Investigating the Global Socio-Economic Benefits of Satellite Industry and Remote Sensing Applications

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Abstract

In recent years we have seen a growth in the revenues and investments of satellite industry. Originally, satellites, remote sensing (RS), and other navigations systems were only employed for government and military purposes. However, in the past two decades there has been an increase use of these tools for commercial purposes. In particular, satellites and RS can be used for space and earth observations, support military operations, precision agriculture, meteorological forecasting, communication and internet connectivity to lesser-known applications such as in transport tracking and monitoring of utility networks. In this paper, we analyse the current trends, benefits and limitations of the use of satellites and RS. In particular, we try to identify the main socio-economic benefits deriving from the use of RS in several sectors. We also seek to introduce economists to the science of RS data, and give a flavour of how this new fountain of data can be utilized so far and what might be done in the future.

Keywords: satellite industry, remote sensing, socio-economic benefits, satellite industry revenues

Introduction

Space has always been an engine for innovation (Flemish Space Industry (2018)). Space inspired us to cross limits of the possible and walk into the impossible. Exploring and observing the space allowed us to discover the solar system and asteroids, study the nature of Dark Matter, acquire images of earthquake and tsunami, monitor lakes and rivers and watch the world's see traffic (NASA (2017); Space Station Research and Technology (2017)). These observations have had a massive impact on our lives. For instance, it has improved our understanding of climate, forecasting the weather, assessing environmental hazards and managing natural resources. However, most of the benefits arisen from space observations are still unknown and difficult to quantify due to intangible and long-term factors. The goal of this paper is to provide a critical literature review of the current trends, benefits and limitations of the use of satellite industry and remote sensing (RS). We identify if and how satellite and in particular RS improve our life, and what are the main socio-economic benefits deriving from the use of RS in several sectors, including but not limited to the smart and precision agriculture, universal navigation, meteorological forecasting, broadcast of live television and internet connectivity to lesser-known applications such as in transport tracking, resource extraction and monitoring of utility networks.

The paper is organized as follows. In section 2, the employed methodology is described. In section 3, we analyse the economic aspect of the satellite industry and the main application of satellites. In section 4, we illustrate and classify the remote sensing applications in different sectors. In the final section, the conclusions and limitations of the employed study are discussed.

Methodology

The bibliographic research can be divided in two steps. In the first step, we searched information about Satellite Industry and RS in the main federal, government and private space agencies and associations (e.g. NASA, Space Foundation). In the second step, only peer-reviewed or blind-reviewed academic books and papers were examined. To access to the content of the articles, two different and main were used: Scopus and Web of Science. The papers were selected using different keywords (e.g. satellite industry, economic benefits of satellites, remote sensing). Next, papers were selected on the base of title and abstract. The papers selected belongs to journals from several domains: Economic (e.g. Journal of Political Economy, Journal of Economic Perspectives), Management (e.g. Journal of Innovation Economics & Management), Agriculture (e.g. American Journal of Agricultural and Biological Sciences), Remote Sensing (Remote Sensing), Other (e.g. Atmospheric Measurement Techniques, Journal of Applied Ecology) and Conference (e.g. Proceedings of National Conference on Development & Planning for Drought Prone Areas).

Satellite Industry

Satellite industry is an important part of the space economy. More than 76.82% of the world space economy turnover came from the satellite industry (Barbaroux (2016); Satellite Industry Association (2017)), such as the combination of satellite services, satellite manufacturing, satellite launch services and satellite ground equipment (NASA (2017); Space Station Research and Technology (2017)). In particular, the global satellite industry revenues increased from 122 billion dollars in 2005 to 206.5 billion dollars in 2016, approximately by 1.6% in nine years (Figure 1 and 2), even though more than 44% of the satellite global industry is served by the NASA. The global satellite industry growth was 2% in 2016, below worldwide economic growth (3.1%) and slightly above the U.S. growth (1.6%) (Satellite Industry Association (2017)). More importantly, the forecasts of several governmental and no-governmental agencies and research institutes (e.g. Space Foundation, NASA, European GNSS Agency, New Zealand space agency, and Satellite Industry Association) show that the satellite industry will continue to demonstrate steady and consistent growth. This growth has also a positive effect on employment rates. In fact, satellite industry and Earth operations require workers in many different occupations, such as scientists, engineers, technicians, media and communications

