodology-2020.pdf>



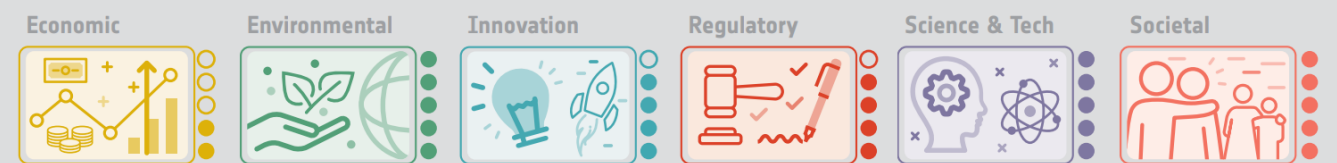
Operational use
of Sentinel data
by a primary user.

Value chain of actors in 4 tiers from supplier to citizens and society.



Benefits for each tier analysed across 6 dimensions of value

Total benefits



Anticipated Monetary Benefits: €4m – 7.8m pa across Germany

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Methodology: 6 Dimensions of Value



ECONOMIC

Impacts related to the production of goods or services, or impacts on monetary flow or volume, such as revenue, profit, capital and (indirectly, through turnover generation) employment.



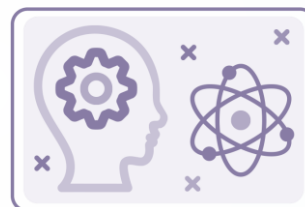
INNOVATION AND ENTREPRENEURSHIP

Impacts linked to the development of new enterprises, business or jobs and/or the introduction of technological innovation into the market.



ENVIRONMENTAL

Impacts related to the state and health of the environment, particularly as regards the ecosystem services on which human societies depend.



ADVANCEMENTS IN SCIENCE AND TECHNOLOGY

Impacts linked to academic, scientific or technological research and development, the advancement of the state of knowledge in a particular domain.



REGULATORY

Impacts linked to the development, enactment or enforcement of regulations, directives or other legal instruments by policy makers.



SOCIETAL

Impacts related to societal aspects such as increased trust in authorities, better public health or secured geostrategic position.

An extensive set of **indicators** for each dimension was developed

Summary of Economic Benefits

Economic benefits can manifest in numerous ways. Below is a snapshot of the different ways in which we have seen the Sentinel's adding financial value to companies, users and beyond.

Capital expenditure reduction																			✓		
Cost savings		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓		✓	
Increased revenues				✓					✓						✓		✓	✓	✓		✓
Efficiency gains	✓	✓				✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
Reduction of risk	✓	✓	✓		✓			✓	✓	✓			✓		✓			✓	✓		
Employment			✓	✓						✓	✓			✓		✓	✓	✓		✓	
Economic Benefits																					

Find details by expanding the icons on the right side

- Ground motion
- Vegetation
- Water
- Emergency
- Air quality



Lower estimate (M€)	11	2.5	33	3.9	0.2	41.7	6.6	5.6	19	4	0.1	5	31.7	3.8	1.1	1.8	8.6	6.5	1.1	15.2	16.1	24	Totals: 242.5
Upper estimate (M€)	22.2	3.6	38	4.1	3.8	81.1	24.8	13.6	33.6	7.8	1.1	9	71.8	8.7	5.3	2.6	12.5	30.3	1.2	18.3	21.6	116	531

Short cases gallery

GREEN WELLBEING INDICATORS IN POLAND



SOURCING DEFORESTATION-FREE CACAO IN PERU



IRRIGATION DETECTION & MAPPING IN AUSTRIA

Copernicus Sentinel data are used to detect irrigation on agricultural fields in Austria by the Umweltbundesamt – Environment Agency Austria to understand water usage in time and space. This helps to prepare and inform current and future water management policies and measures in the country.



MONITORING ILLEGAL, UNREPORTED, AND UNREGULATED FISHING IN UK OVERSEAS TERRITORIES



RENEWABLE MINIGRID DEPLOYMENT IN ETHIOPIA

The World Bank is using a platform based on Copernicus Sentinel data in order to support its electrification projects in Africa, thereby reducing planning time and costs and increasing accuracy in execution.



