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Space Economy: an Opportunity for Sustainability

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ABSTRACT

This thesis focuses on the adoption of new technological opportunities offered by the so-called 'space economy' to increase the sustainability of the value chain.

Many global issues today influence value chain efficiency, turning corporate sustainability into an imperative.

Rapid changes make the act of monitoring a fundamental challenge to succeed in the current dynamic, hasty world.

Space economy can be the basis for a strategic approach to the monitoring of many global risks currently affecting the business landscape, thereby contributing to the achievement of the Sustainable Development Goals.

This thesis focuses on the possible role of space technologies, on their business applications and on the increases to all societal and economic benefits they can bring. It presents concrete examples of cutting-edge companies leveraging satellites and Earth Observation to heighten their sustainability degree.

The thesis also presents the business idea for a new feasible, commercial service that utilises satellites technologies and contributes to Agenda2030. This is Sky-I: a start-up to monitor suppliers around the world.

Sky-I Business Model Canvas has been designed in order to be ready for implementation, although the required technology is still under development. The company mission is to monitor the CO_2 emissions of other companies in the supply chain, carrying significant implications for the environment, society, and the economy. It thus contributes to a new, more interconnected, future-oriented world, where sustainability is of the essence.

Joining space economy and sustainability can therefore be the perfect equation, as outlined in the text.

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1. Global risks affecting business landscape

1.1 Challenging issues influencing value chain efficiency

Reaching Global Sustainable Development Goals before 2030 seems harder & harder. In a reality where people continuously alter their viewpoints and behaviours, managing issues is something very arduous and challenging to do. Constant change is, in itself, the very driver of this complexity. Nowadays, it is crucial to find innovative solutions to achieve significant levels of sustainability in all existing business sectors. However, the answer may well be found in the sky: space technologies could provide the key.

Global risks must be avoided because for many different industries they will generate significant negative consequences in a decade. Many global issues are becoming always more evident, and everything is more complex than in the past. Government policies and norms aiming at achieving international standards result in increased consumer prices, while earnings for employers decrease. In this day and age, the planet is trying to move towards a greener world which sometimes, looking at the global safeguard, limits the producers' revenues. New economic, demographic and technological forces lead to changes in command and authorities. Nationalist policies are booming, resulting in an unsettled geopolitical scenery, higher trade barriers, lower fiscal prudence, and less global investment. Unfortunately, international capitalism has in part negatively affected the global economy: It has led to saturation in developed markets, broadened disparities between rich and poor, and increased environmental degradation. Therefore, since then, sustainability has been deemed as a way to improve societal and environmental performance (Hart and Milstein, 2003).

As in the past, when advanced technology, globalization and the revolution of communication have led to new paradigms and to new ways of living life, current challenges also bring new outcomes and developments. These are accompanied by shifts in the ways of doing management and business. The traditional management paradigms of Fayol, Taylor and Weber, which were characterized by centralized decision-making processes and hierarchical communication channels, have been replaced by open

networking organizations, learning by doing ideology, and collaborative forms of power and teamwork (Jamali, 2004). There has been a change from mass to lean production, with the introduction of an integrated form of marketing (Clarke and Clegg, 2000). The objectives of cutting costs, rule compliance, respect for hierarchy and the division of labour into specialized jobs, have been surpassed by a longing for variation, flexibility, and customization. The approach changed because classical management systems could be effective with slow markets dynamics, typical of the past (Turner and Keegan, 1999). Management in the 21st century has to deal with perpetual change and unsteadiness. It is organized around communities and social bonds, with frequent rearrangements in partnerships and alliances. The newest organizations are made of complementary relationships based on virtual rather than vertical integration (Jamali, 2004). Furthermore, recently there is greater awareness about the effects of the current demographic explosion, post-industrialization pollution, green consumerism, environmental and societal disasters. People are more aware that evident alterations of the natural environment are mainly imputable to human activities, understanding also that adaptation to these variations is crucial for the survival of both individuals and corporations. For this reason, space is turning into, not simply a possibility, but rather a unique alternative.

1.2 Global risks currently affecting our planet

It has been proved that the population is increasingly growing. It is expected to reach 9.7 billion people by 2050, making our ecological footprint and biocapacity deeply unbalanced (United Nations - Department of Economic and Social Affairs, 2019). The amount of land and goods consumed to maintain current lifestyles and habits by far exceed what is available in nature. Greater attention to the use of disposable assets is needed. If the population continues to grow at the current rate, food may become more and more an emerging problem. In addition to this, satisfying customers' demands and avoiding disappointment turns out to be always less simple, most of all in recent times when sustainability has assumed the shape of a "must" in all industries.

Furthermore, according to the 2020 Global Risk Report (World Economic Forum, 2020), edited by the World Economic Forum, one of the global risks heading the classification is climate change. It is number one concerning the danger of impact, and number two

regarding the likelihood of worsening over the next decades. Climate fluctuations have greater and more rapid impacts than previously expected: Recent years have been registered as the warmest ever and natural disasters are always more common and severe. Talking about this specific theme, people cannot bear the expense of failures because implications are and will be catastrophic: food and water crises, loss of lives and damages on ecosystems, increased migration, disrupted supply chains, economic losses, distorted prices and consequences on capital markets.

Among high-priority repercussions, water scarcity is a crucial one. Water is an indispensable resource for the survival of living beings, an invaluable asset to which everyone should have access. However, this is not granted and the probability of insufficient water for all and everyone has increased. Its decreased availability is due to huge water waste, which comes, for example, from intense farming and also because of the lack of rain, which in turn comes from global warming. The issue arises because human beings use water as if it were unlimited. Without understanding the importance of utilising it responsibly. Moreover, every global risk arising in remote regions also affects people thousands of miles away. Everything is interrelated and the world is an enormous ecosystem made up of interdependencies. The water crisis, for example, generates a decrease in the number of crops and the obtainable of meat. This, in turn, may cause the closure of companies in these industries. Further to this, the undersupply of food causes price rises, worsening problems like hunger, poverty and social disparities (World Economic Forum, 2020). Mutual dependences are indeed so binding that increasing sustainability in one single company contributes to solving problems regarding the overall ecological system.

Another matter, considered by the World Economic Forum as the second most impactful and third in terms of risk probability, is biodiversity loss. The current rate of extinction is much higher than it was in the past, and it is speeding up. It has a lot of effects on human beings, in food, health and in the functioning of entire supply chains. The main causes are deforestation, urbanization, pollution and the extensive use of pesticides in commercial agriculture. Insects, for example, have recently declined by 40%, with significant consequences on the survival of many other animal species. Even coral reefs are in danger, threatened by overfishing, industrial activity and pollution, but most of all by the heightened global temperatures.

Thirdly, there is digital technology. Although this leads to multiple economic and social benefits for most of the global population, it also results in some significant social issues. These may be uneven access to the Internet, the lack of a global technology governance framework and cyber insecurity.

Among all these further concerns, the rapid and massive spread of infectious diseases, such as Covid19, is a societal global risk with high levels of impact and devastating implications. Some examples are unemployment, economic and financial crisis, asset bubbles, disrupted supply chains, geopolitical repercussions because of some failures of governance, interstate conflicts, and profound social instability. But most of all, Covid19 has affected people's lifestyles and daily behaviour, leading to a new paradigmatic shift (World Economic Forum, 2020). Differently from previous recessions, the pandemic will probably result in many second-order and longer-term effects on business models, consumer behaviour, national and local policies, and operations which are still hidden and unpredictable. There are new consumer preferences for essential things and there is a need for real-time tracking as well as for changes in government regulations, such as trade embargoes, sanctions, and other restrictions.

So, some sectors may need to totally rethink their business models and understand how their industries could recover after this global challenge. There appears to be a need to fathom how to become sustainable in the current dramatically changing world. Moreover, actors may have to transform crises into opportunities for sustainability, aligning their businesses with the Sustainable Development Goals and moving towards a greener, more inclusive, resilient industry (International Labour Organization, 2020) (Peeyush, Vivek, Gary and Gaurav, 2020).

Covid19 has outdone all the other global risks in the WEF Global Risk Report of 2021 (World Economic Forum, 2021). Infectious diseases are now the number one ranked risk, up from 10th place in the previous survey. Last year was characterized by an unprecedented global pandemic, an economic downturn, political unrest and a climate emergency. Covid19 has brought not just an alarming loss of human lives, it has additionally impeded economic development in some of the poorest parts of the world, thereby magnifying global social inequalities. Finally, it has added to the turmoil in international trade and travel.

As for climate, there has been a decline in carbon emissions, due to lockdowns. Despite this, as soon as economies start to recover, the number of discharges will climb

again. Environmental degradation is clearly still a present threat for humankind and a greener global economy needs to be a common goal to which no one is exempt.

The 2021 WEF Report places infectious diseases, livelihood crisis, unemployment, and climate action failure in the foreground. They are now categorized as the top three short-term global risks, with an expected impact in the next 0-2 years. In terms of probability, extreme weather is ranked first, followed by climate action failure, human environmental damage, and infectious diseases (World Economic Forum, 2021).

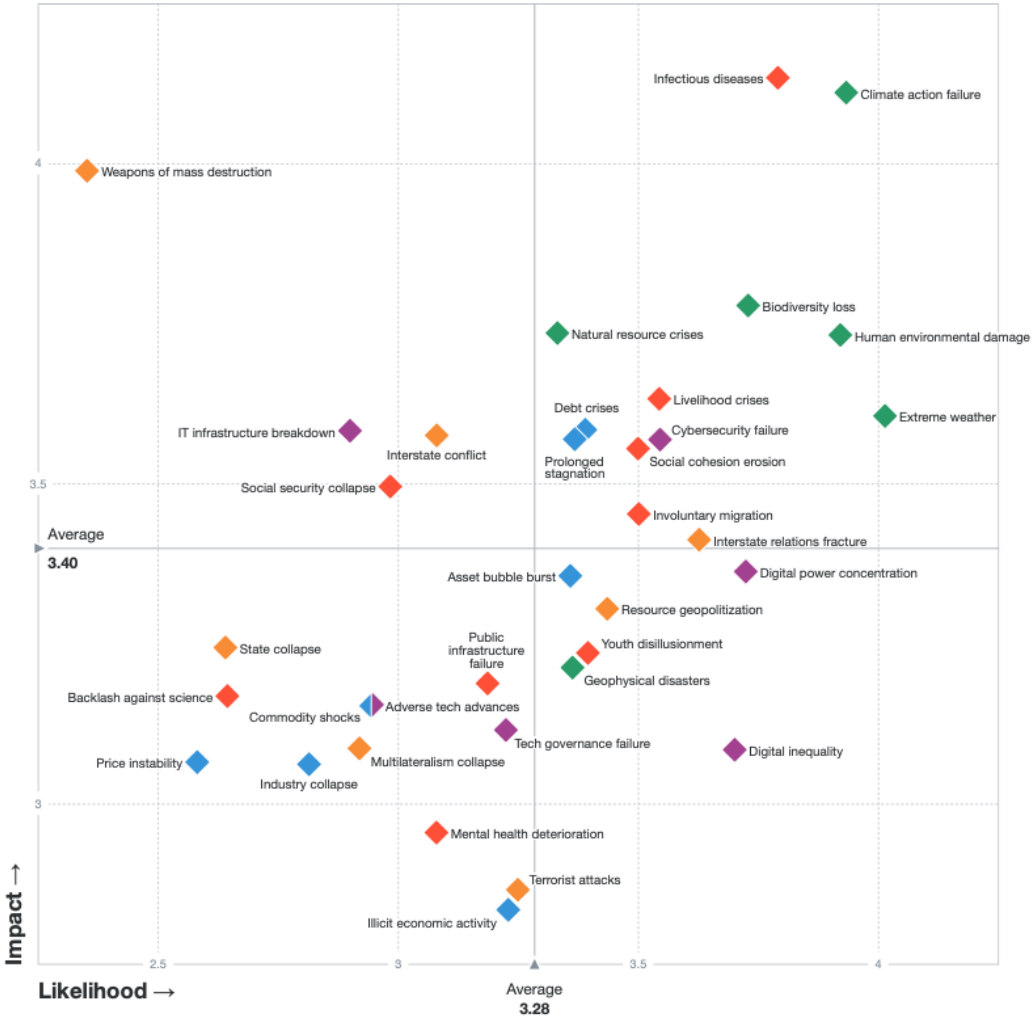

Figure 1. Global Risks Landscape (World Economic Forum, 2021)

Everything is connected. Global issues therefore directly influence the global economy and threaten long-term business sustainability. Social inequality, for example, is directly correlated to economic damages. Hence, as homogeneity diminishes, economic results decrease too. In addition, environmental disasters have huge economic consequences: "Natural catastrophes such as floods, heatwaves, droughts, and storms currently cost

$195 billion annually in direct expenses. By 2040, researchers found that this number could rise to $234 billion, an increase of $39 billion a year". Moreover, "drinking water or protection against floods puts it at $125 trillion per year" (Azapagic, 2003).
Finally, WEF reports show how, over time, critical global challenges have been aggravated and reshaped, leading to the necessity for more collaborative efforts. This seems to indicate a high probability of continuous future shifts in the business landscape. But it is exactly the recognition of the need for change that can bring to a new start. Hence, breaking points might be seen as an opportunity to invest in sustainable practices and to showcase the companies' intentionality in lessening the negative impacts, while increasing the positive ones (Hart, 2019).

1.3 Corporate sustainability: a long-term strategy

Sustainability is a global objective. As such, there is the need for a strategy to achieve it and to apply it to business with a durable perspective.
Some sectors are growing so rapidly that their impact on the planet is getting worse. A further problem is given by the fact that sometimes human beings do not recognize all the means at their disposal to overcome current issues. These concerns often make it arduous for firms to manage the progress and sustainability that can be the way out. (Indvik, 2020).
Sustainability and transparency are crucial to a supply chain from raw materials selection to the presentation of the final good. Clarity in choices and in processes, which today is still rare, is therefore essential to succeed. Hence, corporate sustainability can be the solution to prosper in the long term. Differently from the past when it was mainly perceived as a cost and a constraint, nowadays it is rather considered as an opportunity. Corporate Social Responsibility (CSR), in fact, is a scheme that is seen as an invaluable tool to cut down on costs, manage threats, launch new products, and guide crucial internal changes in culture, structure and employees' attitude. It allows safety and labour costs to decrease, thus leading to higher productivity, innovative solutions, and cleaner production methods. It makes companies avoid further expenses, cutting even the costs of energy and materials. Moreover, compliance with public policy and regulations positively impacts the earnings of corporations. Finally, public accountability encourages consumers to pay a higher price for more sustainable products and services. For example,

pollution prevention and eco-efficiency improve the environmental effectiveness of products and processes by shrinking waste and emissions. This signifies better utilization of inputs, ending again in lower costs (Hart and Milstein, 2003). Corporate sustainability also permits easy access to lenders and insurers, granting positive evaluation from investors, too. It increases a company's reputation and legitimacy, strengthens market competitive advantage and favours deeper relationships with customers.

Sustainable ecosystems are those able to be successful by constantly innovating, being mindful about the surrounding volatile circumstances, and continuously aiming at staying competitive. In this new way to conduct business, only forward-looking proactive companies could be able to handle the situation (Azapagic, 2003). Moreover, to become sustainable, companies should adopt a systematic approach with holistic thinking. The purpose is to see the big picture, acknowledging that the company is part of a business network, where participants share the wherewithals and capabilities, and work cooperatively (Moore, 1993). For this reason, they will influence each other and will co-evolve dynamically, trying to reach common sustainable goals, such as social cohesion, economic growth, and environmental protection. They will consequently become more sensitive towards problems like resource scarcity, social instability, food crisis and interstate conflicts (Eamonn, 2015). It is for this reason that solving these difficulties at the firm level, allows to give credit in part to the solution of global ecosystem issues, too.

All these are the motivations that led to considering CSR as a strategy to increase the company net worth and the most effective way to preserve it even in the long-term.

Corporate sustainability is something that must be intrinsic to the company identity, and all the members must be committed to it. It is about discerning sustainability priorities and aligning them with the business ones (Azapagic, 2003). Sustainability requires a common vision, intense commitment and powerful leadership, everything lined up with a proper management approach and appropriate communication of the adopted sustainable policies.

The means to implement this long-term strategy fully are cooperation, engagement and education. No one can totally solve the "unsustainability issue" and reach 100% of sustainability in all the practices. What we can all do, from the business side to the consumers' side, is to contribute to reducing the impact. Each of us can make a difference, but every member of the supply chain must do his/her own part. If people are incentivized and motivated, and if the entire organizational structure has a common vision along the

overall business path, this can be a solid basis for the accomplishment of a sustainable program (Stocchetti, 2012). Every contribution is of vital importance and even the little deeds made by individual customers can certainly be influential. Changing buying habits and consumption behaviour can result in a paradigmatic change. It is necessary to raise citizens' awareness about the importance of taking care of the Earth, and about the fact that we are all participating in the damage of our "Home". In every sector and industry, purchasers tend to buy more than is actually needed, thus contributing to increasing production, pollution and waste. This is why the sustainability approach needs to be proactive throughout the entire production process, not just at the presentation of the final product or service. Moreover, sustainable responsibilities must be shared and not just seen as an issue for technical departments.

Another milestone is the significance of building strong customer relationships based on limpidness and trust because this is the only way to make the desired shift happen. This type of bond can be achieved when companies are available to disclose every step taken along the product life cycle, while committing themselves to quantify and reduce their total impact. Some companies tried to solve this issue by shortening the supply chain, manufacturing their own goods, holding their factories and producing the necessary raw materials by themselves. Despite this, globalisation and the new exchange policies have incited brands to outsource production, and in this way, they have lost control over their chain. Companies engage with thousands of facilities internationally, many of which sign up agreements to subcontract the work to other enterprises. Therefore, as it is impossible to always have the title and possession of every needed activity, it is important to incentivize even third-party suppliers to convert to being greener in all possible aspects. It is something that calls for determination, perseverance, a lot of patience and financial investment, too. Powering suppliers' tools with renewable energy or leading them towards the adoption of lower-impact materials, are examples of how cooperation can effectively achieve the desired outcome (Indvik, 2020).

