Operational uses of satellite-based applications in the public sector
A case-study review

ANALYTICAL REPORT

eurisy
acting collectively to bridge space and society

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FOREWORD

This publication is Eurisy's latest research output. Mandated to raise awareness on satellite-based services for civilian uses, since 2007 Eurisy has been employing a bottom-up approach to encourage the use of services relying on satellites by local and regional public authorities and to provide feedback to decision-makers on possible measures to overcome obstacles to the transfer of space-derived benefits to society.

The Eurisy bottom-up approach is based on the assumption that by addressing directly the professionals involved in daily, concrete operations of public administrations, it is possible to grasp the mechanisms leading to the adoption and continuous use of satellite-based services, as well as the challenges encountered in this process, and to identify and quantify the impacts they produce more precisely.

National and European governments have invested significantly in the development of satellite hardware and infrastructure, fostering the development of space-derived services meeting current and future societal needs. Indeed, some of the benefits produced by the use of these technologies in sectors like environmental monitoring, transport and risk management are becoming more visible.

Nevertheless, the lack of harmonised and systematic evidence-based reporting mechanisms makes it difficult to qualify and quantify the impacts of satellite-based services in the public sector. Such impact assessment could encourage other public entities to adopt available satellite-based services, while at the same time providing valuable feedback to the space community.

This document represents a first step in applying the Eurisy bottom-up approach to seize mechanisms and impacts of the operational use of satellite-based services within a selection of European public entities. The ten cases considered are analysed both individually and in an aggregated fashion, with the aim of testing a methodological approach to gather harmonised information on the use of satellite-based services within the public sector. The sample considered here is not representative of European public authorities or of available services based on satellites, and the lessons learned do not apply to public authorities using satellite-based applications in Europe overall. A second phase of the analysis will aim at applying the methodology to a larger sample, hence providing more representative results.

This report was produced at the instance of the Eurisy members by Grazia M. Fiore, research and project coordinator, under the guidance of Stefaan De Mey, Eurisy secretary general. We are especially grateful to the public authority officials and the service providers who opened the door for this analysis by sharing their experiences. Eurisy acknowledges the advice and methodological inputs kindly provided by Claire Jolly, Head of the OECD Space Forum, and the feedback of Beth Greenaway and her team at the Space for Smarter Government Programme of the UK Space Agency, which partly sponsored this initiative. We equally thank Piero Messina and the Relations with Member States Office of the European Space Agency, which also supported the backgournd research on the cases reviewed. Editorial assistance was provided by Laure Lepastier and Teodora Secara, from the Eurisy Secretariat.

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EXECUTIVE SUMMARY

Since 2007, Eurisy has been using a bottom-up approach, based on the experiences and direct testimonials of public managers, to analysing the mechanisms leading to the adoption of satellite-based services, the challenges encountered and the benefits derived from their use for individual public administrations.

In 2014, the association launched an initiative aiming at reporting - periodically and consistently - on the uses of satellite-based services by public authorities in Europe. This publication presents the results of the first phase of this initiative.

During this phase the Eurisy methodology has been tested by analysing ten case-studies. The cases have been selected from the database of success stories collected by Eurisy under its User Programme, aimed at raising awareness on available satellite-based applications through good practice exchanges among user organisations. The sample has been selected according to the availability of the public managers concerned and does not represent the range of public authorities using satellite-based services in Europe.

In 2015, the methodology will be amended and used by Eurisy to launch an online survey aimed at obtaining a wider overview of the uses of satellite-based services within European public administrations.

This Executive Summary presents the main findings resulting from the analysis of the ten selected case-studies.

PUBLIC ADMINISTRATIONS USING SATELLITE-BASED SERVICES

This analysis has included ten public administrations working at the local, regional and national levels in the fields of transport, environmental monitoring and territorial management (see list on page 24).

Seven entities had an annual budget between EUR 500k and 50m. The remaining three had budgets above EUR 100m, showing that the size of the public authority is not a discriminatory condition for the adoption of satellite-based services, and that organisations with small budgets can also profit from them.

PRECONDITIONS AND PREVIOUS KNOWLEDGE OF SATELLITE-BASED SERVICES

In-house expertise is not a precondition to the use of satellite-based services by public administrations. Nevertheless, in cases where it exists, it leads to more proactivity in considering them. In-house technical expertise is also correlated with knowledge of support mechanisms and funding sources.

Some 60% of the user organisations had in-house staff with expertise in satellite-based applications. 40% of these organisations had previously used satellite-based services and 40%

were aware of similar experiences implemented by other public administrations. Six of them had knowledge of support programmes or mechanisms to facilitate access to satellite-based applications before adopting services relying on them.

In half of the cases, the satellite-based system was proposed by a service provider, while in the other five cases the public authorities thought themselves about this technological solution.

DRIVERS AND MOTIVATIONS FOR THE ADOPTION OF SATELLITE-BASED SERVICES

In terms of drivers, 80% of the public authorities consulted adopted a satellite-based solution to respond to social, economic or environmental needs, 70% to improve public services and 30% to implement a policy.

Two favourable conditions for the successful and enduring utilisation of these solutions were the adequateness of the satellite-based services to provide answers for strategic needs, and the ability to adapt to pre-existing work procedures and tools. In seven cases, the satellite-based service substituted (fully or partially) a previous solution.

Administrations chose these new solutions not because of their advertised technical merits alone, but because of their competitiveness in terms of efficiency (50%) and costs (40%).

PUBLIC ADMINISTRATIONS' IMPLEMENTATION FRAMEWORK

In the ten cases analysed the implementation framework - demonstration project or operational setting - did not emerge as a discriminatory condition to the successful and enduring use of the satellite-based services. In half of the ten cases considered, the satellite-based services were adopted within the framework of publicly funded demonstration projects. In the other five cases, the uptake of the services resulted from an operational decision of the public authorities concerned and was funded with their own budgets.

- The free provision (even partial), of satellite-based information or services appears here as a valuable incentive to innovate within demonstration projects (in four out of five cases), whereas it seems less important when satellite-based services are adopted within operational settings (two out of five cases).
- The decision to invest in the satellite-based solution was taken internally in 80% of the cases, with no need for permission from higher administrative levels. This suggests that public authorities can decide on the tools to be used to implement their mandate. Therefore, providers of satellite-based services have an interest in "marketing" their products directly among public managers working at the operational level.
- Eight public authorities participated in the design and seven in the implementation of the services with their service providers, showing the importance of actively involving public authorities throughout the whole process of implementation or adoption of a satellite-based solution, not only in the pilot phase.
- In all cases, partnerships were established and in eight cases with more than one entity: 30% of respondents partnered with international organisations, 40% with research

institutions, 60% with other public administrations, and 80% with private companies, which seem to be placed at the right level to understand the needs of public authorities and to adapt new services accordingly.

THE SATELLITE-BASED SERVICES

Six of the satellite-based services analysed rely on Earth observation data (EO), two on satellite navigation (Satnav), one on satellite communication (Satcom) and EO, and one on both Satcom and Satnav.

All satellite-based systems had been operationally used for at least one year and 60% of them were implemented at least five years ago. All were still operational as of summer 2014.

In 90% of cases, the satellite-based solution was not off the shelf, but had to be adapted to the requirements of the user organisation.

The cases reviewed indicate that public authorities do not necessarily have the capacity to develop the satellite-based services needed in-house. This could be partially explained by the fact that most of the experiences reviewed concern the use of services based on Earth observation. All respondents outsourced (fully or partially) the implementation of the satellite-based services to private companies (70%), international organisations (20%) or to research institutes (10%).

In seven out of the ten cases analysed, the main service provider is located within the country of the user public authority. Indeed, geographical and cultural proximity of service providers makes it easier for public authorities to procure the services needed and simplifies communication.

FUNDING AND COSTS OF THE SATELLITE-BASED SERVICES

The cases reviewed highlight the relatively small cost of both adopting and operating these services, despite the fact that six of the systems considered are based on EO. In the cases analysed, both implementation and operational costs are lower when the services are adopted within regular operations (as opposed to demonstration projects).

In five out of ten cases, the uptake of the satellite-based service was technically or financially supported by national programmes or international organisations.

- Initial investments: The initial adoption of the satellite service cost less than EUR 20,000 for 70% of the organisations. For 90% of them, this investment represented less than 5% of their annual budgets. Four out of the five public authorities adopting the services within their regular operations spent even less than 1% of their annual budgets.
- Operating costs: To run the services cost less than EUR 10,000 and less than 1% of the annual budget for more than half of the organisations consulted.

USE OF THE SATELLITE-BASED SERVICES

Some initial training, although not essential, was an important condition to enable public managers to fully operate their satellite-based systems in the medium and long terms. Indeed, 70% of user organisations needed some training to start using their satellite-based services, but 90% of them were subsequently able to run them autonomously. 70% of the public authorities consulted rely on the satellite-based services for regular operational duties.

Only in 30% of cases resistance was opposed to the adoption of the satellite-based solutions and only in one case organisational changes were needed.

BENEFITS OF USING SATELLITE-BASED SERVICES

Concerning the impacts of using satellite-based services, respondents indicate time-savings (100% of responses), cost-savings (40% of responses), and several qualitative benefits. The three main qualitative benefits pinpointed by public authorities include: the improved quality of information available for operational uses, the improved quality of the services provided by the public entities and positive environmental impacts. Only four out of ten organisations performed a formal economic assessment of their satellite-based services, which indicates that there is still a need to promote economic impact practices in this community.

Further analyses should be carried out to quantify externalities. These could also include the use that other organisations make of the satellite-based data provided by the systems (80% of the organisations consulted share satellite-based data with other entities). Indeed, because of their reliability, neutrality and comparability in space and time, satellite-based data and services lend themselves to different uses.

CHALLENGES TO ADOPT AND OPERATE THE SATELLITE-BASED SERVICES

70% of respondents faced technical challenges to first implement or adopt their satellite-based services. After the adoption or implementation phase, most public authorities do not face neither economic nor organisational challenges to operate their satellite-based systems, and are able to use them with no need for external assistance (nine out of ten) or for regular training (eight out of ten). However, 60% of respondents declare that it could be a challenge to keep using the satellite-based solutions in the future.

INTRODUCTION

Despite the economic crisis, European institutions keep supporting and investing solidly into the space sector: the EU allocated around EUR 6.3 billion to Galileo, the European satellite navigation system, and 4.3 billion to the European Earth observation system GMES-Copernicus for the period 2014-2020. The Horizon 2020 EU Research and Innovation programme will dedicate a further 1.73 billion[1] to space research and development[2]. Meanwhile, the European Space Agency is investing EUR 325.3 million, i.e. 7.9% of its budget for 2014, to Telecomunications and Integrated Applications[3], supporting the development of market-oriented space-based services.

Indeed, many services based on satellites have reached the downstream market, providing data and signals needed by professionals working in non-space sectors. What is more important, satellite signals and imagery, as well as satellite communications, are increasingly used to improve management in strategic public sectors like environmental monitoring, land planning, agriculture, transport and health, which will be crucial to ensure the well-being of European societies in the coming decades.

The space economy supply chain has been the object of analyses aimed at quantifying the economic return of space investments in terms of revenues, employment and economic growth. As an example, the revenue of the European space manufacturing industry has been estimated at EUR 6.8 billion in 2013[4], with positive impacts on employment and growth.

However, few analyses exist which focus on the final users at the end of the space supply chain to qualify and quantify the return of public investments to society[5]. The implementation of such analyses at national, regional and European levels would be particularly timely, as Galileo and Copernicus have entered their operational phase in 2013[6]. According to the European Commission, this step will provide the EU with the strategic infrastructure to exploit the estimated huge economic potential of downstream services and applications[7].

The decision to focus the present analysis on the public sector was driven, on the one hand, by the recognition of the pivotal role played by governments as funders and major customers of satellite-based

[1] Figures from: OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing, p. 25.
[2] The Horizon 2020 programme calls for "a cost-effective competitive and innovative space industry (including SMEs) and research community to develop and exploit space infrastructure to meet future Union policy and societal needs". See more at: http://ec.europa.eu/programmes/horizon2020/en/h2020-section/space
[3] European Space Agency website, ESA budget by domain for 2014 (M€: Million Euro). Consulted in December 2014 at: www.esa.int/About_Us/Welcome_to_ESA/Funding
[4] OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing, p. 50
[5] To this end, the newly released OECD publication "The space economy at the glace 2014", points out that "As institutional funding still supports the bulk of the space R&D taking place in space agencies, industry, academia and research institutes, there is a growing demand worldwide for impact assessments to evaluate any derived economic and societal benefits" (p. 80). The same document specifies that "(...) the flow of evidence-based information to decision-makers and citizens needs to be improved. When assessing the net benefits of space investments, more effort is needed internationally in building the knowledge base and devising the mechanisms for transferring know-how and experience to practitioners worldwide. This can improve the provision of evidence-based information on the benefits and limitations of space applications, while at the same time reducing the risk of 'reinventing the wheel'" (p. 10). Excerpts from OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing.
[6] Data for emergency services and land monitoring is now available free of charge to Copernicus users. To know more, see the *2014 Report from the Commission to the European Parliament and the Council on the evaluation of the Union's finances based on the results achieved* (COM(2014) 383 final), at p.12: http://ec.europa.eu/smart-regulation/evaluation/docs/2013_report_en.pdf
[7] Ibidem

infrastructure and services[8] and, on the other hand, by the intention of identifying and, where possible, quantifying the positive impacts produced by satellite-based applications for the civil society and the environment.

Within its User Programme, Eurisy has been reporting extensively on efficiency gains derived from the use of satellite information and services for individual public authorities. The Programme promotes a bottom-up approach to stimulating adoption of satellite-based services by final user organisations by implementing peer-to-peer knowledge exchanges. This publication capitalises on Eurisy's greatest strengths – its enduring direct work with user public authorities, its focus on benefits rather than on technology, and a peer-to-peer approach to facilitate innovation. It scales up Eurisy's efforts in inventorying and analysing experiences of use of satellite-based services among public authorities by employing for the first time a common analytical framework and standardised research tools.

The analysis is grounded on the assumption that understanding the mechanisms leading to the adoption of satellite-based services by public authorities, identifying the challenges they face and recognising the benefits they entail on the basis of concrete, operational examples, are necessary steps to inform and encourage public authorities to consider satellite-based services. This approach can also help service providers to develop products more adapted to users' needs, and public agencies to better target future programmes to enhance the transfer of space-based applications to the public sector.

This report is structured in four sections:

- Part I describes the methodology applied, the criteria used to select the ten cases considered, and the limitations of the analysis.
- Part II presents the aggregated results derived from the analysis of the case-studies.
- Part III summarises the key findings of the analysis, in terms of common aspects and lessons learned from the case studies and of favourable conditions for the adoption of satellite-based services within the public sector. It also highlights the need for a more extensive research on the use of these services by European public authorities, as Eurisy plans for the second phase of this initiative.
- The Annex "Case-study reports" describes the ten case-studies analysed, using a common framework and pinpointing key facts on how the public authorities adopted, operate and benefit from their satellite-based services. This section can be of particular use to other public authorities and to the service providers working with them.

