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SPACE FOR ALL: HOW TO CONNECT SPACE AND SOCIETY RAISING AWARENESS ON SATELLITE APPLICATIONS FOR SOCIETAL NEEDS

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Abstract

When we talk about Space, our interlocutors think about planets, stars, asteroids, astronauts and, sometimes satellites. But, only a small percentage is aware of what satellite technology can do and the relevance of satellite applications in our everyday life. From satellite communication, to navigation and to earth imagery, satellites data and technology are contributing in improving our daily life, or businesses or helping the management of our cities. Often, the end users come across an obstacle in communicating their needs to the service providers. On the other side, the service providers themselves are not fully aware how to communicate with the end users. In some cases, this lack of communication makes difficult to meet the demand of space applications from the user side with the supply from the service providers. Eurisy, an association of space agencies established thirty years ago, works to put the end users at the core of the space value chain. In this last decades, Eurisy has been attentive and responsive to the changes of the space sector trying to picture how end users are becoming familiar with space technology. In particular, how the democratisation of space is turning space, especially satellite technology, into an enabler to guarantee the development of a sustainable living, accessible to everyone. Eurisy recently started a review of the case studies collected over the last ten years thanks to direct testimonials, event and conferences, publications and surveys. The user-centred approach adopted is innovative in the space sector and over the years proved to be effective in connecting users and service providers in different contexts. The paper aims at: 1- Identifying challenges and barriers that characterise the relations between service and/or information providers and end users. 2- Analysing the changes occurred in the relations between end users and service providers from 2007 to date in Europe. 3- Presenting the reasons that motivates the use of satellite data and technologies and which of these is the most used. 4- Presenting Eurisy's approach as an applicable model outside the European borders and the benefits deriving from connecting space and society. Furthermore, the paper will briefly present the ongoing activities as examples of the work put in place by the organisation and how the user-centred approach is applied.

Keywords: Satellite, applications, downstream, end users, service providers, space policy.

1. Introduction

In recent years, space technology and applications, derived from satellite signals and data, are contributing to enhance the socio-economic development of society. In the past, space was mostly oriented in developing upstream solutions to support space exploration and science. Only in the 21st century, space innovation began to be conceived differently. The closeness between space and society is in continuous evolution. But the first steps towards a new down-to-earth approach, was mostly related to the digitalisation of society. Indeed, the advancements in technology and a more connected society, created a fertile environment for space applications to respond to societal needs. Digitalisation did not radically change society, but impacted positively on space manufacturing, contributing to the evolution of a downstream sector mainly centred on applications. [1]

At political level, there is still a certain resistance to adopt space-based solutions, even if there are examples of governments that facilitate the adoption of such services, increasing the investments firstly in Satellite Navigation technology and then in Earth Observation. The advent of New Space has changed the way space should be seen, pushing for a more sustainable and accessible use of space. Such revolution in the sector led to a growing rounds of investments and the presence on the market of new entrants. [2] This flow of investments favours the transition from a technology-push innovation. Today the market is starting to be more oriented towards a technology pull innovation [3], especially considering the implementation of user-oriented programmes like Copernicus and Galileo.

Making space nonexclusive is becoming a priority for traditional and new space actors, namely start-ups, which are adopting a user-oriented approach, partially moving away from an end-to-end approach, that was only partially taking the user needs into consideration.

The increase of satellite-applications is the result of a different approach also adopted by the space sector as whole. The space market is today more oriented towards the needs of users. Such shift is related to the idea of making space services and technologies more accessible to everyone. The so-called democratisation of space, is mostly related to the upstream, but the decrease of the cost of launches and the growing business of small and non-satellites, has consequences on the downstream. Such a concept is bringing space closer to non-space actors and it is stimulating the interaction between the two different sides of the market.