Moreover, when talking about sustainability, there is a deep need for education. There are some common biases about the production of natural resources and their connection with businesses. Organic resources have often been considered inexhaustible, and the impact of consumption behaviours and lifestyles has frequently been underestimated. Additionally, the capacity for natural systems to regenerate renewables has rarely been considered in the past.

As the United Nations Environment Programme stated in 2000, what inhabitants can do is to understand that "sustainable consumption is not just about consuming less, but rather about consuming differently". This mindset change would help to solve the issue of decreased available non-renewable resources and the consequent price increase. It is necessary to understand that resource depletion does not happen in a calculable way and that some of these valuable materials are not replaceable at all. This new necessary attitude could be reached by preferring the production of green products and by implementing information campaigns to help consumers in wiser choices (Sedlacko et al., 2012). However, to achieve this type of knowledge, it is necessary not simply to tell or show something. People need to be involved, as inclusion and participation are the only ways to reach a true understanding. Only awareness can lead to action, becoming the only pathway to making the world a better place (Kaczmarek, 2020).

Patagonia's Alex Weller gives some advice to work out the required shift: *"reprogramming*". Companies need to effectively engage people in what they do, investing a lot in sustainability, which takes time and perseverance (Indvik, 2020). Recurrent paradigm shifts are fundamental to surviving in a reality that is constantly innovating, and these continuous transformations must be adapted accordingly to all the sectors that build up an ecological interdependent system. The first step is to recognize and accept the necessity for change, while the main requirement to actuating the revolution is about having dynamic capabilities. These elements will enable to stay competitive in an evolving, fast-moving and geographically dispersed environment, open to global rivalries. It is therefore important to engage and educate people on this topic to foster business efficiency and to reduce value chain costs. This is a way to define the basis of long-lasting growth, to implement innovative methodologies of managing the world economy, to anticipate the unknown and to forecast the consequences in the economy, society and natural environment (Stocchetti, 2012) (Clarke and Clegg, 2000). By reason of this, CSR establishes a new way of doing business, which combines the success and the creation of value with a respectful attitude towards the planet and its stakeholders. It is concretely a strategy to minimize the negative aftereffects of companies' activities, both towards nature and social unrest, without renouncing to profitability (Carroll, 2008) (Stocchetti, 2012).

It has been demonstrated that incorporating sustainable development within all business processes brings numerous long-term benefits, not just in ecological terms, but even in economic ones, too.

1.4 Monitoring the value chain: a fundamental challenge to succeed

Ecological sensitiveness heightens long-term legitimation and world preservation. In this paragraph, we will treat how to actually achieve all this (Bansal and Roth, 2000). The main methodology is about monitoring all the procedures and steps in a supply chain and about making this information available to consumers. It takes into account who does what and whether it is correct on the basis of sustainable principles. Being able to monitor the entire path is extremely important. The success or the failure of a process will strongly influence all other aspects of a business. A malfunction in logistics, for example, will initiate disruptions in inventory management, which in turn will impact sales volume and customer service (Nichols, 2020).

Moreover, chains of production have become progressively global and elaborated, geographically distributed and multi-tiered. Companies often outsource a large scale of their value creation to external suppliers, who successively commission some activities to other sub-tier providers. The latter, therefore, will also influence the final result and brand reputation indirectly (Achilles, 2014). In these cases, a company's outcome depends more and more on the efforts of its supply network, making chain clarity hard to sustain, and increasing the difficulty of sharing prompt information about the various operations, participants and linkages (Lambert and Cooper, 2000) (Gardner and Cooper, 2003). This often makes companies struggle to maintain complete visibility and manage risks along all passages. Firms that outsource production, in fact, have the most total costs tied up in the supply chain. These expenses include the overheads related to suppliers' management, outlays of fixing quality management issues, high inventory expenditures when undersupply is verified, logistics costs, lost sales due to late deliveries and long lead times.

However, as modern technology enables global supply chains, it also provides the tools to cope with them. It offers real-time access to the information needed for effective management, reduced risks and faster adjustable breakpoints. All this contributes to the

shift from traditional to connected, smart, highly efficient and integrated supply chain ecosystems, where digitization and monitoring from space bring advanced transparency, normally reachable with difficulty. Moreover, GPS technology empowers companies to know the exact shipment locations, while field sensors evaluate environmental conditions, salient in defining levels of sustainability (Schrauf and Berttram, 2016). This is a system that ensures business continuity and the possibility to communicate with all stakeholders through sustainability reporting. Another advantage is that accurate monitoring allows also to demonstrate the corporate social responsibility to which a company is committed, by assuring that all suppliers comply ethically with regulations (Achilles, n.d.).

Furthermore, satellite images can be fundamental to dealing with unexpected events creating "what-if" scenarios. These include disruptions and recovering more rapidly from them, maintaining relations and meeting supply order schedules (Kelber, 2019) (Ponomarov and Holcomb, 2009) (Wichmann, Brintrup, Baker and Woodall, 2018). This is more than crucial if we think that risks can arise all of a sudden for different reasons. Delays, inflexibility, changing operation methods, wrong predictions, inaccuracy, seasonality, short life cycles, product variety, inventory, lack of visibility, demand and supply uncertainty are just some of the threat drivers. Therefore, monitoring flexible and adaptable supply chains gives the possibility of benefitting from both lower direct and indirect costs, with a consequent increase in revenue and improved organizational profitability (River Logic, 2020). Conceived plans and implemented strategies will also provide accurate profiling of customer requirements and needs. These can then be shared with all the other actors of the chain to offer quick and efficient service, thus improving brand reliability (Scatteia, Frayling and Atie, 2020).

Keeping an eye on each stage along the way and embracing an evaluation system based on key performance indicators, controlling the results over time helps to improve decision-making at all levels and for all stakeholders. It is for this reason that we can state that monitoring is more than simple data collection, and it should be part of everyone's job. All value chain's members should see themselves, not as responsible for just specific activities, but they should rather hold themselves liable for maximizing long-term results (USAID, n.d.) (Miehlbradt and Riggs, 2012).

Thus, Earth Observation permits a re-evaluation of the supply chain to become efficient in all circumstances, being able to keep up with the rapidly changing consumers' demand

thanks to the use of artificial intelligence, machine learning and satellites. From 2021 on, an increasing number of companies are expected to adopt advanced technologies to harmonize demand and supply, optimize the use of resources and production capacity and even ensure a competitive advantage.

Mapping, therefore, becomes essential to understanding which organisations belong to extensive supply chains, which products they handle and where they are originated (Achilles, 2015). It is in fact impossible to control the unseen or to manage human resources well without knowing exactly what is being carried out. Satellites can give the opportunity to build an understandable, inclusive and full picture of the entire path. This clarity enables the detection of potential problems, their prevention and a boost to the whole performance. It offers the possibility of being prepared in managing unforeseen obstacles and potential spillover effects (Nichols, 2020). The sudden changes in people's needs, typical of the Covid19 pandemic, are examples of the importance of flexibility as well as of the need to reduce vulnerability and possible damages in a climate of constant evolution. Because the Covid19 situation has a direct impact on business activities, it exemplifies how global phenomena disturb companies' competitive ecosystems. Supply chains and logistics are often subject to different risks. Resiliency is thus an important goal to decrease the impacts of potential further crashes. Recording precise real-time data leads to savings in supply chain operations and inventory investments, facilitates the manufacturing process and lowers the necessity of insurance rates (McKinney et al., 2015). Additionally, value chain monitoring encourages the adoption of responsible and sustainable business models. It thus facilitates deep analyses, like life cycle assessment, to measure the impact of a production process from the moment raw materials are chosen to the disposal of a final good.

Effectiveness is therefore reached by studying business continuity plans, analysing activity impacts, and assessing risks; all objectives that refer to ISO 22301:2019 (ISO, 2019). This, however, can be achieved when the actors understand that organizations cannot function separately. They depend on a far-flung network of global suppliers and stakeholders, where one failure may compromise the whole capacity to achieve the final goal. Obviously, this necessitates a lot of time and money. That is why not all companies have already adopted this strategic methodology. However, companies might consider that a break in the value chain can sometimes be much more expensive than making a deep analysis of it (Livelli, 2021). Sustainability will always increase as a priority, thanks

also to the fact that consumption awareness in modern consumers is positively evolving. This is demonstrated by the great majority of millennials who exhibit a preference for eco-friendly companies and sustainable values.

As Thomas Clarke and Stewart Clegg from the University of Technology in Sydney suggest, "the champions will be those who can read the new game, and master its rules quickly and successfully" (Clarke and Clegg, 2000). Companies need to refocus and transform themselves in accordance with technology and innovation. It is for this reason that we are now going to explore how space economy can be the next step towards achieving the Sustainable Development Goals in a world striving to survive.

2. The role of space technologies in the fight against global challenges

2.1 Space economy: a fast-growing sector

Leveraging space economy can be a winning strategy to foster sustainable development on our planet. It may help to minimize the negative repercussions that human activities have on the environment.
As defined by the Organization for Economic Cooperation and Development in the handbook on Measuring the Space Economy of 2012, the Space Economy includes:

> "*The full range of activities and the use of resources that create value and benefits to human beings in the course of exploring, researching, understanding, managing, and utilising space*" (OECD, 2012).

This definition is the same given by NASA in 2007, and it means that this type of economy is about exploiting what is present in outer space to bring advantages to what is on Earth. To be better understood, space economy can be divided into three components. The first is the upstream sector, which includes research and development, manufacturing and the launching of space infrastructures. Secondly, in the downstream sector, we find daily space operations and "down-to-Earth" products and services. Finally, space-derived activities used in other fields of operation, like space technology that can be applied to automotive, medical and other domains (OECD, 2012). Additionally, space economy gives the possibility to create new services in different fields, such as meteorology, energy, telecommunications, transportation, aviation, maritime activities and urban development.
Human activities, within all these sectors, clearly have damaging impacts on the Earth's natural environment. They contribute to problems such as deforestation, desertification, soil degradation and climate change. Space-based technologies have, indeed, improved the scientific understanding of water cycles, air quality, forests and other aspects of nature, thereby resulting in further economic and societal advancements (UNOOSA, n.d.).

Nowadays, all the existing cutting-edge technology, having led to innovative applications in many disciplines, has brought people to consider space economy as a very saturated market. It is important to remember that space is not only a progress sector in itself, but it also allows constant growth and improvement in others (European Space Agency, 2019). The United Nations have agreed that the seventeen Sustainable Development Goals must be the main priorities to be pursued and to be reached by 2030. We must strive for them as a global community, remembering that technology from space can prop them up (Wood, 2017). The benefits derived from space technologies have even led to the establishment of the "Space2030" agenda, which outlines a long-term mission for space, detailing how its data, infrastructures, services and applications can address the achievement of the UN Goals. The four pillars of Space2030 cover space economy, society, accessibility, and diplomacy.

The first component focuses on economic benefits, while the second one is about promoting the relative societal benefits of activities. Accessibility aims at granting access to the universe for all, while diplomacy tries to strengthen international cooperation and partnerships on related activities (Scatteia, Frayling and Atie, 2020). The Cosmos, in fact, is not something affordable to just a few selected nations, anymore. In the current interconnected world, more than eighty countries have launched satellites into orbit. Hitherto, more than 5,200 rockets have been launched to place 7,500 satellites into orbit, of which 1,200 are currently operational.

An OECD study conducted in 2019 (OECD, 2019) revealed that 2018 had been the year with the highest number of orbital launches since 2000, with 114 launches. During this year, SpaceX emerged as registering the greatest number of annual launches handled by one single company. Moreover, in the period ranging from 2014-2018, there has been an exponential growth of very small satellite launches, up to 900 (OECD, 2019).

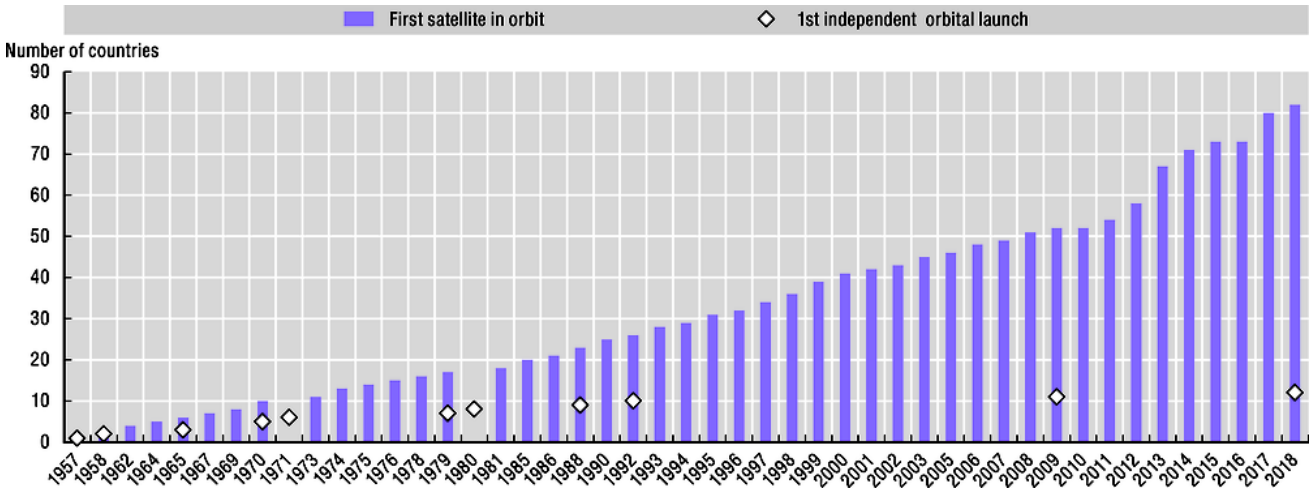

Figure 2. Number of countries with a registered satellite in orbit (OECD, 2019)

In the past decade, international public and private actors taking part in space activities have increased exponentially. They now invest in programmes contributing to scientific exploration and knowledge with the aim of tackling Earth's everyday challenges. In 2019, public investments represented the majority of funding in space activities, with an amount of almost $ 79 billion (OECD Space Forum, 2020).

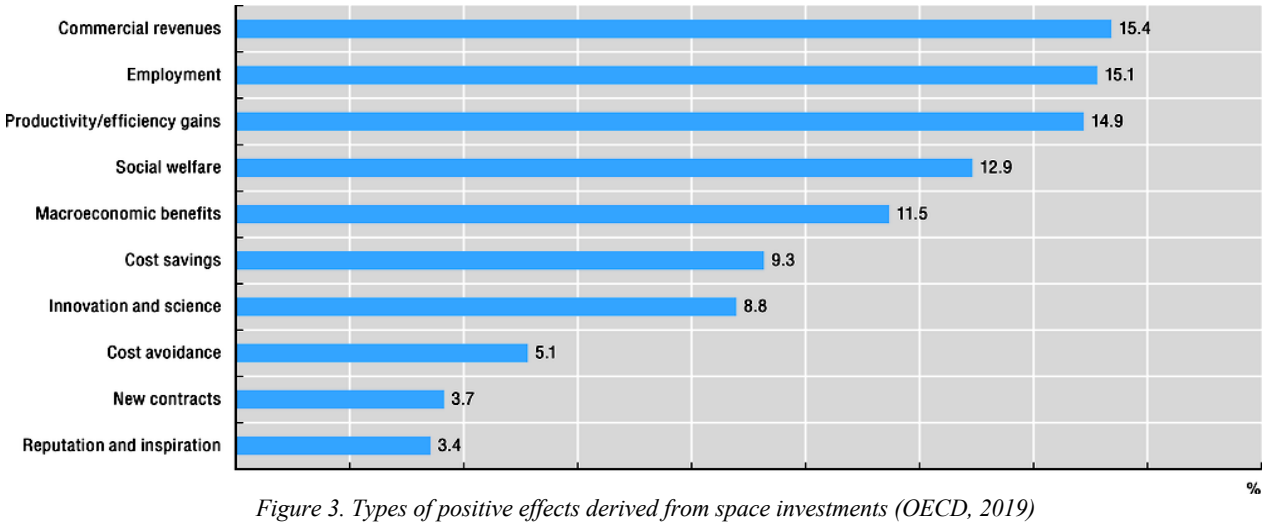

Figure 3. Types of positive effects derived from space investments (OECD, 2019)

This is due to the fact that the positive effects derived from space investments are extremely numerous. Commercial revenues, employment, productivity, social welfare, innovation and reputation can all be enhanced. This then produces macroeconomic benefits, cost savings and cost avoidance, too.

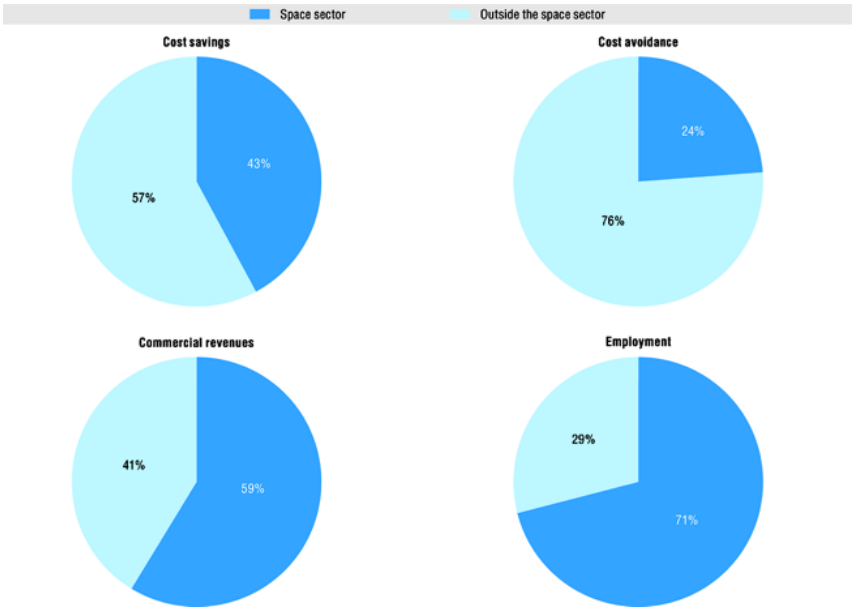

Figure 4. Benefits in and outside the space sector derived from space investments (OECD, 2019)

Benefits will affect the space sector, as well as other non-related fields, making the deal interesting from different points of view. It is also advantageous to investors, who look for information on companies' environmental impacts. In this case, satellites can become the eyes of sustainable investing, providing a clear view of how businesses are impacting the environment, but also to the converse, how environmental changes are affecting industries. Satellite data can be helpful in offering a full picture of environmental qualitative and measurable information for company reporting. Through these means, investors can monitor companies' activities, including pollution, greenhouse gas emission levels, and deforestation.