[8] The OECD publication "The space economy at the glace 2014" explains that "In all countries, the role of governments remains essential as a source of initial funding for public R&D, as well as a major anchor customer for many space products and services" (p. 17). The publication also points out that "typically, space manufacturing activities are more developed where strong institutional customers are established", while "other customers (i.e. the commercial operators, providing commercial satellite communications services or Earth observation and geospatial data to third parties) play a key role in enhancing competition and innovation in the space industry" (p. 20). Excerpts from OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing.

DEFINITIONS

This analysis explores case-studies involving public administrations using satellite-based services to perform or improve their work. The following definitions will be used:

Satellite-based applications	Data and data fluxes derived from satellites and integrated into operational services that can be used, alone or in combination with other technologies / methodologies to enable or improve a service. A satellite-based application can rely on Earth observation, satellite navigation or satellite communication, or on a combination of those.
Satellite-based services	Services based on a satellite-based application, or on a combination of satellite-based applications.
End-user public authorities (PAs)	Publicly funded entities mandated to provide services in sectors of public interest and using satellite-based applications to perform or improve their activities.
Case-study	Descriptive, exploratory and explanatory analysis of one experience of integration of satellite-based applications into the operational practices of a public authority.

SATELLITE-BASED APPLICATIONS IN A NUTSHELL

Earth observation (EO) images are nowadays acquired continuously. They allow to monitor large areas and to compare phenomena in space and in time. Data derived from satellite imagery can be processed with computer software to extract information that can be of use in a number of public sectors, ranging from weather forecast to agriculture, environmental monitoring, urban planning, solar energy production and health, among many others.

Satellite navigation (Satnav) indicates absolute location, relative movement and time. It only takes a receiver - small enough to be embedded into a mobile phone - to pick up the signals of navigational satellites. Satnav has become of paramount importance in several sectors of public interest. To quote but a few examples, satellite navigation signals enable public managers to locate distress calls as part of emergency interventions, to monitor coastal and beach erosion, to track fleets, to study species behaviour, to facilitate multimodal transport, and to implement reliable transport information systems.

Satellite telecommunication (Satcom) is the most mature space application. Today, Satcom is embedded in a number of services: as an example, it is used to transmit TV and radio signals, to distribute text, audio and video contents and to access the internet, but also to control remotely equipment in water reservoirs or pipelines, or to enable tele-education and tele-medicine. In particular, Satcom ensures connectivity when terrestrial connections are down or inexistent.

The applications resulting from these technological capabilities are often used together and in combination with data from a multitude of sources – whether field measurements, statistics, historical data, or even tweets – to deliver useful digital services that allow us to navigate, to take decisions, or to communicate in new ways.

Source: Eurisy website. See more at: www.eurisy.org/on-satellite-applications.php

I. The case-study review:

methodology, selection of case studies and limitations

THE CASE-STUDY REVIEW: METHODOLOGY, SELECTION OF CASE STUDIES AND LIMITATIONS

This review presents the results of the first phase of a research on the mechanisms and benefits of the use of satellite-based applications by European public authorities. This first phase built and tested a methodology on a limited sample of public authorities, while the second phase will apply it to a larger, more representative sample:

CASE-STUDY PHASE: During this phase, a questionnaire for public authorities has been designed to collect information on the processes leading to the adoption of satellite-based services, the benefits derived from their use, and the challenges encountered. At this stage, the accessibility, relevance and completeness of the questionnaire have been tested on ten selected case-studies. The analytical work has relied on the responses to the questionnaire by public authority representatives, and on an in-depth background research to define the context in which these entities operate.

SURVEY PHASE: Following the case-study phase, the questionnaire will be amended so as to include only questions which are essential to defining processes and outputs of institutional uses of satellite-based applications. The questionnaire will be disseminated through the Eurisy website and its partner institutions, seeking to collect a maximum number of replies from European public authorities.

The ten cases included in the first phase have been selected from the database of success stories collected by Eurisy under its User Programme. The overall study approach was to select cases of public authorities using satellite-based services operationally and successfully at the time the questionnaire was disseminated, during summer 2014.

Since Eurisy has traditionally worked with local and regional authorities, most of the cases reviewed concern public entities working at the local and regional levels. The sectors covered are transport, environmental monitoring and territorial management. In consideration of the support received by the Space for Smarter Government Programme (SSGP)[9] to implement this analysis, four of the ten cases selected concern public entities in the UK area, while the other six involve public authorities from Belgium, France, Germany, Italy and the Netherlands.

The analysis of seven out of ten experiences took into account the overall financial and human resources of the public entities. In three cases, the analysis focused on the work of specific departments or units.

As illustrated in Part II (Results of analysis), in most of the cases considered public authorities used data and services derived from satellite Earth observation. The reason for this choice is that services based on remote sensing are less used than those relying on satellite navigation signals or satellite communication[10].

The conclusions drawn from the first phase and presented in this report refer to the cases analysed only. As such, they do not apply to the adoption and use of satellite-based services within the public sector in Europe overall.

[9] To know more about the Space for Smarter Government Programme, please visit their website at: http://www.spaceforsmartergovernment.uk/

[10] The OECD report "The Space Economy at a Glance 2014" recognises that "the commercialisation of Earth observation data remains a niche area, with relatively few commercial satellite operators" and that "their revenues are mainly derived from institutional customers". OECD (2014), *The Space Economy at a Glance 2014*, OECD Publishing, p.56.

II. Results of analysis

RESULTS OF ANALYSIS

This section presents the aggregated results of the original analysis conducted by Eurisy on ten case-studies.

The full description of the case-studies can be found in the Annex to this publication.

Table 1 provides a list of the experiences under review.

The cases have been analysed taking into account the following aspects:

- Public administrations using satellite-based services: Who are the public authorities using satellite-based services, whose cases are being analysed?
- Preconditions and previous knowledge of satellite-based services: What did these public authorities know about satellite-based services?
- Drivers and motivations for the adoption of satellite-based services: What prompted these public authorities to consider the services?
- Public administrations' implementation framework: In which contexts did user public authorities decide to adopt satellite-based solutions? Who is supporting them?
- The satellite-based services: On which satellite applications do they rely? Are they ready for use?
- Funding and costs of the satellite-based services: How are the satellite-based services funded? What is their monetary cost?
- Use of the satellite-based services: Is it difficult to use the services? What are the requirements?
- Benefits of utilising satellite-based services: Which are the advantages of satellite-based services for public administrations?
- Challenges to adopt and operate satellite-based services: Which are the obstacles encountered by public authorities to implement and operate the services?

PUBLIC ADMINISTRATIONS USING SATELLITE-BASED SERVICES

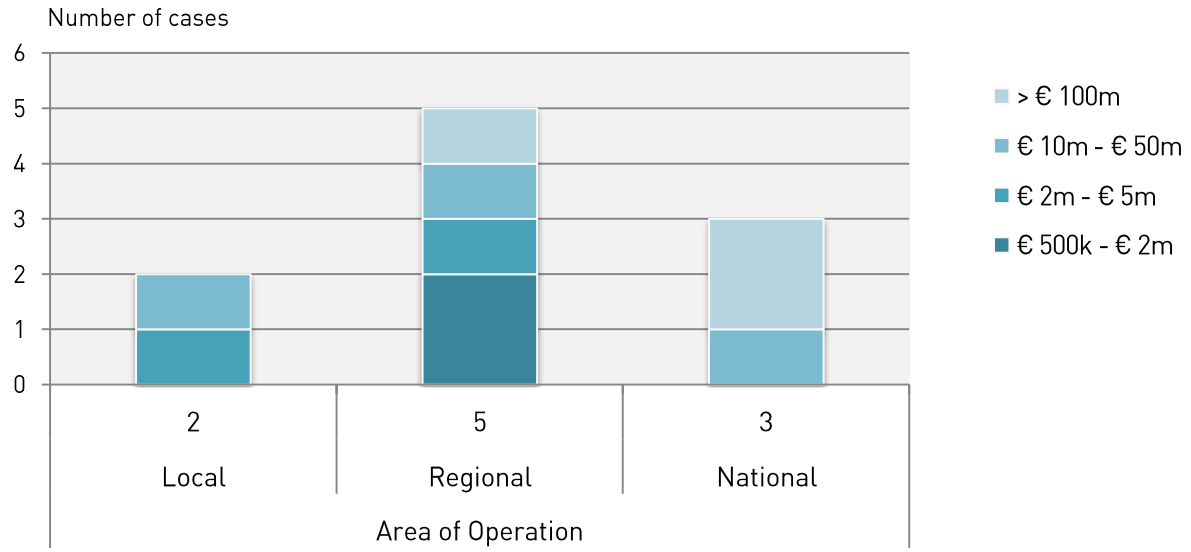
Who are the public authorities using satellite-based services, whose cases are being analysed?

This analysis includes ten cases from different sectors and public administration levels. The examples have been chosen by Eurisy on the basis of previous field-work within its User Programme, and according to the availability of the public entities concerned to share their experience and to participate in this review.

The cases included in this analysis have been selected taking into account three different levels of administration (local, regional and country) in a variety of different public sectors / policy areas.

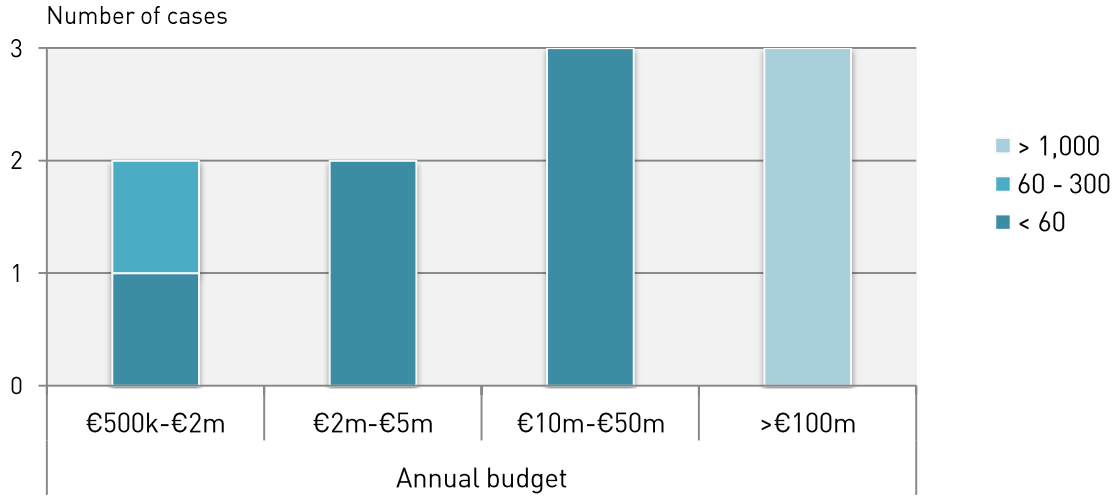
Table 1: Case-studies analysed			
NAME	SECTOR	AREA (Main / Secondary)	COUNTRY
Guernsey and Alderney Airports: EGNOS to support landing in Alderney	Aviation	National / Local	Channel Islands
Arno River Basin Authority: EO for slope monitoring	Risk management	Regional	Italy
Central Command for Maritime Emergencies: EO for oil spill detection	Environmental protection / Law enforcement	Regional / Local	Germany
City of Diemen, Department of Infrastructure: EO to manage soil resilience	Urban planning	Local	The Netherlands
DREAL Alsace, Hamster Mission: EO to protect biodiversity	Environmental protection	Regional	France
Environment Agency, England: EO to manage floods	Risk management	National / Regional / Local	United Kingdom
Flemish Agency for Roads and Traffic, Traffic and Telematics Division: Satnav to regulate traffic lights	Infrastructure and works	Regional	Belgium
Natural Resources Wales (former Countryside Council for Wales): EO to map habitats	Biodiversity monitoring	National / Regional	United Kingdom
SPL Lyon-Confluence: EO to monitor PV systems	Energy / Urban planning	Local	France
University Hospitals Coventry and Warwickshire, Breast Screening Unit: Satcom for remote breast screening	Health	Regional	United Kingdom

Fig. 1: **Public authorities' annual budget ranges**



The experiences reviewed include two public authorities working at the local / city level, five operating at the regional or interregional levels, and three with competences at the national / country level.

Fig. 2: **Number of staff**



70% of the entities considered in this analysis had a yearly budget between EUR 500,000 and 50 million in the years 2010-2014, while the remaining 30% had more than 100 million.

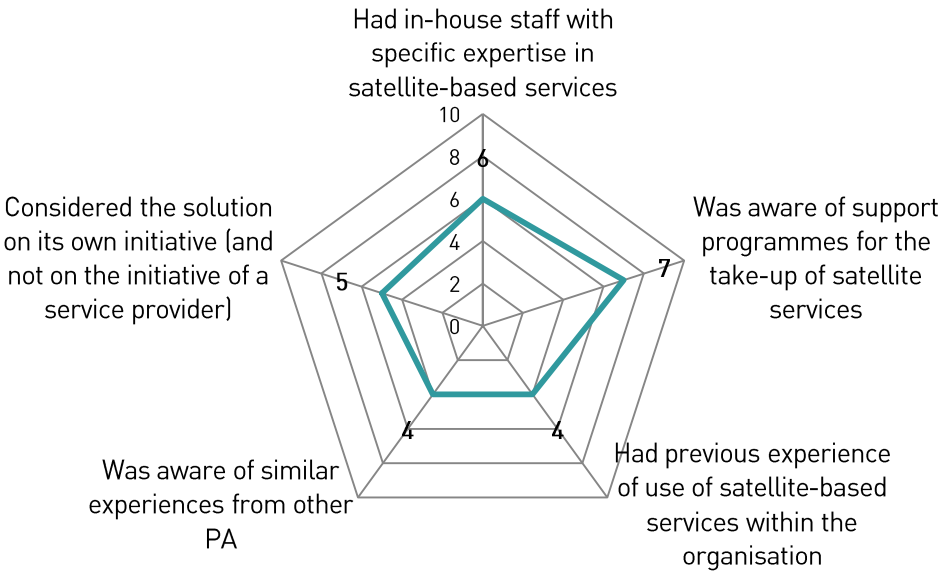
The seven public authorities with a budget below EUR 50 million employ less than 60 persons, with the exception of the DREAL Alsace, which has a staff of 250 (of which two are assigned to the Hamster Mission). The three organisations with a budget above EUR 100 million employ between 1,000 and 10,000 people.

On the one hand, the inclusion of organisations very different in size and resources was motivated by the intention of emphasising the economic accessibility of satellite-based services also for organisations with small budgets; on the other hand, it will help contextualise challenges and benefits of utilising these services operationally.

PRECONDITIONS AND PREVIOUS KNOWLEDGE OF SATELLITE-BASED SERVICES

What did these public authorities know about satellite-based services?