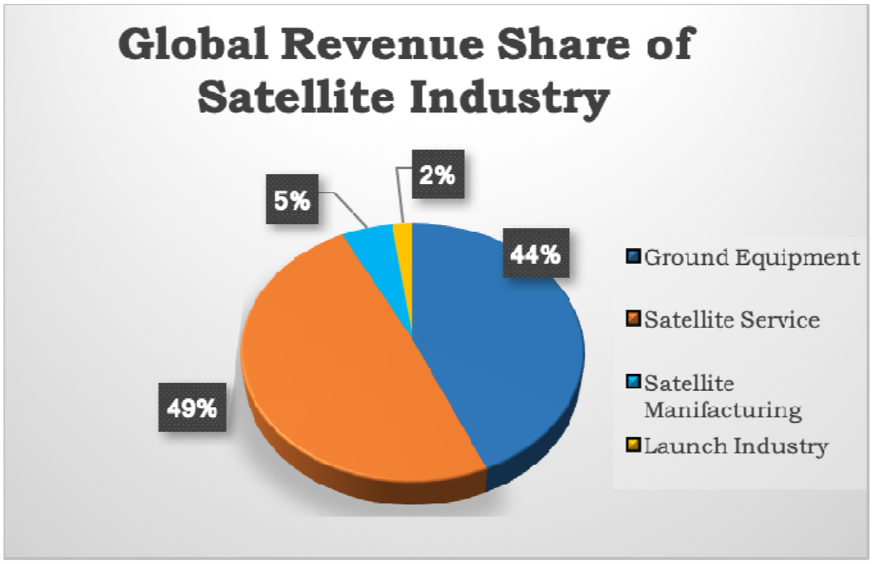

Fig. 1: The global revenues of the satellite industry were 206.5 billion dollars in 2016. The pie chart shows how each sector of the Satellite Industry contributes to the Global Revenue.

and photographers. For instance, employment of aerospace engineers is projected to grow 6% from 2016 to 2026 in USA (Bureau of Labor Statistics (2018)). The median annual wage for aerospace engineers was 113,030 dollars in May 2017 (Bureau of Labor Statistics (2018)). Federal agencies such as NASA employ more than 17,000 workers (Angeles and Vilorio (2016)). Other government agencies, such as U.S. Department of Defense, the Federal Communications Commission, and the National Science Foundation, also employ workers in space-related occupations (Angeles and Vilorio (2016)). Finally, private companies, including those that contract with federal agencies, employ workers in industries such as aerospace product and parts manufacturing and scientific research and development services (Angeles and Vilorio (2016)). For example, space research and technology in Harris County, Texas employed 2,920 in March 2016, with average weekly wages of about 2,540 dollars.

The global number of satellites lunched is increasing rapidly in the past 7 years. According to the 2018 Index of Objects Launched into Outer Space provided by the United Nations Office for Outer Space Affairs (UNOOSA), 8,126 objects have been launched into space in human history, and over 22% of these were lunched within the last eight years alone. Currently, there are 4,857 satellites orbiting the planet (1,980 of those are active) —an increase of almost 5% in the last five years. Only at the beginning of 2018, UNOOSA has recorded 204 objects launched into space. In total, there are 81 countries with operators represented by at least one satellite, even if some of them are part of regional consortia (UNOOSA (2018)). USA has the highest number of satellites (859). Followed by China with 250 and Russia with 146 (UNOOSA (2018)). Other countries such as Japan (72), India (55) and the UK (52) also have a large number of satellites (UNOOSA (2018)). At least other 19 countries have, or are planning to host spaceports for orbital or suborbital launches (Facchinetti (2016)). Although sometimes, satellites are also launched by institutions and organisations that represent continents such as the European Space Agency.