Transforming findings obtained from space into meaningful knowledge is a fast-emerging field of investment research. The French start-up QuantCube, for example, analyses satellite data for investment purposes by using artificial intelligence and indexes like the Pollution Index. By exploiting Sentinel 2 satellite images, it can define whether the emissions come from residential, commercial, or industrial sites. Moreover, by means of high-resolution images, it can even trace watercourses and sea contamination back to their origins (Société Générale, 2020). So, it is clear how there is always a stronger relationship between sustainability and investment decisions. As stated by Adam Jonas, who leads the Space Team at the Morgan Stanley Research company:

> "*Space and sustainability could increasingly align, thanks to innovative applications of satellite technology and the many exabytes of data that space infrastructure will produce over time*" (Morgan Stanley, 2020).

Global risks are shared concerns that deeply affect everything, from consumers' demand to business activities. For this reason, they are considered as predominant goals that should be pursued with the greatest urgency. Space can be an unparalleled opportunity to drive steady development and space surveillance can permit the constant study of elements determining burgeoning sustainability.

Besides this, as space activities become more assimilated into the daily lives of citizens, the consequent results on the economy and society are flourishing stronger and extending further. New technologies, for instance, assure always more secure and resilient connectivity and grant energy generation and distribution in people's everyday life. Satellite data is increasingly used to support the policies on climate change, environment, sustainable development, and civil security. It can bring significant socio-economic benefits to everyone and everywhere: from agriculture to finance, from education to transportation, winter navigation and flood management. Space, in fact, is contributing concretely in many sectors (Teodoro, Schrogl and Becerril Avila, 2020) (UNOOSA, n.d.) (European Space Agency, 2020). Evidence of this is that space activities have consequences not just in commercial income, but they also have repercussions in many segments of the economy. They also positively impact national GDP with increased earnings, cost avoidances, superior technology, better food safety, public security and defence, pollution abatement and innovations. As far as the specific economic benefits are concerned, exploration programmes generate financial growth and support employment. New job opportunities in space are a future prospect, as are new markets and enhanced competitiveness (European Space Agency, 2019).

The main purpose of the Space Initiative of 2020 was greater accountability and sustainability in space activities. The global space economy grew to $ 356 billion in 2018, and $ 378 billion in 2020, with future estimates of more than $1 trillion revenue in 2040. The majority of space economy revenues are deemed to be related to commercial satellite services, such as satellite fixed and mobile services, satellite radio, satellite broadband, commercial remote sensing and satellite television services.

The second-largest share of earnings is derived from devices used to obtain positioning, navigation and timing signals, and to consumer equipment such as satellite television dishes. This is followed by gains coming from space systems' manufacturing and commercial launch industry (OECD, 2019).

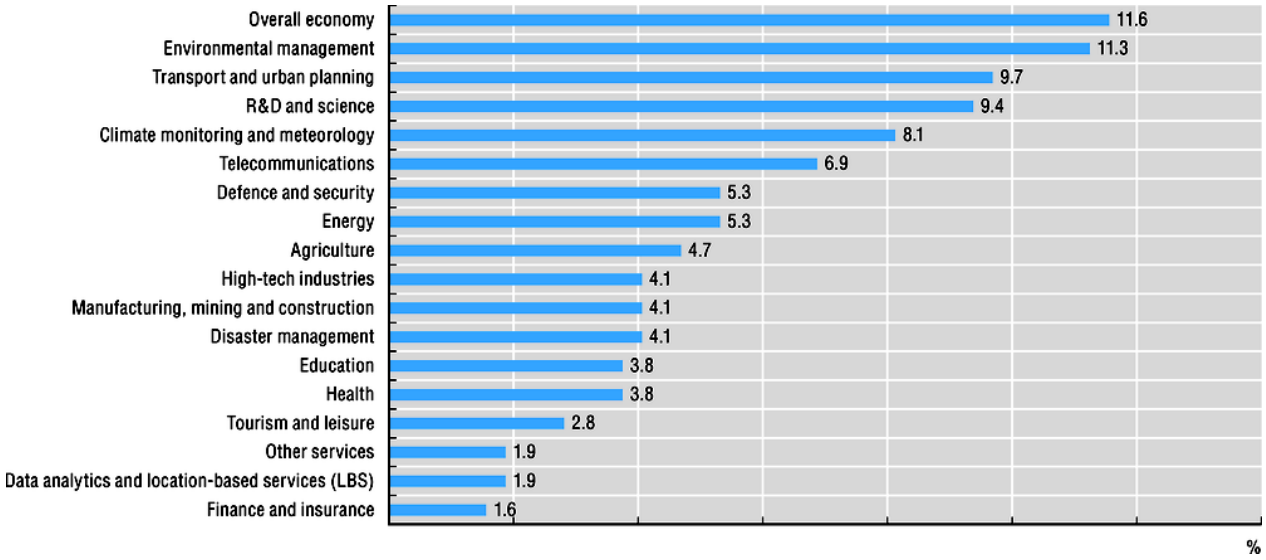

Figure 5. Selected sectors that benefit from socio-economic effects derived from space investments (OECD, 2019)

Moreover, this acquires even more significance if we think of all the socio-economic improvements that can consequently follow in other sectors.

The numbers make satellite technologies the mainstays of modern society. They allow the possession of data, essential even for policymakers. Similarly obtained information is helping many states to monitor the implementation of the Paris Climate Agreement and the UN Sustainable Development Goals (Mazareanu, 2020) (Morgan Stanley, 2020). Importantly, therefore, space is not just about exploration. Rather, it includes multiple objectives. It is not just about the major global giants, such as NASA, but it is a developing industry favouring many new players, as data from records and databases clearly show. The number of active companies belonging to the 3030 NACE code, on the "Manufacture of air and spacecraft and related machinery", excluding public authorities and governments, is continuously growing. Considering specifically those dealing with satellite manufacturing, what immediately stands out are the profit levels and the number of employees involved. The first ten businesses, in terms of revenue, currently range from $65 billion down to $16 billion, contracting up to 114,000 employees.

Table 1. Satellites' manufacturing market (ORBIS database, 2021)

	Company name	Quoted	ISO country code	NACE code	Last available year	Total production value $ USD	Number of employees
1.	LOCKHEED MARTIN CORP	Sì	US	3030	2020	65,398,000,000	114,000
2.	AIRBUS SE	Sì	NL	3030	2020	61,408,957,341	131,349
3.	BOEING COMPANY (THE)	Sì	US	3030	2020	58,656,000,000	141,000
4.	GENERAL DYNAMICS CORP	Sì	US	3030	2020	37,925,000,000	100,700
5.	CHINA AEROSPACE SCIENCE AND INDUSTRY CORPORATION	No	CN	3030	2019	37,075,242,959	320
6.	NORTHROP GRUMMAN CORPORATION	Sì	US	2651	2020	36,799,000,000	97,000
7.	HONEYWELL INTERNATIONAL INC	Sì	US	2932	2020	32,637,000,000	103,000
8.	SAFRAN	Sì	FR	3030	2020	21,634,987,748	86,785
9.	LEONARDO S.P.A.	Sì	IT	3030	2020	17,060,361,560	49,882
10.	NORTHROP GRUMMAN SPACE & MISSION SYSTEMS CORP.	No	US	2932	2001	16,383,000,000	93,700

Space agencies create value by setting the conditions for future technological and market opportunities. They aim at driving sustainable growth on Earth, and at leveraging space research for further, successful innovations. For this reason, in many countries, there are increasing expectations concerning space activities as enablers of economic growth, societal advancements and job creation (European Space Agency, 2019).

The greatest challenge, therefore, is finding a global strategy that will keep the impact of human activities on the natural environment in check. The answer is placed exactly above our heads: we should just look up.

2.2 Space technologies and business implications

Space technologies nowadays can be valuable for almost all global issues. They offer many different solutions for high-priority risks, as well as for the less damaging ones. Business

implications and commercial services are so numerous that companies are willing to leverage space tools to render sustainability profitable. This is evinced by well-known firms managing to lessen their environmental footprints while earning money and accelerating their socio-economic development (Worldfavor, 2019).

Current space instruments permit global events to be predicted to reduce the chances of global threats turning into reality. Earth Observations, satellite-based positioning and telecommunications are being used in multiple projects around the world in overseeing nature and in assessing environmental issues. They can already monitor the evolution of disasters and emergencies, thanks to the use of satellites, GPS devices, Internet access tools, supercomputers able to process vast amounts of data, artificial intelligence and machine learning. The contributions of these technologies to support sustainable development are therefore well recognized. Many of them, together with the growing use of drones, can manage ecosystems and wildlife. Moreover, the screening of detailed images makes for short time comparisons.

Existing technologies can monitor climate change, extreme weather conditions, natural disasters, greenhouse-gas emissions and water scarcity. They provide the possibility of foreseeing volcanic eruptions and of monitoring issues, such as sea levels, the ongoing melting of polar caps and the continuous increase of ocean temperatures.

This monitoring system can also detect illicit trade, as can occur in hunting and fishing. Earth Observation allows real-time tracking, the monitoring of entire supply chains to ensure transparency and the possibility to keep track of the health state of our planet. Instantaneous tracking has a lot of uses. One is the possibility of discovering areas with greater CO_2 emissions. Similarly, satellites can optimize renewable energy infrastructure employing models to predict sunlight and cloud obstruction. This can be used in deciding the locations of solar panels (Morgan Stanley, 2020) (Ierace, 2020). Space, therefore, is a source for both renewable and scarce, non-renewable energies. This is feasible thanks to direct sunshine and wind for clean energy, and thanks to the provision of materials that are in scant supply on Earth.

Space even offers solutions to some societal risks. For example, Internet access in remote areas reduces social distances. Space infrastructures are also crucial for improved telecommunications, high-speed connectivity, finance and utilities. This is essential in emergency periods as the current Covid19 situation (OECD Space Forum, 2020). Satellites also permit the evaluation of annual cycles of land and oceans vegetation, thus

determining the most negatively affected areas. By so doing, space contributes to monitoring poverty levels, as well as food and water shortages typical of certain areas around the planet (World Economic Forum, 2020).

The examination of space-derived data, then, suggests meaningful inputs for companies' decision-making processes and it is becoming key towards the achievement of internationally agreed sustainable goals (UNOOSA, n.d.). For example, NASA uses satellite sensors, airborne instruments, supercomputers, and visualization methods to better understand our planet and to help its improvement. There exist small satellites, called CubeSats, which are so small, that they can be held in the palm of a hand. These are able to collect highly developed data. NASA invented even some microwave radiometers, which are satellite instruments that overcome the interference issue and gather high-quality data on soil moisture, meteorology, climate and much more. They are small satellites, that can identify and filter any radio frequency interference in real-time, thanks to new technology. This diminishes the amount of data to be transmitted back to Earth, thereby improving the quality of weather and climate measurements. Moreover, through NASA's Cyclone Global Navigation Satellite System (CYGNSS), which is composed of eight microsatellite spacecraft, it is possible to carefully overlook hurricanes from a low-Earth orbit. They collect data to favour weather forecasts, and by continuously monitoring surface winds over the oceans, they upgrade existing storm predictions. Radar from weather satellites usually had troubles in the past with the presence of heavy clouds near the centre of hurricanes. CYGNSS solves this problem by obtaining GPS satellite signals, which can penetrate even the heaviest clouds.

Additionally, thanks to machine learning, researchers at NASA have taught a computer to better map the effects of tropical forest fires, applying artificial intelligence techniques to satellites. They have trained a computer to distinguish burned from unburned pixels with the aim of detecting fire activity. Then, using a new radar instrument called Doppler-Scatt, NASA is trying to study ocean flows. Winds blow over the ocean's surface thereby creating currents. At the same time, the temperature of water determines the wind's speed. Analysing this relationship is significant to foresee climate changes, as well as to track oil spills, outline navigation routes and estimate ocean productivity, the last of which concerns fisheries (Walbolt, 2018).

Hence, space has ever more validated its role in Earth monitoring, facilitating operations and offering services of geo-localization. These applications and the data obtained with

them permit the forecast of the needs of our society, and so the improvement of people's lives. Finally, it is important to underline the synergic relationship that there is between space-to-Earth and Earth-to-space technologies. This spin-out and spin-in cycle are characterized by a mutual dependence that allows evolution and innovation in time for both Earth and space products (ASI, n.d.).

2.3 Space economy and societal improvements: a glimpse into the future

Business implications centred on societal concerns are those that mainly focus on reduced disparities, quality education, dignified work, and economic growth: all components of the Global Sustainable Development Goals list.

In 1967, the world's nations signed the Outer Space Treaty. This stated that "the exploration and use of outer space should be carried on for the benefit of all peoples, irrespective of their level of economic or scientific development". People strived to make this statement a reality, but constraints derived from colonialism, racism and gender inequality have always been dominant, creating the consequent belief that space is for the few that can afford it. Inequality continues to be highly influential in the global risks landscape, together with political divergences. As cohesion and cooperation diminish, economic performance is expected to follow suit.

However, such attitude must change. The world is committed to the vital task of improving life for every human being. Satellites can, therefore, bring people closer. Communication satellites give access to smartphone and internet services nearly anywhere on Earth. This has led satellite broadband to consistently grow over the last years, reaching more than 5.2 million subscriptions in 2017 (OECD, 2019).

This type of services is essential especially during periods of disaster, like the current one, where people, forced into lockdowns, need the Internet to communicate, to keep social bonds, to follow school and to work from home. Another example is what happened to the Philippines when they recorded one of the strongest tropical cyclones ever, the so-called Typhoon Haiyan of November 2013. On that occasion, the local communication networks were in urgent need of being repaired, and so they linked communication antennas to satellites for the recovery phase (Wood, 2017).

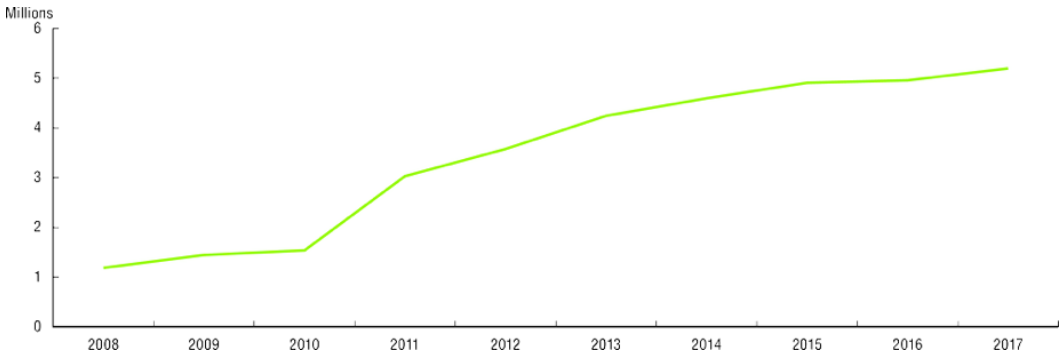

Figure 6. World-wide satellite broadband subscriptions (OECD, 2019)

The group of satellites of SpaceX, named Starlink, are another example of space technologies that try to make affordable high-speed and low-latency internet access available to consumers across the globe. They can reach even remote and rural locations where, because of the lack of terrestrial infrastructures, access is unfeasible or completely unavailable. SpaceX launched 122 low-Earth-orbit broadband satellites in 2019, and the company has already agreed to launch another 42,000 of them in the upcoming years. This future prospect is incentivised because researchers have demonstrated that Internet usage might mean up to a 2.5% difference in a country's GDP (Belfiore, 2020) (Morgan Stanley, 2020).

The International Broadband Commission set, in fact, some Sustainable Development Targets to be reached within 2025, to support the United Nations Sustainable Development Goals. They determined that by 2025 all nations should have a solid national broadband plan or strategy, and basic broadband services should be made affordable in developing countries. Moreover, they added that by the same year broadband Internet user penetration should be 75% worldwide, 65% in developing and 35% in the least developed countries (Garrity, Sundberg, Polomska and et al., 2020). Considering that in Sub-Saharan Africa, only one person out of five has access to the Internet, innovative services are expected to have massive impacts in all emerging countries in the world. Besides, the development of space-based communication services not only makes connectivity available, but also allows to encompass Information and Communications Technologies (ICT) in public services. These innovations in the healthcare, administration and education sectors, bring huge improvements to the inhabitants' quality of life. Furthermore, Internet navigation services are essential for the development of the transportation sector and other activities based on the use of location services or GPS.

They would be able even to increase safety in occupations like aviation or the maritime sector.

Among the future space technologies, there is the growth potential for the 5G Space Network. This was launched in 2020 and it relies on communication between satellites to generate faster mobile connections for people on Earth. It can reach locations outside Earth-generated signals, thus becoming indispensable for activities like shipping and transit (Easy Reader, 2020). A further good example to take into consideration, by what the Bolivian state has done. In 2009 the Government decided to launch their first national telecommunications satellite to offer access to all Bolivian citizens. Before that year, more than 30% of the population in rural areas lived without access to these services because of the geographic and topological landscape of Bolivia surrounded by mountains and the Amazon Forest. This successful event brought many benefits to their society. Plans are now being made for future space programs and activities.

Space actions in Bolivia played an important role in contributing to the objectives of the 2030 Agenda. At the same time, they have also been able to boost the national economic sector by an average annual growth rate of 4.9%, especially during the first decade starting from 2004. In addition, over the Bolivian satellite's fifteen-years lifetime, the State is expecting total revenue of $500 million from it. Besides this, space applications can support the most fruitful Bolivian economic sectors, like agriculture, forestry, fishing and mining (Scatteia, Frayling and Atie, 2020).