Fig. 3: **Knowledge of satellite-based services. The public authority...**



A majority of the public authorities considered in this analysis have in house staff with specific expertise in satellite remote sensing, navigation or communication (six out of ten) and/or knowledge of support programmes or mechanisms provided at regional, national or EU level to facilitate the access of public authorities to satellite-based services (seven out of ten). 40% of public authorities had previously used satellite-based services and 40% were aware of similar experiences from other public administrations (cf. Figure 3).

In these cases, the existence of staff with some knowledge of satellite-based applications played an important role in determining the adoption of services relying on them. The six organisations with internal expertise also have knowledge of support mechanisms, and in five cases have previously used satellite-based applications or know other public authorities who do so. The four organisations without internal expertise, have neither previously used satellite-based applications, nor have knowledge of similar experiences by other public entities; only one is aware of available support mechanisms.

In half of the cases, the satellite-based solution was proposed and prompted by a service provider, while in the other five cases the public authorities thought themselves about this kind of technology. Four out of the five public authorities which autonomously considered a satellite-based solution, had some in-house knowledge of satellite-based services.

Out of the ten cases reviewed, only three public authorities meet all the following conditions: some specific knowledge of satellite applications, awareness of support programmes to access them, previous experience using satellite-based services, and knowledge of other entities using similar

solutions. In these three cases, public authorities are using Earth observation data to carry out environmental monitoring and risk prevention: these organisations are the Arno River Basin Authority (Italy), the Central Command for Maritime Emergencies (Germany) and the Environment Agency England.

The following sections of this analysis look into other implementation aspects that these three examples have in common, such as the economic and technical contribution of international organisations to the full or partial implementation of the services utilised, and the active participation of the user public authorities in both the design and the development of the satellite-based solutions.

Case-study: The Arno River Basin Authority, Italy, uses satellite imagery to improve monitoring of hydro-geological phenomena

In 2005, the Arno River Basin Authority profited from the ESA-funded project SLAM (Service for Landslide Monitoring), to build a Landslide Geographic Database. This was created using 350 satellite images of the region and data from other sensors and surveying tools. Thenceforth, the database has been used by the Basin Authority to map and monitor old and new unstable areas and to build the Hydro-geological Structure Plan for the Arno River Basin.

Before 2005, the Arno River Basin Authority had sporadically used EO data to map flooded areas and land changes. Three of its employees have specific expertise in satellite based services.

Nature	Public
Area of operation	Regional
Sources of budget	National and EU public funds
Annual budget	EUR 2 m - 5 m (2014)
N° staff	34
Service implementation framework	Demonstration project (ESA Data User Programme)
User's implementation costs	1% - 5% of annual budget in 2005
User's operational costs	1% - 5% of annual budget in 2014 (including human resources)

The organisation had been also involved in the implementation of the Extraordinary Plan of Environmental Remote Sensing, an agreement programme between the Ministry of Environment and the Ministry of Defence, created to make available EO data within the Italian public administration.

Moreover, the organisation was aware of the activities carried out by the Departments of Earth Sciences and Civil Engineering at the University of Florence, respectively using data from satellite remote sensing to monitor landslides and to assess moisture conditions.

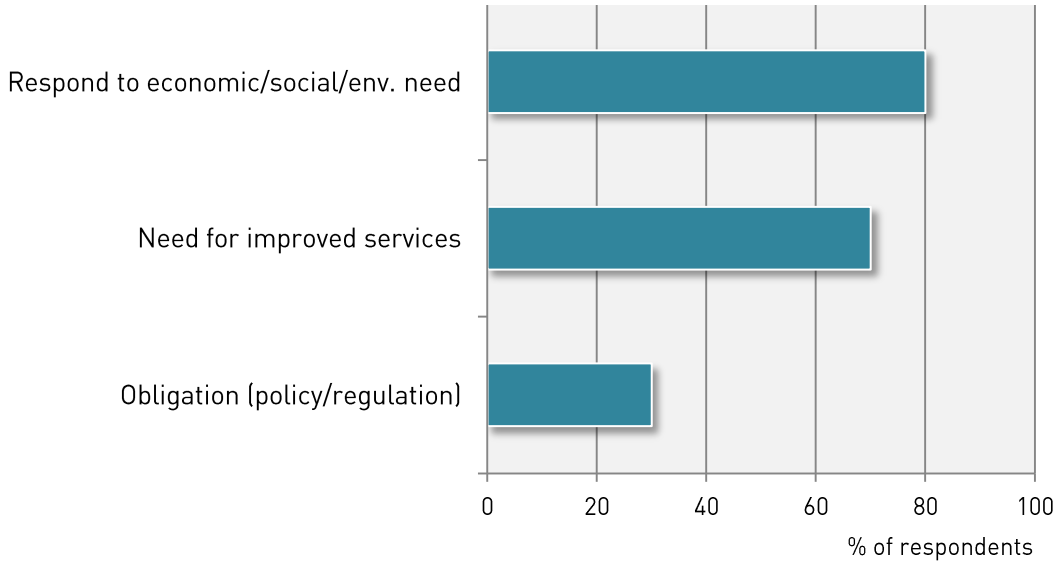
The presence within the organisation of staff with experience of Geographic Information Systems including satellite-based data, awareness of support programmes, previous experience of use of satellite-based applications, and knowledge of similar experiences proved to be essential to enable the Arno River Basin Authority building its Landslide Geographic Database.

KEY-FACT: 27,000 landslides identified and 10,000 classified as active.

DRIVERS AND MOTIVATIONS FOR THE ADOPTION OF SATELLITE-BASED SERVICES

What prompted user public authorities to consider satellite-based services?

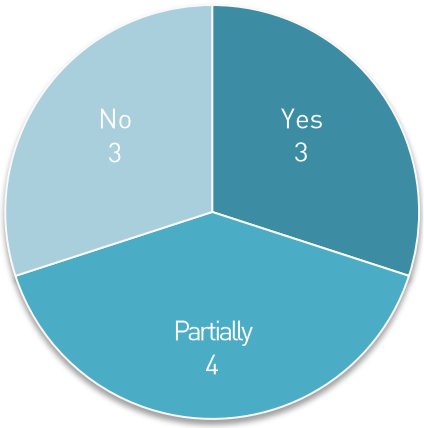
Fig. 4: **Main motivations for first investing in a satellite-based system**



There are several motivations for public authorities to invest in a satellite based system: 80% of respondents mentioned the intention to tackle social, economic or environmental needs; 70% declared that the satellite-based system was adopted to improve the services provided to the community; and for 30% the satellite service was instrumental to the implementation of a policy or a regulation (cf. Figure 4).

The majority of the organisations consulted turned to the satellite-based service to fully or partially replace pre-existing procedures related to the provision of public services. Indeed, in seven out of ten cases the satellite-based service was adopted to substitute or improve methods and procedures based on other technologies (cf. Figure 5).

Fig. 5: **Satellite-based system to replace previous system?**



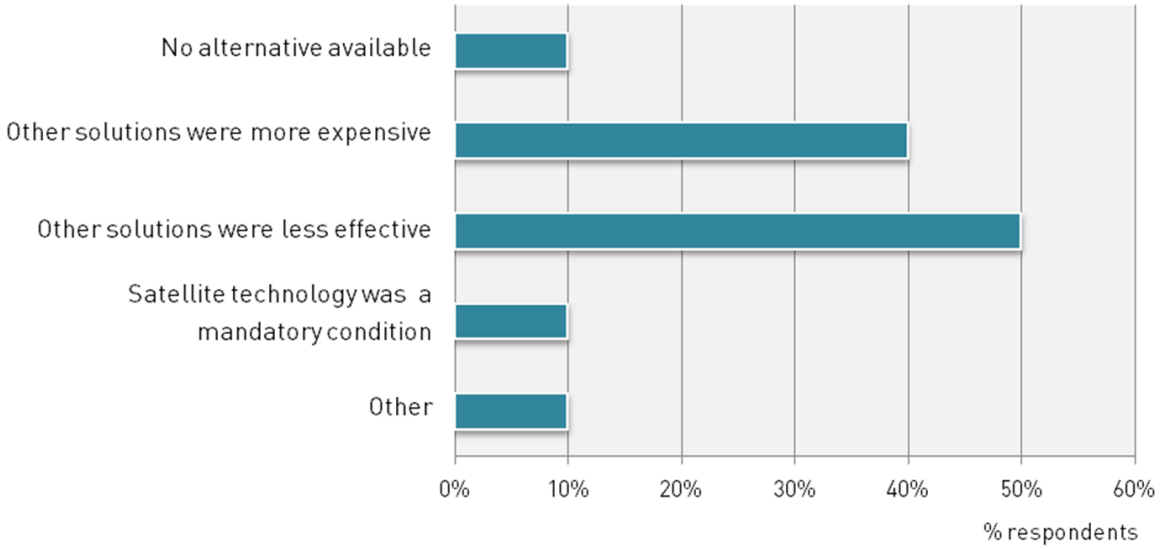
All seven public authorities substituting (fully or partially) a previous system, declare that they were motivated by the intention of improving their services, in addition to other reasons.

In six out of the ten cases reviewed, public authorities considered other technologies before deciding to adopt a satellite-based solution. Only one of the respondents (the Central Command for Maritime Emergencies, Germany) declared that no other solution was available to perform the

same tasks, showing that public organisations pondered over their choice before turning to a satellite-based solution.

Half of the public authorities judged other available solutions as less effective than the satellite-based service used. 40% of them declared that services based on other technologies would have entailed higher implementation and/or operation costs (cf. Figure 6).

Fig. 6: **Trade-off among technologies, why choosing a satellite-based service?**



The ability of the services to provide solutions for strategic needs and to adapt to pre-existing work procedures and tools emerged as two favourable conditions for their successful and enduring use.

In the experiences analysed, carrying out a cost-benefit assessment of the satellite-based service proved to be a determining factor in continuing to use the service after the implementation phase. Indeed, in six out of the ten cases reviewed public authorities weighted the added-value of the satellite-based systems as compared to other available solutions and the services had to prove both their efficiency and their value-for-money before the public authorities resolved to rely on them for their operational needs.

Overall, these figures show that the public authorities decided to use a satellite-based service not because they were driven by technological innovation *per se*, but because they considered the solution adopted as being more competitive (in terms of cost and performance) than other available technologies. Therefore, when promoting satellite-based services among public institutions, emphasis should be placed on their added-value and competitiveness, rather than on their technical merits alone.

An example of adoption of a satellite-based service to substitute a pre-existing service is given by the Breast Screening Unit at the University Hospital Coventry and Warwickshire (UK).

Case-study: Breast Screening Unit at University Hospital Coventry and Warwickshire, Satcom use in public health campaigns

The University Hospitals Coventry and Warwickshire (UHCW) is a teaching hospital in the West Midlands, UK.

The Breast Screening Service at UHCW uses two vans, equipped with screening units, to perform breast screening tests outside the hospital. Until recently, the staff collected these tests into a hard disk to then transport them to the laboratories by car. The hospital had thought about using a 3G connection to "virtually" transfer the tests, but this would drop very often.

In 2012, within the ESA-funded "Mercury" project, the two vans were equipped with a satellite connection to secure the transfer of the screening tests to the radiologists in the hospital.

Nature	Public
Area of operation	Regional and local
Sources of budget	National public funds
Annual budget	EUR 500 k - 2 m (2014)
N° staff	40
Service implementation framework	February 2013 - July 2014: ESA Mercury project From August 2014: Operations
User's implementation and operation costs	Demo project: free of charge Since Aug. 2014: approx. 2% of annual budget of the Unit (2014)

Moreover, GNSS data (date and location) was embedded into the patient medical data. Two years later, after completion of the project, the organisation performed a cost-benefit assessment of the system. The satellite-based solution was evaluated as cost/neutral compared to the old procedure, while enabling the users to save time and avoiding the risk of losing clinical data during their transfer into hard disks.

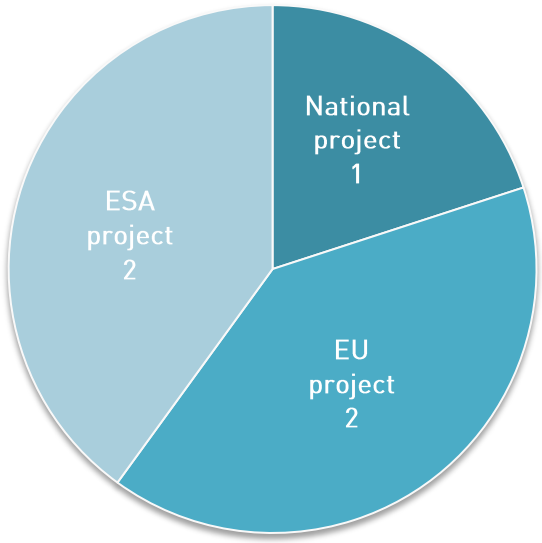
The pertinence of the satellite-based system proposed to the hospital, the adaptability of the solution to pre-existing procedures, and the assessment of its added-value, were all elements that facilitated both its adoption and its consecutive operational use.

KEY-FACT: Improved service with same costs.

PUBLIC ADMINISTRATIONS' IMPLEMENTATION FRAMEWORK

In which context do public authorities decide to adopt satellite-based solutions? Who is supporting them?

Fig. 7: **Funding framework of demo projects reviewed**



In half of the ten cases considered, the satellite-based services were adopted within the framework of publicly funded demonstration projects (cf. Figure 7).

One of them, the Countryside Council of Wales (today Natural Resources Wales) implemented its satellite-based service thanks to a national programme, the Government Information from the Space Sector (GIFTSS) programme of the British National Space Centre (today UK Space Agency).

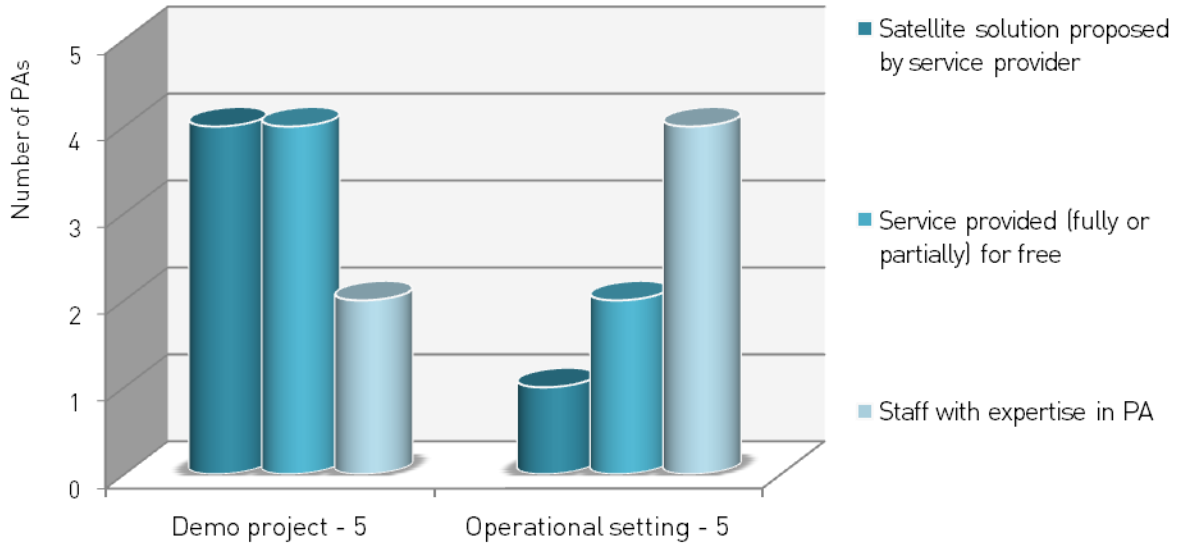
Four were provided funding and/or expertise from international organisations, namely the European Commission (EC) and the European Space Agency (ESA): the Alderney Airport profited from the EC Trans-European Networks (TENs) programme, while the SPL Lyon Confluence developed its satellite-based system within the 6th European Research Framework Programme (FP6), not specifically dedicated to space-based applications. Finally, the Breast Screening Unit at UHCW and the Arno River Basin Authority were supported by ESA under the Advanced Research in Telecommunications Systems (ARTES) 20 Integrated Applications Promotion (IAP) Programme, and the Data User Programme respectively.