From an economic perspective, as assessed by studies on the socio-economic relevance of space activities at national, regional and local level, the impact on national GDP of space activities is of about 11.5%. This percentage can be justified considering that the benefits deriving from the applications is positively assessed. This brings down the operating costs in non-space sectors, in particular environmental management, meteorology and disaster management. [4] In these sectors, as in others, the increasing exploitation of satellite-based applications, has not exclusively positive impacts on the GDP, but has also improved decision making processes. Indeed, satellite imagery or navigation offer decision and policy makers data, that used in combination with others from different sources, would improve the decision making process, resulting in more targeted policies and strategies.

Technology transfers policies and the commercialisation of satellite-based applications can contribute to foster socio-economic development, supporting and stimulating innovation in non-space fields. This is also true, considering the United Nations Agenda 2030, that approved the 17 Sustainable Development Goals (SDGs). The preparatory works for the implementation of a Space 2030 Agenda, gave the UN Member States the possibility to delineate their vision to enhance the use of space to achieve SDGs.

The benefits of changing approach towards applications has a series of positive consequences that could be summarised in two points:

1- For the non-space users, adopting or including space-based applications, can prevent the growth of economic and societal costs and losses, while boosting productivity in the industry, impacting on the job market, increasing the well-being of people and making the decision making easier and more targeted.
2- For the space sector, opening more to non-space targets could attract more investments to the market and could put space in the position of playing a specific role in the soft power processes. This has been proved to be effective considering the advantages derived by the implementation of European assessed markets. There has been a certain stimulation of the European Space industry, allowing Europe to become a space leader, innovative and independent in terms of access to data, as demonstrated by Copernicus and Galileo. Both programmes show the rest of the world how Europe can positively contribute to the socio-economic development of Europe and across the borders. [5]

2. About Eurisy

Eurisy, a European non-profit associate, was created in 1989 on the occasion of the International Space Year 1992. It was founded by Hubert Curien, former French minister of Science and Technology (1st mandate 1984-1986, 2nd mandate 1988-1993). Its members are mainly space agencies and other space-focused organisations from across Europe. [6]

Eurisy works as *a facilitator* of relations between space and society. The model built by Eurisy relies on the design of events that act as platforms to help the match-making of needs and potential solutions. [7]

The role of facilitator and catalyst for innovation, help Eurisy in stimulate and support collaboration between public institutions, SMEs, industry and academia from both space and non-space sector.

Over the years, different topics characterised Eurisy's mission. More recently, the light has been shed over four main topics:

1- Space for Cities, that aims at exploring how satellite applications can improve the quality of life in urban areas, categorising the applications needful for the development and the sustainability of life in cities, as foreseen in the Sustainable Development Goal 11- Sustainable Cities and Communities.
2- Space for Culture. Branch of the Space for Cities initiative, focuses on the implementation of a dialogue and collaboration between the cultural/artistic sector and the space actors.
3- Satellite Applications for the Alps: Search and Rescue. Started as a project fully dedicated to supporting the integration of geolocation technology for search and rescue in the Alps, turned quickly into a broader topic. Indeed, Eurisy is supporting the activity of the European Emergency Number Association

(EENA) to lobby for the implementation of Advanced Mobile Location (AML) for emergency calls made from mobile phones, incrementing the capability of saving lives.

4- Satellites for Future Health. This project aims at supporting and raise awareness to the healthcare sector and end-users, on the relevance of adopting telemedicine to guarantee the access to cures to everyone.

3. The identification of challenges and trends

Talking about satellite applications within the space sector is undoubtedly very easy. Talking about applications to non-space actors is, on the contrary, very difficult. As said, Eurisy's mission is to disseminate and raise awareness on the benefits of space technologies for societal needs. Most of the times that language used to communicate with them is not clear enough: there are technical rigidities, lack of a clear explanation on why to use the applications, how to process the data, how to integrate them and finally how to frame them in a specific financial scheme.

If the democratisation of space underlined the need for an open access to space to everyone, the whole space sector has to become firstly understandable by everyone. The Eurisy's series of Good Practices, tends to embrace such philosophy, presenting users testimonials on operational satellite applications.