Something more and still under study is the provision of new healthcare methods from space for people on Earth. To improve their quality of life, attempts are being made to replicate on Earth some medical methods used in space, where there is no gravity, to cure specific diseases. Microgravity research is resulting in a lot of new knowledge and positive impacts for both humans and industries. For instance, some studies obtained from experiments made on astronauts can be adapted to elderly people (Scatteia, Frayling and Atie, 2020). This can be possible because when explorers are in the microgravity environment, their physical bodies behave as if they were growing old rapidly: Bones and muscles debilitate, and the cardiovascular and immune systems change. For this reason, scientists study how to transfer the exercises and techniques used to keep astronauts healthy in space to people on Earth (Wood, 2017).

In addition, some metals found in space can be used to make artificial limbs. The absence of gravity can be exploited to restore muscle loss in bed-ridden patients. Space

technologies can be applied to eye laser surgery and to make lung diagnoses (Scatteia, Frayling and Atie, 2020). A further application can be a system of water filtration, by which used wastewater in a space station is distilled for use again.

Hence, all this confirms that the technologies we conceive for astronauts and spacecraft are inventions that can then be readjusted to improve life on Earth (Wood, 2017). We have now seen how space can provide solutions to societal issues by fostering education, facilitating scientific research, creating business opportunities and by favouring employment and economic growth (Scatteia, Frayling and Atie, 2020). Now we are going to see how it can benefit economies and businesses.

2.4 Earth Observation to ensure supply chain improvement

Additional to the previous business implications, other Earth Observations are leading to revolutionary innovations. Space can be an opportunity to drive sustainable growth and to solve contemporary issues in management by increasing and assuring transparency in all procedures. This can happen thanks to Earth Observation and the monitoring of supply chains from the sky.

As the European Space Agency has stated, Earth Observation is like "taking the pulse of our planet from space", and over the last decade, it has become a dramatically growing market (European Space Agency, 2019). In 2017, the global market reached $4.8 billion for EO data and additional services, and $4.6 billion for satellite manufacturing. The downstream EO sector is prospering at about 6% growth rate globally and at about 12% within Europe. In weather forecast applications, it has resulted in socio-economic benefits of more than $18.9 billion. As for the future, Earth Observation is expected to bring more than 54,500 jobs by 2030. Additionally, 515 European companies working in this sector were registered in 2018. In total, they employed approximately 8,400 employees, leading to $1.47 billion in revenues (Morgan Stanley, 2020).

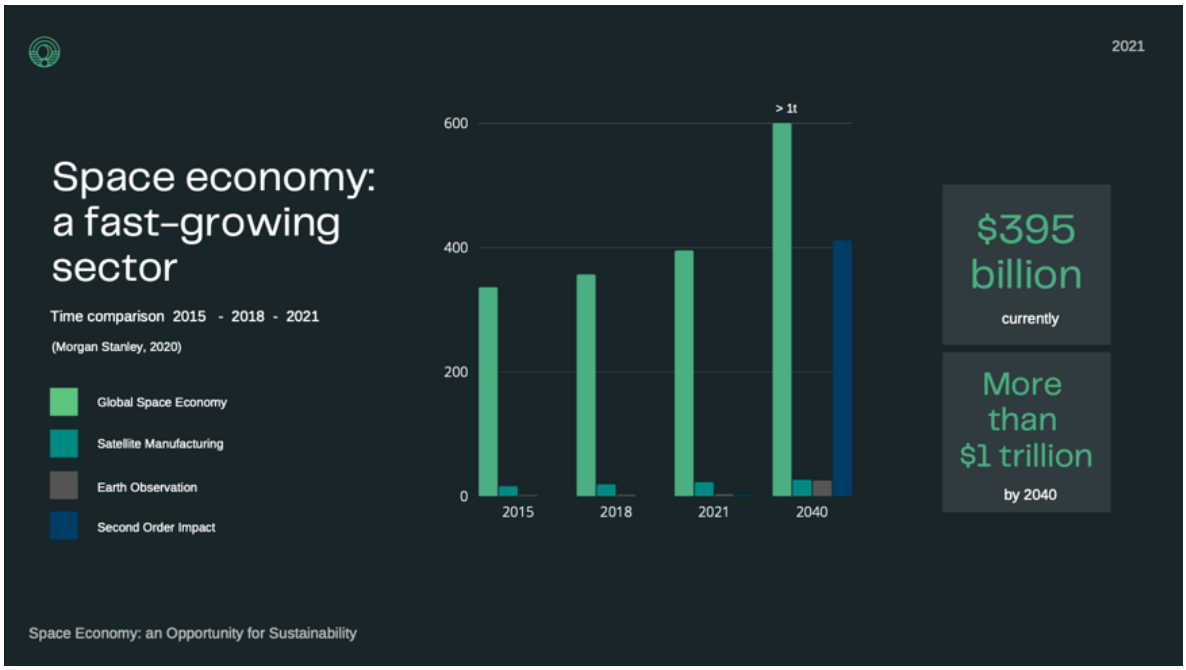

Figure 7. Time comparisons and forecasts (Author's own elaboration from Morgan Stanley, 2020)

Earth Observation has numerous benefits in many different applications, such as crop monitoring, water and coastal management and international development aid. Thanks to higher resolution images, big data and artificial intelligence, even the impediment of clouds is an issue that has been solved. In this way, detailed supply chain mapping has become possible (European Space Agency, 2020). Progress is helping always more to understand changing supply chains' structures and to quantify accumulated environmental impacts. Plus, Victor Maus from the Vienna University of Economics and Business, added that

> *"There is a huge potential to combine Earth Observation and economic data to support efforts by business and policy in making supply chains more sustainable".*

This is even made easier thanks to satellite images, where a non-expert eye can make comparisons and deductions too (Ierace, 2020) (Allen, 2019). At the moment, there are more or less 150 Earth Observation satellites managed by more than sixty government agencies. In addition, private companies are joining this list to provide better information on environmental developments. A concrete example is the one of the European Union's Earth Observation Programme called Copernicus with which ESA implements a group of

six satellites called Sentinels to observe the globe. By leveraging optical, radar and super spectral imagery, they monitor the land, ocean and atmosphere, turning the obtained data into meaningful insights (Société Générale, 2020). These are not simple pictures, but rather measurements combined with complex computer models, ending in interesting visualizations of the planet. They can show salt, smoke and dust in the atmosphere, rainfall and snowfall levels, floods, changes in watercourses, forest fires, pollution and deforestation. Furthermore, clear images obtained with very high spatial resolution distinguish water, trees, crops, arid lands, glaciers and even human-made buildings (Scatteia, Frayling and Atie, 2020).

Thanks to this information, for example, scientists can understand which are the more endangered areas of famine or drought. They can then make this knowledge available to organizations, to prepare sufficient emergency food supplies, before the hunger issue becomes severe (Wood, 2017).

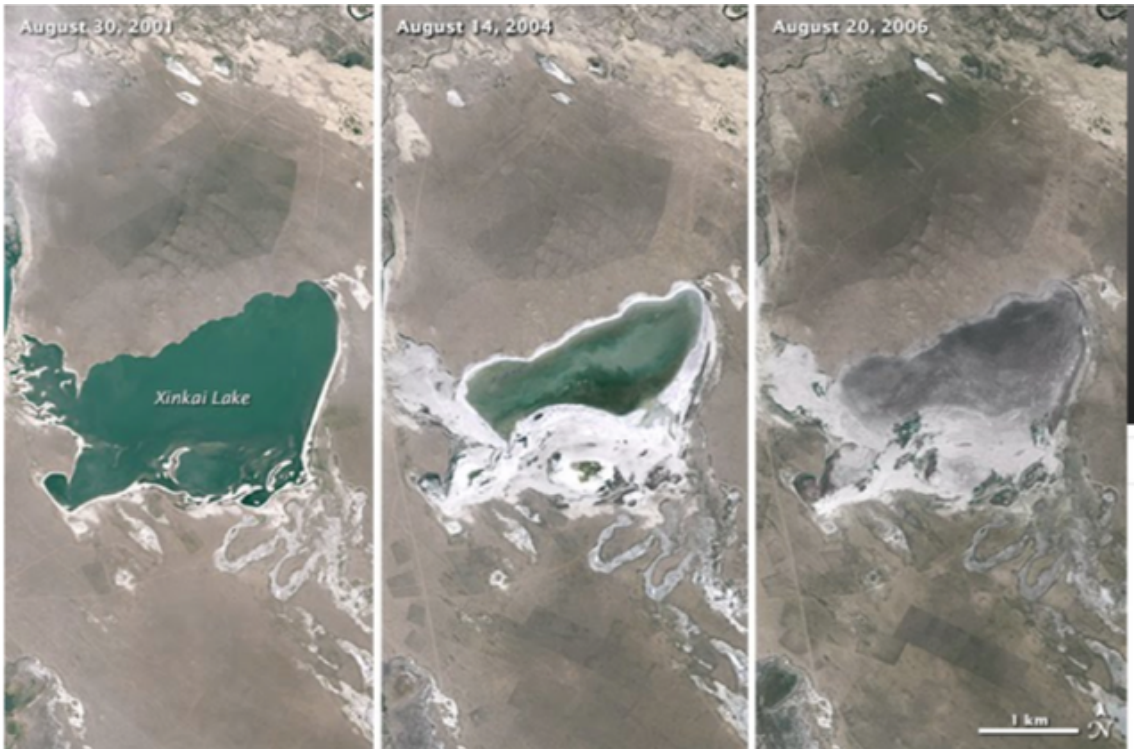

Figure 8. Satellite monitoring of Xinkai Lake (NASA, 2015)

A more specific application of satellite imagery is mapping agricultural production and its associated impacts. Satellites allow the visualisation of the spatial distribution of agricultural commodities like soybeans, sugar cane, cotton, and maize. Machine-learning algorithms can map all developments of land usage and even track product consumption.

This becomes useful in tracing global supply chains, where goods are produced in one country and commercialized in the opposite part of the world. Thanks to space technologies applications, agriculture has recently developed and advanced significantly. Precision agriculture, for instance, is a method used to manage crops by leveraging information technology, satellite positioning data and remote sensing. This is done to decrease environmental impacts as much as possible while maximising returns.

The implementation of this management approach has been realized thanks to the evolution of sensors incorporated into operations like tillage, seeding, fertilization, pesticide usage, harvesting and animal husbandry (Joint Research Centre of the European Commission, Zarco-Tejada, Hubbard and Loudjani, 2014). Furthermore, as crops are the foundation of the world's food supply, the monitoring of soil conditions, water availability, weather extremes and climate change can constitute a valuable aid both for producers and populations. Remote sensing satellites allow making assessments to help to schedule and quantify the irrigation needed. Plus, they can forecast the number of upcoming yields, thus preparing for potential shortages or leftovers. This methodology allows even to identify the areas that need specific agricultural interventions (UNOOSA, 2019) (UNOOSA, 2015).

The sector is so highly developed, that there already exists a system that can guide tractors autonomously by means of GPS. This is a software developed by NASA, which enables the introduction of self-driving machines, and it is already used in the majority of American fields.

In addition, high-resolution NASA satellite images contribute to water resource management, preventing the negative effects of dry seasons. In this case, space satellites study global water cycles, map watercourses and monitor catastrophes with greater ease. There is a project designed to program irrigation in accordance with the biological needs of each crop, essential to augmenting efficiency in water usage (NASA, 2019). A real example is what happened in 2016 when the United Nations Office for Outer Space Affairs (UNOOSA) and the Prince Sultan Bin Abdulaziz International Prize for Water (PSIPW) signed an agreement to cooperate on their common goal of incentivizing the use of space-based technology to increase access to water. They developed the so-called Space4Water Portal, a platform to share knowledge on space technologies and matters about water for companies, whose activities are related to the topic (UNOOSA, n.d.). As ESA suggests, water is a vital natural resource without which there cannot be life. For this reason, water

conservation and management are among the most urgent global challenges to be met. Sustainable agriculture has consequently been unanimously recognized as indispensable for the achievement of the Sustainable Development Goals (UNOOSA, n.d.). Even meteorological satellites are of vital importance for many businesses on Earth. Apart from monitoring and forecasting global weather conditions, they inform about atmospheric humidity, temperature, winds, concentrations of greenhouse gases, and cloud density. Rainfall predictions, obtained from infrared and microwave satellite imagery, help farmers' work together with ground-based measurements of air and soil (UNOOSA, 2015).

Researchers are even implementing some future-oriented projects, in which they are studying the gravitational effects on plant seeds and small organisms by simulating microgravity conditions. An example is the one of a Chinese spacecraft, which sent into space about 10 kg of rice to observe possible variations in their genetic model. When they brought them back to Earth, they planted them in an Agriculture and Biotechnology Laboratory in Austria, to evaluate their resistance to stress, their improved quality, and to discover any hidden potential of crops (UNOOSA, 2015). Technological advances have even been brought to the mining sector. Satellite images are used to assemble a global picture of where mineral extraction takes place. Hence, by leveraging space, land-use variables derived from different practices, like mining and deforestation, can now be supervised and managed. Earth Observation services, therefore, strengthen different economic sectors and shed light upon the importance of global risks, making Sustainable Development Goals easier to achieve.

We can conclude by highlighting that space data and analytics help us to improve real-time choices, and to make supply chains function effectively as true consolidated and harmonised systems (Dharmani, 2020).

2.5 Cutting-edge companies leveraging space technologies

As demonstrated in the previous paragraphs, space economy has a lot of favourable implications for human life. Companies are already exploiting it to become successfully innovative. In the following section, we will see how companies are increasingly adopting space tools to turn satellite imagery into strategic insights. These enterprises consider space, not as the final boundary to be reached, but rather as a "*business model arena*" in

which to model strategies (Strategyzer, 2019). Space has become an accessible economy in rapid expansion for whoever desires to emerge as an "Astro-preneur" (Strategyzer, 2019). The different applications can vary from Earth Observation to societal concerns. It is fascinating to explore how many original and clever employments have been designed up to now.

2.5.1 The case of the Nestlé company and the Starling satellite

Nestlè has committed a budget of $3.6 billion to be spent over the upcoming years to cut 50% of emissions by 2030 and reach net-zero emissions by 2050. The company's CEO, Mark Schneider, stated that dealing with climate change and trying to take care of it is a duty that no one can avoid right now, it cannot wait. He even added that for companies like theirs, that operate in almost every country of the world and that have a size to really make the difference, sustainability commitment must be an imperative:

> *"We will work together with farmers, industry partners, governments, non-governmental organizations and consumers to reduce our environmental footprint"* (Napoli, 2020).

Nestlè implements activities of Responsible Sourcing Traceability to prove the origin of its products and related ingredients. It executes a supply chain management program coordinated by Achilles Ltd, by which it allows its suppliers and their corresponding subcontractors to understand where everything comes from. This type of organization even allows learning more about producers and providers thanks to an online, low-cost, rapid and secure procedure. This choice is key to holding all of the chain's actors liable to common goals, keeping them updated about progress, pinpointing gaps and strengthening efficiency in the company.
By 2016, in fact, Nestlè guaranteed traceability of 50% of its main raw materials, eventually correcting all the identified cases of non-compliance. Plus, it fosters sustainable practices to ensure that all goods are sourced responsibly, contributing in this way to the achievement of a healthier future (Nestlé Italia, 2015) (Earthworm.org,n.d.). Deforestation, one of the global challenges that affects the company more intensely, is witnessed by the fact that forests around the world are strained by human activity,

resulting in vegetation loss and degradation. Palm oil cultivation, shifting agriculture, mining, rubber plantations and urban expansion, considered responsible for the loss of tropical forest habitats, are all examples of causes for global concern (Earthworm.org,n.d.). Every year from 1990 to 2015 was characterized by 5 million hectares of forest devastated globally. The estimated greenhouse emissions corresponding to this degree of deforestation is equal to the emissions of 600 million cars. Between 2015 and 2020, the rate of deforestation per year doubled, due to continuing agricultural expansion.

It is evident how progress has resulted in some serious societal and environmental damage. This emphasizes the necessity to pursue a true balance between environmental preservation and the satisfaction of human needs (FAO, 2020). At the same time, forest ecosystems continue to be highly endangered despite the drop-off in deforestation rates registered in some regions. It is, in fact, a complex issue that requires collaboration and commitment from the whole global industry in order to be addressed.

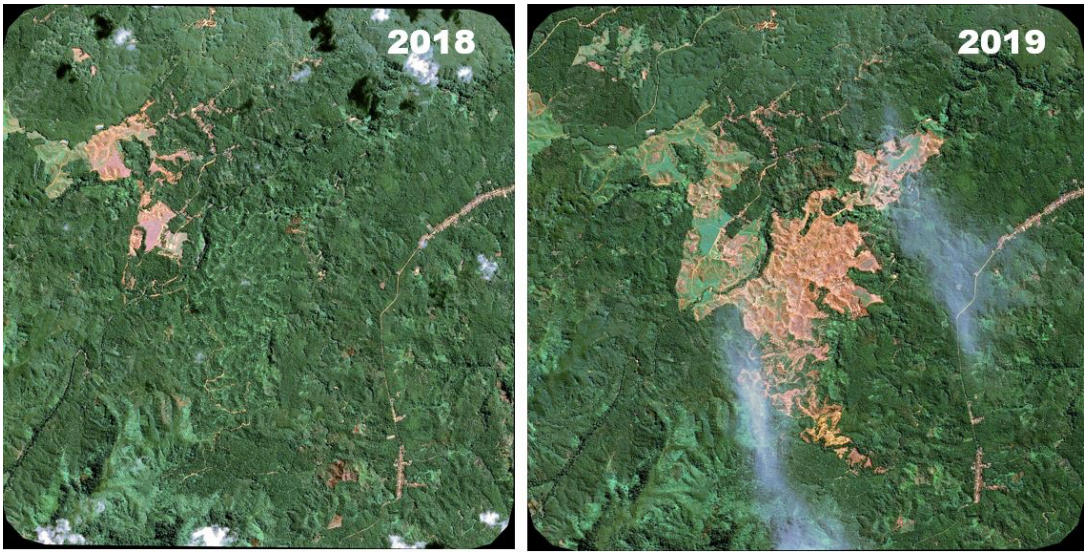

Figure 9. Forest cover in Malaysia by Starling (Airbus, 2020)

The common purpose must be not only to participate to a no-deforestation strategy, but rather to a "forest-positive future". This means aiming at playing a role both to support societies whose lives depend on woodlands, and to directly protect entire ecosystems (Nestlé, n.d.). Being forest-positive signifies buying not only from suppliers that do not deforest but preferring those that also take actions to preserve and restore vegetation, while always recognising human rights, too. In accordance with this, Nestlè stands up for

tree protection and replanting initiatives in countries like Malaysia, Indonesia, and Mexico (Nestlé, 2019).