In the other five cases reviewed, the uptake of the satellite-based services resulted from an operational decision of the public authorities concerned and was funded from their own budgets.

For the cases analysed, the implementation framework - demonstration project or operational setting - does not emerge as a discriminatory condition to the successful and enduring use of satellite-based services by public authorities. Other aspects of the initial implementation framework are therefore to be considered, which refer to the level of awareness of public authorities on existing satellite-based services, their decisional capacity, the incentives which are likely to persuade them to invest in new technologies, the partnerships established, and their involvement in the design and implementation of the solutions adopted.

Figure 8 shows, according to the initial implementation framework (demonstration project vs operational setting), the number of cases in which the satellite-based solution was prompted by a service provider, rather than on the initiative of the public authority itself; the cases in which the satellite-based solution or part of it (e.g. only satellite imagery) is provided for free; and the cases in which public authorities have internal expertise in the use of satellite-based applications.

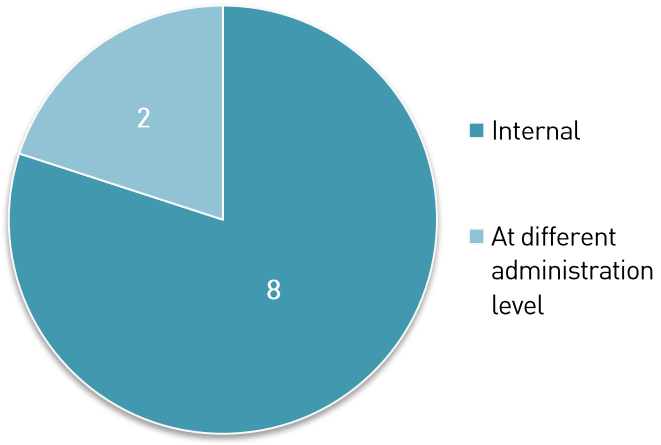
Fig. 8: **Implementation/adoption framework**



In demonstration projects, the satellite-based solution was proposed by an external service provider in four out of five cases. When the satellite-based solution was instead adopted within an operational setting, four out of five public authorities thought about using satellite-based applications on their own initiative, seeing a possibility to improve their work and optimise resources. The only exception is the Flemish Agency for Roads and Traffic, whose Satnav system to regulate traffic lights was proposed on the initiative of the company supplying the previous system.

The possibility of receiving satellite-based information or services at least partially free of charge appears as a valuable incentive to innovation within demonstration projects (in four out of five cases), whereas it seems less important when satellite-based services were adopted within operational settings (two out of five cases).

Fig. 9: **Decision to invest in the satellite-based service**



Out of the five public authorities adopting the satellite-based service within a demonstration project, three declared to be aware of support programmes and mechanisms to finance, at least partially, the adoption of satellite-based services, but only two had staff with specific expertise in-house, and only one had previous experience using these technologies and knew other public authorities with similar experiences.

Fig. 10a: **The PA participated in the design phase**

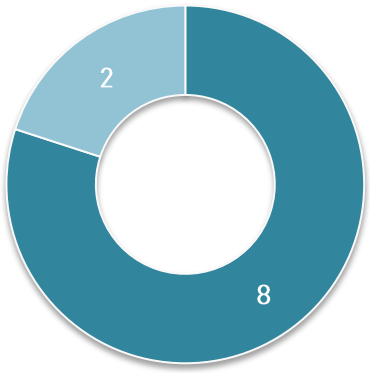
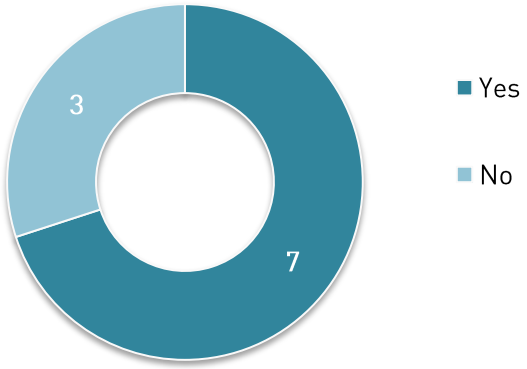


Fig. 10b: **The PA participated in the implementation phase**



Out of the five public authorities adopting the satellite-based service within the framework of their operations, four have internal expertise in satellite-based applications and services, in addition to knowledge of support mechanisms to access them (cf. Figure 8).

Under both implementation frameworks, only two public authorities had to obtain permission from a different administration level to invest in satellite-based services, which indicates that administrative bottlenecks were not a main challenge for the uptake of satellite-based services (cf. Figure 9).

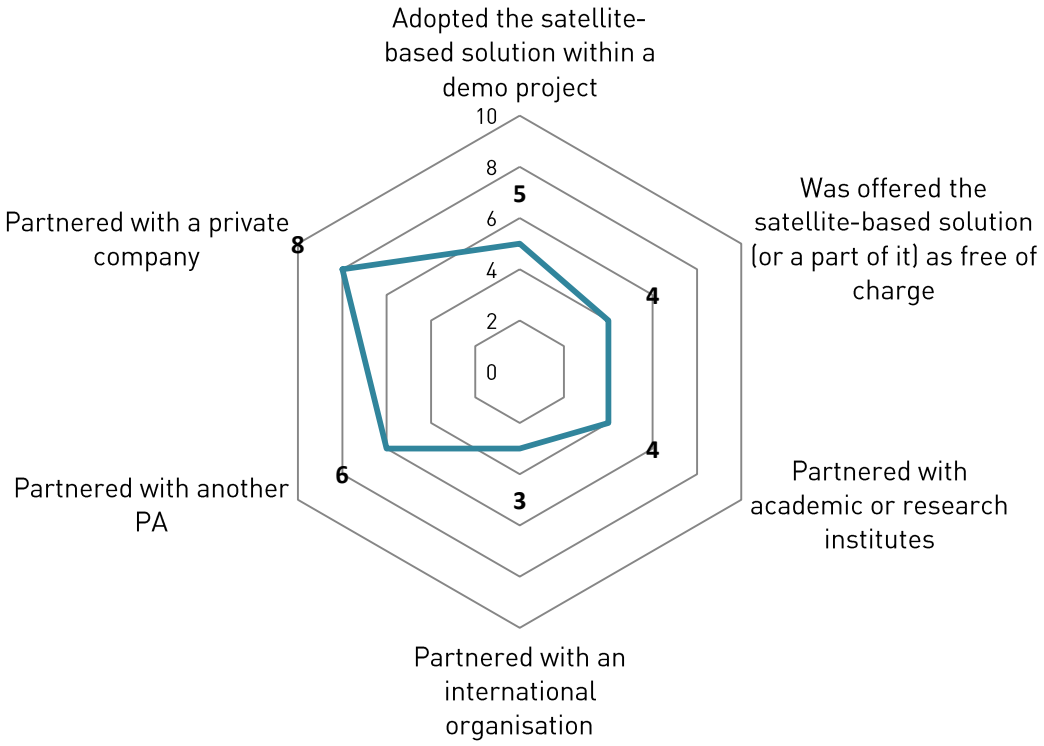
Eight out of the ten public authorities consulted participated in the design of the satellite-based system together with their service providers and seven of them also participated in the implementation of the service (cf. Figures 10a and 10b).

In all cases, public authorities established collaborations with other institutions to implement or adopt the satellite-based solutions used (cf. Figure 11). Eight of the respondents partnered with a private company, six with other public administrations, four with academic or research institutions, and three with international organisations.

Eight out of ten user public authorities collaborated with more than one kind of institution to implement or adopt the satellite-based solution, like the Central Command for Maritime Emergencies, Germany, which collaborated with a number of private and public entities to develop and use Earth observation to spot oil spills in the sea.

Fig. 11: **Partnerships and implementation/adoption framework.**

The public authority ...



Even though in these cases the implementation framework (demonstration project or operations) does not influence the successful use of satellite-based services, some distinctions can be made.

The cases analysed seem to indicate that demonstration projects can compensate for the lack of internal knowledge or expertise within public entities, and provide valuable frameworks for the adoption of satellite-based services. At the same time, and even though internal skills are not an essential precondition for the adoption of satellite-based services, they certainly play an important role when the satellite-based solution is considered within the framework of an operational setting (see also the "Previous Knowledge" section of Part II).

Under both implementation frameworks, 80% of public authorities took the decision to invest in the new services internally, indicating that public authorities can decide on the tools to be used to implement their mandate. Therefore, providers of satellite-based service have an interest in targeting public managers working at the operational level when promoting their products.

The results of this review also point to the importance of actively involving public authorities throughout the whole process of implementation or adoption of the satellite-based solution, and not only in the pilot phase. Finally, they highlight the role of private companies as providers of satellite-based applications. Indeed, private companies seem to be placed at the right level to understand the needs of public authorities and to adapt new services accordingly.

Case-study: the Central Command for Maritime Emergencies, Germany, relies on EO for oil spill detection

The Central Command for Maritime Emergencies (CCME) started exploring the potential of satellite imagery to monitor sea pollution back in 1999.

In 2006, the organisation participated to a consultation of the European Maritime Safety Agency (EMSA) on the possibility of using satellite remote sensing to detect oil spills in the sea. Among other European coastal authorities, the CCME was able to express its needs in terms of number of images needed, frequency of delivery, resolution, and other parameters.

The organisation actively participated with private service providers, research and space institutions, and with other coastal authorities in the development of CleanSeaNet, a near real-time European satellite-based oil spill monitoring and vessel detection service, freely provided by EMSA to Member States.

Nature	Public
Area of operation	National and regional
Sources of budget	National public funds
Annual budget	EUR 10m - 50m (2013)
N° staff	36 (regular staff)
Service implementation framework	Operational framework
User's implementation costs	None
User's operational costs	None in 2014 (not including human resources' cost)

Since 2011, the CCME uses the service to spot and remove oil spills and to identify potential polluters, contributing with human and technical resources to the operational use of the information received. Training sessions are regularly organised by EMSA for the staff of the organisation.

Not only the amount, but also the size of the oil spills detected in the German Seas decreased over the past three years. By addressing the issue of oil spills in seas through a shared system among member states, it was possible to reduce the costs of both building and operating the service, and to put pressure on service providers to improve its capabilities.

KEY-FACT: Free service, decreased pollution.

THE SATELLITE-BASED SERVICES

On which satellite applications do they rely? Are they ready for use?

In this analysis, the satellite-based applications that are the most used are geospatial tools using either Earth observation data (six out of ten) or satellite navigation signals (two out of ten). In two instances, satellite communications are also integrated in the service (cf. Figure 12). A little more than half the satellite-based systems were implemented at least five years ago (cf. Figure 13). All are still operational as of summer 2014.

Fig. 12: **Type of satellite-based applications used by the public authorities**

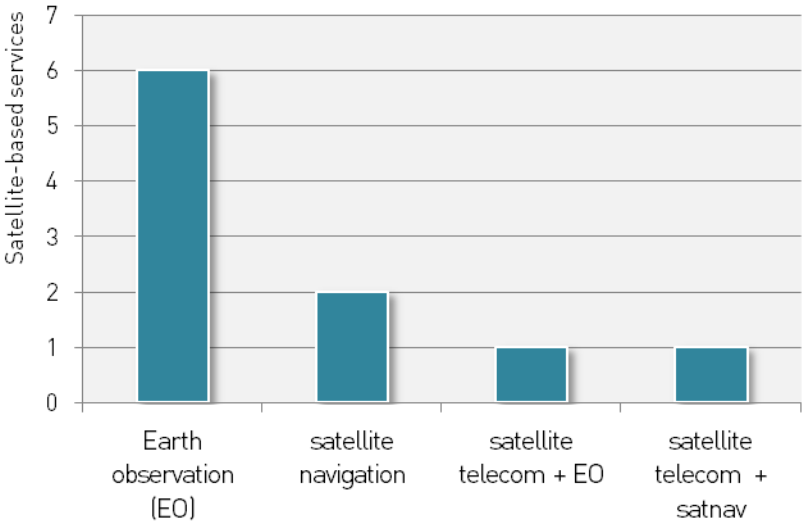


Fig. 13: **Start date of use of the satellite-based systems**

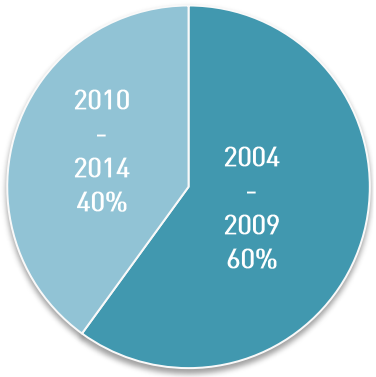
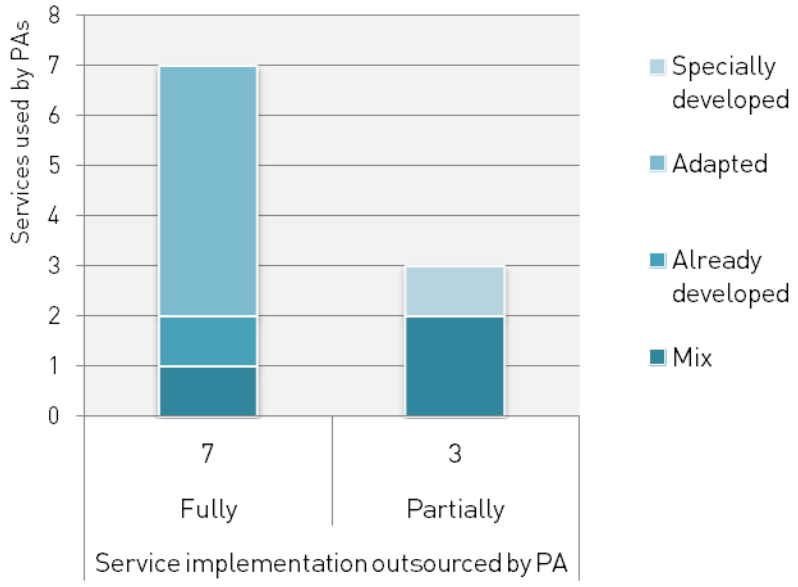


Fig. 14: **Availability of the satellite-based service**



As compared to services based on Satcom, which are easily accessible with the specific equipment, and on Satnav signals, which are by now largely used by a number of private and public institutions free of charge, satellite imagery needs in general specific expertise and customised software to enable users to access relevant information.