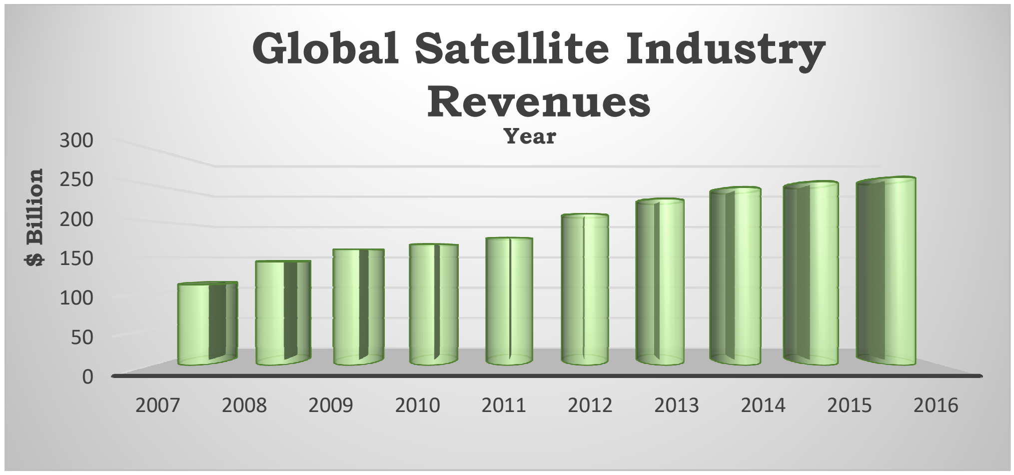

Fig. 2: The figure shows the global satellite industry revenues between 2007 and 2016.

Applications of Satellites

Analysing the countries involved in the satellite industry is certainly relevant, however we believe that it is not sufficient to define the potential and large-scale benefit of the use of satellite. Thus, we tried to examine the main actors involved in the satellite industry and the main usages of satellites. From the past experiences, we identify that satellites can be used for three main reasons: government, military and commercial purposes.

Satellite uses by government are almost 700 (UNOOSA (2018)). Government satellite activities are military or civil activities such as Earth observation, navigation, and science and technology development (Bryce Space and Technology (2017); Satellite Industry Association (2017)). For instance, satellites provide information about Earth's clouds, oceans, land, air, wildfires, volcanoes, stars, asteroids, comets, and planets exploration including (NASA (2017); Space Station Research and Technology (2017)). Satellites recognize earth observation images, such as the Katrina hurricane prediction at U.S. coast. The data captured by the NOAA GOES satellites, serve to illustrate the danger of these enormous storms. They bring a clear benefit by predicting damages to the U.S. government in general, and accurate prediction of severe weather can help to address the economic and social costs of weather-related damages (Hertzfeld and Williamson (2007)).

Military forces (e.g. Ministries of Defence, Air Forces, Defence Acquisition Agencies) use about 400 satellites, almost 20% of the all active ones (Barbaroux (2016); UNOOSA (2018)). In particular, satellites are used for surveillance, imagery and communications. Various satellite applications such as RS, communications systems, and GPS can be utilized in the War on Terror to facilitate and support military operations and intelligence gathering (Lee and Steel (2014)). Regarding secure communications worldwide, military satellites provide low data rate communications for voice and data at 75 bps to 2,400 bps and medium data rate communications at 4.8 kbps to 1.544 mbps (price tag of 800 million dollars) (Lee and Steele (2014)). Instead, RS data has been used in order to gathering visible light for photography, recording imagery in those parts of the spectra, scanning the surface of the Earth, detecting and record radio, telephone, and data transmissions on the Earth and transmissions relayed by communications satellites (Lee and Steele (2014)).

Before the 21st century, satellites were entirely used for military and government purposes. However, the past two decades revealed a significant decrease in military orders together with a growing importance of commercial and non-government demands for satellite technology (Barbaroux (2016)). Nowadays, 41.7% of the active satellites (826 in total) is used for commercial purposes (particularly from start-up companies, UNOOSA (2018)). The commercial services and products that satellites provide are radio and television broadcasting, broadband connections, navigation aeronautical and nautical system for organisations and people around the world (Bryce Space and Technology (2018);