Over the years, the company has collaborated with organizations like Airbus, the non-profit Earthworm Foundation, previously known as The Forest Trust, and the Earth Observation expert SarVision, to launch Starling. This is a satellite renowned for its utmost accuracy, its capability to detect areas at risk and its ability to make historical comparisons. These companies have come together in a project that has reached some of their sustainability goals by capitalising on certifications, supply chain mapping, on-the-ground verification and satellite imagery. From September 2018 Nestlé began to rely on digital solutions by having 100% Starling Satellite remote sensing for monitoring palm oil deforestation and land degradation. It became the first-ever company committed to this.

Nowadays, Nestlé uses satellites to authenticate its deforestation avoidance for three-quarters of the supply chain. 77% of its agricultural commodities are verified as deforestation-free, in line with the company's zero-deforestation commitment (Maier, 2019).

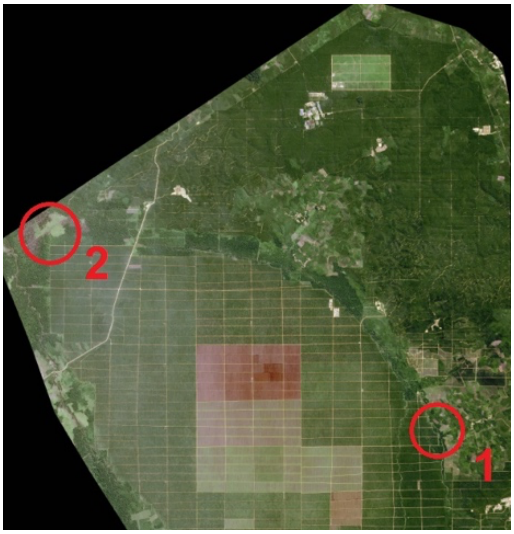

Figure 10. Oil palm plantation in, Indonesia by SPOT 6 satellite (Airbus, 2014)

Figure 11. Closeup 1.5 m resolution (Airbus, 2014)

Figure 12. Evidence of fire (Airbus, 2014)

Specifically, this approach has been adopted for all its palm oil cultivation areas around the world, where one of the main challenges is obtaining traceability for all the mills. They intended to reach even the activity of independent smallholder farmers. More than 1,200 mills are now mapped and analysed almost in real-time, leading to a further reduction in the deforestation rate. This is of great significance if we think that Nestlè palm oil comes from eighty-eight different suppliers, with a provenance from over 1,624 mills distributed in twenty-four countries (Nestlé, 2019). Moreover, Starling is trying to expand its supplier base for packaging pulp to some cocoa regions in Ivory Coast and Ghana, as well as to forests in the USA, Canada and Russia. This includes soya plantations (Sachet, 2019). Until now, verification and assessments were more difficult to attain, because they were based on ground-based checks done by auditing firms, which can supervise only a limited portion of land. The increasing speed of advances in commercial agriculture has raised the need for a more trustworthy methodology for sustainable commitments. Starling has provided the answer. By combining 1.5m resolution images and radar capable of slicing through clouds and obstacles, it offers pioneering exactness, to the point that it can easily distinguish the different types of crops. It can zoom close enough to count the trees and discern replanting and deforestation zones. Thus, even small changes in tree coverage and vulnerable areas can always be noted (Earthworm, 2017) (Jacobson, 2016).

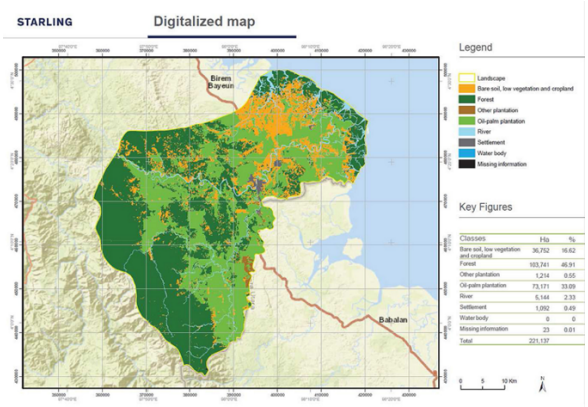

Figure 13. Starling digitalized map (Airbus, 2018)

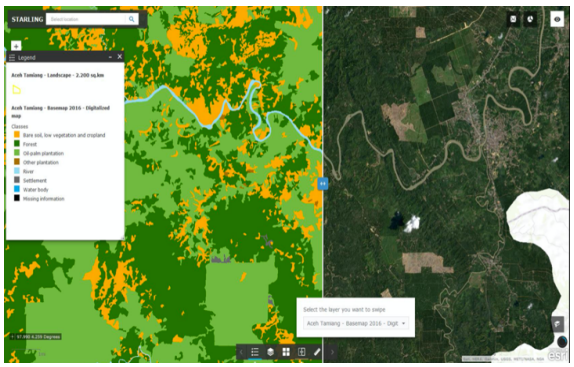

Figure 14. Starling swipe function (Starling, 2017)

This type of high-quality images is obtained thanks to the group of Airbus's satellites called SPOT. They offer tracking tools, statistics, and meaningful insights to detect emerging issues with updating every six to ten days (Nestlé, 2018) (Airbus Defence and

Space, n.d.). Starling has turned out to be crucial for the company's development and a worthwhile alliance. Its advanced technology allows a better understanding of where deforestation occurs, the causes and those involved. The objective is to intervene rapidly with the best possible decisions. Captured data and its analytics lead to risk management, strategies of intervention and changes in the field. This is done by studying and elaborating the data with machine learning (Nestlé, 2018) (Maier, 2019) (Earthworm.org,n.d.). This is further proof that supply chain visibility is essential to sustainability.

It is also supported by Nestlé publishing Starling data in a Transparency Dashboard to make information on deforestation trends available. Results then become publicly available to all interested parties, from consumers to investors. The company names direct suppliers and the mills supplying its palm oil. It adds progress reports to share on each step forward and all its learning and challenges (Nestlé, 2018).

Nestlé is representative in its care of the environment and of the issues of sustainability. By so doing, its brand value becomes truly internationalised. Moreover, it urgently promotes its willingness for collaboration and encourages other firms to adopt this innovative satellite monitoring service. It incentivizes other companies in the hope of expediting deforestation-free supply chains and of improving the entire industry as soon as possible (Maier, 2019).

In conclusion, deforestation is an international struggle to be seen as a shared responsibility. All supply chains participants should jointly contribute to the solution of the problem, perceiving it as a personal liability (Ferrero, 2021).

2.5.2 The case of the Rezatec company: leading Scottish Water to adopt an innovative methodology for water management

Water typically lies between climate and agriculture. It requires managing to improve decision-making on farm droughts, to ensure food security and to upgrade soil tilling. Monitoring freshwater lakes and reservoirs is indispensable for fishing and recreational activities. The same applies to obtaining drinkable water and to sustaining the surrounding wildlife (NASA, 2021). Obtaining measurements through remote sensing data on surface water width, altitude, depth and storage levels is being ever more

practised. In the water market, Earth Observation harnessing satellite data is expected to be worth more than $2 billion by 2027.

However, this methodology is not new in the field. Scientists started making weather predictions using satellites in the 1970s. Developments have been huge, with the water industry benefitting greatly. For instance, high standards of water quality could be defined and possible risks, such as water stress, access, season variability and pollution could be anticipated (Aquatech, 2020).

Precipitations, climate change, soil and vegetation areas, drainage, population density and water consumption rates are all aspects that significantly influence a lot the global water volume. They are the main thrust of endeavour if there is the will to reach sustainable, efficient water usage (NASA ARSET, 2020).

A good example is Rezatec founded in Oxford in 2012. It relies on geospatial solutions, combining artificial intelligence analytics with satellite measurements to monitor and detect environmental changes. Rezatec defines its platform as 'landscape intelligence'. It offers refined, state-of-the-art and cloud-based knowledge to support decision-making in all organisations operating with land-based assets. More precisely, it focuses on four key sectors: water utilities, forestry, agriculture and energy to provide help to organisations in these branches.

As water scarcity is going to be one of the most urgent challenges that humans will have to face, we will now concentrate on the company's water applications. The firm monitors the quantity and quality of water in lakes and reservoirs to attain rigorous and outstanding supervision of them (Aquatech, 2020). Rezatec's Scottish Water project to map UK peatlands from the sky is emblematic. It is financially supported by the European Space Agency and Innovate UK, to reduce clients' water treatment costs thanks to satellite observations and measurements. In this way, Rezatec concretely helps water companies to reduce the costs needed to assure drinkable water. These costs, however, depend on many different factors, such as the degree of land erosion and usage, pollution derived by fertilisers and pesticides used in cultivations, and animal waste carried and spread by water run-off.

Peatlands, despite appearing as enormous water deposits, store enormous amounts of atmospheric carbon. This is proved by the fact that in peats there is a great amount of concealed carbon, even more than in trees. For this reason, we can state that this Rezatec project has been an extremely important mission to increase the UK Sustainability level.

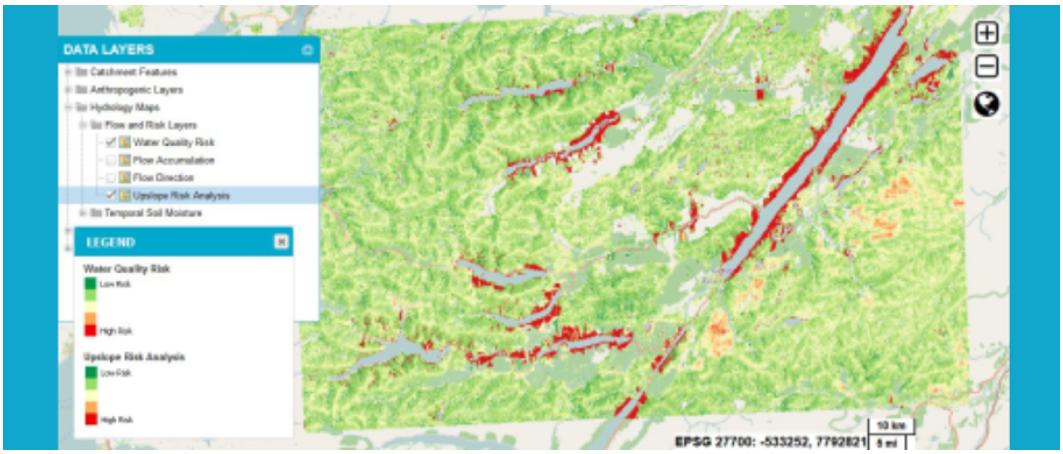

Figure 15. Monitoring Scottish Water's peatlands (Rezatec, n.d.)

Over the years, peatlands have deteriorated, influencing the amount of dissolved organic carbon (DOC) in water. This has been demonstrated by the almost fifty-eight peatlands analysed for Scottish Water, where there were signals of degeneracy and high DOC levels. Therefore, as this necessitates costly treatments to meet the mandatory drinking water standards, Rezatec has been the perfect affordable, non-aggressive and time-saving solution to monitor the state of peatland areas in an easier way (Rezatec, n.d.) (Scottishwater, n.d.).

Everything has been realized in collaboration with the Scottish Environment Protection Agency (SEPA). Being among the main beneficiaries of the project's outcomes, SEPA has been consulted to examine the feasibility of adopting Earth Observation technology in the daily operations taken to improve water quality. Rezatec exploited ESA's Sentinel-2 satellite to identify pollutants in water, like the generation of detrimental algal (SEPA, 2018). This project originated a peatland integrity index and water quality information, allowing even the possibility to detect changes and to make predictions through the use of algorithm calculations. Additionally, it allowed diminishing time and costs required to control the condition of wide and far-off catchments from which to draw drinking water, without the need for physical checks (Rezatec, n.d.).

2.5.3 From Facebook to Spacecom, aiming at providing Internet access in Sub-Saharan Africa

Space economy and terrestrial society are highly interconnected, especially as regards technological progress and evolution. There are some services that in modern times should be present everywhere. However, this is not always so. It is exactly in these circumstances that satellites can make a difference.

Africa, for example, is one of the main continents that still faces numerous challenges. This derives mostly from weak economies and consequent low commodity prices, high levels of poverty, unemployment, inefficient transportation and lack of infrastructure that increases trade barriers. Other reasons for struggling, that are still widespread in Sub-Saharan Africa, are political disorder and the frequent religious conflicts that worsen entire situations, exacerbating the obstacles for both governments and communities. Moreover, climate change intensifies the food insecurity problem and the presence of serious diseases that, in turn, increase migration. Aside from bringing solutions to tackle these issues, space is again considered as a way to induce socio-economic growth. Evidence of this is the African Space Agency established by the African Union (AU) by incentivizing the use of sophisticated technologies for different applications. The main ones are remote sensing and spatial data to elaborate maps and to monitor natural resources, respectively. Additionally, there are space sciences, which develop sensors for Earth Observation and process the obtained information to make everything understandable.

Over the last few decades, for example, Egypt has launched some satellites both for communication and Earth Observation, cooperating with numerous foreign countries. These tools have been essential even to ensure state security and to identify illegal activities, not to mention the many different advancements they introduced to face environmental concerns. Developments have been achieved in controlling water scarcity, high temperatures, reduced agricultural production, Nile River pollution and delta erosion, which consequently decrease tillable land and food yielding, too (Scatteia, Frayling and Atie, 2020). Publicly available satellite imagery aids the assessment of economic well-being in Africa, bringing significant knowledge to both researchers and policymakers. Being able to distinguish between prosperous urban and poorer rural areas, is in fact determinant to make rigorous economic estimations. It contributes

samples and reliable, cost-efficient statistics for the Sustainable Development Goals (Yeh, Perez, Driscoll and Et Al., 2020).

Facebook has been one of the most advanced in trying to revolutionize this continent: It has exploited space satellites to bring free internet there, even if later it failed. In 2016, the renowned social network together with the French satellite company Eutelsat launched the AMOS-6 satellite. It was leased from the Israeli company named Spacecom, with the purpose of making connectivity affordable to everyone (Kelly, 2015). This project was realised after the drafting of a UN report which stated that more than 50% of the world's population still does not have a stable connection. Of this percentage, nearly 90% belongs to the least developed countries of the world. The lowest levels have been identified in the Sub-Saharan area of Africa with less than 2% of households being connected, accounting for more or less 10% of the world's online population.

For this reason, Mark Zuckerberg, Facebook CEO, has committed himself to reduce the disparities in connectivity and access, organizing various initiatives since 2013. He aimed at leveraging the European Eutelsat Communications satellites to make the Internet available to the entire world (Talk Business, n.d.). Despite this, the launch mission unfortunately failed in 2016, with the Amos-6 satellite being lost in an explosion. The plan was entirely taken over three years later by Israel's Spacecom, which in 2019 launched a superior and progressive satellite, called Amos-17. The objective was to supply Africa with communications services, picking up again the project originally formulated by Facebook.

Spacecom is today a leading company that exploits satellites to offer solutions to the media industries. It provides advanced broadcast and broadband services for Europe, Africa, Middle East and Asia. The company has already received numerous orders and expects even more purchases during the upcoming years. This high demand is due to the fact that it offers cost-effective, ever-present coverage and stable connectivity even in remote areas, becoming useful for maritime and aeronautical activities. Spacecom, therefore, fosters growth in many different businesses and societies (Solomon, 2019). In addition, this enterprise is heading the communication revolution in Africa. It is accelerating the continent's development and it is improving all aspects of people's lives, becoming in this way a possible inception for many further opportunities (Improvate, 2021).

3. Sky-I: a start-up to monitor your suppliers

3.1 Sky-I's Value Proposition

In the previous chapters, we had an overview of how global risks are currently affecting our planet. We could see how critical the situation is, and how a corporate social responsibility strategy becomes essential to survive. We understood how it is now important to monitor the whole value chain to reduce the impact, and how the Space Economy could be truly the answer. The upswing is very fast, with a market already worth billions of dollars and promising under different points of view. Investing in it is a way to anticipate the future. It seems to be a very saturated market, seeing the various existing applications, but it is rather a deep source of innovative solutions. We are in fact experiencing a revolutionary approach to the observation market, thanks to the increase in available technologies, satellites, and people interested in the sector (Volpe, 2021).

Thinking of further developments on how space could help in fostering sustainability on Earth, I developed a business idea: Sky-I, the start-up that allows you to monitor your suppliers. Its mission is to provide a monitoring service of CO_2 emissions by means of satellite imagery and measurements. It aims at contributing to the urgent need of reducing global warming and air pollution, offering a tool useful for the implementation of the forthcoming carbon taxes.

Sky-I is a service that can be proposed to the suppliers themselves, in order to prove their compliance with sustainable standards. At the same time, it can be a valuable strategy for final companies to choose the suppliers they want to deal with, basing on their carbon footprint.

Looking at the needs, fears and wants of people, there is an ever-greater call to reduce global impact and to facilitate sustainability in all sectors. Furthermore, since relying on local suppliers is not always possible, there is also the necessity to manage suppliers from all over the world.