Indeed, in all cases analysed the respondents outsourced at least part of the implementation of the satellite-based service.

Seven public authorities fully outsourced the service implementation to other entities (cf. Figure 14): five of them adopted services which had been already developed, but that had to be adapted to their specific needs; in one case (the Central Command for Maritime Emergencies) the satellite-solution resulted from a combination of sub-services adapted or specially developed; in one case only a simple transfer of an existing solution was meeting the requirements of the public authority - the Alderney Airport, which local airline was the first in Europe to use EGNOS to support landing operations, is a perfect example of adoption of an already existing satellite-based service fully outsourced to other entities.

In three cases, all related with environmental monitoring, the satellite-based services used were only partially outsourced: for one of these public authorities (Natural Resources Wales), the satellite-based solution had to be specially created, while in the other two cases, it resulted from a mix of satellite-based services already developed, adapted and specially developed.

Fig. 15: **Main provider of the satellite-based solution**

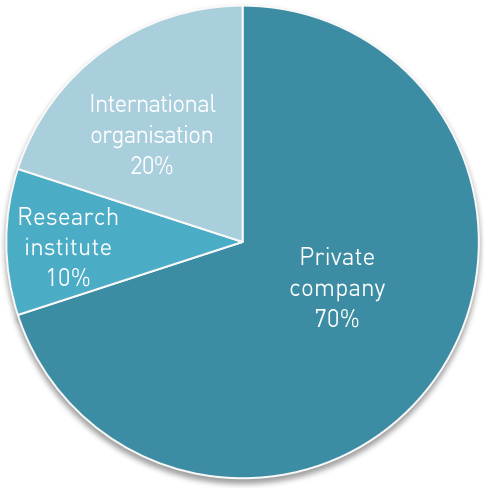
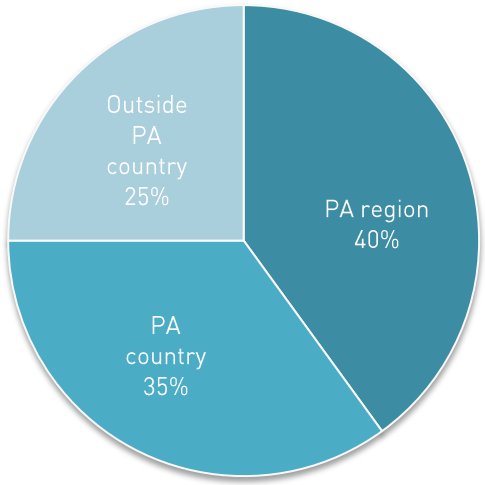


Fig. 16: **Location of the service provider**



Seven of the public authorities consulted outsourced, fully or partially, the implementation of their satellite-based systems mainly to private companies, two to international organisations, and one to a research institute (cf. Figure 15).

Seven public authorities procured the expertise to implement the satellite-based service in their own countries, and four of them within their own regions (cf. Figure 16). This is the case of the Department of Infrastructure of the City of Diemen, which heard of the possibility of building a soil subsidence map based on satellite imagery and asked a local company to adapt a service already provided to private entities to the needs of a municipality of over 26,000 inhabitants. In two cases, service providers are international organisations or research institutes located outside the country of the user public authorities. In one case the services are procured both nationally and abroad: this is the case of the Environment Agency England, which acquires satellite imagery for flood risk management both through national entities and international platforms - namely Copernicus and the International Charter on Space and Major Disasters.

To sum up, all cases considered here revealed the necessity of external support from a service provider. This need could be partially explained by the fact that most experiences analysed concern the use of services based on Earth observation.

Private companies represent the main service provider in 70% of cases, confirming their pivotal role in making satellite-based services available to public authorities. Even more interesting, most public authorities were supported by service providers located within their own countries, showing that proximity matters and that it is indeed an incentive for public authorities to adopt satellite-based services. To be able to rely on a local service provider simplifies and facilitates not only service implementation, but also maintenance and improvement.

Case-study: Use of EGNOS to support approaching and landing at Alderney Airport

Weather conditions and constraints created by the location of the runways, can make it very difficult even for experienced pilots to approach and land at the Alderney Airport, regularly forcing operators to delay, divert or cancel scheduled flights.

Alderney had always had a non-precision approach (NPA) supported by a non-directional radio beacon (NDB) to support landing operations. This approach provided lateral but not vertical guidance to pilots.

In 2011, ESSP (European Satellite Services Provider) proposed to the local airline to test the EGNOS system on its aircrafts landing in Alderney. The new system provides both lateral and vertical guidance. Planes can hence approach the runaway with no need for ground-based navigation support, including in low-visibility conditions which might have prevented or delayed landing in the past.

Nature	Public
Area of operation	Country, Local
Sources of budget	Local public funds
Annual budget	EUR 10m - 50m (2013)
N° staff	40 (regular staff)
Service implementation framework	Demonstration project EC Trans-European Networks -TENs- programme
User's implementation costs	< 1% of annual budget in 2011
User's operational costs	< 1% of annual budget in 2014

The system's requirements (type and frequency of signals and service standards) were identified by the UK Civil Aviation Authority (CAA), while the new Instrument Approach Procedures and the Low Visibility Procedures were designed by NATS (formerly National Air Traffic Services) with inputs from the Airport authorities and the local airline. The operation was certified by the European Aviation Safety Authority in December 2011.

The testing phase lasted 12 months before the introduction of the system on an operational level during 2012. The system is currently installed on six aircrafts, and has been used everyday during the last two years.

The EGNOS system was ready to use, and its provision was fully outsourced by the Airport, which was only requested to participate in the creation of the new procedures needed by the pilots and the Airport authorities to integrate the system into their operations.

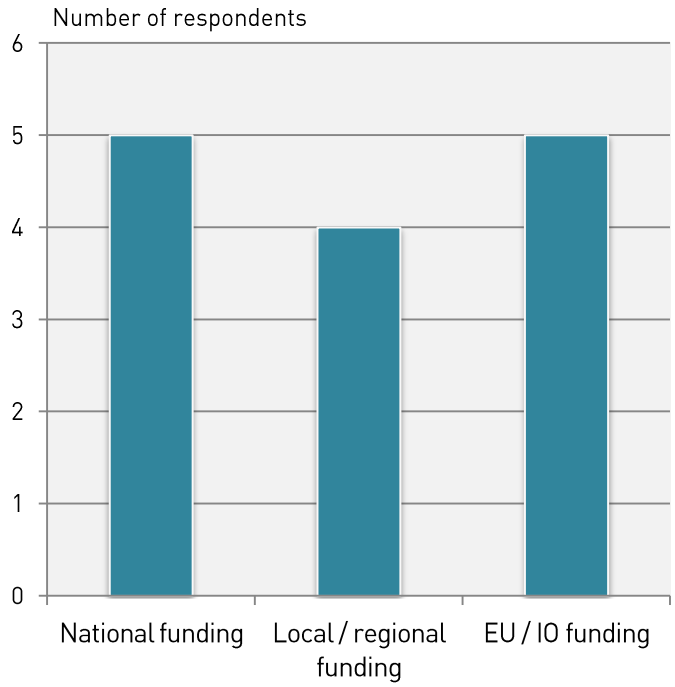
KEY-FACT: It would have cost GBP 1,000,000 (EUR 1,278,000) to achieve the same precision offered by EGNOS with ground equipment.

FUNDING AND COSTS OF THE SATELLITE-BASED SERVICES

How are the satellite-based services funded? What is their monetary cost?

In all ten cases, the implementation or adoption of the satellite-based solution was financed with public funds, received either within local, national or international frameworks or a combination of them (cf. Figure 17). As part of the initial funding necessary to set up the satellite-based service, four public authorities received funding from multiple sources.

Fig. 17: **Sources of funding for the satellite-based service**



Five out of ten relied primarily on national funds and five on funding provided by international organisations, namely the European Union and the European Space Agency.

The adoption or implementation of seven out of the ten satellite-based services represented an investment of less than EUR 20,000, and in several cases quasi-zero euro investments (cf. Figure 19).

Only two services represented much larger investments and only one out of the ten public authorities consulted, namely the Countryside Council of Wales, invested more than 20% of its annual budget to adopt or implement the satellite-based service used (cf. Figure 18).

Fig. 18: **Initial investments as a share of annual budget**

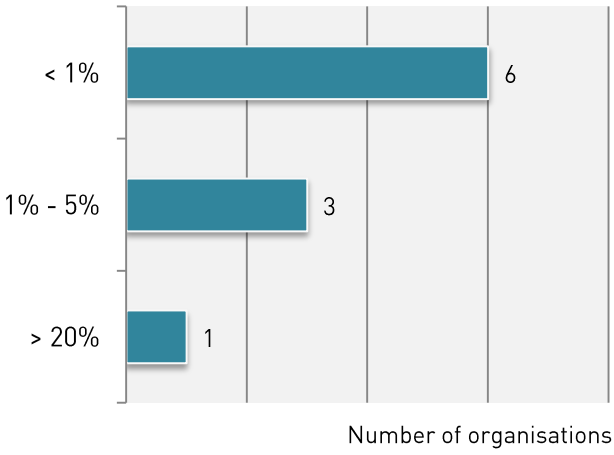


Fig. 19: **Inititial investments in the service**

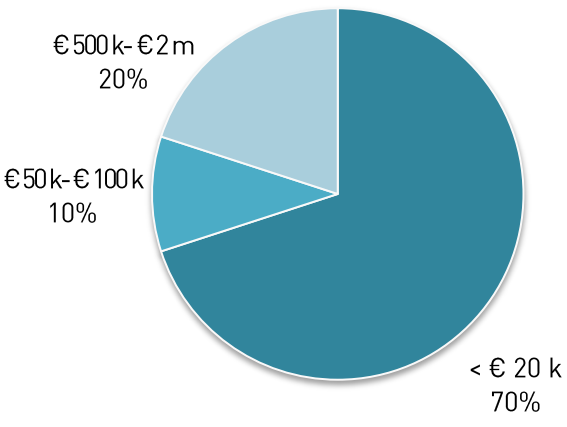


Fig. 20: **Initial level of investments according to implementation framework**

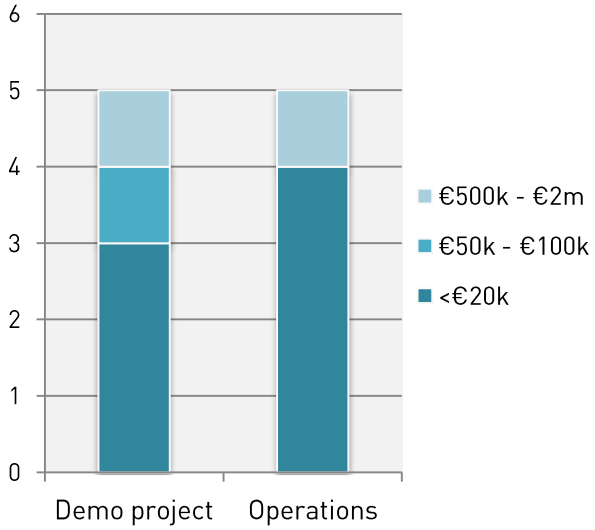
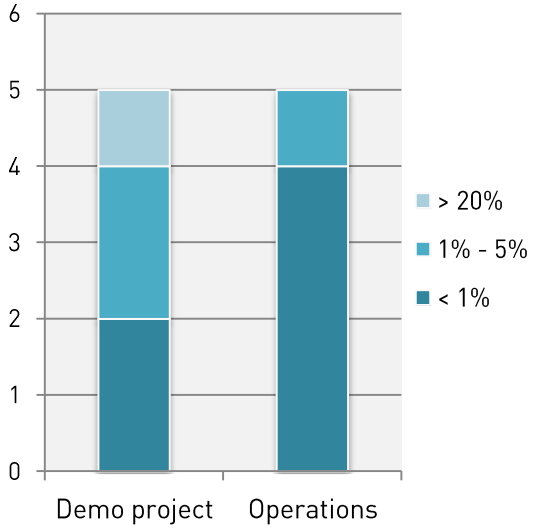


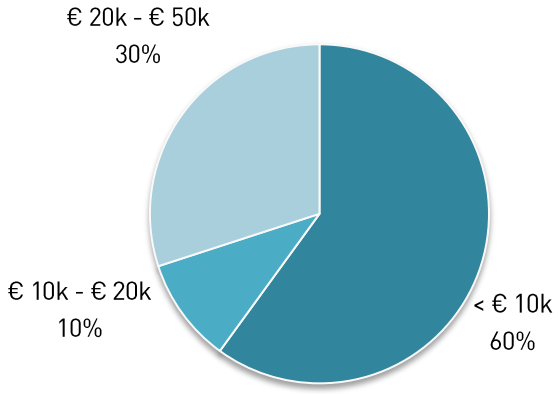
Fig. 21: **Initial level of investments as a share of annual budget according to implementation framework**



The average level of investments was higher within demonstration projects, although also in these cases implementation costs did not exceed EUR 20,000 for three out of five public authorities (cf. Figure 20).

Fig. 22: **Annual operational costs as a share of annual budget**

Fig. 23: **Annual operational costs to use the satellite-based service**



For four of the public authorities adopting the solution within the framework of their regular operations, the initial investment represented less than 1% of their annual budgets, and for one about 2%: it is the case of the Hamster Mission of the DREAL Alsace (cf. Figure 21).

Operational costs of using the satellite-based solution are also limited, representing less than EUR 10,000 and less than 1% of the annual budget for six public authorities (cf. Figures 22 and 23).