Pham (2013)). Satellites can also be used to improve mobile connections and communications as well as location-based services (LBS) for smartphones, tablets, laptops and people tracking devices (Pham (2013)). The use of satellites is also increasing in order to improve data traffic and to support wireless networks connections and requirements. In fact, the rapid growing data traffic brings increasing pressure to the wireless networks, which is predicted to increase by over 10,000 times in the next 20 years (Kuang et al (2018)). Communication and Internet providers are increasingly bonded to guarantee continuous data connection in order to support services such as Machine-to-Machine communication and Internet of Things. Existing terrestrial wireless networks are not able to support these services, considering the deficiency in ubiquitous on-demand coverage (Kuang et al (2018)). Satellites could be used to increase networks coverage and requirements for rural, remote and other not-well-connected areas. In the next future, terrestrial networks will be used to achieve high-speed data service at low cost, instead satellites will be used to cover an area with a radius of thousands of kilometres, providing coverage to otherwise inaccessible locations (Kuang et al (2018)).

Overall the consumer equipment for satellite TV, radio, broadband, and mobile satellite terminals revenues is increasing (1% growth in 2016) (Satellite Industry Association (2017)). In particular, satellite radio and consumer satellite broadband posted 10% and 3% growth respectively in the consumer services segment, while more mature satellite TV stayed flat in 2016 (Satellite Industry Association (2017)). However, satellite TV services still account for 77% of all satellite services revenues (97.7 billion dollars) with up to 220 million satellite pay-TV subscribers worldwide, driven by demand in emerging markets (Satellite Industry Association (2017)).

Remote Sensing (RS)

Earth observation applications mainly designate RS capabilities, distant, on-orbit, and earth surveillance (Lodgson (2011); Morel (2013)). Earth observation and RS services revenues grew 11% only in 2016, thus it is forecasted that Earth observation will take the lead with 73% of the applications market in the future research (Satellite Industry Association (2017); International Space Safety Foundation (2018)). RS can be defined as "*the science of observation from a distance*" (Barrett and Curtis (1999)). RS and Earth observing satellites maximize our understanding about environment and provide some global perspectives on developments. RS can be utilized in different fields, such as medicine (diagnosis and surgery), industry (quality control of products), and viticulture (monitoring and managing variations in productivity within single vineyard blocks) (Barrett and Curtis (1999); Hall et al (2002)). According to the Satellite Industry Association (2017), the continued growth is due to established satellite RS companies with new entrants reporting revenue, whereas the largest revenue growth occurred in defence, intelligence and in the sectors of energy and natural resources, allowing for pre-planning and management.

Dave and Adam (2016) report that the main advantages of RS data to economists are divided into three categories: 1) Access to information difficult to obtain by other means, 2) Unusually high spatial resolution, and 3) Wide geographic coverage. Firstly, RS technology provides panel data at low marginal cost, repeatedly, and at large scale on proxies for a wide range of hard-to-measure characteristics. Secondly, RS data sources are typically available at a substantially higher degree of spatial resolution than traditional data. Much of the publicly available satellite imagery used by economists provide readings for each of the hundreds of billions of 30-meter-by-30-meter grid cells of land surface on Earth. Thirdly, RS data provide wide geographic coverage. Using RS, scientists can study data that have been collected in a consistent manner—without regard for local events like political strife or natural disasters—across borders and with uniform spatial sampling on every inhabited continent. Equally important, many research satellites offer substantial temporal coverage, capturing data from the same location at weekly or even daily frequency for several decades and counting. Such as this aspect of RS works on the economic impacts of climate change and agriculture (Costinot et al (2016)).

RS Applications in Different Sectors

Remote sensing technology generates and encompasses a wide variety of data, for speed, types and velocity. Thus, the processing and interpretation of RS data have specific uses within various fields of study, for instance agriculture, geology and forestry (Alvino and Marino (2017), Barrett and Curtis (1999), Navalgund et al (2007)).

Based on our finding, we identified four main area of application of Remote Sensing technology. We argue that RS can be used for 1) *Military Surveillance*, 2) *Environment*, 3) *Human activities* and 4) *Environmental and Illegal Issues Caused by Human Activities* (see Table 1).