Between the period 2011 and the first months of 2019, Eurisy published 174 Good Practices, mainly covering the European geographic area. The GPs are classified accordingly to the Field of Application, the User type, the Satellite Technology and the Geographic context. What resulted is an overview on where the applications are mostly integrated, by who and which technology is the most adopted. Such information together with the outcomes of conferences and workshops, allow Eurisy to identify potential challenges that are faced by the users. Such exercise could present interesting information to understand what measures should be taken to favour the take up of satellite-based solutions all over Europe and outside, looking at developing space faring nations, that are willing to create their own space sector implementing the downstream business starting from how to approach society, identifying their challenges and opportunities.

3.1. The users

Looking at the Good Practices collected, over the past eight years, the main aspect to consider is that the majority of the end users are local and regional public authorities.

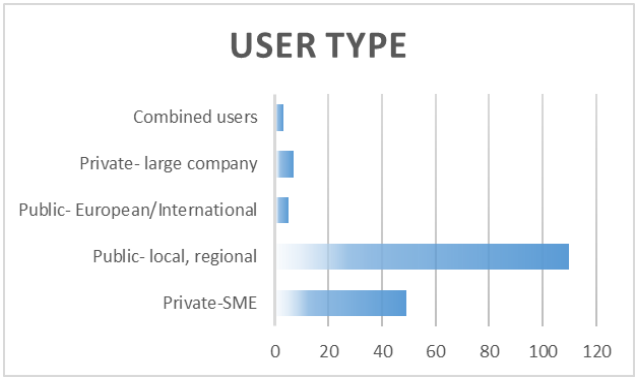

Fig.1. User Type Classification. Table elaborated by Eurisy

We have identified 110 regional and local public authorities that have used satellite applications to respond to specific challenges. An example is the case of the Municipality of Bologna, in Italy. The main challenge is to avoid traffic congestion and favour the movements around and across town. Considering that the city is too small to have an underground system, finding an alternative solution to provide an efficient above-ground public transportation service was necessary to facilitate urban mobility. The solution, adopted in 2005 by the Land Management Department of the Municipality, was to equip buses with a satellite-based positioning system that gives green light priority to public buses. The green bus priority system ensures the punctuality of buses arrival times while smoothing city traffic and reducing commuters' travel time. Since 2012, the travel data collected from public buses through satellite navigation are open and freely available online. The next challenge for the municipality is to also introduce the green priority system on city centre taxi routes.

In this case, the integration of satellite data has been done adopting an off-the-shelf solution. The benefits have been proven directly through the extension of the project, which proved to be successful in its first phase. [8]

This is just one of the examples, but it has been noticed- also through the initiative "Space4Cities"- that local authorities tend to be more open towards the adoption of solutions that includes satellite data and technology. What is interesting to notice is that some of the local/regional authorities that uses satellite-based solutions, not rely on in-house staff or resources. Quite often, there is an external support or to manage the data or to collect funds through projects, even at European level such as Horizon 2020.

Looking at the graph, it can be seen that a discrete number of private companies and SMEs adopted satellite-based technologies to respond to their internal business. Ranging from a Parisian sandwich shop that aimed at reduce food wasting through an app that included satellite navigation data, to the health sector, where a UK-based start-up created and launched "HappySun", which exploits satellite data to support healthy life style and disease prevention. When launched this represented the first international commercial app using satellite remote sensing for sun protection. [9]

Less interest towards the adoption of satellite solutions has been noticed in large enterprises or in institutions at European and international level.

3.2. The Geographic Location of the End-Users

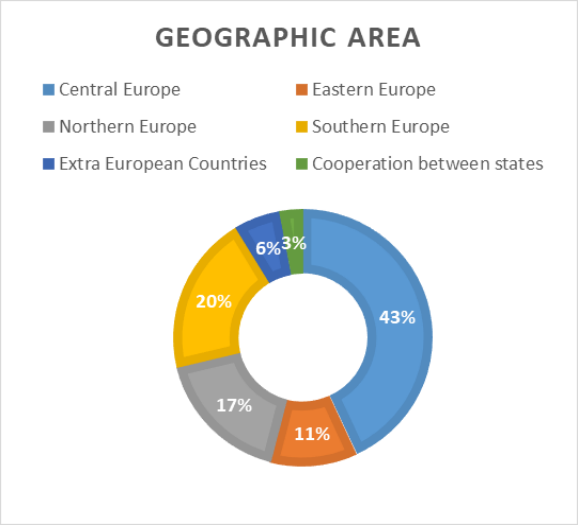

Fig.2. Users classification by geographic location. Table elaborated by Eurisy

The case studies collected can be categorised in different ways, one is using their geographic location across Europe.*