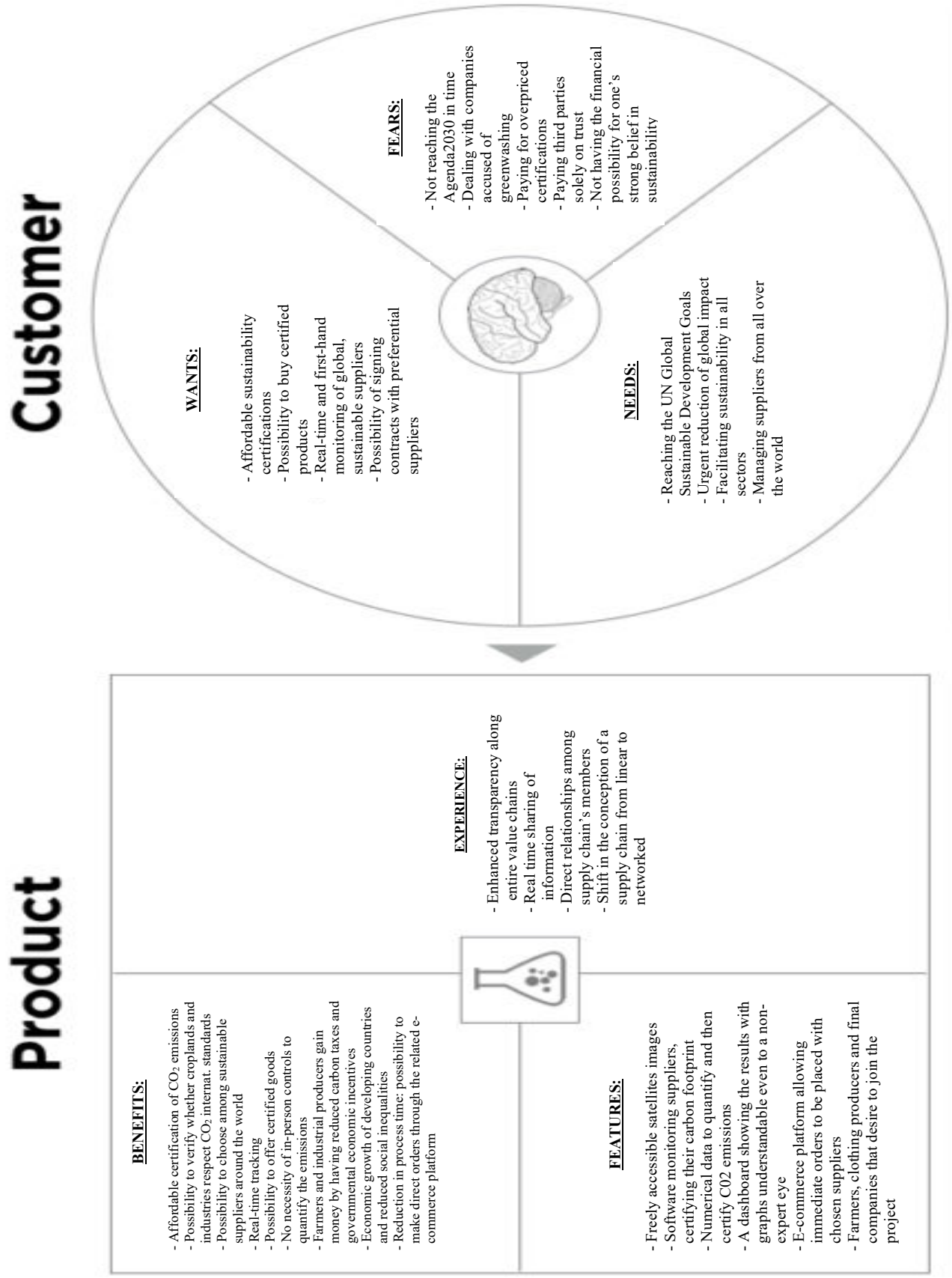

Figure 16. Sky-I's Value Proposition (Author's own presentation)

The planet is striving to reach the Agenda2030 goals in time and there are numerous fears: dealing with companies accused of greenwashing, paying for overpriced certifications, paying third parties solely on trust and not having the financial possibility to get the right price for one's strong belief in sustainability.

Companies nowadays desire affordable sustainability certifications, real-time and first-hand monitoring of global, sustainable suppliers and the possibility of signing contracts with preferential suppliers.

Sky-I is a start-up that ensures transparency along entire value chains by utilizing freely accessible satellites images, such as those of ESA's Copernicus. It certifies that the CO_2 emissions of crops and industries respect international standards and that companies are in a position to supply sustainable goods. It quantifies emissions in numerical terms and then illustrates them in a dashboard showing the results with graphs understandable even to non-experts. The app is linked to an e-commerce platform that allows immediate orders to be placed with chosen suppliers. This enables real-time sharing of information and direct relationships among the actors in the chain. It will also shift the conception of a supply chain from linear to networked.

Moreover, this business idea is precious if we think that in the upcoming future, an increasing number of governments will implement the carbon tax to comply with The Paris Agreement of 2015. This deal was drafted as an international framework to avoid the dangerous consequences of climate change. Specifically, the agreement limits global warming to an average of 2°C, preferably to 1.5°C, and it aims at achieving a balance between emissions and removals of greenhouse gasses by the second half of the century (European Commission, n.d.). The problems related to global warming and climate change are, in fact, the focus of the present public and political debate. As a result, economists suggest the implementation of a tax on products and services that produce carbon dioxide emissions, as a powerful strategy to limit them. This tax can be calculated by quantifying the costs of energy consumed, taking into consideration all the generated environmental and societal externalities. Another methodology is the pricing per ton of CO_2, in accordance with the Paris Agreement.

Current studies affirm that the existing level of taxation is extremely under-taxed with respect to the optimal level. Without the introduction of new regulations and constraints, the expected temperature increase is 4 °C by the end of the century (Bonini, 2019).

Imposing efficient energy taxes would hence globally reduce CO_2 emissions by 23% and deaths due to polluted air by 63%. Moreover, this tax would also result in a tax dividend of 2.6% of global GDP, which could be used, for example, to reduce other taxes or to contribute to other sustainability concerns. The estimated carbon tax, which should be enforced by 2030 to conform with the Paris Agreement, corresponds to $75 per ton of CO_2. Nevertheless, two other less ambitious scenarios with taxes at $50 and $25 are taken into consideration, as they would still be in line with the Paris targets for some countries (Bonini, 2019). The importance of this is witnessed by the fact that the number of countries that have introduced carbon pricing measures has risen from nineteen countries in 2010 to fifty-seven in 2019. The trend is increasingly diffusing even in Europe, where Sweden was one of the earliest nations to adopt this taxation. This country introduced the carbon tax in the 1990s, and since that moment its GDP has grown by 58%, with a decrease in greenhouse gas emissions of 23%. Additionally, Sweden has already passed a law committing itself to become carbon neutral by 2045, five years ahead of the European targets. Italy, on the contrary, is an example of a nation in which emissions have not decreased since 2014. Despite the urgent need to innovate its climate policies, it continues to be passive. As stated by Edo Ronchi, former Environment Minister and current President of the Italian Foundation for Sustainable Development, "we will not be able to achieve drastic reductions in carbon emissions if we continue to allow them to be emitted into the atmosphere free of charge" (Greenreport, 2019). Therefore, as the entire world is committing to reduce negative impacts increasingly, we can make a foolproof prediction that, within a short period of time, all nations will start adopting measures to reduce CO_2. This gives additional value to the planning of a business like the one of Sky-I.

3.2 Further technological developments needed to implement Sky-I.

Sky-I can be leveraged in almost all business sectors, but we will examine one specific application in detail, to make the project explanation easier. We will focus on the cotton clothing value chain, the apparel sector being one of the most polluting.

Sky-I satellites will monitor the impact of cotton cultivations and cotton clothing industrial producers around the globe to ensure their compliance with sustainability regulations concerning GHG emissions. This allows the avoidance of in-person controls and expensive, temporary certificates.

In this section, we are going to see the various type of existing satellite technologies and how they are currently employed in agriculture, the main challenges and possible future solutions.

Firstly, a brief introduction on the main differences of existing satellites is essential to have clarity of mind as to what typifies each category of use. Sensors are classified into mission groups according to their mission type and spatial resolution.

Considering their properties, a primary subdivision is the one between Multispectral and Synthetic Aperture Radar (SAR) sensors. The former is effective in the visible and infrared spectral domain, the latter operating in a microwave spectrum.

This means that the efficiency of multispectral sensors, which measure reflected sunlight, depends on whether there is sufficient solar illumination and no cloud cover. SAR sensors, instead, capture the backscattered radiation from a microwave pulse they emit, so that the imagery can be obtained independently of the sun and clouds. This allows the generation of reliable and consistent time series, for example, to compare information from different crop seasons, for crop delineation and area measurement. With the introduction of SAR systems in orbit, the mapping of irrigated land has become an established available service. Surpassing the static perspective of a map has thus been revolutionary because it has permitted to enhance the quality of the obtained measurements. It has allowed the detection of changes and databases to be updated in a cost-effective manner. Radar images, in fact, are considered very favourable for the future, and for this reason, are in continuous improvement.

A further subdivision in sensor groups is the one that depends upon spatial resolution. This is of interest because it determines whether the technology can be applied in the context of agricultural statistics, importantly concerning production unit sizes, i.e., crop parcels and grazing areas as well as landscape characteristics, such as tree cover, mixed crops and eligible land use elements. Lower-resolution sensors can capture much wider areas per orbit, but not detailed landscape features to portray production areas. This is the reason why today this category of instruments is not directly used for agricultural statistics, but rather for large areas and multiannual phenological analysis. On the other hand, very high-resolution images, like WorldView-3, can reach a resolution of 31 cm for atmospheric control, cloud, snow, and ice detection. They do not, however, offer measurements like GHG emissions, yet. Nevertheless, these technologies continue to be studied to constantly improve the obtainable data (Achard et al., 2017).

There are different indexes in agriculture, to analyse farms and to increase productivity. An example is the renowned Normalized Difference Vegetation Index (NDVI), which identifies the presence of photosynthetic activity and describes the vigour level of the crop, is a basic indicator of the health of plants. It can discover anomalies in crop development and it offers the possibility of detecting areas that need intervention. Higher values, usually recognized by a darker colour, imply denser coverage and healthier condition, while negative values indicate vegetation stress.

The Normalized Difference Moisture Index (NDMI), instead, recognizes humidity and water stress levels in the cultivated field. For this reason, it is used to monitor drought and to calculate the probability of fire. Then there are other indexes, which can compute the absorption of water and nitrogen in the foliage of the plant, and how they interact with inward solar radiation. Other indicators are used specifically to estimate soil and vegetation moisture or to determine the growth of plants. All this knowledge derived by using satellite remote sensing, is essential for harvest and irrigation planning, leading to better management of the activity. Such a way of obtaining information enables farmers to apply different fertilizing and seeding treatments depending on the specific zone. (Latitudo40, 2021) (DynaCrop, n.d.).

Today, therefore, satellites can measure vegetation condition, soil moisture, rainfall prediction, the CO_2 levels of large areas and surface temperature. Geospatial technologies combine climate and soil information, fertilizer usage, irrigation water and agrometeorology to assess crop production and to forecast crop yields. Crop simulation models (CSMs) provide computerized portrayals of crop growth and harvests, simulated thanks to mathematical equations as functions of soil, weather, and management. Hence, thanks to their comprehensive coverage and their ability to track over time, space technologies are considered valuable tools for agricultural monitoring, ecosystem accounts and carbon accounting. The latter consists of measurements of carbon stocks and flows, to analyse carbon cycles and carbon pools. This becomes crucial when alternative ways of acquiring data are scarce (Paganini et al., 2018).

Another way in which satellites can lead to improved and sustainable practices is by studying and forecasting pests and diseases, thus reducing the need for insecticides and chemical substances. Some plant pests may be detectable by satellite, even if not all of them. Locusts, for example, are not precisely monitorable from above, but large swarms can already be approximated by analysing the availability of fresh vegetation, weather

conditions and other factors. However, for smaller-scale pests, like fire blight bacteria, the resolution of satellite images is not enough, and in this case, drones may be a solution. Drones, better called Unmanned Aerial Vehicles (UAVs), have enhanced sensors that are already used in precision agriculture to identify nitrogen-deficient areas in a crop and to plan precise fertilizer programmes. Practices can be customized to meet the nutrient requirements of different crops in diverse zones and to establish weed and disease levels in tillable crops. The number of pesticides and fertilizers used in agricultural processes can thus be reduced while keeping a high crop yield. Moreover, these methods help farmers prevent pests and the damage they cause. They become, in this way, a contribution to the resolution of the global food security emergency (Achard et al., 2017).
After having seen what already exists, we will now turn to the still unresolved problems, bearing in mind that our Sky-I project is based on monitoring CO_2 emissions.
Spatial resolution, for example, is still premature to take specific GHG measurements of a single cultivated area or of a specific, identified company. There could be an enterprise that regularly emits pollutant gasses in the neighbouring areas of the field, and this influences the obtainable data, which consequently may not be accredited to the field taken into consideration. In other words, it is possible to monitor CO_2 emissions, but these cannot be strictly attributable to a particular harvested field. More advanced satellites technologies are needed, capable of higher resolution atmospheric measurements. But they will be realizable only with future missions.
An additional challenge in the cultivation business is that satellite technology analysis is closely linked to several factors. Difficulties in crop area estimation include the study of small fields and diverse cropping systems depending on phenological differences. They are also due to long sowing periods, short-durable crops, and complex physiography, such as terrace farming. Everything is made even harder by complex seasonality, i.e., some crops grow in multiple seasons depending on the climate. The elaboration of estimates thus becomes even more challenging. Furthermore, the whole process is complicated even more because crop area estimation must be done at more than one stage, before and during initial sowing, halfway through the season and prior to the harvest. This explains why the conventional method of crop area estimation could not be enough. It takes a lot of time and cost, it is conditional to human biases, and it is also hugely challenging in some types of terrains. To rise above these issues, satellite remote sensing has been indispensable, but the aspects to consider in machine learning

applications are numerous. Furthermore, everything is made more critical because each crop has its own growing specificities and different phenological phases. Because of this, rigorous phenological models facilitate researchers in monitoring and forecasting vegetation reactions to climatic variability, thus becoming always more a prerequisite. One of the most important determinants is the resolution of acquired satellite images. For this reason, a technological distinction among satellite developments is necessary in order for the correct choice to be made to implement Sky-I.

A very important historical step for the sector was made in 2015 with the launch of the Sentinel 2 satellite. Since then, it has been possible to receive images of the Earth every four days. This data has a resolution of ten meters. So, a single pixel of a Sentinel 2 image is equivalent to ten square meters of the Earth's surface. It can easily monitor the growth status of crops and be specific in the field, given its resolution.

In addition, the Sentinel 5P satellite was launched into orbit in 2017, again thanks to ESA's Copernicus program. It allows the acquisition of information on the emissions of CO_2, ozone, methane, formaldehyde, aerosols, nitrogen dioxide and sulphur dioxide into the atmosphere (ESA, n.d.). The degree of these greenhouse gasses is significantly influenced by land management activities. Methane (CH_4), nitrous oxide (N_2O), and additional CO_2 emissions, for example, are derived from the drainage of organic soils for agriculture and biomass fires, including fires on organic soils. The problem is that unlike Sentinel 2, Sentinel 5P has a resolution of 7 km x 7 km. This result in a precise amount of CO_2 in the atmosphere for 7 km^2. Therefore, it is possible to monitor CO_2 emissions, but these cannot be strictly imputable to a specific cultivated field, yet, but rather to the entire area of at least 7 km^2. However, thanks to the data of the Sentinel 5P satellite, it is possible to identify initial information, at a much lower cost than of a massive installation of sensors throughout the territory. The main issues to be solved remain the spatial scale and the possibility of analysing aspects hitherto validated only from the ground, and of studying them with similar accuracy from the sky.

Sentinel 2 and Sentinel 5P, with their different technologies, may therefore be integrated to reach the desired level of measurement. The former mounts a lens, an optical sensor that photographs single fields. Sentinel 5P is equipped with a spectrometer sensor. A combination of these two technologies, with SAR data to overcome the cloud problem, may be the means to obtaining a more detailed measurement of polluting gasses, as needed for Sky-I.

No individual satellite system can in fact provide all the information needed for the start-up by itself, because it would lack the desired scale. There is the need for innovative complementary development, for example, the one between Landsat satellites and the Moderate Resolution Imaging Spectroradiometer (MODIS). The first ones offer an excellent spatial resolution, but their measurements are too irregular in time, whereas the latter has poor resolution, but much more frequent sampling intervals. The aim was to elaborate daily evapotranspiration maps with a resolution of 30 meters, taking into consideration the evaporation of water from the soil, canopy, water sources, and vegetation transpiration (Cook, 2017) (Hoogeveen, 2021). Another example is the association between Sentinel 2 and Landsat 8 to define canopy coverage and to play a part in the differentiation of crop types.

These are clear illustrations of how the merging of the best features of different satellites can often lead to great results. The key is to find the right, necessary balance between temporal and spatial resolutions. The first aspect requires reaching more observations per day, while the second entails being able to have a finer resolution when the fields of study are very small, as in our case. However, as observation technology improves with every new satellite mission, these are all features that will improve with future launches. This is not a problem, considering that the time needed for satellite development is as long as the time needed to design a start-up. Therefore, the two things can go hand in hand and be developed contemporarily.

Detecting the sustainability of crop fields and crop production is thus less obvious than it sounds, as there are too many factors to be taken into consideration and that are different for each crop. Nutrients in the soil, however, are probably the most difficult parameter to measure from a satellite; understanding whether pesticides and chemical substances are used, is the most difficult part. Additionally, the use of these compounds, together with the availability of sunlight and water, influence land temperature and plant growth. Such information can then be combined with and completed by ground observations and ancillary data to cope with the challenge given by differences in crop types, growth timing, and the implemented practices. Ancillary information usually relates to supplemental expertise that comes from sources other than remote sensing, and that can help to improve classification accuracy (Achard et al., 2017). So, in this day and age, with the appropriate technology still lacking, there is the need for ground measurements to determine carefully the plant productivity and related carbon capture. Today this can be

done, for example, by leveraging flux towers, that identify CO_2, water vapour and other gasses exchanged between forests and the atmosphere. This implies that to be successful, technologies need to be adapted locally, in view of the harvesting systems and environmental conditions.

However, it is also possible to analyse the differences between crop types with their relative emissions levels. In the case of cotton, for instance, it would entail the study of variances in CO_2 emissions when sustainable practices are adopted vis-à-vis when pesticides, chemical fertilizers or other substances are used. By looking at satellite measurements, this examination will generate a threshold that will enable us to understand, whether cultivated fields probably adopt organic practices or not.