GROUND MOTION INTELLIGENCE IN ROMANIA



WILDFIRE MANAGEMENT IN GREECE



INSURANCE AND RISK MONITORING IN SLOVENIA

Copernicus Sentinel data is being used by insurance companies to conduct better risk assessments. In the wake of natural disasters, the data also allows for rapid mapping of impacted areas and helps in determining future exposure to similar events.



FOREST MONITORING IN PORTUGAL



GOLF COURSE MONITORING IN ITALY

Copernicus Sentinel data is being used by Centrale Valutativa to monitor the health and status of the grass of the golf course as well as to give recommendations on the most efficient way to irrigate the grass helping to save water and energy.



GLOBAL OIL INDUSTRY ACTIVITY MONITORING

Copernicus Sentinel data is being used by energy companies, commodity traders and oil market speculators to better understand the markets they operate in, allowing them to optimise trades and make better informed business decisions.



ILLEGAL WILD BOAR ACTIVITY IN LITHUANIA

Copernicus Sentinel data is being used by the courts in Lithuania to help resolve legal disputes, leading to more efficient use of the judiciary's time, fairer judgements and earlier compensation payments for plaintiffs.



ASSESSING GESE DAMAGE IN THE NETHERLANDS

Copernicus Sentinel data is being used by the Province of Friesland in the Netherlands to improve the management of geese damage compensation through the Fauna Fund, leading to more efficient appraisals by saving time and cost.



DREDGING IN THE MALDIVES

Copernicus Sentinel 2 data is being used in the Maldives to improve the efficiency of dredging for sand on saving ship time on site and reducing negative environmental impacts derived from damage to endangered coral reefs.



PEATLAND MANAGEMENT IN THE UK

Copernicus Sentinel data is being used by water utilities in the UK to improve the management of peatlands, leading to better water quality for local citizens, reduced costs of purification for the water companies and strong environmental benefits.



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Water Quality Management in Germany

- EOMAP, a small German company offers a service EoLytics which allows subscribers to download measurements of water quality for water bodies in their areas of interest.
- LUBW - the Baden-Württemberg State Institute for the Environment - accesses data for the region via eoLytics so providing a better service to its citizens for an affordable cost.

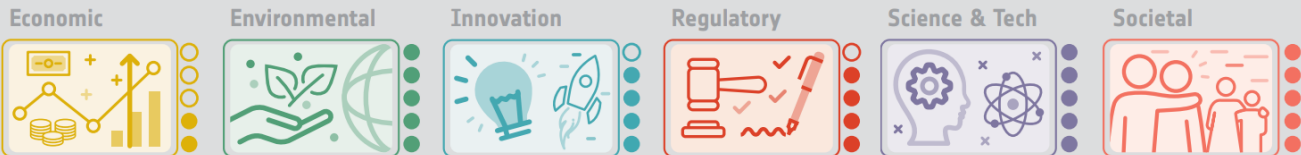
Benefits:

- The service helps to reduce exposure to dangerous harmful algal blooms (HABs) whilst improving the environment, reducing pollution and helping nature conservation.
- Satellite-derived measurements of the quality of water in lakes help local and regional authorities monitor the lakes in their region more effectively, more frequently and more comprehensively and to keep their citizens informed.