As emerges from the graph, Central Europe seems to be the most fertile area where to find use cases. Most of the GPs presented in the online database are related to use cases from local and regional public authorities. Such high rate of take ups can be justified looking at the socio-economic conditions and the Technology Readiness Level (TRL) of a country. According to the World Bank data, collected between 2007 and 2017, Germany, for instance, is one of the top leaders at European level, after Northern European countries and the UK. [10]

The 20% of the case studies published by Eurisy comes also from Southern Europe, the majority of which from Italy (57% of the Southern Europe GPs). The Italian use cases examined were 25, the users identified were mostly public and/or regional authorities. This might be a consequence of favourable financial conditions to allow the adoption of satellite applications by an authority, supported by a developed downstream sector, that creates a fertile ground.

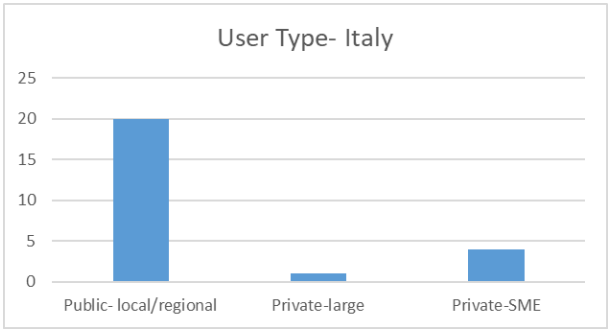

Fig. 2.1. User Classification in Italy. Chart elaborated by Eurisy

Northern Europe follows Southern Europe with 17% of the cases. Once again the public sector seems to be keen in adopting satellite technology to respond to societal challenges, like city management or water management. An example on which Eurisy worked intensely is the one of the Municipality of Lemvig in Denmark, where InSAR data were used to monitor soil subsidence to identify the pipes that need to be restored before they break up and with no need for regular site inspections. In this case, the use of satellite technology for risk management purposes had positive returns, both from an economical and logistic point of view, and led to additional feasibility studies involving other sectors that could benefit from the integration of satellite technology. [11]

Emerging on the scene are also Eastern Countries, especially Romania that is rapidly developing its space market, implementing the EO segment and its application especially in forestry, as demonstrated by the use of EO to track down illegal deforestation in the country. [12]

* The geographic areas are grouped as followed: Northern Europe (Denmark, Finland, Ireland, Norway, Sweden, UK); Central Europe (Austria, BENELUX, France, Germany, Switzerland); Eastern Europe (Bulgaria, Czech Republic, Poland, Serbia, Slovakia, Romania); Southern Europe (Greece, Italy, Malta, Spain, Portugal). Extra European Countries are French Guyana, Israel, Morocco, Senegal, Togo, Turkey, US.

3.3. A categorisation of fields applications

Forestry is just one of the sector where satellite technologies can be integrated. Eurisy categorised the fields of applications as follows:

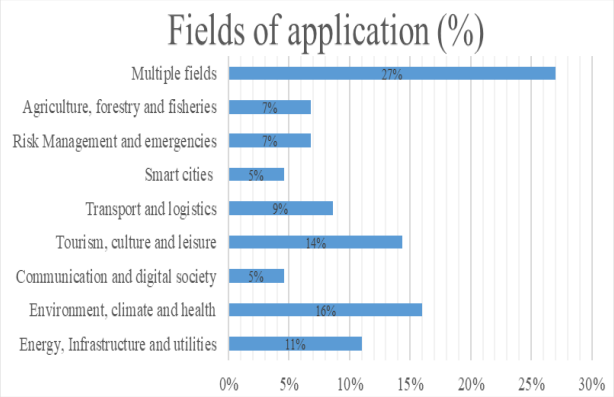

Fig. 3. Elaboration of the main fields of satellite applications

Quite often it has been seen that one single application can cover multiple fields, responding in a broader way to specific challenges.