Firstly, an important area of application of RS system is Military surveillance. RS systems are often used for military purposes, in order to improve organization, strategic, tactical, and logistic functions of military organizations (Hudston et al (1975)). RS can help to spy on enemies, to create 3D maps of uranium enrichment site and to spot undeclared nuclear power plants (e.g. India) and (Lee and Steele (2014)). RS can also help to identify intercontinental ballistic missile launches, methods for the detection of atmospheric contaminants, such as poison gas, under field conditions, aids for the precision delivery of weaponry (including passive, active, and laser designator guidance techniques), and sensor systems for reconnaissance and surveillance (Lee and Steele (2014)).

Secondly, RS system are used to study several environmental issues. RS can help to improve our understanding of weather forecast or help researchers and companies in more complex tasks such as assessing and managing natural resources, extracting mineral deposits and more importantly monitoring climate changing. Over the last century, forest covers of the world have declined at an alarming rate. With the help of RS data, governments and researchers can generate information with regards to forest cover, types of forest present within the area of the study, human encroachment into forest land/protected areas, encroachment of desert like conditions and so on (Oisebe (2012)).

Thirdly, RS can be used to improve several human actives in different fields (we refer to activities that can be accomplished only thought human actions). For instance, in agriculture, RS can be in both precision agriculture and farming. In fact, RS data used provides a synoptic view and multi-temporal data for land use and land cover mapping. Thus, RS can help researchers and governments by giving a quicker and cost effective analysis for various applications with accuracy for planning (Prakasam (2010)). RS data can also use in construction (map updating, city modelling, urban growth analysis, change monitoring) (Khoshelham et al (2010)) or in urban land use management. RS provide benefits for on fundamental observations of urban encroachment and environmental monitoring that are not available from other sources (Batty and Howes (2001)).

Finally, RS system can be used to monitor illegal actions that have an impact on both environment or human activities. Illegal actives (e.g. sex trade and illegal forest cutting) are usually performed in remote areas or at night (night lights), thus it is really difficult for police or federal agencies be able to identify with traditional tools. Instead, RS system records visible and near-infrared light from clouds and the Earth’s surface at night (Li et al (2017)). The geospatial time series of data generated by RS can be a valuable source for locate criminal activity.

Table 1: RS major remote area applications

Application(s)		**Literature**
Military Surveillance		
	- 3D mapping at uranium enrichment site - Observing darker North Korea - Spotting undeclared nuclear power plants	Lee, R. L. and Steele, S (2014), ‘Military Use of Satellite Communications, Remote Sensing, and Global Positioning Systems in the War on Terror’, *Journal of Air Law* & Commerce, 69. Hudson, R. D. and Hudson, J. W. (1975). ‘The

	- Spying on enemies - Infrared laser guidance for weapon delivery	military applications of remote sensing by infrared'. Proceedings of the IEEE, 63(1), 104-28.
Environment		
Climate change	- Boreal forest loss - Calculating snow pack (depth) - Climatic factors, from past to present - Coral reefs - Desert blooms - Examine soil condition - Salinity - Forecasting weather	Garcia, L., Eldeiry, A. and Elhaddad, A. (2005). 'Estimating soil salinity using remote sensing data'. Proceedings of the Central Plains Irrigation Conference. Delincé J., Ciaian, P. and Witzke, H.P. (2015), 'Economic impacts of climate change on agriculture: the AgMIP approach'. *Jornal of Applied Remote Sensing,* 9(1).
Health	- Assessment of drought - Classify land capability - Change shoreline and coastal erosion - Conserving lakes and rivers, wetlands - Counting polar bears to ensure sustainable population levels	Sumner, D. A., Hanak, E., Mount, J., Medellín-Azuara, J., Lund, J. R., Howitt, R. E. and MacEwan, D. (2015), 'ARE Update'. *The Economics of the Drought for California Food and Agriculture,* 1(16).
Mining and Petroleum	- Extracting mineral deposits - Coal Mine Fire	Bedell, R., Crósta, A. P., and Grunsky, E. R. I. C. (2009). 'Remote sensing and spectral geology'. *Reviews in Economic Geology*, 16, 266.
Pollution	- Carbon, Nutrient, Water footprints - Detecting oil spills for marine life and environment preservation - Monitoring Water Pollution - Observing groundwater activities in well	Network, W.F. 2014. Energising the drops: Towards a holistic approach to carbon & water footprint assessment. Water Footprint Network Report.
Resources	- Environmental Impact Analysis (EIA) - Monitoring sediment transport: - Picking signals from submarines underneath waters	Vorovencii, I. (2011) 'Satellite remote sensing in environmental impact assessment: an overview'. Bulletin of the Transilvania University of Braşov Series II: Forestry, Wood Industry, *Agricultural Food Engineering,* 4(53).
Human activities		
Agriculture	- Precision farming - Precision Irrigation	Liaghat, S., & Balasundram, S. K. (2010). 'A Review: The Role of Remote Sensing in Precision Agriculture'. *American Journal of Agricultural and Biological Sciences,* 5(1), 50-55.
Archaeology and Prehistory	- Discovering ancient archaeological sites - Landsat image has been useful for providing evidence of ancient Mega Lake	Bini, M., Isola, I., Zanchetta, G., Ribolini, A., Ciampalini, A., Baneschi, I. and D'Agata, A. L. (2018), 'Identification of leveled archeological mounds (Höyük) in the Alluvial plain of the Ceyhan River (Southern Turkey) by satellite remote-sensing analyses'. *Remote Sensing*, 10(2), 241.