LUBW

EOMAP

Total benefits

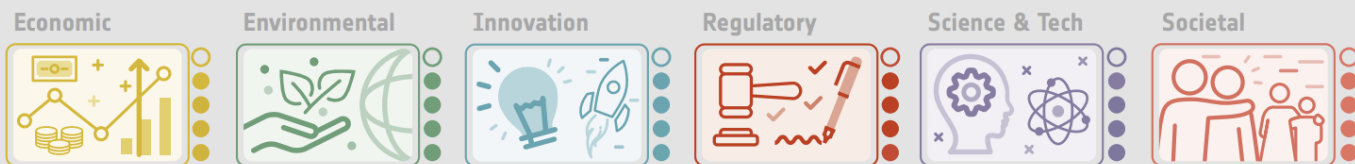


Anticipated Monetary Benefits: €4m – 7.8m pa across Germany

Water Quality Management in Finland

- Sentinel data helps regional authorities and the Finnish environmental institute to monitor the lakes more effectively, more frequently and more comprehensively.
- Thanks to the use of Sentinel data offered through a publicly available platform, economic and leisure activities are better informed and lake ecosystems are better protected. The associated benefits are important and will grow significantly in the next five to ten years.
- This exemplary use of Sentinel satellite data in Finland not only generates positive impact in the country but also illuminates the associated value for regulatory aspects of water monitoring across Europe.
- **Benefits for:**
 - Primary user: Environmental offices located in each of the regions of Finland | Other users: Ministries of the Environment and of

Total benefits



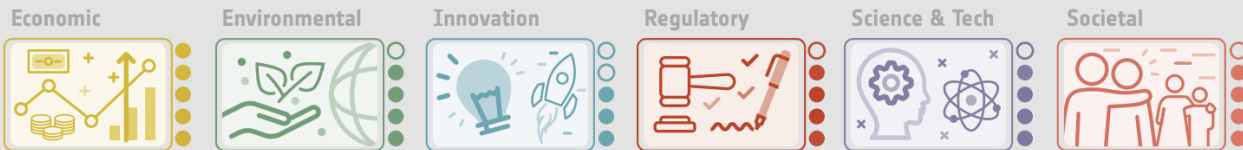
€6.62m -24.82m pa across Finland



Water Quality Management in the Netherlands

- Sentinel data is used by a regional water board to monitor lakes more effectively, more frequently and more comprehensively.
- Lakes in The Netherlands are at an elevated risk of pollution due to high population density and intensive agriculture practices.
- Water Insight, a Dutch SME, leverages Copernicus Sentinel-2 and Sentinel-3 data to offer satellite-based services on water monitoring, complementing in-situ measurements.
- **Benefits for:**
 - Primary user: Noorderzijlvest Water Board
 - Other users: Ministry of Infrastructure and Water Management

Total benefits



Anticipated benefits: €33m - €38m pa across The Netherlands



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Water Quality Monitoring

How satellites can help?

- Provide ability to measure water quality in many more lakes (all over 0,5ha) more frequently and with better spatial coverage (ie more measurement points in v large lakes).
- Give earlier warning of degrading water quality.
- Supports evaluation of the impact of regulations on land-use and agricultural practices on the water quality

Where satellites are helping:

- In active use in: Germany (core case), Finland (core case), Netherlands (core case).
- Under assessment in Austria, Belgium, France, Italy, Norway, Spain, but not yet in operational use.
- Some differences in use between regions with deep lakes and those with shallow ones where the temperature rises more quickly, agriculture is more intense and run-off a greater problem.

The Benefits of using Satellites:

- Improved links between measurements and implementation of regulation (can be further improved with reference in the Water Framework Directive)
- Avoidance of costs of making in-situ measurements in many more lakes.
- Earlier detection of problems
- Improved bathing water quality information for citizens

Water Quality Monitoring

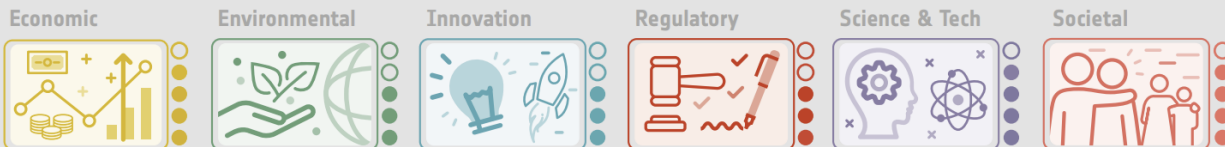
Insights:

- Satellite data provides the capability to monitor lake water quality over large areas and any number of lakes which is not possible using conventional means.
- Introduction so far is determined by local use since national reporting under the WFD is not required. As a result, investments and operational budgets are not granted.
- Only where local expertise and champions have promoted the use of satellite data has this become systematic (ie in Finland).
- Local conditions influence strongly the risk and the need for monitoring. In the Netherlands, the shallow waters heat more rapidly and intense agriculture leads to high chemical pollution, whilst in Finland the enormous number of lakes drives monitoring needs.
- Trusted agents have been instrumental in driving adoption. The environmental institute in Finland has been key whilst industrial actors have demonstrated the capability in Germany and the Netherlands.