Fig. 24: **Annual operational costs according to implementation framework**

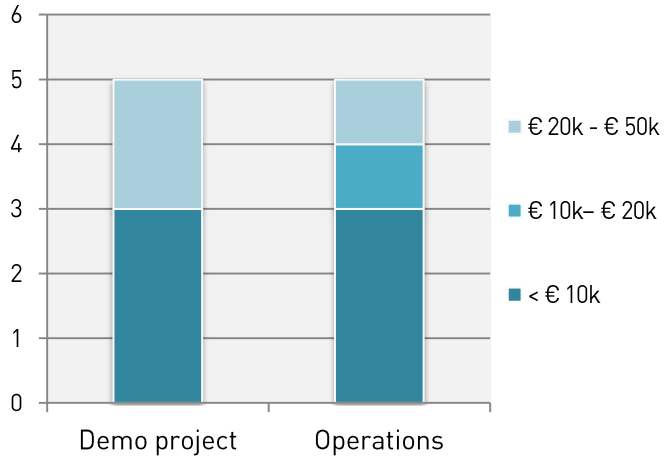
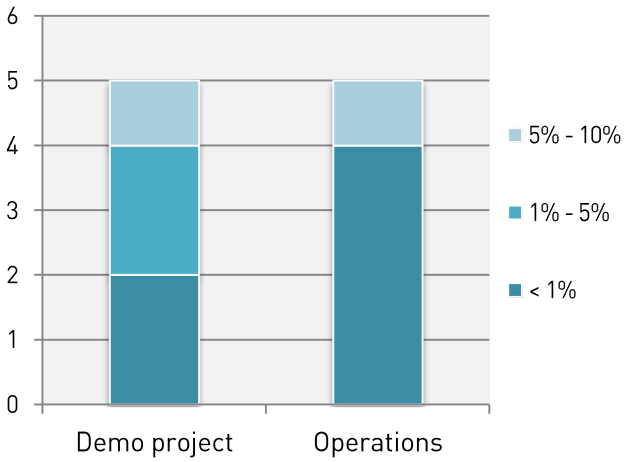


Fig. 25: **Annual operational costs as a share of annual budget according to implementation framework**



Operational costs do not exceed 5% of the annual budget for four out of the five public authorities adopting the satellite-based solution within a demonstration project (cf. Figure 25).

The public authorities adopting the satellite-based service within an operational framework have in general lower costs associated with the operational use of the service, corresponding to less than 1% of the annual budget in four out of five cases, the fifth being the example of the DREAL Alsace for which only the budget of the Hamster mission was taken into account (cf. Figure 25)[11].

Fig. 26: **Implementation costs according to type of satellite application**

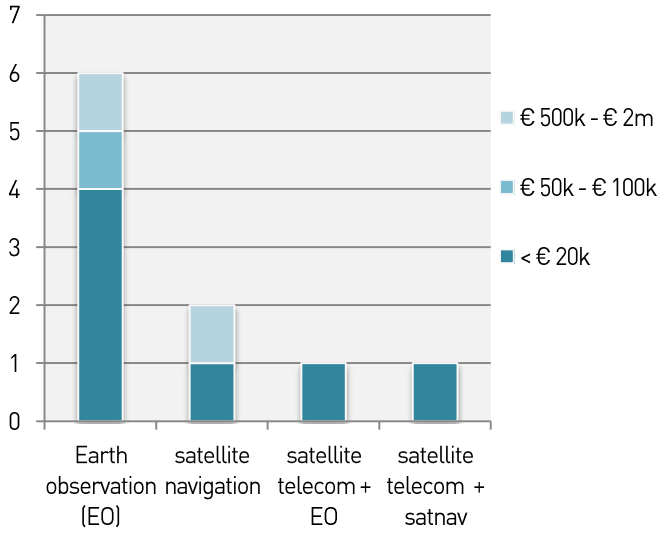
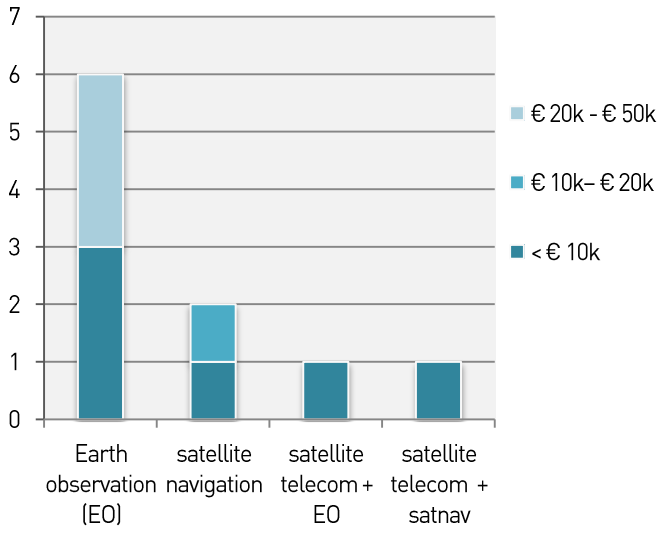


Fig. 27: **Operational costs according to type of satellite application**



[11] It is worth noting that even if half of the public authorities adopted their satellite-based services within demonstration projects, they contributed with financial and human resources throughout the implementation process. On the other hand, when the services were adopted within operational settings, some public authorities were able to acquire satellite data for free: this is the case for the Central Command for Maritime Emergencies, using the CleanSeaNet service freely provided by the European Maritime Safety Agency, and for the Environment Agency, England, receiving part of the satellite-based data needed to manage floods free of charge, through Copernicus and the International Charter on Space and Major Disasters.

As most of the cases considered (seven out of ten) rely on satellite imagery, it is not really possible to draw conclusions on the costs associated with the take-up and the operation of satellite-based services according to the type of satellite-based applications used (cf. Figures 26 and 27).

To sum up, the satellite-based services considered were all developed with public funds available to public authorities. In five cases, the satellite-based solutions were adopted or implemented with the financial support of the EC or ESA. This shows that investments made by international organisations in projects aimed at transferring space-based technologies to the public sector can indeed result in operational practices.

Adoption costs represented less than 1% of the annual budget for more than half of the public administrations (or departments) and not more than 5% for nine of them. The Municipality of Diemen invested even less, i.e. 0.25% of the annual budget allocated to public infrastructure maintenance works.

Operational costs are also low, corresponding to less than EUR 10,000 and less than 1% of the annual budget for six of the organisations consulted.

Case-study: The City of Diemen (the Netherlands) copes with soil resilience with the support of satellite imagery

In Diemen soil can sink up to two cm per year, forcing the municipality to heighten the entire public space about once every twenty years, including all roads, sewers and public gardens.

The Department of Infrastructure of the city was inspired by the experience of Italian scientists using EO to monitor soil movements after the Earthquake in L'Aquila. The Department identified a local company which could provide the service, and in 2011 acquired a city-wide deformation map based on satellite imagery.

The deformation map shows the resilience rate of the soil in specific locations, enabling the organisation to prioritise maintenance cycles with no or little need for expensive, time-consuming ground measurements.

Nature	Public
Area of operation	Local
Sources of budget	Local and national public funds
Annual budget for infrastructure maintenance	Approx. EUR 4m in 2014
N° staff	60
Service implementation framework	Operations
User's implementation costs	0.25% of annual budget for maintenance works in 2011
User's operational costs	None in 2014

The map cost approximately 0.25% of the organisation's annual budget for maintenance of roads, sewers, and other infrastructure. Its use does not entail any costs, excluding those associated with human resources and concrete infrastructure maintenance works. It will need to be updated with new satellite data approximately every ten years.

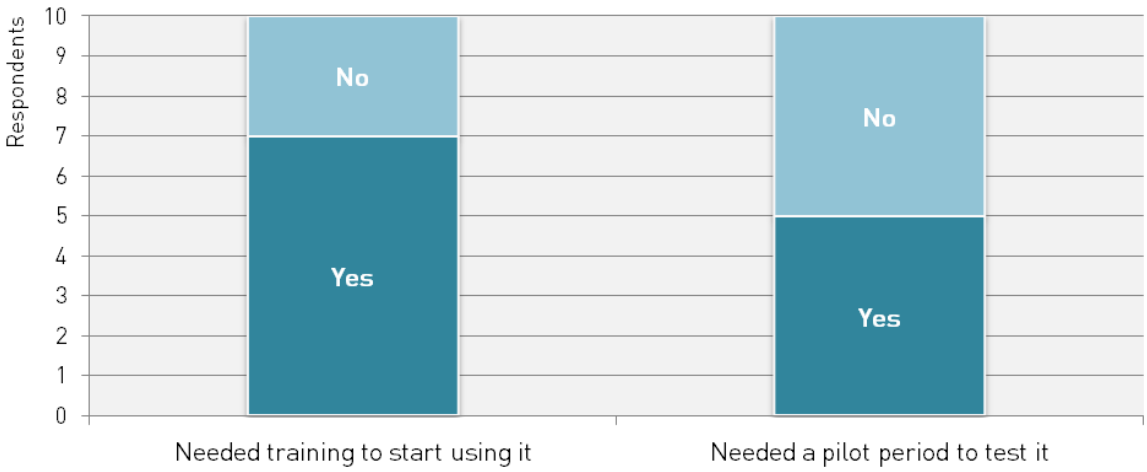
KEY-FACT: To assess soil resilience with traditional methods (namely ground measurements) would cost and entail an effort in terms of time of at least ten times the cost of contracting the satellite-based deformation map.

USE OF THE SATELLITE-BASED SERVICES

Is it difficult to use satellite-based systems? What are the requirements?

Seven out of ten public authorities profited from some training to first start using their satellite-based services. Half of them needed a pilot period to test the solutions before deciding to keep using them (cf. Figure 28).

Fig. 28: **Uptake of the satellite-based systems. The PA....**



In 70% of cases there was no resistance within the public administration to the adoption of the new solutions, while in 30% of cases, colleagues had to be convinced of the convenience of adopting the satellite-based services, as they distrusted them. In all three examples, the services were used to partially replace previous systems.

Fig. 29: **Difficulties with colleagues**

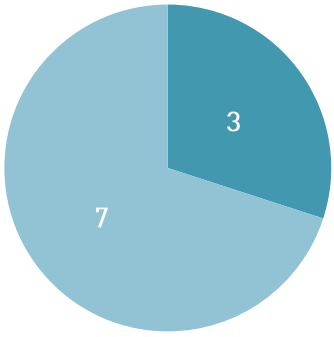
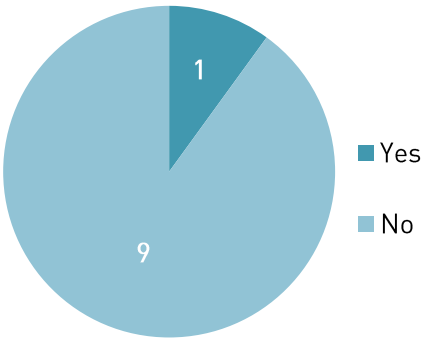


Fig. 30: **Organisational changes**



While it was commonly assumed that organisational changes (including dismissal of colleagues and hiring of new staff) are necessary to integrate new technologies, only the Environment Agency England, which is using satellite-based services to manage floods since 2007, mentioned this necessity. The changes were implemented gradually, by selecting new staff as necessary over several years.

70% of the public authorities use their satellite-based services for regular activities which are essential to achieve their missions. As an example, the Flemish Agency for Roads and Traffic relies on Satnav for the regulation of street lights on regional tramways. Another 20% of respondents rely on these services to perform punctual tasks, also essential to pursue their mandate (cf. Figure 31). The Environment Agency England, for instance, acquires satellite imagery only during floods and emergency situations.

Fig. 31: **Operational use of the satellite-based systems. The PA....**

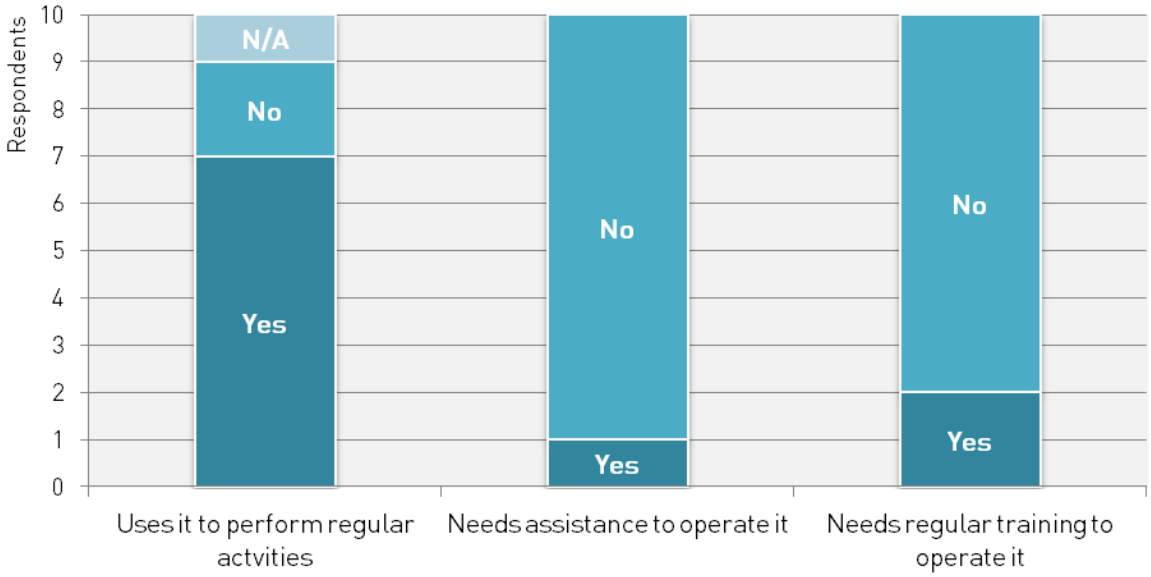


Fig. 32: **Period of use of the satellite-based services**

After adoption, 90% of the users needed no further external assistance to run their services (cf. Figure 31). The only exception is the Alderney Airport, which has a working agreement with ESSP (European Satellite Services Provider) to deliver service continuity and integrity.

In summer 2014, all ten public authorities consulted had been using the satellite-based services for up to more than five years and for at least one year and a half after adoption (cf. Figure 32).

This analysis suggests that some training is needed to familiarise public authorities with satellite-based services. Beyond that, most organisations do not need any additional training or assistance to use the systems. Half of the organisations considered have been using satellite-based services for five years or more. In 90% of cases, the services were used for essential tasks. Only in three cases the uptake of the satellite-based service encountered internal resistance and only in one case it entailed organisational changes.

Case-study: The Traffic and Telematics Division of the Flemish Agency for Roads and Traffic uses Satnav to optimise transit of regional trams

The Traffic and Telematics Division of the Flemish Agency for Roads and Traffic used a system of cables and physical loops to ensure priority in traffic for the trams and buses of the Flemish public transport company.

The management of this system was outsourced to a local private company. In 2008, this company proposed to test a system of virtual loops, supported by satellite navigation and short range radio signals, on the regional coastal tramway.

The Satnav solution was first tested on few trams and traffic lights, and then extended to the whole coastal tramway network between 2011 and 2013.

Nature	Public
Area of operation	Regional
Sources of budget	Regional public funds
Annual budget	EUR 600m in 2014 (Agency)
Annual budget to reduce public transport congestion	EUR 18m in 2014
N° staff	1,500 (Agency)
Service implementation framework	Operations
User's implementation costs	0.2% of annual budget in 2014
User's operational costs	< 1% of annual budget in 2014

Special training was needed for the staff of the Agency and the provincial operators to start using the new system, but no organisational changes were necessary and the staff of the Agency did not resist innovation. Afterwards, the system has been operationally used with no further need for training or external assistance.