Constructions	- Dam Construction	Tchotsoua, M., Moussa, A., and Fotsing, J. M. (2008), 'The socio-economic downstream impact of large dams: A case study from an evaluation of flooding risks in the Benue River Basin downstream of the Lagdo Dam (Cameroon)'. *GEFAME Journal of African Studies*, 5(1).
Fisheries	- Catching fish and improving long-term fisheries sustainability	Sala, E., Mayorga, J., Costello, C., Kroodsma, D., Palomares, M.L., Pauly, D., Sumaila, U.R. and Zeller, D. (2018), 'The economics of fishing the high seas'. *Science advances*, 4(6), eaat2504.
Forestry	- Estimating forest supplies - Forest Inventory and forest trends - Preventing spread of forest disease	Maher, J., and Song, X. (2013), 'Linking Remote Sensing and Economics: Evaluating the Effectiveness of Protected Areas in Reducing Tropical Deforestation'. Annual Meeting, Washington, DC, August 4-6, 2013.
Housing	- Complete view of real estate - Planning black diamond ski runs -Assess economic contribution of Space Solar Power	Stubkjær, E. (2004). "Satellite accounting of housing and real estate affairs–The Case of Denmark". COST G9 6th Workshop, Riga, 14-16 October, 1-19. Macauley, M. K. and Davis. J. F. (2001). 'An Economic Assessment of Space Solar Power as a Source of Electricity for Space-Based Activities'. *Space Policy*, 18(1), 45-55.
Insurance	- Charging higher insurance premiums in flood prone areas	Averett, N., and Jarbeau, S. (2017), "County-Wide Collaboration Reduces Flood Risks and Insurance Rates". *U.S Climate Resilience Toolkit*.
Transportation	- Assessment of fuel economy - Building base map for visual reference - Counting cars in parking lots - Improving air traffic control - Navigating ships	O'Neil-Dunne, J. (2015), "Do We Have Enough Parking? A Remote-Sensing Approach to Parking Inventory". *Earth Imaging Journal*.
Environmental and Illegal Issues Caused by Human Activities		
Emergency, disaster monitoring and disaster management	- Controlling forest fires - Creating automatic road networks - Cyclone aftermath - Forecasting weather to warn about natural disasters - Identification of volcanic hazard - Mapping fire prevention - Mapping out ocean floors - Measuring protest size - Monitoring active volcanoes and ash - Monitoring economic night activities Searching crashed aircrafts	Michael Y., Lensky, I., Brenner, S., Tchetchik, A., Tessler, N. and Helman, D. (2018), 'Economic Assessment of Fire Damage to Urban Forest in the Wildland–Urban Interface Using Planet Satellites Constellation Images'. *Remote Sensing*, 10(9), 1479. y Silva, Martínez, J.R.M. and Soto, M.C. (2013). 'Methodological approach for assessing the economic impact of forest fires using MODIS remote sensing images'. Proceedings of the fourth international symposium on fire economics, planning, and policy: climate change and wildfires. General Technical Report, 245, 281-295.
Health of populations	- Deriving factors contributing in poverty	GRIPS Development Forum (2003), "Linking Economic Growth and Poverty Reduction.