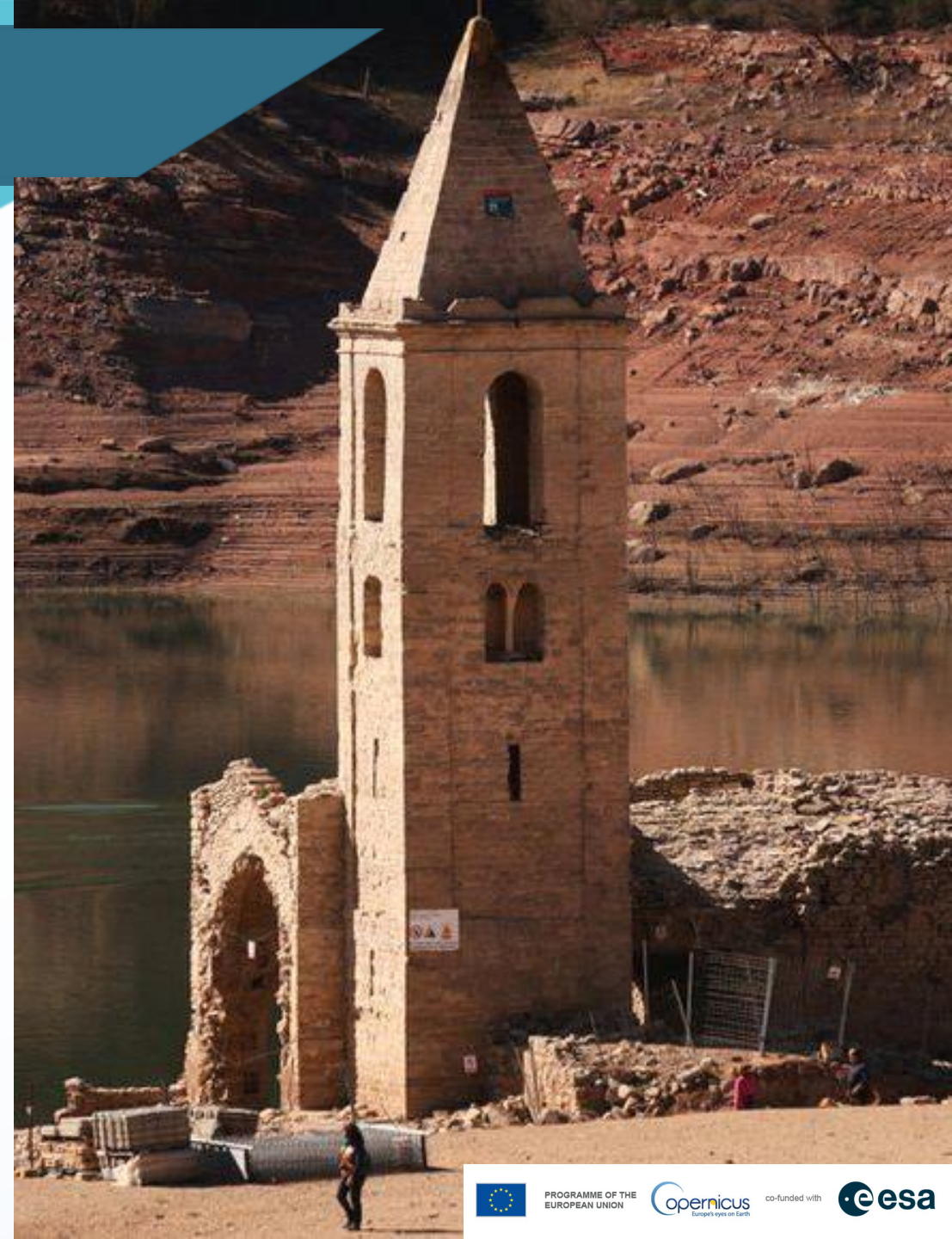
Water Resources Management in Spain

- Innovative solutions using Sentinel data are now being implemented by the Catalan Water Agency (ACA) together with the Cartographic and Geological Institute of Catalonia (ICGC).
- The ACA utilizes ICGC's services on ground deformation to improve aquifer monitoring and efficiently manage groundwater resources across Catalonia. This includes optimizing wells concession rights, detection of illegal extraction and mitigating issues such as aquifer salinization and subsidence.
- **Benefits for:**
 - Primary user: Catalan Water Agency
 - Other users: Municipalities and water utilities

Total benefits



Anticipated benefits: €1,78m - €3,58m pa in Catalonia, extrapolation of €11m - €22,17m across Spain



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Aquifer Monitoring in Spain

- The Segura River Basin management authority (CHS) in the region of Murcia abstracts water from deep-underground aquifers.
- Over abstraction leads to subsidence of the ground surface and potential damage to property in the region.
- IGME, the Spanish geological survey and DARES, a Spanish start-up are supplying maps showing ground movement

Benefits:

- Better control of the water abstraction
- Reduced cost by avoiding the need for expensive in-situ sensors
- Better regulations through knowing that precise measurements can be made using InSAR
- Better compliance with environmental regulations governing the use of scarce resources (water).

Total benefits



€31.7 - 71.8m pa



Richness of the Cases bring new insights

Consistent framework for the analysis of more and more cases allows transversal analyses yielding highly valuable conclusions – some examples are:

Working together



In **Ireland**, flood mapping with shared information helps services co-ordinate their activities better through a common operating picture

GROWING POTATOES IN BELGIUM



In **Belgium**, having a common picture helps to bring together many different stakeholders across the potato industry, cutting across political and administrative lines.

FORESTRY MANAGEMENT IN SWEDEN