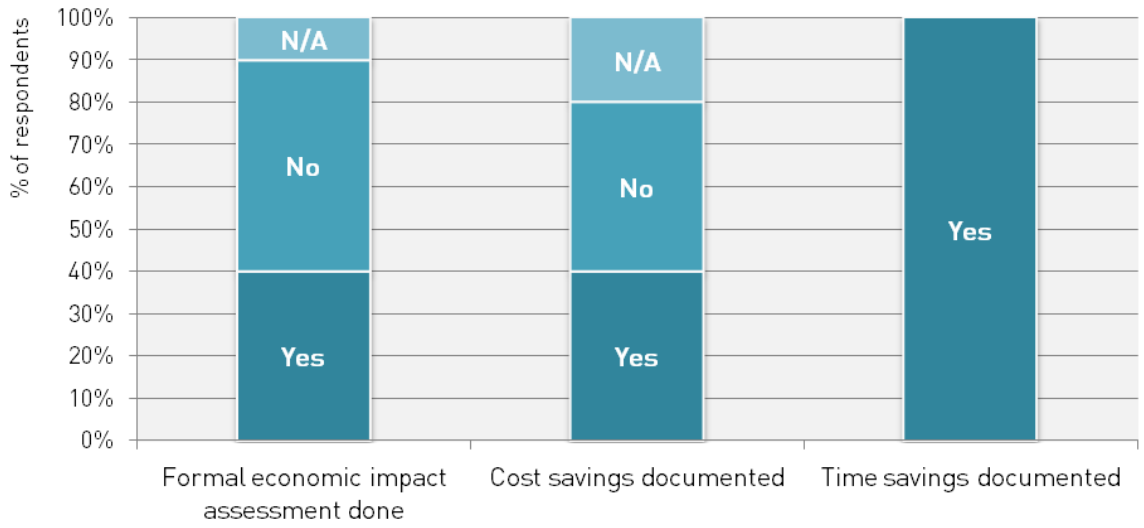
A first assessment of the new system estimates savings for about EUR 140,000 per year, resulting from reduced annual maintenance costs. Time-savings have been also documented, as well as an improved quality of the information available and of the services offered to the public.

KEY-FACT: Estimated EUR 140,000 saved each year.

BENEFITS OF UTILISING SATELLITE-BASED SERVICES

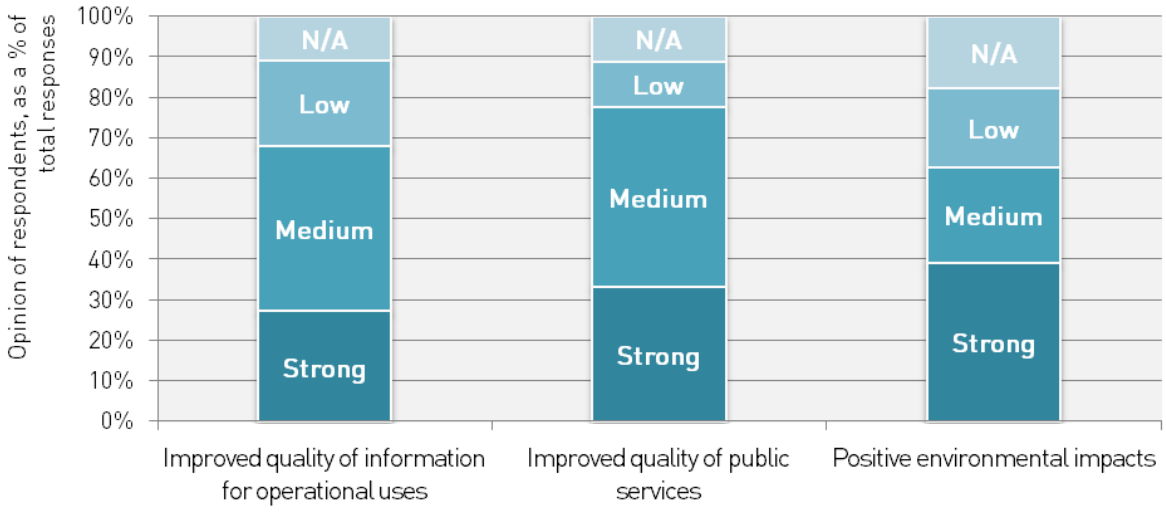
Which are the advantages of satellite-based services for public administrations?

Fig. 33: **Assessment of the quantitative benefits derived from the services**



Concerning the impacts of using satellite-based services, respondents indicate time-savings (100% of responses), cost-savings (40% of responses), and several qualitative benefits (cf. Figures 33 and 34).

Fig. 34: **Assessment of the qualitative benefits derived from the services**



The three main qualitative benefits pinpointed by public authorities include: the improved quality of information available for operational uses, the improved quality of the services provided by the public entities and positive environmental impacts.

In 80% of cases, these experiences inspired other public authorities, who adopted similar satellite-based solutions. Moreover, eight out of the ten public authorities consulted share the data provided by their satellite-based systems with other public bodies (cf. Figures 36 and 37).

Fig. 35: **The satellite-based service used is....**

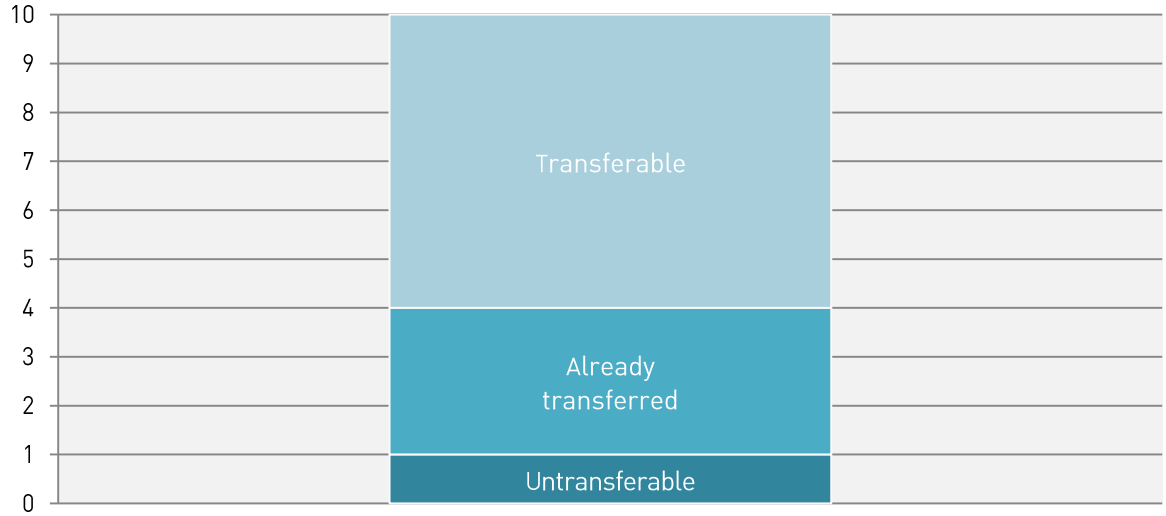


Fig. 36: **Others inspired?**

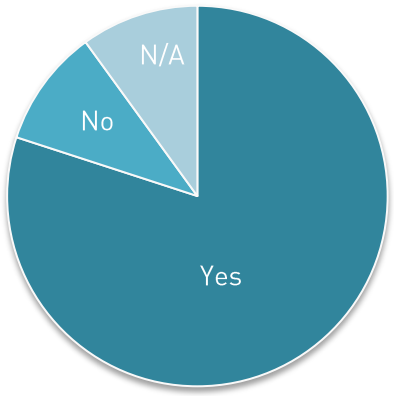
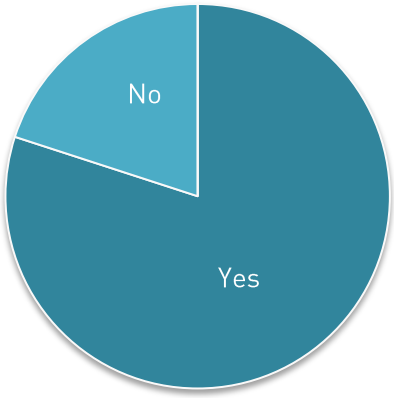


Fig. 37: **Satellite data shared with other PAs?**



Since the limited number of cases analysed allows it, the specific benefits reported by each public authority are condensed in Table 2. Four main kinds of benefits have been identified: cost-savings, efficiency gains, positive externalities, and return on image. Repeating key-words have been underlined to facilitate comparison among different cases.

Table 2: Benefits reported by user public authorities					
Case-studies	Guernsey and Alderney Airports: EGNOS to support landing operations	Arno River Basin Authority: EO for slope monitoring	CCME: EO for oil spill detection	City of Diemen: EO to manage soil resilience	DREAL Alsace, Hamster Mission: EO to protect biodiversity
Cost-savings	Service cost-neutral compared to previous system.	Service implemented free of charge.	Service provided free of charge.	Savings provided by satellite-based deformation map estimated at more than 20% compared to previous system. Costs to achieve same results with site inspections estimated to be at least 10 times more by user PA.	Potential fines from the EU to France (up to EUR 55 million) avoided.
Efficiency gains	More accurate instrument approach. Improved service continuity. Time-savings reported.	Soil deformation calculated with millimetre-accuracy. Increased efficiency when updating the hazard maps. Time-savings to collect data.	Improved surveillance capacity. Decreased pollution. Time-savings reported to intervene on oil spills.	Subsidence rates known with millimetre accuracy. Increased efficiency to plan maintenance cycles. Improved information to support policy proposals and planning of budget expenditures. Time-savings reported to realise the map.	Habitat extension and modifications shown throughout time, allowing planning of timely interventions. Time-savings reported to map the area.
Positive externalities	Alderney population of around 2,000 people provided with more reliable air links.	27,000 landslides identified and 10,000 classified as active. Access to the web-GIS granted to private and public entities.	Reduced pollution risks for coastal states. Increased collaboration among Member States.	Soil resilience's extent proven to city authorities. Reduced impacts of maintenance works for the population.	Satellite-based data shared with regional environmental protection associations, local communities and relevant professional associations.
Return on image	Alderney Airport first to use EGNOS-based LPV approach procedure. Increased reputation of local airline			Experience shared with other local authorities, promoting pioneering role of Diemen Municipality.	Alsace's environmental concerns proven to the EU and to regional population.

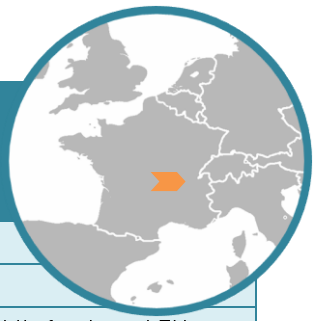
Table 2: Benefits reported by user public authorities

Case-studies	Environment Agency, England: EO to manage floods	Flemish Agency for Roads and Traffic: Satnav to regulate traffic lights	Natural Resources Wales: EO to map habitats	SPL Lyon-Confluence: EO to monitor solar energy production	UHCW: Satcom for remote breast screening
Cost-savings	Part of EO-based data received free of charge. Cost-savings reported, but not quantified.	Decreased costs of installation and maintenance. Savings estimated at about EUR 140.000 annually (installation and maintenance of traffic loops).	Cost to repeat a survey of Wales with field-measurements estimated at EUR 4.5 million, against about EUR 894,441 actually spent.	Costs to monitor the PV installations with site inspection estimated at about the double of the satellite-based service.	Satellite-based service cost-neutral compared to the previous system.
Efficiency gains	EO-data used to map flood extent on large areas during emergency situations and to assist with immediate relief operations. Data used to create change detection maps and to plan mitigation measures. Time-savings reported to receive data on flooded areas.	Increased accuracy and reliability in traffic control. Time-savings reported to install and to maintain the traffic light system.	Increased accuracy to monitor changes in land cover and habitats. Time-savings reported to map habitats.	Satellite-based solution costs about 1% of the value of the energy annually produced (approx. EUR 125,000). Time-savings reported to detect system malfunctioning.	Increased security in data transfer. Time and resource savings to transfer screening tests.
Positive externalities	Data shared with Cobra (the government's emergency committee) and with local public bodies to implement recovery measures.	Less traffic disturbance to traffic due to loop installation and maintenance.	Improved monitoring of land changes and land uses.	Decreased pollution for energy production. Increased perception of the renewable energy production in the territory.	Decreased environmental impacts to transfer screening tests. More hospital personnel available for other tasks.
Return on image			Wales first European country to produce a national map of its wildlife habitats using satellite technology.	Promotion of Lyon Confluence as a model of green neighbourhood.	

Only four out of the ten organisations consulted performed a formal economic assessment of their satellite-based services, which indicates that there is still a need to promote economic impact practices in this community. All users declared that they are able to save time and 40% that the satellite-based services entail economic savings. Also, all mentioned qualitative benefits, such as improved services and accuracy of available information, as well as positive environmental impacts.

Finally, 80% of public authorities share the data derived from the satellite-based services with other institutions and inspired other organisations to experiment with similar solutions. This is the case of the SPL Lyon Confluence, which outsourced the implementation and management of a system to monitor PV installations based on satellite solar radiation data to a local company.

Case-study: Satellite data support solar energy production in the sustainable city quarter "Lyon Confluence" (France)



The SPL (Local Public Society) Lyon Confluence is the local public redevelopment entity created in 1999 by Grand-Lyon to manage the Lyon Confluence initiative, a major urban project of requalification of an area of 150 hectares near Lyon's historic centre.

Funded under the FP6 Concerto initiative, the Renaissance project aimed at building a sustainable model neighbourhood relying on green energy in Lyon Confluence.

Solar was among the green energy sources chosen: 11 PV systems were installed and the assessment of the energy potential and the implementation of a PV monitoring tool were entrusted to the local association Hespul.

Nature	Public
Area of operation	Local
Sources of budget	Local public funds and EU funds
Annual budget	EUR 15.7m in 2012
N° staff	23 (regular staff)
Service implementation framework	Demonstration project (6th European Research Framework Programme -FP6)
User's implementation costs	<1% of annual budget in 2009
User's operational costs	EUR 1,500 in 2013

Based on data extracted from satellite imagery, Hespul analysed solar radiations to assess the potential energy output of the panels in their location, and to monitor the proper functioning of the installations by comparing the energy potential of a solar panel with its actual output. This comparison is performed every hour; in case of difference, an alert is sent so that the faulty PV system can be repaired as soon as possible.

The PV installations produce 250 kw per hour, for an annual production of approximately EUR 125,000. Hespul estimates that to operate and maintain the installations without the satellite-based solution would cost approximately the double, requiring at least one hour of work per day on each installation.

The use of the system by Lyon Confluence also inspired other public or private organisations all around Europe. Immediately after the installation of the solar equipment in Lyon Confluence, the Region of Rhône-Alpes adopted the satellite-based solution to monitor a PV system on the roof of their premises.

KEY-FACT: The satellite-based solution costs 1% of the value of the energy annually produced (approx. EUR 125,000).