This measurement methodology, moreover, can benefit many policy-relevant issues, like those regarding greenhouse gas emissions, use of energy and degree of deforestation. Carbon accounting can be crucial to tracing the compliance of some of the Sustainable Development Goals Indicators, such as the one defining carbon stocks. This is one of the aspects that worsens land degradation (Paganini et al., 2018). Hence, remotely sensed data from Earth Observation satellites is the most cost-effective way to collect timely and reliable information over wide land areas. They increase accuracy, bring practical efficiency, allow repeatability, and reduce costs by employing less time to generate sampling frames. Space technologies can be essential in monitoring crop development, facilitating agronomic interventions and giving the possibility to plan personal visits to the field.

The result is again a reduction of costs, more sustainable production, and more stable access to food for all. Another advantage is that further improvements in detailed crop mapping will permit to characterize crop-specific growth cycles better. Of course, all this will entail considerable investments in information technology to accelerate the processing of a great amount of data. Despite this, a paradigm shift is now occurring. Remote sensing offers ever more reliable primary estimates of agricultural production, and these are no longer conceived as purely secondary data only useful for verification (Achard et al., 2017).

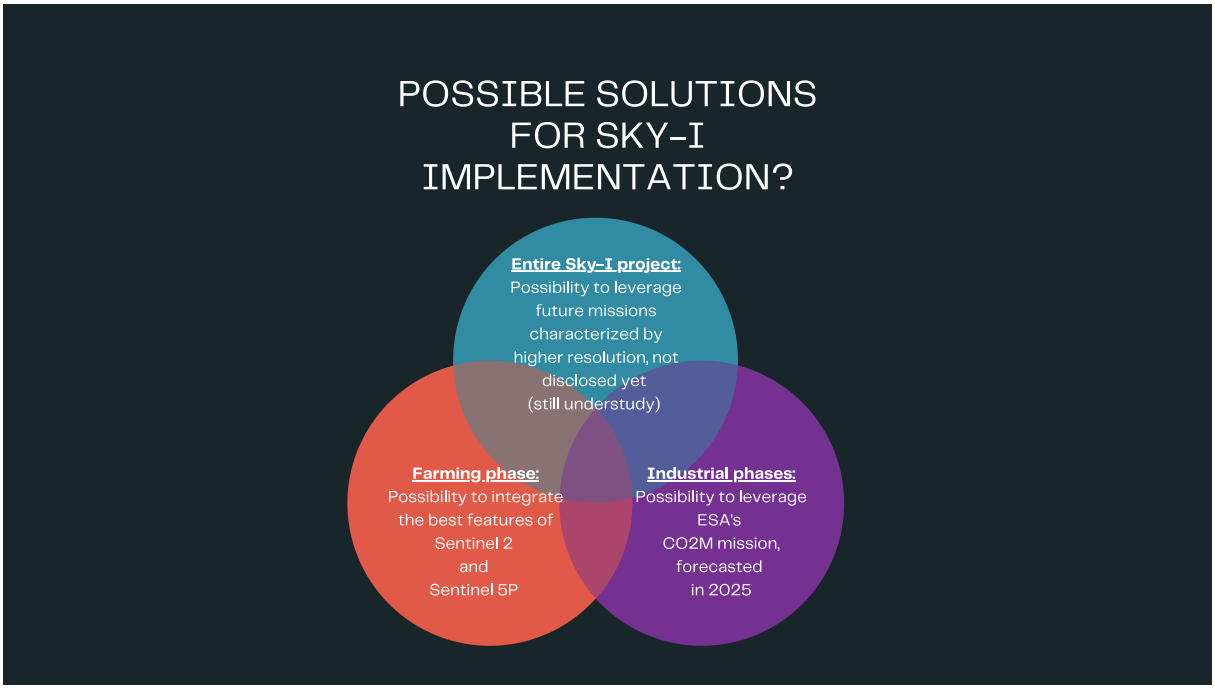

Figure 17. Possible solutions for Sky-I implementation

For Sky-I, finally, we could partially leverage the Copernicus program CO2M mission, forecasted for 2025. It will focus mainly on Anthropogenic Carbon Dioxide. This means that its goal is to measure emissions from industrial complexes, from vehicles in cities and from the exhaust of buildings. These measurements are performed with a spatial resolution of 4 km^2 and a precision of 0.7ppm. This is not sufficient to monitor the CO_2 emissions of agricultural sources as these vary significantly less than the concentration of anthropogenic emissions. However, in Sky-I, this can be utilized to trace the impact of production industries. As for farming, further satellite advancements are still required to detect CO_2 emissions from cultivated fields.

Nevertheless, as the technology is evolving towards higher and higher resolutions, and CO2 tracking is becoming a core business for institutions and private individuals, Sky-I implementation might be possible in the future. Taking this into account, the next paragraph will present the details on how to develop a possible commercial service to be showcased as soon as the technology is ready.

Table 2. Some expected future satellite missions concerning CO2 monitoring

Satellite	Institution	Service Dates	Resolution	Field of application
MicroCarb	CNES (France)	expected 2022	2 km x 2 km	Designed to map sources and fluxes of CO_2 between the atmosphere and the oceans/vegetation
GOSAT-3	JAXA (Japan)	expected 2022	10 km x 10 km 3 x 3 km 1 km x 1 km (spatial resolution three times higher than that of its predecessor, GOSAT 2)	Designed to observe concentrations of greenhouse gases with high precision. It will cover large areas of Earth's surface without discontinuity, thus enabling more observation points than with previous models
GeoCARB	University of Oklahoma (U.S.)	expected 2023	10 km x 10 km 5 km x 5 km	Designed to conduct observations of vegetation health and stress, as well as observe the processes that govern the carbon exchange between the land, atmosphere, and ocean
Biomass	ESA	expected 2023	200 m x 200 m	Designed to determine the amount of biomass and carbon stored in forests
CO2M	ESA	expected 2025	2km x 2km	Designed to measure atmospheric carbon dioxide produced by human activity

3.3 Business Model Canvas

After having consulted various experts of the field, such as members of the Copernicus Programme, OHB Spacecraft, Latitudo40 start-up and an aerospace engineer, I came to the conclusion that, as soon as the technology will be ready, a business project like Sky-I may be implemented. We will now explore thoroughly all the project characteristics. As anticipated above, when using freely accessible Earth Observation satellites, the objective is to monitor the CO_2 emissions of international suppliers, belonging to different sectors. The purpose is then to enable final companies in a supply chain, henceforth "final company", to choose the farmers and producers who respect international emission standards. In addition, they will be able to monitor suppliers' impact in real-time.

Figure 18. Author's own presentation

Considering, specifically, the cotton production value chain, the Sky-I start-up would measure CO_2 emissions at the farming level, and at all the stages of the industrial work. This chain consists of cotton cultivation as a first stage, followed by other different steps

in industries: ginning and yarn production, knitting and textile refinement, and final good processing.

No less important is pollution deriving from retailers' and households' usage phase. A powerful communication programme might profitably be attached to this project to increase awareness. TV advertising sponsoring the app should be studied to also increase people's knowledge of their personal contribution to GHG emissions. If, for example, a t-shirt is washed 55 times, it accounts for 31% of the total emissions of a clothing value chain (Ton, Kasterine and Knappe, 2011). Therefore, advertising and communication would be efficacious both to promote the launch of the start-up as well as to educate citizens about the fact that, in the textile industry, a great part of emissions comes from product use.

Furthermore, there are various reasons for developing this business idea. First, there is the desire to favour the relationship between people and nature while creating impactful solutions. There is the willingness to incentivize changes in production practices that will positively affect our world's climate, environment, and people. These ambitions are then strengthened by the fact that, in 2021, it is not acceptable that sustainability is still something not economically affordable to everyone. So, another purpose is to sustain small enterprises, making satellite monitoring accessible to them also. Moreover, as agricultural emissions are expected to rise by almost 40% by 2030, due to the rising demand for food caused by an increasingly growing population, the adoption of certified organic cotton, which does not utilise chemicals, becomes crucial. Compared to the traditional cotton production, the organic one would result in a 46% reduction in global warming and a decrease of over 90% in the use of freshwater (CFT Masserini, n.d.). The main objective is therefore to collaborate with the UN Agenda 2030.

In Sky-I, this is done by committing to further minimisations of emissions, by incentivizing increased efficiency in input usage, by contributing to the progress of developing countries and by providing further income possibilities to millions of farmers. Beneficiaries of this start-up would be both final companies and the participatory suppliers, which either strive to reduce their footprint or to become carbon neutral. Specifically, final resellers will gain money by offering their customers certified sustainable goods and by having the possibility to increase prices and sales. They will even benefit from having the possibility of monitoring the suppliers by themselves and not having to rely on third parties anymore. Traditionally firms trust in certifying bodies,

that being on the ground, issue only certifications with a temporary validation due to the limited number of inspections that can be done during a year. Hence, final, end-user companies will have the advantage of real-time tracking, having the possibility to see with their own eyes how suppliers work. This avoids the need for in-person controls and assures transparency in all the procedures.

On the supply side, all the suppliers that take part in the project can demonstrate their sustainable working system. This will result in them gaining money from reduced carbon taxes and government financial incentives. They have the possibility of proving their sustainable commitment daily, not having to pay for expensive certifications. This is very important, for example, for micro-enterprises that will therefore be empowered to freely certify their environmental footprint. Moreover, this will have positive repercussions on the national economic growth of developing countries and will reduce social inequalities at the same time.

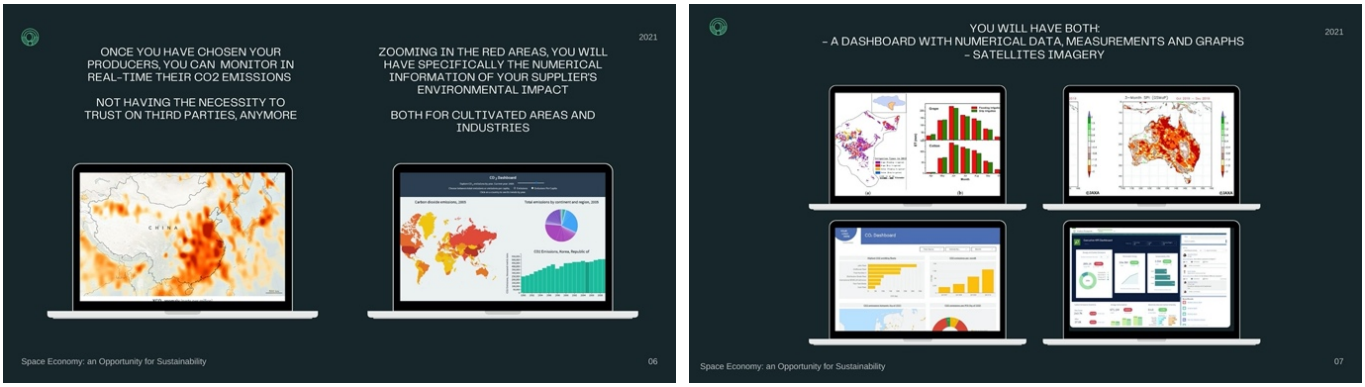

Figure 19. Author's own presentation

Nevertheless, Sky-I would not be beneficial only for those enterprises with financial problems. It would be favourable for all companies wanting to certify their compliance with the international sustainability regulations. This will consequently make clients feel confident about the way in which all a chain's actors work.

All participants will jointly benefit from a reduction in process time, too. Being all in direct contact among themselves, they can place orders through the related e-commerce platform.

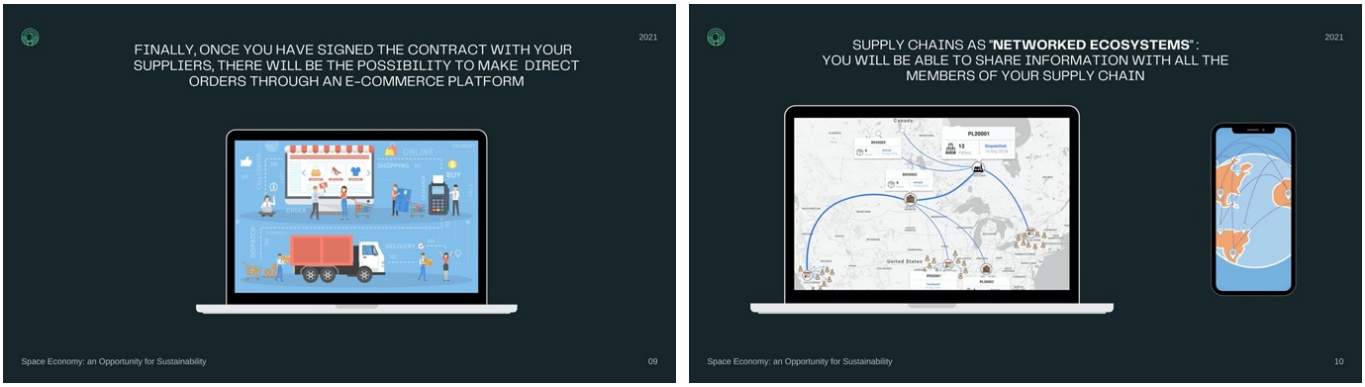

Figure 20. Author's own presentation

The experience thus offered will consist in the opportunity to join a networked supply chain where there is cooperation and clear visibility.

Now we are going to see in detail the key activities needed for the implementation of this business. One task will be to find farmers and clothing producers willing to adhere to the project and to register them on the app. Another would be to investigate daily, via satellites imagery, whether these actors meet sustainable standards. If so, certificates will need to be developed for them too. However, all this would entail storing updated information about each supplier on the app. Another employee activity would be to search for final companies looking for certified sustainable suppliers selling products with a certified carbon footprint.

The key partners for the project will be satellite manufacturers and space agencies that render satellites and their images publicly available.

Trained staff is essential, especially teams of experts that must be able to interpret satellite imagery. Also needed are researchers and scientists with agricultural competence, capable of studying the relationship between the use of pesticides, chemical substances, irrigation methods, machinery, and fuels on one side, and CO_2 emissions on the other. They should analyse the quantitative differences in released emissions between organic versus non-organic farming practices. This will give Sky-I the means to understand the type of cultivation adopted and whether sustainable practices are executed. For this reason, there is the need for teams of experts in agronomy capable of examining the data generated by remote sensing and capable of statistical computation. Another requirement is the participation of an ICT team to instal the platform and to develop the app. Other fundamental partners would be UN Governments willing to invest

money to incentivize sustainable cultivation and production practices. The European Commission, currently dedicating itself to Natural Capital Accounting, may be an example. This commitment is about keeping track of the EU economic well-being deriving from its natural capital, such as biodiversity, fertile soil, forests, productive land and seas, water and air quality, climate regulation and defence against natural disasters. If we think of all the goals that governments must reach in the near future, we can affirm that they will be always more attracted to this service. The European Green Deal, the EU Biodiversity Strategy for 2030 and the Paris Agreement are just some examples.

Therefore, Sky-I is a project that can aid the United Nations in policy decision-making, allowing them to dispose of a tool that can be crucial to set common rules, methods, reports, or taxes (European Commission, 2021). The UN Member States, in fact, agreed to sign the United Nations Framework Convention on Climate Change (UNFCCC), committing to regulate greenhouse gas concentrations in the atmosphere to head off dangerous human influences on climate. To reach these global Sustainable Development Goals, sustainable management and practices are needed, which will also stimulate interest in the start-up offer (Tubiello et al., 2014).

As for further partnerships, large bodies like EMAS may be helpful in promoting business activities. Being an internationally recognized management tool, conceived by the European Commission to assess, report, and improve organizations' environmental performance, it may promote business success (European Commission, n.d.).

The main competitors would turn out to be the current, expensive certifications companies. These, however, may become potential customers, too. They may need a faster method to collect data, useful in ranking organizations in terms of their sustainability. Other rivals could be people working for GHG ground measurement systems, and even the traditional e-commerce platforms. The latter commonly place orders by leveraging the trader's role, hence with longer waiting times. However, this commercial service being a revolutionary business, it may somehow be sold to all these potential competitors, who in turn would become clients.

The main customer segments are farmers and industrial producers willing to demonstrate their carbon footprint. Final companies with activities based on cotton would be among the primary targets, too. Even investors, who want to have information about companies' environmental impact, may become potential customers.

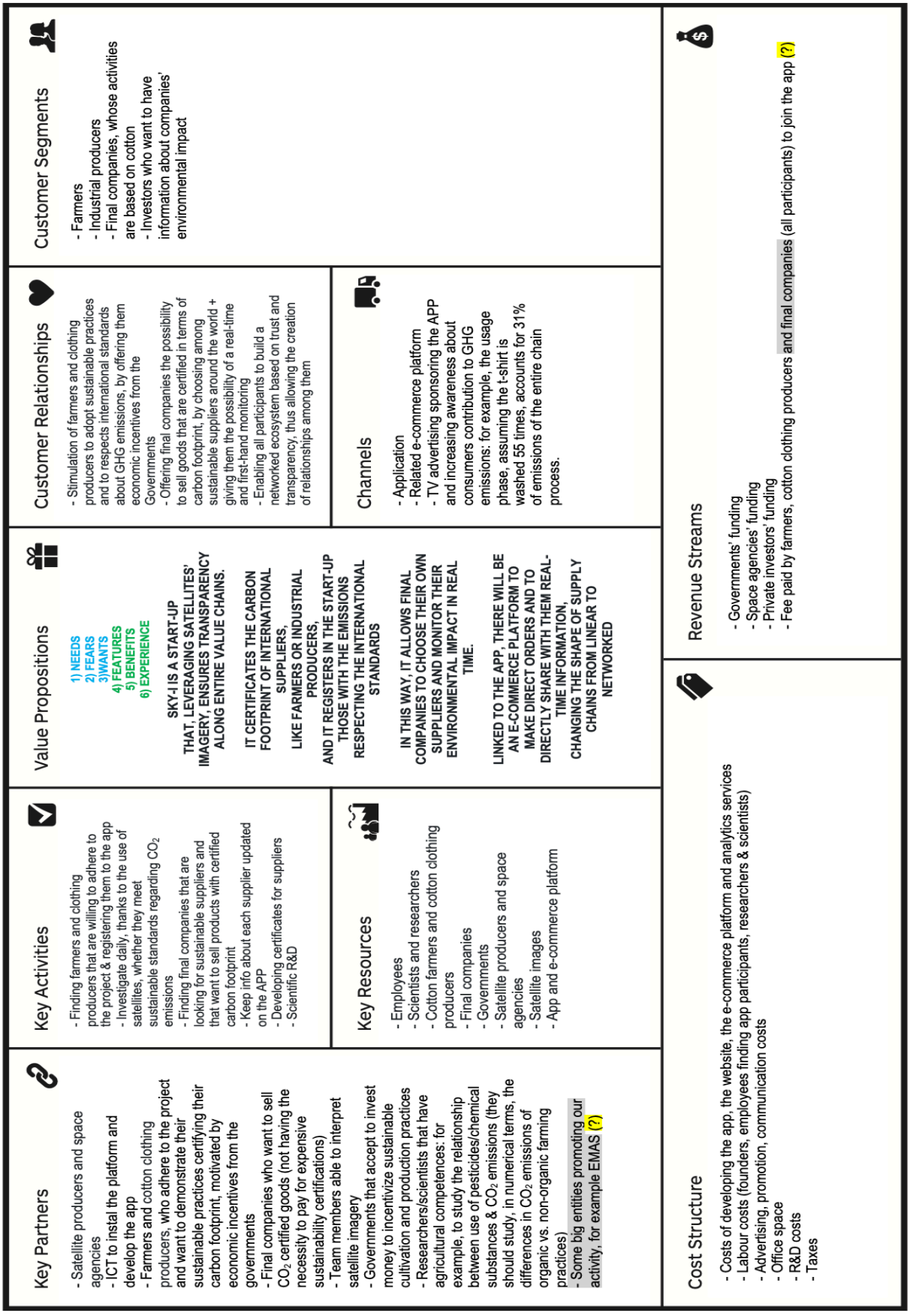

Figure 21. Sky-I's Business Model Canvas (Author's own presentation)

Regarding the relationships with them, it is important to encourage suppliers to adopt sustainable practices by offering them economic incentives from the governments they belong to. It is then important to motivate them to be registered and to join the project. In addition, it is even necessary to communicate the benefits for the end-user companies, benefits obtainable by selling certified products. Participants would be enabled to build a networked ecosystem based on trust and transparency, thus creating direct relationships among themselves.