In **Sweden**, families can plan their future as a result of knowing better the evolution of their woodland and when it may be harvested.

NAVIGATION THROUGH SEA-ICE OFF GREENLAND



In **Greenland**, knowing where the ice has formed and when supply ships can pass, allows whole communities, living in isolated areas, to plan their lives better and to develop the strategic value of the island.

Better Regulation

GROUND MOTION MONITORING IN NORWAY



In **Norway**, liabilities for co-lateral damage coming from road works are more easily managed by knowing when movement took place as well as the precise location. Allows better definition in regulations; ie 20 years limits rather than 5 years.

Basis for Transversal Analysis

Cross-cutting analyses contribute to strengthening the cases and the methodology as well as providing additional insights



Led us to the question of **what factors influence the uptake/adoption of services by public authorities?**

Common Indicators of Benefits



Economic Benefits e.g. cost savings, efficiency gains...

Examples are: Sweden/Forests (EO data helps save money) and Germany/water quality (improves performance).



Environmental Benefits e.g. reduced pollution, mitigating impacts...

Examples are: Finland/water quality (reducing pollution) and Netherlands/water quality (mitigate pollution impact).



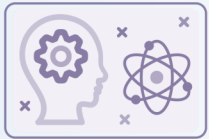
Regulatory Benefits e.g. better regulation, better policing, compliancy promotion...

Examples are: Sweden/forests (helping to design better legislation), Netherlands/water quality (monitoring implementation).



Innovation or Entrepreneurship e.g. trigger for innovative processes or for creating business

Examples are: Italy/highways (driving innovation in public bodies), Netherlands/water quality (enabling new business in private companies)



Research and Science e.g. enabling new research...

Examples are: Germany/water quality and Norway/highways (providing information which is unobtainable by other means).



Societal Benefits: improving citizens lives and enabling better societies

Examples are: Italy/highways (directly benefit citizens e.g open roads), Sweden/forest (geopolitical factor i.e. increased forest inventory)

How “Common” are the Benefits?