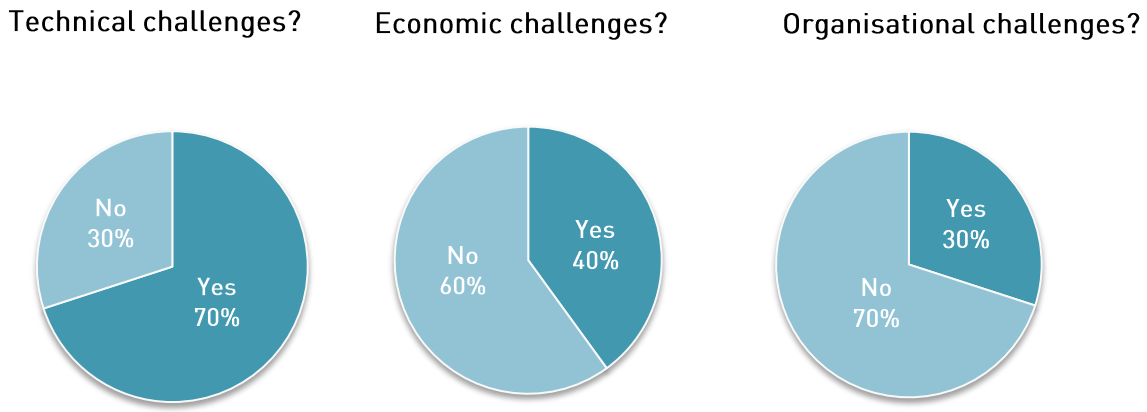
CHALLENGES TO ADOPT AND OPERATE SATELLITE-BASED SERVICES

Which are the obstacles encountered by public authorities to implement and operate the services?

The challenges to implement the satellite-based services used were mainly technical in nature (70% of respondents). The public authorities mentioning this kind of challenges also declared that they needed some initial training to start using the satellite-based solutions.

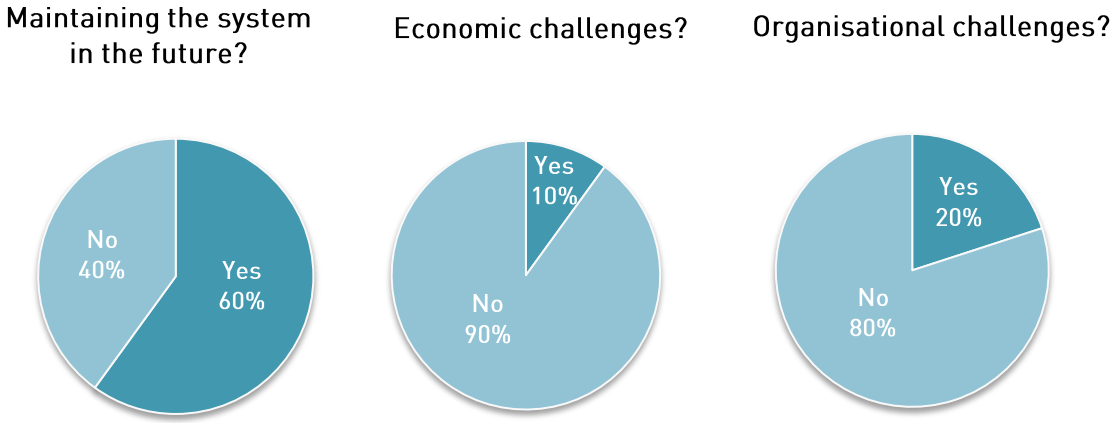
For more than half of the respondents budgets were not an issue in the uptake of the services. Only a few experienced organisational barriers deriving from the lack of trust of colleagues in the new service. These users also experienced technical difficulties (cf. Figure 38).

Fig. 38: **Challenges to implement the satellite-based solution**



When it comes to running the satellite service, most public authorities face neither economic nor organisational changes. 60% of them however doubt being able to maintain the satellite service in the future (cf. Figure 39).

Fig. 39: **Challenges to operational use**



Users quoted diverse factors challenging the future use of the services: for Natural Resources Wales, taking over the responsibilities previously assigned to other entities, organisational restructuring and the limited number of internal staff with specific knowledge in satellite image analysis; the Arno River Basin Authority mentions instead the difficulty of constantly updating internal skills with increasing budget cuts; in the case of the DREAL Alsace, the future use of satellite imagery to update a habitat carthography has been compromised by the lack of trust of farmers towards satellite-based information, demonstrating the importance of securing the engagement of all stakeholders when changing operational procedures which are likely to affect them.

Case-study: The Hamster Mission of the DREAL Alsace uses EO to save a European species from extinction

The Alsatian Hamster is a protected species, although its number has been dramatically decreasing in the last decade. Since 2007, the European Commission had been warning France that, if adequate measures to protect the species were not taken, the country could be fined for as much as EUR 17 million.

In 2010, the DREAL ordered a habitat cartography for the common hamster based on EO. The map was used to identify priority sites in which agricultural measures should have been taken in the following year to improve the hamster's habitat. As an example, farmers were advised to focus on wheat or alfalfa plantations providing food and protection to the hamster in spring and in early summer, or to leave some plots of land unharvested to ensure hamsters with coverage against predators.

Nature	Public
Area of operation	Regional
Sources of budget	National public funds
Annual budget of the Hamster Mission	EUR 525k in 2010
N° staff	250
Staff of the Hamster Mission	2
Service implementation framework	Operations
User's implementation costs	2% of Hamster Mission's annual budget in 2010
User's operational costs	5.14% of Hamster Mission's annual budget in 2010

The DREAL did not encounter any significant economic, technical or organisational challenge to both implement and use the satellite-based cartography.

After relying on EO to map the hamsters' habitats during three years, the entity decided not to use the service in 2015. Indeed, discrepancies were found between the results of the satellite-based cartography of the plantations and the declarations made by the farmers under the European Common Agriculture Policy (PAC).

Confronted with the opposition of the main stakeholders after the public sector in the protection of the Alsatian hamster, the DREAL decided to stop updating the habitat cartography with satellite imagery and to rely for this task on the declarations made by the farmers. Unfortunately, this method does not allow to automatically record the changes of the habitat throughout the years in the same cartography, but the collection and comparison of the habitat status will have to be made manually.

KEY-FACT: Million euros penalties to France avoided.

III. Final remarks and future perspectives on documenting the use of satellite-based services in the public sector

FINAL REMARKS AND FUTURE PERSPECTIVES ON DOCUMENTING THE USE OF SATELLITE-BASED SERVICES

This third section condenses the main lessons learned from the analysis of ten selected case-studies and attempts to elaborate on them to identify possible favourable conditions for the adoption and use of satellite-based services. Taking into account the smallness of the sample, lessons learned have to be read with the necessary caution. More representative figures will become available when the survey will be applied to a larger sample during the second phase of this study.

FINAL REMARKS

Satellite-based services can effectively support the work of public administrations operating at national, regional and local scales. This is demonstrated by the enduring use of these services throughout the years in the cases reviewed in this analysis.

National administrations have been the first to benefit from space products and services. Nowadays, regional and local administrations are catching up as institutional customers. This is probably due to lowering costs as compared to the past, and to the creation, at European and national levels, of infrastructure to receive and transmit satellite signals and of platforms providing Earth observation data free of charge.

R&D activities and increasing competition among service providers are likely to raise the quality and attractiveness of these applications in the coming years, while further reducing their costs. Therefore, the transfer of satellite-based data and services to public authorities is expected to accelerate in the next decades.

The cases reviewed suggest that this transfer has the potential to bring benefits to user public administrations and to the society at large for relatively small costs. Some of the findings of this analysis can provide pointers on how to accelerate the full disclosure of these benefits.

Adaptability, i.e. the capacity to adjust to different conditions, needs and environments, is a remarkable feature of satellite-based applications. For this reason, Eurisy has been promoting peer-to-peer exchanges among experienced users and potential customers of satellite-based services as a means to foster the transfer of good practices from a context to another.

For this transfer to actually take place, the cases included in this analysis indicate that public authorities should be involved in all phases necessary to adjust satellite-based applications to their needs.

Indeed, engaging the users in the design, the implementation and the testing phases, increases the quality of the satellite-based services eventually produced and reassures the final users about the usefulness and manageability of these new tools.

Effective communication between public managers and service providers is essential to both instil interest towards satellite-based services and to produce services that are adapted to the users' needs and to existing working processes.

Cultural and spatial proximity facilitates communication. As an example, the EMSA CleanSeaNet service has been created after an intense labour with coastal states speaking different languages but sharing a common professional culture. The continuous involvement of user public administrations throughout the design, implementation, and

improvement of the service ensured that this responded to the needs of each coastal authority, while the development of a joint platform helped to reduce costs.

Communication is also enhanced by spatial proximity. In the ten case-studies analysed the presence within the region or the country of entities providing satellite-based information and services have emerged as positive conditions for the adoption, the continuous use and the improvement of satellite-based solutions.

Indeed, local service providers are best placed to understand the context in which public authorities operate, to provide punctual assistance in case of system's malfunctioning and to further adapt the service to new needs and circumstances.

The public authorities consulted declared that their decision to invest in satellite-based services was driven by the expected added-value of these services compared to other available technologies.

For the cases analysed, the added-value of satellite-based services is not limited to cost savings, but includes time-savings, improvements in the services provided by public authorities, and the availability of more accurate information.

In other words, using satellite-based services not only allowed public authorities to fulfil their mission in providing more efficient, reliable public services with less resources, but also enabled them to bring about benefits that are more difficult to quantify on the short and medium term, such as the well-being of the communities at large, environmental sustainability and economic growth.

The public authorities whose experiences have been analysed mostly relied on private companies to provide them with satellite-based services. This confirms the importance of public-private partnerships and highlights the contribution of private entrepreneurs to the process of transferring space-based technologies to society.

Private companies, driven by profit opportunities and competition, are expected to play an increasingly important role in the development of better, more user-oriented services integrating satellite information and signals. An increase in the number of private companies offering satellite-based services should also entail a raise in the offer for public authorities and more opportunities to find the services needed within their own regions or countries.

Service providers - which include private companies, international organisations and research centres - have another important role in the process of adoption and use of satellite-based services by public authorities. They help public authorities to translate their operational needs into technical requirements and provide, in the cases analysed, the initial training needed by public managers to handle their systems.

Most of the public authorities consulted faced technical challenges in adopting or implementing a satellite-based service, and therefore needed some initial training and support in those stages. 90% of them were then able to use the services without further assistance.

Eurisy offers indirect support to public and private providers of satellite-based services by raising awareness on their available services through the testimonials of end-user organisations relying on them for their operational tasks. The association is constantly looking for success stories to be disseminated through its website and thematic publications and within its regional and international conferences.

The case-studies reviewed demonstrate that support programmes and demonstration projects can sometimes compensate for the lack of internal technical expertise within public administrations; indeed, in these cases, demonstration projects resulted in operational practices.

However, awareness of available satellite-based services remains a condition of paramount importance for satellite-based services to be considered by public administrations within their normal operations.

Eurisy has been raising awareness on available satellite-based applications among end-user communities since 2007. Even though public authorities are now more aware of the opportunities offered by these technologies, more efforts are needed to enable them to grasp their full potential and gear up for the new services that are expected to emerge in the near future, as a consequence of Galileo and Copernicus entering their operational phase in 2013.

Training and awareness raising will still play an important role in this process. Eurisy will continue acting as a facilitator to make aware public authorities at all levels of satellite-based solutions which have proven their usefulness. At the same time, it will keep advocating for the development of services which take into account the concrete needs and the viewpoints of those who work on the frontline in the provision of public services.

FAVOURABLE CONDITIONS FOR THE ADOPTION AND USE OF SATELLITE-BASED SERVICES WITHIN THE PUBLIC SECTOR

The review of key facts and lessons learned from the analysis allowed us to identify a series of favourable conditions for the uptake of satellite-based services by public authorities. These refer to the public authority as such (its staff and internal organisation), to the satellite-based solution and to the framework under which the solution is adopted or implemented.

The public authority

- Staff with some knowledge of satellite-based applications
- Awareness of available satellite-based solutions
- Awareness of support programmes and mechanisms
- Previous experience of use of satellite-based services within the institution
- Knowledge of similar experiences by other public entities
- Autonomy on investment decisions
- Involvement of the user public authorities in all development and implementation phases
- Initial training for the public authorities' staff in using the satellite-based service

The satellite-based service

- Regard for strategic needs
- Adaptability to pre-existing working procedures and tools
- Improvement of public services and positive social, economic and environmental impacts expected

The implementation and operational frameworks

- Availability of satellite-based data and services, and of external technical expertise free of charge
- Opportunities to establish partnerships with other public administrations, international organisations and private entities to adopt/implement and utilise satellite-based services
- Existence on the national territory of a pool of private companies offering integrated, commercial satellite-derived services
- Availability of support programmes and mechanisms, from national and international agencies, to access and use satellite-based services
- Agreement of stakeholders on the reliability and usefulness of the satellite-based service.

FUTURE PERSPECTIVES ON DOCUMENTING THE USE OF SATELLITE-BASED SERVICES IN THE PUBLIC SECTOR ON A BROADER SAMPLE

The emphasis put by users on the added-value of satellite-based services suggests that these should not be promoted among public authorities on the basis of their mere technological sophistication, but first and foremost because of their benefits. Evidence-based analysis on the impacts of using satellite based-services can potentially provide substantial support to public managers interested in these technologies and would also help marketing them within the public sector.

Documenting and communicating on the added-value of satellite-based services should primarily be the interest of service providers. Nevertheless, governments would also profit from analyses reporting on the return of investments in space for the public civil sector. Space agencies would equally benefit from feedback from public administrations on their needs, requirements and experiences of use of satellite-based applications. Most importantly, public authorities could capitalise on the experiences of other administrations and get ideas to adapt the satellite-based solutions used by others to the needs of their own territories.

The ten public authorities participating to the present analysis contributed with their experience to building a knowledge-base which will be useful to a number of space and non-space organisations. For the knowledge-base to grow, many more public authorities will have to be consulted and invited to provide feedback on their own experiences.

However partial and incomplete, the information collected here proves the usefulness of the bottom-up-approach applied. The second phase of the present analysis foresees the design of an online survey based on this approach to be disseminated within a much wider audience.

The online survey will be designed on the basis of the responses received within the first phase, and will include a more limited number of questions, with the aim of capturing information on the use of satellite-based services within a large community of public administrations.

Eurisy's Members will play an important role in supporting the dissemination of the survey through their channels and within their countries. Hopefully, other organisations will also join the effort.

Eurisy encourages stakeholder organisations to capitalise on its end-user approach and is open to possible collaborations to apply it within regional and sectorial analyses on the use of satellite-based services within the public sector.

EURISY'S FULL MEMBERS

About Eurisy

Eurisy is a non-profit association of space agencies and government offices dealing with space affairs in Europe.

It is mandated and financed by its members to increase the access of society to the benefits of satellite information and services.

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bridge space and society