Considering all the above-mentioned aspects, the costs of realizing this idea will be the costs of developing the app, the website, the e-commerce platform and of all the data analytics services. There would even be advertising and communication costs, plus office space. Moreover, if we think of the necessary, competent staff, labour costs will be the highest. These will include the salaries of the business founders, staff employed to find participants, researchers, and scientists.

To support this, there exist staff training programs, like NASA ARSET, that help to lower the costs of research and development. These consist of webinars and training sessions organised by space agencies on how to read and interpret satellite imagery, and how to integrate Earth data science into decision making. Finding skilled staff, however, remains the focus: Geographic Information Systems (GIS), image investigation, statistics, agrometeorology, soil and crop science are all subjects that, requiring specialists, entail the majority of costs.

On the contrary, cost factors relating to commercial imagery would not be an issue for this project, as it relies on free and openly accessed data. For some sensors, result usage is licensed, meaning that customers do not own the data, but rather pay for its obtainment. The introduction of free and open license satellites images, on the other hand, continues to increase. Sentinels belonging to the EU Copernicus programme, as well as to the American MODIS and Landsat missions, are all of this kind. They respond to the international efforts to open up Earth Observation records to the public, with the aim of sharing knowledge about global environmental monitoring. This type of service has a noteworthy impact on many potential applications in agricultural statistics, leading to cost-effectiveness.

To determine the actual advantage, we need to compare the costs between remote sensing and traditional data collection systems. Considering area estimates based on

satellite measurements, the benefits would be reduced direct costs due to the achievement of the same estimate at a lower cost, but also improved responsiveness and accuracy. Concerning agricultural statistics, cost-effectiveness depends on several parameters, such as the level of landscape fragmentation and weather influence, but there would certainly be greater precision in statistics with a reduction of sampling variance. Moreover, considering the great availability of free satellite data, the general reduction in the sector prices, and the improved image quality, we can guarantee the cost-effectiveness characterizing remote sensing (Achard et al., 2017).

Revenue streams, instead, will mainly derive from different funding sources coming from governments, space agencies, public and private investors. Moreover, there will be a fee paid by all participants joining the app, from farmers to cotton clothing producers and final companies. Another option would be the one to make producers pay while treating final companies as users who do not pay for the service.

However, many organizations are supporting the realization of start-ups, not to mention the many different entities willing to invest in sustainability projects. An example is the European Space Agency, which financially sustains business incubation centres. It resulted in more than 500 company creations since 2003, and it continues to fund nearly 140 start-ups per year (OECD, 2019). In addition, space agencies typically organise hackathons, prizes and challenges to detect promising businesses.

All these initiatives are being involved in elaborating business ideas, which, without economic aid, would remain unattainable (Achard et al., 2017). Proof of this are the numerous existing start-ups born to analyse satellite images, such as the Italian Latitudo40. There is still huge fertile ground for commercial applications.

3.4 How Sky-I contributes to Agenda2030

Sky-I would take part in the action for World Sustainable Development, by supporting different objectives of Agenda2030. It would answer the need of all the people that cannot simply rely on local artisans or farmers by facilitating the management of suppliers coming from all around the world. It is a system that aims to sustain all those enterprises that do not have the economic possibility of paying expensive certifications, making sustainability an affordable value for all. Therefore, it is a way of reducing costs simply by complying with regulations.

Sky-I is also a way to incentivize changes in farming practices by motivating companies to reduce the emissions from their crop cultivations. The significance of this becomes apparent when we see how sustainable practices would lead to a reduction in global warming and water usage, positively impacting life and nature.

This business aims at reaching the UN Global Sustainable Development Goals by the defined deadline, facilitating the introduction of sustainability in different sectors.

Figure 22. Sustainable Development Goals (United Nations, n.d.)

Regarding the societal concerns, it would contribute to the Goals n.1, n.8, and n.10 concerning "*No poverty*", "*Decent work and economic growth*", and "*Reduced inequalities*", by making sustainability accessible to everyone. It would sustain the jobs and salaries of workers living in developing countries, such as cotton farmers, offering them an opportunity to widen their market internationally. This is also improved by offering farmers and producers around the world the possibility to verify their compliance with international standards, and to pay accordingly less taxes while receiving governmental incentives. This is in line with Objective 1.4, which is about allowing the:

> "*Access to basic services, ownership and control over land and other forms of property, … natural resources, appropriate new technology and financial services*" to all (United Nations, n.d.).

It conforms even with Objective 1.A, which commits to:

> "*Ensure significant mobilization of resources …, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, … to implement programmes and policies to end poverty in all its dimensions.*" (United Nations, n.d.).

Another purpose would be to "*Achieve higher levels of economic productivity through diversification, technological upgrading and innovation*", as stated in point 8.2 (United Nations, n.d.). Sky-I would contribute also to Goal n.9 about "*Industry, Innovation and Infrastructure*", by modernizing market dynamics, and by innovating and improving supplier relationships. The aim is to reach an:

> "*Inclusive and sustainable industrialization, together with innovation"*, to allow *"dynamic and competitive economic forces that generate employment and income"* (United Nations, n.d.).

New technologies will permit to facilitate *"international trade and to enable the efficient use of resources*." It is a way of advancing the manufacturing sector of many developing countries and of bolstering investments in scientific research and innovation. Continuous technological progress would lead to higher profits for companies, as well as to improved outcomes for all the stakeholders. Furthermore, it would foster competition, heightening innovation in the industries and satisfying Objective 9.5. This advocates the advancement of R&D by 2030, which is fundamental for Sky-I's realization, and the creation of opportunities coming from enhanced operational efficiency and saved time (United Nations, n.d.).

In addition, Sky-I upholds "*Responsible consumption and production*", as intended with Goal n.12, by encouraging efficient inputs use. Changes in production practices, cultivation, and consumers' habits are all essential in facing the imbalance between the increasing population and available natural resources. Sky-I, consequently, tries to foster even an increase in people awareness, prospecting an ad-hoc advertisement to incentivize consumers' sustainable behaviours.

Goal 12.A says that a necessary action is to:

> "*Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production*" (United Nations, n.d.).

Goal 12.B, instead, suggests to "*Develop and implement tools to monitor sustainable development impacts*", while point 12.C advises a restructuration of current taxation. These are all objectives included in Sky-I's action.
Accordingly, Goal 2.3 aims at increasing the *"incomes of small-scale food producers, in particular women, indigenous peoples, and family farmers."* It tries also to ensure a:

> *"Secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition"* (United Nations, n.d.).

Space Economy is also lending a hand to reach goal n. 2.A to:

> *"Increase investment, ... and international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant".* This is done *"in order to enhance agricultural productive capacity in developing countries, in particular, least developed"* ones (United Nations, n.d.).

Sky-I would touch even Goal n.17 about "*Partnerships for the goals*", striving to obtain support from all the UN members. Moreover, one of its business goals is exactly the establishment of a strong international network that would ease cooperation for sustainability. It "*enhances policy coherence for sustainable development*" as aimed with the objective 17.14, enhancing global partnerships and supporting developing countries, too (United Nations, n.d.). Relating instead to the environmental challenges, Sky-I participates in the struggle against climate change. It sustains UN Goal n.13 about the "*Climate Action*", trying to limit the CO_2 levels and other greenhouse gases in the atmosphere, which have increased to new records in recent years. There has only been a temporary improvement in the global situation, due to Covid19 circumstances, but it is expected to worsen again as soon as the Pandemic ends. Objective 13.A is about:

> "*Implementing the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change".* This agreement is about *"mobilizing jointly $100 billion annually … from all sources to address the needs of developing countries"* to "*fully operationalize the Green Climate Fund as soon as possible*" (United Nations, n.d.).

This must be reached with a parallel commitment to raise people's awareness of the gravity of the problem (United Nations, n.d.). It is a fight that, if won, has positive consequences on people's lives, economies, extreme weather, sea and land life concerns. Furthermore, Sky-I, monitoring CO_2 emissions, would take part in purpose n. 12.4, which aspires to:

> "*Achieve the management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks."* This is extremely important to *"significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment*" (United Nations, n.d.).

This specific start-up action is extremely important if we think, as already mentioned above, of the increasing number of governments that will soon introduce the carbon tax. This business idea would be even beneficial for Goal n.3: "*Good health and well-being*", specifically answering at point 3.9. This is about "*Substantially reduce, by 2030, the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination"* (United Nations, n.d.).

Air pollution is currently considered the most dangerous environmental health risk. In 2012, the World Health Organization (WHO) imputed 3.2 million deaths to air pollution, with Asian inhabitants as the most at risk, because of the fast urbanization and industrialization that characterize them. Many different industrial processes, such as combustion and materials processing produce some particles that can enter human respiratory and circulatory systems. If this happens, they can bring health problems, such as pulmonary diseases and heart attacks.

Apart from industrial reasons, forest fires too, caused by climate change and drought events, contribute to air pollution. The Intergovernmental Panel on Climate Change (IPCC) has reported that CO_2 emissions originated from land usage and deforestation correspond to up 25% of total human-generated ones, with commercial agriculture as the main driver.

All the above-mentioned environmental issues can be monitored by leveraging Earth Observations. Gas concentration can then be estimated and value-added to the proposed start-up (Paganini et al., 2018). This would contribute even to Goal n.6, "*Clean Water and Sanitation*" because it implicitly fosters sustainable farming and production practices that imply reasonable water usage. This, therefore, denotes a great commitment to Objectives 6.3 and 6.4. They state the 2030 goal as follows:

> "*Improve water quality by reducing pollution, eliminating dumping and minimizing the release of hazardous chemicals and materials."* This may be obtained by *"halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally* (…) *substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater."* These actions would help to *"address water scarcity and to substantially reduce the number of people suffering from it."* (United Nations, n.d.).

Satellites provide repeatable and objective observations of the water cycle, uniformly across regions and globally.

Finally, as reality proves that the health of ecosystems on which living beings depend is deteriorating ever more rapidly, Agenda2030 strongly aims at bringing radical changes to restore and protect nature. If this shift does not occur, there will be negative impacts for economies, food security and quality of life worldwide, making sustainable development an increasingly urgent path to take.

For these reasons, food and agriculture are central themes in the 2030 Agenda, as they heavily influence the degree of sustainability in different areas. They influence poverty and hunger emergencies, the protection of natural resources and climate change. Hence, FAO has been chosen as the Custodian Agency of several SDG indicators, with the responsibility to provide technical assistance and to keep track of progress towards some of the goals (Paganini et al., 2018).

Therefore, geospatial and satellite data, as we have seen in this chapter and across the entire text, are already contributing to several global sustainable goals, providing reliable and comparable information about the Planet in a unique way.

4. Conclusion

Many people wonder if we will achieve the Global Goals within the next nine years, whether we will be able to halt hunger, inequalities, and climate change. The United Nations have set the seventeen goals that we precisely discussed above, with 169 correlated targets, followed by hundreds of indicators. All of them commonly share some aspects that people in a society should have, for example, basic needs of survival, such as food, water, and safety, as well as an improved life through education, health, and a sustainable environment. The main goal is to experience considerable societal progress, even in those countries with a lower GDP. Agenda 2030 is the plan, but we need to hurry to achieve the desired outcomes. The success of the UN's 2001 "Millenium Development Goals" suggests that the Sustainable Development Goals may also be reached according to plan. The UN's 2001 goals were to be reached by 2015. The main target was to halve the number of people living in poverty, considering 1990 as the baseline, i.e., 36% of the world's population below the poverty threshold. In 2015 we did not get to 18% of poverty, which corresponds to half, but we exceeded that threshold to 12%. No doubt, the world still has plenty of problems to face, but this is proof that the world can succeed. This has been possible because of the economic growth characterizing many countries, such as China and India, where some of the more significant reductions in poverty have been registered. The importance of this is that it makes us understand that the Global Goals are not impossible to be achieved. They truly are an opportunity to solve the world's challenges radically. They should be believed in, and their progress tracked in the coming years. We should just continue to look for innovative tools to realize them and change business strategies and methods (Green, 2015). The combination of statistics, geospatial information, Earth Observations, together with innovative technologies and approaches are increasingly becoming a must-have for countries to monitor sustainable development policies and plans. They are evermore a requirement in different sectors, making real-time monitoring operations simpler, faster and more rigorous. Satellites increase

sampling quality by improving timeliness, precision, accuracy, reliability, and cost-effectiveness. Earth Observation datasets are increasingly necessary because they provide frequent coverage and repeated measurements. They offer unique and complementary information to verify the trustworthiness of in-situ data, complementing traditional statistical methods when something is missing. Furthermore, they produce richer spatial and temporal information by providing it on multiple scales up to the global. For this reason, it is possible to save time and money on traditional methods, and to make comparable measurements across different countries (Paganini et al., 2018). We have seen how Space Economy, for all the advantages it brings, is rapidly expanding, becoming accessible to all. Evidence of this is given by the great number of space agencies operating and planning to organize an increasing number of satellite missions. Countries have begun to cooperate to obtain commonly useful outcomes in harmony, integrating their observing systems. This supports hundreds of applications thanks to publicly available data, with the aim of improving citizens' lives and of dealing with Earth's everyday challenges. It leads to positive impacts in many sectors, offering the possibility to cut costs and increase earnings. It facilitates the reach of innovation and sustainability while answering people's needs and improving their lives.

In this project, we have even seen how technologies conceived for space can solve many issues on Earth, and we have seen how they can be the resolution both for economic and societal concerns. What is key for the implementation of all this, is rising citizens' awareness about current global concerns, about the importance of safeguarding our world, and about the fact that results will be obtained only through cooperation. International synergy is fundamental to protect outer space, but also to learn and grow, remembering that social cohesion, economic growth, and environmental protection must go hand in hand (UNOOSA, 2020).

Space Economy and Sky-I, therefore, would be examples of strategies to solve the world's issues. Leveraging Earth Observation, they make the implementation of the global indicators for the Sustainable Development Goals workable (Paganini et al., 2018). Space can be the driving force for sustainable growth and for transparency assurance, being a huge source of innovative solutions. Sky-I, in effect, would make all this possible, helping to enhance the efficiency of supply chain functioning, and benefiting the international ones (Scatteia, Frayling and Atie, 2020). Events around the world, even those happening far from your own business, can have an impact on our revenue and brand reputation.

Hence, having full supply chain information can be the key for companies needing more control over events in order to manage risks and prevent failures. Supply chain mapping enables companies to maintain solid business continuity and true and effective visibility along with all the steps. It is a way also to engage suppliers at every tier, increasing the action-oriented collaboration. This would reduce the probability of contingencies and would foster strong resistance to disruptions (Achilles, 2015). To be able to consider and judge a company as "sustainable", in fact, it is necessary to assess practically if it has a positive impact on all its stakeholders. Accordingly, Sky-I would be beneficial for sustainable investment managers who obtain evidence about companies' environmental performance by using satellite data. This is how supply chain transparency becomes the needed strategy to communicate a company's actions to stay competitive, to build trust and to gain consumer preference (Worldfavor, 2019). Moreover, this methodology would ease and guide decision-making, while revolutionizing various industries (Nestlé, 2019). In addition, another useful tactic would be, as Sky-I does, to reveal information reporting climate footprints directly on the products.

Sky-I's value proposition, therefore, would provide measurable ecological, societal, and economic value, answering different human needs and influencing both production and consumption systems. It is important to make a cost-benefit evaluation, understanding that what is important now, is to face the challenges, seeing space as an opportunity to foster sustainability on Earth. It would be a powerful source offering indisputable results, that would go beyond the reach of what a company reports about itself (Société Générale, 2020). Finally, in our current world, individuals and corporations will win only by recognizing the need for change, by accepting and adapting to it, while being able to keep up with the shifts of time and with constant innovation. It is important to create value and to succeed while respecting nature in all its aspects. As Francis Bacon once said, "*A wise man will make more opportunities than he finds*", this means that innovation can take place only if people recognize the possibility to introduce something new. Innovation is the basis for changes, improvements, and human progress.

What makes the difference is discovering potential tools that were previously hidden. Space technologies are an example of those promising tools with high capacity, that are not yet exploited to their full extent. Therefore, the ace in the hole must be the cleverness to think of the unprecedented, putting together different worlds, such as may be space and sustainability.

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