[*OECD Observatory on Public Sector Innovation, Copernicus4Regions webinar on innovating public policies](#)

What factors influence the uptake/adoption of services by public authorities and the related accruable benefits?

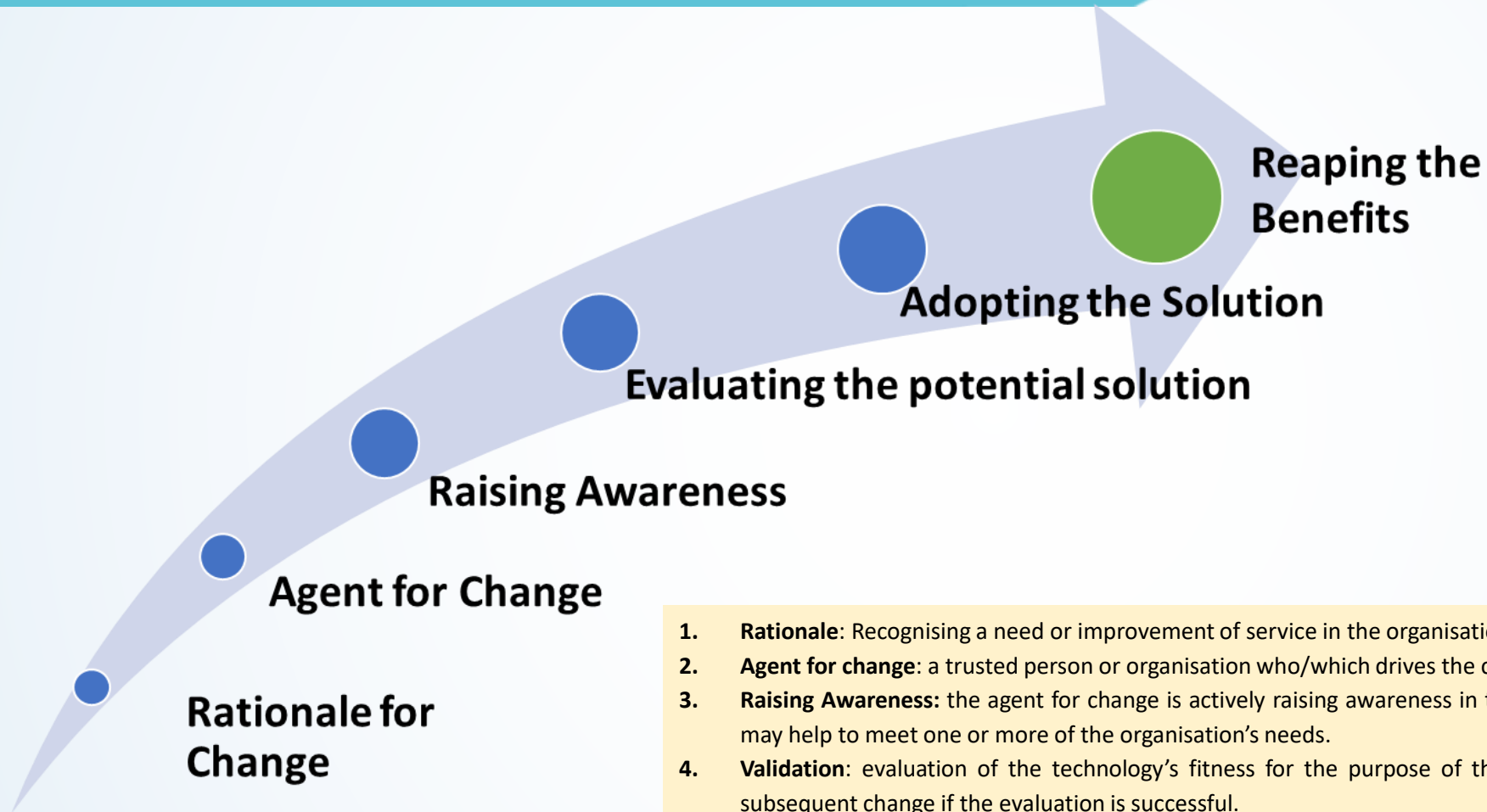
Benefits are specific to each case (even if the application is the same) → The extrapolation of benefits from one case to another cannot be directly applied without due consideration of all boundary conditions.