In general, it can be said that the category where a consistent number of cases have been identified is the one that combines Environment, climate and health. The focus is principally on environmental issues and climate change. According to the review of the GPs and conferences and workshops, solutions using satellite technology have been tested or adopted in a definitive/semi-definitive way to solve the problem of Urban Heat Islands, air quality monitoring, environmental sustainability and climate change applied to the preservation of the vegetation. It is also increasing the demand for satellite-bases solutions for the Health sector in relations to the principle that healthcare should be accessible by everyone through every means, as also targeted by the SDG 3- Good Health and Well-Being. [13]

While traditional fields seem to be more resistant in adopting and/or implementing technological solutions, the tourism, culture and leisure are approaching technology in a different way. There is a certain interest in this sector, where EO, Satellite Navigation and Telecommunications are supporting the creation of mobile apps to enhance the cultural and the touristic experiences. It is common today to see EO or Satellite Navigation data included in apps that helps the promotion of green tourism rather than outdoor games. An increasing trend is to combine satellite technologies with 3D and Augmented Reality.

Energy, Infrastructure and Utilities is also a field where satellite-based applications are easily included in bigger projects as supportive tools. The "smart cities" category embraces the concept of making cities sustainable and citizen-friendly. For this reason, the fields mentioned above see the adoption of satellite-based technologies for citizen engagement activities.

Finally, around the topic of transport and logistics Eurisy has been able to categorise case studies focused on the use of satellite applications for public transportation, fuel consumption, flight safety and traffic optimisation also in relations to smart mobility and pollution/air quality.

3.4 The adopted Satellite Technology

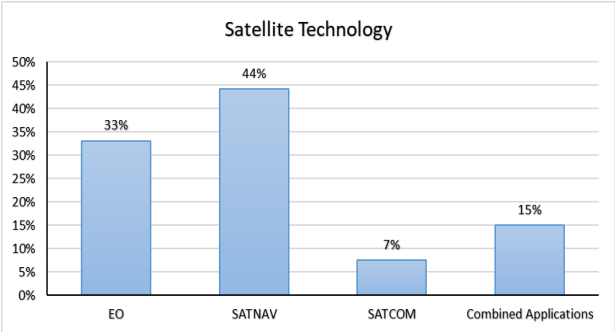

Fig.4. Categorisation of the Satellite Technology adopted by end-users. Eurisy data and elaboration.

After looking at the areas of applications, it is interesting to analyse Satellite Technology and data integrated in the aforementioned sectors. The main technology adopted is Satellite Navigation, followed by Earth Observation, the combination of different applications and finally Satellite Communication.

SatNav seems to be the most used technology. The Global Navigation Satellite Systems (GNSS) allows users to pinpoint their locations at any moment. The advantages related to GNSS can be found in the numerous applications. Examples are mainly on the optimisation of transport in cities or to favour the use of alternative means of transportation in cities or for touristic purposes. The successful integration of GNSS compared to other satellite technologies, is due to a better knowledge of the benefits deriving from its applications, a major awareness deriving from the integration of GNSS technology in mobile devices, that makes GNSS more accessible and understandable by the general public. According to the GNSS Market Report issued by the European Global Navigation System Agency (GSA), in 2017 smartphones account for almost 80% of the global installed base of GNSS devices. [14]

Such percentage explained clearly why it is easier to use a technology as the GNSS compared to others. Globally, the GNSS downstream market grew by more than 6% in 2015 and it is expected to grow at this pace until 2020. The consequence on the downstream market led to a growth of 20% annually. This segment of the market may continue to grow, especially in Europe, where the operational phases of Galileo and Copernicus are leading to a more concrete use of space data. With the full deployment of Galileo in 2020, the European GNSS, the number of users will increase even more. [15]