	- Population growth in urban areas - Predicting famine - Restricting diseases from spreading in epidemiology	Large-Scale Infrastructure in the Context of Vietnam's CPRGS". Meeting for Vietnam, 19-21 June. Shoko et al (2015), 'In-depth analysis of the impacts of rural population growth on the natural environment: a GIS and remote sensing approach'. *Transactions of the Royal Society of South Africa*. 70(2), 149-153
Monitoring of illegal activities, Fiscal control	- Catching tax-evaders red-handed by locating new construction and building alterations - Doing the detective work for fraudulent crop insurance claims - Figuring out fraud insurance claims	Hanson G., Lin, A., Block, J., Ganapathy, V., Khandelwal, A. and Schochet, A. (2019). "Measuring Economic Impact with High-Resolution Satellite Data". *Policy design and evaluation lab.* Hansen-Lewis, J. and Shapiro, J.N. (2015), 'Understanding the Daesh economy'. *Perspectives on Terrorism*, 9(4), 142-155.

Conclusion and limitations

Earth observation has had a massive impact on our lives. These observations have changed –and are still changing–human knowledge, pushing the boundaries and addressing fundamental questions about our planet and the history of human.

In this paper, we analyse the economic trends and composition of the satellites industry. We conclude that the worldwide turnover and economic growth of the satellite industry-as well as the global number of satellites lunched in the space- is increasing. Satellites industry contributes to industrial and governmental economies worldwide (206.5 billion dollars in 2016), creating direct and indirect jobs (e.g. researchers, engineers, technicians, etc.). Satellite industry has driven scientific and technological innovations that benefit people around the globe every day. In fact, satellites have improved our understanding of climate, forecasting the weather, assessing environmental hazards and managing natural resources, radio and television broadcasting, communication and increasing networks coverage and requirements (e.g. Machine-to-Machine communication and Internet of Things).

We also examine how the satellite industry contributes to deliver value by providing a central point for industry, defence and government entities. We identify three main applications of satellites: governmental, military and commercial uses. Initially, satellites were used only for government and military purposes. In recent years, private and commercial satellites become a significant provider of satellite services. In fact, almost 42% of the total satellites is used for commercial purposes. Even tough, satellites are used mainly for commercial purposes, we conclude that satellite industry embeds a large variety of application fields that are at the edge of government, military and commercial purposes.

In this paper, we also focus on Remote Sensing (RS) technologies, as part the Earth observation. We investigate the socio-economic benefits of RS applications, in particular we identify the main RS applications in different sectors.

The RS systems utilize sensors and instruments that produce a huge amount of data at different scales (temporal and spatial) and distances from the target. RS systems can maximize our understanding about environment and provide some global perspectives on developments. RS data can provide access to information difficult to obtain by other means, using high spatial resolution and wide geographic coverage. Hence, RS data compared to other systems allow to reduce costs as well as to provide that data that are more accurate, constantly trackable, superior quality resolution and higher traffic. In particular, we identify four different area of applications in which the use of RS has contributed to improve academic, industrial, military and governmental operations such as Military surveillance (e.g. spotting undeclared nuclear power plants, spying on enemies), Environment (e.g. climate changes, pollutions monitoring, natural resources), Human activities (e.g. agriculture, archaeology and prehistory, constructions), Environmental and illegal Issues Caused by Human Activities (e.g. health of populations, monitoring of illegal activities, fiscal control).

We conclude that RS systems can substantially improve our knowledge of Earth phenomena, monitoring resources and improving our prediction of natural disasters and treats in different sectors. In fact, RS can contribute to manage processes and resource assessment in an easier, safer, and cost-effective way.

Limitations and Future Work

This study has a certain number of limitations. In this paper, we did not consider the costs related to the use of satellites industry and RS systems. Future research could try to investigate the main costs related to the construction and lunch of satellites. Moreover, it would be useful try to estimate the costs of the satellites lunched into the space but currently not in use. We also did not examine the main advantages related to the non-satellite industry, as part of the space economy. Future studies could try to identify the socio-economic benefits of the non-satellite industry, plus investigating the main differences between satellites and non-satellites industry.

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