Main factors that influence adoption of services by public bodies, and accruable benefits

Geography	Geography dictates the scale of the benefit whether quantitative or qualitative. For instance: the extent of the areas to be monitored (e.g. sqkm of forest, stable/unstable geology, number of lakes to be monitored) provides a key trigger for the interest in effective monitoring methods.
Governance or Administrations	The way the public body is structured and the decisions are taken (national/regional/local authorities) and the degree of autonomy/budgets... – also addressed by OECD and Nereus*.
Culture	A general culture open to innovation and proactive problem-solving can also play a role. Absence of willingness and possibilities to innovate can bring general reticence to do so in public bodies
Legal Framework	Whether there a legal requirement to use the technology to measure/monitor there is a clear trigger. This was visible with the new CAP. Absence of legislative requirement undermines the investment case needed to establish a funded process. This is visible through the water framework directive. The legal basis often differs between countries if there is no European legislation.
Space awareness	Knowledge can “demystify space”. We have seen that sometimes space-based solutions are perceived as complex and costly by administrations who have poor awareness.
Industrial presence	The presence of a strong and proactive EO downstream industrial sector is key to ensure uptake especially in the absence of expert public providers (e.g. cartographic institutes or universities...). Companies wishing to do business help demonstrate the benefits.
“EO champions” within the organisation.	The “human factor” is often key: we found that an internal “champion” is almost always necessary unless use is required through the hierarchy. Changing roles and responsibilities undermines continuity and greatly weakens any commitment to the introduction of new processes. The process and EO use must become institutionalised.



The path to adoption



Stages of adoption of new services

1. **Rationale:** Recognising a need or improvement of service in the organisation which may be addressed using the new technology.
2. **Agent for change:** a trusted person or organisation who/which drives the change.
3. **Raising Awareness:** the agent for change is actively raising awareness in the organisation about the new technology and how this may help to meet one or more of the organisation's needs.
4. **Validation:** evaluation of the technology's fitness for the purpose of the organization and preparation of the organisation for subsequent change if the evaluation is successful.
5. **Adoption:** having proven its suitability, the new technology is adopted and implemented into the internal processes of the organisation.

Conclusions and recommendations

- The benefits derived from the use of Sentinel-based services are very specifically determined by a number of contextual factors →→ When extrapolating the benefits from one case to another, due consideration shall be taken of the relevant boundary conditions.
- The level of uptake of Sentinel-based solutions by public administrations in Europe was found to be surprisingly divergent. Successful adoption in one administration is not matched in others. This led to the question why this is the case and an analysis of the pathway to the uptake → → Benefits and challenges largely depend on the adoption level of the organization so this should be taken in due account in every analysis
- The use of Sentinel-based services by different public organisations is often customized to fit their specific need, leading to peculiar practices and experiences that can be of great interest for benchmarking and cross-fertilization. Agencies can benefit by exposing their needs and practices through dedicated networks of peers. → → Build (or leverage existing) international networks of peers to exchange experience and views and develop understanding of how and why benefits can arise.

EO for Water Management.

- SeBS cases have exposed the significant benefits arising from the use of EO data to support water management practices.
- Cases looking at water quality are driven by regulatory requirements. Without a European (or international) standard, countries have taken their own approaches driven by institutional factors.
- Further cases looking at aquifer management demonstrate how a holistic approach to water management could be introduced.
- In Austria (SeBS short case), irrigation and water use are being monitored through the use of EO data.
- Many of the SeBS agriculture cases include the use of EO to inform and to optimise water use for cropping.
- An integrated tool to support water management could be possible including both demand and supply factors with significant benefits in all dimensions.

Thank you for Listening

Please contact Geoff.sawyer@earscl.org

For more information

And visit

earscl.org/sebs