Differently, Satellite Earth Observation is less used. EO is still highly conceived as an "expert" technology, complicated to use because it needs specific knowledge, expertise and funds. On the last points, it can be affirmed that the commercialisation of EO offers different solutions to the users, but if there is no in-house expertise, the use of EO and the solutions offered remain limited and adoptable exclusively by experts. Nevertheless, the commercial EO data market it is expanding at a global level. As said, the advent of Copernicus [16] is slowly changing the approach toward EO, both implementing a full, free and open data policy that can be tailored to the needs of the users, and offering to potential users training on how to use the DIAS. Still, EO remains a technology mostly preferred by institutional actors, at national and international level, rather than at local level. In different cases it has been observed that similar results to satellite based imagery can be obtained by using other means as drones, easier to use and less expensive.

Satellite Communication is by far the largest services market. Only in 2017 the revenues generated in the downstream segment amount to 80% [17]. The market is focused on the management of the end user segment, leveraging the capabilities of the network infrastructures. The user communities in Eurisy's study showed less interest toward the use of SatComs. However, it proves its importance in rural areas, where connectivity represents an issue that has negative consequences to the development of those areas. To bridge the existing digital divide, SatComs has proved in some cases its effectiveness. At the same time, the integration of SatCom technology is relevant to the health sector, to support telemedicine initiatives, and in the search and rescue field. In combination with SatNav, SatCom technology provides support to search and rescue operations in the alpine region or the maritime field. This last application, is now central in the public debate, considering the numerous incidents during winter and summer time on the mountains.

4. Eurisy model replicability outside Europe

The mission of Eurisy is to help the creation of strong relations between the civil society and the space actors, working on four main aspects:

- *Awareness raising*. Eurisy works on raising awareness on emerging satellite applications that could help professional communities in different fields of application (health, risk management, climate change, etc.)
- *End-users Support.* The organisation offers support to end-users of satellite applications by leveraging its network to make available experience and expertise for them.
- *Decision-making process.* On the basis of the findings and the field work with end-users, Eurisy provides feedback to decision-makers on possible measures to overcome obstacles to the diffusion of space-based innovation in society.
- *Market Knowledge*. Adopting a user-centred approach, Eurisy is also helping to stimulate the market for satellite applications.

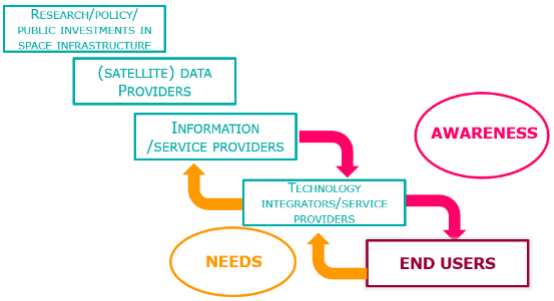

Fig. 5. Eurisy Value Chain. Eurisy elaboration.

Raising awareness and the open dialogue with decision –makers is fundamental to reach both end-user communities and space actors, namely service providers, and finally politicians. Recently, some space agencies are trying to create the conditions to improve such interactions, through dedicated programmes like the ESA Business Applications. But still there are some barriers that need to be overcome to make space not a closed sector, but to transform it into a non-space friendly one.

This existing barriers are mostly related to the lack of resources, both financial and human. The lack of financial resources is the main obstacle in the quest for innovative solutions. When the financial resources are available, there may be a lack of in-house expertise and

infrastructures combined with no trust towards these solutions. This last point, is especially true considering the absence of political frameworks and the misconception that space is only scientific. All these barriers are intertwined, and for this reason it is hard to convince the non-space actors about the benefits deriving from the adoption or integration of satellite technology into economic or social activities.

On the other side, service providers are slowly turning their attention towards a more direct approach and relation with the end-users. The technical knowledge of service providers represents a key for the end-users that want to invest in space-based solutions, but this is not enough. When talking about certain services, once the needs are identified, it is necessary to examine the real return of their investments: it is fundamental to explain how the proposed solution could be effective for a specific challenge, how much this would cost and the benefits for society, assessing also the positive impact that might be recorded on the job market.

The Eurisy model adopts this bottom-up approach, putting the end-users at the centre. [18] One added value of the work is the adoption of a clear language that demonstrates mainly the benefits for the final users without using technical words. Over the years, this approach has favoured the interactions between different end-users' communities and service providers, supporting the evolution of a downstream sector, oriented towards applications rather than the infrastructures. This has been possible through the definition of a strategy adapted to the field of its research, using human interaction as the main tool to further develop studies, researches and policy recommendations to be addressed to European and local politicians.

Nevertheless, it is important to break certain prejudices. In general, it can be said that the Eurisy approach has proved to be effective to support the implementation of innovative solutions for the well-being of the European society.

Such an approach represents an innovative way to include civil society in the decision-making process for both the space and political sectors. The collection and identification of needs is fundamental to understand how to find appropriate solutions and to address investments to support the integration of space-based technologies into non-space sectors. Working directly with society requires the adoption of a technology-pull approach that differs from technology-push, a feature of the space sector.

The technology-push approach is suitable in contexts where a downstream sector exists already, and there is a favourable ecosystem for innovation. For emerging space nations, this is not always applicable due to the lack of infrastructures or of a mature enough industrial background. In these cases, the bottom-up approach is key in representing societal needs. NGOs can help in developing a dialogue platform to help civil society to meet the supply of the space sector.

As outlined by the draft of the United Nations Space2030 Agenda, space needs to be seen differently as it is now within and outside the UN system. It is underlined that space could serve as a tool to support the fulfilment of the United Nations Agenda2030. [19] The model developed by Eurisy would be beneficial, also in the framework of the SDGs, especially the SDG 8-Decent Work and Economic Growth, SDG 9-Innovation, Industry and Infrastructure, SDG 11-Sustainable Cities and Communities. [20]

The advantages of working directly with society should result in a better channelling of the allocation of resources from the space sector and a clear vision of the returns for the end-users. Such an objective can be achieved through the involvement of regional and local actors, able to understand what could be advantageous to the population and would maximise the output of certain sectors, supporting the development of a downstream market. [21]

A suggestion to "export" and adapt the model put in place by Eurisy to the context, is the creation of a dialogue with service providers, crucial to this interaction, to assess what would favour the replicability of the solutions in the future. Such a capacity building oriented initiative, has the advantage of stimulating the technology readiness level of the country, boosting collaboration with other regions or other user communities.

5. Conclusions

In conclusion, to help society to become fully aware about the potential deriving from the use of satellite-based technologies, it is important to map the user needs to create a dialogue both with the space community and the non-space one. It is, then, important to present the potential return of the investments, demonstrating the benefits they will have, not just the technical aspects. Space Agencies should act as the main source of information about financial opportunities and offering technical support by offering learning courses aimed at supporting technical officers in public and local institutions, or non-space related start-ups/SMEs how to deal with data and to integrate the technology.

Policy and decision-makers should be participating more to space events and conferences, that should serve as platform to connect politicians and space representatives to work jointly on concrete solutions, that would encourage the take-up of satellite-based solutions.

Once these mechanisms have been implemented and tested, it would be useful to create a capacity building initiative that aims at showing such model to public regional and local authorities outside the European borders, to demonstrate that space is really for all.

Acknowledgements

Eurisy would like to acknowledge the support of all its members and partners. Thanks to them it has been possible to set up a database of use cases that, we hope, will be useful for the future use cases communities. We would like to acknowledge the users and service providers that trusted us over the past thirty years.

Acronyms/Abbreviations

AML Advanced Mobile Location
DIAS Data and Information Access Services
EC European Commission
EENA European Emergency Number Association
EO Earth Observation
EU European Union
GDP Gross Domestic Product
GNSS Global Navigation Satellite System
GP Good Practice
GSA European GNSS Agency
NGO Non-Governmental Organisation
SATCOM Satellite Communication
SATNAV Satellite Navigation
SDGs Sustainable Development Goals
SMEs Small and Medium Enterprises
TRL Technology Readiness Level

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